90-DAY REPORT OF MARINE MAMMAL MONITORING AND MITIGATION DURING A 2D SEISMIC SURVEY BY TGS-NOPEC GEOPHYSICAL COMPANY IN THE CHUKCHI SEA, AUGUST THROUGH OCTOBER 2013

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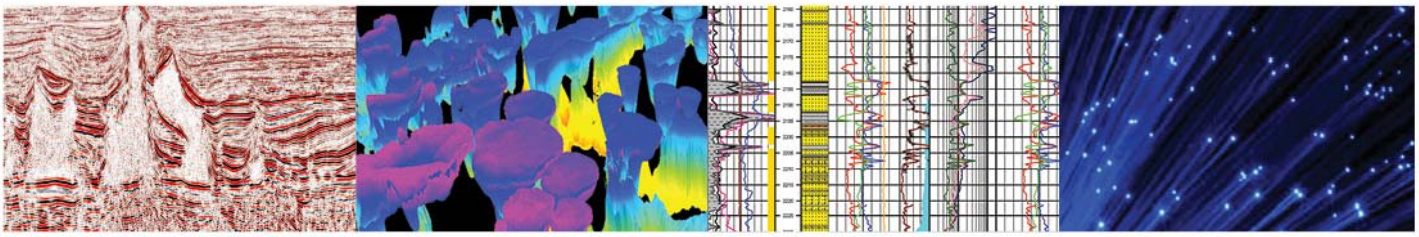

90-DAY REPORT OF MARINE MAMMAL MONITORING AND MITIGATION DURING A 2D SEISMIC SURVEY BY TGS IN THE CHUKCHI SEA, AUGUST THROUGH OCTOBER 2013

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Appendix I Beaufort sea state definitions
Appendix J Density from other Chukchi Sea studies

ABBREVIATIONS

°	degree(s)
µPa	micro Pascal
µPa@1m	micro Pascal at 1 meter
χ^2	Chi-square
2D	two-dimensional
3D	three-dimensional
4MP	Marine Mammal Monitoring and Mitigation Plan
AASM	airgun array source model
AEWC	Alaska Eskimo Whaling Commission
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASL	above sea level
BOEM	Bureau of Ocean Energy Management
CAA	Conflict Avoidance Agreement
CDS	Conventional Distance Sampling
CFR	Code of Federal Regulations
CI	confidence level(s)
cm^3	cubic centimeter
Com Center	Communication Center
CPA	Closest point of approach
CSESP	Chukchi Sea Environmental Study Program
CV	coefficients of variations
dB	decibel(s)
ESA	Endangered Species Act of 1973
FR	Federal Register
ft	feet/foot
G&G	Geological and Geophysical Permit
GPS	global positioning system
h	hectares
hr	hour
HSWUA	Hanna Shoal Walrus Use Area
Hz	Hertz
ID	identification
IHA	Incidental Harassment Authorization
in^3	cubic inch(es)
IWC	International Whaling Commission
JASCO	JASCO Applied Sciences
km	kilometer(s)
km^2	square kilometers
km/hr	kilometer per hour
L	length
LBCHU	Ledyard Bay Critical Habitat Unit

LOA	Letter of Authorization
m	meter(s)
mi	statute mile(s)
mi^2	square miles
MMPA	Marine Mammal Protection Act of 1972
MONM	Marine Operations Noise Model
M/V	Motor Vessel
n	number
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NSB	North Slope Borough
PAM	passive acoustic monitoring
PBSG	Polar Bear Specialist Group
POC	Plan of Cooperation
PSD	perpendicular sighting distance
psi	pounds per square inch
PSO	Protected Species Observer
re 1μPa	relative to 1 micro pascal
rms	root mean square
RPS	RPS Group Plc.
RSL	received sound levels
R/V	Research Vessel
Shell	Shell Gulf of Mexico Inc.
Statoil	Statoil USA Exploration and Production, Inc.
TGS	TGS–NOPEC Geophysical Company
SSV	sound source verification
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
W	width
WGS	World Geodetic System

CONVERSIONS

Metric	**Imperial**
1 m	3.281 ft
1 km	0.621 mi
16.387 cm^3	1 in^3

1.0 Introduction

In 2013, TGS-NOPEC Geophysical Company (TGS) conducted a two dimensional (2D) seismic survey in United States (U.S.) Federal and international waters of the Chukchi Sea. TGS was permitted to survey 9,425 kilometers (km) (5,856 miles [mi]) and acquired only 6,078 km (3,773 mi). Seismic lines surveyed in 2013 are shown in Figure 2-1. Project vessels departed Nome on 25 and 26 August, sound source verification (SSV) was conducted 28 to 30 August and seismic data acquisition began 29 August. TGS acquired 5,540 km (3,442 mi) of seismic lines (91%) of the 2013 seismic survey effort, in U.S. Federal waters and 538 km (334 mi). Seismic data acquisition concluded on 29 October and the project was completely demobilized on 31 October.

The purpose of this 90-day report is to describe TGS' 2013 seismic survey activities in the Chukchi Sea, the marine mammal monitoring and mitigation methods implemented and their results, and to provide an estimate of the number of marine mammals potentially exposed to levels of sound generated by the seismic activity.

The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) regulate activities that have the potential for auditory and behavioral disturbances that result in a "take" under provisions of the Marine Mammal Protection Act of 1972 (MMPA) and the Endangered Species Act of 1973 (ESA).

NMFS issued TGS an Incidental Harassment Authorization (IHA) on 14 August 2013 to allow for the incidental take, by Level B harassment, of small numbers of whales and seals in conjunction with the 2D seismic program. As the federal agency with jurisdiction over Pacific walrus and polar bear, USFWS issued TGS a Letter of Authorization (LOA) on 28 June 2013 for the incidental taking of small numbers of polar bear and walrus in conjunction with the 2D seismic program.

A Marine Mammal Monitoring and Mitigation Plan (4MP) was developed and implemented in compliance with the issued IHA and LOA to minimize impacts to marine mammals during seismic survey activities. The 4MP required TGS to employ Iñupiat and scientific Protected Species Observers (PSOs) for the visual-based monitoring program on the two project vessels: the seismic vessel (Motor Vessel [*M/V] Geo Arctic*) and the monitoring vessel (Research Vessel [*R/V] Norseman*). The PSOs monitored marine mammals and implemented mitigation (e.g., shut down) if a marine mammal approached or entered the appropriate exclusion zone: 190 decibels (dB) relative to 1 micro pascal (re 1µPa) root mean square (rms) for pinnipeds and 180 dB re 1µPa (rms) for cetaceans. A towed passive acoustic monitoring (PAM) system was deployed from the monitoring vessel to augment the visual monitoring program.

TGS developed a Plan of Cooperation (POC) in accordance with Title 50, Code of Federal Regulations, Part 216.104(a)(12) (50 CFR 216.104[a][12]) for the IHA and 50 CFR 18.124 for the Letter of Authorization (LOA). If TGS activities took place in or near traditional arctic subsistence hunting areas and had the potential to affect the availability of a species or stock of marine mammals for subsistence use, the POC identified the measures TGS would take to minimize adverse impacts to the availability of marine mammals for subsistence use. TGS met with a number of marine mammal co-management groups; community and leadership in Barrow, Wainwright, Point Lay, Point Hope, and Kotzebue; the Alaska Eskimo Whaling Commission (AEWC); and the North Slope Borough (NSB) Planning Commission and Department of Wildlife Management to discuss proposed activities, when and where they were to occur, and the mitigation measure proposed. TGS also signed the AEWC's 2013 Conflict Avoidance Agreement (CAA), which outlines mitigation measures specific to avoiding conflict with the bowhead whale hunt and participated in the 2013 Communication Center (Com Center) Program.

A description of seismic survey activities and equipment and the methods and results of the 4MP are included in this 90-day report. This report includes five sections:

1. Introduction (this section)
2. Project Description;
3. Summary of marine mammals in the project survey area;
4. Overview of marine mammal monitoring and mitigation program; and
5. Marine mammal monitoring analysis methods and results.

There are 10 appendices attached to this 90-day report, including PSO observation data for further information, relevant documents and field procedures, data analysis and marine mammal monitoring, and mitigation results. The appendices include:

A. JASCO Applied Sciences (JASCO) 5-day SSV and final SSV report
B. Weekly marine mammal sighting maps
C. RPS Group Plc. (RPS) passive acoustic monitoring report
D. A copy of the NMFS issued IHA, U.S. Fish and Wildlife Service (USFWS) issued LOA, and Bureau of Ocean Energy Management (BOEM) issued Geological and Geophysical (G&G) for TGS
E. The 2013 AEWC CAA
F. Sighting table
G. Vessel specifications
H. Stranding reports
I. Beaufort sea state definitions
J. Density estimates from other Chukchi Sea studies

2.0 Summary of the 2013 TGS Chukchi Sea 2D Seismic Survey Project Description

The purpose of the 2013 TGS 2D seismic program was to acquire new seismic data and supplement existing Chukchi Sea datasets by using newer, higher-quality technology. Existing data are from the Lease Sale Area 193, collected in the Chukchi Sea in the 1980s and 2000s. New data were acquired by TGS inside the lease area, outside of the lease area to the north and in international waters. These new data will provide an increased and broad understanding of the geologic structures over this large region, including potential hydrocarbon reserves. Figure 2-1 shows the 2013 planned seismic survey and Figure 2-2 shows the seismic survey lines acquired.

2.1 Project Details

During the seismic survey, low-frequency pulsed sound were emitted at regularly spaced intervals while the seismic airguns were operating. The sound travels mostly downward, penetrating the seafloor, before it is reflected back to the surface and received by a hydrophone. Portions of this sound energy are lost through horizontal propagation and therefore may be detected at various distances from the source. Although sound intensity decreases with increasing distance from the source, pulses may be strong enough to be detected at distances of up to 50 to 100 km (31 to 62 mi) from the source if ambient sound levels are low (Burgess and Greene 1999). Most seismic airgun sounds occur at frequencies below 200 hertz (Hz) near the source, but can extend to around 2,000 Hz or more, potentially overlapping with the hearing ranges of species that communicate at lower frequencies. In baleen whales, which communicate in low frequencies (e.g., bowhead whales), seismic sounds have been documented to cause avoidance or other behavioral reactions. The largest documented avoidance distance to date is 20 to 30 km (12 to 19 mi) from the source (120 dB re 1 μPa) (Richardson 1999). Toothed whales, though believed to be less sensitive to low-frequency sounds, are thought to detect sound to a distance of 10 to 20 km (6 to 12 mi) (LGL 2006).

The MMPA explains a disturbance due to seismic activities can occur when marine mammals near the survey change their behavior as a result of the sound. Any disturbance or behavioral reaction is dependent on multiple factors: species, the animal's activities at the time of exposure, distance from the sound source and received level of sound. TGS received an IHA from NMFS, authorizing the incidental take, or Level B harassment, of small numbers of marine mammals during their 2013 2D seismic program. Species authorized for Level B takes under the IHA included: beluga whales (*Delphinapterus leucas*), harbor porpoises (*Phocoena phocoena*), killer whales (*Orcinus orca*), bowhead whales (*Balaena mysticetus*), gray whales (*Esrichtius 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*).

Additionally, TGS applied for and received a LOA from the USFWS to allow for the incidental taking of small numbers of polar bears (*Ursus maritimus*) and Pacific walruses (*Odobenus rosmarus divergens*). TGS deployed PSOs to monitor marine mammals during project activities aboard all project vessels as part of the mitigation measures required in the issued IHA and LOA. Both permits are provided in Appendix D.

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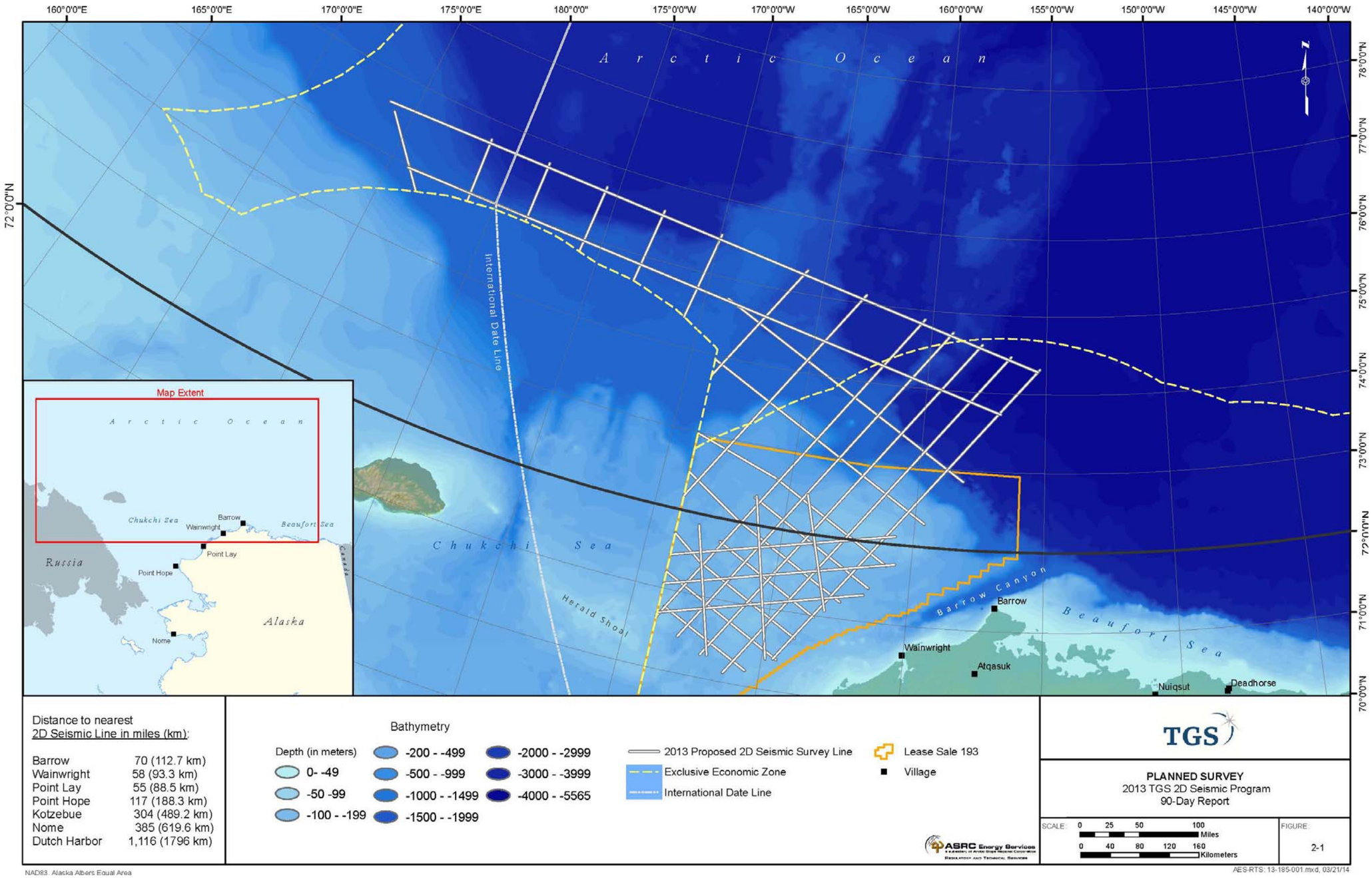

Figure 2-1. Planned Survey

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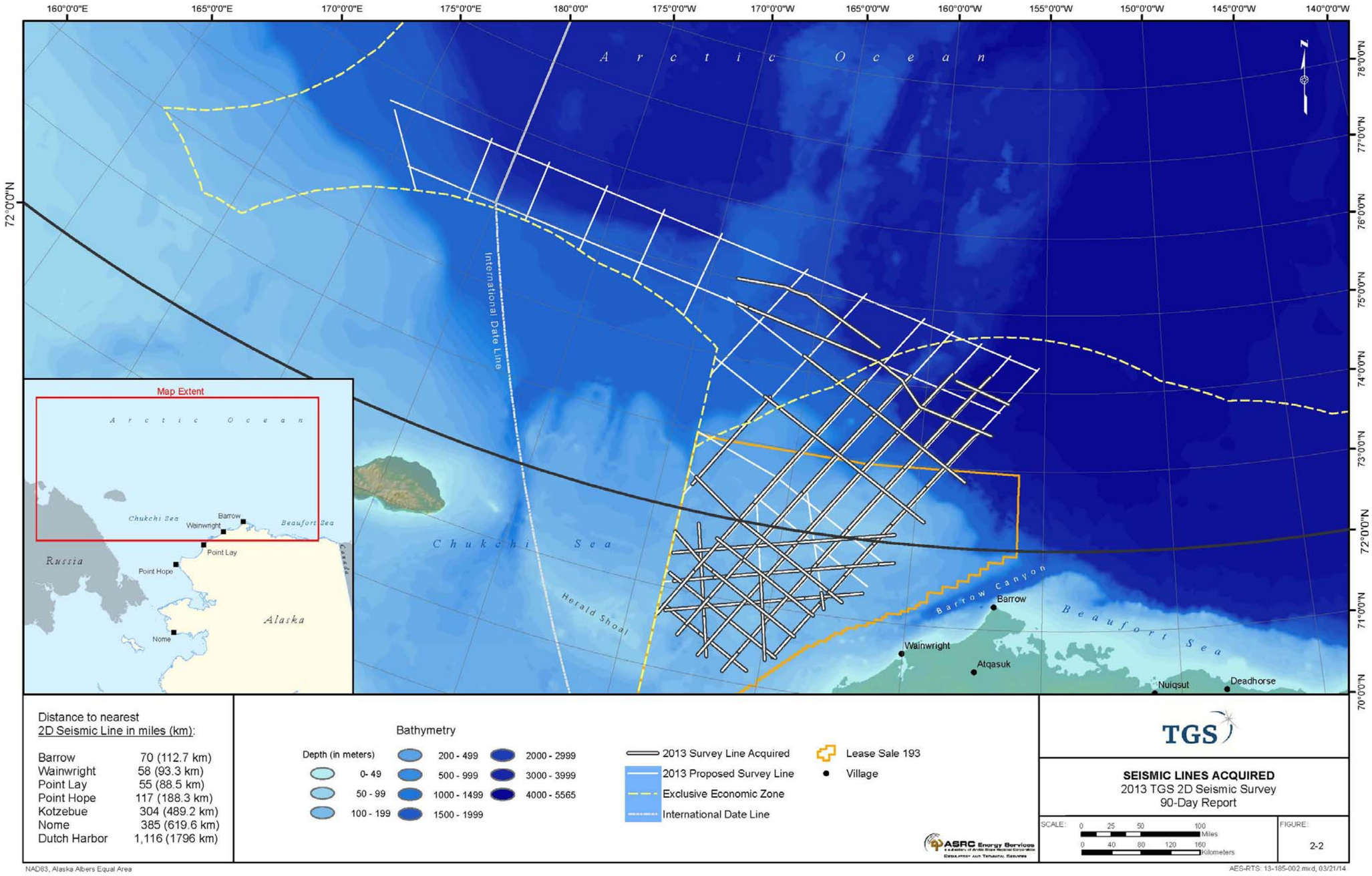

Figure 2-2. Seismic Lines Acquired

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The following sections further describe the components of the TGS 2013 2D seismic program.

2.1.1 Dates, Duration, and Region of Activity

The IHA TGS received from NMFS was valid for activities from 14 August through 31 October 2013. The vessels arrived in Nome, Alaska in mid-August: the *Geo Arctic* from Russia and the *Norseman* from Seward, Alaska. The vessels departed Nome 25 to 26 August and deployment of seismic gear began 27 August. SSV was conducted by JASCO 28 to 30 August. Data acquisition began on 29 August and concluded on 29 October. On 30 October, both vessels transited to Nome and the project was completely demobilized 31 October.

The approximate boundaries of the TGS program were from 70 degrees north (°N) to 75°N and from 156 degrees west (°W) to 179°W. The project area included U.S. Federal and international waters of the Chukchi Sea, including the Lease Sale Area 193 (Figure 2-1).

2.1.2 Source Arrays and Gear Deployment

Two vessels were used for the 2013 TGS 2D seismic survey; the *Geo Arctic* and the *Norseman*. The *Geo Arctic* deployed an airgun array of 3,280 cubic inches (in^3) at a depth of approximately 6 meters (m) (20 feet [ft]). The *Geo Arctic* also towed an 8.1 km (5 mi) streamer of hydrophone receivers at a depth of approximately 10 m (33 ft). This setup is referred to as a towed array and allows for the creation of a 2D image of sub-seafloor geologic structures. In contrast to three dimensional (3D) seismic, which uses multiple hydrophone streamers to produce more detailed 3D images, 2D seismic only requires towing one streamer. 3D seismic also requires the tracklines to be closer together than 2D. 2D seismic vessels generally do not need support vessels for gear deployment, recover or data acquisition. The *Norseman*, was used primarily as a monitoring vessel and as support for crew changes.

The complete airgun array totaled 3,280 in^3 discharge volume and comprised of 40 airguns (26 active, 14 spare) with individual volumes ranging from 40 in^3 to 250 in^3. Within the large array, there were four sub-arrays, each comprised of 9 or 11 guns, including spares. The peak sound pressure level of the 3,280 in^3 array was approximately 247.6 dB re 1 µPa. The arrays were towed 86.5 m (284 ft) behind the source vessel at a depth of approximately 6 m (20 ft). The *Geo Arctic* traveled along predetermined permitted lines at an average speed of 8.5 kilometers per hour (km/hr) (4.6 knots). During seismic activity, shots were fired approximately every 8 to 12 seconds equaling 40 pulses per km (64 pulses per mi). When conditions allowed, seismic operations were conducted 24 hours per day. Table 2-1 summarizes the specifications of the vessel and airgun array.

Table 2-1. Vessel and airgun specifications

Description	Array Parameters
Distance of observer to stern	69.25 m
Array offset from stern	86.5 m
Total array volume	3,280 in^3
Number of airguns	40 airguns (40-250 in^3), divided over 4 sub-arrays of 9-11 airguns each (26 active, 14 spare)
Zero-to-Peak	247.6 dB re1 µPa@ 1m
Peak-to-Peak	261.6 dB re1 µPa@ 1m
rms pressure	2,000 psi
Frequency (Hz-kHz range)	10-2,000 Hz

in^3 = cubic inches, psi = pounds per square inch,
dB re1 µPa@ 1m = decibels relative to 1 microPascal at 1 meter,
Hz = hertz
Hz-kHz = hertz to kilohertz
m = meter
psi = pounds per square inch
rms = root mean square,

2.1.3 Receivers and Recording Units

The receivers consisted of Sercel Flexible Hydrophones with recorder units placed on a Sercel streamer trailing behind the *Geo Arctic*. The 8,100 m (2,657 ft) hydrophone streamer began 174 m (571 ft) behind the vessel and was towed at an approximate depth of 10 m (33 ft). The system automatically rerouted data on an alternate transmission line if an interruption occurred in active sections. Redundancy was also carried in the power delivery system with two independent pairs; the system continually supplied power regardless of other potential issues.

2.1.4 Survey Design

TGS' 2013 2D seismic program was designed to minimize impact to the environment, subsistence hunts, marine mammals, birds, and other fauna. The source vessel towed both the airgun array and the hydrophone streamer and traveled along lines covering 6,072.8 km (3,773.46 mi) of the 9,423.99 km (5,855.79 mi) permitted (see Figures 2-1 and 2-2). Survey lines were designed in a grid pattern; situated in a northeast to southwest direction (mean 106 km [66 mi] per line) and perpendicularly northwest to southeast (mean 110 km [68 mi] per line). The southern section of the Lease Sale Area 193 contained east-northeast to west-southwest diagonal lines (mean 99 km [62 mi] per line) and north northwest to south-southeast (mean 83 km [52 mi] per line). The seismic survey extended approximately 74 km (46 mi) north and west of the Lease Sale Area 193 until ice was encountered limiting the northward movement.

The *Norseman* traveled on average approximately 7.5 km (4.7 mi) ahead of the *Geo Arctic* in a zigzag pattern to assist in localization of acoustic detections. The *Norseman's* primary purpose was to visually and acoustically monitor the 160, 180, and 190 dB re 1 µPa (rms) exclusion zones.

2.1.5 Vessels and Other Equipment

The *Geo Arctic* was operated by Sevmorneftegeofizika and the *Norseman* was operated by Norseman Maritime Charters. The *Norseman* operated in advance of the *Geo Arctic* to monitor for marine mammals during all seismic activity. The *Geo Arctic* arrived in Nome from Russia and the *Norseman* transited from Seward, Alaska to Nome in mid-August. All major equipment needed for seismic acquisition and marine mammal monitoring (e.g. airguns, PAM) was loaded on both vessels prior to their arrival in Nome. The two project vessels and brief specifications are summarized in Table 2-2 and complete specifications are provided in Appendix G.

Table 2-2. Vessel names, dimensions, and activities used for the TGS 2D seismic program

Vessel Name Type	Dimensions (m) L x W	 Draft	Dimensions (ft) L x W	 Draft	Purpose
Geo Arctic Seismic Vessel	81 x 15	5	266 x 49	17	Seismic Data Acquisition
Norseman Research Vessel	33 x 9	4	108 x 28	13	Monitoring

L = length
W = width

3.0 Summary of Marine Mammals in Project Area

The purpose of this section is to provide a summary description of the marine mammals found in the project area and to briefly describe those species occasionally documented in the larger region. Thirteen marine mammal species, falling under NMFS jurisdiction, have been documented in the Chukchi Sea. Twelve of the thirteen species have been documented within the planned seismic survey area (Figure 2-1). The six most common species are the bowhead whale, gray whale, beluga whale, bearded seal, ringed seal, and spotted seal. Of these six, three are protected under the Endangered Species Act of 1973 (ESA): the bowhead whale is endangered and the ringed and bearded seals are threatened (75 Federal Register [FR] 77476, 75 FR 77496).

The less common species falling under NMFS jurisdiction and occasionally documented in the Chukchi Sea are the humpback whale, fin whale, minke whale, harbor porpoise, killer whale, ribbon seal, and the narwhal (*Monodon monoceros*). The narwhal is the only species not documented within the project area boundary, and is not discussed further in this document. Two of the less common species, humpback and fin whales, are protected under the ESA and listed as endangered.

Two marine mammal species falling under USFWS jurisdiction have been documented within the project area boundary: the Pacific walrus and the polar bear. The Chukchi and Bering Sea stocks of polar bear are listed as threatened under the ESA and depleted under the MMPA.

All of these marine mammal species are protected under the MMPA. The general status, distribution, and seasonal occurrences of the 12 species known to occur within the project area boundary are discussed below.

3.1 Bowhead Whale

The Western Arctic stock is the largest of four bowhead stocks globally recognized by the International Whaling Commission (IWC) (Allen and Angliss 2012; IWC 2010). The stock is found throughout the Bering, Chukchi, and Beaufort seas and is classified as federally endangered under the ESA (35 FR 18319). No critical habitat has been designated.

The Western Arctic stock winters in the Bering Sea. From March through June, the stock migrates north and east across the Chukchi Sea following open ice leads to summer and feed in the Canadian Beaufort Sea (Allen and Angliss 2012; Braham et al. 1980; Braham et al. 1984; Moore and Reeves 1993; Rugh et al. 2003; Quakenbush et al. 2010a, b). In the fall, these bowhead whales migrate back west past Barrow and through the northern Chukchi Sea, in both U.S. and Russian waters, before turning southeast toward the Bering Sea (Mate et al. 2000; Moore et al. 1995; Quakenbush et al. 2010a).

Over the last four decades, the Western Arctic stock has been documented to be steadily increasing in numbers. George et al. (2004) reported the stock increased at a rate of 3.4% from 1978 to 2001. During this period, abundance doubled from roughly 5,000 to 10,000 whales (LGL 2012). The Western Arctic stock was recently estimated at 16,892 whales, with a population growth rate of 3.7% (Givens et al. 2013).

3.2 Gray Whale

The Eastern North Pacific gray whale stock ranges from the Bering, Chukchi, and Beaufort seas in the summer to the Gulf of California in the winter (Moore et al. 2003; Nerini 1984; Rice 1998; Rice and Wolman 1971). Most of the stock makes a round-trip annual migration of over 8,000 km (4,970 mi) from

Alaska feeding waters to breeding and calving waters in Baja California, Mexico (Allen and Angliss 2012; Rice and Wolman 1971; Rice et al. 1981). From late May to early October, the majority of the population feeds in the northern and western Bering and Chukchi seas. Typically, gray whales inhabit shallow water, remaining closer to shore than any other large cetacean throughout the year. As a result, they are considered common summer residents in the nearshore waters of the eastern Chukchi Sea.

Like all large whale populations, this stock was once hunted to near extinction by commercial whalers. The stock has since recovered significantly and was removed from the ESA in 1994. The population is currently estimated at 19,126 whales (Allen and Angliss 2013; Laake et al. 2009).

3.3 Beluga Whale

Of the five beluga stocks occurring in Alaska (Allen and Anglis 2012; O'Corry-Crowe et al. 1997), the Eastern Chukchi Sea and Beaufort Sea stocks have been documented within the project area boundary, though most individuals will likely be from the Eastern Chukchi Sea stock. Both stocks overlap in the Beaufort Sea and winter in the Bering Sea (Allen and Angliss 2012; Suydam et al. 2001). Much of the Eastern Chukchi Sea stock breeds in Kasegaluk Lagoon in June and July.

The current abundance estimate for the Eastern Chukchi Sea stock is 3,710 (DeMaster et al. 1998; Lowry and Frost 2002), though a complete abundance estimate for this stock is not available (Allen and Angliss 2012). The current population trend of the Beaufort Sea stock is not in decline and is estimated to be 39,258 whales (Allen and Angliss 2012; Frost et al. 1993). The Eastern Chukchi Sea and Beaufort Sea stocks are not listed under the ESA. Based on combined data, sighting rates of belugas and numbers of individuals were highest within 26 to 35 km (16 to 22 mi) of the Chukchi Sea coast.

3.4 Fin Whale

Fin whales in the North Pacific are considered as a single stock, according to the IWC (Mizroch et al. 1984). However, for management purposes, three stocks of fin whales are recognized in U.S. waters: Alaska (Northeast Pacific), California/Washington/Oregon, and Hawaii. Fin whales occur seasonally off the coast of North America and the Bering Sea in the summer (Allen and Angliss 2012; Stafford et al. 2007). Fin whales in the Bering Sea belong to the Northeast Pacific stock.

Fin whales are listed as endangered under the ESA and depleted under the MMPA. The population for the entire North Pacific region was estimated at 1,652 in 2006 (Zerbini et al. 2006). However, reliable estimates of current and historical abundance for the entire Northeast Pacific fin whale stock are currently not available (Allen and Angliss 2012). Recent studies provide information on distribution and occurrence of fin whales, but do not provide population size estimates. Fin whale abundance estimates are nearly five times higher in the central-eastern Bering Sea than the southeastern Bering Sea (Moore et al. 2002). Most sightings in the central-eastern Bering Sea occurred in a zone of particularly high productivity along the shelf break (Allen and Angliss 2012; Moore et al. 2000).

3.5 Humpback Whale

Relatively few humpback whales have been documented in the Chukchi Sea. Though the stock origin of the documented humpback whales remains unknown, they likely belong to the Central North Pacific stock (Allen and Angliss 2012; Funk et al. 2010) or the Western North Pacific stock (Hashagen et al. 2009). The Western North Pacific stock distribution extends into the southwestern Chukchi Sea during the summer feeding period (Allen and Angliss 2012; Baker et al. 1990; Calambokidis et al. 1997; Perry et al. 1990). While humpback whales have been known to feed periodically in the southern Chukchi Sea

(Allen and Angliss 2012; Johnson and Wolman 1984; Mel'nikov 2000; Nemoto 1957; Tomlin 1967; Zenkovich 1954), they are considered extralimital in the northern Chukchi Sea.

Humpback whales are listed as endangered under the ESA and designated as depleted under the MMPA. The most recent population estimate for the Central North Pacific stock is 6,000-14,000 (Allen and Angliss 2012; Barlow et al. 2011; Calambokidis et al. 2008). The Central North Pacific and Western North Pacific stocks are known to mix and the best bias-corrected estimate for the entire North Pacific Basin is 20,800 whales (Allen and Angliss 2013; Barlow et al. 2011).

3.6 Killer Whale

Of the eight recognized killer whale stocks in the Pacific, the trans-boundary Alaska Resident stock is the only stock documented within the project area boundary. Killer whales inhabit all Alaskan waters (Braham and Dahlheim 1982), although they are considered rare in the Chukchi Sea. Killer whales are most common in cooler coastal waters in both hemispheres, appearing in greatest numbers within 800 km (497 mi) from continental coasts (Forney and Wade 2006; Leatherwood and Dahlheim 1978; Mitchell 1975). Sightings near Point Barrow have coincided with the bearded seal migration, which may attract killer whales so far north.

Based on recent NMFS stock assessments, the Alaska Resident stock consists of an estimated 2,347 killer whales (Allen and Angliss 2013; Matkin et al. 1999; Matkin et al. 2003; Matkin et al. *in prep*). Killer whales, including the Alaska Resident stock, are not listed as protected under the ESA or as depleted under the MMPA.

3.7 Harbor Porpoise

The Bering Sea stock of harbor porpoises ranges as far north as Point Barrow (Suydam and George 1992), most frequently in waters less than 100 m (328 ft) deep (Allen and Angliss 2012; Waite and Hobbs 2010). Harbor porpoises are small cetaceans, generally inhabiting shallow, coastal waters (Dahlheim et al. 2000, 2009; Gaskin 1984). Records of harbor porpoises within the project area boundary are minimal.

The most recent abundance estimate for the Bering Sea stock, based on aerial surveys conducted by National Marine Mammal Laboratory (NMML) in Bristol Bay, is approximately 48,000 animals (Allen and Angliss 2012; Barlow et al. 1988; Wade and Angliss 1997). These estimates are considered conservative, but are higher than an earlier estimate of 11,000 by Dahlheim et al. (2000).

3.8 Ringed Seal

Ringed seals of the Alaska stock are the most abundant marine mammals in the Beaufort, Chukchi, and Bering seas (Frost et al. 1988; Funk et al. 2010; Kelly et al. 2010). In the North Pacific, ringed seals inhabit the southern Bering Sea and range as far south as the seas of Okhotsk and Japan (Allen and Angliss 2012; Harwood and Stirling 1992). Ringed seals are year round residents in the Beaufort, Chukchi, and Bering seas and extend as far south as Bristol Bay in years of extensive ice coverage. They tend to prefer large ice floes (i.e., over 48 m [157 ft] in diameter) and often inhabit interior pack ice where sea ice coverage is over 90% (Kelly et al. 2010; Simpkins et al. 2003). Ringed seals remain in contact with ice most of the year and pup on ice late winter through early spring (Allen and Angliss 2012; Frost 1985).

The previous Chukchi Sea population of ringed seals was estimated to number 250,000 seals (Allen and Angliss 2012; Frost et al. 2002), but a more recent number from combined Beaufort and Chukchi sea

surveys yielded an estimate of at least 300,000 individuals (Allen and Angliss 2013; Kelly et al. 2010). However, there is currently no reliable information on population abundance or trends of ringed seals for the entire Alaska stock (Allen and Angliss 2012). Ringed seals have recently been listed as threatened under the ESA and as depleted under the MMPA. No critical habitat area has been designated.

3.9 Spotted Seal

Spotted seals inhabiting the Chukchi Sea belong to the Alaska stock (Allen and Angliss 2012). Spotted seals are coastal pinnipeds that summer in nearshore areas in the Chukchi Sea and winter along the ice edge in the Bering Sea (Lowry et al. 1998; Quakenbush 1988; Simpkins et al. 2003). During summer months, ringed seals haulout on sand spits in bays and lagoons in the Bering and Chukchi seas, with some animals ranging into the Colville River delta (Rugh et al. 1997; Lowry et al. 1998).

A reliable abundance estimate for the Alaskan stock of ringed seals is not currently available (Allen and Angliss 2012; Boveng et al. 2009). However, Ver Hoef et al. (*in press*) used aerial survey data, modeled ice distributions and seal haulout locations to derive an estimate of 141,479 spotted seals (Allen and Angliss 2013). Spotted seals are not listed as threatened or endangered under the ESA or as depleted under the MMPA.

3.10 Bearded Seal

The Alaska stock of bearded seals is the second most common seal species in the Chukchi Sea (Allen and Angliss 2012; Laidre et al. 2008). Bearded seal distribution is dictated by the presence of ice. They feed mainly on the seafloor and are thus rarely found in water depths they cannot effectively access (i.e., more than 200 m [656 ft]) (Allen and Angliss 2012; Burns 1981). Bearded seals winter along the ice front in the Bering Sea and move north in the spring with the receding ice edge (Allen and Angliss 2012; Burns 1981; Burns and Harbo 1972; Moulton and Lawson 2002). During summer, bearded seals occur in both the Chukchi and Beaufort seas in areas of high ice coverage along the pack ice edge (Bengston et al. 2000; Burns et al. 1981; Simpkins et al. 2003).

A reliable abundance estimate for the Alaska stock of bearded seals is not available (Allen and Angliss 2012). The most recent surveys occurred May through June of 1999 and 2000 between Shishmaref and Barrow with average densities between 0.07 and 0.14 seals per square kilometer (km^2) (approximately 2.6 square miles [mi^2] per km^2), respectively. Early estimates of the Bering-Chukchi population ranged from 250,000 to 300,000 (Burns 1981), but the best recent estimate is about 155,000 individuals (Allen and Angliss 2013; Cameron et al. 2010). Bearded seals have recently been listed as threatened under the ESA and as depleted under the MMPA. No critical habitat area has been designated for this species.

3.11 Ribbon Seal

Ribbon seals occurring in the Chukchi Sea belong to the Alaska stock (Allen and Angliss 2012). Ribbon seals inhabit the North Pacific Ocean and adjacent parts of the Arctic Ocean. In Alaskan waters, ribbon seals primarily inhabit the open sea on pack ice, also rarely inhabiting shorefast ice (Allen and Angliss 2012; Kelly 1988). As the ice recedes in May to mid-July, ribbon seals move into the Bering Sea, hauling out on the receding ice edge and remnant ice (Burns 1970; Burns 1981; Burns et al. 1981). There is little known about the range of ribbon seals during the rest of the year. Recent sightings suggest many ribbon seals migrate into the Chukchi Sea for the summer (Allen and Angliss 2012; Kelly 1988). Satellite tag data from 2005 and 2007 suggest ribbon seals disperse widely (Allen and Angliss 2012; Boveng et al. 2008).

A reliable abundance estimate for the Alaska stock of ribbon seals is currently not available (Allen and Angliss 2012). However, Ver Hoef et al. (*in press*) used aerial survey data, modeled ice distributions and seal haulout locations to derive an estimate of 61,100 ribbon seals (Allen and Angliss 2013). Ribbon seals are not listed as threatened or endangered under the ESA or as depleted under the MMPA.

3.12 Minke Whale

Minke whales are baleen whales found in coastal and offshore waters, including along ice floes and pack ice. Their normal range is limited to the Gulf of Alaska north to the Bering and Chukchi seas, where they are considered relatively common (Allen and Angliss 2012; Mizroch 1991). Minke whales are known to penetrate loose ice during the summer, with some individuals venturing north of the Bering Strait (Allen and Angliss 2012; Leatherwood et al. 1982).

The population of minke whales in Alaska is unknown and there is insufficient data to determine population trends for this stock, but the best estimate is 810 whales (Moore et al. 2002). This is a minimum estimate because only a portion of the stock's range was accounted for (Allen and Angliss 2012). Minke whales are not listed as threatened or endangered under the ESA or as depleted under the MMPA.

3.13 Pacific Walrus

Pacific walruses are protected by the MMPA under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) and are not currently listed under the ESA, but they are considered a candidate species. Pacific walruses extend from the Bering and Chukchi seas to the Beaufort and East Siberian seas (USFWS 2013). The current size of the Pacific walrus population is unknown, but the best available minimum population estimate from aerial surveys is approximately 129,000 individuals (Speckman et al. 2011). This is considered an underestimate because many areas could not be surveyed due to poor weather (USFWS 2013). In 2013, USFWS introduced the Hanna Shoal Walrus Use Area (HSWUA), to limit specific activities within the Hanna Shoal foraging grounds (defined in Jay et al. 2012) during prime foraging months of July through September (see LOA in Appendix D).

3.14 Polar Bear

Polar bears are protected by the MMPA under the jurisdiction of the USFWS. Due to a determination by the USFWS that polar bear habitat, particularly sea ice, is declining, the polar bear was listed as threatened under the ESA in 2008 (USFWS 2008a). As a result of a 2013 U.S. District Court decision, there is currently no critical habitat designated for the polar bear.

Two polar bear stocks exist in Alaska and population estimates for both have a high uncertainty: the Bering/Chukchi Sea stock has a population of >2,000 bears (Walton et al. 2013) and the Southern Beaufort Sea stock has a population of 1,526 bears (Regehr et al. 2006). A recent study that compared diet, body condition and recruitment between stocks indicated the Chukchi/Bering Sea stock may be in better condition than the Southern Beaufort Sea stock (Rode et al. 2013). The worldwide abundance estimate of polar bears is between 22,000 to 32,000 animals (Polar Bear Specialist Group [PBSG] 2014).

4.0 Marine Mammal Monitoring and Mitigation Program Summary

This section describes measures implemented through TGS' 4MP to address and supplement requirements specified in the NMFS issued IHA and USFWS issued LOA for TGS' 2013 2D seismic survey. Copies of both permits can be found in Appendix D. All data related to SSV and acoustic monitoring and measurements are contained in Appendices A and C. Section 5 provides a detailed summary of data analysis methods and results of the marine mammal monitoring and mitigation program.

4.1 Purpose

Vessel based monitoring and mitigation was designed to avoid and minimize sound exposure to marine mammals, prevent conflict with subsistence species and users, and ensure documentation of potential effects on marine mammals through compliance with provisions of the IHA, LOA, and CAA. PSOs onboard both vessels were tasked with both monitoring and mitigation.

- Monitoring: Record data in reference to marine mammals both during seismic operations and inactive periods, particularly the number of marine mammals present and reactions of the animals, if any.
- Mitigation: Identify marine mammals within or approaching the associated exclusion zone and initiate mitigation actions as appropriate.

4.2 Mitigation Measures

Mitigation measures implemented during the 2013 TGS 2D seismic survey are summarized in sections 4.2.1 and 4.2.2. These were implemented during all seismic operations (including operations in international waters), during mobilization, demobilization, and during all support operations for the project.

4.2.1 General Mitigation Measures

PSOs had the authority and responsibility to call for appropriate mitigation measures while aboard TGS vessels throughout the duration of the 2013 TGS 2D seismic survey. TGS adhered to all mitigation measures during the entirety of their program.

Specific mitigation measures implemented in accordance with the IHA and LOA issued to TGS, as applicable, included:

- Speed alterations in order to avoid marine mammals or subsistence activities, provided that doing so did not compromise operational safety. This included reducing vessel speeds to 5 knots or less within 274 m (900 ft) of whales and reducing vessel speeds in conditions of poor visibility.
- The vessels were operated in a manner in which to avoid causing marine mammals, specifically whales, to make multiple changes in direction.
- Groups and concentrations of whales were avoided, vessels operated at a maximum distance possible from such groups. The vessels were operated in a manner to avoid separating individuals in a group of whales.
- PSOs alerted the crew and/or seismic airgun operators to the presence of marine mammals so appropriate mitigation measures (i.e., power downs, shut downs, and ramp ups) could be initiated.

- The seismic source was initiated (i.e., powered on) from a cold start (i.e., no active airguns) only during daylight after the full 180 dB re 1 μPa (rms) zone was visible and clear of marine mammals for 30 minutes immediately prior to initiation, or as otherwise stipulated in the IHA and/or LOA.
- Vessels did not approach:
  - within 0.8 km (0.5 mi) of polar bear and walrus on ice;
  - within 1.6 km (1 mi) of groups of walruses on land; or
  - within 0.8 km (0.5 mi) of polar bears on land.
- Vessels did not transit through the Ledyard Bay Critical Habitat Unit (LBCHU), except in the event of an emergency. Refer to the BOEM's G&G permit in Appendix D, for more information about the LBCHU.
- Restrictions to vessel presence in the HSWUA during the 2013 open water season were implemented by USFWS. The designated areas were monthly average forage and occupancy utilization distributions and present the probability walrus would have been using the area. Restricted area boundaries were provided by USFWS and adhered to by TGS. Real-time monitoring conducted by the United States Geological Survey (USGS), USFWS, and National Oceanic and Atmospheric Administration (NOAA) provided general location and movement data of walruses during August through September. Based on walrus movements, TGS agreed to communicate their survey plans to USFWS to further avoid interactions (see letter from USFWS dated 11 September 2013 in Appendix D).

4.2.2 Seismic Survey Mitigation Measures

4.2.2.1 Exclusion Zones and Zones of Influence

Current NMFS and USFWS guidelines define "exclusion radii", hereafter referred to as exclusion zones, for marine mammals around industrial sound to be 180 dB re 1 μPa (rms) for cetaceans and walruses and 190 dB re 1 μPa (rms) for pinnipeds and polar bears. The 160 dB re 1 μPa (rms) radius is known as the zone of influence in the IHA, but is hereafter referred to as the monitoring zone; individual animals may be in this area, however, mitigation (e.g., power down) was required if a group of 12 or more walruses was seen in this zone.

The monitoring zone guidelines are in place to minimize disturbance or behavioral effects on marine mammals and are based on the assumption that sound energy at lower received levels will not impair marine mammals' abilities to hear, but higher received levels may have such effect.

The acoustic source level of the 3,280 in^3 seismic source array was predicted in pre-season 2013 using JASCO's airgun array source model (AASM) based on data collected from three sites chosen in the project area by JASCO (Appendix A). Water depths at the three sites were 17, 40, and 100 m (56, 131, and 328 ft). JASCO applied its Marine Operations Noise Model (MONM) to estimate acoustic propagation of the seismic source array and the associated distances to the 190, 180, and 160 dB re 1 μPa (rms) isopleths relative to standard NMFS mitigation and monitoring requirements for marine mammals. The resulting isopleths modeled for the exclusion zones, differed with the three water depths. An additional 10% distance buffer was added by JASCO to these originally modeled distances to provide larger, more conservative exclusion zone radii distances (Table 4.2-1).

Upon arrival to the project area, sound source levels for the equipment were measured to verify pre-season models, otherwise known as SSV. The SSV measurements are shown in Table 4.2-1.

The actual radii measured during the 2013 SSV were equal to or smaller than the radii modeled for the 2013 IHA, therefore JASCO recommended that TGS apply the average of the modeled and measured radii (Table 4.2-1). As the JASCO-recommended radii for the 3,280 in^3 (53,750 cm^3) airgun array were equal to or smaller than the modeled radii, PSOs on the 2013 TGS survey monitored the modeled distances when the airgun array was in use to be conservative and reduce any potential marine mammal takes. These distances were 930 m (3,051 ft), 2,500 m (8,202 ft), and 15,000 m (49,213 ft) for the 190, 180, and 160 dB re 1 µPa (rms) zones, respectively.

Appendix A provides detailed reports of JASCO's pre-season sound modeling and the SSV results.

Table 4.2-1. Distances for the full 3,280 in^3 array to various exclusion zone isopleths at three water depths in TGS' 2013 Chukchi Sea project area based on results of JASCO Applied Sciences pre-season sound modeling and 2013 empirical field measurements. Modeled values include a 10% precautionary factor above the modeled results.

Exclusion Zone	Pre-Season Modeled Distance (m)[1,2]			2013 SSV Results (m)[2]	2013 Recommended Radii (m)[2,3]	Actual Final Distances Monitored by 2013 PSOs[3]
dB re 1 µPa (rms)	Depth (m) 17-40	Depth (m) 40-100	Depth (m) >100	Depth (m) 40-100	Depth (m) All Depths	Depth (m) All Depths
190	930	920	430	390	700	**930**
180	2,200	2,400	2,500	1,100	1,800	**2,500**
160	8,500	9,900	15,000	8,000	15,000	**15,000**

[1] Blees et al. 2010, JASCO SSV report.
[2] The pre-season modeled depth categories were different than those used during SSV measurements (see Appendix A).
[3] TGS chose to implement the JASCO-recommended, conservative isopleth distances for PSO monitoring.
dBre1mµPa = relative to 1 microPascal
m = meter
PSO = Protected Species Observer
rms = root mean square
SSV = sound source verification

For the single 60 in^3 mitigation airgun, estimated distances to the 190, 180, and 160 dB re 1µPa (rms) isopleths for the TGS 2013 IHA were based on measurements reported by JASCO during a SSV monitoring study conducted for Statoil USA Exploration and Production, Inc. (Statoil) in the Chukchi Sea during the 2010 open water season of 2010 (Blees et al. 2010) (Table 4.2-2). Results indicated that the corresponding distances were 13, 68, and 1,500 m (43, 223, and 4,921 ft) for the 190, 180, and 160 dB exclusion zones, respectively (all dB re 1µPa [rms]). JASCO also conducted an SSV on the 60 in^3 mitigation airgun at the start of TGS' 2013 program. However, the associated distances were less than the modeled distances from Blees et al. 2010.

Table 4.2-2. Distances for the 60 in^3 mitigation airgun to various isopleths in TGS' 2013 Chukchi Sea project area based on results of JASCO Applied Sciences pre-season sound modeling and 2013 empirical field measurements. Modeled values include a 10% precautionary factor above the modeled results.

Exclusion Zone dB re 1 µPa (rms)	Pre-Season Modeled[1] Depth (m) All Depths	2013 SSV[1] Depth (m) 40-100	2013 Recommended Radii [1,2] Depth (m) All Depths	Actual Final Distances Monitored by 2013 PSOs[2] Depth (m) All depths
190	13	7	10	**13**
180	68	43	56	**68**
160	1,500	1,600	1,500	**1,500**

[1]The pre-season modeled depth categories were different than those used during SSV measurements (see Appendix A).
[2]TGS chose to implement the JASCO-recommended, conservative isopleth distances for PSO monitoring.
m = meter
PSO = Protected Species Observer
rms = root mean square

4.2.2.2 Ramp-up Procedure

Ramp-up procedures involve a step-wise increase in the number of operating airguns and thus the volume of the seismic source, to provide a gradual increase of sound levels into the environment. This procedure is intended to alert marine mammals of seismic activity in the area and allow them time to leave the area and avoid injury or hearing impairment. Two PSOs observed for marine mammals during the 30 minute observation period prior to ramp-ups and during ramp-ups. At least one PSO was on-watch during all daylight seismic source operations.

After the start of a ramp-up procedure, the rate of ramp-up was no more than 6 dB re 1 µPa (rms) per five-minute period. After ramp-up began with a 60 in^3 airgun seismic source, TGS followed this standard NMFS-accepted ramp-up guidelines. During ramp-up, the exclusion zone of the full seismic source array was maintained.

After a complete shut-down, ramp-up procedures did not commence until the 180 dB re 1 µPa (rms) exclusion zone of the full array was completely visible for at least 30 minutes and no marine mammals had been observed within the exclusion zones for at least 15 to 30 minutes, depending on species. Specifically, if a marine mammal was observed within the appropriate exclusion zone (180 dB re 1 µPa [rms] for cetaceans and walruses and 190 dB re 1 µPa [rms] for pinnipeds and polar bears), a cold start was not initiated until the animal was observed outside of the exclusion zone or not observed for at least 15 minutes for pinnipeds and polar bears and 30 minutes for cetaceans and walruses.

Ramp-up procedures were adhered to when the seismic source array had been shut down or operating with reduced volume (e.g. mitigation gun) for 10 minutes or more. This time period is approximately the amount of time it would take the vessel to cover the 180 dB re 1 µPa (rms) zone depending on the speed of the seismic vessel, water depth, and array volume. If the seismic source array had been operating with the mitigation airgun (i.e., survey line changes), ramp-up procedures to the full seismic source array volume could commence during nighttime or periods of poor visibility (e.g., fog) on the assumption marine mammals would be alerted by the sounds and able to move out of the area.

4.2.2.3 Power-down and Shut-down Procedure

Power-down procedures typically involve reducing the seismic source array volume (by reducing the number of active airguns), thereby reducing the distance to the 180 dB and 190 dB re 1 μPa (rms) exclusion zones to an extent that the marine mammal(s) is no longer within the applicable zone. During a power-down, the seismic source array was reduced to the single 60 in^3 mitigation airgun or shut down completely. Shut-downs could also occur when the seismic vessel was transitioning between survey lines if a marine mammal entered or was about to enter the smaller exclusion zones associated with the single mitigation airgun. The single mitigation airgun seismic source was intended to alert marine mammals of the presence of a sound source in the environment and retained the option to initiate seismic source ramp-up procedures under conditions of poor visibility or darkness.

If a marine mammal was detected outside, but approaching the appropriate exclusion zone, the PSO immediately requested a power-down to the 60 in^3 (or smaller) mitigation airgun so long as the marine mammal was not within or approaching the reduced exclusion zone of the single mitigation airgun seismic source. If the marine mammal(s) continued to approach the reduced exclusion zone of the single mitigation airgun seismic source, the single airgun was completely shut down.

Once powered down, seismic source operations could resume after the marine mammal was confirmed outside the exclusion zone. A marine mammal was considered to have cleared the zone if:

- It had been visually detected outside of the exclusion zone;
- It had not been observed for 15 minutes (polar bears, pinnipeds, or small odontocetes);
- It had not been observed for 30 minutes (walruses and mysticetes; large odontocetes do not occur in the survey area); or
- As otherwise stipulated by the NMFS IHA and/or USFWS LOA.

Shut-down procedures included a complete cessation of the seismic source. These procedures were implemented if a marine mammal was observed within the appropriate exclusion zone of the single mitigation airgun. Once shut down, seismic source operations resumed only after the marine mammal had been confirmed outside the exclusion zone as described above.

PSOs were instructed to implement emergency shut-downs if observations were made or credible reports received that one or more marine mammals within the seismic survey area was injured, dead, dying, or indicated acute distress due to seismic noise, unless otherwise stipulated by NMFS or USFWS. In the case of an emergency shut-down, NMFS (or USFWS for Pacific walrus and polar bear) was to be contacted immediately. If it was determined the marine mammal injury or death was likely not due to seismic activities (e.g., obvious signs of killer whale predation; signs of hunting, such as bullet wounds), TGS was to collect information as specified by and notify NMFS or USFWS and resume seismic activities. If cause of death could not be attributed to causes other than the seismic program, activities would not have been restarted until NMFS or USFWS gave approval.

It is important to note that early in the survey, TGS elected to implement shut-down procedures for all marine mammal sightings within or approaching applicable 180 dB re 1 μPa (rms) and 190 dB re 1 μPa (rms) exclusion zones of the full seismic array, so as to be extra conservative.

4.2.2.4 Protocol for Poor Visibility Conditions

During times of poor visibility, including fog or nighttime, TGS adhered to the following procedures:

- During limited visibility due to fog and/or darkness, the entire 180 dB re 1 µPa (rms) exclusion zone may not have been visible. If the entire zone was not visible for a minimum of 30 minutes immediately prior to startup of the seismic source from a cold start (i.e., no airgun activity), initiation of the seismic source did not occur.
- If a single mitigation airgun or full seismic source array was operational before visibility decreased or before nightfall, the seismic source operations continued even though the entire exclusion zone may not have been visible.

4.2.3 Mitigation Measures for Subsistence Activities

- **Communication Centers:** As agreed to in the AEWC's CAA (Appendix E), TGS PSOs communicated with the nearest Com Center at minimum every six hours. PSOs called the Com Centers via radio or phone to communicate their position (using handheld global positioning system [GPS] equipment) and activities. All activities were documented in the Com Center log book by Com Center Operators. Diligent communication with the Com Center and subsistence users occurred during the crew change offshore of Wainwright to ensure no impact was made to Wainwright's fall bowhead whale hunt.
- **Exclusion Zones**: All of the TGS 2013 seismic activity occurred more than 48 km (30 mi) offshore of the Chukchi Sea coast, and was therefore outside of the fall bowhead whaling exclusion zone identified in the CAA for Wainwright, Point Lay, and Point Hope. Likewise, seismic operations did not occur within the Barrow exclusion zone (~152°15'W to ~157°20'W).
- **Subsistence Species:** During seismic activities, PSOs were on-watch on both vessels to monitor for marine mammals, including subsistence species, in order to minimize impacts.
- **Ledyard Bay Critical Habitat Unit:** TGS vessels did not enter or transit through the LBCHU in accordance with this restriction identified in the BOEM G&G Permit in Appendix D. This was to avoid potential impacts to this area known to be rich in critical marine bird habitat.
- **Hanna Shoal:** Hanna Shoal restrictions were adhered to, as discussed in Section 4.2.1. These areas are important feeding grounds for Pacific walruses, a primary subsistence species.

4.3 Monitoring Procedures

The 2013 TGS 2D seismic survey used a combination of vessel-based visual monitoring and PAM. Vessel-based PSOs were on board the seismic and monitoring vessels to visually monitor the 180 dB re 1 µPa (rms) exclusion zone and the 160 dB re 1 µPa (rms) zone of influence. Monitoring within these zones was also supplemented by the use of a towed PAM array. All monitoring was implemented in accordance with the provisions of the IHA and LOA. Detailed monitoring methodology for the 180 dB re 1 µPa (rms) and 190 dB re 1 µPa (rms) exclusion zones are provided in Section 4.3.1. Methodologies used for the towed PAM array and data analysis are described in Section 4.3.2 and in Appendix C.

4.3.1 Vessel-based Visual Monitoring

Prior to the start of the seismic project, all PSOs participated in a seven-day NMFS-approved PSO training course. Topics covered included: local marine mammal identification, mitigation and monitoring protocol, data collection methods and the software used in the process, and familiarization

with TGS operations. PSOs also went through a cold water survival course and a health and safety training. An emphasis was placed on operational procedures and considerations given and directed to health, safety, and environmental issues.

There were nine PSOs (five on the *Geo Arctic* and four on the *Norseman*) present for the project from 24 August to 18 October. Due to personnel logistic issues, eight PSOs (five on the *Geo Arctic* and three on the *Norseman*) remained to finish the survey (18 to 31 October). There was a lead PSO on each vessel with the additional responsibilities of PSO oversight, data management, scheduling, and being the point of contact for each vessel. PSOs on both vessels were on-watch during all vessel activities including transit times, stationary operations (at dock or crew transfers) and low light/nighttime conditions until 2 October. PSOs aboard both vessels maintained opportunistic (off-watch) environmental observations throughout the nighttime after 2 October, excluding the period of 18 to 31 October when the *Norseman* PSOs were on-watch during daylight hours only. To allow for 24-hour observations, each PSO was on-watch for a shift of 8 to 10 hours each. However, PSO watches aboard the *Norseman* increased to 12 hours per day after 18 October. Two PSOs were on-watch from the *Geo Arctic* for all pre-clearance and ramp-ups. Although not stipulated in the IHA, at least one PSO remained on-watch during non-required periods (i.e. darkness) to provide additional supplemental marine mammal monitoring.

Marine mammal observations were conducted from the bridge or flying bridge on both the source and monitoring vessels. The approximate eye height on the bridge was 12 m (40 ft) above sea level (ASL) on the *Geo Arctic* and 6.5 m (21 ft) ASL on the *Norseman* bridge. During daylight watches, two PSOs systematically scanned the area around the vessel with the naked eye, reticle binoculars (7x50 Fujinon) or big-eye binoculars (Fujinon 25x150) during all vessel activities. Observations with the Big Eyes binoculars were often limited due to poor weather conditions (i.e., increased sea state). During sightings with multiple PSOs on-watch, one PSO would maintain visual contact with the marine mammal, while the other recorded data. When only one PSO was on-watch, that PSO quickly recorded the sighting time then observed as long as possible before recording the sighting data. During darkness, scans were conducted by one PSO with the aid of night vision binoculars. Distance to a marine mammal was estimated using the reticle binoculars, a clinometer and/or best estimation using the naked eye of the trained observer.

Environmental effort was recorded by PSOs for the entire duration of their watch in accordance with recommendations made by USFWS based on types of data collected during previous projects. Data collected included, but was not limited to: date, time, seismic activity (i.e. transit, line shooting, mitigation gun on, ramp-up, etc.) water depth, Beaufort sea state, visibility, glare, sea-ice cover and type, vessel position, vessel speed. Environmental effort data was collected every 30 minutes or when conditions/activities changed significantly.

Similarly, when a marine mammal was sighted, additional data were recorded based on recommendations from USFWS, again based on results from previous projects. This included, but was not limited to: date, time, species, number of animals in group, number of juveniles, closest point of approach to the vessel, location of animal (in the water or on ice/land), latitude and longitude of sighting, heading of the animal, behavior at time of sighting and behavioral reaction to the vessel (if any), vessel latitude and longitude, water depth, vessel and seismic activities, if they were detected acoustically, and the time mitigation measures were requested and implemented (if required). All data were entered into the observation software program, Mysticetus™ which has a built-in system for quality control and verification of data (i.e., Mysticetus™ only allowed certain data to be entered and automatically populated specific data, such as latitude/longitude, water depth, etc.). Section 5 details the analysis performed on the data collected. All data were exported to Microsoft Excel for quality control (fixing inconsistent data, wrong codes, etc.) and analysis.

4.3.2 Passive Acoustic Monitoring

A towed real-time PAM cable was used to complement the visual monitoring conducted by PSOs during the 2013 TGS 2D seismic survey. The towed hydrophone array system was comprised of two parts: the "wet end" and the "dry end." The wet end consisted of the hydrophone array and tow-cable, and was towed behind the vessel. The dry end included the analog-to-digital, computer processing, signal conditioning and filtering system used to process, record, and analyze the acoustic data. Specific noise filters were used to maximize the system's ability to detect low frequency bowhead whales. The towed hydrophone array was deployed using a winch from the monitoring vessel. Details on the towed PAM system and specifications on the equipment, effort, data collection, and data analysis can be found in Appendix C.

5.0 Marine Mammal Monitoring Analysis and Results

This section describes the data analysis and results of the marine mammal monitoring that occurred during TGS' 2013 2D seismic survey in the Chukchi Sea during the open water season. Monitoring and mitigation methods were summarized in Section 4 of this report and in the IHA and LOA (Appendix D). For clarity, the numeric values in this section are presented in metric units only and a metric-to-imperial unit conversion table is provided on page xi.

5.1 Marine Mammal Monitoring Data Analysis Methods

5.1.1 Classification of Data

PSO effort and sighting data were classified by five categories based on the number of PSOs, species grouping, vessel activity, environmental conditions, and location. These categories were comparable to similar surveys conducted under IHAs in the Arctic (e.g., Blees et al. 2010; Patterson et al. 2007) and are defined below in Sections 5.1.1.1 to 5.1.1.4.

5.1.1.1 Protected Species Observer effort

As noted above, GPS data (latitude and longitude) were collected every 30 minutes, when conditions changed significantly, and when a sighting occurred. PSO effort was expressed in number of km and h, and comprised all periods when observers were on-watch. On-watch effort defines all times when there was a dedicated PSO observing for marine mammals. This did include some dark periods. PSO effort was calculated separately and differently for the *Geo Arctic* and the *Norseman.* This was because the *Geo Arctic* traveled in straight lines while following seismic survey lines and transits between survey lines while the *Norseman* followed zigzag tracklines to facilitate PAM detection localization. Therefore, *Geo Arctic* PSO effort was calculated in Excel using a great circle distance between each GPS data point. To calculate *Norseman PSO* effort (also in km), all GPS trackline point data were converted to an ESRI shapefile. The distance between each zigzag was then calculated using ArcGIS. The trackline was then split at the location of each point (approximately every 30 minutes) to create a unique line segment between each point. The length of each line segment was calculated in kilometers using the ArcGIS geometry tool.

Due to the zigzag survey design of the *Norseman,* overall PSO effort (km) and vessel speed were higher for the *Norseman* than for the *Geo Arctic*. The *Norseman's* mean speed was 10.6 km/hr versus 9.3 km/hr for the *Geo Arctic*. Effort for each vessel was further categorized by different environmental and seismic activities as further described in Sections 5.1.1.3 and 5.1.1.4.

5.1.1.2 Species Group

For data analysis, sighting data were pooled by species or species groups comprised of cetaceans, pinnipeds (excluding Pacific walrus), Pacific walrus, and polar bear. Due to the expected behavioral differences towards industry activities, cetaceans and pinnipeds were analyzed separately. Pacific walrus were also treated separately for analyses due their management by the USFWS rather than NMFS. Because no polar bears were observed during the TGS 2013 2D seismic survey they are not further discussed in this report.

5.1.1.3 Geographic Boundaries and Vessel Roles

The *Geo Arctic* and the *Norseman* had different roles during the project; therefore data were categorized by each vessel and its respective duty. All data collected by PSOs aboard the the *Geo Arctic,* were classified as "source vessel" data. All data collected by PSOs aboard the *Norseman* were classified as "monitoring vessel" data. Only sighting and effort from vessel activity within the project boundary (see Figure 5-1) were included in the data analysis. The project area used for density and take calculations (see Section 5.1.3 and 5.1.4) differed in order to meet assumptions associated with line transect estimation methods and/or, to represent only areas ensonified to ≥160 dB re 1 µPa (rms). Data from the monitoring vessel were compared to source vessel data (Section 5.2) to assess potential impacts of seismic activities at a greater distance from the seismic source.

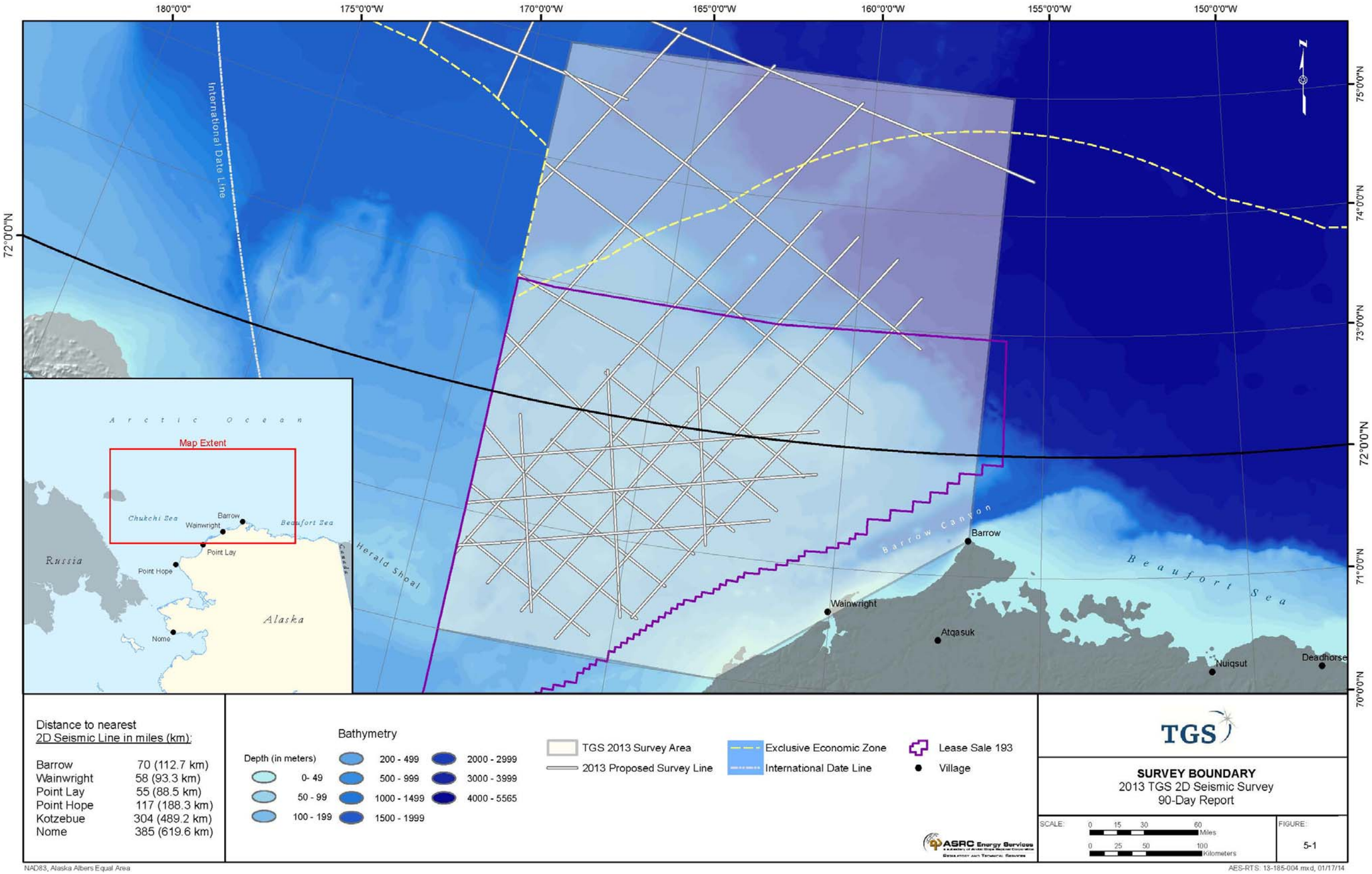

Figure 5-1. Survey Boundary

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5.1.1.4 Seismic Periods

PSO data, including PSO effort and sightings, from the *Geo Arctic* were divided into three categories based on airgun status;

(1) Periods of seismic testing, ramp-up and full array activity were grouped as "full array" which were equivalent to ≥160 dB re 1 μPa (rms).

(2) Times with only the mitigation airgun activity were categorized as "mitigation airgun (≥160 dB re 1 μPa [rms])". During periods when the mitigation airgun was on, the zone of influence implemented for the *Geo Arctic* was 1.5 km. For the purposes of analysis, marine mammal sightings from the *Geo Arctic* during these periods were considered to represent exposure to seismic sounds ≥160 dB re 1 μPa (rms) isopleth.

(3) Periods when no airguns were active were categorized as "non-seismic". Statistical analyses were limited to comparisons between seismic and non-seismic activity where sufficient effort allowed for significant interpretation.

PSO data from the *Norseman* monitoring vessel were similarly divided into three analysis categories based on seismic status. However, the *Norseman* maintained a mean estimated distance of 7.5 km ahead of the *Geo Arctic* source vessel and was always outside the 1.5 km exclusion zone of the single mitigation airgun. This distance was maintained to allow acoustic monitoring to be conducted away from the seismic source and still assist in visual observations within the 160 dB re 1 μPa (rms) isopleth, and the 180 and 190 dB re 1 μPa (rms) exclusion zones of the full array. Therefore, all observations from the monitoring vessel were classified as either occurring during times of "full array", "mitigation airgun (<160 dB)", or "non-seismic". When the *Geo Arctic*'s single mitigation airgun was on, any sightings from the *Norseman* during mitigation airgun activity would have been outside this 1.5 km, 160 dB re 1 μPa (rms) radius. Thus, marine mammals seen from the *Norseman* when the single airgun was operating were exposed to seismic sound levels <160 dB re 1 μPa (rms).

5.1.2 Sighting Rate

Sighting rates for each vessel were calculated as number of sightings per 1,000 km of usable on-watch PSO effort (described below in Section 5.1.2.1). Various environmental conditions and vessel activities were considered during analysis including:

- Beaufort sea state
- Visibility
- Water depth
- Ice cover
- Number of on-watch PSOs
- Seismic status
- Location north or south of 72° N latitude.

In addition, sighting rates were analyzed by species groups, including cetaceans, pinnipeds (excluding Pacific walrus), and Pacific walrus. Where appropriate and when sample size allowed, sighting rates were compared within categories using a Chi-squared (χ^2) contingency test.

Various factors may bias sighting rates of marine mammals therefore data are presented to best capture the potential effects of seismic activity on the behavior, movement and distribution of marine mammals. Specifically, PSO effort and sighting data were analyzed in categories defined by environmental conditions and operational activities according to the criteria described below in Section 5.1.2.1.

5.1.2.1 Usable Data for Sighting Rates

Periods of PSO effort were excluded when detections of marine mammals at the surface would have been unlikely, such as during periods of reduced visibility (e.g., darkness and dense fog) or during high seas states. If these data were included in the analysis, sighting rates and densities would be biased downward. There were no times when another vessel was within 1 km of the source vessel during seismic operations, therefore additional vessels were not considered as a confounding factor.

Effort and sighting data were excluded during sighting rate calculations if they occurred during the periods listed below. Reactions to the seismic survey and vessel activity are assumed to be different between cetaceans and pinnipeds. As a result different criteria (similar to those used for comparable surveys in the Chukchi Sea: Bisson et al. 2013; Blees et al. 2010; Hartin et al. 2011) were used for each group (Pacific walrus were classified with pinnipeds for this purpose) and are hereafter referred to as "usable" data.

- Periods when the vessel speed was <2 knots;
- Times with impaired visibility including:
  - Darkness/nighttime observations;
  - Visibility distance <1 km (variable classifications of <3.5 and >3.5 km were considered as usable data);
  - Sea state greater than Beaufort 4 (see Appendix I for description); or
  - Severe glare >60° within the forward 180° of the vessel.

The rate at which marine mammals recover behaviorally after exposure to underwater noise (i.e., post-seismic) is unknown since comparisons are limited by the inability to confidently identify re-sighted individuals, short sighting duration when the animals are at the surface and vessel/animal movements away from the observers. Therefore, specific criteria were implemented to best assess any potential behavioral responses or potential changes in distribution resulting from the presence of the seismic activity, specifically during seismic and non-seismic activity. However, marine mammal responses to airgun activity are thought to decrease over time after the airguns are turned off, resulting in the classification of a "post-seismic" period (as described in Bisson et al. 2013; Blees et al. 2010; Hartin et al. 2011). The cut-off for the "post-seismic" period was defined as the amount of time after the airguns have been shut off where affects to marine mammals were reduced to zero or close to zero. The reasoning behind these classifications is explained in Maclean and Koski (2005) and Smultea et al. (2004) and the post-seismic criteria used in sighting rate calculations are described below.

- Periods of "post-seismic" activity (after cessation of the airguns)
  - Pinnipeds (including walrus): three minutes to one hour
  - Cetaceans: three minutes to two hours

5.1.2.2 Behavioral Observations and Animal Distribution

Behavioral observations of marine mammals were limited during this project by observational challenges, such as the often brief durations of sightings when the marine mammals are at the water's surface, potential for vessel avoidance and difficulty in positively identifying re-sightings (determining if two sightings occurring close in time are the same animal[s]). Marine mammals were also not able to be tracked for long periods or distances as the vessels were constantly moving along pre-determined track lines.

Marine mammal sighting data were collected during the seismic survey by the PSOs and allow for inferences of potential responses to be determined, again in similar fashion to data collected in other programs in the Chukchi and Beaufort seas (Bisson et al. 2013; Blees et al. 2010; Hartin et al. 2011). Specifically, data used to assess distribution and behavior were:

- Distance of the initial sighting of marine mammals from the PSOs position on the vessels;
- Bearing of the animal's position relative to the heading of the observation vessel at the time of initial sighting of the marine mammal;
- Observed initial behavior of the mammals;
- The mammal's movements relative to vessel movements and activities; and
- Any observable reactions of marine mammals in response to vessel or seismic activities.

5.1.2.3 Closest Point of Approach

The distance of each marine mammal observed was determined by the trained PSOs from the observer's position using reticle binoculars for animals further away and estimated using the length of the vessel as a guide for closer mammals. The closest point of approach (CPA) of each sighting to the observers was assigned at the time of the sighting. The CPA of each sighting to the airgun(s) was calculated post-season for the source vessel only because they were the only vessel who could initiate power- and shut-downs of the seismic array. CPA to the airguns was calculated by using the law of cosines based on the known distance (m) of the *Geo Arctic* PSOs to the airguns, as well as the distance (m) and bearing (°) to each sighting relative to the PSO's position.

5.1.2.4 Marine Mammal Movement, Behavior and Reaction

All movement, behavior and reactions were recorded for each marine mammal sighting then compared to seismic activities for each vessel following protocol previously applied in other Chukchi marine mammal seismic monitoring programs (e.g., Blees et al. 2010). Marine mammal movements relative to vessel were placed into five categories: 1) swim away, 2) swim towards, 3) parallel, 4) none, and 5) unknown.

For each sighting, the initial behavior observed by the PSOs was recorded, and included: blow, breach, dive, fluke, porpoise, resting, surface active, surface active travel, swim, travel, sink, thrash, look, and unknown.

Reaction behavior across resightings of the same sighting was classified by what was considered the most energetically expensive reaction between all re-sightings (Cate 2013). In order from least energetic to most, these included: no reaction, look, changes in direction, splash, dive, increase speed, and rush.

5.1.3 Marine Mammal Density Estimation

Conventional line-transect methods (also known as Conventional Distance Sampling or CDS) (Buckland et al. 2001) were applied to estimate densities (#/km^2) of marine mammals using only vessel-based sighting data collected from the *Norseman* monitoring vessel during the 2013 TGS 2D seismic project. Only data collected within the survey area restricted to just survey lines were used for the estimates. These data do not include some transit (e.g., to Wainwright, AK) effort that is included in the greater survey area as depicted in TGS' 2013 IHA Figure 2-2. Separate densities were calculated for seismic and non-seismic periods as described below. Data were limited to sightings collected only from the *Norseman* for the following reasons:

1. The *Norseman* operated ahead of the *Geo Arctic* to identify marine mammals before they reached the 180 and 190 dB re 1 µPa (rms) exclusion zones and to monitor animals within the 160 dB re 1 µPa (rms) isopleth, which extended up to 15 km;
2. The *Norseman* thus had a better chance of observing marine mammals before they may have reacted to the seismic source and/or either vessel. This is important in line transect theory, as responsive movement by a sighting before detection violates an assumption of this approach (Fewster et al. 2008);
3. The *Norseman* traveled at a faster average speed (about 10.6 km/hr) than the *Geo Arctic* (about 9.3 km/hr) and therefore was better suited to meeting line transect assumptions to avoid re-sighting individuals; and
4. Sighting data from the *Norseman* and *Geo Arctic* could not be combined for the purposes of line transect analyses due to differences in protocol and platform. For example, the *Norseman* followed zigzag lines while the *Geo Arctic* traveled straight along seismic survey lines; both vessels traveled straight along transits between survey lines. In addition, due to vessel bunk space limitations, more observers were usually on-watch from the *Geo Arctic* versus the *Norseman* (see results in Section 5.2-3). The observation platform of the *Geo Arctic* (10.5 m) was also higher than that of the *Norseman* (4.8 m), and higher vantage points result in higher sighting rates due to the greater distance to the horizon among other factors (see Figure 2-2).

The *Norseman* maintained a mean estimated distance of 7.5 km ahead of the source vessel to monitor approximately halfway between the seismic source towed behind the *Geo Arctic* and the outer boundary of the 15 km 160 dB re 1 µPa rms mitigation zone of the full seismic array. The latter approach was decided during communications with the NMFS and in the NMFS-issued final IHA. The *Norseman* followed a zigzag pattern to help resolve left-right ambiguity of acoustic signals recorded with the PAM array it towed (see Appendix C). However, due to the prioritized need to stay within this distance from the source vessel, the followed zigzag pattern may have violated line transect assumptions requiring no overlap of survey areas and re-sightings of individuals. For example, the zigzag pattern of the *Norseman* typically involved turning at an approximately 45° angle about every 10 minutes (i.e., every 1.25 km). Sighting and effort data used to estimate density using line transect analyses were filtered by the following criteria in an attempt to meet basic line transect assumptions and principles:

- Within the seismic survey area boundary (transit sightings to and from the seismic survey area were excluded);
- In sea states of Beaufort 0-4;
- When two observers were on-watch
- When visibility was at least 1.0 km; and
- When the *Norseman* was cruising between 4 and 12 knots.

Density estimates were stratified by seismic and non-seismic periods relative to the status of the airgun(s) towed and operated from behind the *Geo Arctic*. To maximize sample size given the relatively small number of sightings that met the filtered conditions above, the seismic period was pooled to include the following periods:

(1) When the full airgun array was operating while towed behind the *Geo Artic*;
(2) During ramp up and seismic testing periods; and
(3) While the single 60 in^3 mitigation airgun was operating.

The *Norseman* always operated outside the maximum 1.5 km radius around the single operating mitigation airgun towed behind the *Geo Arctic* and thus was within waters ensonified to <160 dB re 1 µPa (rms). However, studies indicate that some marine mammals, particularly bowheads, respond to seismic sounds at lower received sound levels, including near 120 dB re 1 µPa (rms) (e.g., Blackwell et al. 2009). Thus, non-seismic periods excluded the latter single airgun operation periods to represent periods of silence by the TGS airgun(s). It is recognized that marine mammals recently exposed to seismic sounds may still have been affected for a short period near the start of the non-seismic periods. However, non-seismic periods were often long in duration (greater than three hours between seismic survey lines). Therefore, the proportion of this "post-seismic" time was small compared to the total non-seismic periods. Consequently, it is believed that the latter to have had minimal influence on the calculated non-seismic densities. Furthermore, additional stratification into more than two seismic periods (e.g., into post-seismic or single mitigation airgun periods) was not conducted due to further associated reduction of already small sighting sample sizes.

Estimates of density and abundance (and their associated coefficients of variations [CVs]) were calculated using the following formulae:

$$\hat{D} = \frac{n\ \hat{f}(0)\ \hat{E}(s)}{2\ L\ \hat{g}(0)}$$

$$\hat{N} = \frac{n\ \hat{f}(0)\ \hat{E}(s)\ A}{2\ L\ \hat{g}(0)}$$

$$C\hat{V} = \sqrt{\frac{\hat{\text{var}}\ (n)}{n^2} + \frac{\hat{\text{var}}\,[\hat{f}(0)]}{[\hat{f}(0)]^2} + \frac{\hat{\text{var}}\,[\hat{E}(s)]}{[\hat{E}(s)]^2} + \frac{\hat{\text{var}}\,[\hat{g}(0)]}{[\hat{g}(0)]^2}}$$

- where D = density (of individuals),
- n = number of on-effort sightings,
- f(0) = detection function evaluated at zero distance,
- E(s) = expected average group size (using size-bias correction in DISTANCE),

- L = length of transect lines surveyed on effort,
- g(0) = trackline detection probability,
- N = abundance,
- A = size of the study area,
- CV = coefficient of variation and
- var = variance.

The software *DISTANCE* 6.0, Release 2, was used to conduct density calculations (Thomas et al. 2010). All data used were collected in Beaufort sea state conditions of 0-4 and were not stratified by Beaufort sea state or other environmental parameters due to issues associated with small sample sizes (e.g., reduced precision). Stratified estimates of density and abundance for the two survey strata of seismic and non-seismic periods were produced.

5.1.3.1 Detection Functions

The recommended sample size to estimate a detection function providing relatively robust density estimates is typically 60 sightings (Buckland et al. 2001), with about 15 sightings considered the absolute minimum (e.g., Barlow et al. 2006). After filtering data, the total number of sightings identified to species and available for density estimation was 175 (103 during seismic and 52 during non-seismic periods) (see Section 5.4). Thus, detection functions could be estimated for only cetaceans and pinnipeds combined to provide reasonable sample sizes. The number of sightings used for species-specific density estimation ranged from 5 (for ringed seals) to 39 (for walrus). Five sightings were selected as the cut-off for which to perform density analyses, recognizing the limitation of small sample size. Small sample sizes are not desirable as they result in reduced precision, high variability, and reduced reliability of density and abundance as evidenced by high CVs and wide confidence levels (CLs) (Buckland et al. 2001).

A large number of sightings were unidentified to species (e.g., unidentified mysticete whale and unidentified seal). Estimates of density were calculated for these unidentified groupings as well. However, these densities were not used to prorate species-specific densities when estimating numbers of exposures due to the small sample sizes. The associated relatively high CVs contribute to considerable variation in the results. Furthermore, there is controversy about the validity of the proration approach due to the associated uncertainties (Jefferson, pers. comm., 2013[1]) In particular, no gray whale sightings met the line transect analysis criteria; thus, the unidentified mysticetes likely represent some gray whales that would have led to over-estimation of bowheads and underestimation of gray whales. Data were not available to estimate trackline detection probability [g(0)] for this study and thus g(0) was assumed to equal 1.0.

To avoid potential overestimation of group size, the size-bias-adjusted estimate of average group size available we calculated in *DISTANCE*. Due to small sample sizes, the perpendicular sighting distance (PSD) data were not truncated and the data were modeled with the uniform model (with cosine adjustment). As previously mentioned, since data were limited, g(0) was assumed to equal 1.0. As a result, it is recognized that the resulting estimates have relatively low precision and thus likely underestimate the true density and abundance by an unknown factor. However, at this time, they are the most extensive available data for northern U.S. Federal and international waters north of 72° N.

[1] Thomas Jefferson. Marine Mammal Scientist, Clymene Enterprises, San Diego, CA. 22 December 2013

5.1.4 Estimation of Potentially Affected Marine Mammals

Exposures to received sound levels greater than 160 dB re 1 μPa (rms) are considered to be a "take by harassment" (Level B harassment) (NMFS 2005, 2006; USFWS 2008b). Such exposure is considered by NMFS and USFWS to potentially result in disturbance of pinnipeds (including Pacific walrus) and cetaceans. The number of marine mammals potentially exposed to this sound level were estimated based on the conservative JASCO-modeled distances to this isopleth as shown in Table 4.2-1 by water depth for the full array and for the single mitigation airgun (although the 2013 SSV study indicated these radii were smaller—see Appendix A). Any seismic sound other than that produced by the single mitigation airgun was conservatively assumed to be a full array. Thus, ramp up periods and other periods with 2 to 28 airguns operating were treated as if the full array was operating.

To meet requirements in the IHA issued by NMFS for this project, two approaches were used to estimate exposures to seismic sounds levels ≥160 dB re 1 μPa (rms) as follows.

1. The absolute minimum number of estimated exposures was based on direct observations during seismic activities. This approach has been applied previously by various seismic monitoring studies in the Chukchi and Beaufort seas (Blees et al. 2010), as well as other oceans around the world (e.g., MacLean and Koski 2005; Smultea et al. 2004, 2005).
2. The estimated total area ensonified to ≥160 dB re 1 μPa (rms) multiplied by the best available preferentially non-seismic densities for marine mammal species that were observed or may occur in the project region. Where available/applicable, 95% CLs reported for densities were applied to obtain a lower and an upper estimate of such exposures. For species where CLs were not available, other means of estimating a lower and upper range of exposures were applied as described below.

The area of water ensonified to received sound levels (RSLs) of ≥160 dB was calculated based on the depth of water under the seismic vessel relative to the three water depth categories reported by JASCO (Table 4.2-1). Thus, the 15 km radius was applied when the source vessel was operating with 2 to 26 airguns in waters >100 m deep, a 9.9 km radius was used for water depths of 40 to 100 m and a 8.5 km radius was used for water depths <40 m. For the single 60 in^3 mitigation airgun, the most conservative deep-water radius of 1.5 km for the 160 dB isopleth was used. These distances are considered conservative because 1) they encompass an extra 10% buffer applied by JASCO and (2) results of the TGS 2013 SSV performed by JASCO indicated that the actual distances to these isopleths were smaller than initially modeled (Appendix A). Notably, underwater sound transmissions and received sound levels vary considerably and are affected by water depth, the depth of the towed sound source, water temperature and mass, bottom conditions, directionality of the source, and the depth of the animal, among others (e.g., Burgess and Greene 1999; Caldwell and Dragoset 2000; Greene 1997; Greene et al. 1998; Richardson et al. 1995; Tolstoy et al. 2004a,b).

Densities used to estimate the potential number of marine mammal exposures to seismic sounds (≥160 dB re 1 μPa [rms]) during the TGS 2013 2D seismic survey, including estimated densities using sightings made during the 2013 TGS survey, are described in Section 5.4.

5.2 Marine Mammal Monitoring Results.

5.2.1 Protected Species Observer Effort

Total PSO effort, including both on- and off-watch periods is presented in Table 5.2.-1. On-watch effort includes all daylight hours. On-watch can also include periods of darkness if the observer was actively looking at the water for marine mammals (typically with the aid of night vision goggles). This table also presents hours of effort for a reference of the amount of time spent both on- and off-watch.

The total effort of PSOs aboard the two vessels was 30,798 km (3,137 hr). Of this total, 10,738 km (1,170 hr) of observation effort was from the *Geo Arctic* and 11,900 km (1,140 hr) from the *Norseman* (Table 5.2-1) occurred during watch hours. A combined observation effort of 8,160 km (826 hr) occurred during darkness and thus are categorized as off-watch (Table 5.2-1); 3,731 km (399 hr) from the *Geo Arctic* and 4,429 km (427 hr) from the *Norseman*.

Table 5.2-1. Total effort on and off-watch for the *Geo Arctic* and the *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Vessel Name	Effort Type	Distance (km)
Geo Arctic	On-watch	10,738
	Off-watch	3,731
	Total	**14,469**
Norseman	On-watch	11,900
	Off-watch	4,429
	Total	**16,329**
Combined	**On-watch**	**22,638**
	Off-watch	**8,160**
	Total	**30,798**

km = kilometer(s)

5.2.1.1 Effort by Survey Area/Transit Area

PSO effort was calculated using time when PSOs were on-watch, and is hereafter displayed in km only in tables and figures.

On-watch PSO effort is summarized in Figure 5.2-1 by the *Norseman* and *Geo Arctic* in transit and survey area regions. For both vessels, the majority of PSO effort occurred within the project survey area. PSO effort was greater for the *Norseman* during both survey and transit periods due to the zigzag survey design and higher mean speed of the *Norseman*.

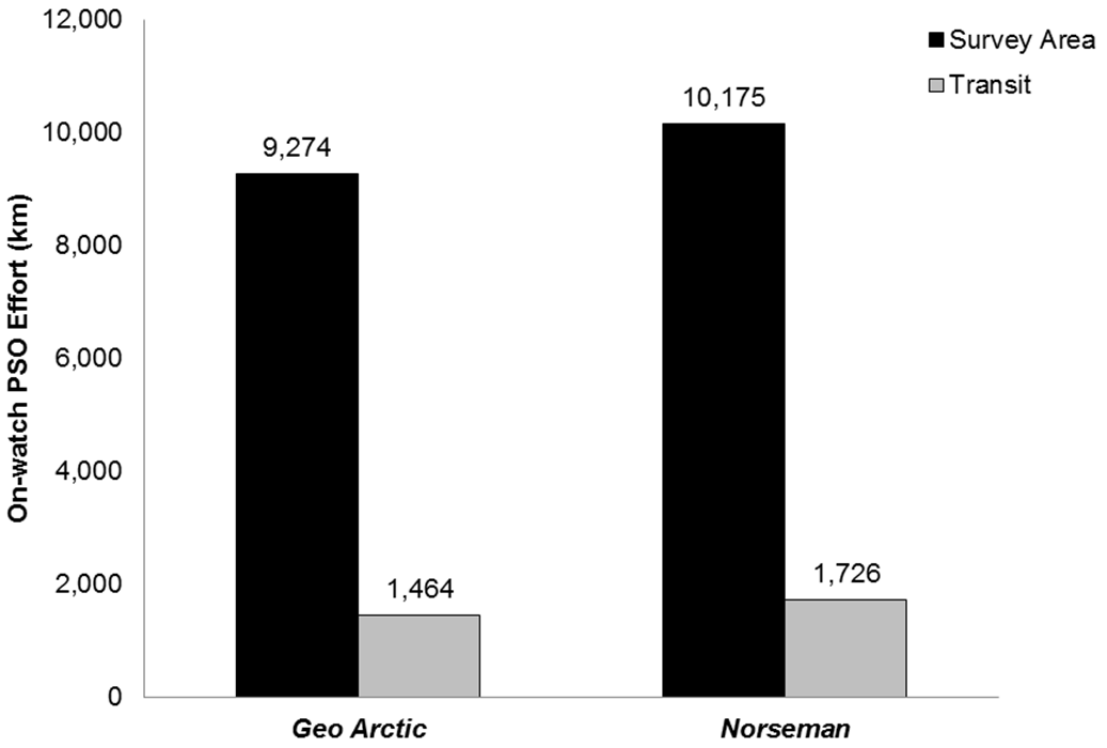

Figure 5.2-1. On-watch PSO observation effort (km) by survey and transit area from the *Geo Arctic* and *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Effort by Daylight and Darkness

On-watch PSO effort during daylight and dark periods is shown in Figure 5.2-2. Observers on the *Geo Arctic* conducted 1,169 fewer km of observations in the daylight than compared to the *Norseman*. As the project progressed, darkness hours increased and PSOs went off-watch during the night. However, they maintained presence on the bridge or nearby in the event that animals were encountered and mitigation necessary.

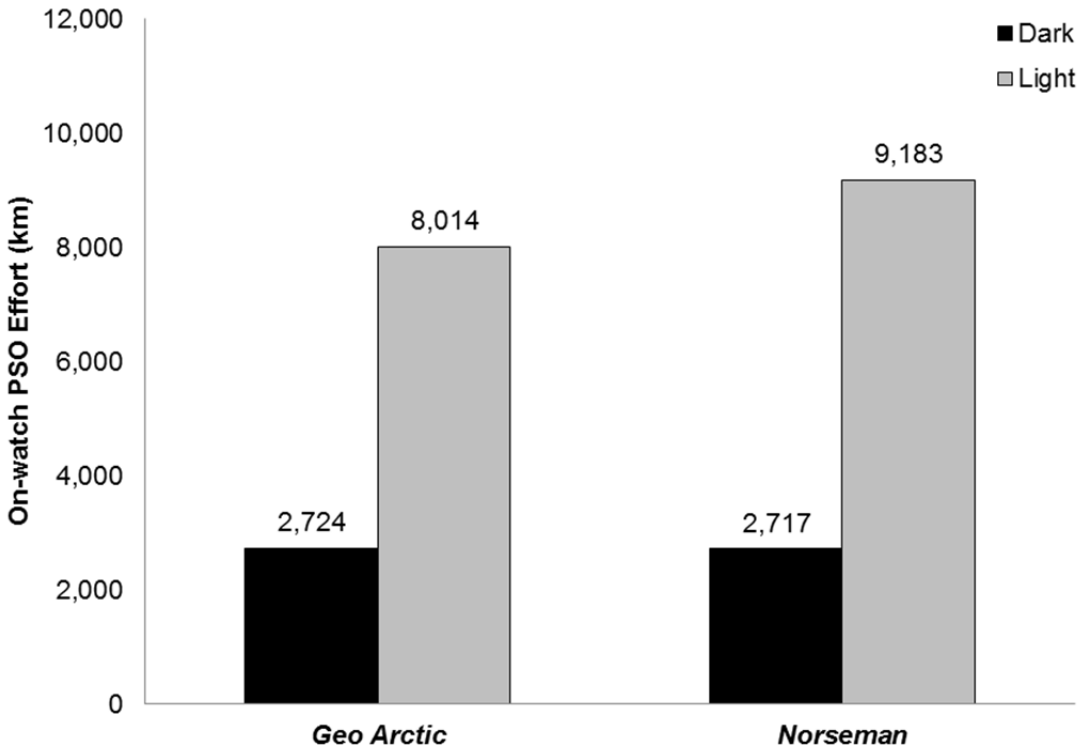

Figure 5.2-2. On-watch PSO effort (km) by light and dark observation periods for the *Geo Arctic* and the *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Effort by Number of PSOs

The number of PSOs on-watch varied from one to three observers depending on the vessel platform and associated monitoring requirements and bunk space limitations, vessel activity (e.g., two PSOs were required to be on-watch on the *Geo Arctic* during ramp ups), and marine mammal activity (e.g., additional PSOs were sometimes called on-watch when marine mammals were sighted) (Figure 5.2-3). Two PSOs were on-watch during the majority of on-watch effort on both vessels. One PSO was on-watch more frequently on the *Norseman* (3,788 km) than on the *Geo Arctic* (1,105 km). The *Geo Arctic* conducted 9,615 km of watch effort while two PSOs were on-watch compared to the *Norseman*'s 8,808 km of watch effort with two PSOs. Two PSOs were on-watch on the source vessel at least 30 minutes prior to initiation of any airgun activities, during ramp-up and as often as possible during daylight seismic activities. One PSO was on-watch more often on the *Norseman* because it had fewer PSOs due to less bunk space onboard and because of the different monitoring requirements. Few observations were conducted with three PSOs on-watch from either vessel. Three PSOs were typically on-watch together only when there were multiple sightings occurring in short duration which occurred most often during transit periods.

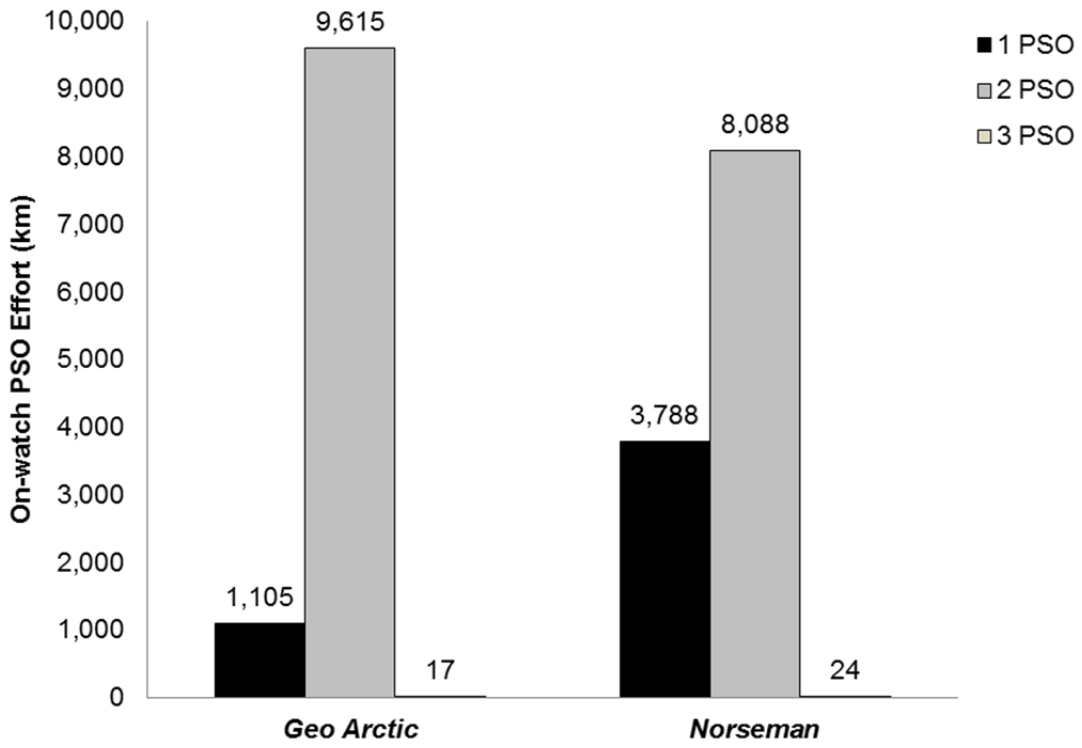

Figure 5.2-3. On-watch PSO effort (km) by number of PSOs for the *Geo Arctic* and the *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Effort by Sea State

On-watch PSO effort from the *Geo Arctic* occurred during Beaufort sea states zero through 10 compared to zero to seven for the *Norseman* (Figure 5.2-4). The *Geo Arctic* PSO effort was greater than the *Norseman* PSO effort in higher sea states (≥4, excluding 5) and zero. There was no *Norseman* effort during sea states ≥8 because it was less safe to observe from the smaller vessel during high sea states. The greatest amount of PSO effort for both vessels occurred during Beaufort three (37% of the combined total of 19,328 km of PSO effort).

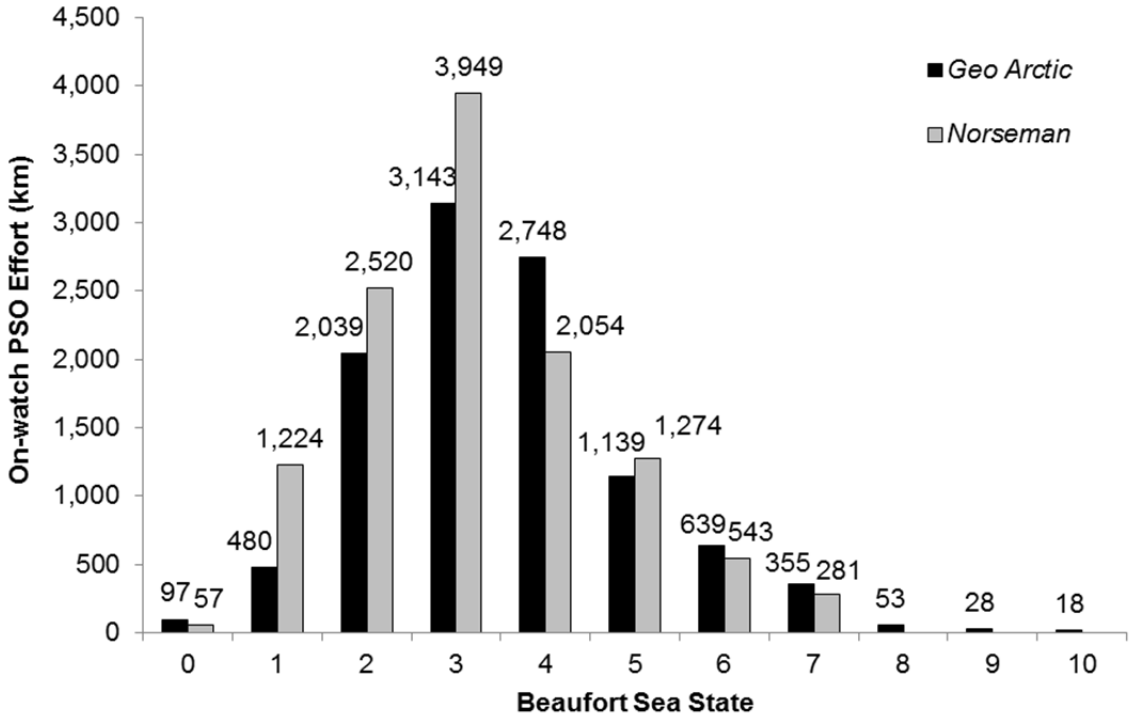

Figure 5.2-4. On-watch PSO effort (km) by Beaufort sea state for the *Geo Arctic* and the *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Effort by Visibility

On-watch PSO effort from the *Geo Arctic* and the *Norseman* occurred during visibility of greater than zero km through 10 km (Figure 5.2-5), where 10 indicated maximum visibility to the horizon. The greatest amount of PSO effort on the *Geo Arctic* occurred during a visibility of 10 km; in contrast, the *Norseman*'s greatest effort occurred when visibility was > zero km to <1 km. The most logical explanation for this difference in visibility was that PSOs aboard the *Geo Arctic* could see farther than PSOs on the *Norseman* due to the higher PSO eye height aboard the *Geo Arctic* at 10.5 m above sea level (ASL) versus 4.8 m ASL from the *Norseman.* In addition, *the Norseman* remained an average distance of 7.5 km ahead of the *Geo Arctic* where there was the possibility of each vessel encountering different fog banks independently of the other.

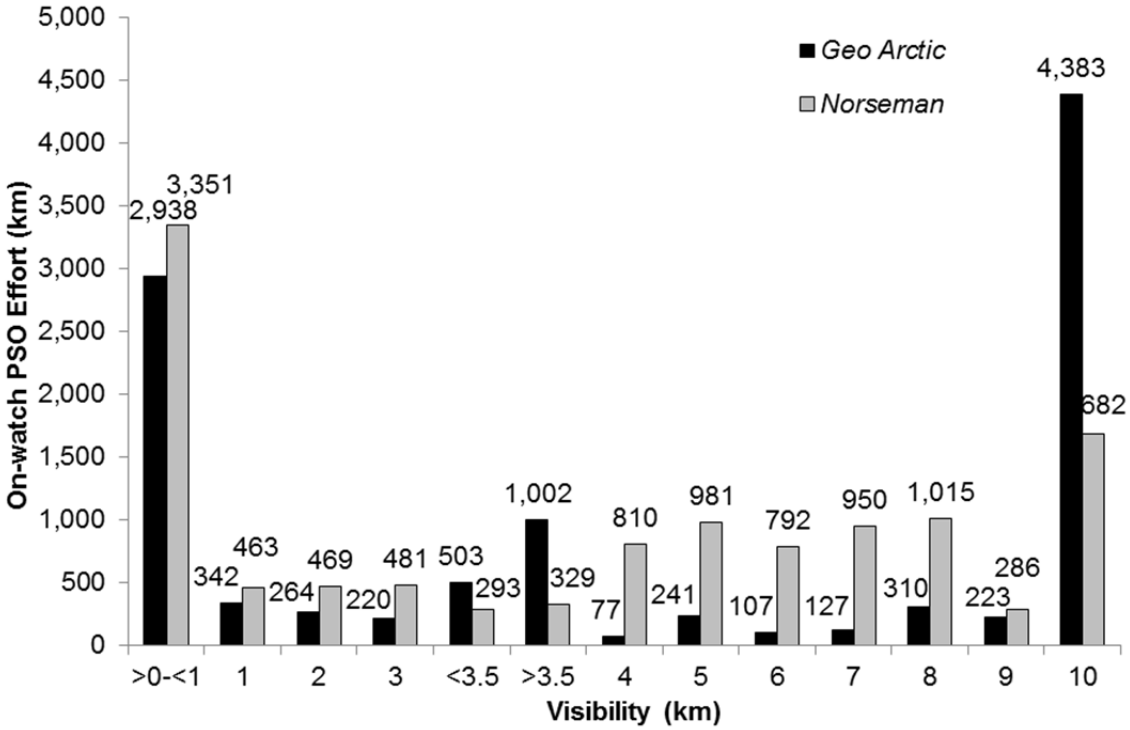

Figure 5.2-5. On-watch PSO effort (km) by visibility distance from the *Geo Arctic* and the *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013. Visibility classifications of <3.5 km and >3.5 km indicate periods when visibility was reduced unevenly across the visual field due to environmental factors such as quickly moving fog banks or low-hanging clouds that differentially impaired different portions of the PSO search area.

Effort by Water Depth

PSO effort from the *Geo Arctic* and the *Norseman* occurred where water depth ranged from 5 m to 3,892 m. For analysis purposes, water depth was separated into three categories following those applied by JASCO for seismic sound modeling (Table 4.2-1) relative to Arctic shelf bathymetry within the survey area: <40 m, 40 to 100 m, and >100 m (Figure 5.2-6). The greatest amount of PSO effort for both vessels occurred over depths of 40 to 100 m, with comparable effort in >100 m depth zones. This corresponds to the survey design, with most proposed survey lines located over depths of 40 to 100 m.

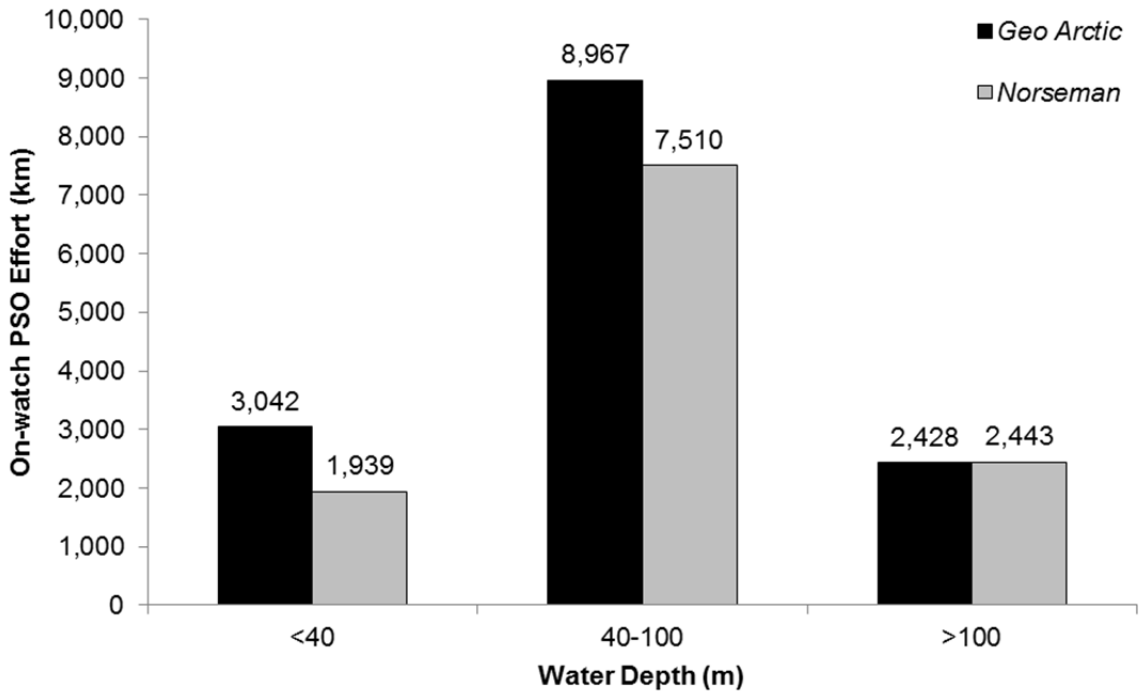

Figure 5.2-6. On-watch PSO effort (km) by three depth zones from the *Geo Arctic* and the *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Effort by Ice Cover

The survey was conducted in primarily (98%) ice-free waters; however freeze-up due to high latitudes and the late fall season resulted in occasional encounters with new sea ice. In total, 25,819 km were conducted in waters free of ice. Periods of operation in waters with some ice coverage totaled 245 km for the *Geo Arctic* and 305 km for the *Norseman.*

Effort by Latitude

Overall, 86% of on-watch PSO effort from both vessels occurred at latitudes south of 72° N (Figure 5.2-7). The *Norseman*, which traveled in a zigzag pattern, had slightly more PSO effort at latitudes south of 72° N and at latitudes north of 72° N than the *Geo Arctic*.

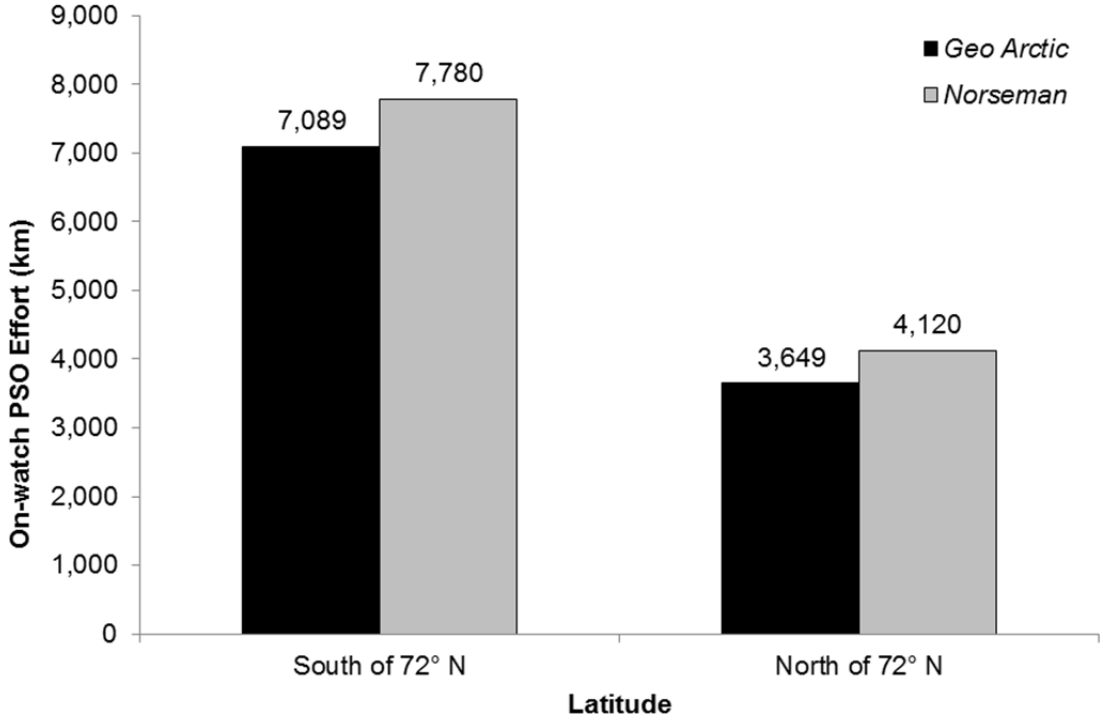

Figure 5.2-7. On-watch PSO effort (km) by latitudes from the *Geo Arctic* and the *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Effort by Seismic Status

Of all on-watch PSO effort from both vessels, 50% occurred while the airguns were at full array, followed by periods of non-seismic activity (40%) and one mitigation airgun (10%) (see Figure 5.2-8). This pattern was similar for both vessels. Notably, while the single mitigation airgun was operating from the *Geo Arctic*, marine mammals observed from the *Norseman* were exposed to received TGS seismic sound levels of <160 dB re 1 µPa [rms], since the *Norseman* operated well outside the 1.5 km, 160 dB re 1 µPa [rms] zone of influence from the *Geo Arctic*.

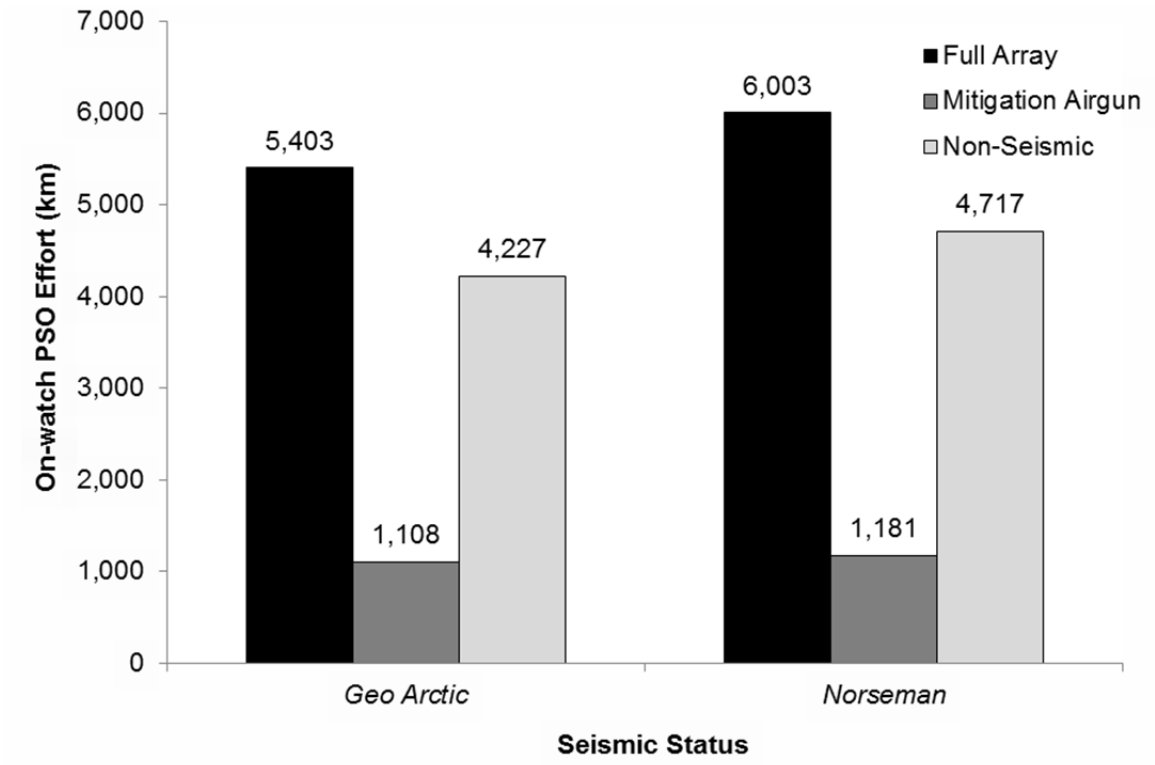

Figure 5.2-8. On-watch PSO effort (km) for the *Geo Arctic* and the *Norseman* by seismic status during TGS' seismic survey, 25 August to 31 October 2013. PSO effort during full array includes both vessels. When the single mitigation airgun was operating from the *Geo Arctic*, marine mammals within 1.5 km of this airgun were modeled to be exposed to received seismic sound levels of ≥160 dB re 1 µPa (rms). However, marine mammals seen from the *Norseman* at these times were exposed to seismic sound levels <160 dB re 1 µPa (rms) since the *Norseman* remained an average of 7.5 km ahead of the *Geo Arctic*. Non-seismic data represent periods when PSOs were on-watch on both vessels and no TGS airguns were operating.

5.2.2 Sightings

In total, 480 sightings made from both vessels (Figure 5.2-9 and Table 5.2-2). Of these, 151 (31%) were seen from the *Geo Arctic* and 329 (69%) were observed from the *Norseman*. PSOs observed 713 individual marine mammals; 235 (33%) from the *Geo Arctic* and 478 (67%) from the *Norseman*. All mammals were identified to at least cetacean or pinniped classification, except for one unknown individual. Of the total 480 sightings, 64% (305 sightings of 468 animals) were considered "usable" because they were seen during conditions meeting the associated usable criteria described in Section 5.1.2.1 (see Figure 5-1).

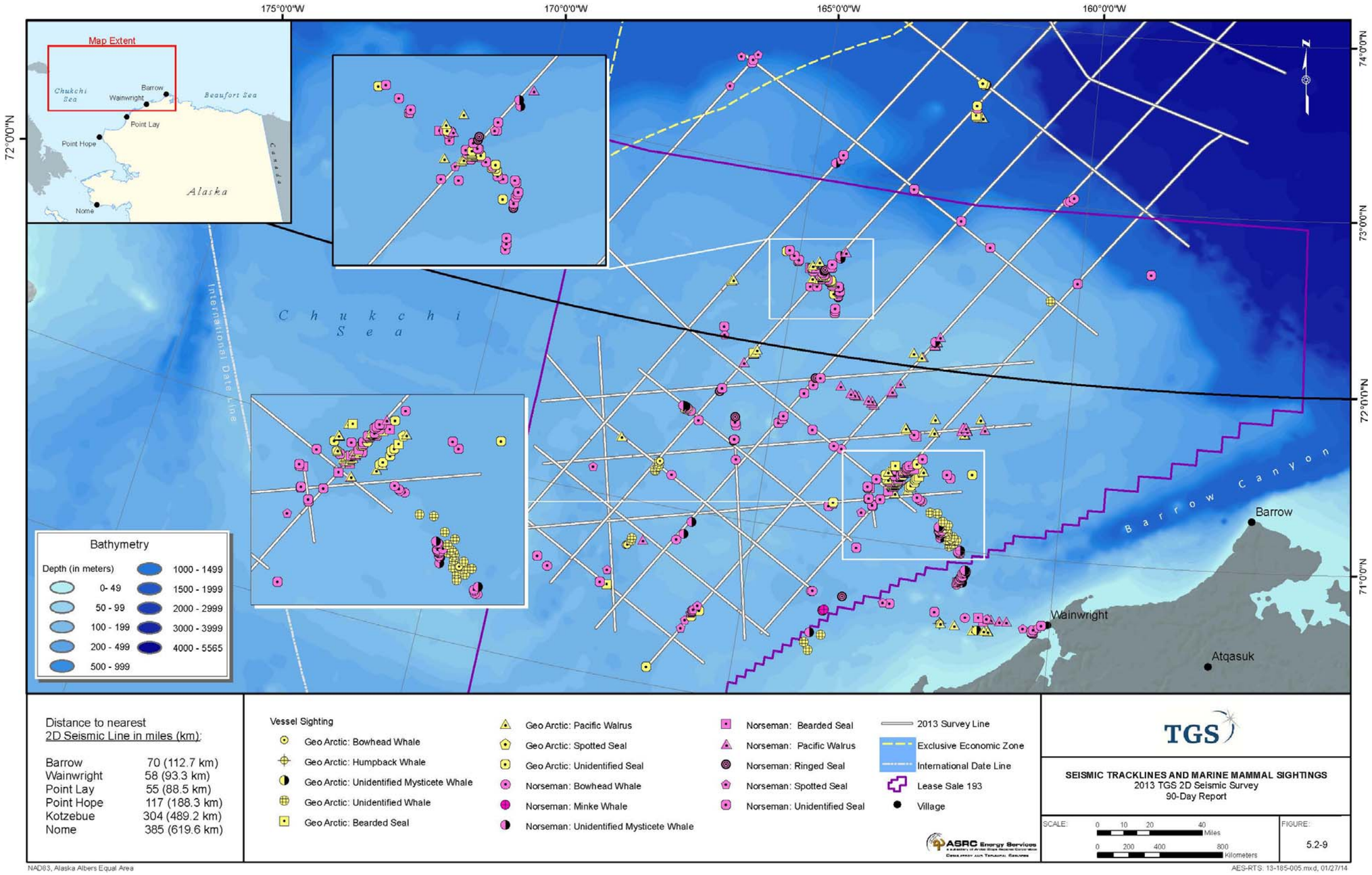

Figure 5.2-9. Seismic Tracklines and Marine Mammal Sightings

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Table 5.2-2. Total sightings from each vessel during the TGS 2D seismic operations, 25 August to 31 October 2013.

Vessels	Number of Sightings	Number of Animals
Geo Arctic	151	235
Norseman	329	478
Total	**480**	**713**

5.2.3 Cetaceans

Of the total 480 cetacean sightings, 116 were observed throughout the entire project conditions from both vessels (Table 5.2-3 and Figure 5.2-10). Of these, 44% (51 sightings) were seen from the *Geo Arctic,* with the remaining 56% (65 sightings) observed from the *Norseman.*

Overall, the most frequently observed cetacean identified to species from both vessels during was the bowhead whale (43% of cetacean sightings). Nearly all (90%) of these bowhead sightings were made from the *Norseman*, many during transits to and from Wainwright while the *Geo Arctic* remained in the project area. As a result of this difference, the *Geo Arctic* bowhead whale sightings accounted for 4% of cetacean sightings, while the *Norseman*'s bowhead sightings comprised 73%. However, an additional 39 sightings of unidentified whales or unidentified mysticete whales were seen from the *Geo Arctic*, compared to 18 such sightings from the *Norseman* (Table 5.2-3). Gray whales were observed only from the *Geo Arctic* (five sightings) as was the one sighting of humpback whales (observed twice on one occasion). Minke whales were seen from both vessels: one sighting from the *Geo Arctic* and two sightings from the *Norseman.* The only harbor porpoise sighting was observed from the *Norseman*.

Table 5.2-3. The number of cetacean sightings and individuals) observed during usable sighting conditions from the *Geo Arctic* and *Norseman* during the TGS 2D seismic operations, 25 August to 31 October 2013.

Species	*Geo Arctic*		*Norseman*		Total	
	Sightings	Animals	Sightings	Animals	Sightings	Animals
Bowhead Whale	5	4	44	86	**49**	**90**
Gray Whale	5	12	0	0	**5**	**12**
Harbor Porpoise	0	0	1	2	**1**	**2**
Humpback Whale	1	2	0	0	**1**	**2**
Minke Whale	1	1	2	2	**3**	**3**
Unident. Mysticete Whale	3	12	17	29	**20**	**41**
Unident. Whale	36	60	1	1	**37**	**61**
Total Cetaceans	**51**	**91**	**65**	**120**	**116**	**211**

Note: All sightings from periods of on-watch effort

It should be noted that a number of factors significantly influenced sighting rates. Thus, there were likely interactions between these variables that cannot be assessed with simple χ^2 contingency analyses. However, more complex analyses could not be conducted within the required 90-day reporting period on such a large database.

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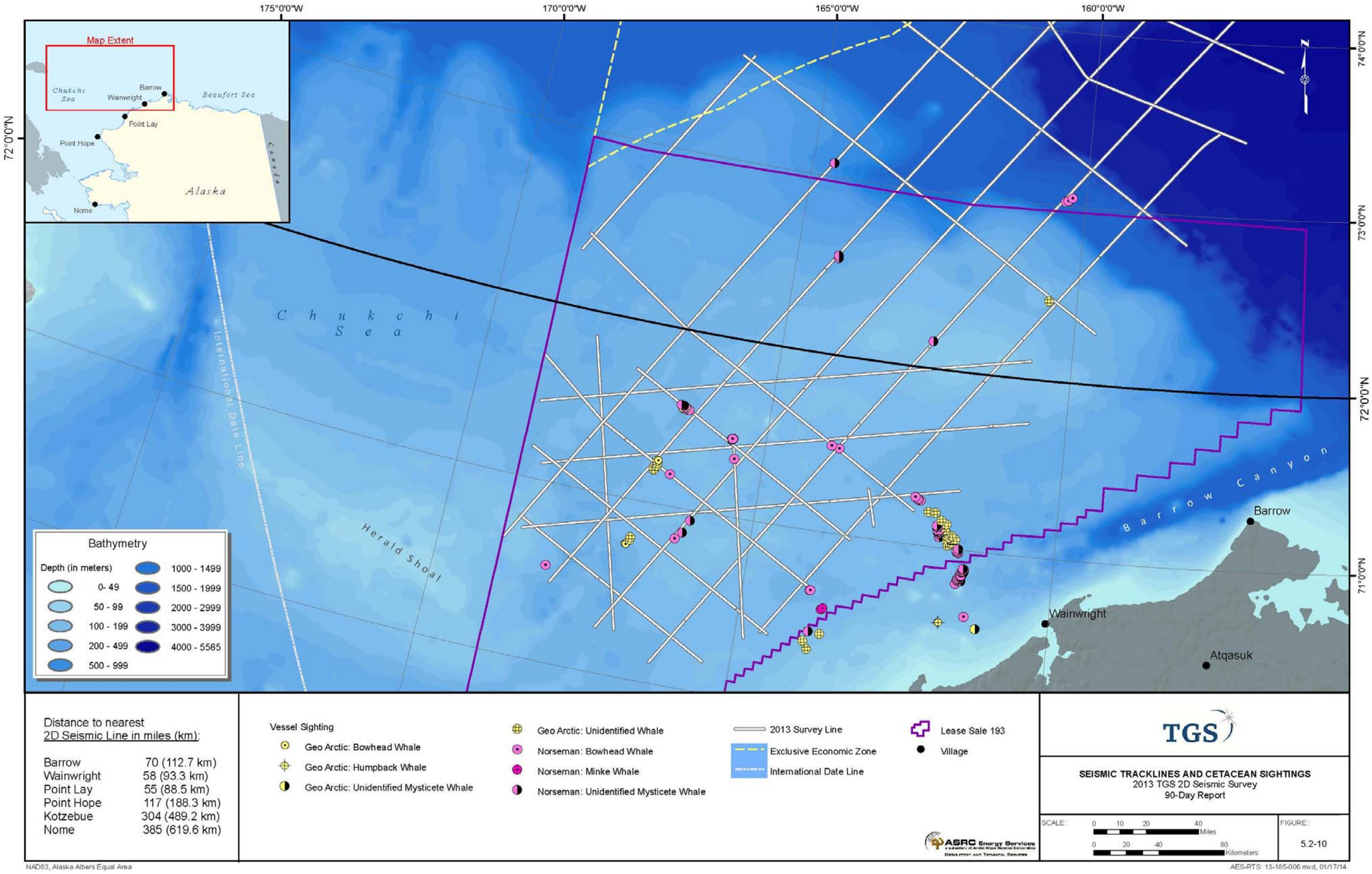

Figure 5.2-10. Seismic Tracklines and Cetacean Sightings

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5.2.3.1 Cetacean Sighting Rates

For reasons described under methods in Section 5.1.2.1, all analyses of cetacean sighting rates are limited to usable sightings.

Cetacean Sighting Rates by Seismic Status

To compare seismic versus non-seismic periods, cetacean sighting rates based on usable effort were compared for three seismic status periods: while the full array was operating, while only the one mitigation airgun was operating, and when no TGS seismic operations were occurring (see Section 5.1.2.1 for criteria description). The highest sighting rates from each vessel occurred during non-seismic periods and was similar for both vessels (21 sightings per 1,000 km of usable PSO effort) (Figure 5.2-11). The cetacean sighting rate was over four times lower during full array periods, especially from the *Geo Arctic* source vessel (0.8 sightings per 1,000 km of usable PSO effort). Sighting rate was similarly low from both vessels when only the single mitigation airgun was on (3 sightings per 1,000 km of usable PSO effort).

Statistical analysis using a χ^2 contingency test was used to compare cetacean sighting rates by seismic (combination of full array and mitigation airgun) and non-seismic periods. Data from each vessel were pooled. There were significant differences (χ^2, $p < 0.0001$) in sighting rates during times of seismic (≥160 dB re 1 µPa [rms]) and non-seismic (<160 dB re 1 µPa [rms]) activities (Table 5.2-4). Moreover, the sighting rate was much lower from the *Geo Arctic* than the *Norseman* during full array periods, and thus received seismic sound levels were higher near the *Geo Arctic* source vessel. The relatively low sighting rates from both vessels while the single mitigation airgun was operating also suggests that these lower seismic sound levels may have resulted in avoidance behavior by cetaceans and/or behavior that reduced their sightability to PSOs (such as increased dive times—e.g., see Robertson [2014]) as these times were linked with seismic sounds vs non-seismic periods. It is also possible that locations of non-seismic periods may have happened to coincide with areas where cetaceans tended to occur.

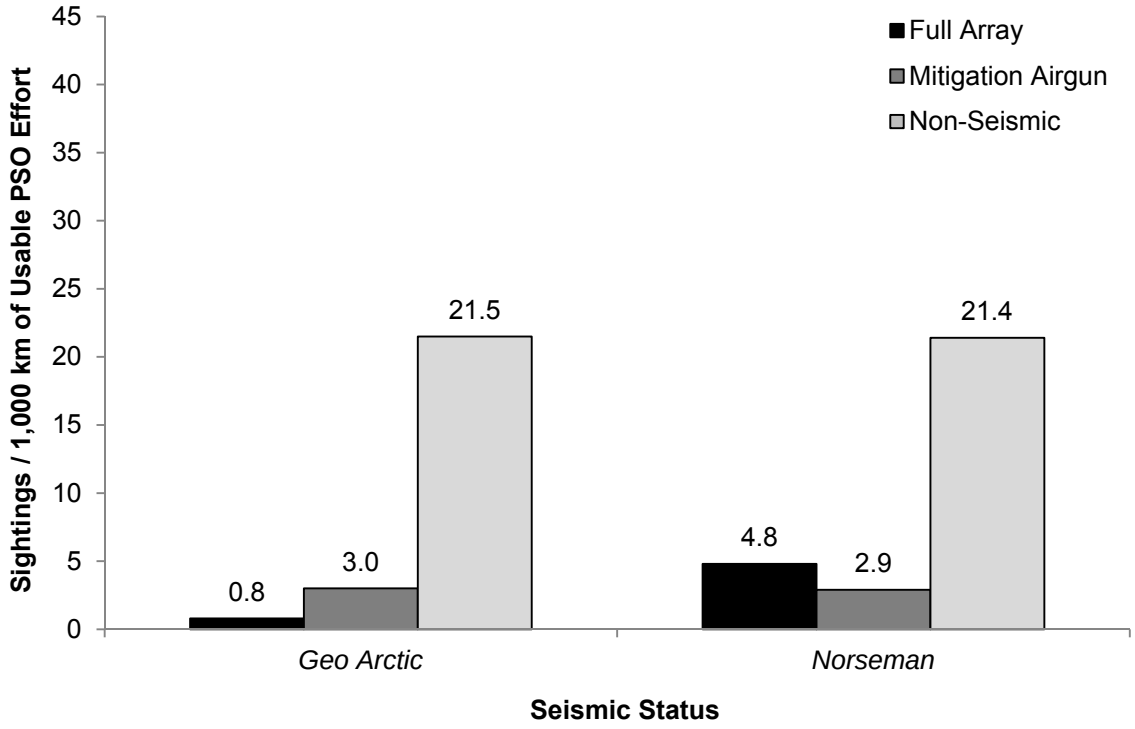

Figure 5.2-11. Cetacean sighting rates by seismic activity for each vessel during TGS' seismic survey, 25 August to 31 October 2013. Usable PSO effort during full array represents periods when the full array was operating from the *Geo Arctic*. Monitoring when the mitigation gun was operating represents received seismic sound levels of ≥160 dB re 1 µPa (rms) within 1.5 km of the *Geo Arctic* and <160 dB re 1 µPa (rms) for the *Norseman.* Non-seismic data incorporates times on both vessels when PSOs were on-watch and no TGS seismic operations were occurring.

Table 5.2-4. *p-values* for Cetacean Sighting Rates. Comparison of sighting rates to differing environmental factors using a Chi-squared (χ^2) contingency test. Note, sighting rates were not analyzed against percent ice cover due limited data availability in usable sighting rates.

Categories	*Geo Arctic* (n = 38)	*Norseman* (n = 53)	Combined (n = 91)
Seismic Status	< 0.0001*	< 0.0001*	< 0.0001*
Beaufort Sea State	-	-	< 0.001*
Visibility (km)	-	-	< 0.0001*
Depth (m)	-	-	0.001*
Number of PSOs	-	-	<0.001*
Latitude (North and South of 72° N)	0.88	0.89	0.84

*indicates p ≤0.05
Note: Chi-squared test for contingency was analyzed separately per vessel and each category was analyzed independently.
°N = degrees north
km = kilometer
m = meter
n = number

Cetacean Sighting Rates by Beaufort Sea State

Usable cetacean sightings from the *Geo Arctic* occurred between Beaufort sea states two through four (Figure 5.2-12). The highest cetacean sightings rate from both vessels occurred during Beaufort sea state four, although the *Norseman* sighting rate was over twice as high as the *Geo Arctic* at these times (12.9 and 27.9 sightings per 1,000 km of PSO effort, respectively). Notably, cetacean sighting rates from the *Norseman* was 30% higher during Beaufort sea state four versus three. Data were pooled from both vessels and analyzed statistically using a χ^2 contingency test between Beaufort sea states two through four. Cetacean sighting rates were significantly different between Beaufort sea states (χ^2, $p < 0.001$; see Table 5.2-4).

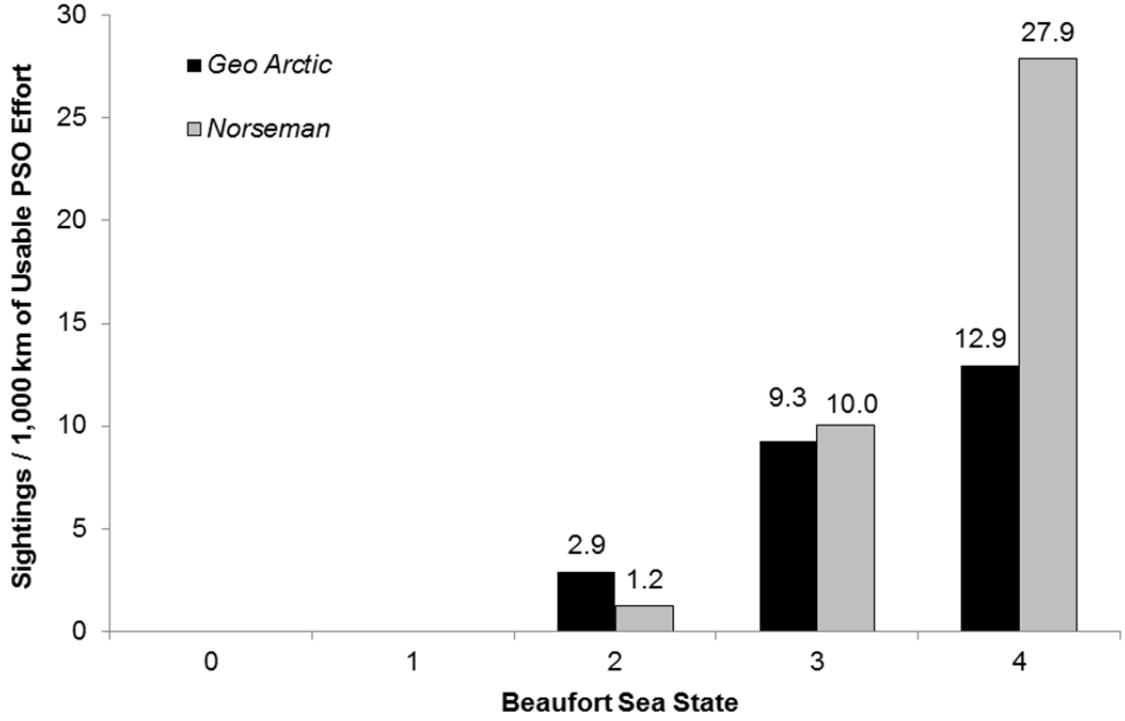

Figure 5.2-12. Cetacean sighting rates during Beaufort sea state conditions during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded for that category.

Cetacean Sighting Rates by Visibility

The minimum acceptable visibility for usable cetacean sightings was at least 1 km. The highest sighting rate from the *Norseman* occurred when visibility was 3 km compared to the highest sighting rate from the *Geo Arctic* when visibility was 6 km (Figure 5.2-13). Sighting rates were broken into ≤ 5 km and > 5 km for statistical analysis based on sighting rate data. These were then pooled together from each vessel for analysis. There were significant differences (χ^2, $p < 0.0001$; Table 5.2-4) in cetacean sighting rates based visibility (km). Therefore, it can be presumed that higher numbers of cetacean sightings occur when visibility is greater than 5 km.

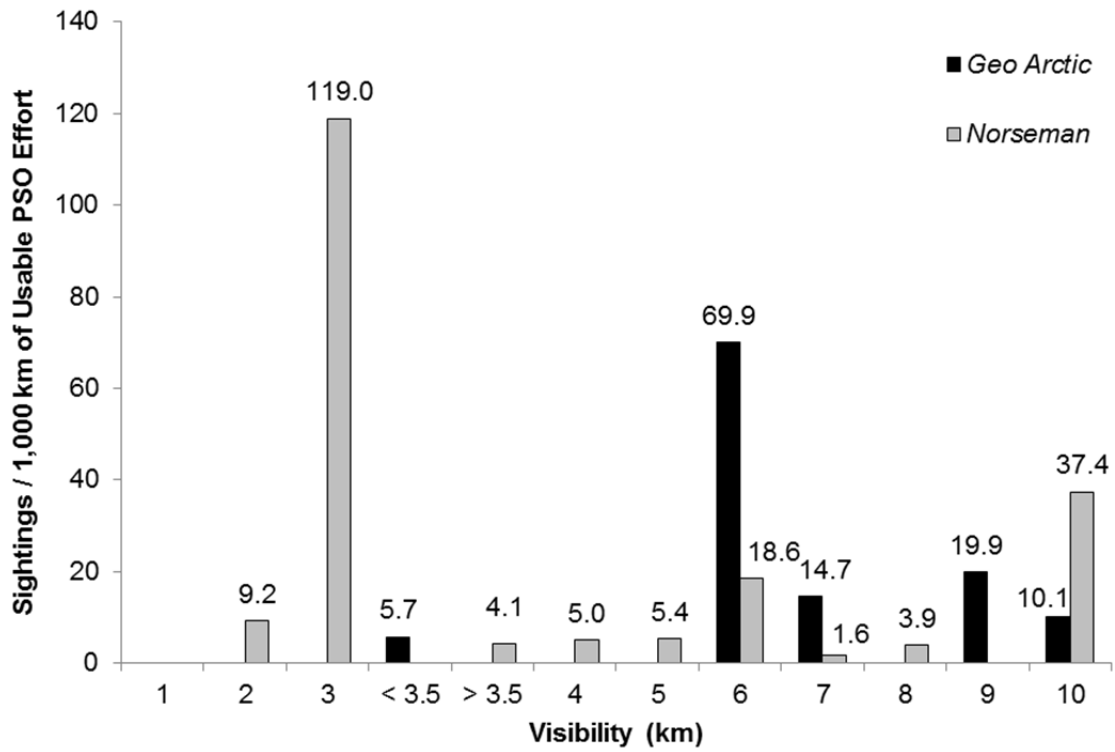

Figure 5.2-13. Cetacean sighting rate by visibility distance (km) categories during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded for that category.

Cetacean Sighting Rates by Water Depth

Usable cetacean sighting rates for both vessels were much higher over intermediate water depths (40 to 110 m) than shallower or deeper depth categories (Figure 5.2-14). Very few usable sightings occurred in waters deeper than 100 m. There were no usable sightings in waters deeper than 100 m for the *Geo Arctic* nor for the *Norseman* in waters <40 m deep. At depths of 40 to 100 m, the *Geo Arctic* and *Norseman* sighting rates were 33.9 and 54.6 sightings per 1,000 km of PSO effort, respectively. These highest sighting rates correspond with depths were the greatest amount of effort occurred. Due to limited data, analyses were conducted on pooled data from each vessel. Water depth was a significant factor in cetacean sighting rates (χ^2, $p \leq 0.001$; see Table 5.2-4) with significantly more cetaceans observed in waters less than, versus deeper than, 100 m.

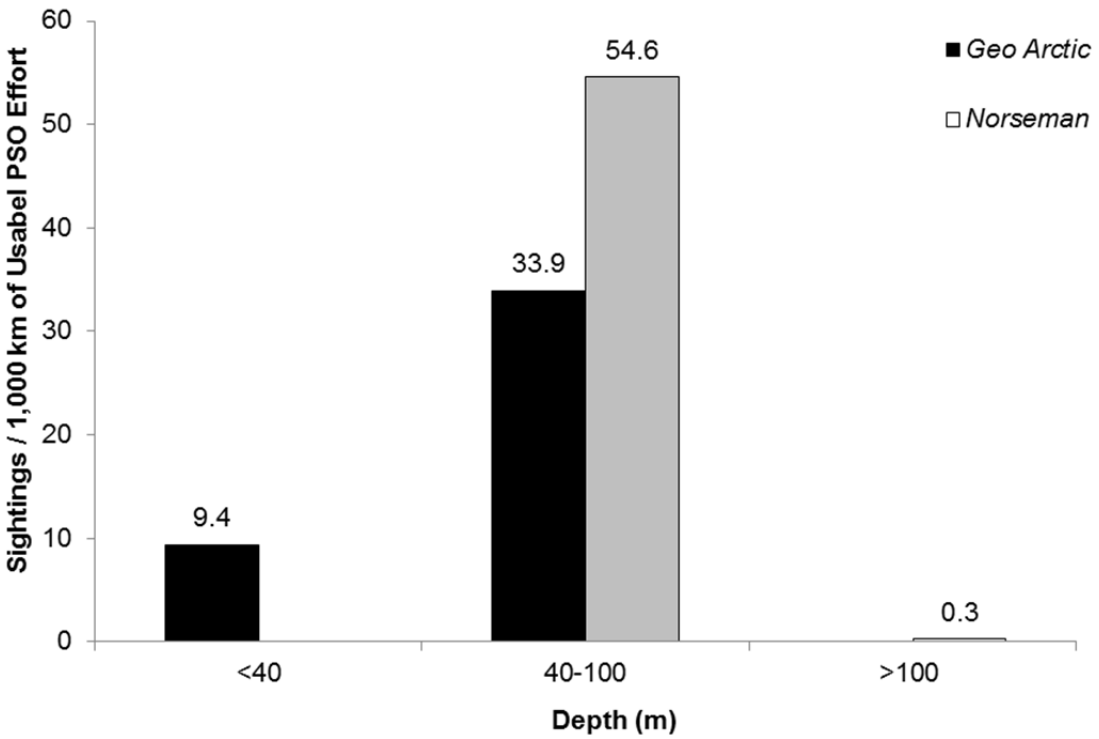

Figure 5.2-14. Cetacean sighting rates by water depth zones during the TGS 2D seismic operations, 25 August to 31 October 2013. Visibility classifications of <3.5 km and >3.5 km indicate periods when visibility was reduced unevenly across the visual field due to environmental factors such as quickly moving fog banks or low-hanging clouds that differentially impaired different portions of the PSO search area. The absence of a bar indicates no data were recorded for that category.

Cetacean Sighting Rates by Number of PSOs On-Watch

Cetacean sighting rate varied with the number of PSOs on-watch at the time (Figure 5.2-15). The sighting rate was highest when three PSOs were on-watch from the *Geo Arctic* (695.5 cetacean sightings per 1,000 km of effort); notably, three PSOs were never on-watch from the *Geo Arctic*. Sighting rates were second highest while one PSO was on-watch from both the *Norseman* and the *Geo Arctic*; these rates were 16 to 26 times lower than periods when three PSOs were on-watch from the *Norseman.* For both vessels, the lowest cetacean sighting rates occurred while two PSOs were on-watch (7.6 and 3.2 cetacean sightings per 1,000 km of watch effort from the *Geo Arctic* and *Norseman,* respectively). Sighting rate data were pooled from each vessel due to limited data availability for each category. This was then analyzed against the number of PSOs. Sighting rates were significantly higher (χ^2, $p < 0.001$; see Table 5.2-4) when three PSOs were on-watch. This was because more observers were needed on-watch when the vessel encountered large numbers of animals in a short period of time over a short duration (thus skewing the sighting rates higher). Most occasions with one and three PSOs on-watch occurred during transit when there were no seismic activities.

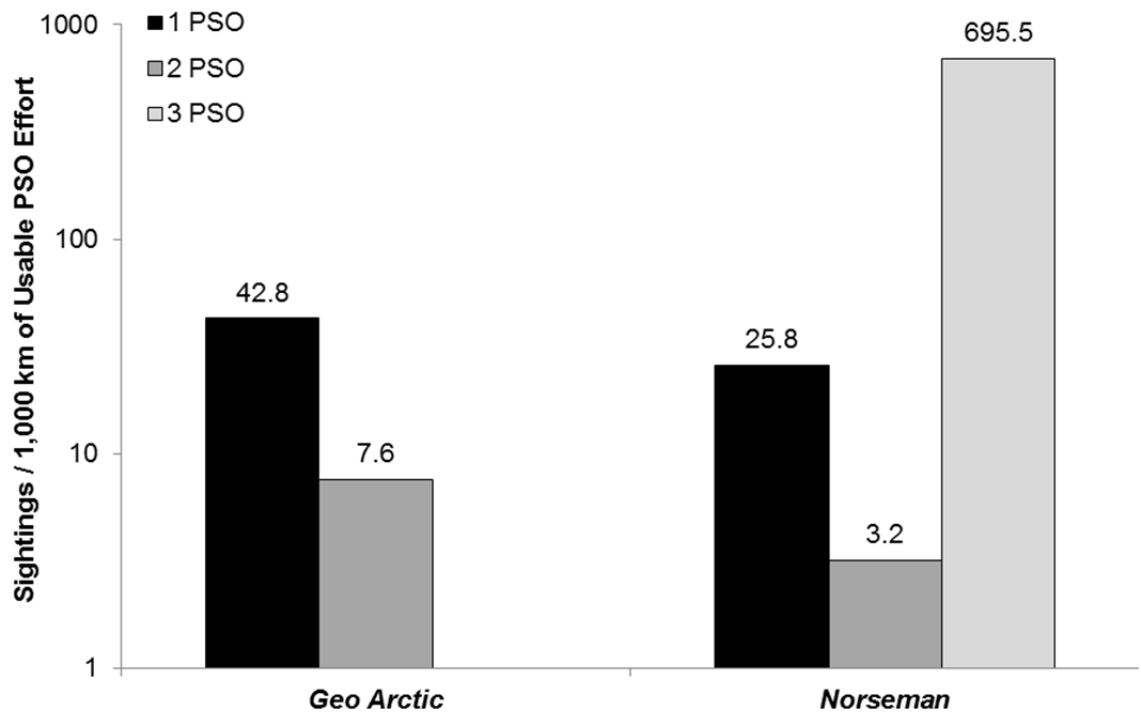

Figure 5.2-15. Cetacean sighting rate by the number of PSOs on-watch during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded for that category.

Cetacean Sighting Rates by Latitude

Cetacean sighting rates were considerably higher south of 72° N from both the *Geo Arctic* and the *Norseman* (92% and 89%, respectively) (Figure 5.2-16). Sighting rate data were first analyzed for each vessel independently against latitude, and then by pooling the vessel data together. The differences in sighting rates between the two vessels and with the pooled data were not significant (χ^2, p >0.05; see Table 5.2-4) and were expected given the higher latitudes. This could be due to several compounding factors including, the amount of time spent surveying north of 72° N, as compared to south of 72° N. Additional influences that could contribute to the lower sighting rates were water depth, sea state, visibility and an assortment of other factors. Most of the survey north of 72° N was in water > 100 m.

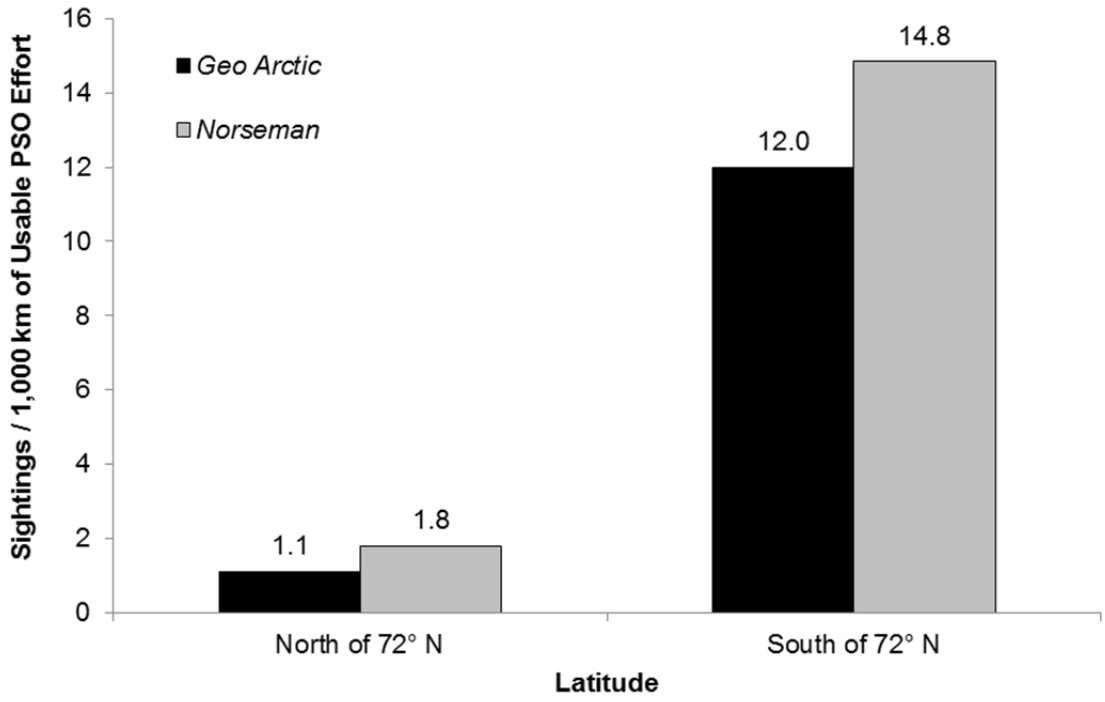

Figure 5.2-16. Cetacean sighting rates by regions north and south of the 72° N latitude line during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded for that category.

Cetacean Sighting Rates by Percent Ice Cover

Usable sighting data for cetacean was limited to periods with no ice. Based on usable PSO effort, the overall cetacean sighting rate from the *Geo Arctic* in ice-free waters was slightly lower than that from the *Norseman* (8.4 versus 10.0 sightings per 1,000 km of PSO effort, respectively).

5.2.3.2 Cetacean Movement

Cetacean movement during the survey was categorized as "parallel", "no movement", "swim away", "swim towards", or "unknown" (Table 5.2-5). During full-array periods, at least 50% of all sightings were moving away or towards both vessels versus exhibiting no or neutral movement. In comparison, during non-seismic periods, sightings were more likely to exhibit no or neutral movement (54%) versus movement away (39%) based data from both vessels. Neutral movement indicates the cetaceans were swimming parallel to the vessel (neither towards nor away). Sample sizes were too small for movement during periods with the single mitigation airgun operating to identify any trends.

Table 5.2-5. Number of cetacean sightings by type of movement and seismic activity status for each vessel in relation to the 160 dB re 1 µPa (rms) isopleth zones.

Behavior	***Geo Arctic***		***Norseman***	
	Seismic	Non-seismic	Seismic	Non-seismic
None	3 (3; 0)	20	5 (3; 2)	17
Parallel	1 (0; 1)	4	2 (2; 0)	10
Swim Towards	3 (3; 0)	12	5 (5; 0)	18
Swim Away	0 (0; 0)	2	3 (2; 1)	5
Unknown	0 (0; 0)	6	0 (0; 0)	0
Total	**7** **(6; 1)**	**44**	**15** **(12; 3)**	**50**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as the number of sightings for each (full array; mitigation airgun).

5.2.3.3 Cetacean Behavior

The first behavior observed for each sighting was recorded as initial behavior (Table 5.2-6). Blow (46%), resting (24%), and swim (24%) were the three most common behaviors observed during seismic activities. During non-seismic periods, more behaviors were observed, with blow (32%), swim (12%), and travelling (12%) being observed the most frequently.

Table 5.2-6. A comparison of initial cetacean behaviors by seismic activity from each vessel.

Behavior	***Geo Arctic***		***Norseman***	
	Seismic	Non-seismic	Seismic	Non-seismic
Blow	4 (4; 0)	30	4 (3; 1)	39
Breach	0 (0; 0)	2	0 (0; 0)	1
Dive	0 (0; 0)	0	0 (0; 0)	1
Fluke	0 (0; 0)	0	0 (0; 0)	9
Porpoise	0 (0; 0)	1	1 (1; 0)	0
Resting	0 (0; 0)	0	4 (4; 0)	0
Surface Active	0 (0; 0)	0	0 (0; 0)	7
Surface Active Travel	1 (1; 0)	0	0 (0; 0)	14
Swim	2 (1; 1)	7	0 (0; 0)	5
Travelling	0 (0; 0)	3	4 (4; 0)	9
Unknown	0 (0; 0)	1	1 (0; 1)	0
Total	**7** **(6; 1)**	**44**	**14** **(11; 3)**	**85**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.2.3.4 Cetacean Reaction

Nearly all (93%) of the 109 sightings did not react to the vessel, regardless of seismic status or vessel platform (Table 5.2-7). Specifically, all cetacean sightings from the *Geo Arctic* exhibited no reaction. Two of the only three behavioral reactions occurred during non-seismic periods (change in direction and increase in speed); the remaining reaction (look) occurred when the single mitigation airgun was operating.

Table 5.2-7. Comparison of behavioral reactions of cetaceans to seismic activity from each vessel.

Reaction	*Geo Arctic* Seismic	*Geo Arctic* Non-seismic	*Norseman* Seismic	*Norseman* Non-seismic
No Reaction	6 (4; 2)	45	14 (12; 2)	48
Look	0 (0; 0)	0	1 (0; 1)	0
Change in Direction	0 (0; 0)	0	0 (0; 0)	1
Increase Speed	0 (0; 0)	0	0 (0; 0)	1
Total	**6 (4; 2)**	**45**	**15 (12; 3)**	**50**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.2.4 Pinnipeds (excluding Pacific walrus)

A total, there were 284 sightings (296 individuals) of pinnipeds, excluding Pacific walrus, observed from both vessels (Figure 5.2-17 and Table 5.2-8). Most (77%) of these sightings (n=220) were seen from the *Norseman*; the remaining 33% were seen from the *Geo Arctic* (n=64). Unidentified seals accounted for 61% of the overall pinniped sightings, followed by spotted seals (17%) and unidentified pinnipeds (8%).

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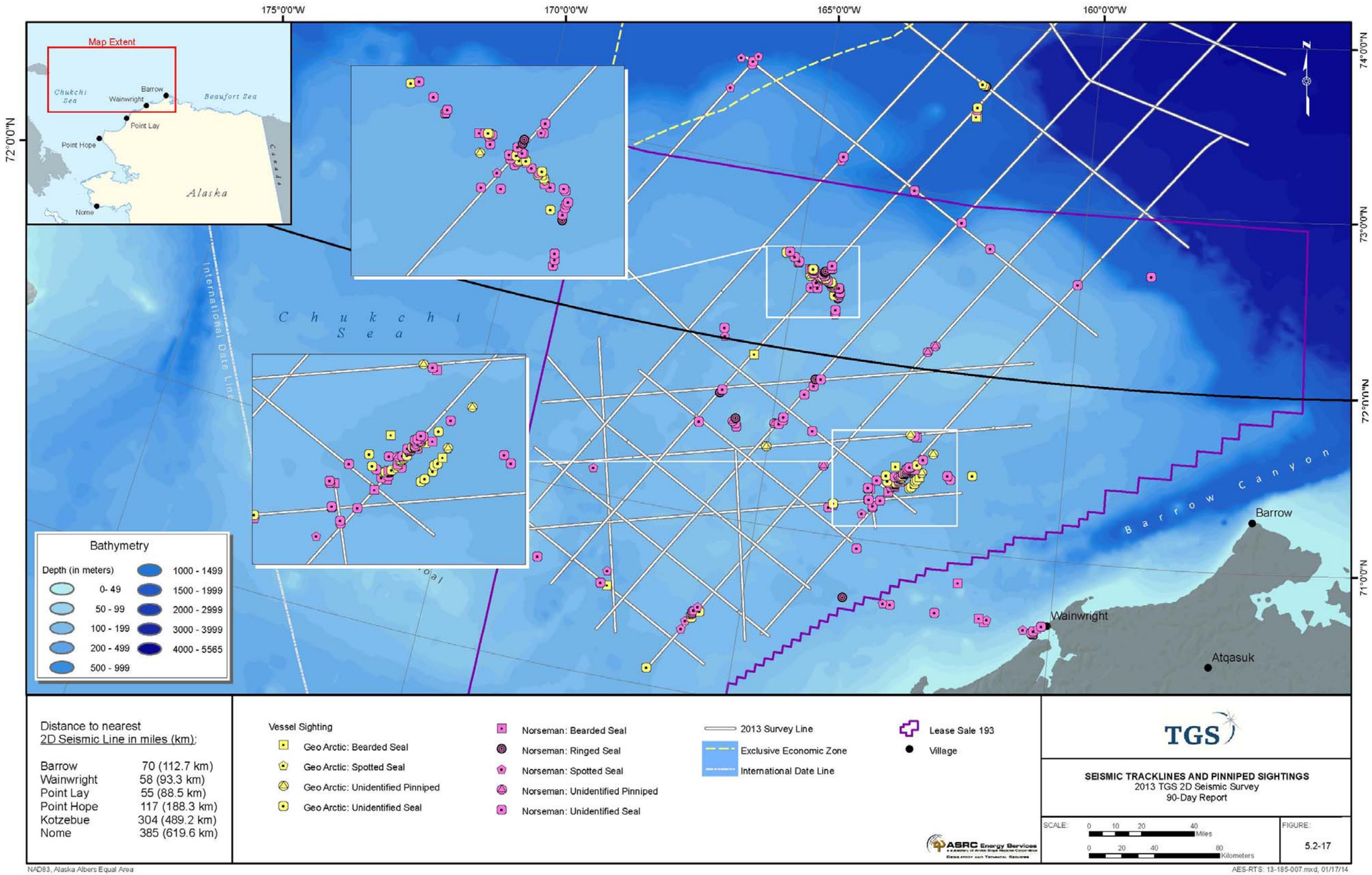

Figure 5.2-17. Seismic Tracklines and Pinniped Sightings

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Table 5.2-8. The number of pinniped sightings and number of individuals during on-watch hours from the *Geo Arctic* and *Norseman* during the TGS 2D seismic survey, 25 August to 31 October, 2013.

Species	*Geo Arctic*		*Norseman*		Total	
	Sightings	Animals	Sightings	Animals	Sightings	Animals
Bearded Seal	8	8	15	15	**23**	**23**
Ribbon Seal	0	0	1	1	**1**	**1**
Ringed Seal	0	0	9	9	**9**	**9**
Spotted Seal	6	6	45	49	**51**	**55**
Unident. Pinniped	9	9	15	17	**24**	**26**
Unident. Seal	41	43	134	138	**175**	**181**
Total Pinniped	**64**	**66**	**220**	**230**	**284**	**296**

Note: All sightings from periods of on-watch effort

5.2.4.1 Pinniped Sighting Rates

Sighting rates were calculated from usable data only.

Pinniped Sighting Rates by Seismic Status

Overall, pinniped sighting rates were highest during non-seismic periods for both vessels (Figure 5.2-18). In particular, from the *Geo Arctic*, sighting rates during non-seismic periods were nearly ten times higher than during full-array periods. In addition, *Geo Arctic* sighting rates were considerably lower when the full array was operating versus when the mitigation airgun was on. The latter difference was not apparent for the *Norseman* sighting rates. The most notable and largest difference between sighting rates for the two vessels occurred during operation of the full array, when the *Norseman* sighting rate was 12 times higher than the *Geo Arctic* sighting rate. The increased sighting rates during full array activities from the *Norseman* were most likely due to its distance (approximately 7.5 km) ahead of the seismic vessel. This spacing resulted in lower received seismic sound levels near the *Norseman* during seismic operations than the *Geo Arctic*, particularly for the single mitigation airgun. Sighting rates for pinnipeds were significantly different (χ^2, $p < 0.01$) when compared between seismic (≥160 dB) and non-seismic (<160 dB) activities for each of the two vessels (Table 5.2-9). The lower sighting rates when both the full array and single mitigation airgun was active suggest that this may be a result of avoidance behavior where animals avoid the area during seismic periods more than non-seismic.

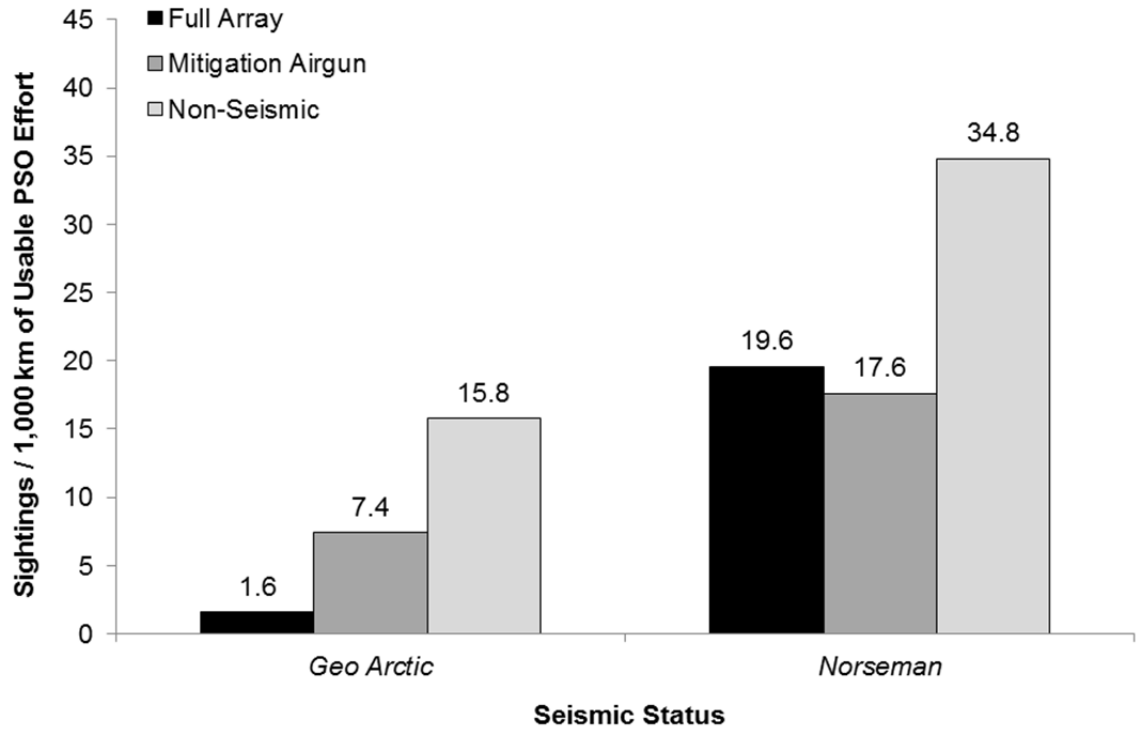

Figure 5.2-18. Pinniped sighting rates by seismic activity for each vessel during TGS' seismic survey, 25 August to 31 October 2013. PSO effort during full array represents periods when the full array was operating from the *Geo Arctic*. Monitoring when the single mitigation airgun was operating represents received seismic sound levels of ≥160 dB re 1 µPa (rms) within 1.5 km of the *Geo Arctic* and <160 dB re 1 µPa (rms) for the *Norseman.* Non-seismic data incorporates times on both vessels when PSOs were on-watch and no TGS seismic operations were occurring.

Table 5.2-9. *p-values* for Pinniped Sighting Rates. Comparison of pinniped sighting rates by various environmental factors using a Chi-squared (χ^2) contingency test. Note that sighting rates were not analyzed by percent ice cover due to small sample sizes for usable sighting rates.

Categories	*Geo Arctic* (n = 34)	*Norseman* (n = 122)	Combined (n = 156)
Seismic Status	0.008*	< 0.0001*	<0.0001*
Beaufort Sea State	-	-	< 0.0001*
Visibility (km)	-	-	< 0.001*
Depth (m)	-	-	< 0.001*
Number of PSOs	-	-	< 0.001*
Latitude (North and South of 72°N)	0.32	0.59	0.26

*indicates p≤0.05
°N = degrees north
n = number

It should be noted that a number of factors significantly influenced sighting rates. Thus, there were likely interactions between these variables that cannot be assessed with simple Chi-squared contingency

analyses. However, more complex analyses could not be conducted within the required 90-day reporting period on such a large database.

Pinniped Sighting Rates by Beaufort Sea State

Usable pinniped sightings were limited to Beaufort sea states zero through four (Figure 5.2-19). Sighting rates for both vessels were highest during Beaufort sea states zero and one, with a notably highest sighting rate during Beaufort sea state zero from the *Norseman* (351.4 sightings per 1,000 km) of PSO effort representing 80% of the *Norseman* sightings. Due to the lower sighting rates on the *Geo Arctic,* data were pooled for each Beaufort sea state and a χ^2 contingency test was run comparing sighting rates to sea states. Sighting rates were significantly different (χ^2, $p < 0.001$; see Table 5.2-9) based on Beaufort sea state levels. Most sightings were of the body (usually only the head) which is small and becomes more difficult to locate with increasing sea states.

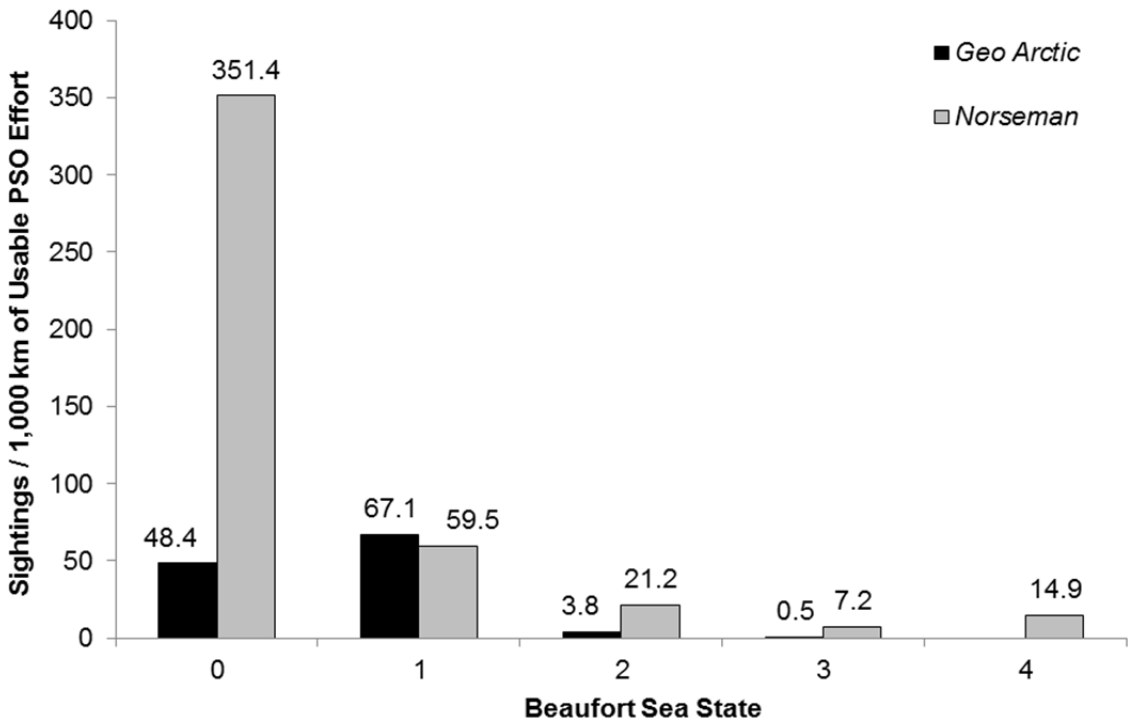

Figure 5.2-19. Pinniped sighting rates by Beaufort sea state and vessel conditions during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded from that category.

Pinniped Sighting Rates by Visibility

The minimum acceptable visibility for usable pinniped sightings was at least 1 km. Sightings rates were highest from both vessels when visibility was 9 km (Figure 5.2-20). Due to limited data availability vessel data were pooled for statistical testing, omitting the variable category of < or > 3.5 km. Sighting rates of pinnipeds were significantly different (χ^2, p <0.001; see Table 5.2-9) when compared to the amount of visibility indicating sightability is heavily correlated with visibility.

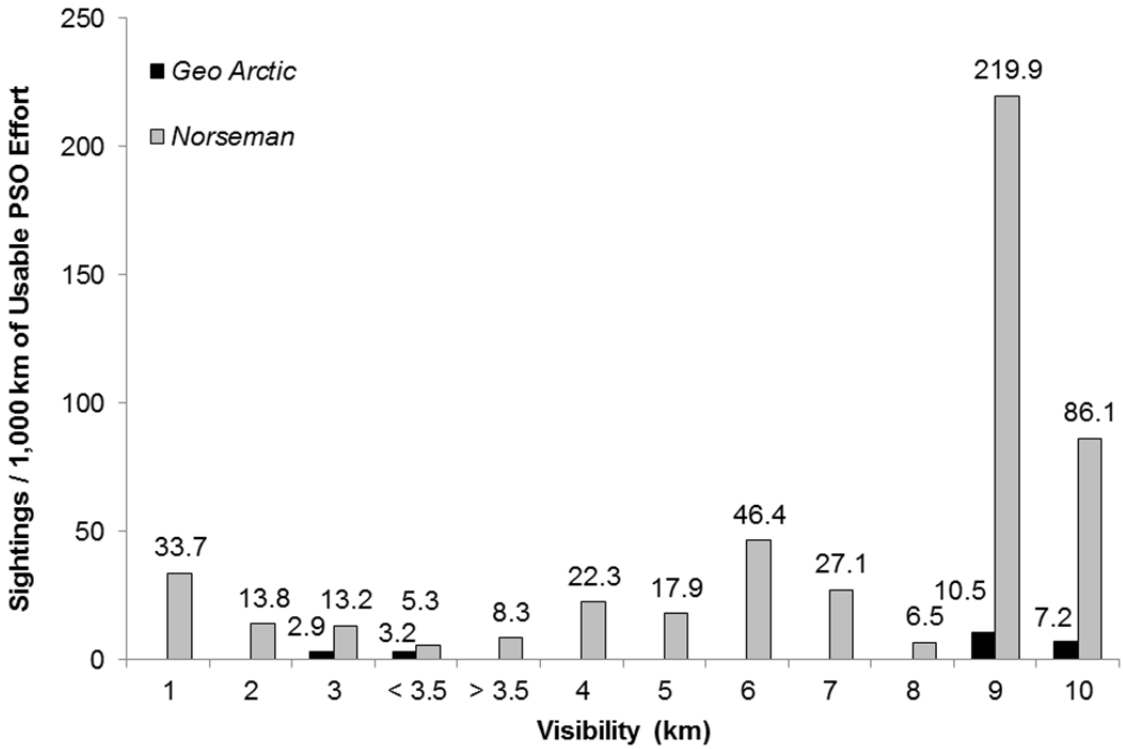

Figure 5.2-20. Pinniped sighting rate by visibility during the TGS 2D seismic operations, 25 August to 31 October 2013. Visibility classifications of <3.5 km and >3.5 km indicate periods when visibility was reduced unevenly across the visual field due to environmental factors such as quickly moving fog banks or low-hanging clouds that differentially impaired different portions of the PSO search area. The absence of a bar indicates no data were recorded from that category.

Pinniped Sighting Rates by Water Depth

The highest pinniped sighting rate for both vessels was at the intermediate depth category of 40 to 100 m with 30.9 and 104.9 sightings per 1,000 km of PSO effort, respectively (Figure 5.2-21). Few sightings occurred at depths >100 m accounting for the lower sighting rates. Sighting rates were pooled from the two vessels for statistical analysis. The differences in sighting rates of pinnipeds with the different depth zones were expected and significantly different (χ^2, p <0.001; see Table 5.2-9). Most pinnipeds were seen in shallower depths (<100 m), coinciding with the vessels' proximity to potential haulout areas (shore or the ice) as well as probably foraging areas. Four pinnipeds were seen in depths >100 m; a bearded seal, spotted seal, ringed seal and an unidentified seal.

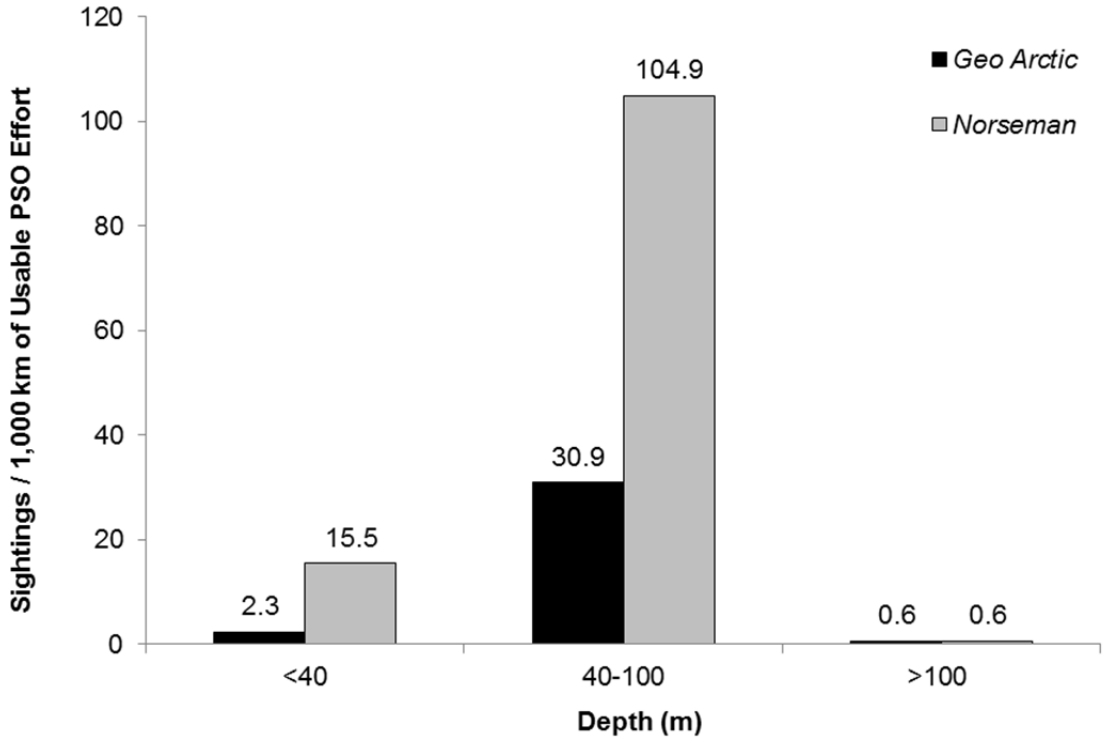

Figure 5.2-21. Pinniped sighting rates by three depth zones during the TGS 2D seismic operations, 25 August to 31 October 2013.

Pinniped Sighting Rates by Number of PSOs On-Watch

As would be expected, overall pinniped sighting rates increased with the increasing number of PSOs on shift (Figure 5.2-22). However, three PSOs were on-watch only from the *Norseman* when the highest sighting was 77.3 pinniped sightings per 1,000 km of PSO effort; this rate was 47% greater than when two PSOs were on-watch. Sighting rates were higher from the *Norseman* than the *Geo Arctic* during periods with more than one PSO on-watch. This may have been due to the overall higher number of sightings observed from the *Norseman* and time spent with three observers on-watch. It may also, however, have been related to the *Norseman's* farther distance from the operating array. In general, as indicated in Table 5.2-9, a number of factors significantly influenced sighting rates. Thus, there were likely interactions between these variables that cannot be assessed with simple Chi-squared contingency analyses.

Similar to cetacean sightings, instances where three PSOs were on-watch were few; however, they were the times when there were multiple sightings of pinnipeds within a short duration of time. As seen from the *Norseman* data, sighting rates increased with increased number of observers, however, this was not significant (χ^2, $p > 0.05$; see Table 5.2-9) and only *Norseman* data could be used to calculate this due to limited *Geo Arctic* data. The greater sighting rate with three PSOs can be explained by the limited amount of distance travelled with three PSOs along with the high sighting rates during those distances.

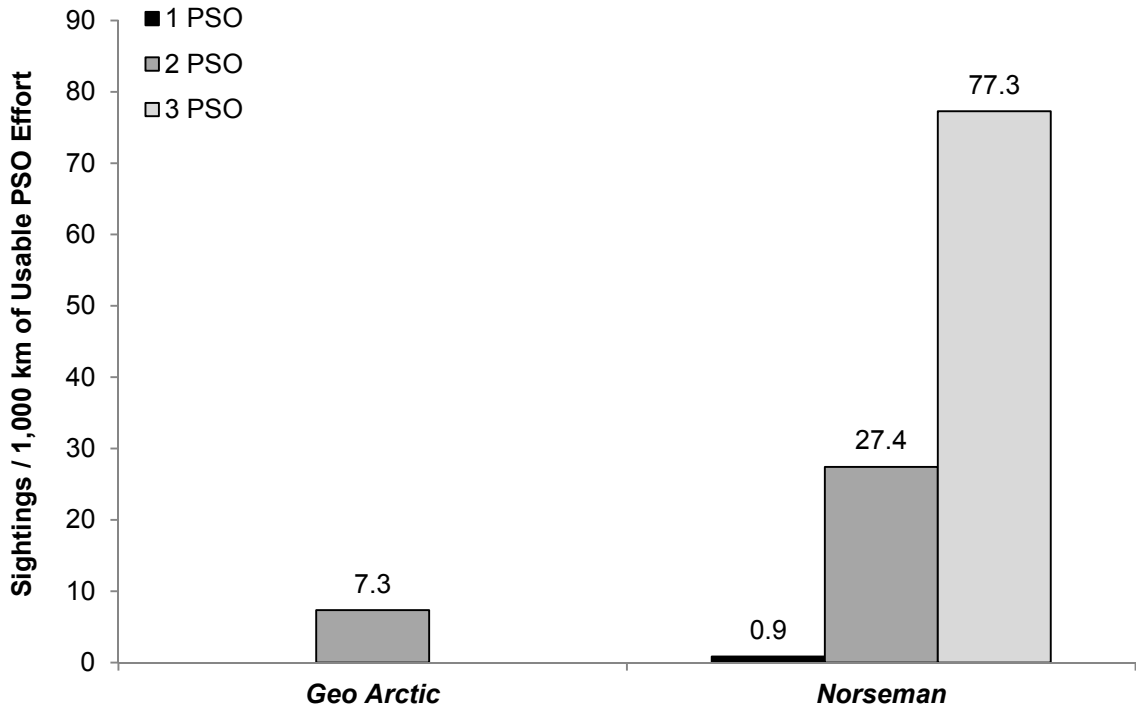

Figure 5.2-22. Pinniped sighting rate by the number of PSOs on-watch during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded from that category.

Pinniped Sighting Rates by Latitude

Overall pinniped sighting rates for both vessels were higher for waters south versus north of 72° N (Figure 5.2-23). However, the *Norseman* sighting rates were higher than those from the *Geo Arctic* both north and south of 72° N. These results suggest that pinnipeds were more common in the southern latitudes, though there were no significant differences in sighting rates between the two latitude zones (χ^2, $p > 0.05$; see Table 5.2-9) by each vessel separately or with the data pooled.

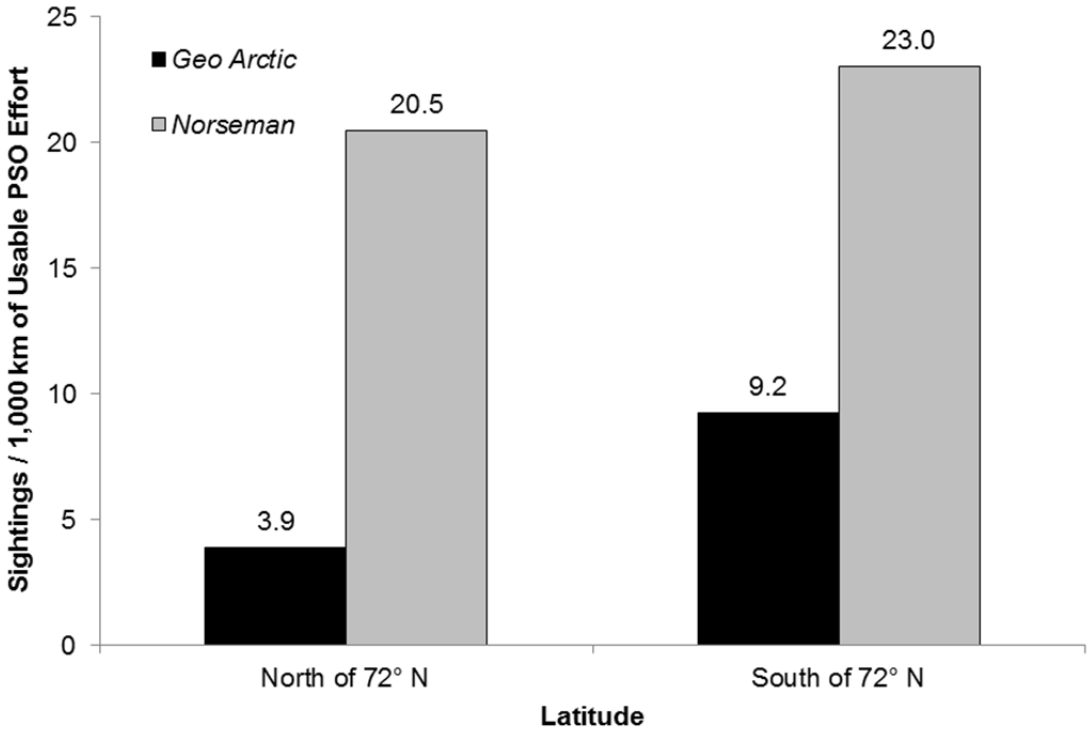

Figure 5.2-23. Pinniped sighting rates by regions north and south of the 72° N latitude line during the TGS 2D seismic operations, 25 August to 31 October 2013.

Pinniped Sighting Rates by Percent Ice Cover

The *Norseman* encountered ice more frequently than the *Geo Arctic.* This was because the *Norseman* was monitoring waters approximately 7.5 km ahead of the *Geo Arctic* and would occasionally encounter small ice floes. Once ice was encountered, the *Geo Arctic* would prepare to turn the vessel away from the small floes. Therefore, the *Norseman* had the potential to observe more animals in sea ice. Figure 5.2-24 shows higher sighting rates in ice cover 40% and greater. The highest pinniped sighting rate from the *Geo Arctic* (143.3 sightings per 1,000 km of PSO effort) occurred during 20% ice cover accounting for 66% of the *Geo Arctic* sightings. The highest sighting rate for the *Norseman* (362.6 sightings per 1,000 km of PSO effort) occurred during times with 100% ice cover accounting for 49% of the *Norseman* pinniped sightings.

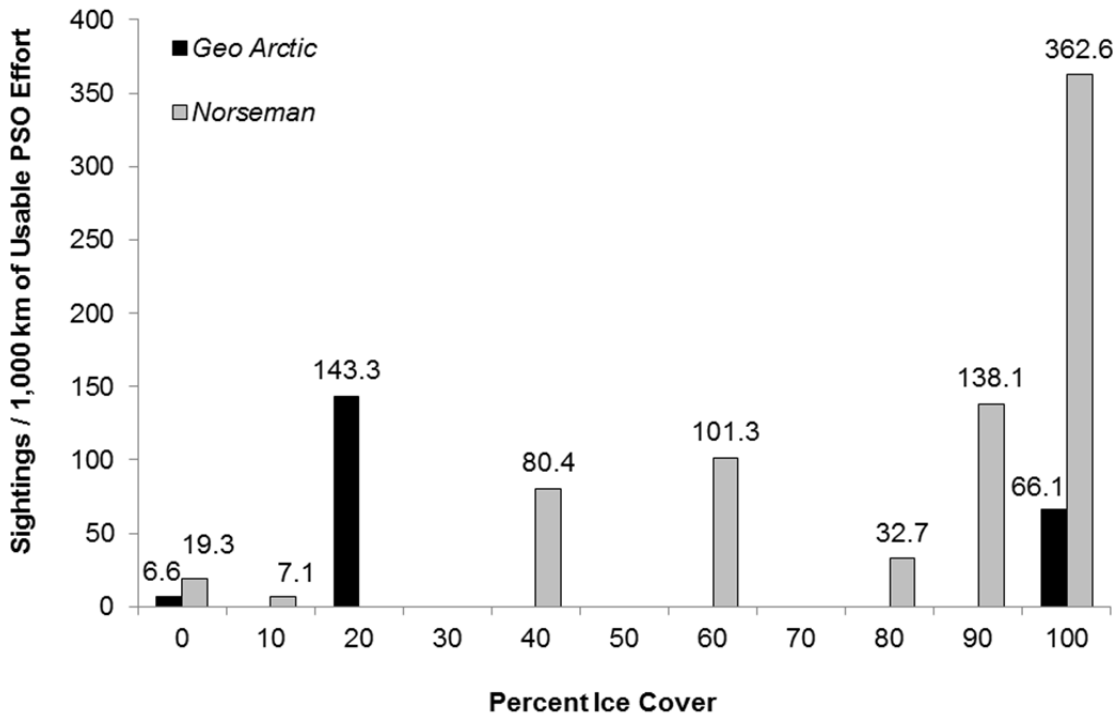

Figure 5.2-24. Pinniped sighting rate by percentage of ice cover during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded from that category.

5.2.4.2 Pinniped Movement

Of the 65 animals observed from the *Geo Arctic* during full array seismic activity, one had observable movement and four swim away (Table 5.2-10). Sightings during seismic activity (full array and mitigation airgun) accounted for 17% of total sightings on the *Geo Arctic* as compared to the *Norseman's* 31%. In general, 14% of pinnipeds were observed either swimming away or toward the vessels and 3% occurred during seismic activities.

Table 5.2-10. Number of pinniped sightings by movement relative to vessels by seismic activity status in relation to the 160 dB re 1 µPa (rms) zone during the TGS 2D seismic operations, 25 August to 31 October 2013.

Behavior	*Geo Arctic*		*Norseman*	
	Seismic	Non-seismic	Seismic	Non-seismic
None	1 (1; 0)	29	45 (31; 14)	97
Parallel	2 (0; 2)	0	12 (8; 4)	20
Swim Towards	6 (4; 2)	16	9 (8; 1)	25
Swim Away	0 (0; 0)	4	3 (3; 0)	6
Unknown	2 (0; 2)	5	1 (0; 1)	1
Total	**11** **(5; 6)**	**54**	**70** **(50; 20)**	**149**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.2.4.3 Pinniped Behavior

The first behaviour observed for each sighting was recorded as initial behavior (Table 5.2-11). Look (34%), swim (18%) were the two most common behaviors observed. Overall, 16% of the sightings occurred during seismic. The most common of these were look (70% of all seismic periods) and swim (20%).

Table 5.2-11. A comparison of initial pinniped behavior by seismic activity from each vessel during the TGS 2D seismic operations, 25 August to 31 October 2013.

Behavior	***Geo Arctic*** Seismic	Non-seismic	***Norseman*** Seismic	Non-seismic
Dive	1 (0; 1)	2	3 (3; 0)	10
Look	3 (0; 3)	21	51 (37; 16)	92
Resting	0 (0; 0)	0	1 (1; 0)	4
Surface Active	0 (0; 0)	0	0 (0; 0)	1
Surface Active Travel	0 (0; 0)	2	1 (1; 0)	3
Swim	6 (4; 2)	27	10 (7; 3)	37
Travelling	0 (0; 0)	1	0 (0; 0)	0
Travelling	0 (0; 0)	1	2 (1; 1)	1
Total	**10 (4; 6)**	**54**	**70 (50; 20)**	**149**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.2.4.4 Pinniped Reactions

The pinnipeds exhibited various reactions including: no reaction, look, change in direction, splash, dive, increase of speed, and rush (Table 5.2-12). Look (34%) and no reaction (21%) were the two most common reactions observed. During seismic periods look (71%) was the most common reaction overall. The *Geo Arctic* observed no reaction more than any other behavior for both seismic (54%) and non-seismic (85%) periods. The *Norseman* observed more looking (72%) than any other behavior and this was consistent for both seismic (63%) and non-seismic (69%) periods.

Table 5.2-12. Comparison of behavioral reactions of pinniped to seismic activity from each vessel during the TGS 2D seismic operations, 25 August to 31 October 2013.

Behavior	*Geo Arctic*		*Norseman*	
	Seismic	Non-seismic	Seismic	Non-seismic
No Reaction	6 (3;3)	46	13 (7;6)	37
Look	4 (2;2)	5	54 (40;14)	103
Change in Direction	0 (0;0)	2	0 (0;0)	1
Splash	0 (0;0)	1	3 (3;0)	3
Dive	0 (0;0)	0	0 (0;0)	1
Increase Speed	1 (0;1)	0	0 (0;0)	3
Rush	0 (0;0)	0	0 (0;0)	1
Total	**6 (4;2)**	**54**	**70 (50;20)**	**149**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.2.5 Walrus

In total, there were 79 sightings (203 individuals) of Pacific walrus observed from both vessels (Table 5.2-13 and Figure 5.2-25). The *Norseman* had markedly more individuals observed (126; 62% of total individuals).

Table 5.2-13. Number of Pacific walrus sightings and number of individuals for on-watch periods during the TGS 2D seismic operations, 25 August to 31 October 2013.

Species	*Geo Arctic*		*Norseman*		Total	
	Sightings	Animals	Sightings	Animals	Sightings	Animals
Pacific walrus	35	77	44	126	**79**	**203**

Note: All sightings from periods of on-watch effort

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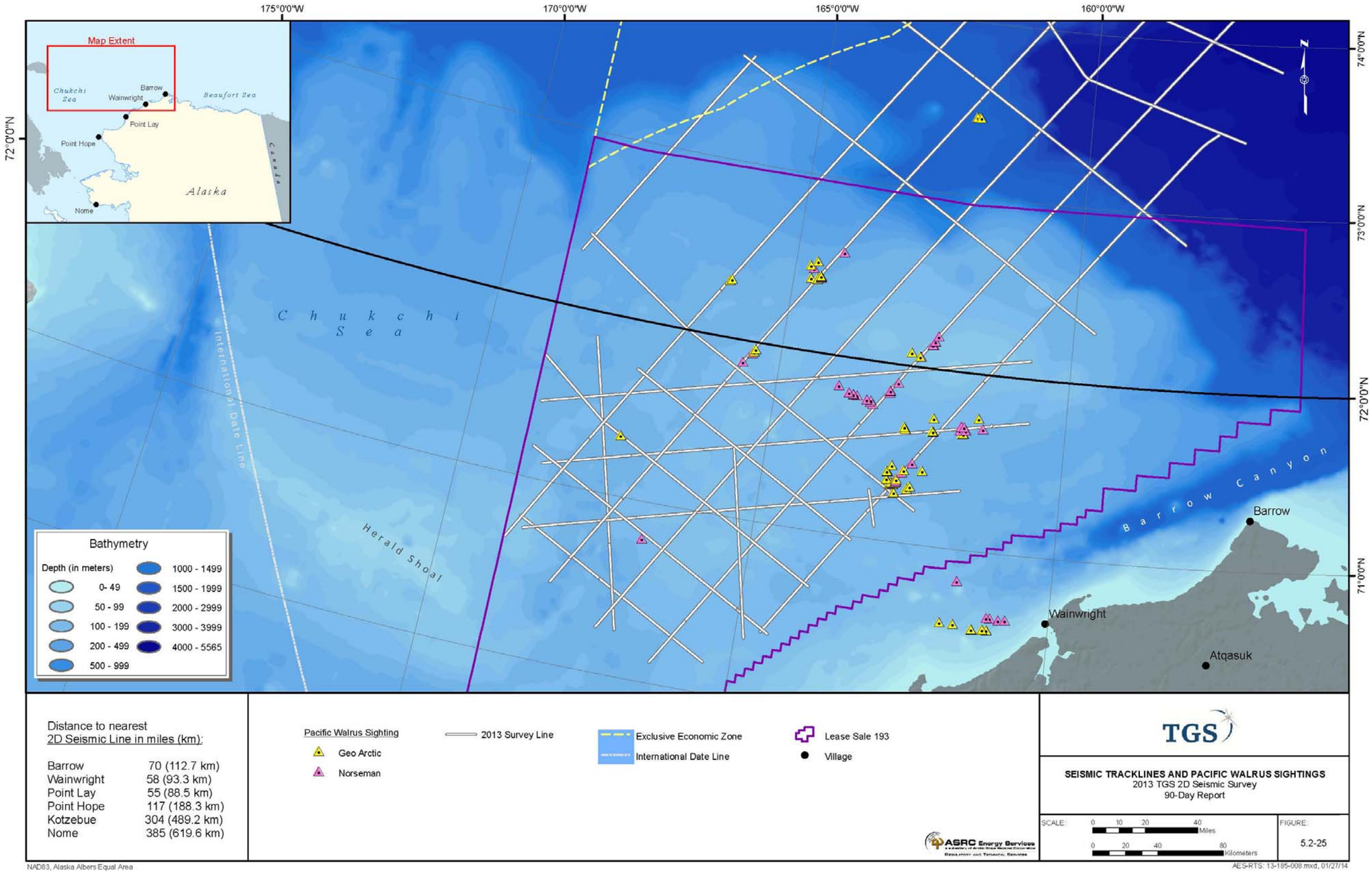

Figure 5.2-25. Seismic Tracklines and Pacific Walrus Sightings

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5.2.5.1 Walrus Sighting Rates

Pacific walrus sighting rates were analyzed using only usable data.

Pacific Walrus Sighting Rates by Seismic Status

Sighting rates increased on the *Geo Arctic* with decreased sound output and were more variable for *Norseman* sighting rates of Pacific walrus (Figure 5.2-26). In contrast, the sighting rate from the *Norseman* was similar during full array seismic activities and non-seismic periods. Due to the limited data, Pacific walrus data were pooled from each vessel and statistically analyzed against seismic status (≥160 dB and <160 dB). Sighting rates were significantly different ($\chi 2$, $p < 0.001$) based on seismic and non-seismic activity (Table 5.2-14).

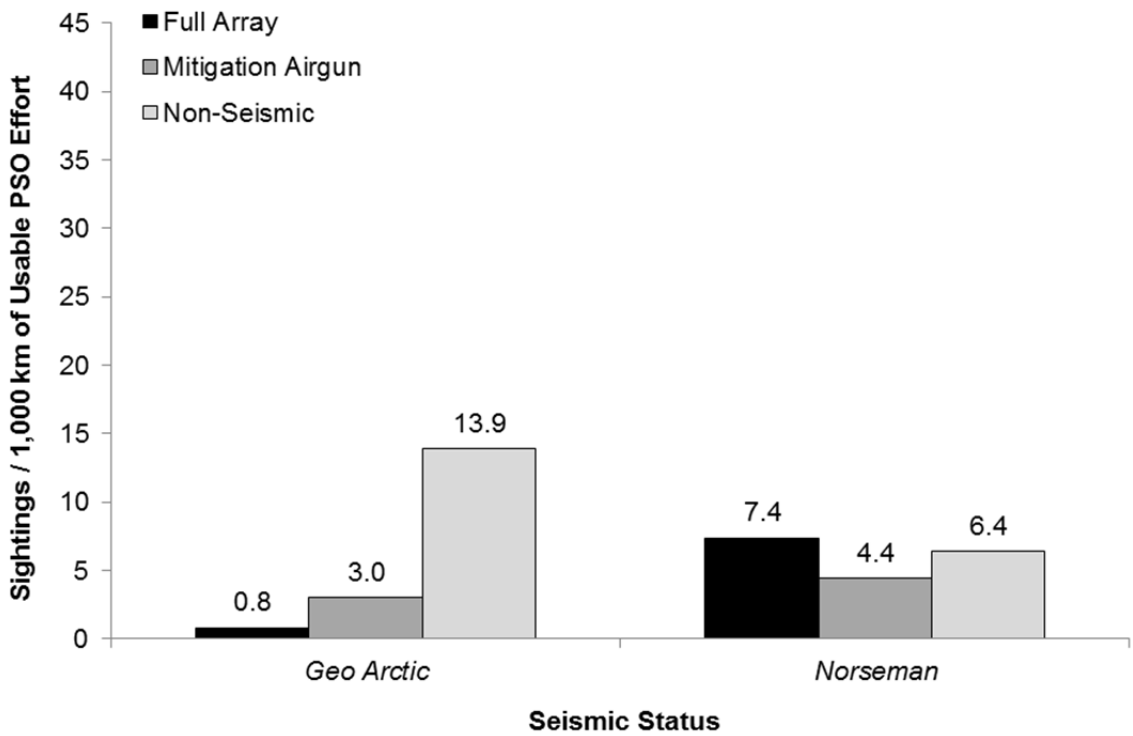

Figure 5.2-26. Pacific walrus sighting rates by seismic activity for each vessel during TGS' seismic survey, 25 August to 31 October 2013. PSO on-watch effort during full array represents periods when the full array was operating from the *Geo Arctic*. Monitoring when the single mitigation airgun was operating represents received seismic sound levels of ≥160 dB re 1 µPa (rms) within 1.5 km of the *Geo Arctic* and <160 dB re 1 µPa (rms) for the *Norseman.* Non-seismic data incorporates times on both vessels when PSOs were on-watch and no TGS seismic operations were occurring.

Table 5.2-14. *p-values* for Pacific Walrus Sighting Rates. Comparison of Pacific walrus sighting rates by various environmental factors using a Chi-squared (χ^2) contingency test. Note that sighting rates were not analyzed by percent ice cover due to small sample sizes for usable sighting rates.

Categories	Combined (n = 58)
Seismic Status	<0.001*
Beaufort Sea State	< 0.001*
Visibility (km)	< 0.0001*
Depth (m)	< 0.01*
Number of PSOs	< 0.006*
Latitude (North and South of 72°N)	0.68

*indicates p ≤0.05
°N = degrees north
km = kilometer
m = meter
PSO = Protected Species Observer

It should be noted that a number of factors significantly influenced sighting rates. Thus, there were likely interactions between these variables that cannot be assessed with simple Chi-squared contingency analyses. However, more complex analyses could not be conducted within the required 90-day reporting period on such a large database.

Pacific Walrus Sighting Rates by Beaufort Sea State

Walrus sightings generally decreased with increasing Beaufort sea state from both vessels (Figure 5.2-27). The highest sighting rates (per 1,000 km of PSO effort) from the *Geo Arctic* occurred during Beaufort sea state one, (65% of the *Geo Arctic* pacific walrus sightings per 1,000 km of PSO effort). *Norseman* sighting rates were highest during Beaufort sea state zero. Sighting rates were pooled for statistical analysis. In general, as sea state increased, sighting rates decreased and were significantly different between the different sea states ($\chi 2$, $p < 0.001$; see Table 5.2-14).

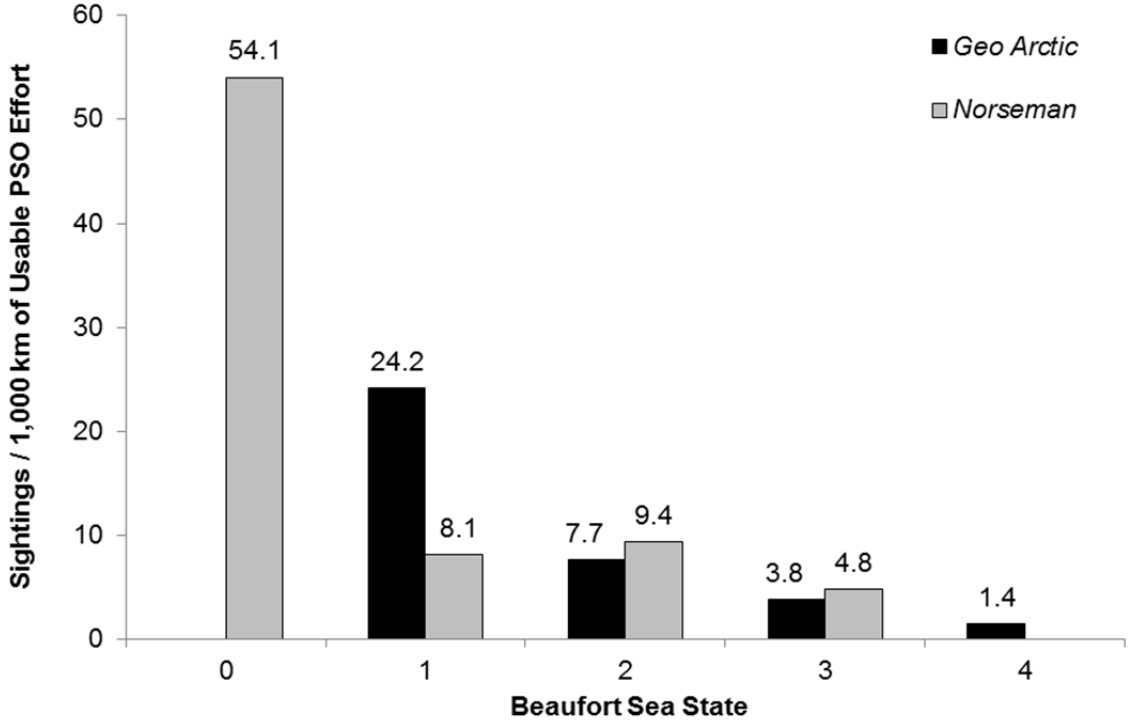

Figure 5.2-27. Pacific walrus sighting rates by Beaufort sea state conditions during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded from that category.

Pacific Walrus Sighting Rates by Visibility

Overall, walrus right rates increased with increasing visibility from both vessels (Figure 5.2-28). The highest sighting rate occurred during a visibility of 6 km (58.7 sightings per 1,000 km of PSO effort) representing 60% of the *Geo Arctic* PSO sightings. The highest sighting rate from the *Norseman* occurred during a visibility of 9 km, with 37.5 sightings per 1,000 km of PSO effort (34%). Data were pooled together from each vessel, omitting the variable category of > and < 3.5 km. Sighting rates were significantly different ($\chi 2$, $p < 0.0001$; see Table 5.2-14) depending on the visibility (km).

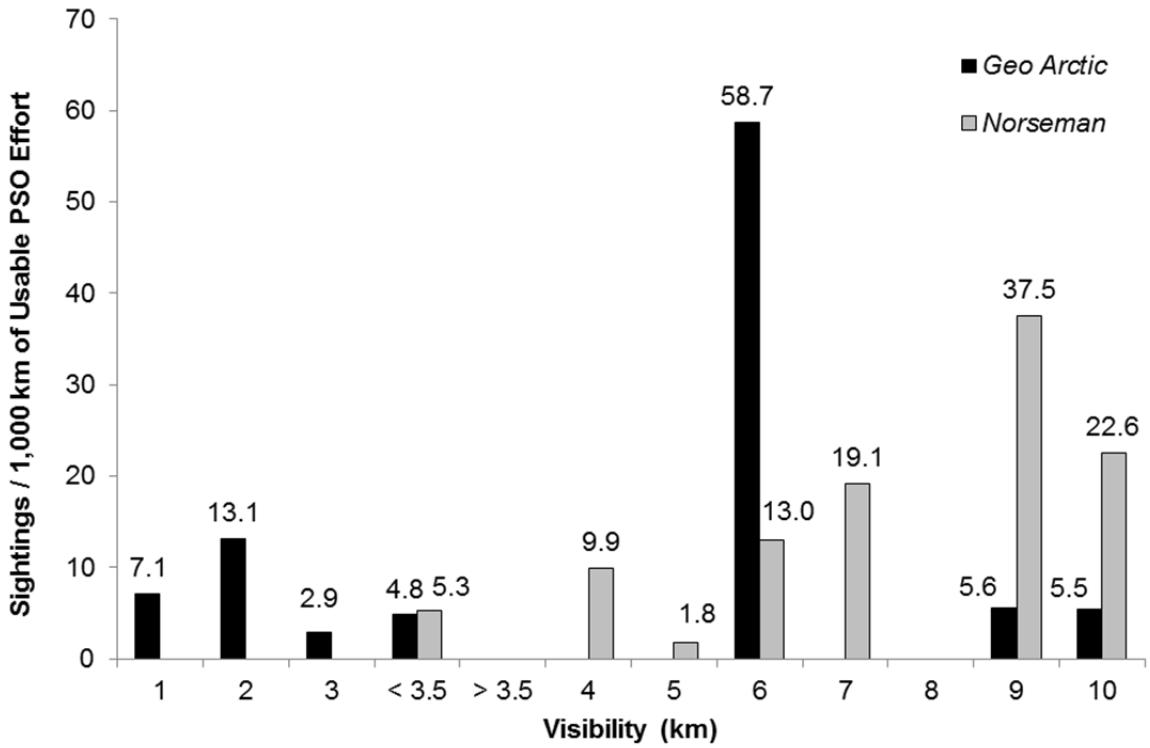

Figure 5.2-28. Pacific walrus sighting rate by visibility distance (km) categories during the TGS 2D seismic operations, 25 August to 31 October 2013. Visibility classifications of <3.5 km and >3.5 km indicate periods when visibility was uneven across the visual field due to environmental factors such as quickly moving fog banks or low-hanging clouds that differentially impaired different portion of the PSO search area. The absence of a bar indicates no data were recorded from that category.

Pacific Walrus Sighting Rates by Water Depth

Overall, nearly all usable Pacific walrus sightings were observed in waters less than 100 m deep (Figure 5.2-29). Sighting rates were similar for the *Geo Arctic* in shallow (<40 m) and intermediate depth waters. However, for the *Norseman*, sighting rates were over four times higher in intermediate than shallow depths. Again, data were pooled from each vessel. Sighting rates were significantly different between the three depth zones (χ^2, p >0.05; see Table 5.2-14). This was an expected trend in walrus statistics because walrus haulouts are over shallower (<100 m) waters where they can easily dive to the bottom for food (Jay et al. 2012).

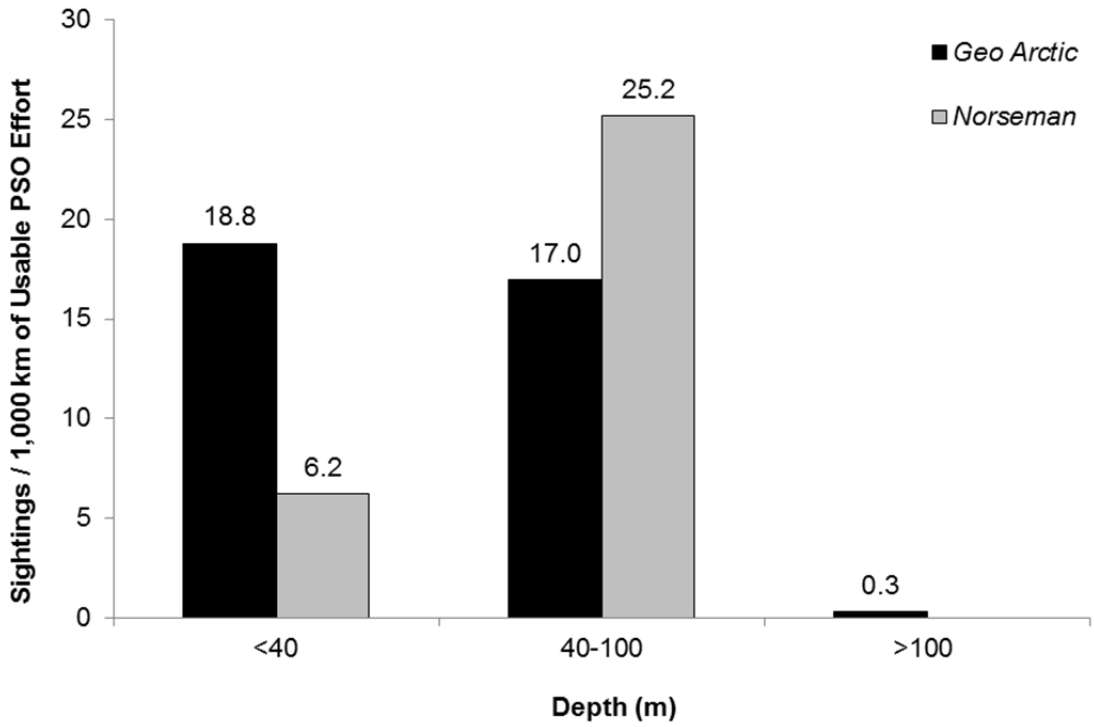

Figure 5.2-29. Pacific walrus sighting rates by water depth zones during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded from that category.

Pacific Walrus Sighting Rates by Number of PSOs On-Watch

Sighting rates were markedly higher for both vessels when three observers were on-watch as compared to two observers (Figure 5.2-30). This was likely related to the high level of sightings in a short period of time requiring more PSOs to be on-watch to help collect data. Statistical tests were conducted on sightings with two and three observers only. This was first compared for each vessel independently, and then by pooling the data. Sighting rates differed significantly based on the number of PSOs on-watch ($\chi 2$, $p < 0.05$; see Table 5.2-14). This was most likely a mechanism of the short duration of sightings with three PSOs and during periods with higher sightings numbers. During the entire project, both vessels conducted 24 km (*Geo Arctic*) and 17 km (*Norseman*) of observation effort with three PSOs on-watch (see Figure 5.2-3). No usable Pacific walrus data were available during periods of only one PSO on-watch.

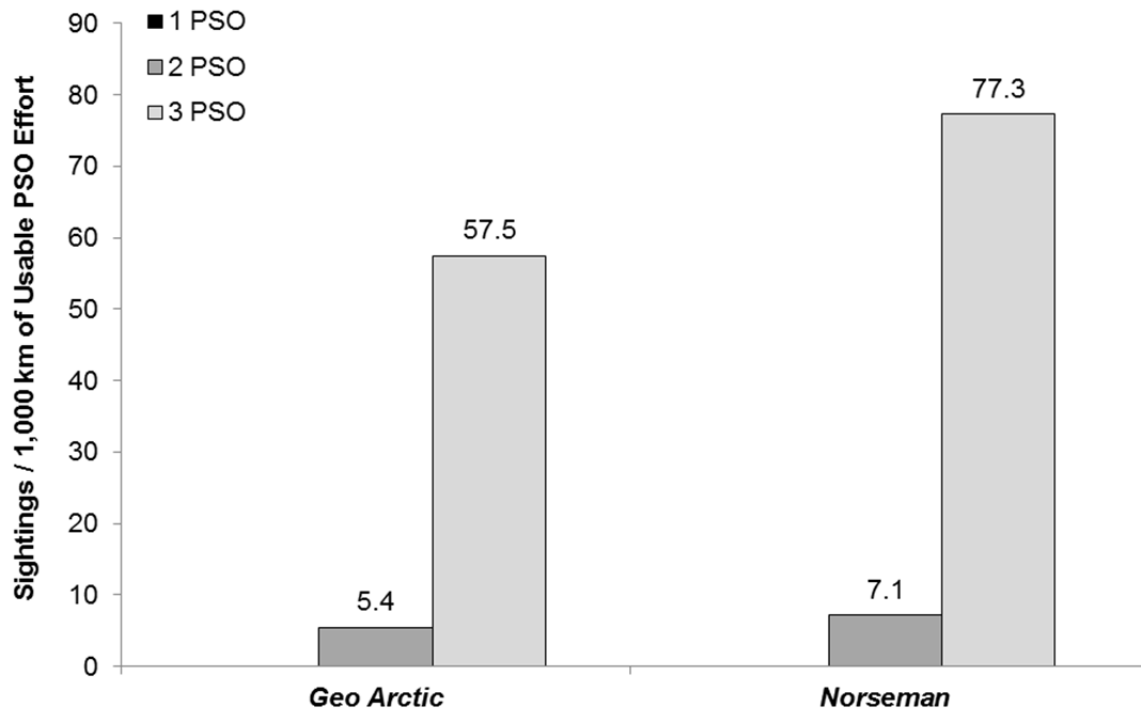

Figure 5.2-30. Pacific walrus sighting rate by the number of PSOs on-watch during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded from that category.

Pacific Walrus Sighting Rates by Latitude

Overall, Pacific walrus sighting rates were 25% to 41% greater south of 72° N versus north of 72° N for both vessels (Figure 5.2-31). Differences in sighting rates between the two latitude categories were not significant (χ^2, p >0.05; see Table 5.2-14) when data were pooled from each vessel.

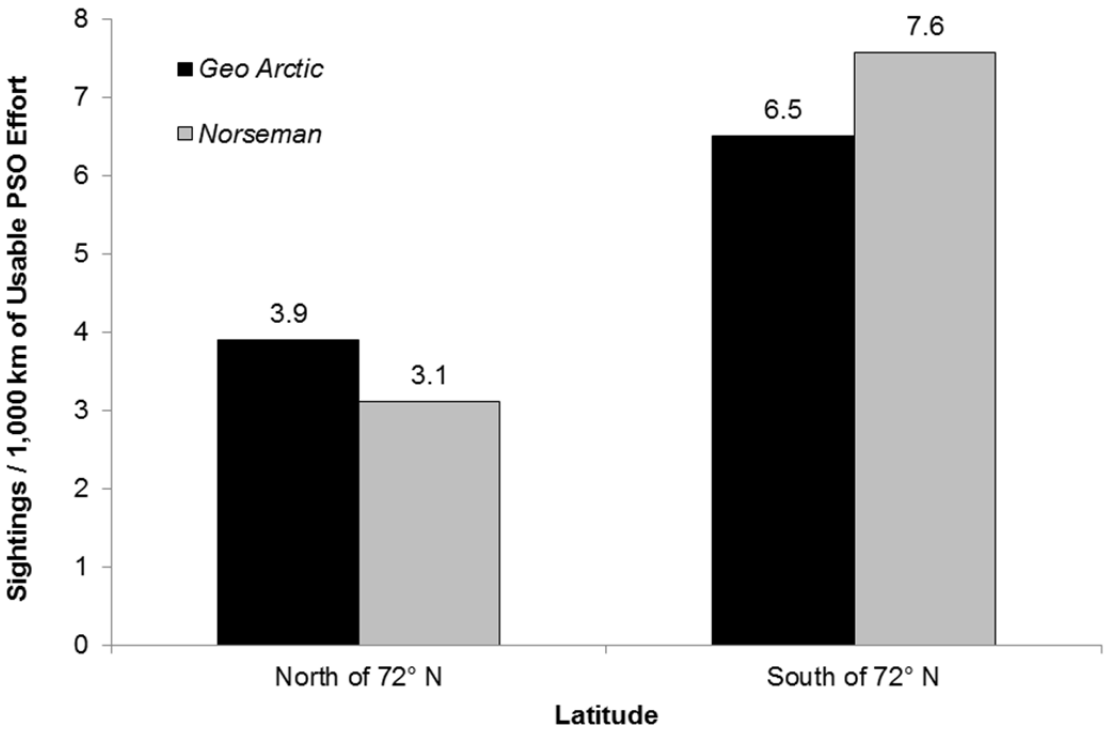

Figure 5.2-31. Pacific walrus sighting rates by regions north and south of the 72° N latitude line during the TGS 2D seismic operations, 25 August to 31 October 2013.

Pacific Walrus Sighting Rates by Percent Ice Cover

Most usable Pacific walrus data occurred when ice cover was 10% or less (Figure 5.2-32); however, the *Norseman* did encounter some larger groups during the few occurrences of 100% new ice cover. This is reflected by the relatively high sighting rate (36.3 per 1,000 km of PSO effort) during periods of 100% ice cover. The *Geo Arctic* only encountered Pacific walrus during periods of zero ice cover.

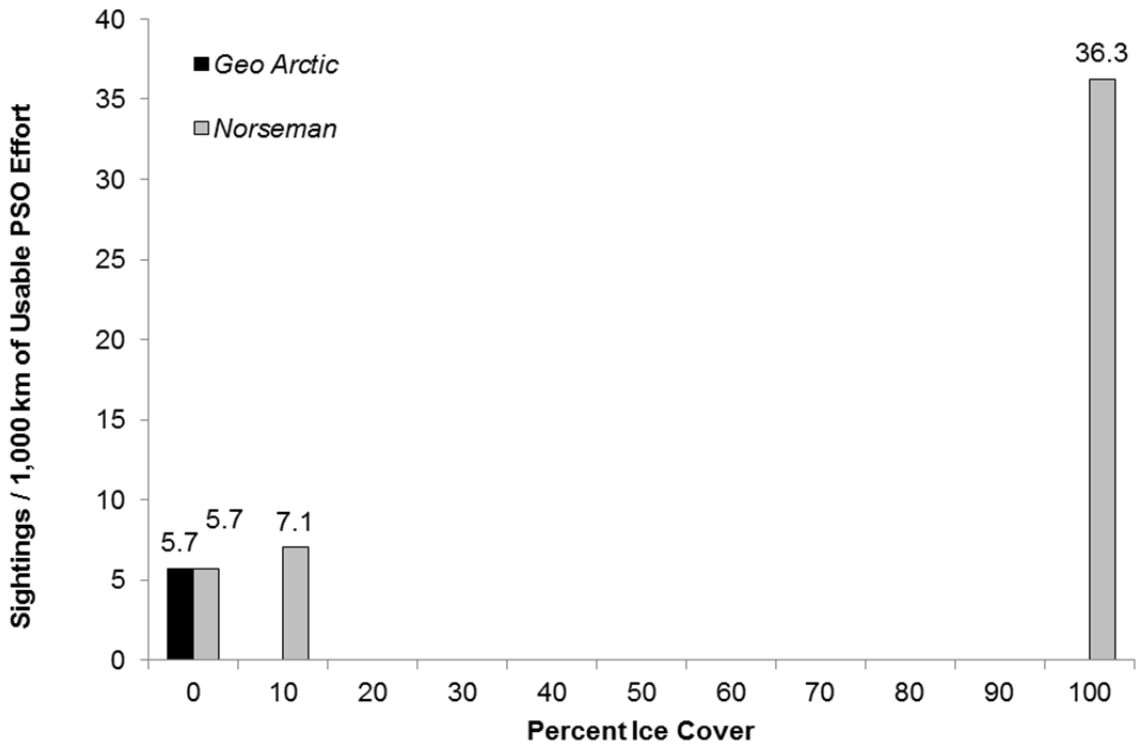

Figure 5.2-32. Pacific walrus sighting rates by percentage of ice cover during the TGS 2D seismic operations, 25 August to 31 October 2013. The absence of a bar indicates no data were recorded from that category.

5.2.5.2 Walrus Movements

The only observed movement relative to the *Geo Arctic* during seismic activity (full array or mitigation airgun) was swim away and toward the vessel (Table 5.2-15). During full array seismic activity, the *Norseman* observed more variable movements. The most commonly recorded movement was swimming away from the vessels. No animals were recorded to have unknown movements.

Table 5.2-15. Number of Pacific walrus sightings by movement relative to vessels by seismic activity status in relation to the 160 dB re 1 µPa (rms) zone during the TGS 2D seismic operations, 25 August to 31hg

Behavior	***Geo Arctic***		***Norseman***	
	Seismic	Non-seismic	Seismic	Non-seismic
None	1 (0; 1)	8	8 (6; 2)	6
Parallel	0 (0; 0)	2	5 (2; 3)	3
Swim Towards	4 (3; 1)	14	11 (8; 3)	7
Swim Away	3 (3; 0)	3	4 (3; 1)	1
Total	**8** **(6; 2)**	**27**	**28** **(19; 9)**	**17**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.2.5.3 Walrus Behaviors

The most frequently observed initial behaviors of Pacific walrus were swim (43%) and look (16%). During seismic activity, swim was observed in 100% of the sightings from the *Geo Arctic*. The *Norseman* encountered more looking events (25%) during seismic activities, followed by surface active (22%).

Table 5.2-16. A comparison of initial Pacific walrus behaviors by seismic activity from each vessel during the TGS 2D seismic operations, 25 August to 31 October 2013.

Behaviors	***Geo Arctic*** Seismic	Non-seismic	***Norseman*** Seismic	Non-seismic
Blow	0 (0; 0)	0	1 (0; 1)	1
Dive	0 (0; 0)	0	2 (0; 2)	0
Look	0 (0; 0)	5	7 (6; 7)	3
Resting	0 (0; 0)	1	4 (2; 2)	1
Surface Active	0 (0; 0)	0	6 (4; 2)	2
Surface Active Travel	0 (0; 0)	2	1 (0; 1)	0
Sink	0 (0; 0)	0	1 (1; 0)	0
Swim	8 (6; 2)	19	4 (4; 0)	8
Travelling	0 (0; 0)	0	1 (1; 0)	2
Total	**8 (6; 2)**	**27**	**27 (18; 9)**	**17**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.2.5.4 Pacific Walrus Reactions

Pacific walrus reactions were recorded from each vessel (Table 5.2-17). During periods of seismic activity (full array and mitigation airgun), 50% of the animals observed from the *Geo Arctic* reacted by looking at the vessel (the remaining 50% exhibited no reactions). In contrast, Pacific walruses observed from the *Norseman* during seismic activity looked more than any other reaction (44%) (48% exhibited no reaction).

Table 5.2-17. Comparison of behavioral reactions of Pacific walrus to seismic activity from each vessel during the TGS 2D seismic operations, 25 August to 31 October 2013.

Behaviors	*Geo Arctic*		*Norseman*	
	Seismic	Non-seismic	Seismic	Non-seismic
No Reaction	3 (2;1)	22	14 (9;5)	5
Look	3 (2;1)	5	12 (9;3)	11
Change in Direction	0 (0;0)	2	2 (0;2)	0
Increase Speed	0 (0;0)	0	1 (1;0)	1
Total	**6 (4;12)**	**29**	**28 (19;9)**	**17**

Note: All seismic values are totals of combining sightings during period of full array and mitigation airgun. The values in parentheses below the totals are presented as (full array; mitigation airgun).

5.3 Mitigation Measures

5.3.1 Exclusion Zones

Although results of the SSV measured radii were much less than the modeled radii for both the full array and the single mitigation airgun, TGS elected to continue using the modeled radii as a more conservative measure based on JASCO's recommendation (see Table 12 of the SSV report in Appendix A). Thus, for the 3,280 in^3 full array, the highest values across the depth regimes of the pre-season modeled radii (Table 4.2-1, Section 4.2.2.1) were used as exclusion zones during the TGS 2D seismic project, regardless of actual water depth at the time. In addition, only one set of modeled values consisting of the most conservative values was implemented for the mitigation source (60 in^3), regardless of water depth.

5.3.2 Mitigation Measures Implemented

For conservative marine mammal mitigation, TGS decided to shut down their entire array instead of employing a power-down procedure (from the full array to the single mitigation airgun) when marine mammals were observed approaching or within the appropriate exclusion zones. This was done to avoid seismic data gaps in the survey lines. The IHA permitted the use of the mitigation airgun for periods of up to three hours under good visibility conditions and for periods greater than three hours if visibility was reduced. Therefore, the mitigation source was turned on during transits and turns between seismic survey lines only if visibility conditions were compromised (e.g., fog, darkness; see IHA for regulations in Appendix D).

A total of 20 mitigation events (i.e., shut-downs) were implemented during the TGS 2D seismic survey as a result of marine mammal sightings within or approaching the applicable exclusion zones. There were no power-downs given TGS' decision to shut down for sightings as discussed above.

Three shut-downs for cetaceans were requested by PSOs and implemented on 16 September, 26 October, and 27 October; each shut-down was for an unidentified whale sighting that approached or was seen within the 180 dB re 1 µPa (rms) exclusion zone as described below and in Table 5.2-18.

- The first sighting consisted of a group of two unidentified whales initially seen within the 160 dB re 1 µPa (rms) zone of influence of the full array by the *Norseman*. A shut-down was subsequently implemented in anticipation that the two whales might enter the 180 dB re 1 µPa (rms) exclusion zone. The whales were re-sighted in the same area by the *Norseman*, though the *Geo Arctic* was not shooting during this time. Full airgun array was firing when shut-down was implemented.
- The next shut-down (26 October) occurred when three unidentified whales were spotted approaching the 180 dB re 1 µPa (rms) exclusion zone for the full array. A shut-down was implemented before the whales reached this exclusion zone, after which the *Geo Arctic* began its 360° turn to re-shoot the line. The shut-down occurred as a monitoring measure. No guns were firing, however, since whales were sighted, this was implemented in order to start the pre-clearance procedure pre-gun activation.
- The last shut-down (27 October) occurred for a single unidentified whale that was first observed within the 180 dB re 1 µPa (rms) exclusion zone, 1,749 m from the airgun array (see Table 4.2-1). The whale did not enter the exclusion zone of the mitigation airgun. As a result, the mitigation gun was turned on three minutes following the shut-down due to reduced visibility conditions. The whale was subsequently observed while the airguns were off until it left the exclusion zone.

Table 5.2-18. The three shut-downs implemented for cetaceans observed from the *Geo Arctic*.

Date	Vessel	Sighting ID	Species	No. Animals	Initial Behavior	Reaction to Vessel	Final CPA to Airguns (m)
16-Sep	*Geo Arctic*	23	Unidentified Whale	2	Swim	None	8,519
26-Oct	*Geo Arctic*	141	Unidentified Whale	3	Swim	None	2,168
27-Oct	*Geo Arctic*	142	Unidentified Whale	1	Blow	None	1,749

CPA = Closest observed point of approach
ID = identification

There were a total of seven shut-downs for seals within the 190 dB re 1 µPa (rms) exclusion zone of the active array (Table 5.2-19).

- Two shut-downs occurred on 31 August and 9 September were for seals that were first observed within the 190 dB re 1 µPa (rms) exclusion zone of the full array. In both cases, the array was shut down and the vessel started to turn off the line.
- The next two shut-downs (29 September and 4 October) were implemented when a seal was first observed within the 190 dB re 1 µPa (rms) exclusion zone of the single mitigation airgun. A shut down was implemented, and the mitigation airgun was activated within a few minutes when it was certain each animal was outside the exclusion zone of the mitigation airgun. The first seal (29 September) elicited no noticeable reactions towards the vessels or activities and was only

seen the one time. The sighting on 4 October, however, was seen swimming away from the vessel. Upon a resighting, it stopped and looked at the vessel.

- Two shut-downs occurred on 22 October for two different single seals first observed within the 190 dB re 1 µPa (rms) exclusion zone of the full array. In both cases, the seal was not observed leaving the mitigation zone. A 15-minute clearance was implemented before the airguns were turned back on.

  A third shut-down occurred on 22 October. During this encounter, the seal was first and last observed outside of the exclusion zone of the mitigation airgun. The mitigation airgun was subsequently turned on one minute later due to limited visibility conditions since the vessel had moved well beyond the seal relative to the exclusion zone radius.

Table 5.2-19. The seven shut-downs implemented for pinnipeds observed from the *Geo Arctic*.

Date	Vessel	Sighting ID	Species	Number Animals	Initial Behavior	Reaction to Vessel	Final CPA to Airguns (m)
31-Aug	*Geo Arctic*	10	Bearded Seal	1	Swim	Look	170
9-Sep	*Geo Arctic*	14	Unidentified Seal	1	Swim	None	179
29-Sep	*Geo Arctic*	53	Unidentified Seal	1	Swim	None	199
4-Oct	*Geo Arctic*	63	Spotted Seal	1	Swim	Look	352
22-Oct	*Geo Arctic*	127	Unidentified Seal	1	Look	None	529
22-Oct	*Geo Arctic*	128	Unidentified Seal	1	Look	None	311
22-Oct	*Geo Arctic*	129	Unidentified Seal	1	Swim	None	373

CPA = Closest observed point of approach
ID = identification

Ten shut-downs were implemented for Pacific walruses observed within or judged about to enter the ≥180 dB re 1 µPa (rms) exclusion zone around the *Geo Arctic's* full airgun array as described below (Table 5.2-20). Additionally, a shut-down occurred for a group of 12 walruses observed from the *Norseman* within the 160 dB re 1 µPa (rms) exclusion zone. Standard mitigation consistent of pre-clearance and ramp-up procedures was implemented after 30 minutes of a shut-down.

- The first shut-down was implemented on 5 September immediately upon observing the animal within the exclusion zone of the full airgun array. Pacific walrus was seen over a four minute period and appeared to be undisturbed by vessel activity.
- The second shut-down was implemented for a group of five walruses on 13 September. This group was only observed the one time and there appeared to be no reaction towards the vessels.
- Four shut-downs, occurring on 15 September, 30 September, and 1 October were for a cow/calf pair.
  - The first cow/calf pair (15 September) was observed swimming away from the vessel at a vigorous pace and looking at the vessel. The shut-down occurred immediately when they were spotted within the 190 re 1 µPa (rms) exclusion zone of the mitigation airgun.
  - The second pair (30 September) appeared within the 180 re 1 µPa (rms) exclusion zone of the full array. They were swimming slowly and diving repeatedly over a 12 minute period.
  - The third pair (30 September) looked at vessel as they were within the 180 re 1 µPa (rms) exclusion zone of the full array.

  - The fourth cow/calf pair (1 October) appeared within the 190 re 1 µPa (rms) exclusion zone of the full array. They looked at the vessel while they were swimming away.
- The *Norseman* notified the *Geo Arctic* of the two walrus on 9 October and the airguns were shut down upon visual confirmation within the 180 re 1 µPa (rms) exclusion zone. They did not appear to react to vessel.
- A shut-down was implemented on 9 October for a pair of walruses within the 180 dB re 1 µPa (rms) exclusion zone. There were no reactions to the vessel.
- PSOs aboard the *Norseman* observed a group of 12 walruses and notified the *Geo Arctic*. A shut-down was implemented because the animals were within the 160 dB re 1 µPa (rms) exclusion zone (see LOA for mitigation requirements in Appendix D). This group was on a small ice floe and did not react to the vessel (approximately 1,000 m away).
- The final shut-down for walrus occurred on 13 October for a single animal within the mitigation airgun exclusion zone. The animals did not react towards the vessel, and dove shortly after sighting.

Table 5.2-20. The 10 shut-downs implemented for Pacific walruses.

Date	Vessel	Sighting ID	Species	Number Animals	Initial Behavior	Reaction to Vessel	Final CPA to Airguns (m)
5-Sep	*Geo Arctic*	12	Pacific Walrus	1	Swim	None	542
13-Sep	*Geo Arctic*	16	Pacific Walrus	5	Swim	None	638
15-Sep	*Geo Arctic*	20	Pacific Walrus	2	Swim	Look	501
30-Sep	*Geo Arctic*	56	Pacific Walrus	2	Swim	None	399
30-Sep	*Geo Arctic*	61	Pacific Walrus	2	Swim	Look	133
1-Oct	*Geo Arctic*	62	Pacific Walrus	2	Swim	Look	133
9-Oct	*Geo Arctic*	65	Pacific Walrus	2	Swim	None	1,038
9-Oct	*Geo Arctic*	66	Pacific Walrus	2	Swim	None	895
13-Oct	*Geo Arctic*	100	Pacific Walrus	1	Swim	None	253
11-Oct	*Norseman*	198	Pacific Walrus	12	Swim	Look	7,500*

CPA = Closest observed point of approach
* Distance estimated based on mean distance of the *Norseman* from the *Geo Arctic*.

5.4 Estimated Number of Marine Mammals Present and Potentially Affected

The IHA issued to TGS in August 2013 required estimation of the number of potential "takes" of marine mammals through harassment during the 2013 TGS 2D seismic program. Both NMFS and USFWS assume that harassment through disturbance to marine mammals may occur at RSLs ≥160 dB re 1 µPa (rms). Furthermore, the NMFS IHA requires that monitoring and mitigation be implemented to avoid exposure of cetaceans to RSLs of ≥180 dB and of pinnipeds to RSLs of ≥190 dB re 1 µPa (rms). The USFWS LOA requires that distances to RSLs of 180 dB and 190 dB re 1 µPa (rms) be used to implement mitigation measures for Pacific walruses and polar bears, respectively. In addition, the IHA requires that estimates of uncertainty be presented for the estimated takes by harassment. This uncertainty can be expressed through presentation of confidence limits, a minimum-maximum and other approaches appropriate to the sampling method and data available. The number of NMFS-authorized takes by harassment must specifically be compared to the actual estimated exposure levels based on the actual levels of seismic activity and marine mammal observations made during the seismic program. This section addresses these IHA and LOA requirements.

No recent systematic surveys for marine mammals have been conducted throughout the 2013 TGS survey area in the Chukchi Sea except this survey itself, particularly in U.S. Federal and international and waters north of 72° N (as depicted in Figure 2 in TGS' 2013 IHA). However, sample sizes based on the TGS 2013 survey data were limited (as described in Section 5.3.1.1) and were thus considered too small to provide meaningful densities compared to other, more robust data available. Densities used to estimate and calculate the number of exposures to TGS' pulsed seismic sounds ≥160 dB re1μPa (rms) were obtained from the following sources:

(1) Updated densities (and 95% CLs) for four species were available and applied from Aerts et al. (2013a) based on a compilation of data collection from August to early or mid-October 2008 to 2012 for the Chukchi Sea Environmental Studies Program (CSESP). These surveys overlapped the southern portion of the TGS 2013 survey area, extending as far north as approximately 72° N. Density estimates for the Pacific walrus were obtained from Aerts et al. (2013b) based on CSESP data collected from August to early or mid-October 2008 to 2010. These sources were considered the best available data for U.S. Chukchi waters because the results summarize three to five years of surveys dedicated to collecting baseline data rather than mitigation or monitoring of a specific seismic event. As a result, CSESP sample sizes were considerably larger and more robust with lower CLs than those obtained from the TGS 2013 density analyses (Tables 5.4-1, 5.4-2 and Appendix J). To be conservative, the highest, most recent densities for each species reported in Aerts et al. (2013a, b) were used (Table 5.4-2 and Appendix J).

Table 5.4-1. Line transect parameters and estimates of density and abundance for five species of marine mammals sighted during the 2013 TGS 2D seismic program from the non-seismic monitoring vessel, the *Norseman*, during specific sighting conditions. Densities are stratified by seismic and non-seismic periods. Sightings of other species under NMFS or USFWS jurisdictions were too few or did not meet line transect criteria and thus were not included in this table. CL = Confidence Level, CV = coefficient of variation.

Species	Seismic (2,807 km line-transect effort)					Seismic Off (1,233 km line-transect effort)				
	n	Density (#/km^2)	Lower 95% CL	Upper 95% CL	% CV	*n*	Density (#/km^2)	Lower 95% CL	Upper 95% CL	% CV
Bowhead Whale	8	0.03	0.011	0.081	53	2	0.011	0.002	0.059	32
Unidentified Mysticete	4	0.01	0.003	0.041	67	1	0.007	0.011	0.039	103
Bearded Seal	1	0.002	0	0.008	100	5	0.018	0.007	0.047	51
Ringed Seal	2	0.003	0.001	0.017	101	3	0.011	0.004	0.031	57
Spotted Seal	11	0.017	0.007	0.04	44	12	0.048	0.017	0.134	54
Unidentified Pinniped	5	0.014	0.004	0.048	66	1	0.004	0.001	0.019	100
Unidentified Seal	46	0.074	0.03	0.184	48	25	0.087	0.042	0.183	38
Pacific Walrus	26	0.097	0.04	0.235	46	3	0.024	0.007	0.09	67
Total Sightings	**103**	**-**	**-**	**-**	**-**	**52**	**-**	-	-	-

n = number
km = kilometer

Table 5.4-2. Estimated densities used to estimate the potential number of exposures of marine mammals to TGS 2013 2D seismic program sounds ≥160 dB re 1 µPa (rms). Lower and upper 95% confidence levels (CL) are shown where available. Sources of the estimates are also indicated.

Species	Estimated Density (#/km^2)	Estimated 95% Lower CL Density (#/km^2)	Estimated 95% Lower CL Density (#/km^2)	Reference/Source
Gray Whale	0.013	-	-	Smultea et al. (2013)
Bowhead Whale	0.004	0.002	0.008	Aerts et al. (2013a)
Humpback Whale	0.00004	-	-	Smultea et al. (2013)
Fin Whale	0.00004	-	-	Smultea et al. (2013)
Minke Whale	0.00004	-	-	Smultea et al. (2013)
Killer Whale	0.00004	-	-	Smultea et al. (2013)
Beluga Whale**	0.001	-	-	Smultea et al. (2013)
Harbor Porpoise	0	-	-	Smultea et al. (2013)
Bearded Seal	0.018	0.0067	0.0468	TGS 2013 2D Density Estimate (Table 5.4-1)
Ribbon Seal	0.0002	-	-	Smultea et al. (2013)
Ringed Seal	0.057	0.028	0.117	Aerts et al. (2013a)
Spotted Seal	0.01	0.0036	0.0305	TGS 2013 2D Density Estimate (Table 5.4-1)
Pacific Walrus	0.044	0.022	0.097	Aerts et al. (2013b)

(2) For the remaining species, the densities used for the TGS 2013 IHA were applied based on results from previous studies for summer/fall and fall periods; no other updated densities were available (Tables 5.4-2 and 5.4-3).

Table 5.4-3. Reported and averaged densities (#/km^2) of eight marine mammal species for which updated densities were not available for the 2013 TGS survey data or the 2008-2012 CSESP surveys (Aerts et al. 2013a). Densities for these species were based on surveys conducted in areas overlapping the 2013 TGS project area primarily in the southern one-half of the project area.

Species	Shell Gulf of Mexico Inc. IHA (Shell 2012)	Statoil 2011 90-day Rept. (Hartin et al. 2011)	*Summer Average* [2]	Statoil 2010 90-day Rept. (Blees et al. 2010)	Shell IHA (Shell 2012)	Statoil 2011 90-day Rept. (Hartin et al. 2011)	UAGI IHA (LGL 2011)	UAGI IHA (LGL 2011)	*Fall Average*	*Summer-Fall Average*
Gray Whale	0.0258	0.02	*0.0229*	0.0004	0.008	0	0.0015	0	*0.0022*	*0.0125*
Humpback Whale	0.0001	0	*0.0001*	0	0.0001	0	0	0	*0*	*0*
Fin Whale	0.0001	0	*0.0001*	0	0.0001	0	0	0	*0*	*0*
Minke Whale	0.0001	0	*0.0001*	0.0003	0.0001	0	0	0	*0*	*0*
Killer Whale	0.0001	0	*0.0001*	0	0.0001	0	0	0	*0*	*0*
Beluga Whale	0.001	0	*0.0005*	0	0.0015	0	0.0017	0.0068	*0.002*	*0.0012*
Harbor Porpoise	0.0011	0	*0.0006*	0	0.0007	0	0	0	*0.0001*	*0.0003*
Ribbon Seal	0.0005	0	*0.0003*	0	0.0005	0	0.0003	0.0003	*0.0002*	*0.0002*

[1] The Statoil 2010 project (Blees et al. 2010) occurred from 11 August-4 October 2010 near the same location as the Shell (2012) project area in the U.S. Chukchi Sea; since most of the Statoil 2010 project (Blees et al. 2010) period was during fall, it was categorized as such for the purposes of the IHA. Densities during *non-seismic* periods of confirmed species sightings were used here for the Statoil 2010 project (Blees et al. 2010).
[2] See Section 6 of the IHA application for details on how average and adjusted densities were calculated for the 2014 TGS IHA.

(3) The same adjustment factor for the 2013 TGS IHA was used for waters deeper than 200 m. This factor was applied to all species except the beluga whale and the ringed, ribbon and spotted seals (Table 5.4-4). Results of the 2013 TGS 2D seismic program monitoring clearly supported this approach. Cetacean sighting rates in waters >100 m deep were <0.3 sightings per 1,000 km, compared to 40 and 55 sightings per 1,000 km in waters 40 to 100 m deep, despite considerable effort expended in deeper waters (Figures 5.2-6 and 5.2-14). Pinniped sighting rates were similarly very low (<0.6 sightings per 1,000 km) in waters deeper than 100 m versus waters 40 to 100 m deep (30 and 105 sightings per 1,000 km) (Figures 5.2-6 and 5.2-21).

Table 5.4-4. Adjustment factors applied to adjust for densities of eight species of marine mammals in waters deeper than 200 m and above 72° N for the TGS 2013 project area. The zero adjustment factors assume that these species are not expected to occur within this parameter (based on a literature review and 2013 project survey results — see text). These same species-specific adjustment factors were used for the 2013 TGS IHA.

Species	Adjustment Factor >200 m Water Depth	Adjustment Factor >72° N
Gray Whale	0	0.2
Bowhead Whale	0	1
Humpback Whale	0	0
Fin Whale	0	0
Minke Whale	0	0
Killer Whale	0	0
Beluga Whale	1	1
Harbor Porpoise	0	0
Bearded Seal	0	1
Ribbon Seal	1	0
Ringed Seal	1	1
Spotted Seal	1	1
Pacific Walrus	0	1

°N = degrees north
m = meter

(4) The same adjustment factors for the 2013 TGS IHA were also used for waters north of 72° N latitude (Table 5.4-4). This factor was applied to all species except the bowhead and beluga whale, the bearded and ringed seal, and the Pacific walrus. Results of the 2013 TGS 2D seismic program monitoring also supported this approach. Cetacean sighting rates in waters north of 72° N were <2 sightings per 1,000 km, compared to 12 and 15 sightings per 1,000 km in waters south of 72° N (Figures 5.2-16). Pinniped sighting rates were lower (4 and 20.5 sightings per 1,000 km) in waters north vs. south of 72° N (9 to 23 sightings per 1,000 km) (Figures 5.2-23).

(5) To address uncertainty, small sample sizes, and relatively large variance in density estimations, lower and upper density estimates were also applied when available/applicable. The 95% CL was available and applied to density estimates for five species: the bowhead whale, the bearded seal, ringed seal, spotted seal, and the Pacific walrus (Table 5.4-2). For the CSESP data, the 95% CLs reported in Aerts et al. (2013a, b) were applied (Table 5.4-2 and Appendix J). For the TGS 2013 IHA densities applied to the other species, the mean density was also considered the lower estimate, while the upper estimate consisted of the mean density doubled.

The following subsection summarizes methods and results of the densities estimated for the TGS 2013 surveys and the CSESP surveys (Aerts et al. 2013a, b). In addition, averaged density estimates used for the TGS 2013 IHA are used again for the eight species for which no new density estimates were available for the project region (Table 5.4-3). The latter densities correspond to four different project areas overlapping the 2013 project region based on the observed or derived densities reported in other studies as depicted in Figure 2-2 in TGS' IHA (Blees et al. 2010; Cameron et al. 2012; Hartin et al. 2011; LGL 2011; Shell 2011). Note that only the Cameron et al. (2012) survey occurred north of 72° N in U.S. Federal and international waters partially overlapping the TGS project area (see Section 4.1 Introduction).

In summary, sightings providing data on observed densities were available for the following seven species: the bowhead, gray and beluga whale, the bearded seal, ringed seal, spotted seal and the Pacific walrus. The remaining other six species occur so rarely in the project area vicinity that reliable densities are not available for them and/or no sightings were made during the reported surveys: the humpback, minke, fin and killer whales, the harbor porpoise and the ribbon seal (Blees et al. 2010; Cameron et al. 2012; Hartin et al. 2011). Thus, the same minimal arbitrary densities were assigned to them as in the 2013 TGS IHA to address the rare chance of an encounter (Blees et al. 2010; Cameron et al. 2012; Hartin et al. 2011; LGL 2011; Shell 2011). No polar bears were seen during the 2013 TGS monitoring program as expected, as the two project vessels remained in open water to avoid ice areas. Because there were no sightings of polar bears and this species is closely associated with ice, no polar bears were estimated to have been taken through harassment during the 2013 TGS seismic program.

5.4.1 Density Estimates from the 2013 TGS Monitoring Program

As required in the TGS IHA, densities estimated from the 2013 TGS survey data were calculated separately for periods with seismic airguns on and off (Table 5.4-1). Density calculations using these data were limited to observations made from the monitoring vessel, the *Norseman*, during seismic periods when the full array and single mitigation airgun were operating off the trailing *Geo Arctic*, and during non-seismic periods when no TGS airguns were operating. This is because some marine mammals have been shown to avoid seismic sounds and/or vessels (e.g., Blackwell et al. 2013; Gordon et al. 2004; Richardson et al. 1995, 1999; Smultea et al. 2004; Stone 2003). As a result, sightings would be expected to differ during seismic and non-seismic periods. Most recently, Robertson et al. (2013, 2014) found that some bowhead whales exposed to seismic sounds in the Beaufort Sea reduced their time at the surface by up to 64% compared to periods of no seismic sounds, depending on behavior state among others. This implies that this species should be less likely to be seen by PSOs during seismic periods as individuals tend to spend less time visible at the water surface. The reaction of many pinnipeds to seismic sounds appears to be more variable and in general, less sensitive than reported for many cetaceans (Harris et al. 2001; Moulton and Lawson 2002; Richardson et al. 1995).

TGS 2013 survey data were further limited to periods providing favorable sighting conditions balanced with maximizing sample size (see Section 5.1.3). This resulted in 1,233 km of usable line transect effort and 25 sightings of five confirmed species during non-seismic periods, and 2,807 km of usable effort and 103 sightings of the same five confirmed species during seismic periods (Table 5.4-1). Because usable sample sizes by confirmed species were small for the purposes of line transect analyses, the CSESP results (Aerts et al. 2013a, b) were used to estimate densities and CLs for the bowhead whale, bearded seal, ringed seal, spotted seal and the Pacific walrus, since they represented considerably larger samples sizes collected during a five-year, non-seismic baseline survey (see Section 5.4.2 below).

Results of the density analysis conducted on the 2013 TGS monitoring data collected from the *Norseman* are presented in Table 5.4-1. Line-transect parameters were calculated for five marine mammal species with at least five "on-effort" line transect sightings during seismic and non-seismic periods combined that met the aforementioned criteria. Notably, the relatively small sample sizes used to estimate density for

the TGS 2013 survey data are below the typical minimum generally recommended to enable robust estimation of f(0) and non-idealized survey design. This results in associated relatively low precision and uncertain accuracy of species density estimates. In addition, the estimates likely underestimate true numbers, due to unavailability of g(0) (trackline detection probability data) and the large number of unidentified sightings that were not used in the basic estimates to avoid added uncertainty associated with proration techniques.

Line transect methods were also used to produce a sightability curve (i.e., fitted detection function) to indicate detections versus perpendicular sighting distance) (Figure 5.4.1-1). This graph illustrates the relationship of reduced sightability of animals with increasing distance from the *Norseman* observation platform. However, all marine mammal species were pooled for this detection function, as sample sizes were not large enough to support further stratification. Truncation of this best-fit detection function for the modeled data occurred near a perpendicular sighting distance of approximately 0.36 km (Figure 5.4.1-1).

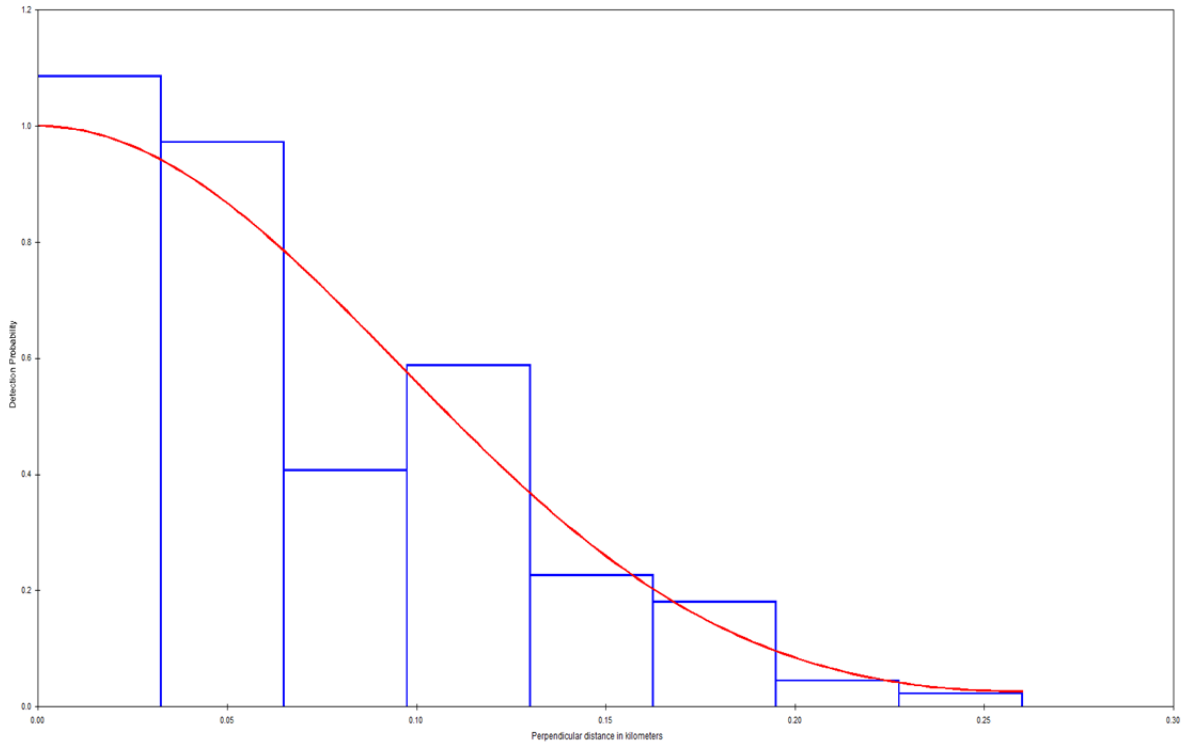

Figure 5.4.1-1. Graph of perpendicular sighting distance (km) and fitted detection functions indicating detection probability versus distance for cetaceans and pinniped sightings combined. Data are limited to on-effort line transect sightings made during seismic and non-seismic periods from the *Norseman* monitoring vessel during the 2013 TGS 2D seismic program.

5.4.2 Estimated Number of Potential Exposures

The number of marine mammals sighted by PSOs within the estimated 160 dB re 1 µPa (rms) isopleth relative to the 2013 TGS seismic source is considered the absolute minimum number of such exposures, following methodology reported in past 90-day reports for the Chukchi and Beaufort seas (e.g., Blees et al. 2010; LAMA Ecological and Oasis Environmental 2011). These numbers were summarized in

Section 5.2, including relative to the 180 dB and 190 dB isopleths, as relevant by species. However, PSOs were not able to simultaneously monitor the entire radius around the full TGS seismic array (15 km). Therefore, some unknown number of additional marine mammals was presumably exposed to seismic sounds ≥160 dB re 1 μPa (rms). To address this limitation, estimates of such exposure were made by multiplying the estimated observed and/or reported densities by the area ensonified to ≥160 dB re 1 μPa (rms). The minimum and maximum numbers of exposures were estimated by multiplying the ensonified area by the lower and upper CLs for the densities, if available. When not available, the minimum density was considered the same as the estimated density and multiplied by the ensonified area to obtain a lower estimate of potential exposures to received levels ≥160 dB re 1 μPa (rms). The corresponding potential upper exposure estimate was obtained by doubling the reported density estimate and multiplying it by the ensonified area.

The approach used to calculate the estimated number of individuals of each marine mammal species exposed to received levels of pulsed seismic source sounds ≥160 dB re 1 μPa (rms) during the 2013 TGS seismic project is described below. This approach is the same as that used in the 2013 TGS IHA. The 160 dB criterion is used by NMFS to determine Level B "take" associated with behavioral impacts resulting from exposure to pulsed sounds for all marine mammals (NMFS 2005). NMFS assumes that marine mammals exposed to seismic source sounds this strong might change their behavior sufficiently to be considered "taken by harassment". However, not all exposures to this sound level or higher would meet necessarily meet the definition of "take" in the MMPA.

(1) The area of water (in km^2) ensonified to ≥160 dB re 1 μPa (rms) around the operating seismic source array on seismic lines as well as turns and transits between seismic lines was calculated by waters shallower and deeper than 200 m and north and south of 72° N, to allow application of adjustment factors (Table 5.4.2-1). For the purposes of this estimation, the full array ensonification area (dependent on water depth) was applied for any period that >1 airgun was operating (e.g., during testing, ramp-up and during the approximately 4 km run-in and 1 km run-out immediately before and after seismic lines, respectively). In addition, the full 15 km isopleth for the single 60 in^3 (or smaller) airgun was applied during turns and transits between seismic lines, regardless of water depth. Ensonified waters were calculated as follows.

Table 5.4.2-1. Estimated area (km^2) ensonified to ≥160 dB re 1 µPa (rms) by seismic sounds during TGS' 2013 seismic lines and turns when airgun(s) were operating in the Chukchi Sea. The distance to the 160 dB isopleth on survey lines for the full 3,280 in^3 array differed based on three water depths as modeled by JASCO (see Table 1-1 and Appendix A). Areas (in km^2) were calculated using the software *Mysticetus*™ by drawing polygons around the survey lines the width of which corresponded with the distances to the three 160 dB isopleths depending on the water depth under the array. Water depths were determined using worldwide 1 arc minute bathymetry data (ETOPO1). For turns and transits between survey lines, the furthest distance to the 160 dB isopleth for the single 60 in^3 airgun was used, regardless of water depth (Appendix A). Ensonified areas were multiplied by the estimated densities of marine mammals as described in Section 5.4.

Area Ensonified to ≥160 dB re 1 µPa (rms)					
	<200 m depth	>200 m depth	South of 72° N	North of 72° N	Total ≥160
Area (km^2)	112,623	49,970	74,305	88,287	**162,592**
Percent	69%	31%	46%	54%	**100%**

°N = degrees north
dBre 1 µPa = relative to 1microPascal
m = meter
rms = root mean square

(2) A buffer was applied on both sides of the surveyed tracklines equivalent to the distances modeled for the proposed 3,280 in^3 seismic source array by JASCO in 2010 at three locations in the project area (Zykov et al. 2013). The buffer width corresponding to this 160 dB re 1 µPa (rms) isopleth varied with three water depth categories as shown in Appendix A. Thus, survey tracklines located over waters 17 to 40 m deep were buffered by 8.5 km those over waters 41 to 100 m deep were buffered by 9.9 km and those over water depths of >100 were buffered by 15 km.

(3) A smaller buffer of 1.5 km width was applied to both sides of turns between seismic lines when the single mitigation airgun was operating equivalent to the associated maximum JASCO-calculated distance to the 160 dB re 1 µPa (rms) isopleth for this airgun operating in deep water (see Appendix A and Table 4.2-2). Thus, the latter buffer was not adjusted for depth but instead assumed the largest radius regardless of water depth.

(4) The associated area in km^2 was calculated using *Mysticetus* ™ software. *Mysticetus* ™ identified water depths at 100 m intervals along the survey trackline using bathymetric data. At each 100 m interval, *Mysticetus*™ applied one of the three aforementioned 160 dB re 1 µPa (rms) radius isopleths corresponding to that water depth. Overlapping areas were treated separately. The resulting World Geodetic System (WGS) 84 polygons were re-projected into North Pole Stereographic coordinates and the total area was calculated.

(5) Densities of marine mammals (Table 5.4-2) were adjusted as applicable for latitude north or south of 72° N and water depth shallower or deeper than 200 m (Table 5.4-4) then multiplied by the area calculated to be ensonified to ≥ 160 dB re 1 µPa (rms). The procedure is outlined below and shown below.

(6) The formula for estimating the number of exposures to TGS seismic sounds ≥160 dB re 1 µPa (rms) is identified below.

5.4.2.1 Adjustment Factors Applied to Provide Lower and Upper Estimates of Density

A number of habitat parameters have been shown to influence the distribution of marine mammal species occurring in the TGS project area. These parameters were applied to adjust the density of species accordingly, as done in the 2013 TGS IHA and previous applications (e.g., Blees et al. 2010; Cameron et al. 2012; Hartin et al. 2011; LGL 2011; Shell 2011). These included the four parameters used in the 2013 TGS IHA application:

(1) Open water (i.e., ice-free) vs. ice-edge margin (higher densities of pinnipeds and beluga whales occur near and/or within the ice margin);
(2) Summer (July-August) vs. fall (September-October);
(3) Water depth (>200 m vs. <200 m deep); and
(4) Likelihood of occurrence above or below 72° N.

Open-water densities were used if available because TGS operations avoided ice to the maximum extent practicable to be able to safely and effectively conduct operations. The adjustment for fewer numbers of some marine mammal species in water >200 m deep and waters north of 72° N based on previous studies was supported by the 2013 TGS results: fewer than approximately 0.9% of all sightings occurred in waters >100 m) deep, although 16% of the observation effort occurred there (see also Section 5.2.2).

5.5 Estimated Number of Exposures

The estimates of the numbers of marine mammals that might have been "taken by harassment" through exposure to received levels of pulsed seismic sounds ≥160 dB re 1 µPa (rms) are presented in Table 5.5-1. These are considered the best estimates based on what are considered to be the best available data. These estimates as well as the potential lower and upper range estimates are shown relative to the NMFS-authorized "takes" per the 2013 IHA issued to TGS. The confidence of these estimates varies by species, as indicated by the range of the CLs when available. When sample sizes are small, the precision and reliability of density and thus exposure estimates are correspondingly low. The estimates based on the CSESP data are considered the most reliable estimates available, but the latter studies did not extend through the end of October nor did they extend much beyond 72° N. However, these data are what is available to the best of our knowledge.

Table 5.5-1. Best, lower and upper estimates of the potential number of exposures of each marine mammal species to 2013 TGS 2D seismic sounds ≥160 dB re1µPa (rms). The NMFS-authorized number of marine mammal "takes" identified in TGS' 2013 IHA (Smultea et al. 2013) through exposure to TGS seismic sounds ≥160 dB re1µPa (rms) is also shown. Population estimates were based on the most current available references.

Species	Authorized 2013 IHA Take Estimates	Best Estim. # Exposures	Lower Estim. # Exposures	Upper Estim. # Exposures	Best Estim. Exposure (% of Population)	Lower Estim. % Population	Upper Estim. % Population	Population Estimate
Gray Whale	1,363	1,282	1,282	2,564	6.7	6.7	13.4	19,126
Bowhead Whale	794	549	275	1,099	3.3	1.6	6.5	16,892
Humpback Whale	5	3	3	6	0	0	0	20,800
Fin Whale	5	3	3	6	0.2	0.2	0.4	1,652
Minke Whale	5	3	3	6	0.4	0.4	0.7	810
Killer Whale	5	3	3	6	0.1	0.1	0.3	2,347
Beluga Whale*	412	202	202	404	0.5	0.5	0.9	42,968
Harbor Porpoise	36	32	32	64	0.1	0.1	0.1	48,215
Bearded Seal	6,000	2,432	921	6,430	1.6	0.6	4.1	155,000
Ribbon Seal	100	20	20	40	0	0	0.1	61,000
Ringed Seal	30,000	6,765	3,323	13,887	2.3	1.1	4.6	300,000
Spotted Seal	500	5,697	2,042	15,905	4	1.4	11.2	141,479
Pacific Walrus	-	6,045	3,023	13,327	3	1.5	0.1	200,000

* The beluga population estimate for the eastern Chukchi Sea is based on the minimum population estimate, as this is the only and most current up to date population estimate per the NMFS Stock Assessment Report.

Overall, the actual number of potential exposures to TGS 2013 seismic sounds is likely to have been lower than estimated for the following reasons:

- The distances to the 160 dB re 1 μPa (rms) isopleths applied during the project are at least 10% larger than actually estimated by JASCO modeling (Appendix A). Thus, marine mammals within the far edge of this isopleth are actually expected to be exposed to sounds <160 dB re 1 μPa (rms).
- Results of JASCO's 2013 SSV found that the modeled distance to the isopleths is considerably overestimated the respective airgun radii (Table 4.2-1).
- For conservative marine mammal mitigation, TGS decided to shut down their entire array rather than employing a power down procedure (to a single mitigation airgun) when marine mammals were observed approaching or first observed within the appropriate exclusion zones.
- JASCO's modeling of TGS' proposed 3,280 in^3 seismic array is wider to the sides than in front of the array (Appendix A). Thus, although the estimated number of exposure assumes that the entire 160 dB isopleth radius is ensonified to this sound level, the actual area ensonified to this isopleth varies by distance. This is related to differences in azimuthal directivity patterns that vary by sound frequency and 1/3 octave bands. Thus, some of this isopleth is ensonified to <160 dB re 1 μPa (rms).
- Furthermore, as summarized previously in Section 5 above, pinnipeds seem to be less responsive to seismic source sounds than are some mysticetes. Thus, pinnipeds may not exhibit behavioral changes when exposed to the 160 dB re 1 μPa (rms) criterion currently applied by NMFS, on which the take estimates are based.
- In addition, responses of bowheads and other cetaceans have been found to vary by behavior state, time of season, received sound level, etc. (reviewed in Smultea et al. [2013]). Thus, not all cetaceans are expected to exhibit behavioral changes when exposed to the 160 dB re 1 μPa (rms) criterion currently applied by NMFS, on which the take estimates are based. In addition, some individuals may react at received sound levels <160 dB re 1 μPa (rms) based on various studies, but would not be considered "take" under the current NMFS criteria for impulse sounds such as seismic.

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Appendix A
JASCO 5-day and Final Report

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Sound Source Verification – Preliminary Report

TGS Chukchi Sea Seismic Survey Program 2013

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1. Introduction

This report presents initial results from sound source verification (SSV) measurements for vessels and airgun sources involved with TGS's 2013 2-D Seismic Survey program in the Chukchi Sea, Alaska. The measurements were carried out by JASCO Applied Sciences on 28-30 August 2013 using autonomous sound recorders placed on the seafloor. Airgun and vessel data from the autonomous recorders completed downloading on 02 Sep 2013. The results presented in this report include the representative distances at which impulsive sound levels reached the 190, 180, 160, and 120 dB re 1 µPa rms thresholds for the full airgun array and a single mitigation airgun. Distances to continuous sound pressure level thresholds were also calculated for the self-noise of the survey vessel RV *Geo Arctic* and of the monitoring vessel MV *Norseman*. The measurement site was located along TGS survey line 3040 at the southwest end of the survey region.

2. Seismic Survey Description

The airguns were deployed from the survey vessel RV *Geo Arctic*, an 82 m (269 ft) seismic survey vessel. The SSV measurements were conducted from the monitoring vessel MV *Norseman*, which also served as the monitoring vessel responsible to clear the 160 dB marine mammal safety zone during airgun operations. The *Norseman*, operated by Norseman Maritime, is a 33 m (108 ft) research and support vessel. Vessel specifications for the *Norseman* and the *Geo Arctic* are given in Table 1 and a photograph of the *Norseman* alongside the *Geo Arctic* is presented in Figure 1.

Figure 1: Survey vessel RV *Geo Arctic* with monitoring vessel MV *Norseman* alongside.

Table 1. Vessel specifications for the Geo *Arctic* and the *Norseman*.

	Norseman	*Geo Arctic*
Length	33 m (108 ft)	82 m (269 ft)
Width	(28 ft)	15 m (49 ft)
Draft	(11 ft)	5.25 m (17 ft)
Engine	Caterpillar 850	3090 kW Zgoda-Zulcer 6ZL 40/48
Propeller	Single screw	Zamen, 4-blade stainless steel controllable pitch

The airgun array geometry is shown in Figure 2. The array consists of 40 airguns with individual volumes between 40 in^3 and 250 in^3. The layout is comprised of four sub-arrays of 9 or 11 guns each, including spare guns as indicated in the geometry diagram. The overall volume is 3280 in^3 from 26 active airguns. The airguns were towed at 6 m depth and 86.5 m behind the vessel.

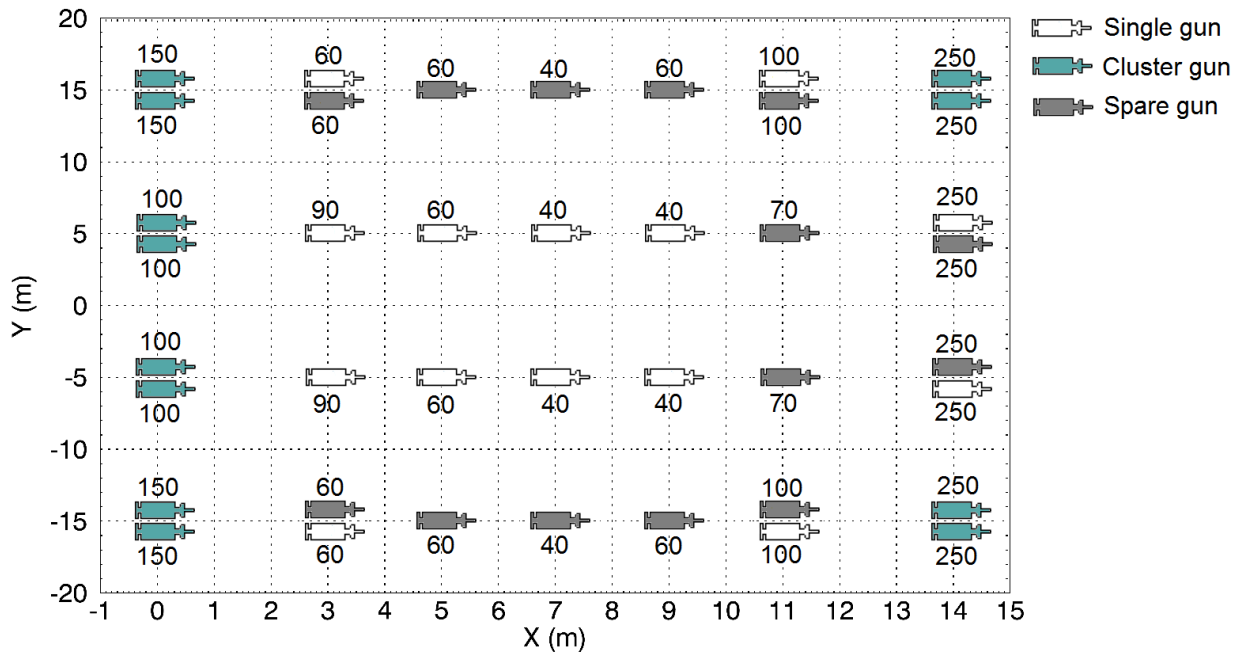

Figure 2 3280 in^3 airgun array layout.

Sound levels from the following sources were measured during the SSV program:

1. 60 in^3 single airgun (used for mitigation),
2. 3280 in^3 airgun array,
3. Vessel self-noise from RV *Geo Arctic* (transiting at survey speed),
4. Vessel self-noise from MV *Norseman* (transiting at survey speed).

3. Pre-Season Estimates of Sound Threshold Radii

Pre-season exclusion zone radii for the survey were determined from computer model estimates, validated against previous measurements of similar sources in the Chukchi Sea. Sound threshold radii were modeled for three depth regimes: 17-40 m, 40-100 m and > 100 m. Table 2 shows the pre-season threshold radii as indicated in the IHA permit application for the 3280 in^3 airgun array and the 60 in^3 mitigation airgun. The exclusion zone radii that are currently being applied for the survey have been maximized over depth regime.

Table 2. Pre-season threshold distances as noted in TGS's IHA permit application.

Received Sound Level (dB rms)	Exclusion Zone Radius (m)			
	3280 in^3 array			60 in^3 mitigation gun
	17-40 m	40-100 m	>100 m	All depths
≥190	930	920	430	13
≥180	2200	2400	2500	68
≥160	8500	9900	15,000	1500

4. Measurement Procedure

The measurements were performed using five JASCO Applied Sciences' Autonomous Multi-channel Acoustic Recorders (AMARs) deployed to capture sound levels as a function of distance and direction from each source. Four AMARs were deployed perpendicular to the test track at ranges of 800, 2500, and 10,000 and 80,000 m to record received sound levels at multiple distances from the sources. One additional AMAR was placed 5000 m from the start of the survey track line to capture sounds from the mitigation gun as the survey vessel approached the line to begin ramp-up. Vessel self-noise of the *Geo Arctic* was extracted from time periods between pulses of the mitigation gun, as the survey vessel transited over location E. The airgun array and source vessel were run along an 80 km (67 mi) track line perpendicular to the line of AMARs that corresponded with TGS' production survey line 3040. The monitoring vessel *Norseman* traversed a 15 km (9 mi) track that passed directly over top of AMAR location A. Figure 3 is a diagram of the track lines and AMAR deployment geometry.

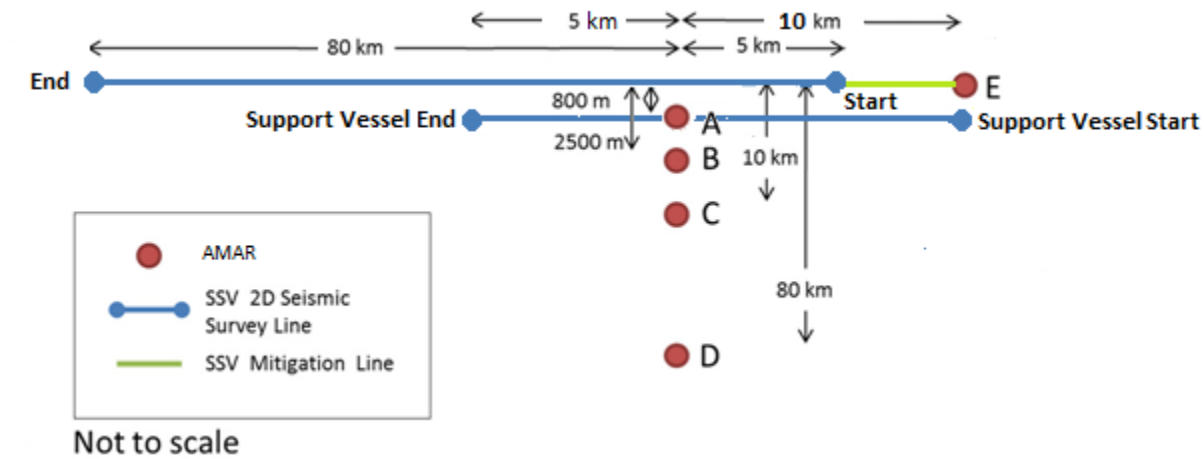

Figure 3: Recorder deployment geometry and survey track lines for the SSV.

The SSV test site and AMAR locations are shown in the map of Figure 4. The AMAR deployment coordinates and start and end coordinates for the SSV track lines are listed in Table 3. Measurements were carried out from 28 – 30 August 2013. Table 4 shows when the sound measurement of each source occurred.

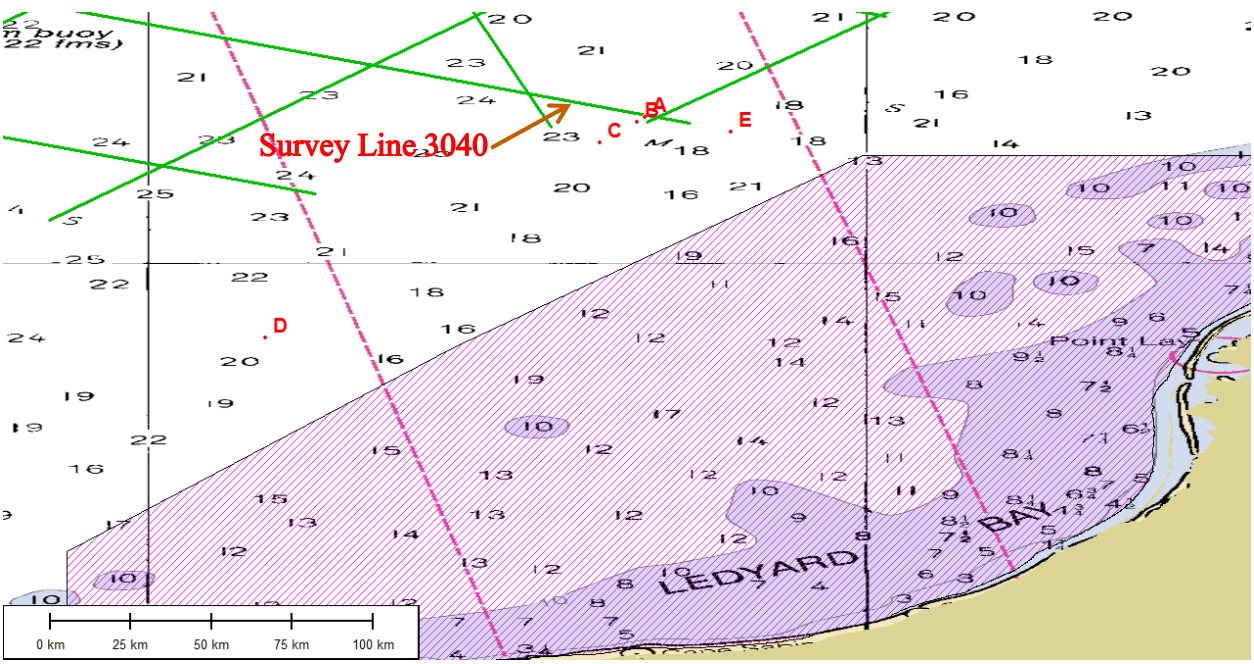

Figure 4: SSV measurement site.

Table 3. AMAR and survey track line coordinates. Coordinates: WGS 84.

Location	Latitude	Longitude	Water Depth (m)
A	70°24.294′ N	164°36.622′ W	45
B	70°23.510′ N	164°38.023′ W	45
C	70°20.041′ N	164°44.177′ W	45
D	69°47.554′ N	165°39.989′ W	41
E	70°21.888′ N	164°22.242′ W	44
Start	70°23.278′ N	164°29.095′ W	45
End	70°46.227′ N	166°27.975′ W	48
Support Vessel Start	70°21.520′ N	164°22.904′ W	44
Support Vessel End	70°25.675′ N	164°43.505′ W	45

Table 4. Schedule of underwater acoustic measurements for the SSV.

Measured Source	Start Date (UTC)	End Date (UTC)	Start Time (UTC)	End Time (UTC)
Norseman transiting alone	28 Aug 2013	28 Aug 2013	00:52	02:20
Mitigation gun	29 Aug 2013	29 Aug 2013	23:02	23:14
3280 in^3 array	29 Aug 2013	30 Aug 2013	23:44	22:40
Geo Arctic self-noise	29 Aug 2013	29 Aug 2013	23:02	23:14

5. Measurement Apparatus and Calibration

The AMAR systems were deployed directly on the seabed with their hydrophones approximately 30 cm above the bottom. Each AMAR had an attached ground line and small anchor, as shown in Figure 5, to facilitate retrievals using a grapple hook so that nothing was left on the seafloor.

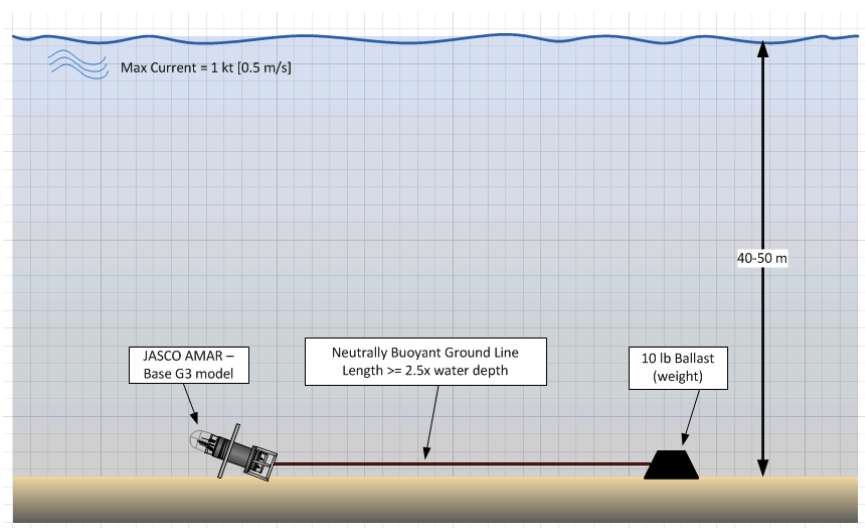

Figure 5: AMAR mooring design.

The AMARs (Figure 6) were each outfitted with two Geospectrum M8E hydrophones; one with nominal sensitivity -200 dB re V/µPa and one with nominal sensitivity -165 dB re V/µPa. One AMAR had a Geospectrum M8K hydrophone, nominal sensitivity -210 dB re V/µPa, in place of one of the M8E hydrophones to provide wider dynamic range of recording at the closest measurement site. The AMARs each recorded two channels of acoustic data to internal memory at 96 kHz sample rate with 24-bit resolution. This configuration captured acoustic frequencies from 10 Hz to 48 kHz.

Figure 6 AMAR with attached ground line on back deck of *Norseman*, ready for deployment (left) and being deployed over the stern (right).

All AMARs were calibrated before and after deployment using a GRAS 42AC pistonphone calibrator. The pistonphone calibrator generates a known 250 Hz reference tone accurate to 0.1 dB at the AMAR hydrophone sensor. The pressure calibration of the AMAR system was obtained from the level of the reference signal in the digital calibration recording. Typical calibration variance using this method is less than 0.5 dB absolute pressure. The pressure sensitivity obtained from the pistonphone calibration was used in the subsequent data analysis for determining sound levels.

6. Data Analysis Procedure

6.1. Acoustic Metrics

Underwater sound amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_o = 1 µPa. Because the loudness of impulsive noise, from seismic airguns for example, is not generally directly proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate the importance of impulsive noise to evaluate its potential effect on marine fauna.

The zero-to-peak SPL, or peak SPL (L_{pk}, dB re 1 µPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an impulse, $p(t)$:

$$L_{pk} = 10\log_{10}\left(\frac{\max\left(\left|p^2(t)\right|\right)}{p_o^2}\right) \tag{1}$$

The peak SPL metric is commonly quoted for impulsive sounds. At high intensities, the peak SPL can be a valid criterion for assessing whether a sound is potentially injurious; however, because the peak SPL does not consider pulse duration or frequency content, it is not a good indicator of perceived loudness.

The root-mean square (rms) SPL (L_p, dB re 1 µPa) is the rms pressure level in a stated frequency band over a time window (T, s) containing the pulse:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_o^2\right) \tag{2}$$

The rms SPL can be thought as a measure of the average pressure or as the "effective" pressure over the duration of an acoustic event, such as the emission of one acoustic pulse. Because the window length, T, is a divisor, pulses of equivalent energy that are more spread out in time have a lower rms SPL.

In studies of impulsive noise, T is often defined as the "90% energy pulse duration" (T_{90}): the interval over which the pulse energy curve rises from 5% to 95% of the total energy. The SPL computed over this T_{90} interval is commonly called the 90% rms SPL (L_{p90}, dB re 1 µPa):

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} p^2(t)dt \Big/ p_o^2\right) \tag{3}$$

The sound exposure level (SEL, dB re 1 µPa^2 ·s, symbolized L_E) is a measure of the total acoustic energy contained in one or more pulses. The SEL for a single pulse is computed from the time-integral of the squared pressure over the full pulse duration (T_{100}):

$$L_E = 10\log_{10}\left(\int_{T_{100}} p^2(t)dt \Big/ T_o p_o^2\right) \tag{4}$$

where T_o is a reference time interval of 1 s. The SEL represents the total acoustic energy delivered over the duration of an acoustic event at a receiver location. It measures the sound energy to which an organism at that location would be exposed. To compute the SPL and SEL of pulses in the presence of high levels of background noise, Equations 3 and Equation 4 are sometimes modified to subtract the background noise energy from the pulse energy:

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} p^2(t)dt \Big/ p_o^2 - \overline{n^2}\right) \tag{5}$$

$$L_E = 10\log_{10}\left(\int_{T_{100}} p^2(t)dt \Big/ T_o p_o^2 - \overline{n^2}T\right) \tag{6}$$

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

$$L_E = L_{p90} + 10\log_{10}(T_{90}) + 0.458 \tag{7}$$

where the 0.458 dB factor accounts for the rms SPL containing 90% of the total energy from the per-pulse SEL. Importantly, L_E has units of dB re uPa^{2}s while L_{p90} has units of dB re µPa.

6.2. Analysis Methods

Acoustic data were analyzed using JASCO Applied Sciences' custom processing software, to determine peak and rms SPLs and per-impulse SELs versus range from the sound sources. For the impulsive sound sources, individual pulses were identified in the recordings using automated detection. For each pulse detected, the slant range to the source was computed from GPS coordinates of the AMARs and the time referenced navigation logs from the *Geo Arctic* (offset applied for the center of the acoustic source).

The SPL data were fit to one of the following empirical propagation loss curves:

$$RL = SL - A\log_{10} R \tag{8}$$

$$RL = SL - A\log_{10} R - BR \tag{9}$$

where R is the slant range from the source to the acoustic recorder, RL is the received sound level, SL is the estimated source level, A is the geometric spreading loss coefficient, and B is an absorptive-type 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 a conservative estimate of the threshold radii, the best fit line was shifted upwards (by increasing the constant SL term) so that the trend line exceeded 90% of all the data. The 90th percentile best-fit equations are shown in the SPL versus range plots in the following section.

7. Results

7.1. Sound Velocity Profiles

Sound speed profiles were measured with CTD (conductivity-temperature-depth) casts performed at the deployment locations A (800 m from the line), D (80 km from the line) and E (5 km before the start of the survey line). Measurements were collected on deployment and retrieval of the AMARs to monitor temporal variability. The Geo Arctic SSV transit occurred in the middle of the time period between deployment and retrieval.

The measured sound speed profiles are slightly downward refracting at depths below an isovelocity upper layer, the depth of which varied spatially and temporally. This layer extended to depths between 10–20 m (location dependent) at the time of AMAR deployment. Increased sea states leading up to the AMAR retrievals resulted in mixing of the water column and a deepening of the isovelocity sound layer to depths greater than approximately 23 m. Under these conditions, sound is neither strongly refracted toward the absorptive seafloor nor toward the lossy sea surface, hence this environment supports sound propagation in the water column.

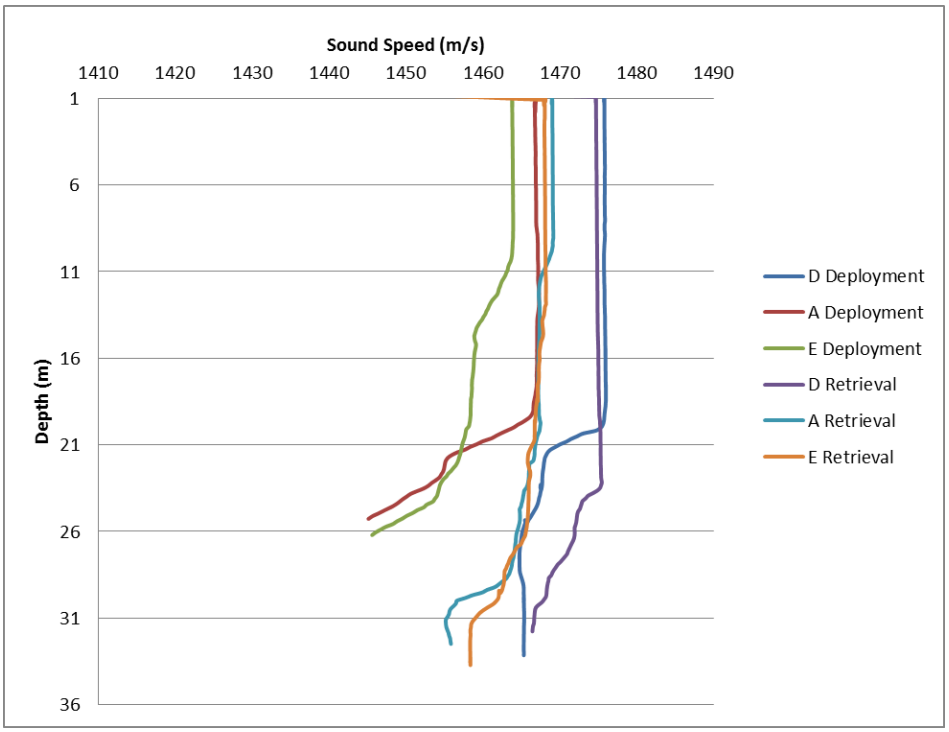

Figure 7 Sound speed profiles measured upon deployment and retrieval of AMARs at locations D, A, and E.

7.2. 60 in³ mitigation airgun

Peak SPL, 90% rms SPL and SEL for each pulse of the mitigation gun were computed from acoustic data from the AMAR at location E. Figure 8 shows sound levels from the 60 in^3 airgun versus range. Since the *Geo Arctic* navigation system was not recording shot point data while the mitigation gun fired, ranges to the mitigation gun were estimated from GPS navigation records from the Geo Arctic PSO team by applying an offset to account for the separation between the GPS antenna and the mitigation gun location. The ranges thus computed could be in error by approximately 15 m due to feathering of the array in the current, which at the time of transit was 3.2 degrees, and due to GPS accuracy. Table 5 shows ranges to rms SPL thresholds from 190 dB to 120 dB re 1 µPa which were computed from the 90th percentile empirical curve fits to the SPL versus range data.

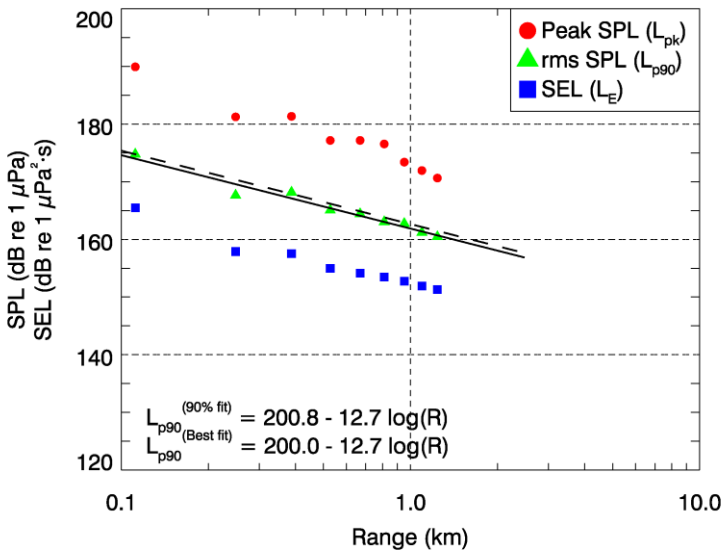

Figure 8: Peak SPL, rms SPL, and sound exposure level (SEL) versus range for 60 in^3 mitigation airgun pulses at the SSV site in the endfire direction. Solid line is best fit of the empirical function to rms SPL values. Dashed line is the best-fit adjusted to exceed 90% of the rms SPL values.

Table 5. Threshold radii at the SSV site for the 60 in^3 mitigation airgun as determined from fit to rms SPL versus distance data in Figure 8.

rms SPL Threshold (dB re 1 µPa)	Best-fit radius (m)	90th Percentile radius (m)
190	6*	7*
180	38*	43*
170	230	260
160	1400	1600**
150	8600**	9900**
140	52,000**	60,000**

*Extrapolated beyond minimum measurement range of 43 m.

** Extrapolated beyond maximum measurement range of 1.5 km.

7.3. Airgun Array – 3280 in³ configuration

Peak SPL, 90% rms SPL and SEL for each pulse were computed from acoustic data from each AMAR. Figure 9 shows sound levels from the 3280 in^3 airgun array versus range in both the endfire and broadside directions. A change in the propagation conditions at endfire ranges between 2 and 5 km resulted in a decrease of the 90%-rms SPL. At those ranges a strong head wave in advance of the main pulse arrival caused a lengthening of the 90%-rms pulse width and corresponding decrease of the 90%-rms SPL. To obtain the best fit to the data through this transition, separate curve-fits were applied to data at ranges less than 3 km and data at ranges greater than 3 km.

Table 6 shows ranges to rms SPL thresholds from 190 dB to 120 dB re 1 µPa which were computed from these 90th percentile empirical curve fits to the SPL versus range data. Figure 10 presents spectrograms of 3280 in^3 airgun array pulses measured on AMAR A at CPA (826 m) and at long range (40 km).

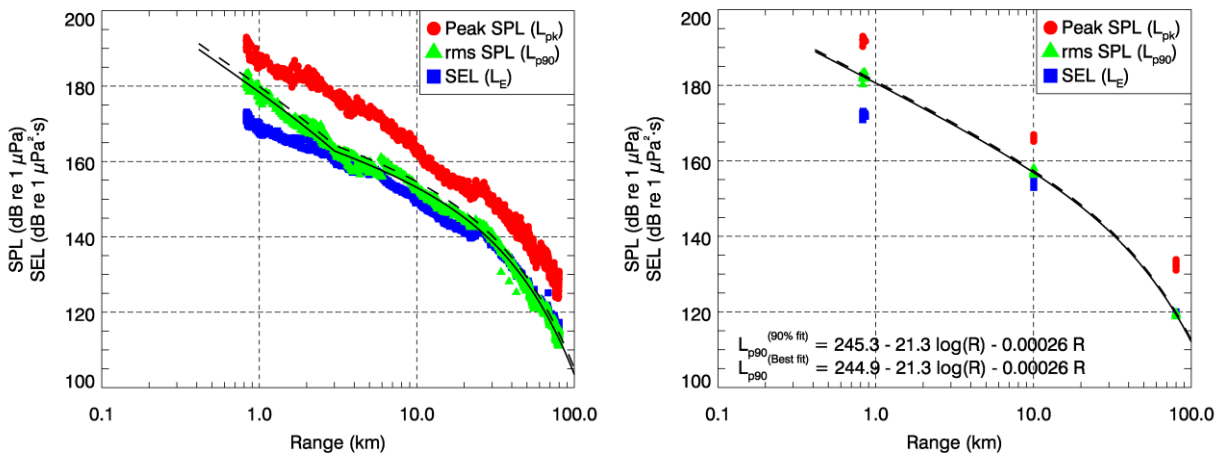

Figure 9: Peak SPL, rms SPL, and sound exposure level (SEL) versus range for 3280 in^3 airgun array pulses at the SSV site in the endfire (left) and broadside (right) directions. Solid line is best fit of the empirical function to rms SPL values. Dashed line is the best-fit adjusted to exceed 90% of the rms SPL values.

Table 6. Threshold radii at the SSV site for the 3280 in^3 airgun array as determined from fit to rms SPL versus distance data in Figure 9.

rms SPL Threshold (dB re 1 µPa)	Endfire		Broadside	
	Best-fit radius (m)	90th Percentile radius (m)	Best-fit radius (m)	90th Percentile radius (m)
190	400*	460*	370*	390*
180	890	990	1100	1100
170	1900	2100	3000	3100
160	4400	5400	7600	8000
150	13,000	15,000	17,000	18,000
140	28,000	30,000	33,000	34,000
130	46,000	49,000	53,000	55,000
120	65,000	68,000	78,000	80,000

*Extrapolated beyond minimum measurement range of 826 m.

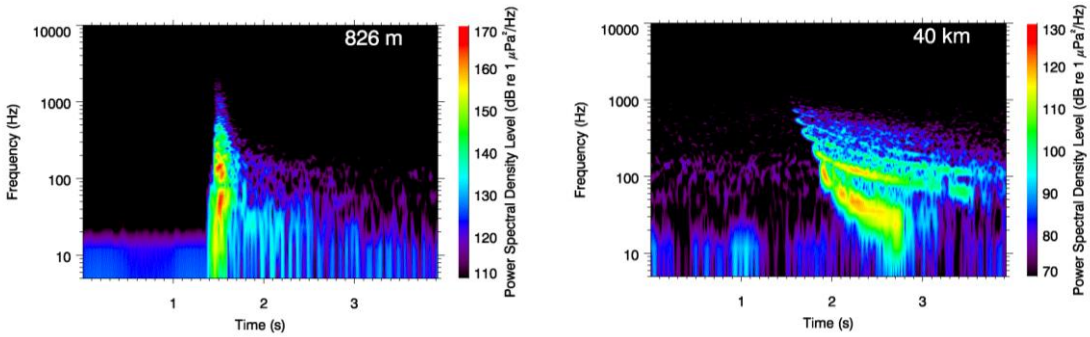

Figure 10: Spectrograms of 3280 in^3 airgun array pulses measured at AMAR position A at CPA (826 m, left) and long range (40 km, right). 8192 pt FFT length.

7.4. RV Geo Arctic

SPLs were computed for vessel self-noise of the *Geo Arctic* as it transited over position E at a nominal speed of 4.4 kts. Figure 11 presents the rms levels versus range, as well as the best-fit and 90th percentile trend lines and the equations thereof. The ranges to sound level thresholds of 150 to 120 dB re µPa (rms) are listed in Table 7.

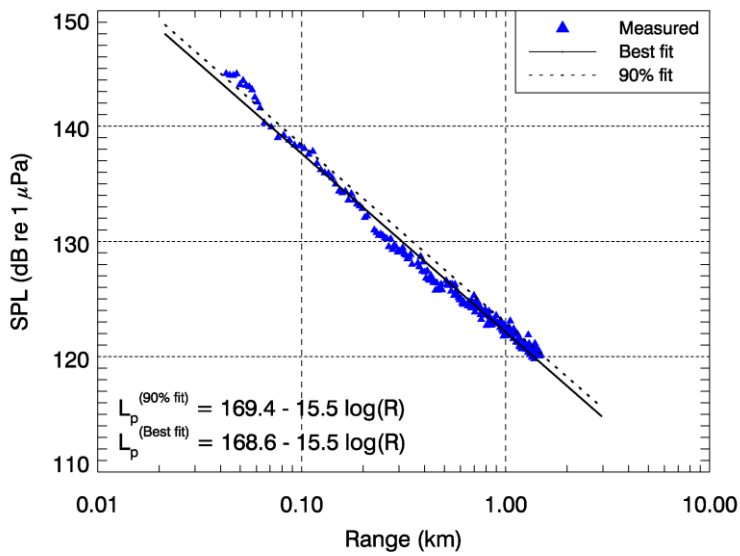

Figure 11: Sound pressure level (*rms*) versus range from the *Geo Arctic* while the vessel transited past position E at 4.4 kts. Solid line is best fit of the empirical function to SPL values. Dashed line is the best-fit adjusted to exceed 90% of the SPL values.

Table 7. Threshold radii at the SSV site for the *Geo Arctic* traveling at 4.4 kts as determined from fit to rms SPL versus distance data in Figure 11.

rms SPL Threshold (dB re 1 µPa)	Best-fit radius (m)	90th Percentile radius (m)
150	16*	18*
140	70	80
130	310	350
120	1400**	1500**

* Extrapolated beyond minimum measurement range of 43 m.

** Extraploated beyond maximum measurement range of 1.5km

7.5. MV Norseman

SPLs were computed for vessel self-noise of the *Norseman* as it transited a specified track that passed over position A. The *Norseman* transited at a nominal speed of 5 kts in 4 ft seas. Figure 12 presents the rms levels versus range, as well as the best-fit and 90th percentile trend lines and the equations thereof. The trend line fits were restricted to data measured within 300 m range of the vessel. The ranges to sound level thresholds of 150 to 120 dB re µPa (rms) are listed in Table 8. The maximum ranges for each sound level threshold are also listed in Table 8 due to the poor curve-fit

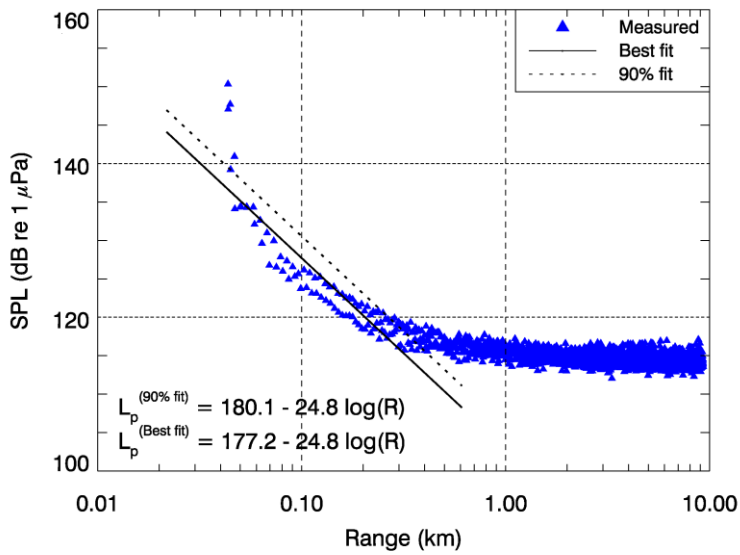

Figure 12: Sound pressure level (*rms*) versus range from the *Norseman* while the vessel transited past position A at 5 kts. Solid line is best fit of the empirical function to SPL values. Dashed line is the best-fit adjusted to exceed 90% of the SPL values.

Table 8. Threshold radii at the SSV site for the *Norseman* traveling at 5 kts as determined from fit to rms SPL versus distance data in Figure 11.

rms SPL Threshold (dB re 1 µPa)	Best-fit radius (m)	90th Percentile radius (m)	Maximum measured radius (m)
150	13*	16*	44
140	32*	42*	46
130	81	100	73
120	205	270	285

*Extrapolated beyond minimum measurement range of 44 m.

8. Summary

Sound source verification measurements were completed for a 3280 in^3 airgun array, a 60 in^3 mitigation gun, a survey vessel, and a support monitoring vessel associated with the TGS 2013 seismic survey in the Chukchi Sea. Table 9 is a listing of the maximum distances to 190, 180, 160 and 120 dB re 1 μPa threshold levels for the 3280 in^3 airgun array and the 60 in^3 mitigation airgun. These distances are based on the 90th percentile empirical function fits and are the maxima over direction (broadside and endfire).

Table 9. Maximum threshold distances for the 3820 in^3 and 60 in^3 airgun arrays. Distances are maximized over direction and are based on the 90th percentile fits.

Received Sound Level (dB rms)	90th Percentile Distance (m)	
	3280 in^3 airgun array	60 in^3 mitigation gun
190	460	7
180	1100	43
160	8000	1600

These measured radii confirm that the pre-season exclusion zone radii defined for the survey were conservative estimates of the propagation ranges of the sound from the airguns associated with the TGS seismic survey. The ratios of measured-to-modeled radii are listed in Table 10. Variability of the exclusion zone radii is expected since the survey region extends over a large geographic area with variable site-dependent environmental conditions. Previous measurements of similar-sized airgun arrays in other regions of the Chukchi Sea have resulted in larger radii than those measured in this SSV study.

Table 10 Ratio of measured radii compared to pre-season estimated radii for the 3280 in3 airgun array and the 60 in3 mitigation gun for water depths between 40 and 100 m.

Received Sound Level (dB rms)	Ratio (measured : modelled) of pre-season estimate for 40-100 m depth regime	
	3280 in^3 airgun array	60 in^3 mitigation gun
190	49%	54%
180	50%	63%
160	94%	107%

Based on the differences between the measured and modelled values for the 190 and 180 dB radii, it is proposed that the radii for these thresholds be adjusted. Due to expected variability, however, it is not recommended that these radii be simply adjusted to the measured values but rather that they be adjusted to the average between the measured and the modeled values. Since the measured160 dB radius was very consistent with the pre-season estimate, it is recommended that this radius remain unchanged from that which is currently being implemented. The proposed updates to the radii (and the radii that are currently being applied) are shown in Table 11.

Table 11 Recommended adjustments to exclusion zone radii based on comparison of SSV measurement with pre-season estimates.

Received Sound Level (dB rms)	Current radii		Suggested radii updates	
	3280 in^3 airgun array	60 in^3 mitigation gun	3280 in^3 airgun array	60 in^3 mitigation gun
190	930	13	700	10
180	2500	68	1800	56
160	15,000	1500	15,000	1500

Sound Source Verification

TGS Chukchi Sea Seismic Survey Program 2013

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1. Introduction

This sound source verification (SSV) study was conducted on behalf of TGS-NOPEC Geophysical Company at the start of their 2013 2-D Seismic Survey Program in the Chukchi Sea, Alaska. JASCO Applied Sciences (JASCO) carried out the study using autonomous sound recorders, placed on the seafloor, to measure underwater sound pressure levels (SPLs) as a function of frequency, distance, and direction from the survey airguns and project vessels. The SSV occurred on 28–30 August 2013 at the south end of the TGS survey region.

This SSV study was performed in accordance with Section 7(e)(i) of the Incidental Harassment Authorization (IHA) issued to TGS by the National Marine Fisheries Service, Section 9.C.i. of the Letter of Authorization from the US Fish and Wildlife Service, and Section 402 of the 2013 Conflict Avoidance Agreement between TGS and the Alaska Eskimo Whaling Commission. A preliminary field report was delivered to NMFS within five days of the measurements as per Section 7(e)(i)(B) of the IHA. This supplemental report provides a more detailed presentation of the results.

The survey sources that were measured include the full 3280 in^3 airgun array and a single 60 in^3 mitigation airgun. This report contains sound propagation distances from the sound sources to various root-mean-square (rms) SPL thresholds derived from these measurements. In addition to the rms SPL analysis, the cumulative sound exposure levels (cSEL) for multiple airgun pulses are also reported. The characteristic properties of the airgun pulses, such as the spectral content and waveforms, are examined as a function of range. Distances to SPL thresholds are reported for the self-noise of the survey vessel M/V *Geo Arctic* and for the marine mammal monitoring vessel M/V *Norseman* from which the SSV was conducted.

2. Methods

2.1. Measured Sound Sources

Sound levels from the following sources were measured during the SSV program:

- 60 in^3 mitigation airgun (a single airgun used for marine mammal mitigation),
- 3280 in^3 airgun array,
- Vessel self-noise from M/V *Geo Arctic* survey vessel (transiting at survey speed),
- Vessel self-noise from M/V *Norseman* marine mammal monitoring vessel (transiting at survey speed).

The airgun array used during the survey had a total firing volume of 3280 in^3 from 26 active airguns (Figure 1). The array consisted of 40 airguns, including spares, with individual airgun volumes between 40 and 250 in^3. The airguns were arranged in four sub-arrays of 9 or 11 airguns each, as indicated in the geometry diagram. The array was towed 86.5 m behind the vessel at 6 m depth.

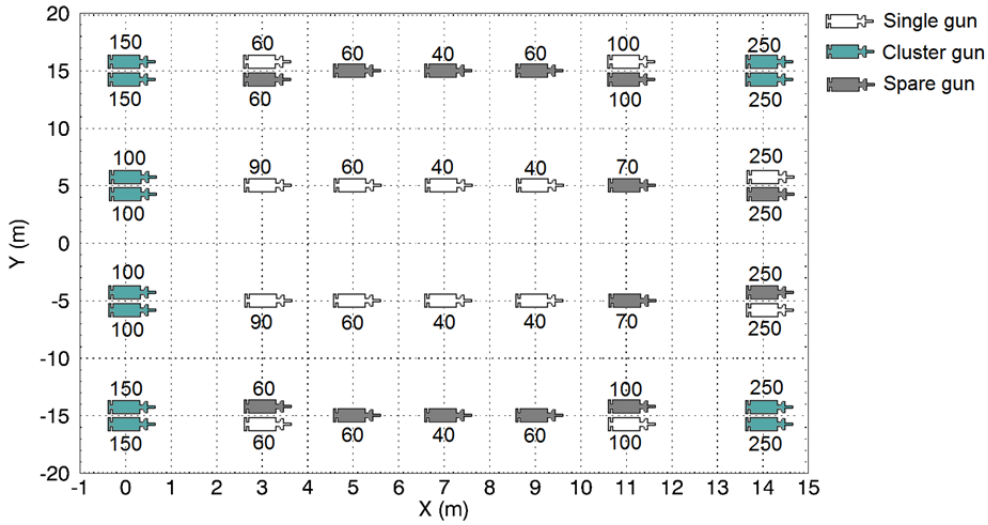

Figure 1. Layout of the airgun array (3280 in^3 active firing volume) used for the 2013 2-D Seismic Survey program in the Chukchi Sea.

The airguns were deployed from the survey vessel M/V *Geo Arctic*, an 82 m (269 ft) seismic survey vessel. A marine mammal monitoring vessel, M/V *Norseman,* remained approximately 9 km ahead of the *Geo Arctic* during airgun operations to scan (visually and acoustically) for presence of marine mammals within the zone of influence where the received rms SPL would be above 160 dB re 1 µPa. The *Norseman* is a 33 m (108 ft) research and support vessel. The SSV equipment was deployed from the *Norseman*. Vessel specifications for the *Geo Arctic* and the *Norseman* are listed in Table 1. Figure 2 depicts the *Norseman* alongside the *Geo Arctic*.

Table 1. Vessel specifications for the M/V *Geo Arctic* survey vessel and the M/V *Norseman* marine mammal monitoring vessel used for the 2013 2-D Seismic Survey program in the Chukchi Sea.

Vessel	Length (m [ft])	Width (m [ft])	Draft (m [ft])	Engine	Propeller
Geo Arctic	82 [269]	15 [49]	5.25 [17]	3090 kW Zgoda-Zulcer 6ZL 40/48	Zamen, 4-blade stainless steel controllable pitch
Norseman	33 [108]	8.5 [28]	3.4 [11]	Caterpillar 850	Single screw

Figure 2. (Background) Survey vessel M/V *Geo Arctic* with (foreground) the monitoring vessel M/V *Norseman* alongside.

2.2. Measurement Apparatus and Calibration

Underwater sound was recorded with Autonomous Multichannel Acoustic Recorders (AMARs, JASCO Applied Sciences, Figure 3). Each AMAR was fitted with two M8E omnidirectional hydrophones (GeoSpectrum Technologies Inc.), one with a built-in signal preamplifier resulting in a nominal sensitivity of −165 re 1 V/µPa and the other with no preamplifier and a sensitivity of −200 dB re 1 V/µPa. This hydrophone combination enabled optimal recording of both low- and high-amplitude sound levels. The AMAR deployed nearest the test track had a GeoSpectrum M8K hydrophone, with a nominal sensitivity of −210 dB re V/µPa, in place of the less sensitive of the M8E hydrophones to provide a wider dynamic range of recording. The AMAR hydrophones were protected by a hydrophone cage, which was covered with a black shroud to minimize noise artifacts due to water flow. The AMARs recorded continuously at 96 000 samples per second for a recording bandwidth of 10 Hz to 48 kHz. The recording channels had 24-bit resolution with a spectral noise floor of 20 dB re 1 μPa^2/Hz. Acoustic data were stored on 256MB of internal solid-state flash memory chips.

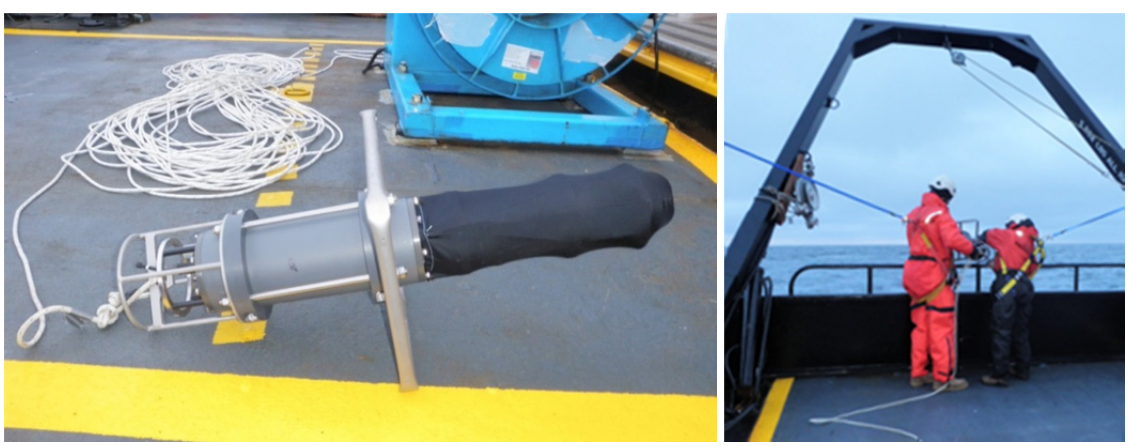

Figure 3. An AMAR with attached ground line on the deck of the *Norseman*: (left) ready for deployment and (right) being deployed over the stern. The AMAR hydrophones were protected by a hydrophone cage, which was covered by a black shroud that minimizes flow noise artifacts.

Each channel on each AMAR was calibrated with a Pistonphone Type 42AC precision sound source (G.R.A.S. Sound & Vibration A/S) before it was deployed and again when it was retrieved. The pistonphone calibrator produces a constant tone at 250 Hz at a fixed distance from the hydrophone sensor in an airtight space with known volume. The recorded level of the reference tone on the AMAR yields the system gain for the AMAR and hydrophone. To determine absolute sound pressure levels, this gain is applied during data analysis. Typical calibration variance using this method is less than 0.5 dB absolute pressure.

The AMARs were deployed directly on the seabed with their hydrophones approximately 30 cm above the bottom. Each AMAR had an attached ground line and a small anchor, as shown in Figure 4, to allow retrieval with a grapple hook so that nothing was left on the seafloor.

The sound speed profile of the water column was derived from conductivity-temperature-depth profiles measured at the SSV site (Minos X CTD, AML Oceanographic).

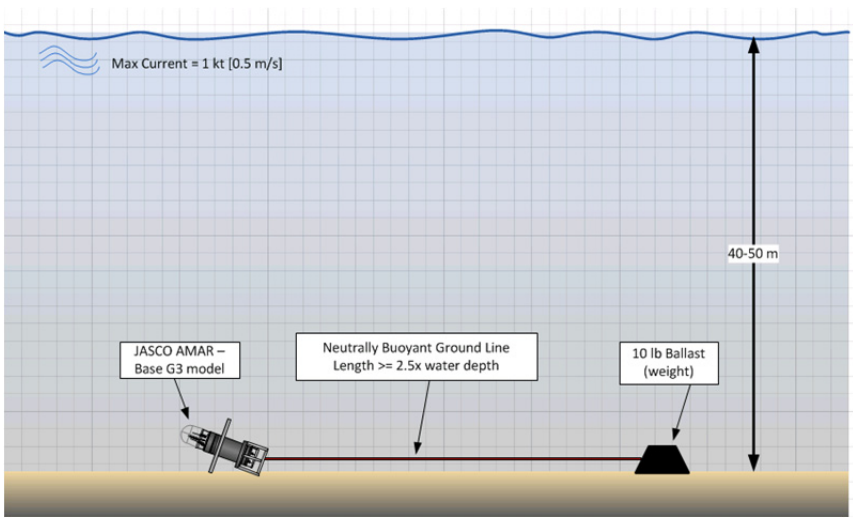

Figure 4. Mooring design for each of the five AMARs used for the SSV.

2.3. Measurement Procedure

The measurements were performed using five AMARs deployed to capture sound levels as a function of distance and direction from each sound source. Four AMARs were deployed on a line perpendicular to Line 3040 of the seismic survey. These AMARs were at ranges of 800 m, 2500 m, 10 km and 80 km (A–D in Figure 5) from the survey line to record received sound at multiple distances from the airguns and the survey vessel. A fifth AMAR was placed 5 km from the start of the survey line (E in Figure 5) to capture sounds from the mitigation airgun as the survey vessel approached the line and began ramp-up. AMAR E also captured vessel self-noise of the *Geo Arctic* between pulses of the mitigation airgun. The *Geo Arctic* transited at a nominal speed of 4.4 kts. The marine mammal monitoring vessel *Norseman* traversed a 15 km (9 mi) SSV track that passed directly over AMAR A. The *Norseman* transited at a nominal speed of 5 kts in 1.2 m (4 ft) seas.

The AMAR locations and the SSV deployment area are shown in Figures 6 and 7. The AMAR deployment coordinates and the start and end coordinates for the SSV track lines are listed in

Table 2. Measurements were carried out from 28 to 30 August 2013. Table 3 shows when each source was measured.

Sound speed profiles were measured with CTD (conductivity-temperature-depth) casts performed at the deployment locations of AMARs A (800 m from the line), D (80 km from the line), and E (5 km before the start of the survey line). Measurements were collected on deployment and retrieval of the AMARs to monitor changes over time. The *Geo Arctic* SSV transit occurred in the middle of the time period between deployment and retrieval.

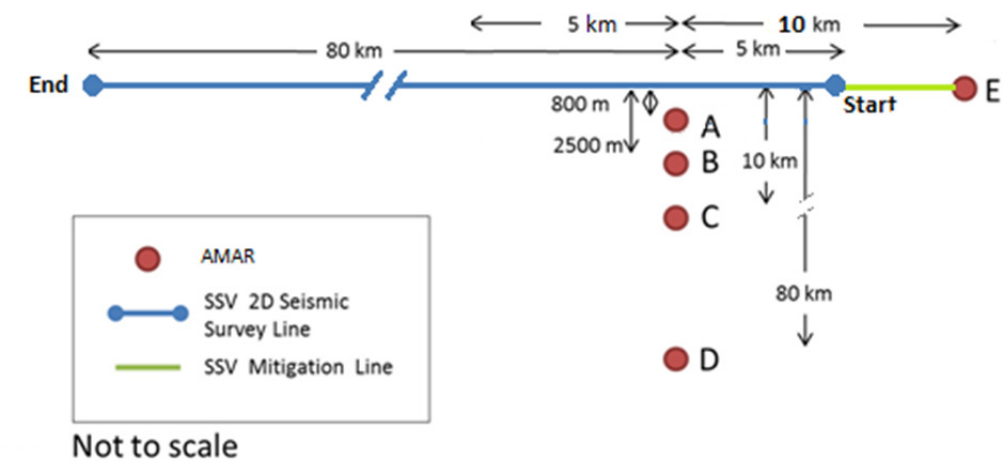

Figure 5. Recorder deployment geometry and survey track lines for the SSV.

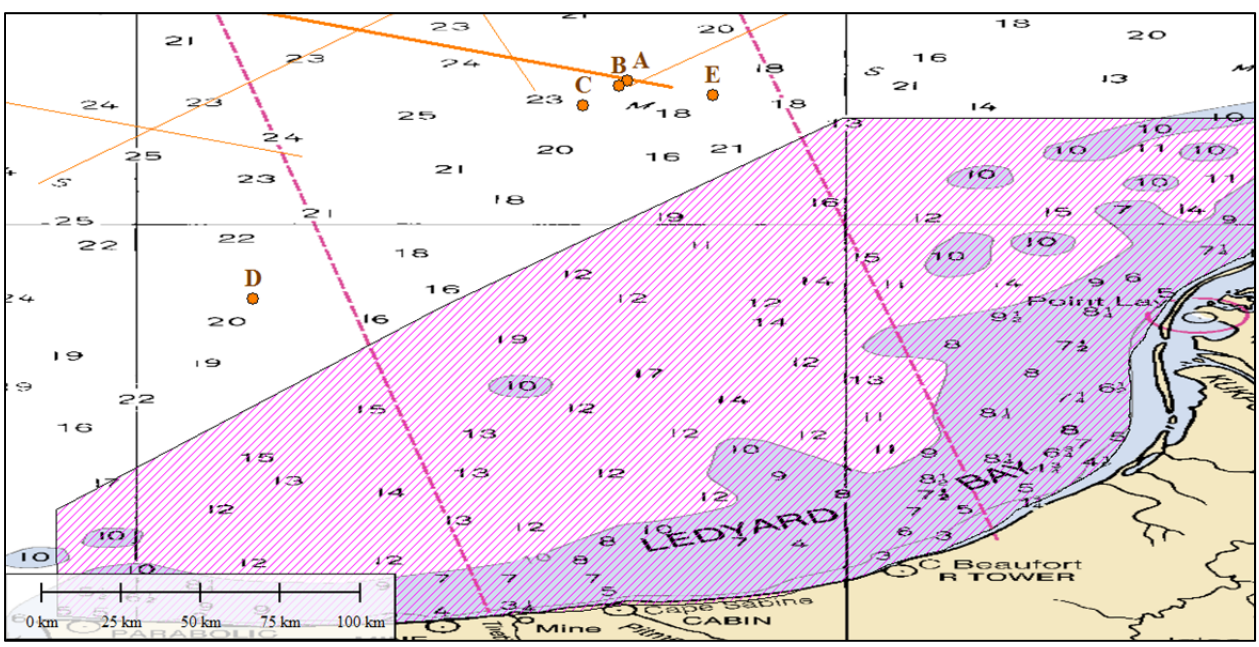

Figure 6. Deployment locations of AMARs A through E relative to the 2-D seismic survey lines (orange lines).

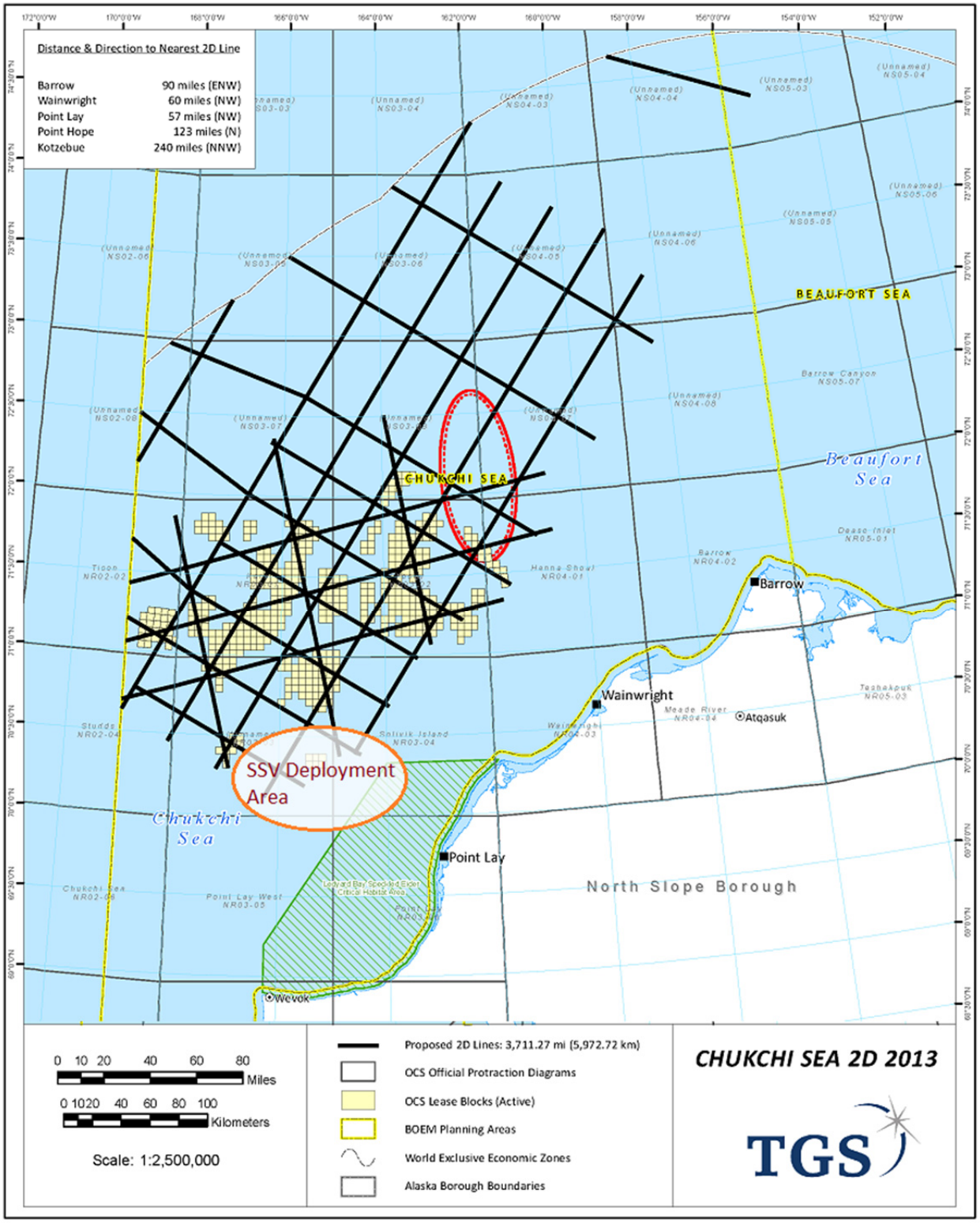

Figure 7. The SSV deployment area in the TGS 2013 2-D survey area in the Chukchi Sea.

Table 2. AMAR and SSV test track coordinates (WGS 84).

Location	Latitude	Longitude	Water depth (m)
AMAR A	70°24.294′ N	164°36.622′ W	45
AMAR B	70°23.510′ N	164°38.023′ W	45
AMAR C	70°20.041′ N	164°44.177′ W	45
AMAR D	69°47.554′ N	165°39.989′ W	41
AMAR E	70°21.888′ N	164°22.242′ W	44
SSV Start	70°23.278′ N	164°29.095′ W	45
SSV End	70°46.227′ N	166°27.975′ W	48
Monitoring vessel start	70°21.520′ N	164°22.904′ W	44
Monitoring vessel end	70°25.675′ N	164°43.505′ W	45

Table 3. Start and end times (UTC) underwater acoustic measurements for the SSV in August 2013.

Measured source	Start		End	
Norseman self-noise	28 Aug	00:52	28 Aug	02:20
Geo Arctic self-noise, mitigation airgun	29 Aug	23:02	29 Aug	23:14
Airgun array	29 Aug	23:44	30 Aug	22:40

2.4. Acoustic Metrics used for Analysis

Underwater sound amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the loudness of impulsive noise, from seismic airguns for example, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate the loudness of impulsive noise and its effects on marine life.

The zero-to-peak SPL, or peak SPL (L_{pk}, dB re 1 μPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic event, $p(t)$:

$$L_{\mathrm{pk}} = 10\log_{10}\left[\frac{\max\left(\left|p^2(t)\right|\right)}{p_0^2}\right] \tag{1}$$

The peak SPL metric is commonly quoted for impulsive sounds, but it does not account for the duration or bandwidth of the noise. At high intensities, the peak SPL can be a valid criterion for assessing whether a sound is potentially injurious; however, because the peak SPL does not account for the duration of a noise event, it is a poor indicator of perceived loudness.

The root-mean square (rms) SPL (L_p, dB re 1 μPa) is the rms pressure level in a stated frequency band over a time window (T, s) containing the acoustic event:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \tag{2}$$

The rms SPL is a measure of the average pressure or the effective pressure over the duration of an acoustic event, such as the emission of one acoustic pulse or sweep. Because the window length, T, is the divisor, events more spread out in time have a lower rms SPL for the same total acoustic energy.

In studies of impulsive noise, T is often defined as the "90% energy pulse duration" (T_{90}): the interval over which the pulse energy curve rises from 5% to 95% of the total energy. The SPL computed over this T_{90} interval is commonly called the 90% rms SPL (L_{p90}, dB re 1 μPa):

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} p^2(t)dt \Big/ p_0^2\right) \tag{3}$$

The sound exposure level (SEL, L_E, dB re 1 μPa^2·s) is a measure of the total acoustic energy contained in one or more acoustic events. The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T_{100}):

$$L_E = 10\log_{10}\left(\int_{T_{100}} p^2(t)dt \Big/ T_0 p_0^2\right) \tag{4}$$

where T_0 is a reference time interval of 1 s. The SEL represents the total acoustic energy received at some location during an acoustic event; it measures the total sound energy to which an organism at that location would be exposed.

Because the 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 energy time window T:

$$L_p = L_E - 10\log_{10}(T) \tag{5}$$

$$L_{p90} = L_E - 10\log_{10}(T_{90}) - 0.458 \tag{6}$$

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

SEL can be a cumulative metric if calculated over time periods containing multiple acoustic events. The cumulative SEL (L_{EC}) can be computed by summing (in linear units) the SELs of the N individual events (L_{Ei}).

$$L_{EC} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{Ei}}{10}}\right) \tag{7}$$

To compute the SPL and SEL of acoustic events in the presence of high levels of background noise, Equations 3 and 4 are modified to subtract the background noise energy from the event energy:

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} p^2(t)dt \Big/ p_0^2 - \overline{n^2}\right) \tag{8}$$

$$L_E = 10\log_{10}\left(\int_{T_{100}} p^2(t)dt \Big/ T_0 p_0^2 - \overline{n^2}T\right) \tag{9}$$

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 acoustic events are absent (e.g., between pulses).

2.4.1. Marine Mammal Frequency Weighting

The potential for anthropogenic noise to affect marine animals depends on how well the animal can hear the noise. For sound levels that are too low to cause physical injury, frequency weighting based on audiograms and critical hearing ratios in noise may be applied to weight the importance of sound levels at particular frequencies in a manner reflective of an animal's hearing sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

2.4.1.1. Type I M-Weighting

Based on a literature review of marine mammal hearing and on physiological and behavioral responses to anthropogenic sound, Southall et al. (2007) proposed standard frequency weighting functions—here referred to as Type I M-weighting functions—for five functional hearing groups of marine mammals:

- Low-frequency cetaceans (LFC1)—mysticetes (baleen whales)
- Mid-frequency cetaceans (MFC1)—some odontocetes (toothed whales)
- High-frequency cetaceans (HFC1)—odontocetes specialized for using high-frequencies
- Pinnipeds in water (PW1)—seals, sea lions and walrus
- Pinnipeds in air (not addressed here)

New criteria proposed by the US Navy (Finneran and Jenkins 2012) split the PW1 group to better describe the hearing differences across species. The first group (referred to here as PPW1) covers phocid and sirenian species, and the second group (OPW1) covers otariids, odobenids, mustelids, and ursids.

The Type I M-weighting functions adapt noise levels by frequency according to hearing sensitivity. The discount applied for frequencies with lower hearing sensitivity is less than that indicated by the corresponding audiograms (where available) for member species of these hearing groups. Audiograms test hearing in noise-controlled environments whereas animals usually hear and use acoustic signals in conditions with varying noise levels. Realistic hearing depends on critical ratios (i.e., the amount by which received sound pressure levels must exceed background noise to be detected), which depend on critical bandwidths—the shape of the animal's hearing filters (Au and Moore 1990). The rationale for applying a smaller discount than suggested by audiograms is due in part to an observed characteristic of mammalian hearing that perceived-equal-loudness contours have increasingly slower roll-off outside the most sensitive hearing frequency range as sound levels increase. This is also why, for example, C-weighting curves for humans are used for assessing loud sounds such as blasts and A-weighting curves are used for quiet to mid-level sounds—the C-weighting curves are flatter than the A-weighting curves. Additionally, out-of-band frequencies, though less audible, can still cause physical injury if pressure levels are sufficiently high or last a sufficiently long time. The Type I M-weighting

functions therefore are primarily intended to be applied at high sound levels where effects such as temporary (TTS) or permanent (PTS) hearing threshold shifts may occur.

The use of M-weighting is considered precautionary because it potentially overestimates the onset of harmful exposure and in terms of the range of frequencies for which no weighting is applied. M-weighting assumes that the observable onsets of behavioral responses to noise (e.g., animals moving rapidly away or increasing respiration rates) are already potentially harmful. And behavioral responses can be elicited by noise at frequencies outside the peak range of hearing sensitivity.

Figure 8 shows the decibel frequency weighting of the five underwater Type I M-weighting functions. The Type I M-weighting functions have unity gain (0 dB) through the passband and their high and low frequency roll-offs are approximately –12 dB per octave. The amplitude response as a function of frequency for the Type I M-weighting functions is defined by:

$$W_I(f) = K + 20\log_{10}\left[\frac{b^2 f^2}{\left(a^2 + f^2\right)\left(b^2 + f^2\right)}\right] \tag{10}$$

where $W_I(f)$ is the weighting function amplitude (in dB) at the frequency f (in Hz), K is a constant used to normalize the function at a reference frequency, and a and b are the estimated lower and upper hearing limits, respectively, and control the roll-off and passband of the function (Table 4). The M-weighting functions for the PPW1 and OPW1 hearing groups are the same as that proposed by Southall et al. for pinnipeds in water except that a smaller bandwidth is applied for OPW.

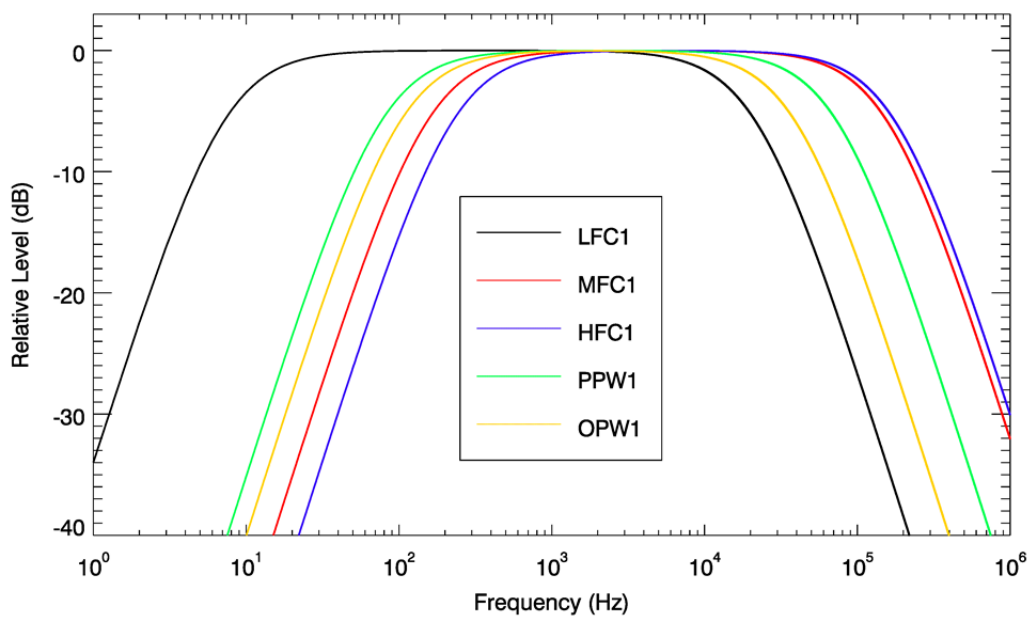

Figure 8. The Type I M-weighting functions for five marine mammal functional hearing groups (Southall et al. 2007).

Table 4. Parameters of the Type I M-weighting functions for five marine mammal functional hearing groups (Southall et al. 2007).

Functional hearing group	K (dB)	a (Hz)	b (Hz)
LFC1	0	7	22 000
MFC1	0	150	160 000
HFC1	0	200	180 000
PPW1	0	75	75 000
OPW1	0	100	40 000

2.4.1.2. Type II M-Weighting

Marine mammals, especially mid- and high-frequency cetaceans, have greater hearing sensitivity at high frequencies compared to other mammals. This is in part because they use sound underwater in the form of echolocation in the manner that terrestrial mammals use light on land (Wartzok and Ketten 1999). To better account for the increased susceptibility of marine mammals to noise at high frequencies (>1 kHz), the US Navy developed Type II M-weighting functions derived from equal-loudness contours for bottlenose dolphins (Finneran and Jenkins 2012). The Type II M-weighting functions incorporate a component based on the Type I functions at low frequencies and an equal-weighting component at high frequencies (Figure 9).

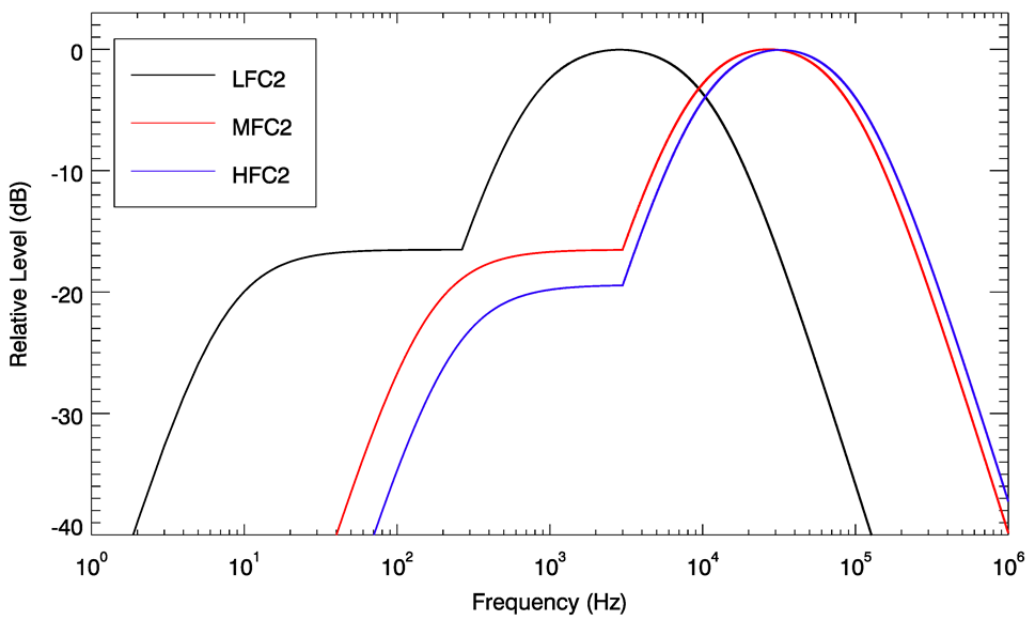

Figure 9. The Type II M-weighting functions for the low- (LFC2), mid- (MFC2), and high-frequency cetacean (HFC2) functional hearing groups (Finneran and Jenkins 2012).

Equal-loudness contours are unavailable for marine mammals other than the bottlenose dolphin, so the Type II M-weighting functions can be extended to other cetacean species only by adjusting the parameters to the estimated hearing responses in noise of other mammals. Each Type II M-weighting function is a simple reformulation of the Type I function and the equal-

loudness contour, equal to the higher of the two curves at each frequency yielding a conservative estimate:

$$W_{\mathrm{II}}(f) = \max\left[G_1(f), G_2(f)\right]$$
$$G_n(f) = K_n + 20\log_{10}\left[\frac{b_n^2 f^2}{\left(a_n^2 + f^2\right)\left(b_n^2 + f^2\right)}\right] \tag{11}$$

To account for an increased susceptibility observed in odontocetes to noise above 3 kHz, the MFC2 and HFC2 functions (Table 5) are adjusted to place the inflection point at this frequency. The LFC2 function is adjusted so the flat portion is 16.5 dB below the peak of the equal-loudness contour, mimicking the trend of the MFC2 function (Finneran and Jenkins 2012) with the inflection point set at 267 Hz.

Table 5. The parameters of the Type II M-weighting functions for the cetacean functional hearing groups and the resulting inflection points (Finneran and Jenkins 2012).

Functional hearing group	K_1 (dB)	a_1 (Hz)	b_1 (Hz)	K_2 (dB)	a_2 (Hz)	b_2 (Hz)	Inflection point (Hz)
LFC2	-16.5	7	22 000	0.9	674	12 130	267
MFC2	-16.5	150	160 000	1.4	7 829	95 520	3 000
HFC2	-19.4	200	180 000	1.4	9 480	108 820	3 000

2.5. Acoustic Signal Analysis

2.5.1. Airgun Pulse Sound Levels

Acoustic data were analyzed with JASCO's custom processing software. For each airgun pulse detected, the slant range to the source was computed from GPS coordinates of the AMARs and the time referenced navigation logs from the *Geo Arctic,* with an offset applied for the center of the acoustic source. The loudness or magnitude of each recorded pulse from the airguns was quantified by computing three noise metrics: peak SPL, 90% rms SPL, and SEL.

The digital recording units were converted to micropascals (µPa) by applying the hydrophone sensitivity, the analog circuit frequency response, and the digital conversion gain. An automated feature detection algorithm picked the start and end times of the individual airgun pulses in the acoustic data. The automated detections were supplemented by manual picks as required. Each pulse was then analyzed as follows:

1. A high-pass frequency filter at 15 Hz was applied to data recorded within 6 km of the source (see Section 4.3).
2. The peak SPL (symbol L_{pk}) was computed according to Equation 1.
3. The cumulative square pressure was computed over the duration of the pulse.
4. The 90% energy pulse duration (T_{90}) was determined and the 90% rms SPL (L_{p90}) was computed according to Equation 3.
5. The SEL (L_E) was computed according to Equation 4 over the duration of the pulse.

2.5.2. Vessel Sound Levels

Vessel sound levels were characterized with rms SPLs calculated with 5 s long Hanning-weighted time windows with 50% overlap.

2.5.3. Sound Level versus Range

To estimate the distance to sound level thresholds, the 90% rms SPLs as a function of range were fit with one of the following empirical propagation loss curves:

$$L_{p90} = \mathrm{SL} - A \log_{10} R \tag{12}$$

$$L_{p90} = \mathrm{SL} - A \log_{10} R - B\,R \tag{13}$$

where R is the slant range from the source to the acoustic recorder (m), SL is the estimated source level at a reference distance of 1 m (dB re 1 µPa @ 1 m), A is the geometric spreading loss coefficient (dB), and B is the absorption loss coefficient (dB/m). Absorption loss does not significantly affect airgun and vessel sounds within ranges of approximately 10 km from the source. Equation 13 was only applied when measurements extended to ranges requiring inclusion of this term to obtain a good fit to the data. The appropriate equation was fit to the SPLs by minimizing (in the least-squares sense) the difference between the trend line and the measured SPLs. To conservatively estimate the distance to the sound level thresholds, the best-fit line was shifted upward (by increasing the constant SL term) until the trend line exceeded 90% of all the data points (called the 90th percentile fit).

2.5.4. Cumulative Sound Exposure Levels

M-weighted (Types I and II) SELs were computed for the data recorded at each AMAR. The M-weighted SELs from all received airgun pulses were summed on a linear scale to yield the cumulative SELs.

2.6. Measurement Terminology

Acoustic energy loss due to spherical spreading depends on the *slant range*, which is the true separation between the source and receiver (Figure 10). The horizontal range is the distance in the horizontal plane from the source to the receiver. The vertical separation between the source and receiver is the water depth minus the source depth and minus the elevation of the hydrophone above the seabed. When the slant range is several times greater than the vertical separation, the slant range and the horizontal range are effectively equal. Slant range is used throughout this report.

Endfire and *broadside* are the principal directions in the horizontal plane relative to the acoustic source. The endfire direction is along the tow axis (i.e., fore and aft), and the broadside direction is perpendicular to the tow axis (i.e., port and starboard). Seismic airgun arrays are often directional sources, so the received levels in both the broadside and endfire directions were assessed.

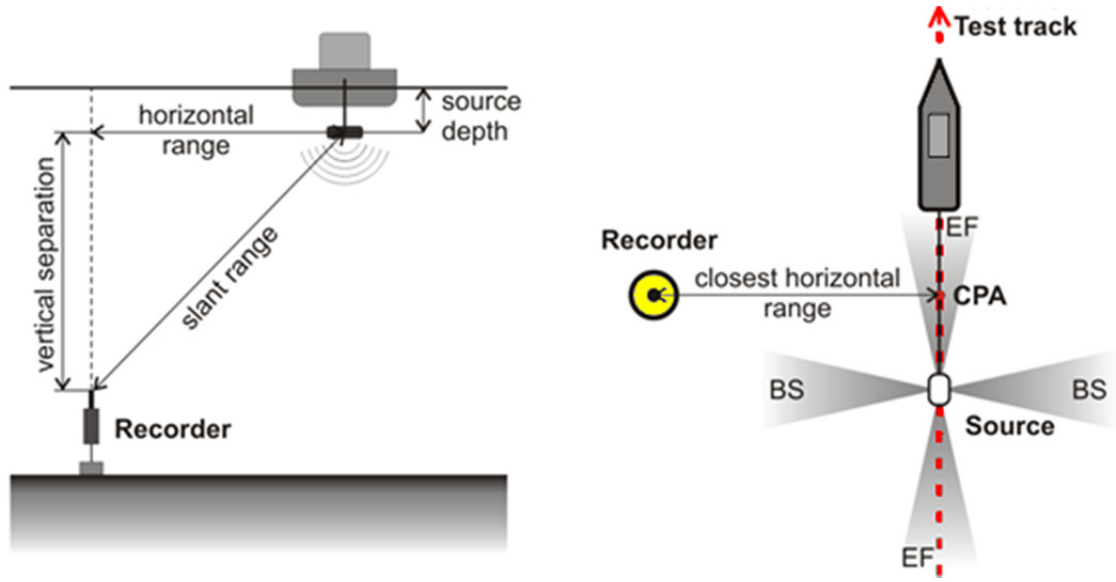

Figure 10. Typical geometry of sound source verification (SSV) measurements and the associated terminology used in this report. Abbreviations: BS, broadside, CPA, closest point of approach; and EF, endfire.

2.7. Sound Exposure Criteria

Operational marine mammal safety radii for this seismic survey were based on auditory injury criteria developed by the National Marine Fisheries Service (NMFS). NMFS defines 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 (MMPA 2007). The NMFS criteria are based on the unweighted 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 SPL for pinnipeds and 180 dB re 1 µPa rms SPL for cetaceans (e.g., NMFS 1995). 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.

The NMFS Level B criterion for behavioral disturbance is based on estimated received seismic noise levels during behavioral studies in which baleen whales exhibited avoidance behavior around airgun pulses (e.g., Malme et al. 1984, Malme et al. 1986). The threshold for the onset of behavioral disturbance to airgun pulses is 160 dB re 1 µPa rms SPL. The airgun array was to be powered down or shut down when aggregations of 12 or more baleen whales or walruses were detected within the pre-defined 160 dB 1 µPa safety radius.

NMFS is currently in the process of revising the sound exposure criteria for noise from seismic surveys. It is anticipated that the revised criteria will include M-weighted cumulative SEL exposure thresholds. Southall et al. (2007) proposed injury thresholds of 198 dB re 1 $\mu Pa^2 \cdot s$ (Type I M-weighted) for cetaceans and 186 dB re 1 $\mu Pa^2 \cdot s$ (Type I M-weighted) for pinnipeds

under water. Finneran and Jenkins (2012) proposed physiological effects thresholds for permanent and temporary threshold shift from sonar and other active acoustic sources (Table 6).

Table 6. Thresholds for permanent (PTS) and temporary (TTS) threshold shifts in marine mammals exposed to sonar and other active acoustic sources.

Functional hearing group	PTS M-weighted SEL threshold (dB re 1 μPa²-s)	TTS M-weighted SEL threshold (dB re 1 μPa²-s)
Low- and mid-frequency cetaceans, Type II	198	178
High-frequency cetaceans, Type II	172	152
Phocids and sirenians in water, Type I	197	183
Otariids, odobenids, mustelids, ursids in water, Type I	220	206

4. Results

4.1. Sound Speed Profiles

The measured sound speed profiles (Figure 11) are downward refracting below an isovelocity upper layer, the depth of which varied with location and time. The isovelocity layer is the vertical part of the profiles in Figure 11. This layer extended to depths between 10–20 m (location dependent) when the AMARs were deployed and to depths greater than approximately 23 m when the AMARs were retrieved. The isovelocity layer became deeper because higher sea states before the AMAR retrievals resulted in mixing of the upper water column. Under each of these conditions, sound from a source near the surface is neither strongly refracted toward the absorptive seafloor nor toward the lossy sea surface, hence this environment supports sound propagation in the water column.

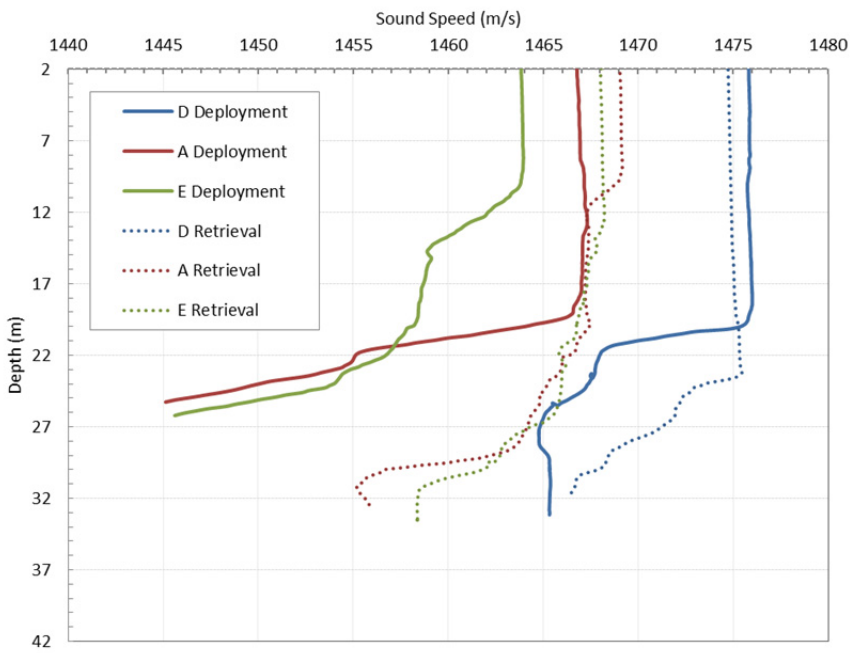

Figure 11. Sound speed profiles measured upon deployment and retrieval of AMARs D, A, and E.

4.2. Mitigation Airgun (60 in³)

Peak SPL, 90% rms SPL, and SEL for each pulse of the mitigation airgun were computed from acoustic data from AMAR E. Figure 12 shows sound levels from the 60 in^3 airgun as a function of slant range. The *Geo Arctic* navigation system was not recording shot point data while the mitigation airgun fired, so the ranges to the airgun were estimated from GPS navigation records from the *Geo Arctic* protected species observer team. The GPS locations were shifted to account for the separation between the GPS antenna and the mitigation airgun. The ranges thus computed could be in error by approximately 15 m due to feathering of the array in the current, which at the time of transit was 3.2°, and due to GPS accuracy. Table 7 shows ranges to the rms SPL thresholds from 190 to 120 dB re 1 µPa, which were computed from the empirical curve fits to the rms SPLs versus range.

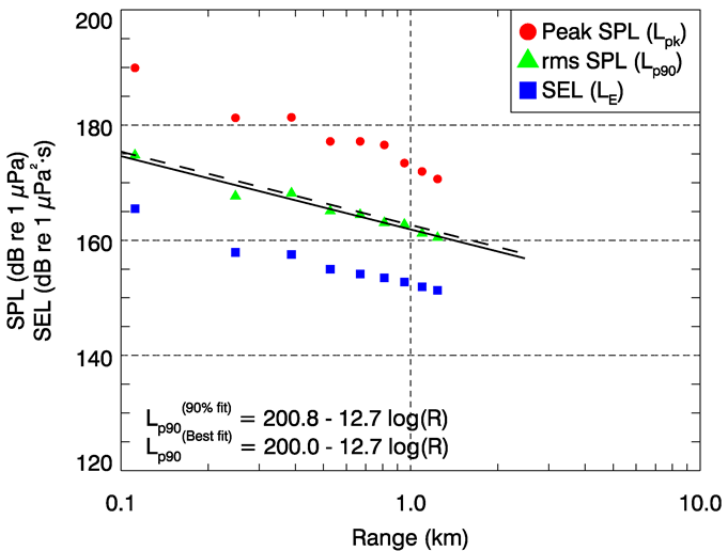

Figure 12. Peak SPL, rms SPL, and SEL versus slant range for 60 in^3 mitigation airgun pulses at the SSV site. The solid line is the best fit of the empirical function to the rms SPLs; the dashed line is the best-fit line shifted up to exceed 90% of the rms SPLs (i.e., the 90th percentile fit).

Table 7. Threshold radii at the SSV site for the 60 in^3 mitigation airgun as determined from the fits to the rms SPLs versus slant range in Figure 12.

rms SPL Threshold (dB re 1 µPa)	Best-fit radius (m)	90th Percentile radius (m)
190	6*	7*
180	38*	43*
170	230	260
160	1 400	1 600**
150	8 600**	9 900**
140	52 000**	60 000**

* Extrapolated beyond the closest measurement range of 43 m.
** Extrapolated beyond the farthest measurement range of 1.5 km.

4.3. Airgun Array (3280 in³)

Peak SPL, 90% rms SPL, and SEL for each pulse were computed from the acoustic data from each AMAR. Figure 13 shows the sound levels from the 3280 in^3 airgun array versus slant range in both the endfire and broadside directions. Table 8 lists the ranges to the rms SPL thresholds determined from the curve fits in Figure 13. Figure 14 shows spectrograms of airgun array pulses measured on AMAR A at the CPA (826 m) and in the endfire direction at long range (40 km). The received sound signals contained ahead wave that arrived before the main pulse (Figure 15,). At endfire ranges between approximately 2 and 6 km this low-frequency feature extended the 90% rms pulse durations beyond what is typical for such an airgun array at these source-receiver separation ranges (Figure 16, top left). These long pulse lengths yielded 90% rms SPLs that were lower than the level-range trend of the overall dataset (Figure 16, top right). A high-pass filter at 15 Hz was applied to data at ranges less than 6 km to reduce the impact of this feature and obtain a precautionary estimate of the ranges to the SPL thresholds (Table 9). The bottom panels of Figure 16 show the 90% rms pulse lengths and SPLs thus obtained.

The M-weighted cumulative SELs, both Type I and Type II (Figure 17), were summed for each airgun shot received at AMAR A during the SSV. The cumulative SEL reached a maximum value near the CPA and then leveled off as the weak pulses received at longer ranges contributed little to the aggregate value. Figures 18 and 19 show analogous plots for AMARs C and D, respectively, for a sufficient number of shots for the cumulative SEL to level off. The flat-weighted and per-pulse SELs are included in these plots for comparison.

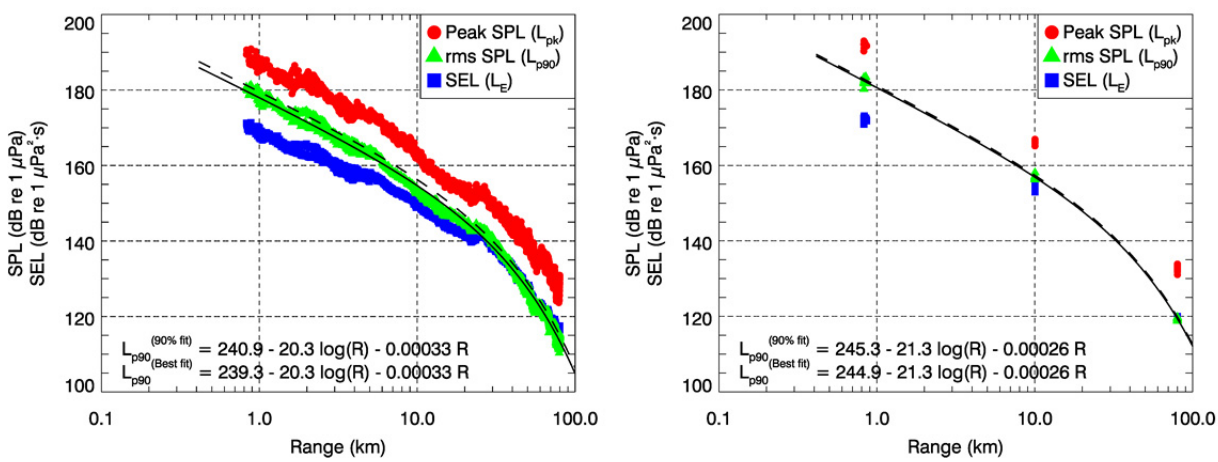

Figure 13. Peak SPL, rms SPL, and SEL versus slant range for 3280 in^3 airgun array pulses in the (left) endfire and (right) broadside directions. The solid lines are the best fits of the empirical function to the rms SPLs; the dashed lines are the best-fit lines shifted up to exceed 90% of the rms SPLs (i.e., the 90th percentile fit).

Table 8. Threshold radii at the SSV site for the 3280 in^3 airgun array as determined from the fits to the rms SPLs versus slant range in Figure 13.

rms SPL threshold (dB re 1 μPa)	Endfire		Broadside	
	Best-fit radius (m)	90th percentile radius (m)	Best-fit radius (m)	90th percentile radius (m)
190	260*	310*	370*	390*
180	800*	950	1 100	1 100
170	2 300	2 800	3 000	3 100
160	6 300	7 200	7 600	8 000
150	14 000	16 000	17 000	18 000
140	27 000	30 000	33 000	34 000
130	45 000	48 000	53 000	55 000
120	65 000	69 000	78 000	80 000

* Extrapolated beyond the closest measurement range of 826 m.

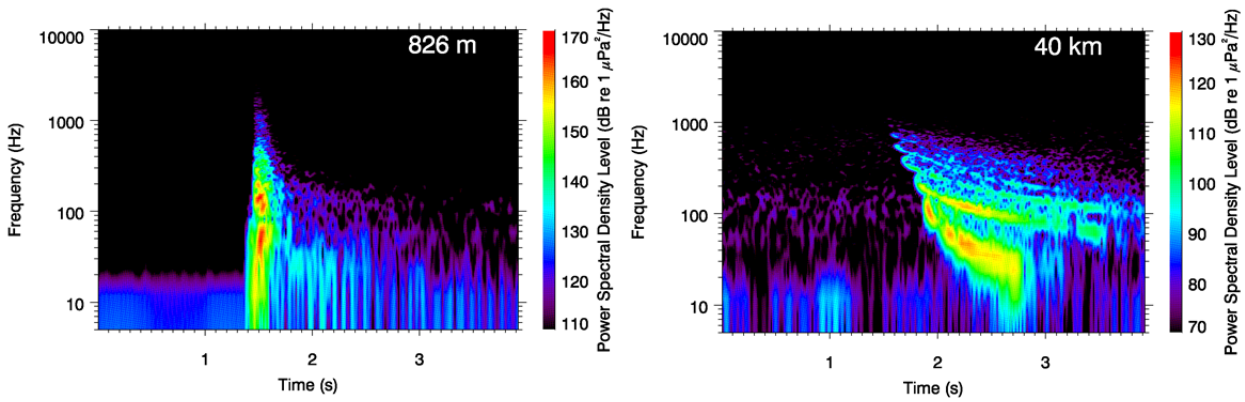

Figure 14. Spectrograms of 3280 in^3 airgun array pulses measured at AMAR A (left) at CPA (826 m) and (right) at long range (40 km). 8192 pt FFT lengths.

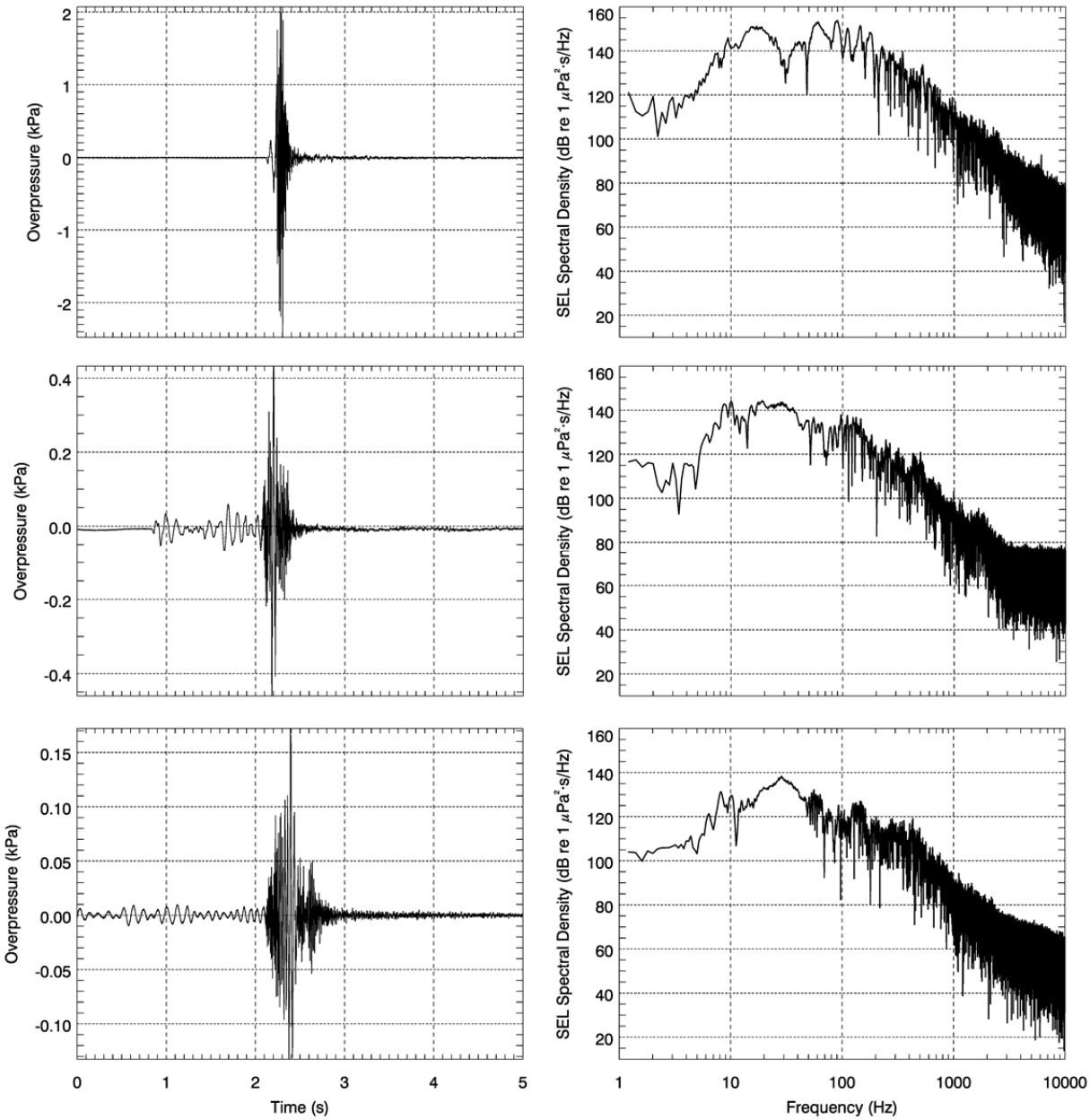

Figure 15. (Left) Pressure waveforms and (right) power spectral density of pulses from the 3280 in^3 airgun array received at ranges of (top)1 km , (middle) 5 km, and (bottom) 10 km in the endfire direction.

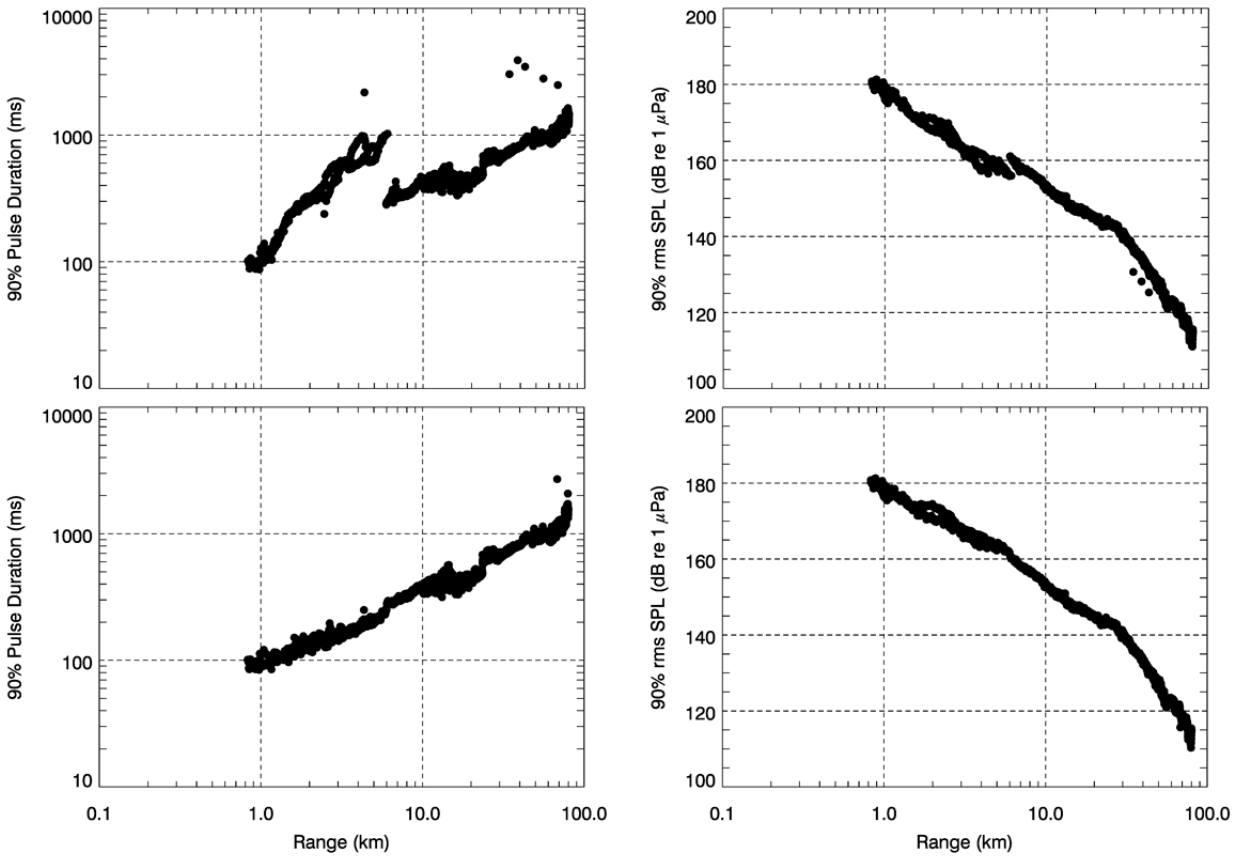

Figure 16. (Left) The 90% rms pulse duration and (right) 90% rms SPL as functions of range for pulses from the 3280 in^3 airgun array received in the endfire direction: (top) unfiltered; and (bottom) high-pass filtered (15 Hz) at ranges less than 6 km.

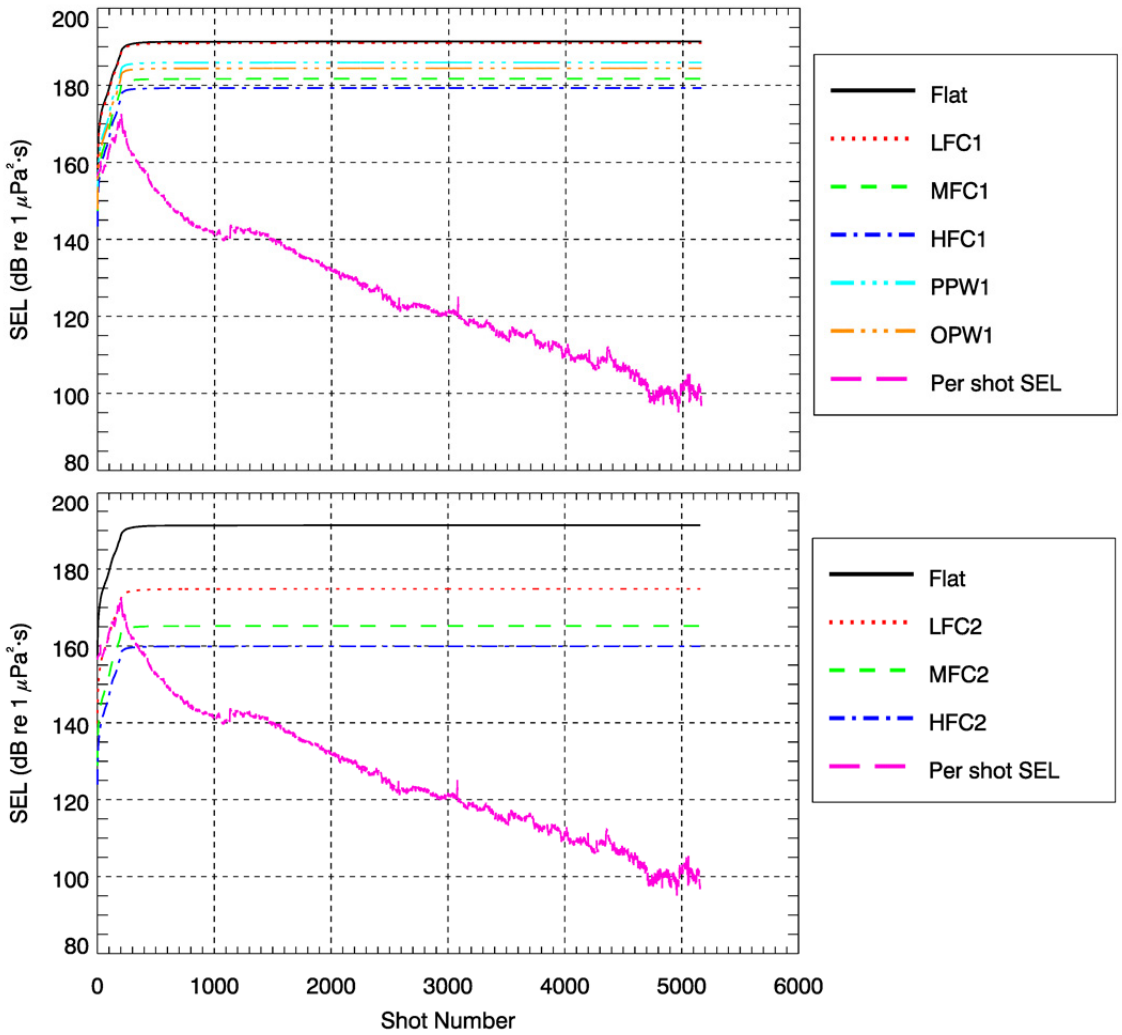

Figure 17. Per-shot and cumulative sound exposure levels received at AMAR A (826 m CPA) as a function of airgun shot number as the airgun array (3280 in^3) transited the SSV test track. Flat-weighted (i.e., unweighted) and (top) Type I and (bottom) Type II M-weighted cumulative SELs are shown.

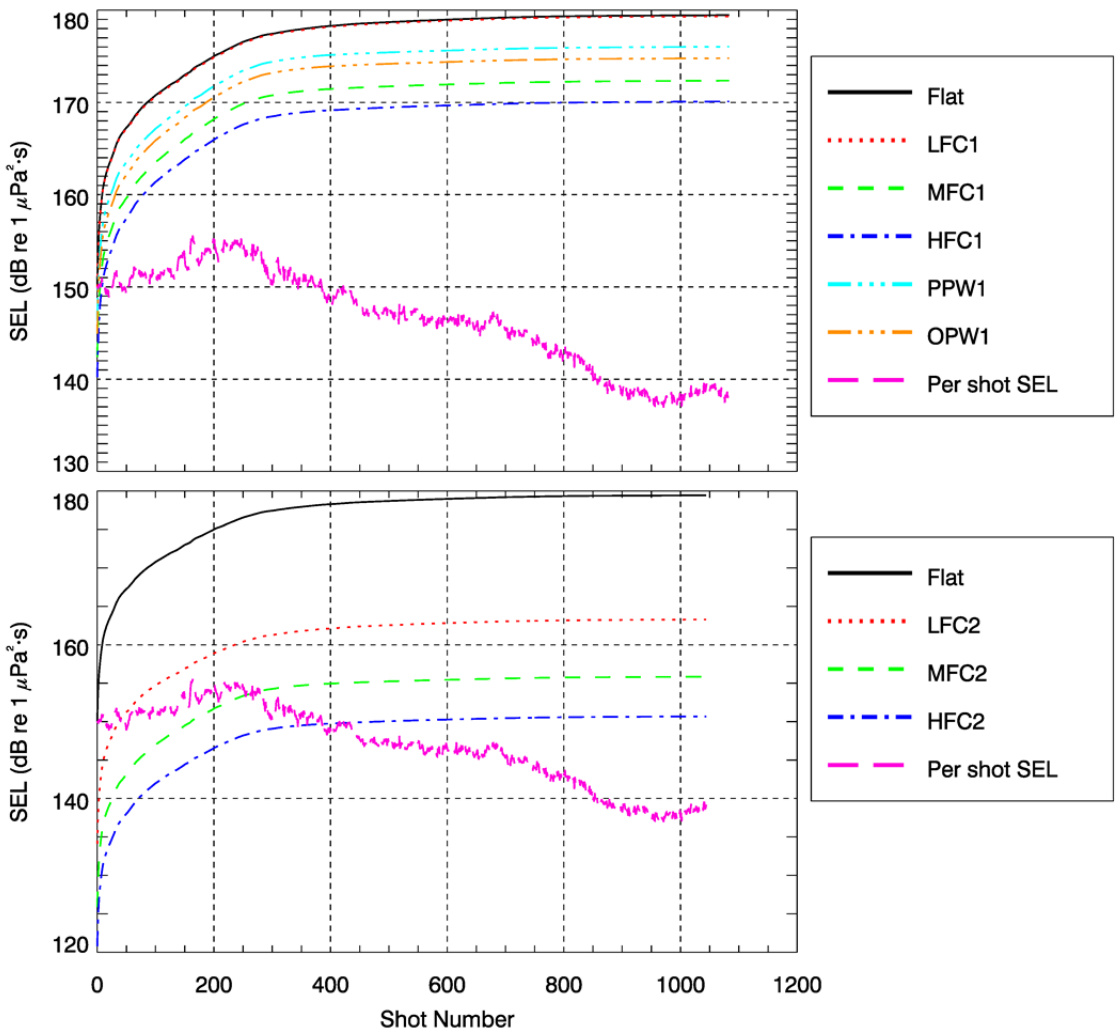

Figure 18. Per-shot and cumulative sound exposure levels received at AMAR C (10 km CPA) as a function of airgun shot number as the airgun array (3280 in^3) transited the SSV test track. Flat-weighted (i.e., unweighted) and (top) Type I and (bottom) Type II M-weighted cumulative SELs are shown.

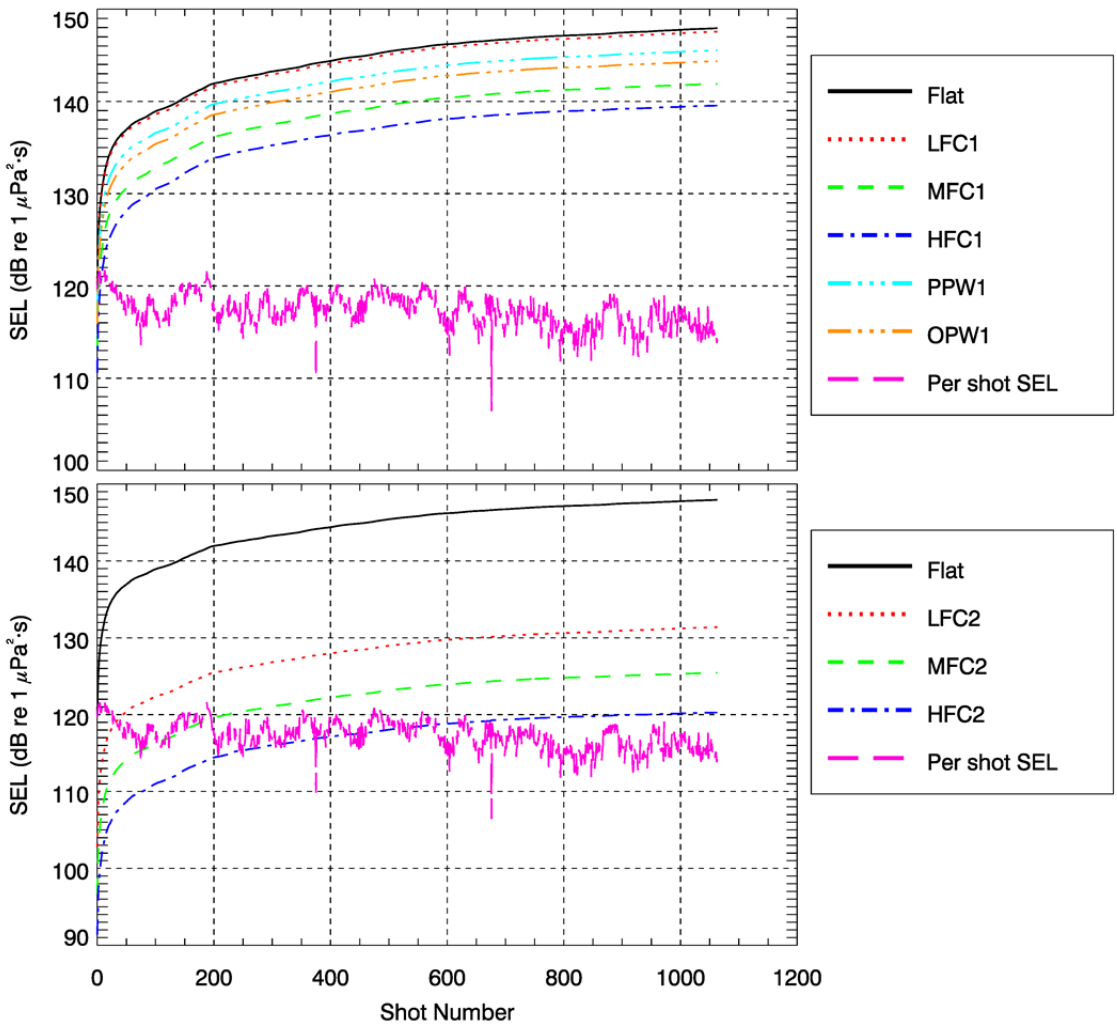

Figure 19. Per-shot and cumulative sound exposure level received at AMAR D (80 km CPA) as a function of airgun shot number as the airgun array (3280 in^3) transited the SSV test track. Flat-weighted (i.e., unweighted) and (top) Type I and (bottom) Type II M-weighted cumulative SELs are shown.

4.4. *M/V* Geo Arctic *Self-Noise*

Figure 20 presents the rms SPLs versus range of the *Geo Arctic* self-noise, as well as the best-fit and 90th percentile trend lines and the equations thereof. The ranges to the rms SPL thresholds of 150 to 120 dB re 1 µPa are listed in Table 9.

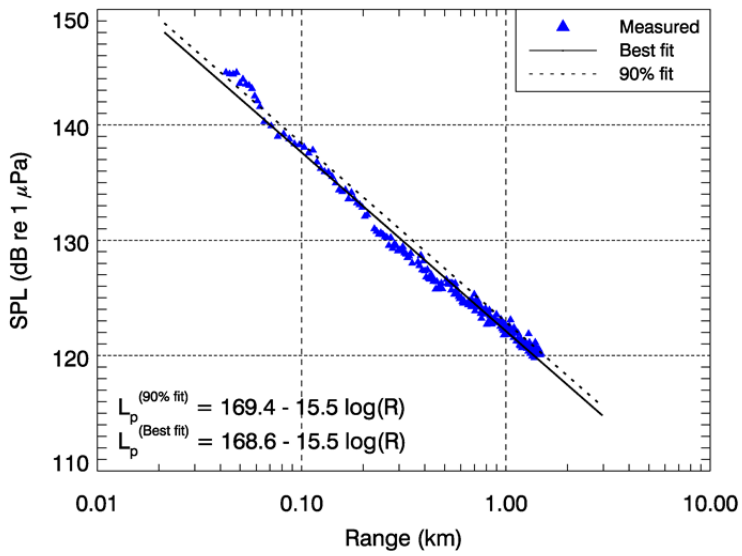

Figure 20. Sound pressure level (rms) versus slant range from the *Geo Arctic* while the vessel transited past AMAR E at 4.4 kts. The solid line is the best fit of the empirical function to the rms SPLs; the dashed line is the best-fit line shifted up to exceed 90% of the rms SPLs (i.e., the 90th percentile fit).

Table 9. Threshold radii at the SSV site for the *Geo Arctic* traveling at 4.4 kts as determined from the fits to the rms SPLs versus slant range in Figure 20.

rms SPL threshold (dB re 1 µPa)	Best-fit radius (m)	90th percentile radius (m)
150	16*	18*
140	70	80
130	310	350
120	1400**	1500**

* Extrapolated beyond the closest measurement range of 43 m.
** Extrapolated beyond the farthest measurement range of 1.5 km.

4.5. M/V Norseman *Self-Noise*

Figure 21 presents the rms SPLs versus range of the *Norseman* self-noise and the best-fit and 90th percentile trend lines. The trend lines were fit only to the data measured within 500 m range of the vessel. The ranges to the rms SPL thresholds of 150 to 120 dB re 1 µPa are listed in Table 10. Because there is a poor match of the trend lines to the close-range data, the maximum ranges measured for each sound level threshold are also listed.

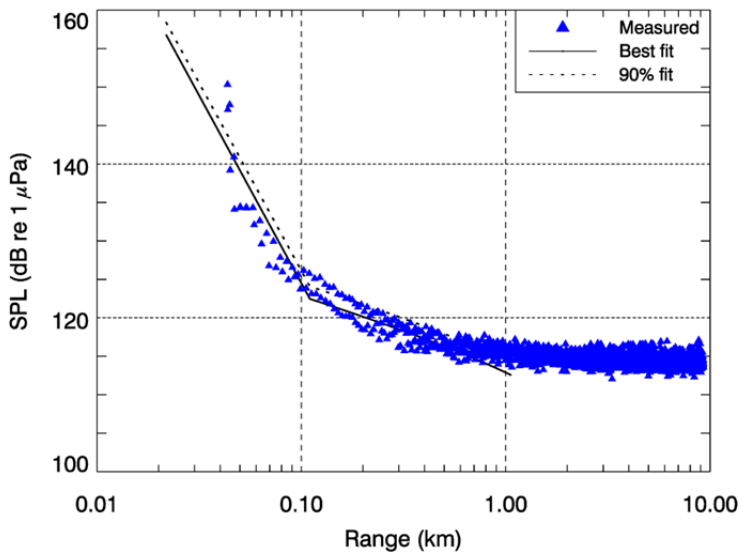

Figure 21. Sound pressure level (rms) versus slant range from the *Norseman* while the vessel transited past AMAR A at 5 kts. The solid line is the best fit of the empirical function to the rms SPLs; the dashed line is the best-fit line shifted up to exceed 90% of the rms SPLs (i.e., the 90th percentile fit).

Table 10. Threshold radii at the SSV site for the *Norseman* traveling at 5 kts as determined from the fits to the rms SPLs versus slant range in Figure 21 and from the direct measurements.

rms SPL threshold (dB re 1 µPa)	Best-fit radius (m)	90th percentile radius (m)	Maximum measured radius (m)
150	30*	32*	44
140	48	52	46
130	77	83	73
120	200	300	285

*Extrapolated beyond the closest measurement range of 44 m.

5. Discussion

5.1. Marine Mammal Exclusion Zone Radii

Marine mammal mitigation for this survey was designed based on the NMFS rms SPL threshold criteria. A marine mammal exclusion zone was defined based on pre-season estimates of the threshold radii from computer model estimates, which were validated against previous measurements of similar sources in the Chukchi Sea. Sound threshold radii corresponding to the NMFS criteria were determined from sound propagation models for three depth regimes: 17–40 m, 40–100 m, and >100 m. Table 11 shows the pre-season threshold radii as indicated in the IHA permit application for the 3280 in^3 airgun array and the 60 in^3 mitigation airgun. The exclusion zone radii for the airgun array that were applied for the survey were maximized over depth regime (bolded values in Table 11).

This SSV analysis confirmed that the pre-season exclusion zone radii were conservative estimates of the propagation ranges for the airgun array sounds. The ratios of measured-to-modeled radii are listed in Table 12. The pre-season estimates consistently overestimated the measured values, with the exception of the 160 dB radius for the mitigation airgun.

Table 11. Pre-season threshold distances noted in TGS's IHA permit application for the 3280 in^3 airgun array and the 60 in^3 mitigation airgun. For the airgun array, the highest value across the depth regimes (bolded) was used as the exclusion zone radius.

rms SPL threshold (dB re 1 µPa)	Airgun array			Mitigation airgun
	17–40 m	40–100 m	>100 m	All depths
≥190	**930**	920	430	13
≥180	2 200	2 400	**2 500**	68
≥160	8 500	9 900	**15 000**	1 500

Table 12. Ratio of measured radii compared to pre-season estimated radii (for 40–100 m water depth) for the 3280 in^3 airgun array and the 60 in^3 mitigation airgun.

rms SPL threshold (dB re 1 µPa)	Airgun array radii (m)			Mitigation airgun radii (m)		
	Pre-season estimate	SSV result	Ratio	Pre-season estimate	SSV result	Ratio
≥190	930	390	42%	13	7	54%
≥180	2 400	1 100	46%	68	43	63%
≥160	9 900	8 000	81%	1 500	1 600	107%

The reason that the measured radii were much less than modeled is undetermined. The measured sound speed profile contained a downward refracting component, varying in extent depending on time and location, whereas the sound speed profile applied in the pre-season model was an isovelocity profile, which better supports sound propagation. This may account, in part, for the discrepancy. Also, a technical problem with the airgun array necessitated the SSV for the airgun array to be interrupted. The array was shut down briefly after reaching 23 km range from the

AMAR line. After the problem was resolved on the survey vessel, the track was resumed. The airgun sound levels increased by approximately 2dB when the airguns resumed firing to continue the SSV track (Figure 22). It is possible that a technical problem with the array reduced the output during the first portion of the SSV track, which could be another reason for the measured radii being less than the pre-season estimates.

The survey region covers a large area of the Chukchi Sea including areas with deeper water, and possibly with different geoacoustic properties, compared to the SSV site. Therefore, the sound threshold radii are expected to vary with location. Previous measurements of similar-sized airgun arrays in other regions of the Chukchi Sea have resulted in larger radii than those measured in this SSV study. As such, the conservative pre-season radii were used throughout the rest of the seismic survey.

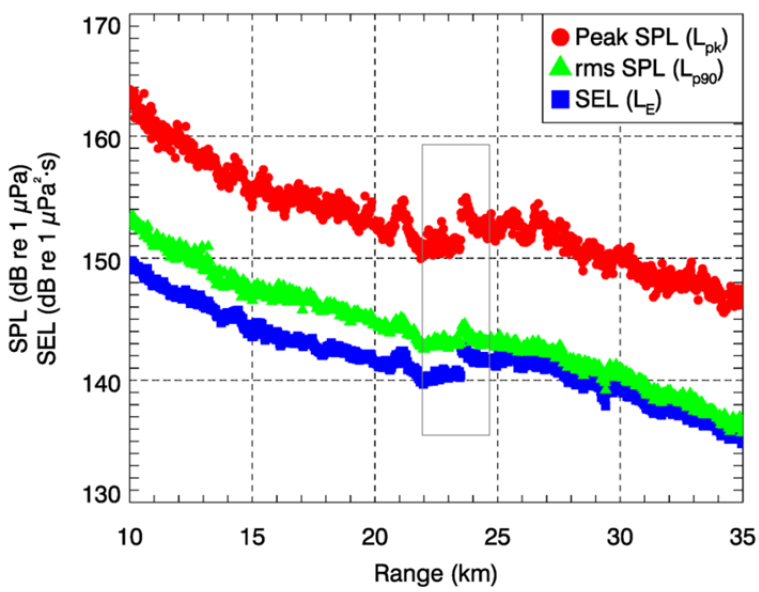

Figure 22. The shift in peak SPL, rms SPL, and SEL at 23 km range as the SSV track was resumed after a technical shutdown.

5.2. Total Cumulative Sound Exposure

The total cumulative sound exposures (cSELs) were analyzed in anticipation of sound threshold radii based on the cSEL metric being implemented in future. The straight summation used to compute cSEL conservatively estimates exposure because it does not account for hearing recovery between pulses as is done for analogous exposure thresholds for humans. The single-shot SEL was highest for airgun shots received at the CPA, and the cSEL accumulated fastest when the airgun array was near the CPA to the recorders. Consequently, the cSEL received by an animal passing near the survey line can be estimated by determining its closest point of approach to the operating airgun array. This assumes that the animal travels slower than the survey vessel and that it does not swim parallel to the operating array for significant distance. This may not always be a reasonable assumption. The ranges to the cSEL thresholds for each hearing group were estimated from plots of total cSEL versus the fixed recorder range off the survey line (Figure 23) by fitting a logarithmic curve to the data from the closest recorders (at 0.8 and

10 km). The proposed cSEL thresholds for PTS were exceeded only at close ranges to the array (Table 13).

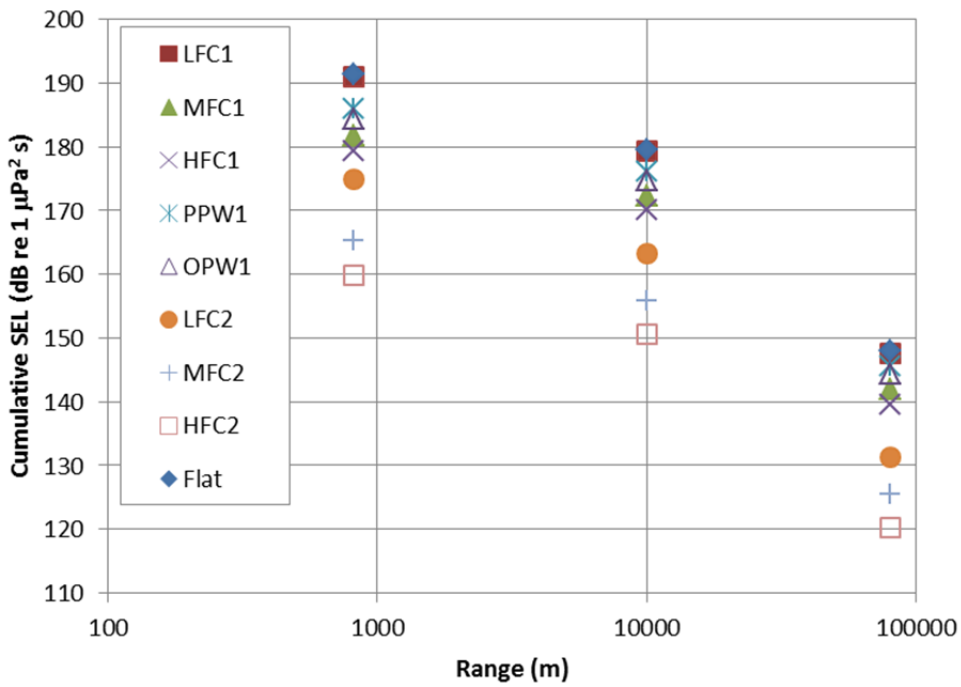

Figure 23. Total cumulative SEL, as a function of CPA range, corresponding to the acquisition of Line 3040 of the seismic survey, with and without M-weighting for each functional hearing group.

Table 13. Logarithmic best-fit equations to cumulative SELs in Figure 23 and the resulting distances to the proposed injury threshold criteria. All distances are extrapolated beyond the closest measurement range of 826 m.

Functional hearing group	Proposed cSEL threshold for PTS (dB re 1 µPa^2·s)	Best-fit equation	Range to threshold (m)
LFC1	198	$222.0 - 4.629 \log R$	180
MFC1	198	$206.6 - 3.720 \log R$	10
HFC1	198	$203.9 - 3.667 \log R$	5
PPW1	197	$212.3 - 3.941 \log R$	49
OPW1	220	$210.2 - 3.842 \log R$	0
LFC2	198	$205.7 - 4.603 \log R$	5
MFC2	198	$190.2 - 3.733 \log R$	0
HFC2	172	$184.6 - 3.682 \log R$	31

6. Summary

Sound source verification measurements were completed for the 3280 in^3 airgun array, the 60 in^3 mitigation airgun, the *Geo Arctic* survey vessel, and the *Norseman* monitoring vessel associated with the TGS 2013 seismic survey in the Chukchi Sea. Radii to specific sound level thresholds were computed for each measured source. The range to the rms SPL threshold of 120 dB re 1 µPa was approximately 1.5 km for vessel self-noise from the survey vessel *Geo Arctic* transiting at survey speed (4.4 kts), and approximately 0.3 km for the monitoring vessel *Norseman* transiting at 5 kts. The measured radii for the airgun array were greatest in the broadside direction. The measured radii for the airgun sounds were less than those estimated with pre-season acoustic modeling. The more precautionary pre-season estimates were applied during the survey for marine mammal mitigation. Table 14 lists the maximum measured distances to the 190, 180, 160, and 120 dB re 1 µPa threshold levels for the 3280 in^3 airgun array and the 60 in^3 mitigation airgun. These distances are based on the 90th percentile empirical function fits and are the maxima over direction (broadside and endfire).

Table 14. Maximum threshold distances for the 3820 in^3 airgun array and the 60 in^3 mitigation airgun. Distances are maximized over direction and are based on the 90th percentile fits to the rms SPLs versus range.

rms SPL threshold (dB re 1 µPa)	90th percentile distance (m)	
	Airgun array	Mitigation airgun
190	460	7
180	1100	43
160	8000	1600

Acknowledgements

Nicole Chorney and Harald Yurk provided editorial and scientific review in the preparation of this report. We gratefully acknowledge the captain and crew of the *Norseman* for their assistance in completing these SSV measurements.

Glossary

90%-energy time window
The time interval over which the cumulative energy rises from 5% to 95% of the total pulse energy. This interval contains 90% of the total pulse energy. Symbol: T_{90}.

90% rms SPL
The root-mean-square sound pressure levels calculated over the 90%-energy time window of a pulse. Used only for pulsed sounds.

A-weighting
Frequency-selective weighting for aerial hearing in humans derived from the inverse of the idealized 40-phon equal loudness hearing function across frequencies.

absorption
The conversion of sound waves into heat, which is captured by insulation.

attenuation
The acoustic energy loss due to absorption and scattering.

audiogram
A curve of hearing threshold (sound pressure levels) as a function of frequency that describes the hearing sensitivity of an animal over its normal hearing range.

audiogram weighting
The process of applying an animal's audiogram to sound pressure levels to determine the sound level relative to the animal's hearing threshold (HT). Unit, dB re HT.

bar
Unit of pressure equal to 100 kPa, which is approximately equal to the atmospheric pressure on Earth at sea level. 1 Bar is equal to 10^6 Pa or 10^{11} µPa.

broadband sound level
The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measurement range.

broadside direction
Perpendicular to the travel direction of a source.

critical ratio
The difference between the sound pressure level for a masked tone, which is barely audible, and the spectrum level of background noise at nearby frequencies. Unit: decibel (dB).

critical band
The auditory bandwidth within which background noise strongly contributes to masking of a single tone. Unit: hertz (Hz).

decibel
A logarithmic unit of the ratio of a quantity to a reference quantity of the same kind. Unit symbol: decibel (dB).

endfire direction
Parallel to the travel direction of a source.

frequency
The rate of oscillation of a periodic function measured in units of cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: f. For example, 1 Hz = 1 cycle per second.

Global Positioning System (GPS)
A satellite based navigation system providing accurate worldwide location and time information.

hearing threshold
The sound pressure level that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hydrophone
An underwater sound pressure transducer. A passive electronic device for recording or listening to underwater sound.

intermittent noise
A level of noise that abruptly drops to the background noise level several times during the observation period.

impulse sound
Sound characterized by brief, intermittent acoustic events with rapid (within a few seconds) onset and decay back to ambient levels.

M-weighting
The process of bandpass filtering loud sounds that reduces the importance of inaudible or less-audible frequencies for broad classes of marine mammals. “Generalized frequency weightings for various functional hearing groups of marine mammals, allowing for their functional bandwidths and appropriate in characterizing auditory effects of strong sounds” (Southall et al. 2007).

noise
Unwanted sound that interferes with detecting other sounds.

peak sound pressure level (peak SPL)
The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak sound pressure level. Unit: decibel (dB). Symbol: L_{pk}.

peak-to-peak sound pressure level (peak-to-peak SPL)
The difference between the maximum and minimum instantaneous sound pressure levels. Unit: decibel (dB). Symbol: $L_{pk\text{-}pk}$.

percentile level, exceedance
The sound level exceeded *n*% of the time during a measurement.

power spectrum density
The acoustic signal power per unit frequency as measured at a single frequency. Unit: $\mu Pa^2/Hz$, or $\mu Pa^2 \cdot s$.

power spectrum density level
The decibel level ($10\log_{10}$) of the power spectrum density, usually presented in 1 Hz bins. Unit: dB re 1 $\mu Pa^2/Hz$.

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa).

pressure, hydrostatic
The pressure at any given depth in a static liquid that is the result of the weight of the liquid acting on a unit area at that depth, plus any pressure acting on the surface of the liquid.
Unit: pascal (Pa).

pulsed sound
Discrete sounds with durations less than a few seconds. Sounds with longer durations are called continuous sounds.

rms
root mean square.

rms sound pressure level (rms SPL)
The root-mean-square average of the instantaneous sound pressure (symbol is L_p) as measured over some specified time interval (symbol T). For continuous sound, the time interval is one second.

See also 90% rms SPL.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure level (SEL)
A measure of the total sound energy in one or more pulses. Unit: dB re 1 $\mu Pa^2 \cdot s$.

sound intensity
Sound energy flowing through a unit area perpendicular to the direction of propagation per unit time.

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R1999). Unit: decibel (dB). Symbol: L_p.

For sound in water, the reference sound pressure is one micropascal (p_o = 1 μPa) and the unit for SPL is dB re 1 μPa:

$$L_P = 10\log_{10}\left(p^2/p_o^2\right) = 20\log_{10}\left(p/p_o\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level (rms SPL).

source level (SL)

The sound pressure level measured 1 metre from a point-like source that radiates the same total amount of sound power as the actual source. Unit: dB re 1 μPa @ 1 m.

spectrogram

A visual representation of acoustic intensity versus time and frequency.

spectrum

An acoustic signal represented in terms of its power (or energy) distribution versus frequency.

See also power spectrum density.

wavelength

Distance over which a wave completes one oscillation cycle. Unit: metre (m). Symbol: λ.

zero-to-peak SPL

See peak SPL.

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Appendix B
Weekly Marine Mammal Sighting Maps

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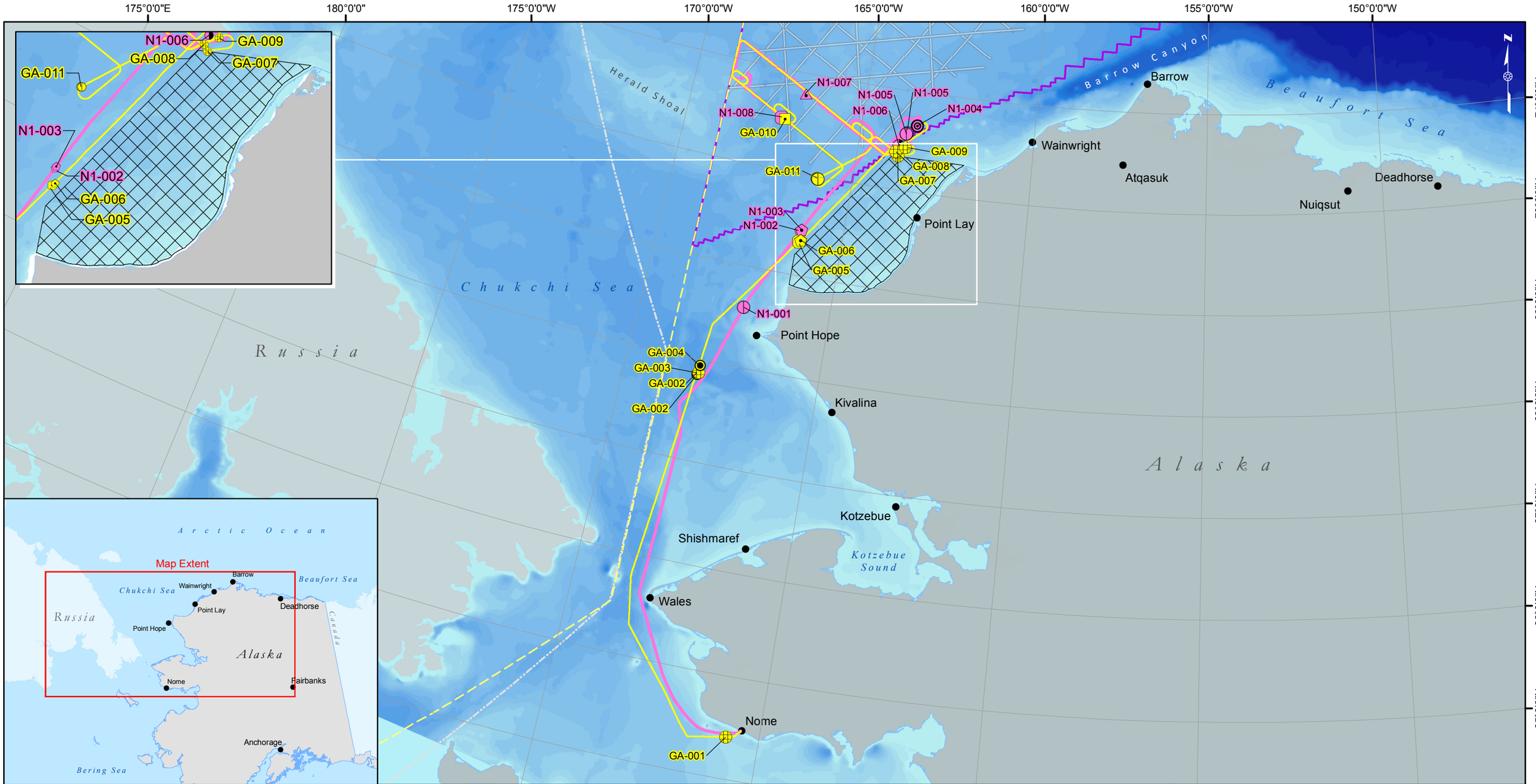
175°0'0"E
180°0'0"
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160°0'0"W
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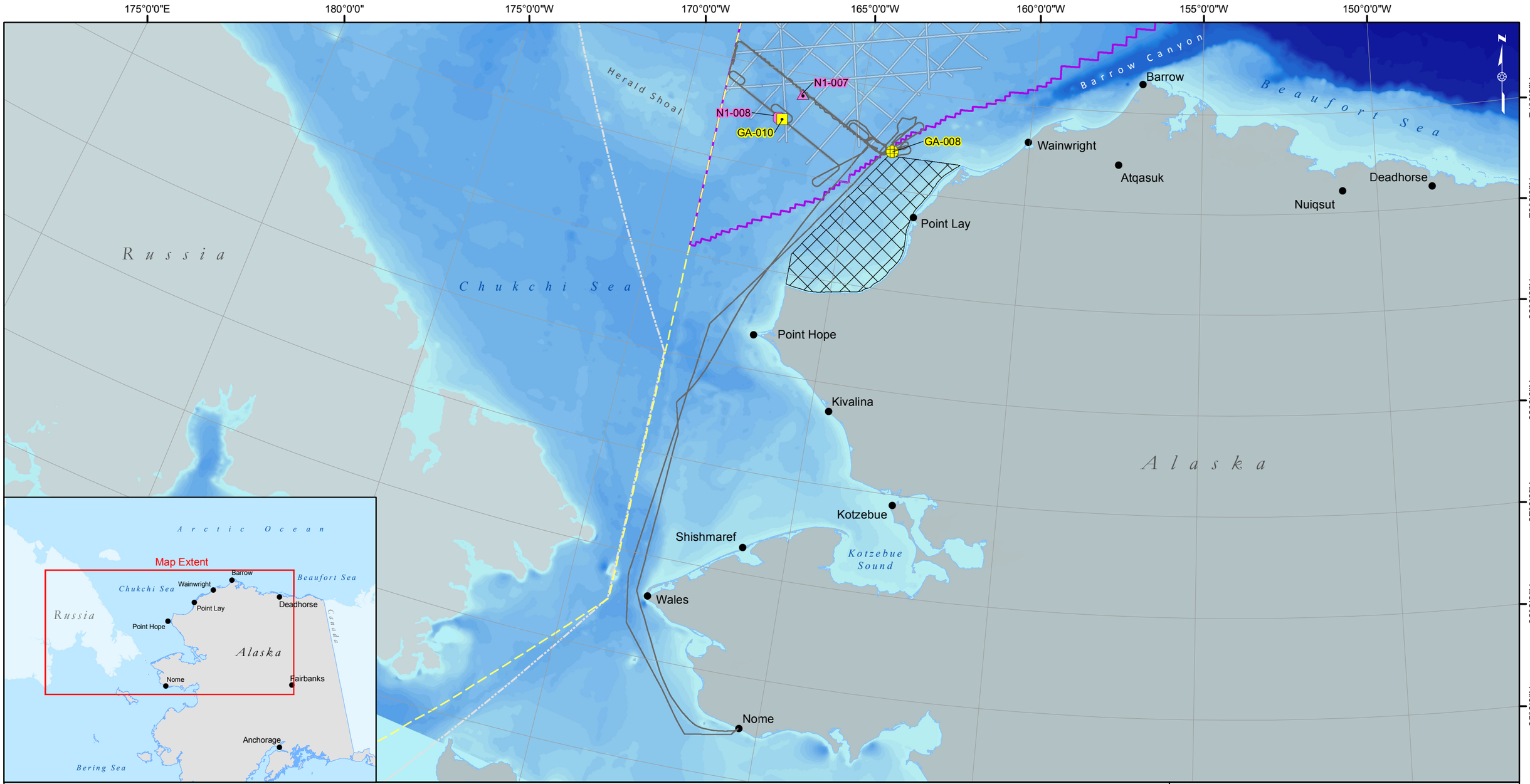
150°0'0"W
71°0'0"N
70°0'0"N
69°0'0"N
68°0'0"N
67°0'0"N
66°0'0"N
65°0'0"N
Herald Shoal
Barrow Canyon
Barrow
Beaufort Sea
Wainwright
Atqasuk
Deadhorse
Nuiqsut
Point Lay
Chukchi Sea
Russia
Alaska
Point Hope
Kivalina
Kotzebue
Kotzebue Sound
Shishmaref
Wales
Nome
N1-006
GA-009
GA-008
GA-007
GA-011
N1-003
N1-002
GA-006
GA-005
N1-007
N1-005
N1-004
N1-008
GA-010
N1-001
GA-004
GA-003
GA-002
GA-001
Arctic Ocean
Map Extent
Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Anchorage
Fairbanks
Bathymetry
Depth (in meters)
0- 49
50 - 99
100 - 199
200 - 499
500 - 999
1000 - 1499
1500 - 1999
2000 - 2999
3000 - 3999
4000 - 5565
Geo Arctic PSO Sightings
Bearded Seal
Gray Whale
Minke Whale
Spotted Seal
Unidentified Seal
Unidentified Whale
Norseman PSO Sightings
Minke Whale
Pacific Walrus
Ringed Seal
Spotted Seal
Unidentified Mysticete Whale
Unidentified Seal
Geo Arctic Track 26 Aug - 1 Sep
Norseman Track 26 Aug - 1 Sep
TGS 2D Seismic Survey Line
Village
Lease Sale 193
Ledyard Bay Critical Habitat
Exclusive Economic Zone
International Date Line
NAD83, Alaska Albers Equal Area
ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services
TGS
TGS ACTIVITY MAP WEEK OF 26 AUGUST - 1 SEPTEMBER
2013 TGS 2D Seismic Survey
90-Day Report
SCALE:
0 25 50 100 Miles
0 50 100 200 Kilometers
FIGURE:
B-1
AES-RTS: 13-185-009.mxd, 01/29/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Bearded Seal
- Unidentified Whale

Norseman PSO Sightings

- Pacific Walrus
- Unidentified Seal

- All Tracks 26 Aug - 1 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Exclusive Economic Zone
- International Date Line
- Village

NAD83, Alaska Albers Equal Area

ASRC Energy Services
a subsidiary of Arctic Slope Regional Corporation
Regulatory and Technical Services

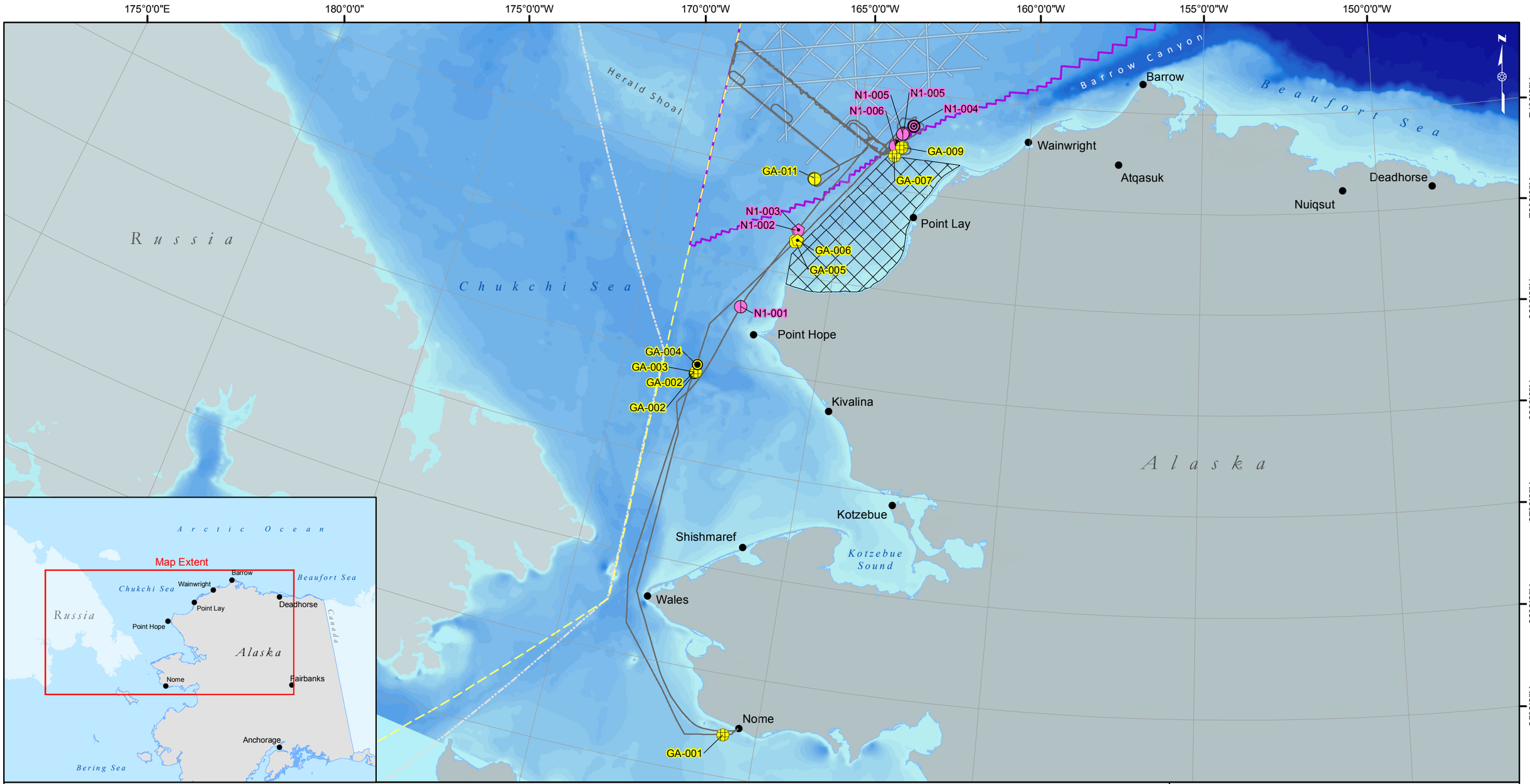
TGS

TGS ACTIVITY MAP WEEK OF 26 AUGUST - 1 SEPTEMBER
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 25 50 100 Miles
0 50 100 200 Kilometers

FIGURE: B-1a

AES-RTS: 13-185-019.mxd, 01/27/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Gray Whale
- Minke Whale
- Spotted Seal
- Unidentified Seal
- Unidentified Whale

Norseman PSO Sightings

- Minke Whale
- Ringed Seal
- Spotted Seal
- UMW

- All Tracks 26 Aug - 1 Sep
- TGS 2D Seismic Survey Line
- Village
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Exclusive Economic Zone
- International Date Line

NAD83, Alaska Albers Equal Area

ASRC Energy Services
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Regulatory and Technical Services

TGS

TGS ACTIVITY MAP WEEK OF 26 AUGUST - 1 SEPTEMBER
DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 25 50 100 Miles
0 50 100 200 Kilometers

FIGURE: B-1b

AES-RTS: 13-185-020.mxd, 01/27/14

170°0'0"W
165°0'0"W
160°0'0"W
72°0'0"N
71°0'0"N
70°0'0"N

Chukchi Sea
Herald Shoal
Barrow Canyon
GA-012
N1-009
N1-010
N1-014
N1-016
N1-015
N1-011
N1-012
N1-013
Wainwright
Barrow
Atqasuk
Point Lay

Arctic Ocean
Map Extent
Chukchi Sea
Beaufort Sea
Barrow
Wainwright
Point Lay
Deadhorse
Russia
Point Hope
Alaska
Canada
Nome
Fairbanks
Anchorage
Bering Sea

Bathymetry

Depth (in meters)
0- 49
50 - 99
100 - 199
200 - 499
500 - 999
1000 - 1499
1500 - 1999
2000 - 2999
3000 - 3999
4000 - 5565

Geo Arctic PSO Sightings
Pacific Walrus
Norseman PSO Sightings
Bearded Seal
Bowhead Whale
Spotted Seal
Unidentified Seal

Geo Arctic Track 2 Sep - 8 Sep
Norseman Track 2 Sep - 8 Sep

TGS 2D Seismic Survey Line
Lease Sale 193
Ledyard Bay Critical Habitat

Exclusive Economic Zone
International Date Line
Village

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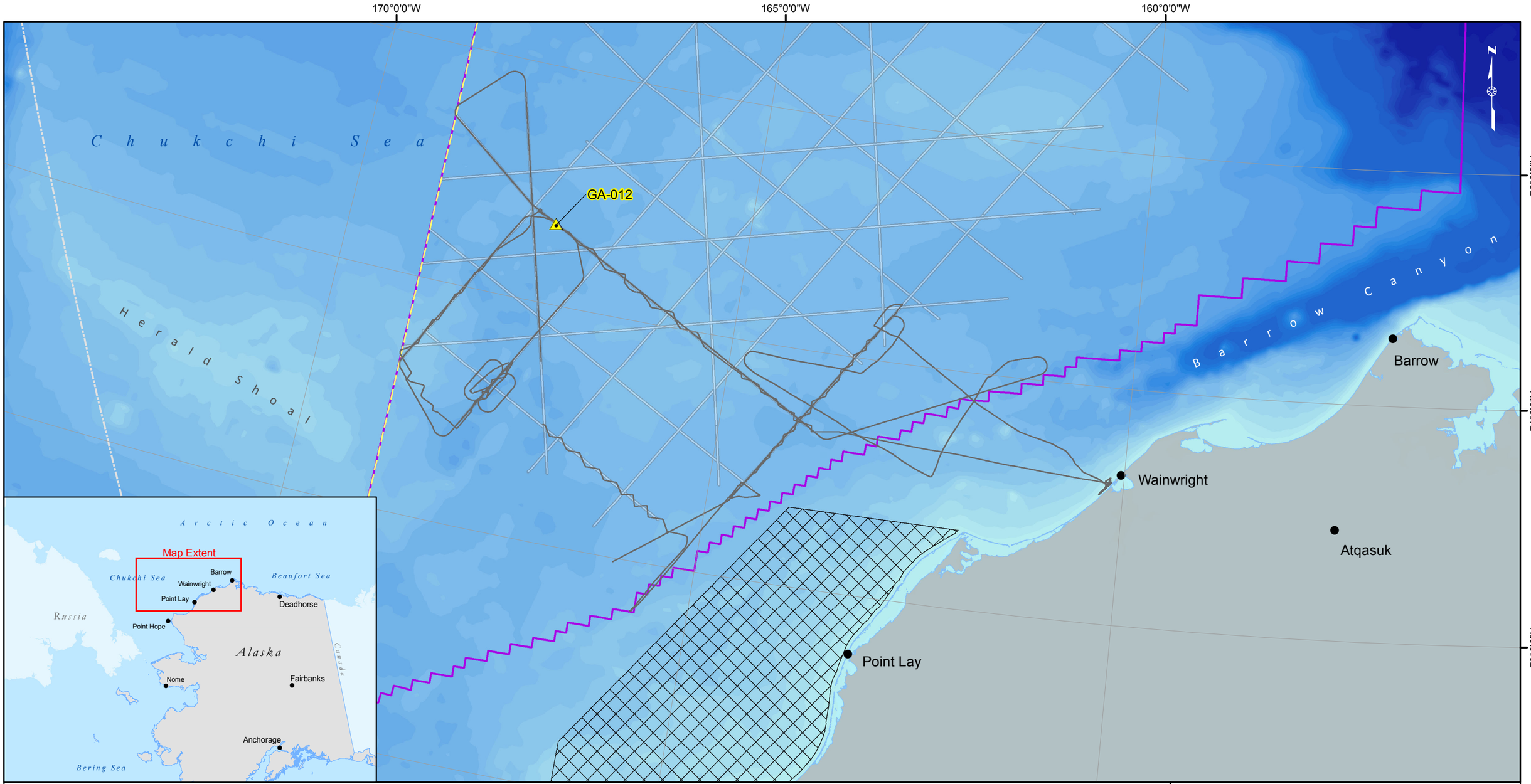
TGS ACTIVITY MAP WEEK OF 2 SEPTEMBER - 8 SEPTEMBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 40 Miles
0 20 40 80 Kilometers

FIGURE: B-2

AES-RTS: 13-185-010.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Pacific Walrus
- All Tracks 2 Sep - 8 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Exclusive Economic Zone
- International Date Line
- Village

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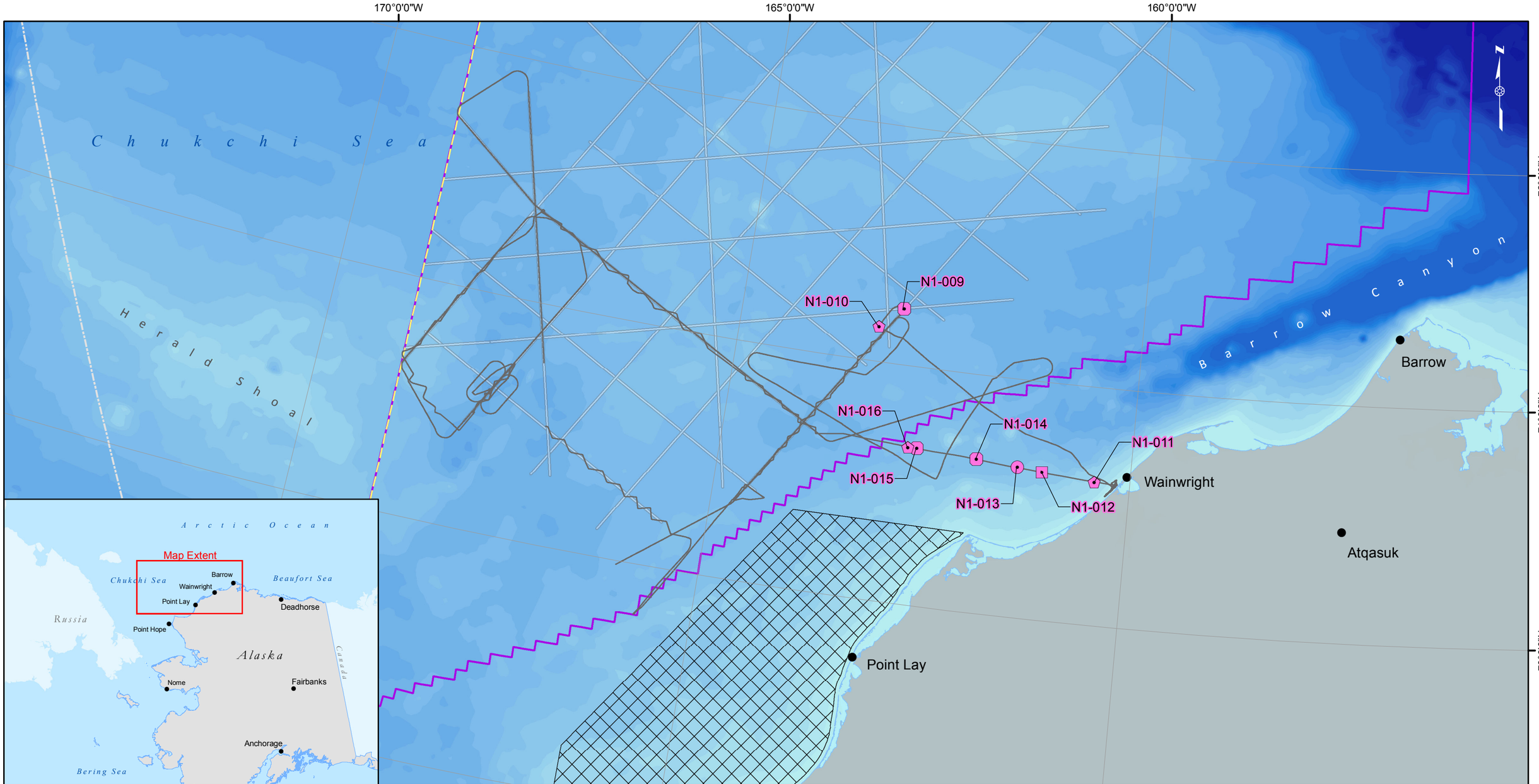
TGS ACTIVITY MAP WEEK OF 2 SEPTEMBER - 8 SEPTEMBER
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 40 Miles
0 20 40 80 Kilometers

FIGURE: B-2a

AES-RTS: 13-185-021.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Norseman PSO Sightings

- Bearded Seal
- Bowhead Whale
- Spotted Seal
- Unidentified Seal

- All Tracks 2 Sep - 8 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Exclusive Economic Zone
- International Date Line
- Village

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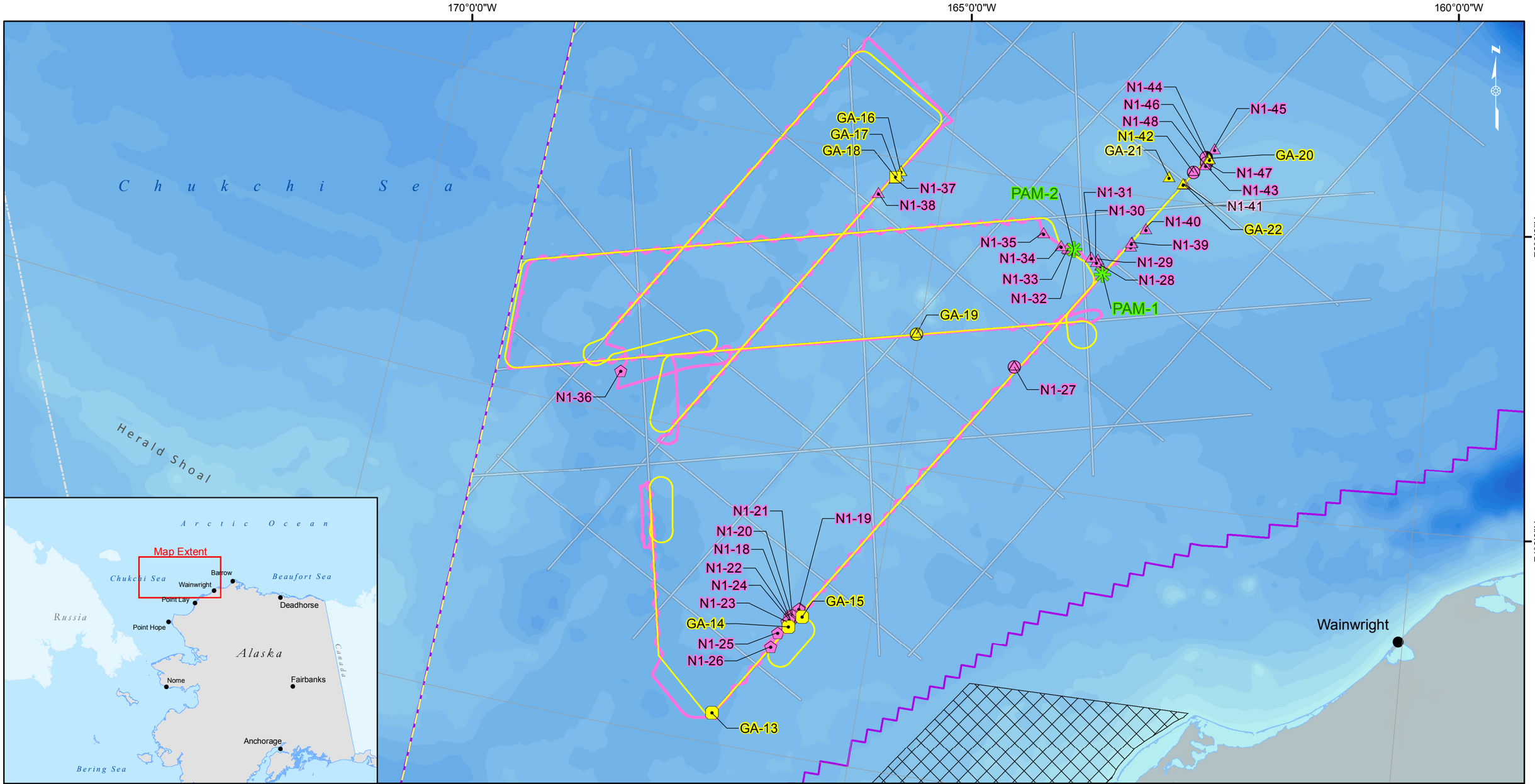
TGS ACTIVITY MAP WEEK OF 2 SEPTEMBER - 8 SEPTEMBER DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 40 Miles
0 20 40 80 Kilometers

FIGURE: B-2b

AES-RTS: 13-185-022.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

- Bearded Seal
- Pacific Walrus
- Unidentified Pinniped
- Unidentified Seal

Norseman PSO Sightings

- Pacific Walrus
- Spotted Seal
- Unidentified Mysticete Whale
- Unidentified Pinniped
- Unidentified Seal

- Geo Arctic Track 9 Sep - 15 Sep
- Norseman Track 9 Sep - 15 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Exclusive Economic Zone
- International Date Line
- Village

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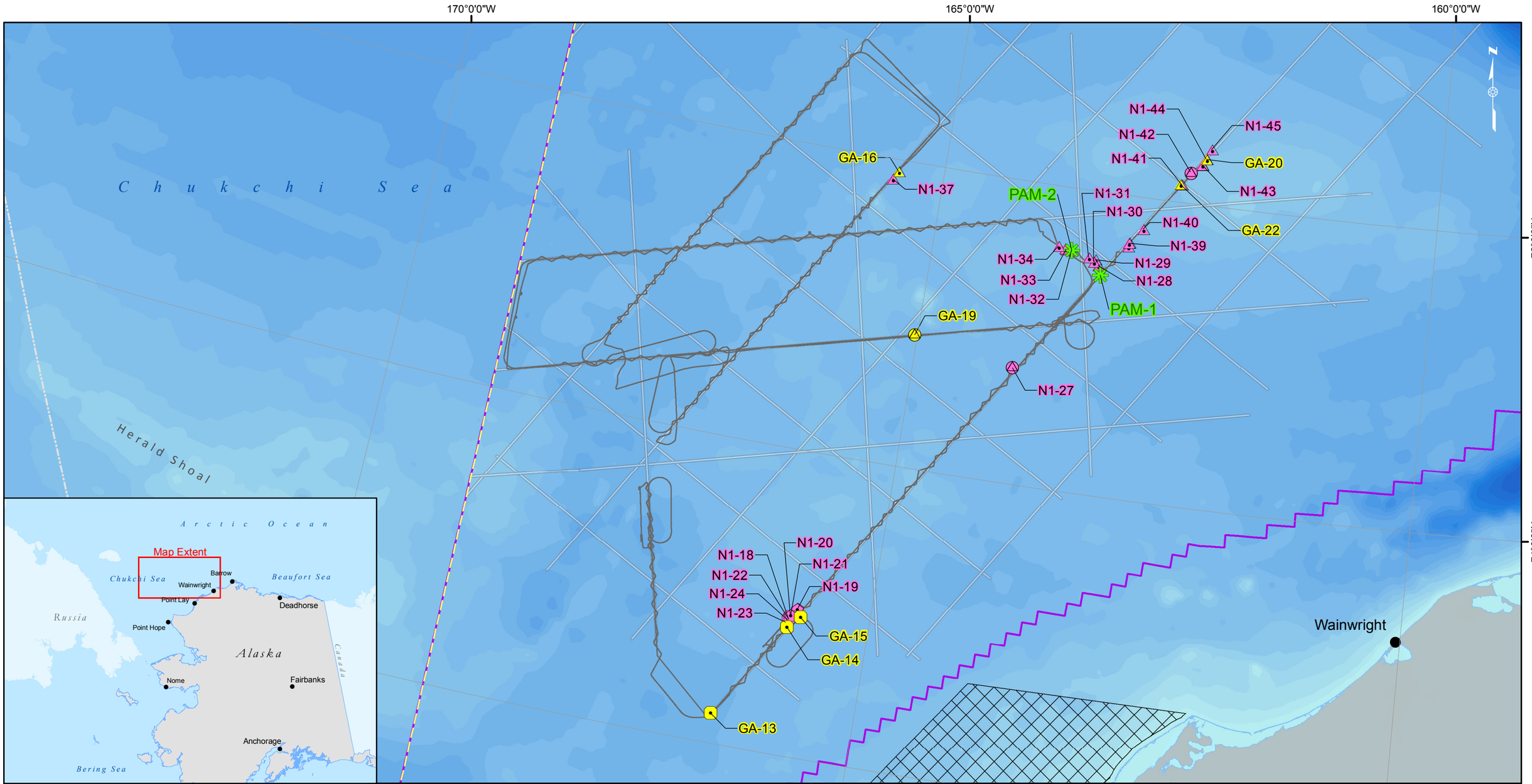
TGS ACTIVITY MAP WEEK OF 9 SEPTEMBER - 15 SEPTEMBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 5 10 20 Miles; 0 250 500 1,000 Kilometers

FIGURE: B-3

AES-RTS: 13-185-011.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

- Pacific Whale
- Unidentified Pinniped
- Unidentified Seal

Norseman_Species

- Pacific Whale
- Spotted Seal
- Unidentified Pinniped
- Unidentified Seal

All Tracks 9 Sep - 15 Sep

TGS 2D Seismic Survey Line

Lease Sale 193

Ledyard Bay Critical Habitat

Exclusive Economic Zone

International Date Line

Village

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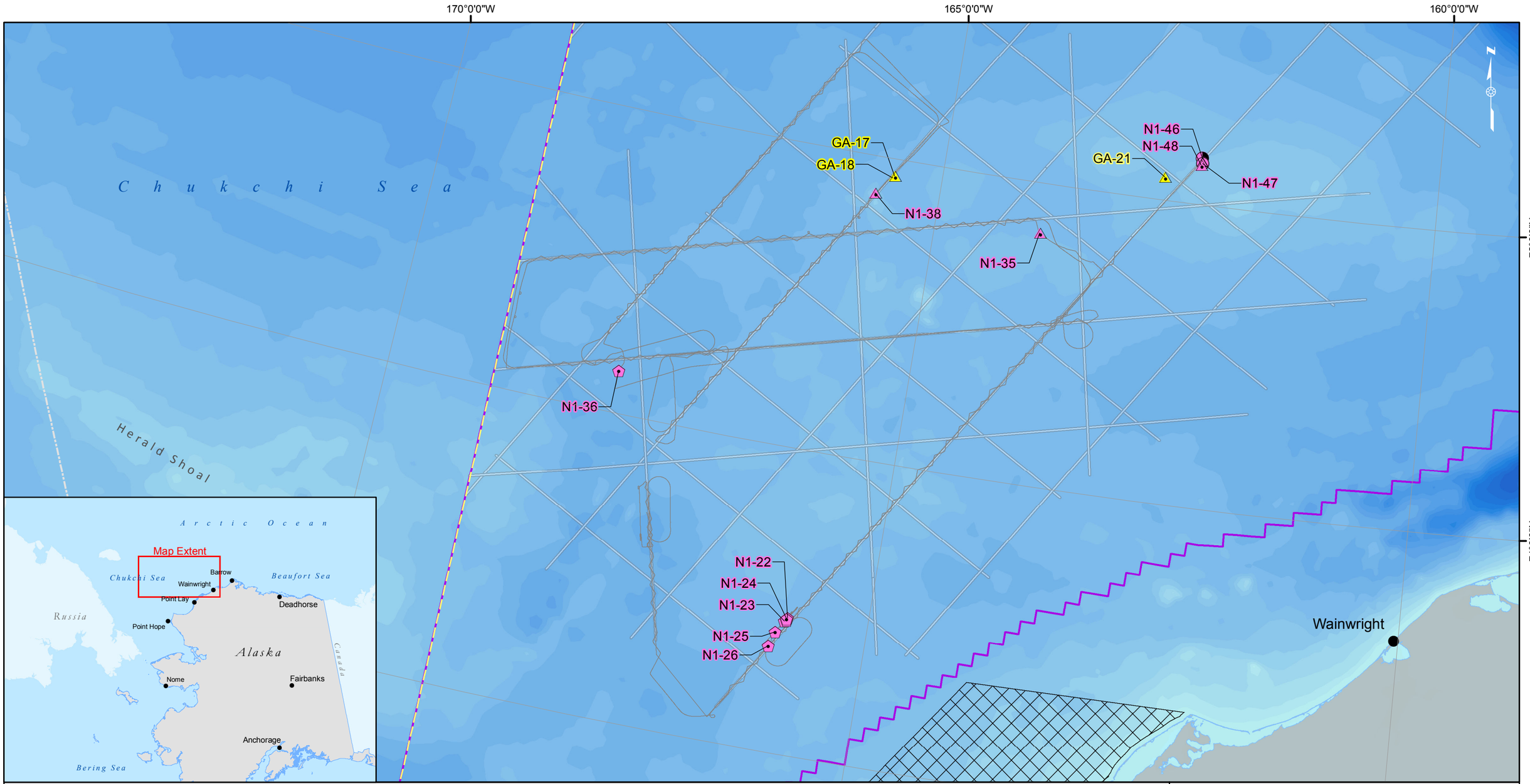
TGS ACTIVITY MAP WEEK OF 9 SEPTEMBER - 15 SEPTEMBER
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 5 10 20 Miles; 0 250 500 1,000 Kilometers

FIGURE: B-3a

AES-RTS: 13-185-024.mxd, 01/28/14



Bathymetry

Depth (in meters)		
0- 49	200 - 499	2000 - 2999
50 - 99	500 - 999	3000 - 3999
100 - 199	1000 - 1499	4000 - 5565
	1500 - 1999	

Geo Arctic PSO Sightings
- Pacific Walrus

Norseman PSO Sightings
- Pacific Walrus
- Spotted Seal
- Unidentified Mysticete Whale
- Unidentified Pinniped

- All Tracks 9 Sep - 15 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Exclusive Economic Zone
- International Date Line
- Village

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TGS ACTIVITY MAP WEEK OF 9 SEPTEMBER - 15 SEPTEMBER
DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 5 10 20 Miles
0 250 500 1,000 Kilometers

FIGURE: B-3b

AES-RTS: 13-185-025.mxd, 01/28/14

175°0'0"W
170°0'0"W
165°0'0"W
160°0'0"W
155°0'0"W
75°0'0"N
74°0'0"N
73°0'0"N

Arctic Ocean

Chukchi Sea

PAM-4

N1-51

PAM-3

N1-50

GA-23

N1-49

Map Extent

Arctic Ocean

Chukchi Sea

Beaufort Sea

Barrow

Wainwright

Point Lay

Deadhorse

Russia

Point Hope

Alaska

Canada

Nome

Fairbanks

Anchorage

Bering Sea

Bathymetry

Depth (in meters)

0- 49

50 - 99

100 - 199

200 - 499

500 - 999

1000 - 1499

1500 - 1999

2000 - 2999

3000 - 3999

4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

Unidentified Whale

Norseman PSO Sightings

Bowhead Whale

Unidentified Seal

Geo Arctic Track 16 Sep - 22 Sep

Norseman Track 16 Sep - 22 Sep

TGS 2D Seismic Survey Line

Lease Sale 193

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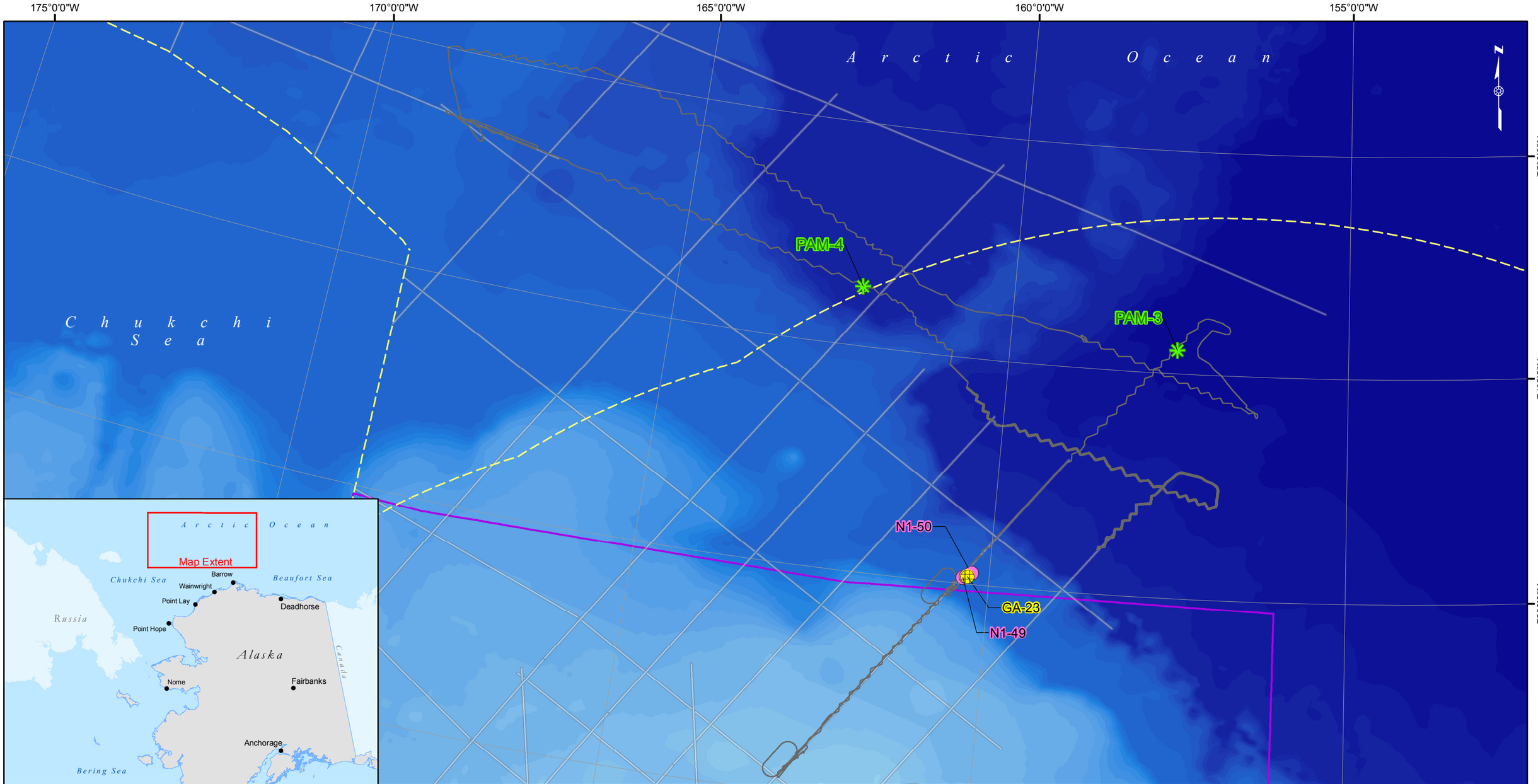
TGS ACTIVITY MAP WEEK OF 16 SEPTEMBER - 22 SEPTEMBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 40 Miles
0 20 40 80 Kilometers

FIGURE:
B-4

AES-RTS: 13-185-012.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

Unidentified Whale

Norseman PSO Sightings

Bowhead Whale

All Tracks 16 Sep - 22 Sep

TGS 2D Seismic Survey Line

Lease Sale 193

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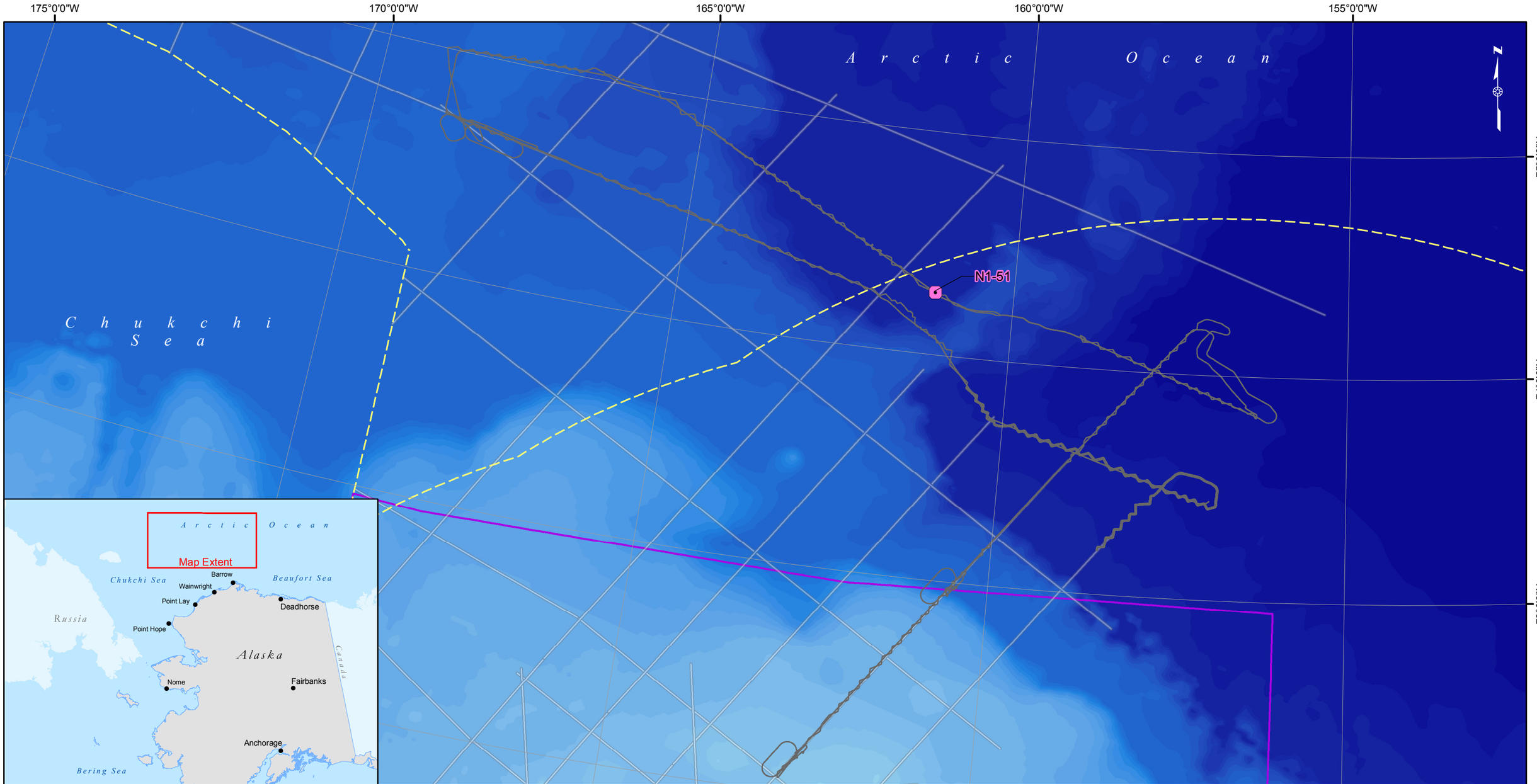
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 40 Miles
0 20 40 80 Kilometers

FIGURE: B-4a

AES-RTS: 13-185-026.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Norseman PSO Sightings

- Unidentified Seal
- All Tracks 16 Sep - 22 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Exclusive Economic Zone

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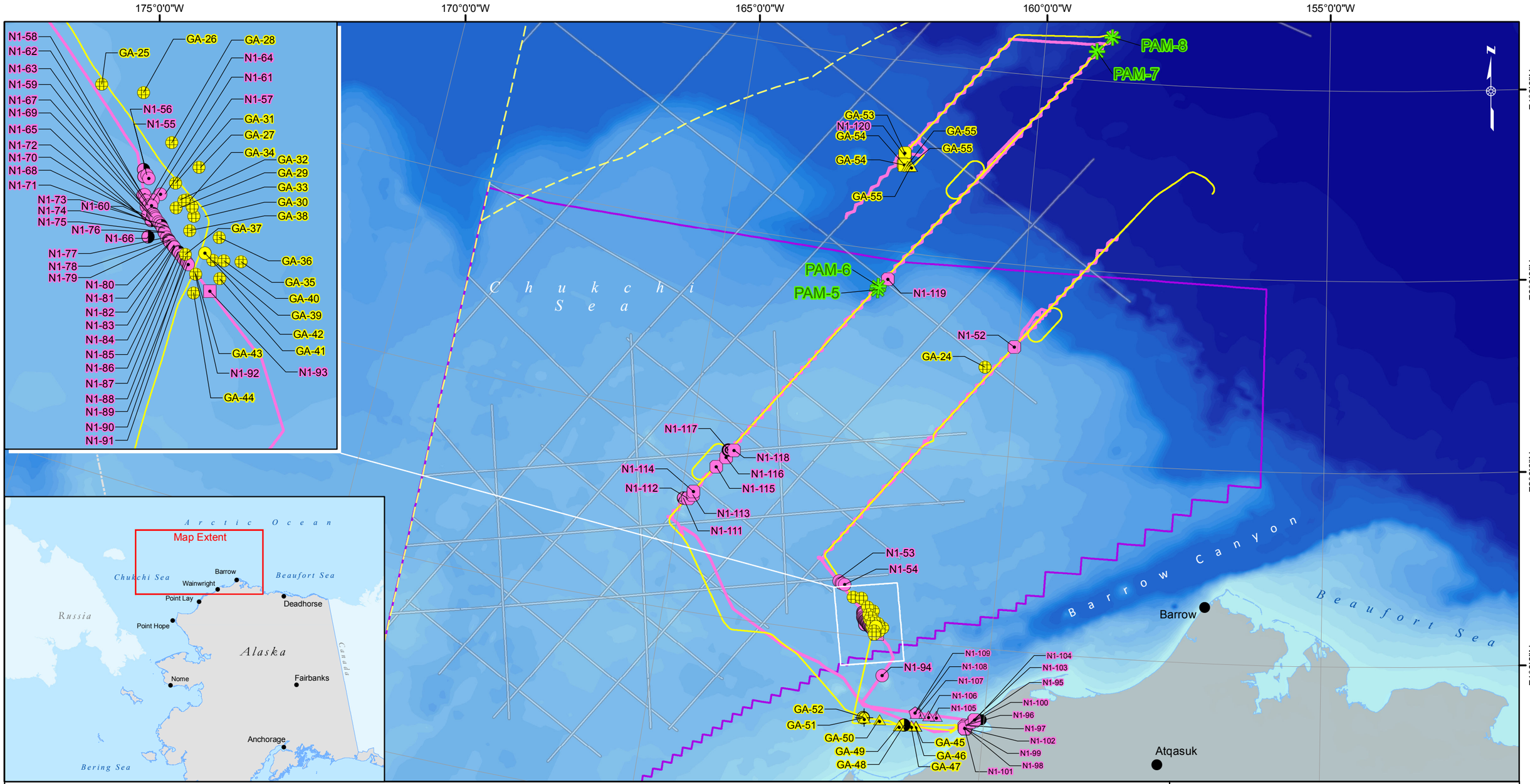
DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 40 Miles
0 20 40 80 Kilometers

FIGURE: B-4b

AES-RTS: 13-185-027.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Bowhead Whale
- Bearded Seal
- Humpback Whale
- Pacific Walrus
- Unidentified Mysticete Whale
- Unidentified Seal
- Unidentified Whale

Norseman PSO Sightings

- Bowhead Whale
- Bearded Seal
- Pacific Walrus
- Ringed Seal
- Spotted Seal
- Unidentified Mysticete Whale
- Unidentified Pinniped
- Unidentified Seal

- Acoustic Detection
- Geo Arctic Track 23 Sep - 29 Sep
- Norseman Track 23 Sep - 29 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Exclusive Economic Zone
- International Date Line
- Village

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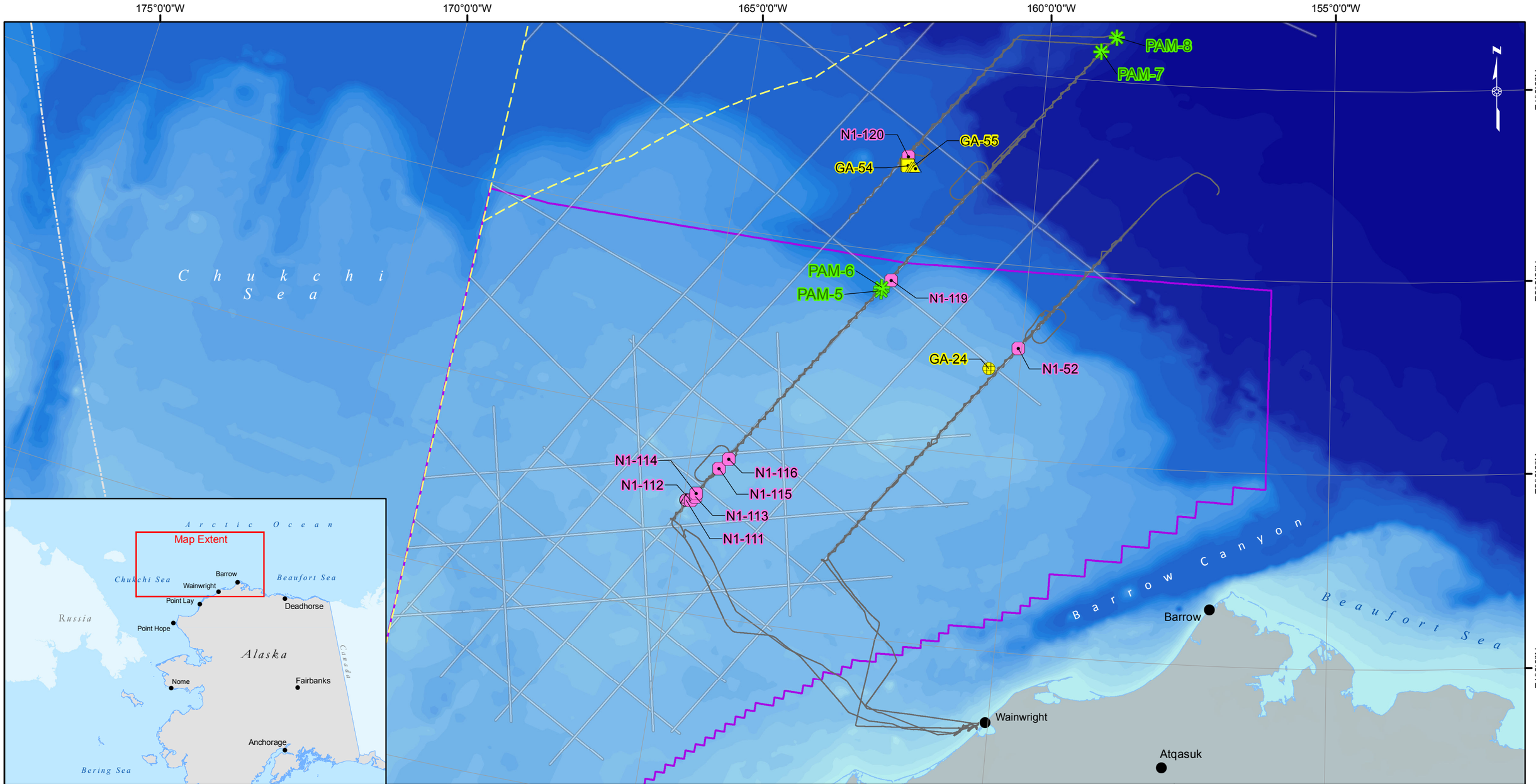
TGS ACTIVITY MAP WEEK OF 23 SEPTEMBER - 29 SEPTEMBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles
0 20 40 60 80 Kilometers

FIGURE: B-5

AES-RTS: 13-185-013.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

- Bearded Seal
- Pacific Walrus
- Unidentified Whale

Norseman PSO Sightings

- Unidentified Pinniped
- Unidentified Seal

All Tracks 23 Sep - 29 Sep

TGS 2D Seismic Survey Line

Lease Sale 193

Exclusive Economic Zone

International Date Line

Village

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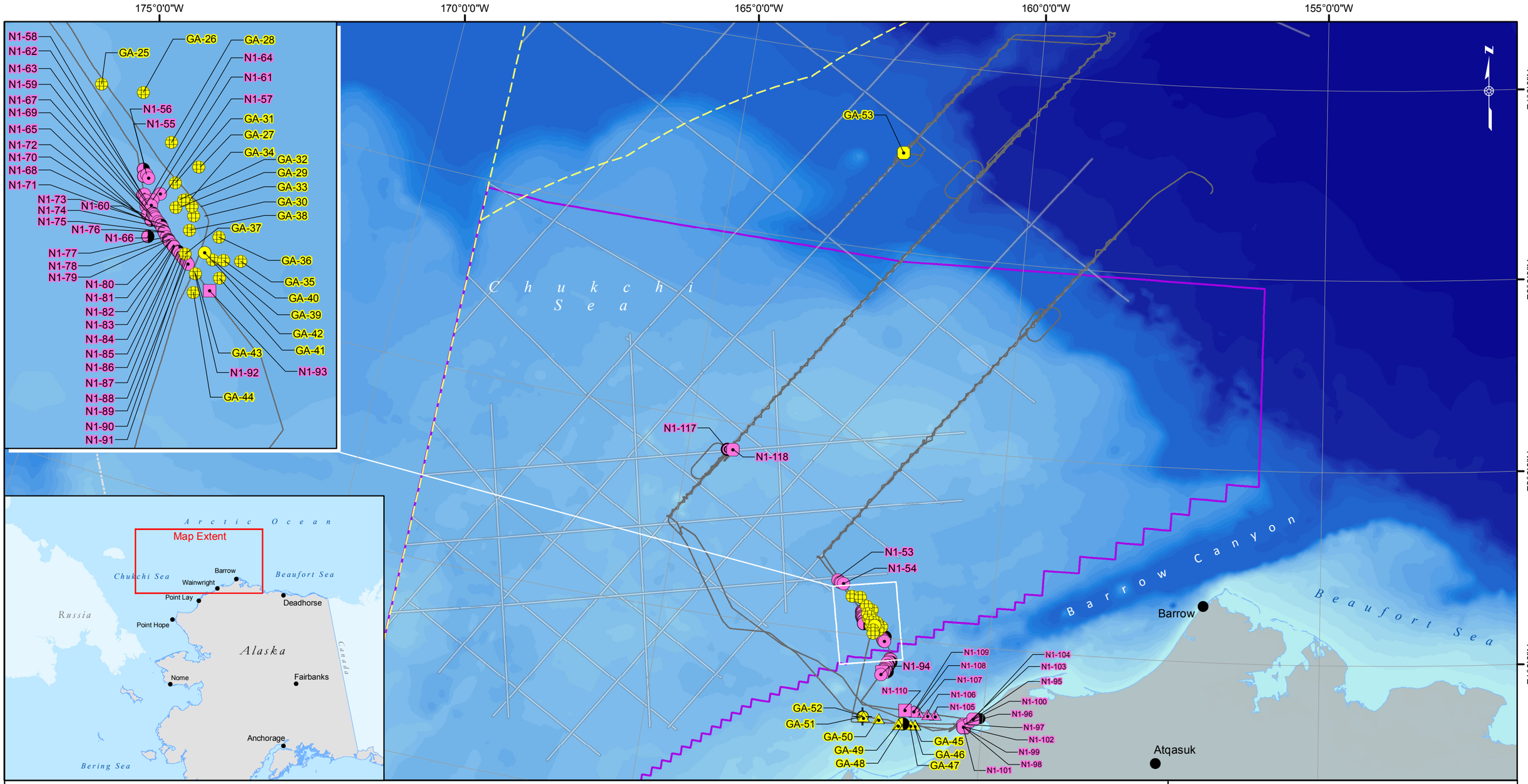
TGS ACTIVITY MAP WEEK OF 23 SEPTEMBER - 29 SEPTEMBER
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles; 0 20 40 60 80 Kilometers

FIGURE: B-5a

AES-RTS: 13-185-028.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Bowhead Whale
- Humpback Whale
- Pacific Whale
- Unidentified Mysticete Whale
- Unidentified Seal
- Unidentified Whale

Norseman PSO Sightings

- Bearded Seal
- Bowhead Whale
- Pacific Whale
- Ringed Seal
- Spotted Seal
- Unidentified Mysticete Whale
- Unidentified Seal

- All Tracks 23 Sep - 29 Sep
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Exclusive Economic Zone
- International Date Line
- Village

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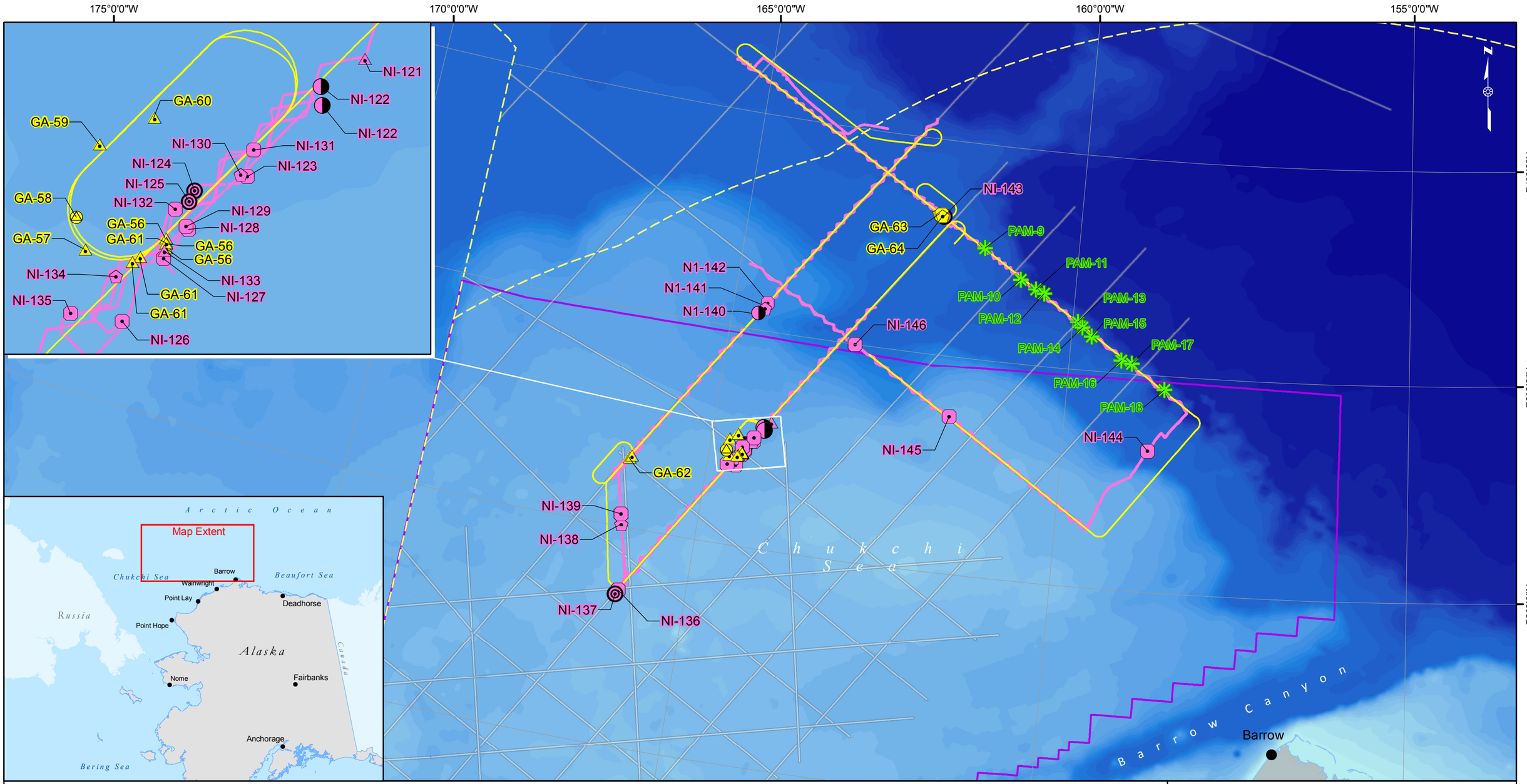
TGS ACTIVITY MAP WEEK OF 23 SEPTEMBER - 29 SEPTEMBER
DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles
0 20 40 60 80 Kilometers

FIGURE: B-5b

AES-RTS: 13-185-029.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

- Pacific Walrus
- Spotted Seal
- Unidentified Pinniped
- Unidentified Seal

Norseman PSO Sightings

- Pacific Walrus
- Ringed Seal
- Spotted Seal
- Unidentified Mysticete Whale
- Unidentified Seal

- Geo Arctic Track 30 Sep - 06 Oct
- Norseman Track 30 Sep - 06 Oct
- TGS 2D Seismic Survey Line

- Lease Sale 193
- Exclusive Economic Zone
- Village

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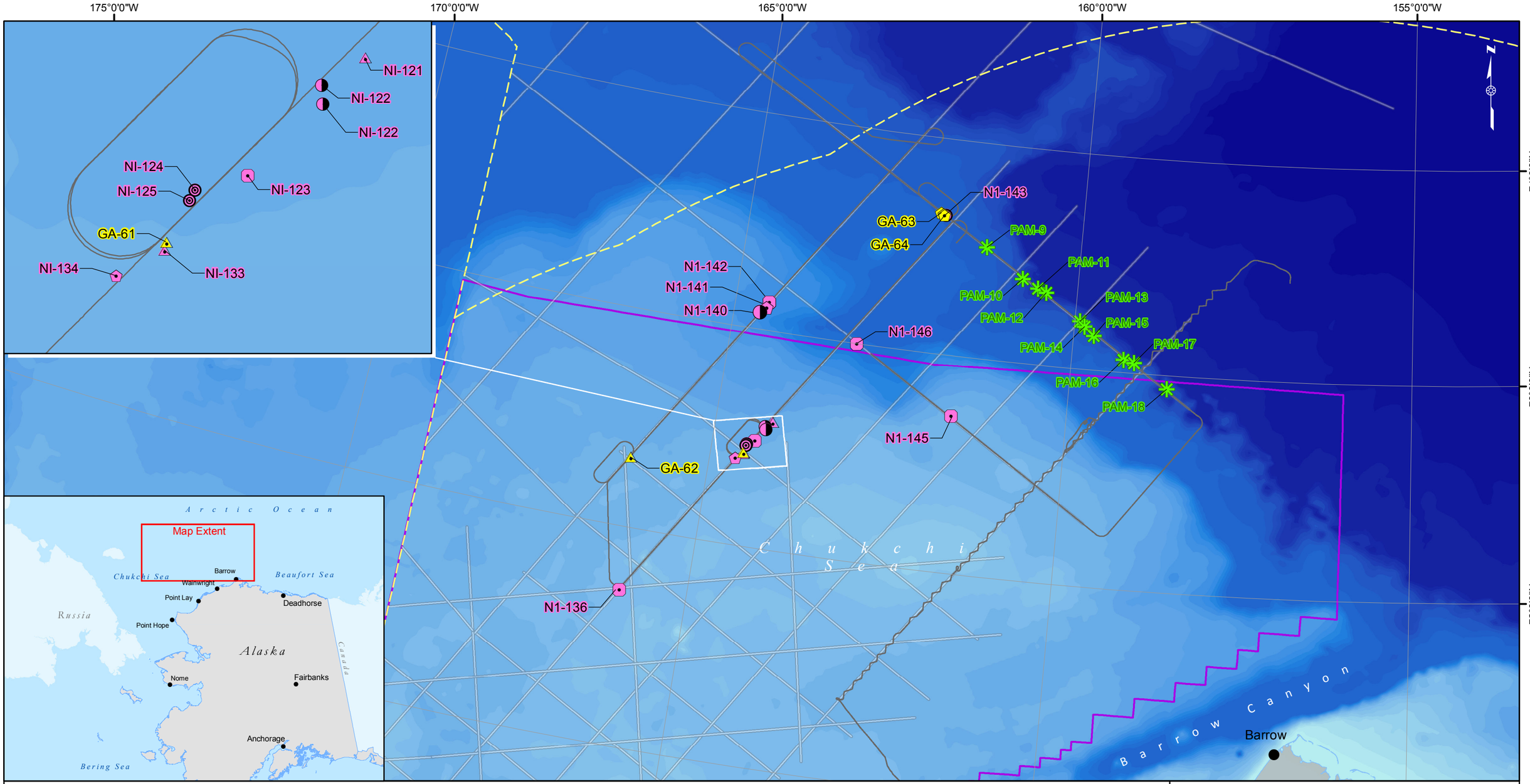
TGS ACTIVITY MAP WEEK OF 30 SEPTEMBER - 06 OCTOBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles
0 20 40 60 80 Kilometers

FIGURE: B-6

AES-RTS: 13-185-014.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

- Pacific Walrus
- Spotted Seal

Norseman PSO Sightings

- Pacific Walrus
- Ringed Seal
- Spotted Seal
- Unidentified Mysticete Whale
- Unidentified Seal

All Tracks 30 Sep - 06 Oct

TGS 2D Seismic Survey Line

Lease Sale 193

Exclusive Economic Zone

Village

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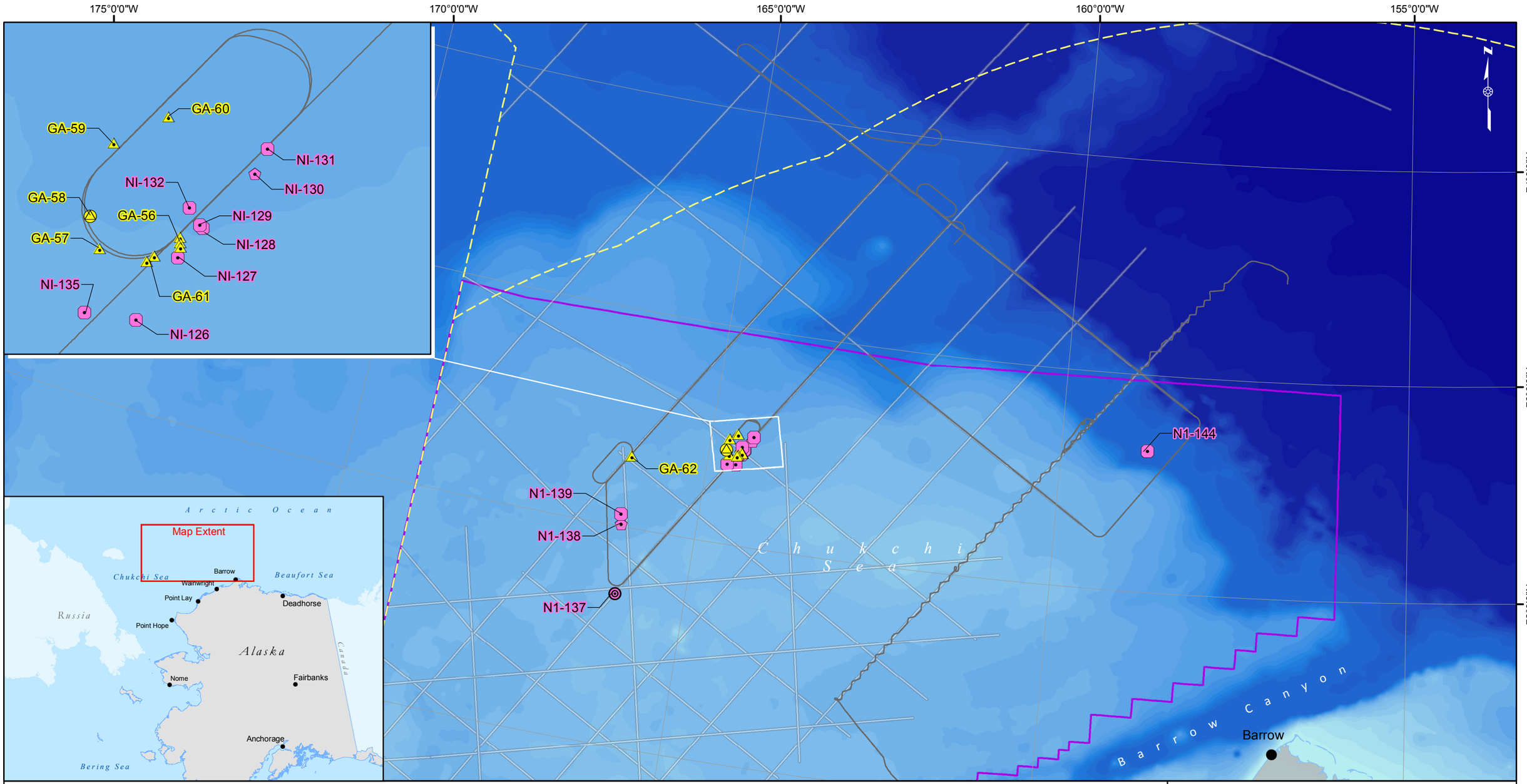
TGS ACTIVITY MAP WEEK OF 30 SEPTEMBER - 06 OCTOBER
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles; 0 20 40 60 80 Kilometers

FIGURE: B-6a

AES-RTS: 13-185-030.mxd, 01/28/14



Bathymetry

Depth (in meters)		
0- 49	200 - 499	2000 - 2999
50 - 99	500 - 999	3000 - 3999
100 - 199	1000 - 1499	4000 - 5565
	1500 - 1999	

Geo Arctic PSO Sightings
- Pacific Walrus
- Unidentified Pinniped

Norseman PSO Sightings
- Ringed Seal
- Spotted Seal
- Unidentified Seal

- All Tracks 30 Sep - 06 Oct
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Exclusive Economic Zone
- Village

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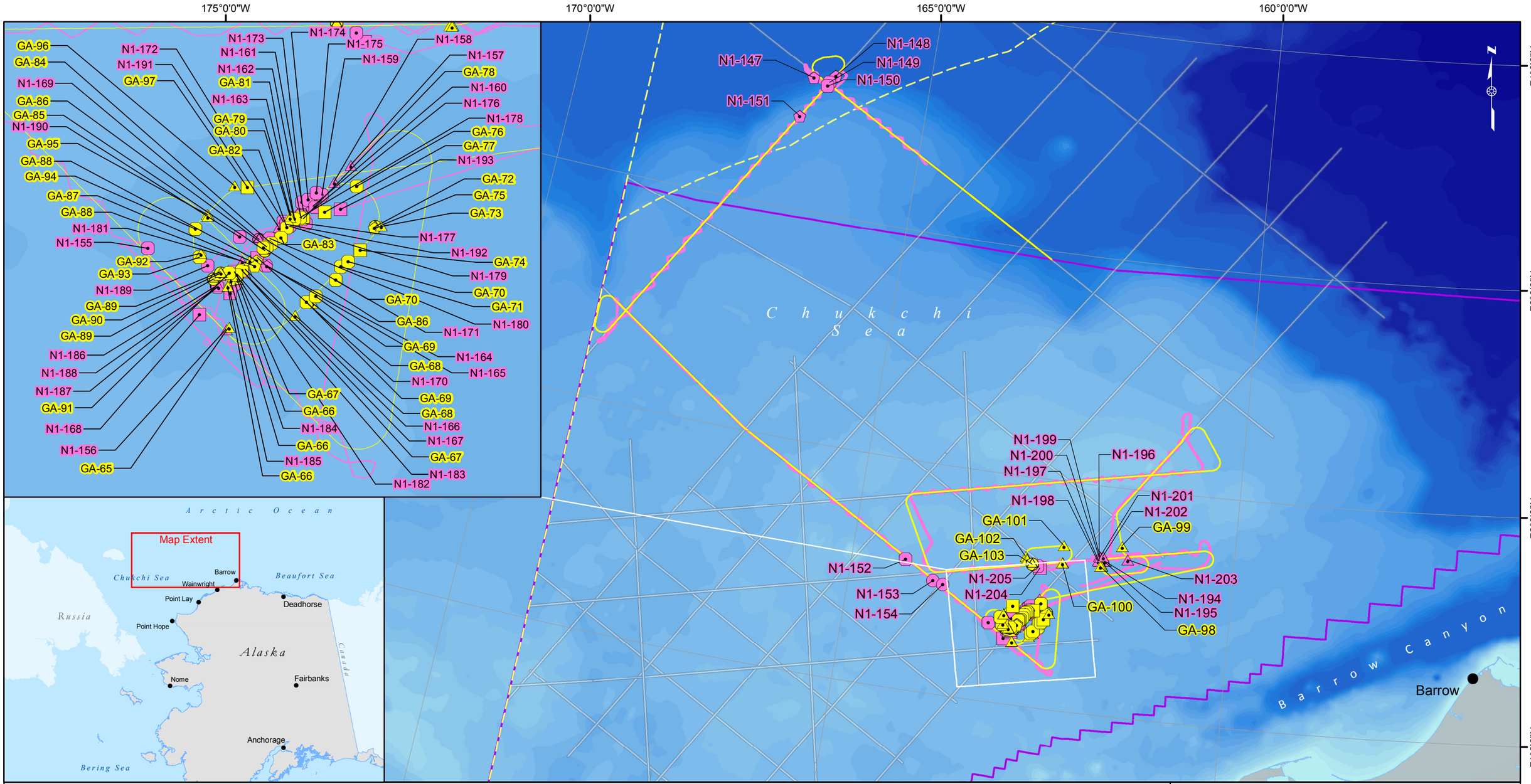
TGS ACTIVITY MAP WEEK OF 30 SEPTEMBER - 06 OCTOBER
DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles
0 20 40 60 80 Kilometers

FIGURE: B-6b

AES-RTS: 13-185-031.mxd, 01/28/14



Bathymetry

Depth (in meters)		
0- 49	200 - 499	2000 - 2999
50 - 99	500 - 999	3000 - 3999
100 - 199	1000 - 1499	4000 - 5565
	1500 - 1999	

Geo Arctic PSO Sightings
- Bearded Seal
- Pacific Walrus
- Spotted Seal
- Unidentified Pinniped
- Unidentified Seal

Norseman PSO Sightings
- BHW
- Bearded Seal
- Pacific Walrus
- Ringed Seal
- Spotted Seal
- Unidentified Pinniped
- Unidentified Seal

- Geo Arctic Track 07 Oct - 13 Oct
- Norseman Track 07 Oct - 13 Oct
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Exclusive Economic Zone
- Village

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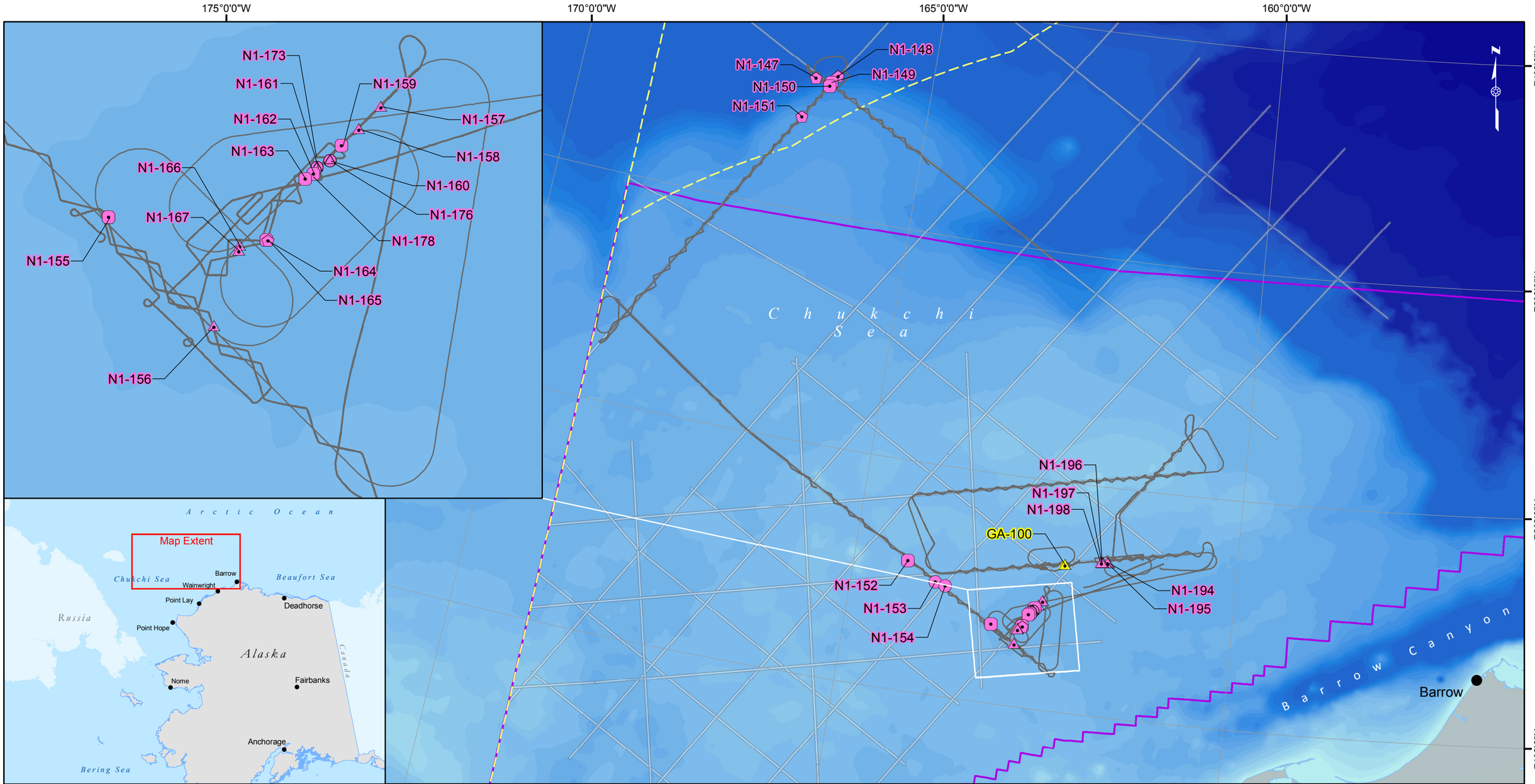
TGS ACTIVITY MAP WEEK OF 07 OCTOBER - 13 OCTOBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles; 0 5 10 15 20 Kilometers

FIGURE: B-7

AES-RTS: 13-185-015.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

GeoArctic_Species

- Pacific Walrus

Norseman PSO Sightings

- Bowhead Whale
- Pacific Walrus
- Spotted Seal
- Unidentified Pinniped
- Unidentified Seal

- All Tracks 07 Oct - 13 Oct
- TGS 2D Seismic Survey Line
- Lease Sale 193
- Exclusive Economic Zone
- Village

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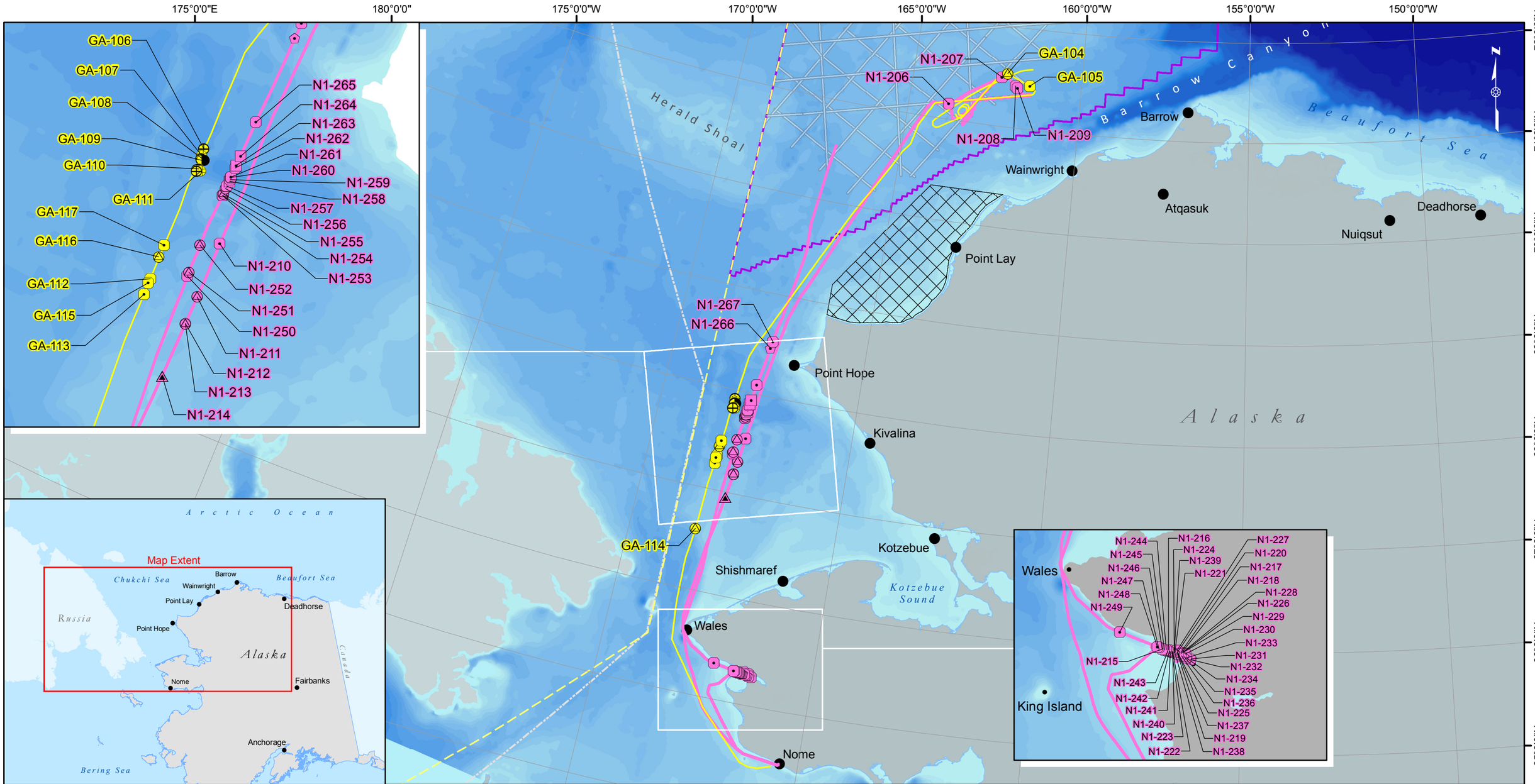
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles
0 4 8 12 16 Kilometers

FIGURE: B-7a

AES-RTS: 13-185-032.mxd, 01/21/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Gray Whale
- Unidentified Mysticete Whale
- Unidentified Pinniped
- Unidentified Seal
- Unidentified Whale

Norseman PSO Sightings

- Bearded Seal
- Harbor Porpoise
- Ribbon Seal
- Spotted Seal
- Unidentified Pinniped
- Unidentified Seal

- Geo Arctic Track 14 Oct - 20 Oct
- Norseman Track 14 Oct - 20 Oct
- TGS 2D Seismic Survey Line
- Exclusive Economic Zone
- International Date Line

- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

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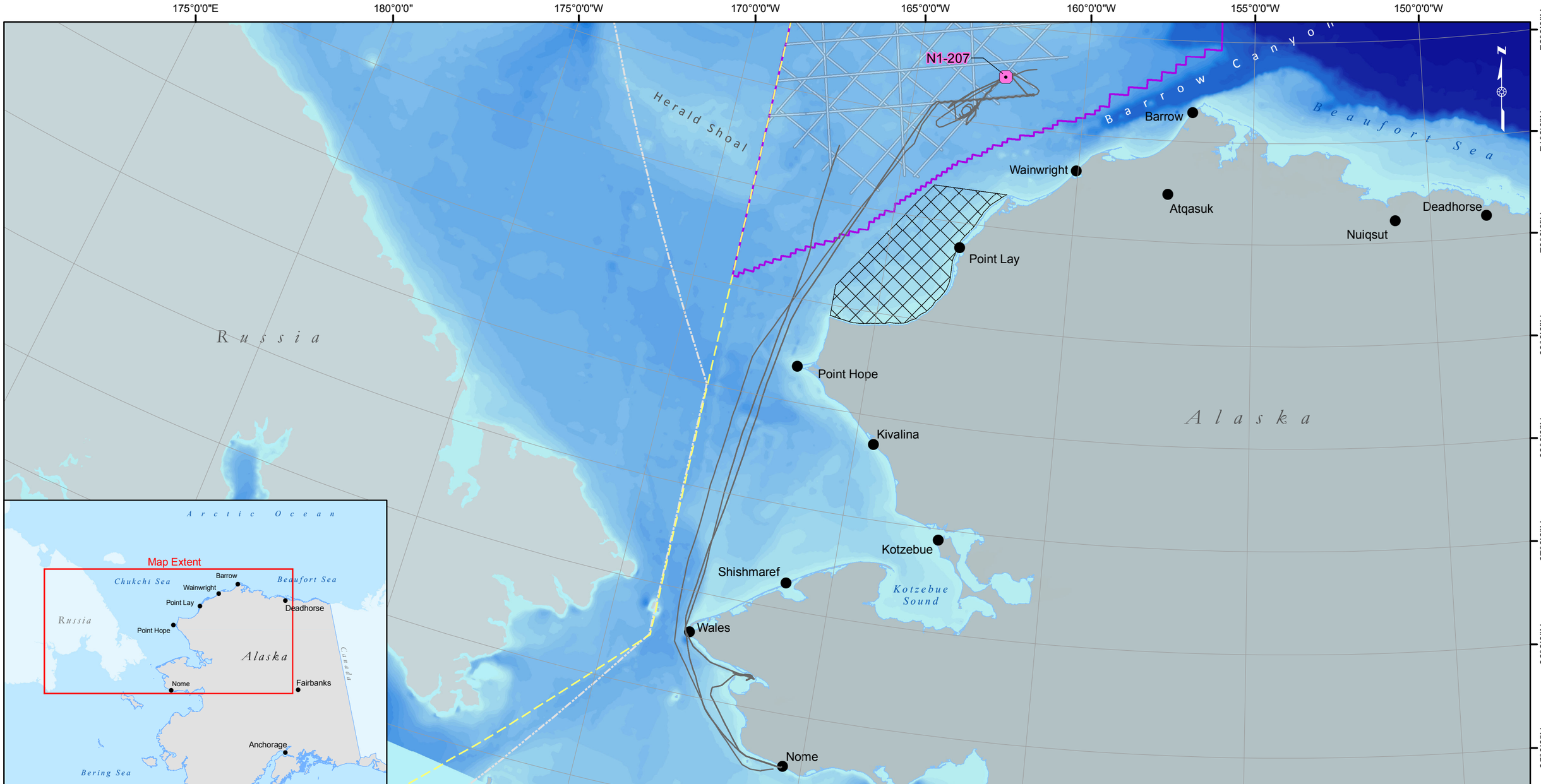
TGS ACTIVITY MAP WEEK OF 14 OCTOBER - 20 OCTOBER
2013 TGS Seismic Survey
90-Day Report

SCALE: 0 25 50 75 100 Miles
0 50 100 150 200 Kilometers

FIGURE: B-8

AES-RTS: 13-185-016.mxd, 01/21/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Norseman PSO Sightings

- Unidentified Seal
- All Tracks 14 Oct - 20 Oct

- TGS 2D Seismic Survey Line
- Exclusive Economic Zone
- International Date Line

- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

NAD83, Alaska Albers Equal Area

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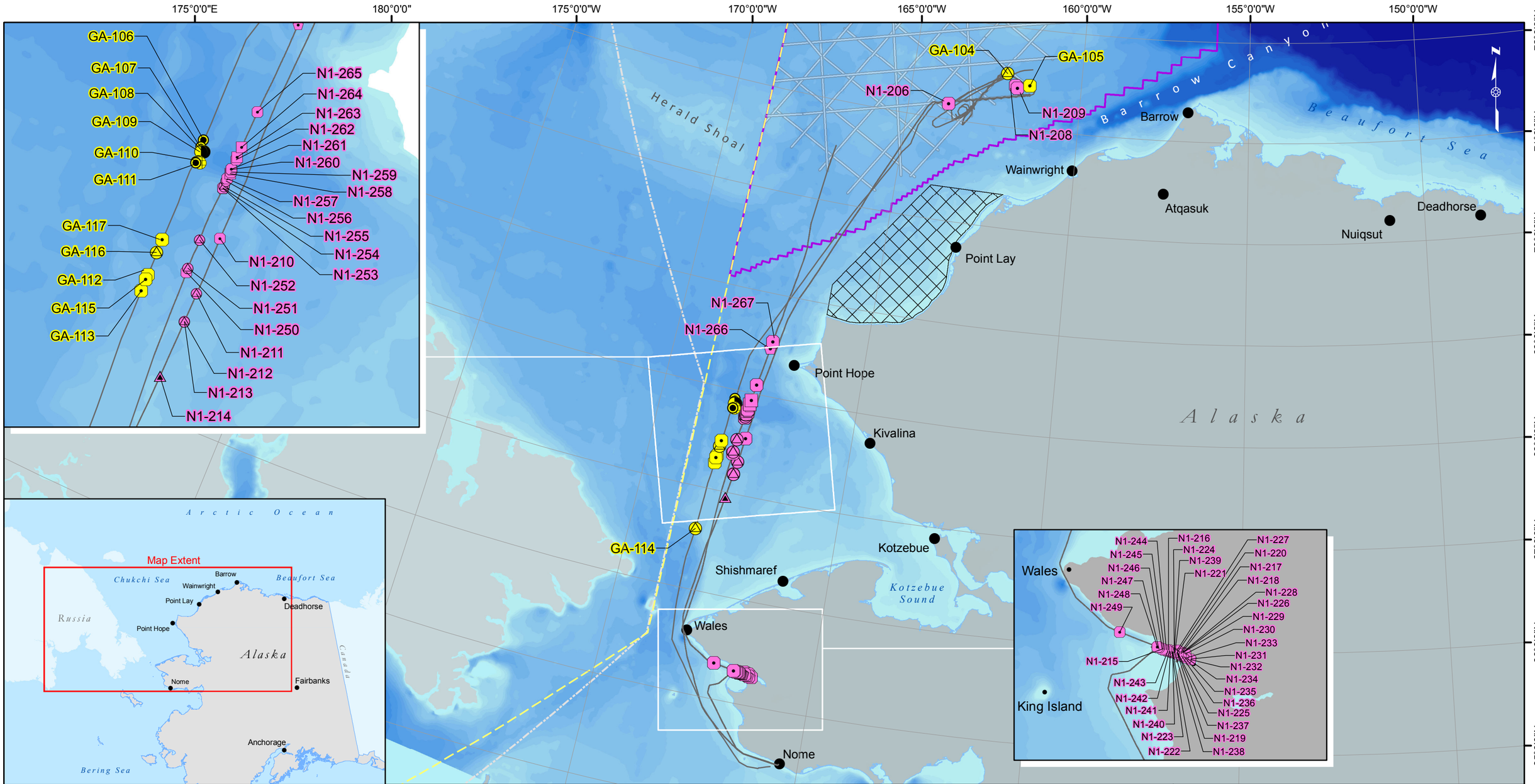
TGS

TGS ACTIVITY MAP WEEK OF 14 OCTOBER - 20 OCTOBER
DURING SEISMIC ACTIVITY
2013 TGS Seismic Survey
90-Day Report

SCALE: 0 25 50 75 100 Miles
0 50 100 150 200 Kilometers

FIGURE: B-8a

AES-RTS: 13-185-034.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Gray Whale
- Unidentified Pinniped
- Unidentified Seal
- Unidentified Mysticete Whale
- Unidentified Whale

Norseman PSO Sightings

- Bearded Seal
- Harbor Porpoise
- Ribbon Seal
- Spotted Seal
- Unidentified Pinniped
- Unidentified Sea

- All Tracks 14 Oct - 20 Oct
- TGS 2D Seismic Survey Line
- Exclusive Economic Zone
- International Date Line

- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

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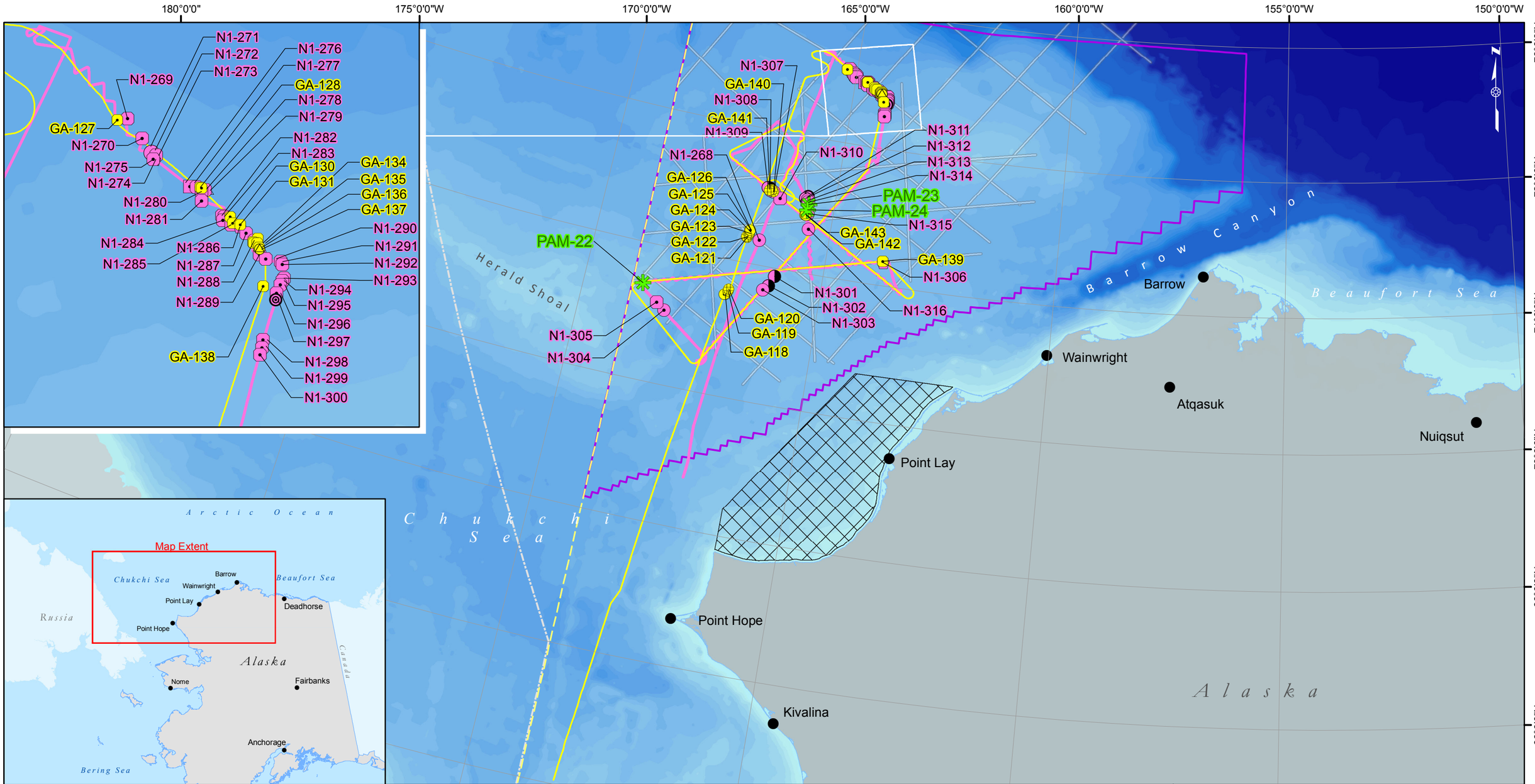
TGS ACTIVITY MAP WEEK OF 14 OCTOBER - 20 OCTOBER
DURING NON-SEISMIC ACTIVITY
2013 TGS Seismic Survey
90-Day Report

SCALE: 0 25 50 75 100 Miles
0 50 100 150 200 Kilometers

FIGURE: B-8b

AES-RTS: 13-185-035.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

- Acoustic Detection

Geo Arctic PSO Sightings

- Bowhead Whale
- Unidentified Pinniped
- Unidentified Seal
- Unidentified Whale

Norseman PSO Sightings

- Bowhead Whale
- Bearded Seal
- Pacific Whale
- Ringed Seal
- Spotted Seal
- Unidentified
- Unidentified Myticete Whale
- Unidentified Pinniped
- Unidentified Seal

- Geo Arctic Track 21 Oct - 27 Oct
- Norseman Track 21 Oct - 27 Oct
- TGS 2D Seismic Survey Line
- International Date Line
- Exclusive Economic Zone
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

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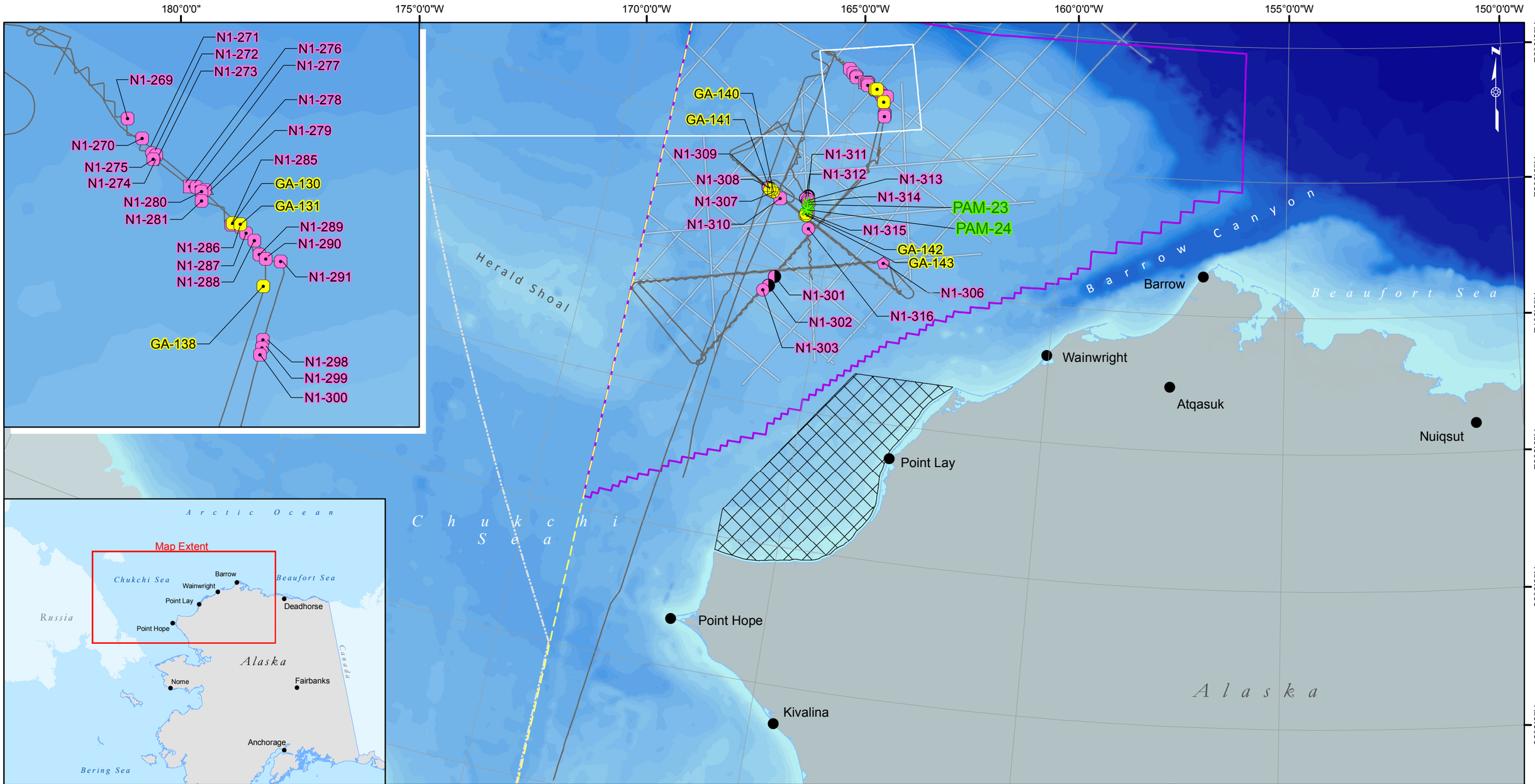
TGS ACTIVITY MAP WEEK OF 21 OCTOBER - 27 OCTOBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles
0 30 60 90 120 Kilometers

FIGURE: B-9

AES-RTS: 13-185-017.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Acoustic Detection

Geo Arctic PSO Sightings

- Bowhead Whale
- Unidentified Seal
- Unidentified Whale

Norseman PSO Sightings

- Bearded Seal
- Bowhead Whale
- Pacific Whale
- Ringed Seal
- Spotted Seal
- Unidentified
- Unidentified Mysticete Whale
- Unidentified Pinniped
- Unidentified Seal

- All Tracks 21 Oct - 27 Oct
- TGS 2D Seismic Survey Line
- International Date Line
- Exclusive Economic Zone
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

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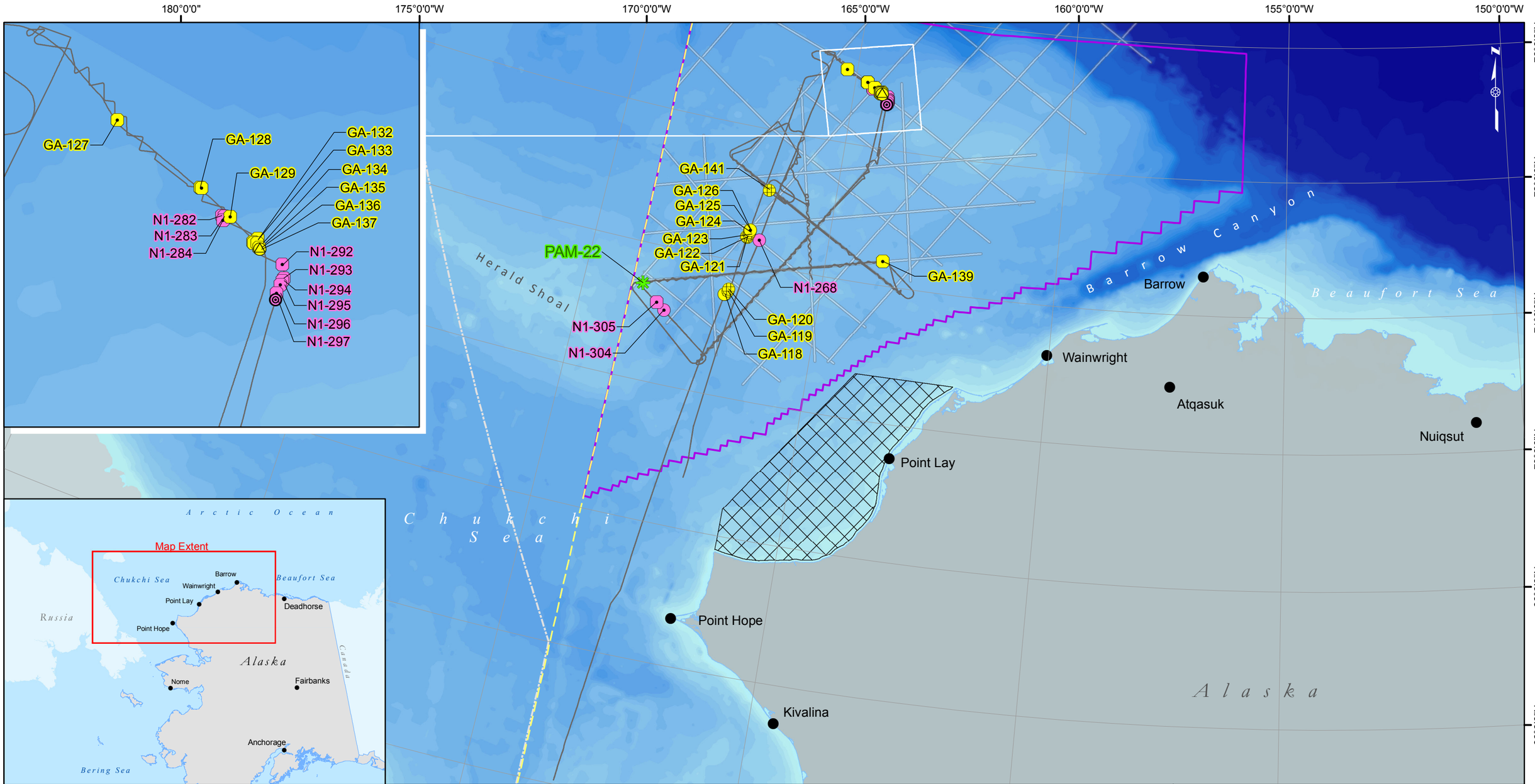
TGS ACTIVITY MAP WEEK OF 21 OCTOBER - 27 OCTOBER
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles; 0 25 50 75 100 Kilometers

FIGURE: B-9a

AES-RTS: 13-185-036.mxd, 01/28/14



Bathymetry

Depth (in meters)		
0- 49	200 - 499	2000 - 2999
50 - 99	500 - 999	3000 - 3999
100 - 199	1000 - 1499	4000 - 5565
	1500 - 1999	

Acoustic Detection

Geo Arctic PSO Sightings
- Bowhead Whale
- Unidentified Pinniped
- Unidentified Seal
- Unidentified Whale

Norseman_Species
- Bowhead Whale
- Ringed Seal
- Unidentified Seal

All Tracks Oct. 21 - Oct. 27

TGS 2D Seismic Survey Line

International Date Line

Exclusive Economic Zone

Lease Sale 193

Ledyard Bay Critical Habitat

Village

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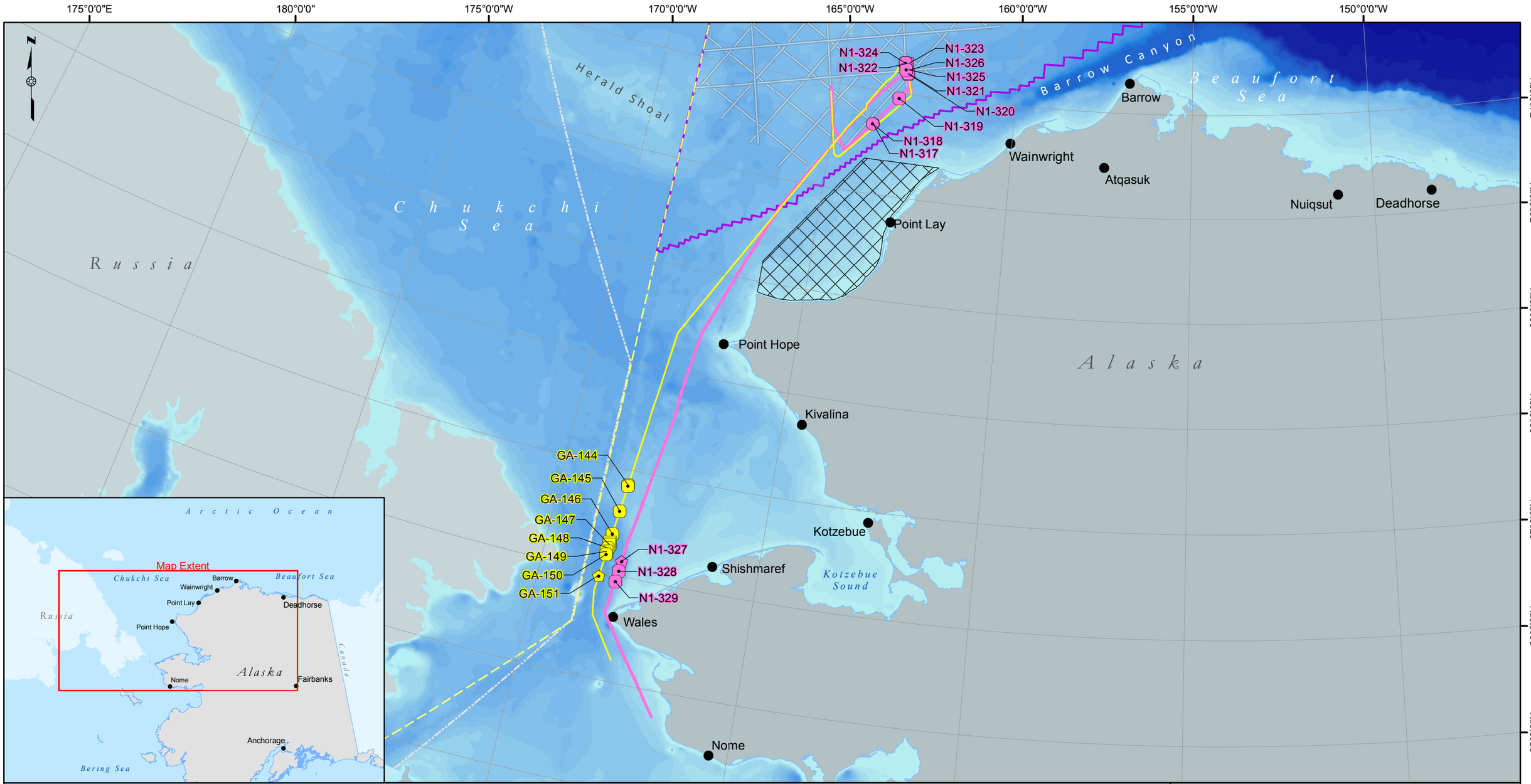
TGS ACTIVITY MAP WEEK OF 21 OCTOBER - 27 OCTOBER
DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles; 0 25 50 75 100 Kilometers

FIGURE: B-9b

AES-RTS: 13-185-037.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Bearded Seal
- Spotted Seal
- Unidentified Seal

Norseman PSO Sightings

- Bowhead Whale
- Bearded Seal
- Spotted Seal
- Unidentified Seal

- Geo Arctic Track 28 Oct - 03 Nov
- Norseman Track 28 Oct - 03 Nov
- TGS 2D Seismic Survey Line
- Exclusive Economic Zone
- International Date Line

- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

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TGS ACTIVITY MAP WEEK OF 28 OCTOBER - 03 NOVEMBER
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles; 0 40 80 120 160 Kilometers

FIGURE: B-10

AES-RTS: 13-185-018.mxd, 01/28/14

175°0'0"E
180°0'0"
175°0'0"W
170°0'0"W
165°0'0"W
160°0'0"W
155°0'0"W
150°0'0"W

71°0'0"N
70°0'0"N
69°0'0"N
68°0'0"N
67°0'0"N
66°0'0"N
65°0'0"N

N1-324
N1-323
Barrow Canyon
Beaufort Sea
Barrow
Wainwright
Atqasuk
Nuiqsut
Deadhorse
Point Lay
Herald Shoal
Chukchi Sea
Russia
Point Hope
Alaska
Kivalina
Kotzebue
Shishmaref
Kotzebue Sound
Wales
Nome

Arctic Ocean
Map Extent
Chukchi Sea
Beaufort Sea
Barrow
Wainwright
Point Lay
Deadhorse
Russia
Point Hope
Alaska
Nome
Fairbanks
Canada
Anchorage
Bering Sea

Bathymetry

Depth (in meters)
- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Norseman PSO Sightings
- Unidentified Seal
- All Tracks 28 Oct - 03 Nov

- TGS 2D Seismic Survey Line
- Exclusive Economic Zone
- International Date Line

- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

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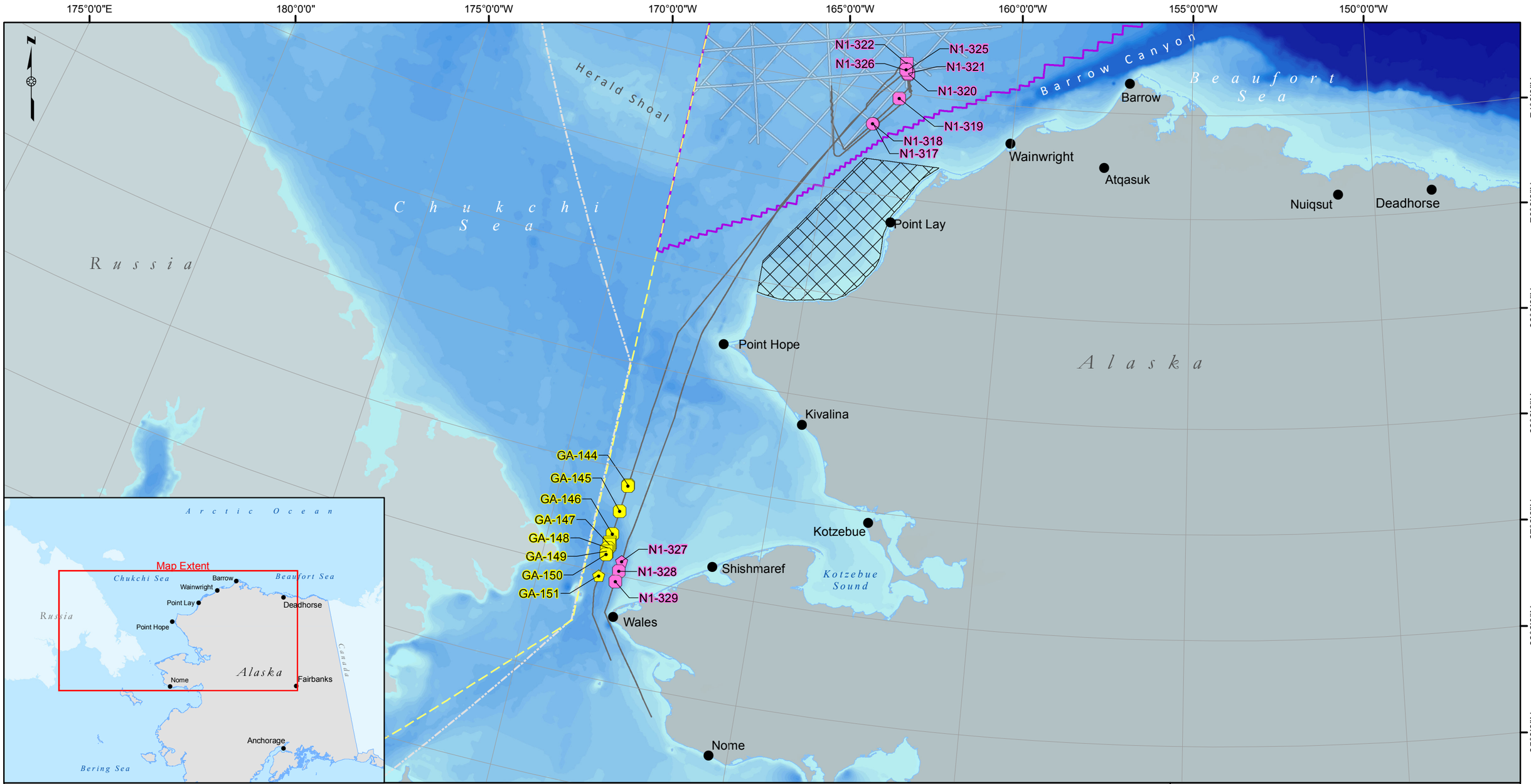
TGS ACTIVITY MAP WEEK OF 28 OCTOBER - 03 NOVEMBER
DURING SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE:
0 10 20 30 40 Miles
0 40 80 120 160 Kilometers

FIGURE:
B-10a

AES-RTS: 13-185-038.mxd, 01/28/14



Bathymetry

Depth (in meters)

- 0- 49
- 50 - 99
- 100 - 199
- 200 - 499
- 500 - 999
- 1000 - 1499
- 1500 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 5565

Geo Arctic PSO Sightings

- Bearded Seal
- Spotted Seal
- Unidentified Seal

Norseman PSO Sightings

- Bearded Seal
- Bowhead Whale
- Spotted Seal
- Unidentified Seal

- All Tracks 28 Oct - 03 Nov
- TGS 2D Seismic Survey Line
- Exclusive Economic Zone
- International Date Line
- Lease Sale 193
- Ledyard Bay Critical Habitat
- Village

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TGS ACTIVITY MAP WEEK OF 28 OCTOBER - 03 NOVEMBER
DURING NON-SEISMIC ACTIVITY
2013 TGS 2D Seismic Survey
90-Day Report

SCALE: 0 10 20 30 40 Miles
0 40 80 120 160 Kilometers

FIGURE: B-10b

AES-RTS: 13-185-039.mxd, 01/28/14

Appendix C
RPS Passive Acoustic Monitoring Report

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TGS 2D CHUKCHI 2013

PASSIVE ACOUSTIC MONITORING AND SYSTEM EVALUATION REPORT

Passive Acoustic Monitoring Report

During the TGS Chukchi / 2D
On board the *Norseman*
From 28 August 2013– 28 October 2013

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RPS Project No: UMS04183

Report No: 1 of 1

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B	**PAM system specifications**
C	**Hydrophone deployment on Norseman**
D	**Acoustic Effort Table**
E	**Acoustic Effort Table with Vessel Speed and Heading**
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1. EXECUTIVE SUMMARY

The following report details the real-time acoustic monitoring by RPS for protected species during the seismic survey conducted by TGS in the Chukchi Sea. The survey took place from 28 August through 28 October 2013 using the seismic survey vessel *Geo Arctic* and the support vessel the *Norseman*.

TGS submitted an application to the National Marine Fisheries Service (NMFS) for a permit to harass marine mammals, incidental to the marine geophysical survey. An Incidental Harassment Authorization (IHA) was granted on 14 August 2013 (Appendix A) with several mitigation measures that stipulated harassment to marine mammals. Mitigation measures were implemented to minimize potential impacts to marine mammals throughout the duration of the survey. Mitigation measures included, but were not limited to, the use of NMFS approved Protected Species Observers (PSOs) for both visual and acoustic monitoring, establishment of safety radii, and implementation of ramp-up, power-down and shut-down procedures.

RPS was contracted by TGS to provide continuous acoustic monitoring and to fulfill the environmental regulatory requirements and reporting mandated by NMFS in the IHA. Four dedicated acoustic protected species observers (APSOs) were present on board the support vessel*, Norseman,* throughout the survey in this capacity.

APSOs undertook acoustic observations throughout day and night, conducting a total of 1195 hours and 23 minutes of acoustic monitoring over 62 days, 1102 hours of which were undertaken with simultaneous visual monitoring. Of the 1195 hours and 23 minutes of acoustic monitoring effort completed, 65% (779 hours and 11 minutes) occurred while the seismic source was in ramp up and full volume.

This acoustic monitoring effort produced a total of 26 marine mammal detection records; including mysticetes, odontocetes, pinnipeds, unidentified cetaceans and unidentified marine mammals. The acoustic detections consisted of one bowhead whale, 12 beluga, seven walrus, one unidentified delphinid, one unidentified mysticete and four unidentified cetacean detections. Four of the acoustic detections were correlated with visual observations. These included the bowhead detection and three of the seven walrus detections.

No mitigation actions were implemented as a result of acoustic detections during the survey.

2. INTRODUCTION

The following report details passive acoustic monitoring undertaken as part of the TGS Chukchi 2D marine geophysical survey on board the *Norseman (*support vessel to the seismic vessel *Geo Arctic)* from 28 August to 28 October 2013 in the Chukchi between approximately 70 to 77°N and 154 to 165°W.

A separate report was prepared concerning the seismic operations, visual monitoring effort visual sightings and mitigation actions undertaken throughout the TGS survey programThis document serves to meet the acoustic reporting requirements dictated in the IHA issued to TGS by NMFS valid from 14 August through 31 October 2013.

2.1. PROJECT OVERVIEW AND LOCATION

The 2D seismic survey took place in open water of the Chukchi Sea in both US federal and international waters. The survey covered approximately 9600 kilometers off the coast of northwest Alaska. The survey was located approximately 58 miles from Wainwright, Alaska and 55 miles from Point Hope, Alaska at its closest points to shore (Figure 1). The water ranged in depths from approximately 20 to 1000 meters with a majority of the survey between 20 to 50 meters.

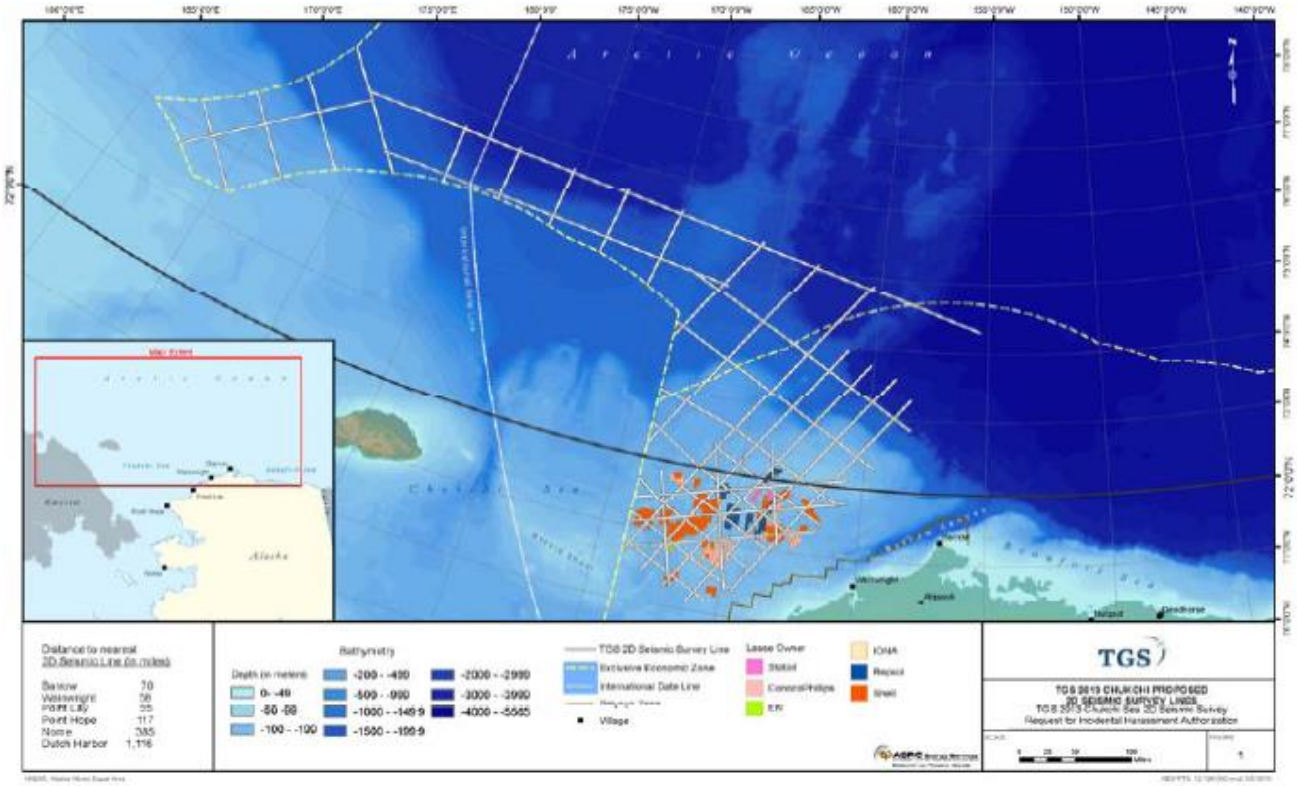

Figure 1: Proposed seismic survey lines for TGS Chukchi 2D program (taken from *Marine Mammal Monitoring and Mitigation Plan*)

The survey utilized two vessels. One vessel, the *Geo Arctic*, acted as both the seismic source and recording vessel and the second vessel, Norseman, acted as a scout and marine mammal mitigation vessel. Both vessels contained visual protected species observers (VPSOs) for marine mammal mitigation. The mitigation zones were based on NMFS pulsed sound exposure regulation resulting in use of 190, 180 and 160 dB re 1 µPa exclusion zones.

The seismic survey vessel towed one 8.1 kilometer solid streamer at a depth of approximately 10 meters. The seismic source consisted of four sub-arrays that resulted in a maximum discharge volume of 3280 in³ emitted. During survey, the seismic source discharged every 25 meters. The sub-arrays had an approximate 10 meter separation at a depth of approximately 6 meters. The center of source was approximately 120 meters from the stern of the *Geo Arctic*.

The *Norseman* acted primarily as a marine mammal mitigation vessel but also scouted for ice and navigational hazards ahead of the source vessel. The *Norseman* continuously positioned approximately 7.5 kilometers ahead of the *Geo Arctic* while on survey and travelled in a zigzag pattern. Acoustic protected species observers (APSOs) were located on the Norseman only and the hydrophone cable utilized for protected species monitoring was deployed from this vessel.

2.2. ACOUSTIC MONITORING VESSEL

The Norseman is a 32.9 meter research vessel with a beam of 8.5 meters and draught of approximately 4 meters (Figure 2). Gross tonnage is 197. Propulsion comes from 850 HP Cat Diesel engine. In addition, the vessel is equipped with three electric generators. The former crab boat can haul 38,000 gallons of fuel and with potential to cover approximately 10,000 miles over 90 days.

Figure 2: Norseman

3. MONITORING METHODS AND MITIGATION

3.1. PASSIVE ACOUSTIC MONITORING (PAM) OPERATORS

The experienced team of acoustic operators onboard the *Norseman* were all qualified protected species observers prior to training in acoustics. All four have been monitoring acoustically for two years or longer, ranging from 1343 to 2058 hours utilizing the PAM system. In addition, all the APSOs earned a four year degree or higher from a recognized institution.

The RPS Lead APSO, Lynn Henneberger, acquired a Bachelor of Science in Animal Behavior/Well-being through Purdue University. The operator has been a protected species observer, certified for the Gulf of Mexico, since 2007. She was trained in JNCC and Passive Acoustic Monitoring in 2010. She has undertaken approximately 2058 hours of acoustic monitoring on seismic surveys.

Heidi Ingram has a Bachelor of Science in Biology, with a focus in Marine Biology. She has worked as a protected species observer for 6.5 years and as a PAM operator for 3.5 of those years. During this time she has conducted approximately 1,590 hours of acoustic monitoring. She has attended BOEM approved protected species observer and PAM courses.

Laura Marcella, RPS APSO, earned a Bachelor of Arts degree in Biology from Lawrence University. She has been a protected species observer since 2007 and was PAM trained in 2011. During which, she has experienced over 1343 hours of passive acoustic monitoring.

Bronson Nagareda, RPS APSO, acquired a Bachelor of Science degree in Zoology from the University of Hawaii. He advanced his education and earned a Doctorate in Biology from Florida Institute of Technology. He has been a protected species observer since 2011 and the following year received training in passive acoustic monitoring. Prior to this survey, he had undertaken 1626 hours of acoustic monitoring on seismic surveys.

3.2. PASSIVE ACOUSTIC MONITORING (PAM) PARAMETERS

A *Seiche Measurements Limited* PAM system was installed in Seward, Alaska by RPS personnel and the *Norseman* crew prior to the vessel transiting to Nome, Alaska. On 24 August, the vessel was met by the four acoustic protected species observers (APSOs) provided by RPS and the visual protected species observers (VPSOs) provided by ASRC. The support vessel the *Norseman* was the only vessel with APSOs and passive acoustic monitoring. The four channel hydrophone array was first deployed and used for monitoring on 28 August 2013. The PAM system was onboard during all survey operations and was uninstalled by the APSOs upon completion of the survey on 28 October 2013.

The PAM system consists of a super broadband (75 Hertz to 200 kilohertz; 3 decibel points) heavy tow four channel 125 meter conventional array cable with depth gage, one heavy-duty 230 meter tow cable, and one 100 meter deck cable, an electronics processing unit with a computer, dual monitors, mouse and keyboard, an acoustic analysis software package, necessary leads and adapters, and headphones for aural monitoring. In addition, there is a complete spare set of electronics, hydrophone cables and other hardware with the same specifications as the main system. The linear hydrophone array contains four broadband elements and a depth gauge (100 meter capacity) embedded directly into the cable. The four hydrophones are positioned in two pairs, with the first pair positioned roughly 97 meters ahead of the second pair which were one meter ahead of the depth gauge; (Figure 3). The

hydrophones within each pair are separated by 3 meters (large hydrophone pair separation allows for better localization for low and mid-frequency vocalizations). Additionally, a 20 meter drogue rope is attached at the depth gage end to assist in a flat tow of the cable through the water column. Hydrophone specifications can be found in Appendix B.

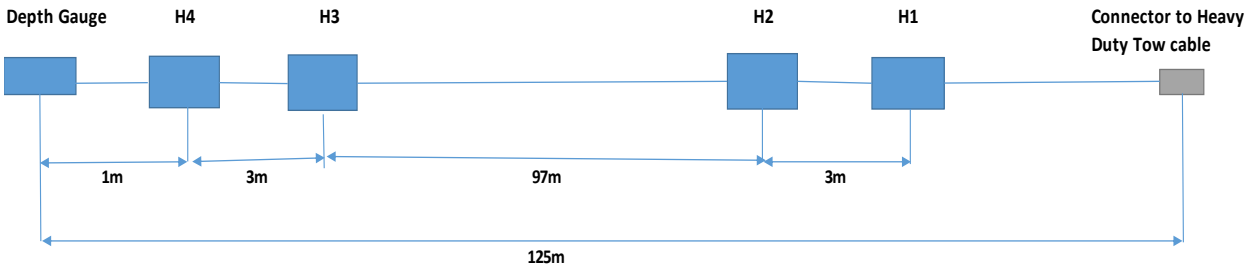

Figure 3: Schematic diagram of the hydrophone array cable indicating the position and separation of individual hydrophone elements and hydrophone pairs.

The PAM system is not typically calibrated end to end prior to seismic survey monitoring and mitigation use but the hydrophone sensitivity is approximately -206dB and a pre-amplifier gain of +40dB is applied. This provides a system sensitivity in the region of -166dB. The noise floor of the entire system is below sea state of 0.5, which excludes vessel noise. Vessel noise contributes the majority of the low frequency noise.

Hydrophones are omnidirectional and are not utilized for beam forming. When vocalizations are detected on more than one hydrophone by the whistle and moan detector or click detectors the difference in time of arrival of the signals to the hydrophones is used to plot bearing lines on the map. If several vocalizations are detected from a relatively stationary (relative to the vessel) over a period of a couple of minutes, the bearing lines intersect on the map over the position of the vocalizing animal, and the distance to the animal can be determined.

The electronics processing unit processes the raw data from the *Sennheiser* hydrophones through two external sound cards, a *National Instruments DAQ card*, and an *ASIO Fireface card* (contained within an RME Fireface 800 unit). The *National Instruments DAQ* sound cards sample raw audio at 500 kilohertz and are used to detect beaked whale, porpoise and delphinid echolocation clicks up to 250 kilohertz. *ASIO Fireface* sound cards sample audio at 96 kilohertz and are used to detect mysticete, odontocete, and pinniped vocalizations up to 48 kilohertz. The data processing unit also contains *a Measurements and Computing* data logger for the depth gage and digital signal amplifiers, and *Ultralink Pro* audio mixer, and an *UltraCurve Pro* graphic equalizer.

Delphinid whistles, clicks and burst pulses, walrus knocks, seal whistles, mysticete moans, beluga song and grey whale echolocation clicks can be viewed on the *Pamguard Spectrogram* display and low frequency (LF) click detector. Beaked whale, porpoise and delphinid echolocation clicks can be viewed on the high frequency (HF) click detector display.

A method to determine range of an animal is the *Pamguard* Map module along with the click detector in the LF *Pamguard* configuration file. In order to successfully utilize this function of *Pamguard* the detection needs to be several minutes in duration, and the successful determination and selection of “click trains” in the Click Detector module. Due to the ambient noise levels, and the brevity of most of the detections, the PAM operator was unable to utilize

this function of *Pamguard.*

The two sound cards supply low and high frequency digital audio feeds to a computer that contains suite software for monitoring cetacean acoustics. *Pamguard (Beta version 1.12.05)* is the primary software utilized on this survey. The International Federation on Animal Welfare (IFAW) software, including *Logger 2000, Rainbow Click, Whistle, and Rainbow Click Porpoise* is the secondary software and was available for use only if *Pamguard* software fails.

The computer receives both the raw audio from the *National Instruments DAQ* USB-6251 sound card as well as the raw audio from the *ASIO Fireface* sound card (which converts it to digital format). *Pamguard* modules including a high and low frequency click detector, whistle and moan detector, spectrogram, map with a direct NMEA GPS feed from the *Norseman's* navigation system, and high and low frequency sound recorders. *Mysticetus,* a mulit-use survey reporting software program, was set up to communicate with *Pamguard* using intermediate software created by Seiche Measurements Limited. The *Mysticetus* program has the potential to log both acoustic detections and visual detections and plot them for immediate viewing at the other PSOs station, and even on another vessel. For this project, the *Mysticetus* was initially set up on the *Norseman's* bridge and at the *Norseman's* PAM station. Attempts were made to implement the software, however, due to some communication issues between the bridge and PAM stations, it was not utilized. Successfully plotted test detections from the *Pamguard Map Module* were observed, but no live feed detections were plotted.

Raw audio from the *ASIO Fireface* sound card, low frequency, is monitored aurally through *Sennheiser* headphones. Whereas, the high frequency audio is fed through the NI sampling card and sent out the USB to the CPU. The depth gage, a pressure sensor, located at the end of the 125 meter array cable, is expressed as voltage and converted digitally. It is then also sent out the USB to the CPU where it can be viewed through the *Pamguard* software. Fireface software controls hydrophone signals observed via the headphones and provides a seismic veto option. However, due to distance between the vessels, the seismic veto was not utilized during this survey.

The computer monitors and electronics processing unit were setup on the main deck in the lab (Figures 4 & 5). An NMEA GPS feed was provided from the *Norseman's* GPS. Both monitors and EPU were secured in preparation for rough seas.

Figure 4: Passive acoustic monitoring station on the main deck including two monitors attached to the EPU.

Figure 5: EPU secured to deck.

The deck cable is used as an extension that directly interfaced with the electronics processing unit (EPU) and the hydrophone tow cable. One 100 meter deck cable was routed from the main deck to the back deck. From the lab on the main deck, the deck cable was run from the EPU, up the wall, along the ceiling and into the bulkhead near the aft door. From inside the bulkhead, the cable ran through the deck, down one level onto the lazarette, an area used for storage and where the cable spools are stored. From the lazarette, the deck cable was run up through the poop deck, also known as the back deck. The opening was then secured with water tight sealant around the cable (Figure 6). From there, the deck cable can be attached and detached near the winch. The system was tested and the hydrophone depth gauge calibrated prior to initial deployment.

Figure 6: PAM deck cable routed through vessel and sealed water tight.

On 22 October 2013, due to perceived signal loss the hydrophone array was replaced with the spare array and the spare was used to monitor for the remainder of the survey on 28 October. However, it was determined that the array was not the cause of the signal loss and therefore, neither arrays received damaged during this survey.

3.3. HYDROPHONE DEPLOYMENT

The hydrophone cable and tow cable were deployed directly off the stern of the Norseman (Figure 7). Approximately 225 meters of the hydrophone and tow cable combination was deployed from the stern with a Chinese finger (Figure 8). The Chinese finger was secured to the vessel's A-frame. The Chinese finger provided slack in the cable between the A-frame and the winch. The railing was wrapped in a protective plastic wrap to reduce possibility of chaffing on the cable. The section of hydrophone tow cable that was not deployed was wound on the winch (Figure 9A).

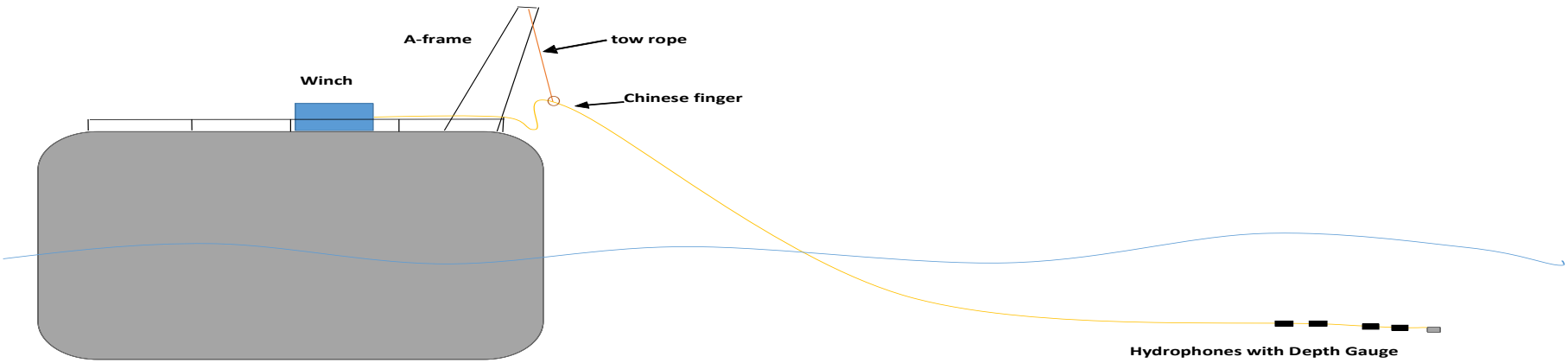

Figure 7: Sketch of the hydrophone deployment off the Norseman stern (~5m drogue rope not shown).

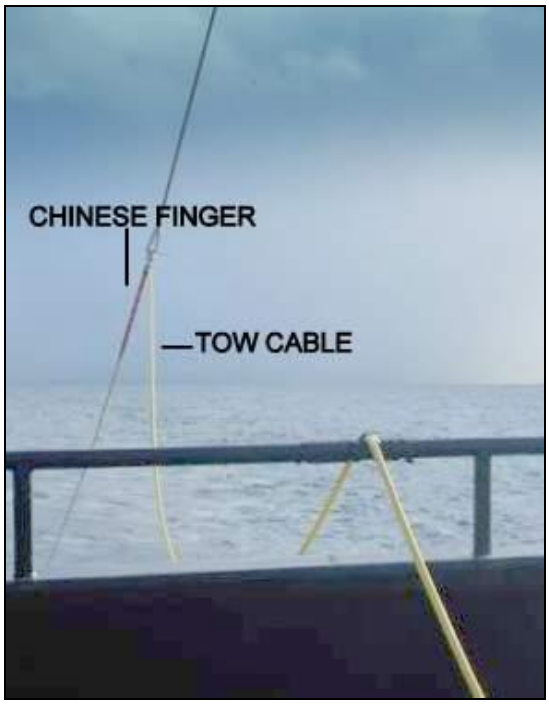

Figure 8: Chinese finger forming the tow point for the hydrophone cable from the A-frame on the stern.

Figure 9: PAM tow cable on winch (A) and tow cable connection to deck cable (B).

During deployment, the first 15 meters of the hydrophone array cable was paid out by hand and tossed out away from the vessel props. Then approximately 218 meters was paid out slowly and directly into the water. At about 218 meters, the Chinese finger was tied onto the cable and attached to the A-frame. Another seven meters was deployed, which positioned the Chinese finger beyond the stern of the vessel. This provided the slack between the Chinese finger, vessel rail and the winch. This slack was necessary to protect the hydrophone cable during the dramatic pitch and roll of the 108 foot (33 meter) vessel. Prior to powering up the EPU, the hydrophone tow cable and deck cable were fastened at the connection located near the side of the winch (Figure 9B). The towing depth on average was 17 to 29 meters depending on vessel speed and swell height.

During retrieval, the hydrophone cable was slowly loaded onto the winch. After the Chinese finger was removed the remainder of the cable was recovered with the winch.

Prior to every retrieval and deployment there was a JSA meeting held with all participating crew. During back deck operations, the required PPE included a mustang suit, hard hat, steel toes, gloves and eye protection. Additionally, the vessel crew working near the stern wore a harness during PAM retrieval and deployment. On this vessel, the *Norseman* crew needed to switched over to the larger generator prior to running the winch.

During periods of light ice, the bridge crew agreed upon 150 meters of cable deployed to increase vessel manoeuvrability. During thick ice, the cable would be recovered completely.

On 01 September the hydrophone deployment was shortened 22 meters from 247 to 225 meters deployed to reduce chance of cable drag when the vessel slowed suddenly.

The hydrophone deployment procedures utilized during the survey program can be found in Appendix C.

3.4. PASSIVE ACOUSTIC MONITORING (PAM) SURVEY METHODOLOGY

Four dedicated acoustic protected species observers (APSOs) were present onboard the vessel to conduct continuous real-time acoustic monitoring day and night, during all seismic operations, as required under the IHA. PAM was not used for mitigation during this project. PAM monitoring began on 28 August 2013. There was a break when the hydrophone cable was retrieved during long transits, for instance, when the vessel steamed into Nome for crew changes, refueling and scouting upcoming survey lines for ice. During these episodes, the hydrophone array was retrieved and secured onboard. At the end of the project on 28 October, monitoring was complete for the TGS Chukchi survey and the hydrophone was retrieved and acoustic gear packed for shipping from Seward, Alaska.

Four APSOs monitored the 24 hour period divided into two shifts, mid-night to noon, and noon to mid-night. There were two APSOs per shift, with one operator monitoring at a time, rotating operators every three hours. Acoustic monitoring overlapped visual monitoring during night-time and daylight hours. On 18 October, due to the loss of one visual PSO, acoustic monitoring no longer correlated with visual monitoring through the end of the project.

Monitoring took place on the main deck in the lab, where the EPU and two computer monitors were stationed. Acoustic monitoring was completed aurally with *Senniheiser* headphones and

visually through two computer monitors using *Pamguard Beta 1.12.05.* The APSO monitored low audible frequencies directly from the *ASIO Fireface* sound card. High frequency sounds were converted from analogue to digital format for visual representation through *Pamguard.*

The *Pamguard's Spectrogram* display, the *Whistle and Moan Detector*, the *Low-Frequency Click Detector* and the *High-Frequency Click Detector*. The *Pamguard Spectrogram* and the *LF Click Detector* displays were continuously monitored for indications of marine mammal vocalizations including whistles and moans, clicks and burst pulses, and knocks.

Recordings of the low and high frequency systems were made whenever there were possible indications of a marine mammal vocalization via the *Pamguard Sound Recorder* module. The recording files were saved as .wav file to a designated location on the CPU where they were available for review.

Similarly, when there was a vocalization detected, the *Pamguard Map* module was monitored to observe bearing lines plotted of the vocalizing marine mammal and to localize the position and distance to the vocalizing marine mammal, when possible. When the distance to a vocalizing marine mammal could not be determined by *Pamguard,* the experienced APSO made a distance estimation assisted by the noise or detection score system developed by Gannier et al. (2002)

When either a VPSO or APSO had a marine mammal detection, they immediately radioed the other station (either the bridge or PAM station) to notify the other PSOs on duty. This resulted in four correlated detections over the course of the seismic survey. Contact with the *Geo Arctic* VPSOs was made via the *Norseman* VPSOs either through use of the bridge radio or the satellite phone, and vice versa. These messages were then relayed to the APSOs.

As per the IHA, the *Norseman* retained speeds between 4 to 6 knots to ensure quality of signal during acoustic monitoring. During times of increased speed, the vessel would reduce speed after 20 to 30 minutes to allow successful listening for marine mammal vocalizations for 5 to 10 minutes before returning to the increased speed. When weather permitted, the scout vessel travelled in a zigzag pattern as planned in the EMP.

3.5. MITIGATION USING PAM

Mitigation measures during the TGS Chukchi 2D marine seismic survey survey were not implemented for acoustic detections without accompanying visual sightings.

4. RESULTS

4.1. ACOUSTIC MONITORING SURVEY SUMMARY

APSOs undertook a total of 1195 hours and 23 minutes of acoustic monitoring beginning on 28 August and ending on 28 October 2013 over a total of 62 days (Figure 10). No monitoring was undertaken on seven days of the 62 survey days (3 September, 21 September and 17 through 21 of October) when the vessel was undertaking crew changes where they transited to port. The hydrophone cable was retrieved prior to the transit such that the *Norseman* could transit at the maximum speed without risking damage to the cable.

The majority of the acoustic moniotring undertaken during the survey program was completed while visual observations were also being undertaken (Table 1, Figure 11): 1102 hours, 93% of the total acoustic monitoring effort. Only 93 hours and 23 minutes of acoustic observations were undertaken while no visual observations were ongoing. The seismic source was active for 779 hours and 11 minutes of the acoustic monitoring survey effort (Figure 12). The 416 hours and 12 minutes of effort undertaken during source silence also includes periods of mitigation source activity and source testing. Acoustic monitoring calculations were made using BOEM source operations weekly reports, not from source logs provided directly to APSOs on the seismic survey vessel and as such, these calculations can be considered close approximations of acoustic effort in relation to source activity. All periods of acoustic effort data are recorded in a table in Appendix D and Appendix E (include vessel speed and heading).

Table 1: Acoustic monitoring effort during TGS Chukchi survey program

Acoustic effort during source silence*	416:12
Acoustic effort during source operations	779:11
Acoustic effort with simultaneous visual effort	1102:00
Acoustic effort with no visual effort	93:23
Total acoustic monitoring effort	**1195:23**

**Source silence calculations include mitigation source (160dB) and source tests (single and multiple)*

Background noise levels during monitoring were recorded using a subjective scale that was developed by Gannier et al (2002). Gannier *et al* monitored sperm whales in the Mediterranean both visually and acoustically and developed a scale based upon the strength or intensity of the sperm whale clicks at various distances. Although the scale is subjective and sounds produced in marine environments will vary according to local conditions, the received sound intensity can be used as a cue for the range of vocalization animals in some cases. It will not always be a reliable indicator, especially for off-axis clicks where the received levels are expected to be much lower than those from on-axis clicks at the same distance. This method of evaluation is also dependant on individual operator perception of signal strength. The scale ranges from one through five, with one being the weakest and five being the strongest.

Background noise levels during the survey varied from level 1 to level 4 on the Gannier scale; however these extremes (1 and 4) were only experienced for short periods during acoustic monitoring shifts. The majority of acoustic monitoring effort was undertaken at background noise levels rated as a two or three on the Gannier scale. Vessel noise was noted as the most significant contribution to background noise levels detected during acoustic monitoring. Flow

noise was assumed to be insignificant in comparison to ship noise levels. Background noise occasionally increased during turns to a Gannier level three when the sea state was choppy with swells of 1.5 to 2 meters or when the vessel was undertaking turns at speeds greater than five knots. In these instances increased vessel engine noise and propeller cavitation was detected.

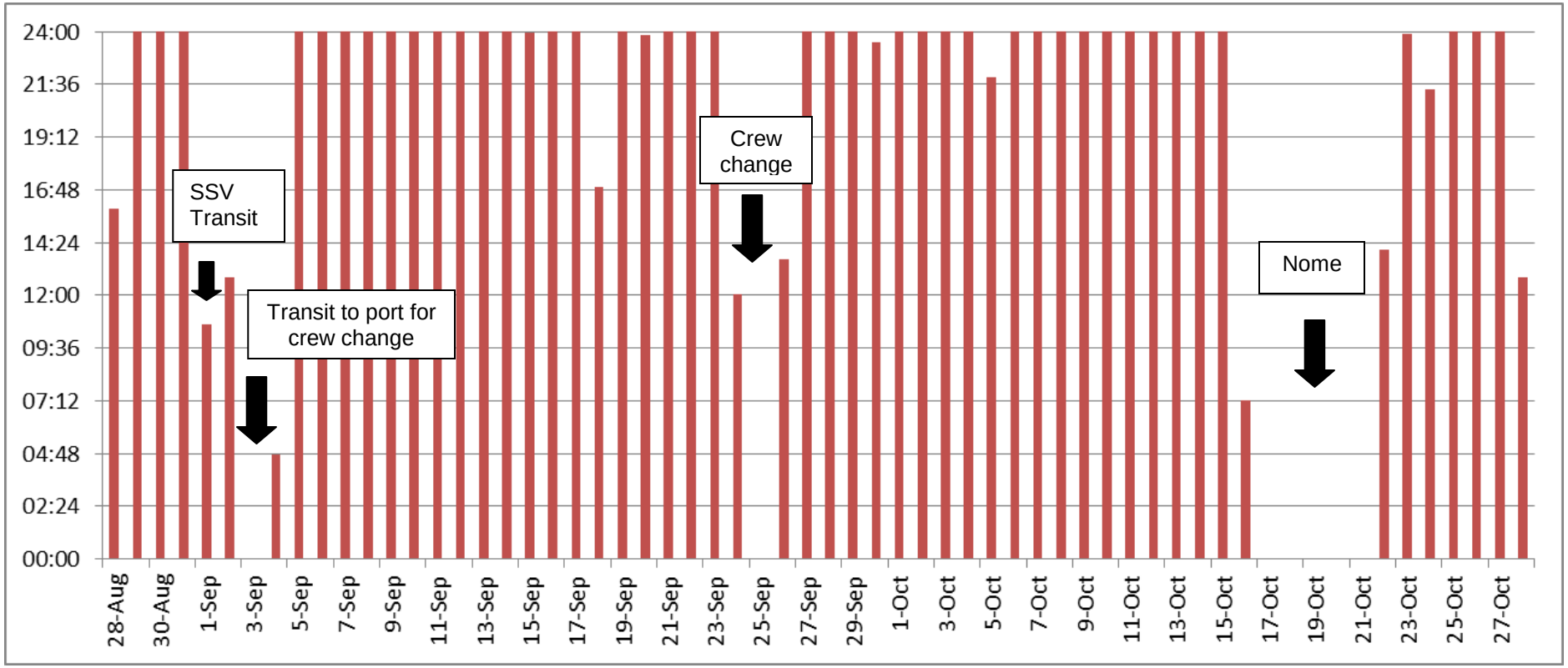

Figure 10: Acoustic monitoring effort (hours: minutes) over each day of the TGS survey program

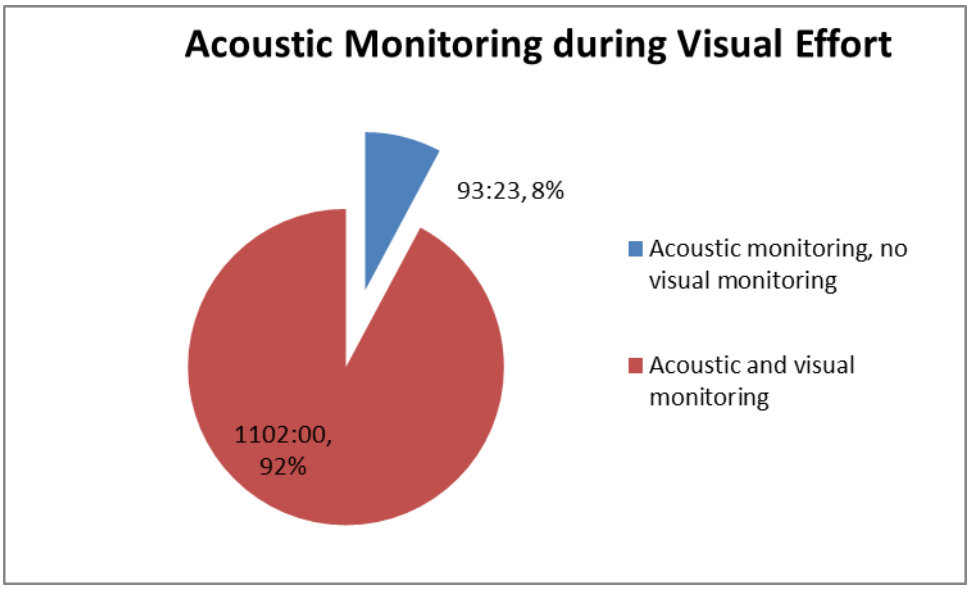

Figure 11: Acoustic effort with simultaneous visual effort

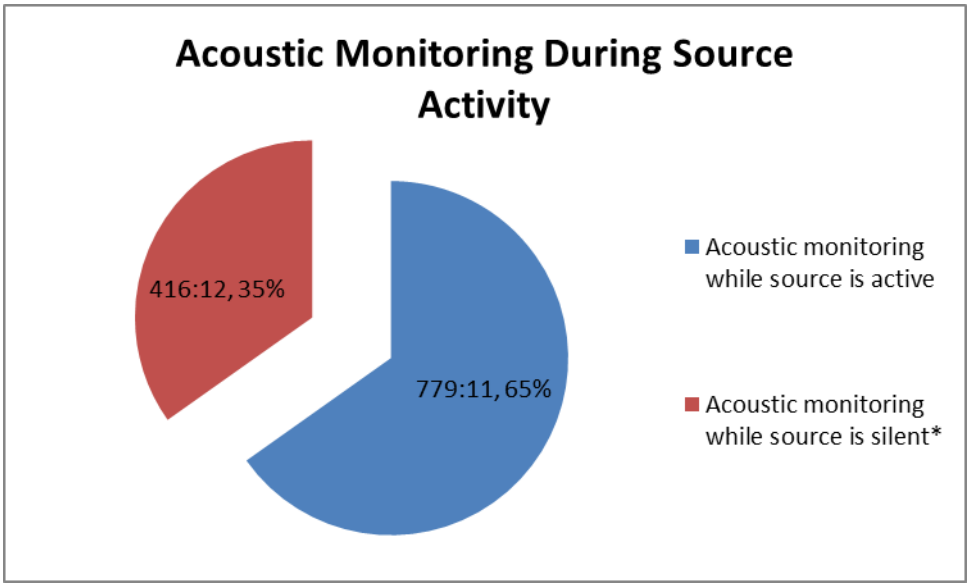

Figure 12: Acoustic effort during source activity

4.2. ACOUSTIC DETECTIONS

A total of 26 acoustic detections of marine mammals were made during the TGS Chukchi 2D survey program (Table 3). The location of each acoustic detection is displayed in the ArcGIS figure of the survey prospect (Figure 13). Screenshots from many detection events can be found in Appendix F.

Acoustic detections consisted of beluga whales (*Delphinapterus leucas*) (12 detections), walrus (*Odobanus rosmarus*) (seven detections), a single bowhead whale (*Balaena mysticetus*), one unidentified delphinid detection (Family Delphinidae), one unidentified mysticete and four unidentified cetacean detections. The acoustic encounter rate for each species is depicted in Table 2. Belugas were detected more frequently than any other species group, with an encounter rate of 0.010039 detections per hour of acoustic effort. Walrus were also encountered at a higher rate during the survey program, at 0.005856 detections per hour of acoustic effort. Mysticetes had a very low detection rate, with only one bowhead whale and one unidentified mysticete encountered during acoustic survey effort.

Table 2: Acoustic encounter rate by species group

Acoustic Encounter Rate by Species/Species Group	
Walrus	
Number of acoustic detections	7
AER per hour	0.005856
AER per km	0.000632
Beluga	
Number of acoustic detections	12
AER per hour	0.010039
AER per km	0.001084
Bowhead whale	
Number of acoustic detections	1
AER per hour	0.000837
AER per km	0.000090
Unidentified delphinid	
Number of acoustic detections	1
AER per hour	0.000837
AER per km	0.000090
Unidentified mysticete	
Number of acoustic detections	1
AER per hour	0.000837
AER per km	0.000090
Unidentified cetacean	
Number of acoustic detections	4
AER per hour	0.003346
AER per km	0.000361

** AER per kilometre was calculated using the average vessel speed of 5.0knots*

Table 3: Acoustic marine mammal detections during the TGS Chukchi 2D survey program

Detection Number	Date	Time First Detection	Time Last Detection	Latitude	Longitude	Species	Source Activity
1	2013-09-10	16:49	17:40	71.72650°N	163.30305°W	Walrus	Silent
2	2013-09-10	18:23	18:33	71.79433°N	163.62018°W	Walrus	Mitigation Firing
3	2013-09-17	11:08	11:09	74.10542°N	157.53055°W	Unid baleen whale	Mitigation Firing
4	2013-09-17	11:08	11:09	74.10542°N	157.53055°W	Delphinid	Mitigation Firing
5	2013-09-21	15:46	15:47	74.26770°N	162.25608°W	Beluga whale	Mitigation Firing
6	2013-09-27	13:34	13:35	72.79147°N	162.37123°W	Beluga whale	Full volume
7	2013-09-27	13:47	13:48	72.81123°N	162.37048°W	Beluga whale	Full volume
8	2013-09-28	18:35	18:36	74.15452°N	159.08512°W	Unid Cetacean	Full volume
9	2013-09-28	19:59	20:02	74.23580°N	158.83290°W	Unid Cetacean	Full volume
10	2013-10-04	19:16	19:16	73.51900°N	161.41390°W	Unid Cetacean	Full volume
11	2013-10-04	22:38	22:38	73.39133°N	160.82903°W	Beluga whale	Full volume
12	2013-10-04	23:51	23:58	73.35262°N	160.58898°W	Beluga whale	Full volume
13	2013-10-05	00:21	00:21	73.33800°N	160.46217°W	Beluga whale	Full volume
14	2013-10-05	03:12	03:13	73.22130°N	159.92217°W	Unid Cetacean	Full volume
15	2013-10-05	03:41	03:42	73.19785°N	159.85032°W	Beluga whale	Full volume
16	2013-10-05	04:26	04:27	73.15932°N	159.70550°W	Beluga whale	Full volume
17	2013-10-05	06:41	06:44	73.06000°N	159.24100°W	Beluga whale	Full volume
18	2013-10-05	07:20	07:22	73.04850°N	159.08383°W	Beluga whale	Full volume
19	2013-10-05	09:50	09:51	72.93888°N	158.58168°W	Beluga whale	Full volume
20	2013-10-11	13:10	13:13	71.67213°N	161.79588°W	Walrus	Silent
21	2013-10-11	16:20	16:28	71.71398°N	161.31942°W	Walrus	Silent
22	2013-10-15	15:51	16:09	71.39985°N	161.89295°W	Walrus	Silent
23	2013-10-24	15:08	15:15	70.70163°N	168.75543°W	Walrus	Silent
24	2013-10-27	15:09	15:10	71.50647°N	165.57387°W	Beluga whale	Mitigation Firing
25	2013-10-27	15:37	15:58	71.46565°N	165.57513°W	Walrus	Mitigation Firing
26	2013-10-27	15:54	16:08	71.42715°N	165.54848°W	Bowhead whale	Mitigation Firing

**Source activity remained consistent throughout all acoustic detection events*

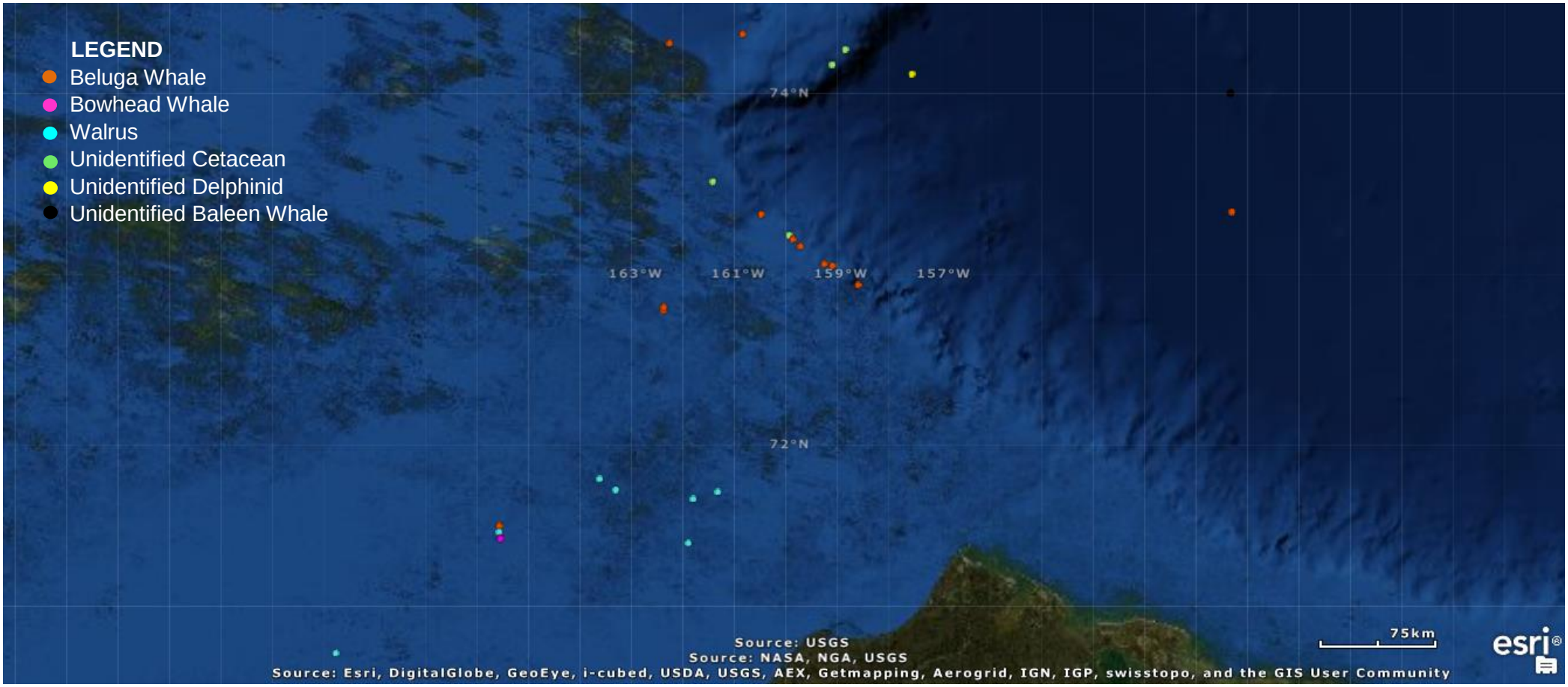

Figure 13: Location of all acoustic detections made during the TGS Alaska 2D survey program

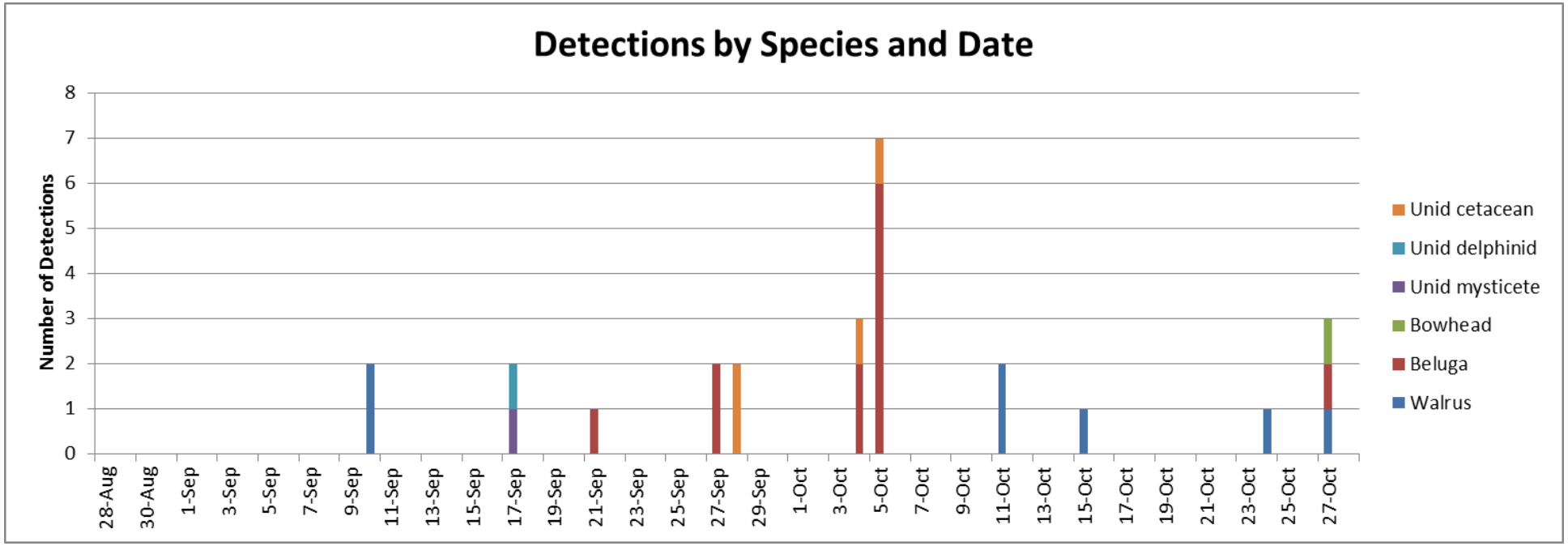

Figure 14: Detections by species and date throughout the TGS Chukchi 2D survey program

Detections were not distributed evenly throughout the 62 days of acoustic survey effort (beginning on 28 August 2013 and ending on 28 October 2013 where no acoustic monitoring was undertaken on 3 and 25 September and 17 through 21 of October while the Norseman was in port or transiting to port). The 26 detections events occurred on 11 monitoring days with multiple detections (more than one) occurring on eight of the 11 days during which detections were recorded (Figure 14). The largest number of detections recorded on a single monitoring day occurred on 5 October when seven detections were recorded including both beluga whales and an unidentified cetacean.

Some trends with respect to species distribution were noted although there were few detections in most species groups which limited the conclusions that can be drawn. All walrus detections occurred south of 72 degrees North (Figure 15). Beluga whales were detected most frequently between 73 and 73.5 degrees North.

The majority of acoustic detections occurred in water depths less than 1000 meters (Figure 16).

Acoustic encounter rates were calulcated for detections North and South of 72 and in water depths greater than 200 meters and less than 200 meters (Tables 4 and 5) however these encounter rates do not account for potential differential acoustic effort expended in the different regions.

Table 4: Acoustic encounter rate north and south of 72 degrees

Acoustic Encounter Rate North and South of 72 degrees	
North of 72 degrees	
Number of acoustic detections	17
AER per hour	0.014221
AER per km	0.001536
South of 72 degrees	
Number of acoustic detections	9
AER per hour	0.007529
AER per km	0.000813

Table 5: Acoustic encounter rate in water depths less than and greater than 200 meters

Acoustic Encounter Rate by Water Depth	
<200m	
Number of acoustic detections	11
AER per hour	0.009202
AER per km	0.000994
>200m	
Number of acoustic detections	15
AER per hour	0.012548
AER per km	0.001355

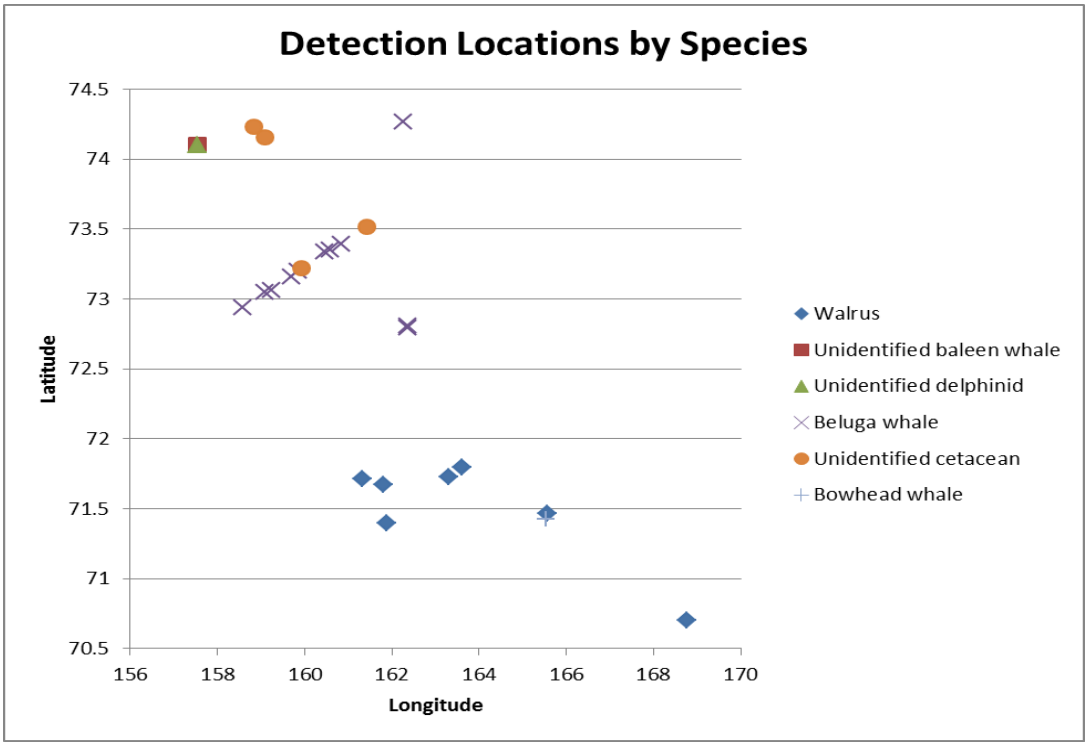

Figure 15: Distribution of species detected relative to North and South of 72 degrees

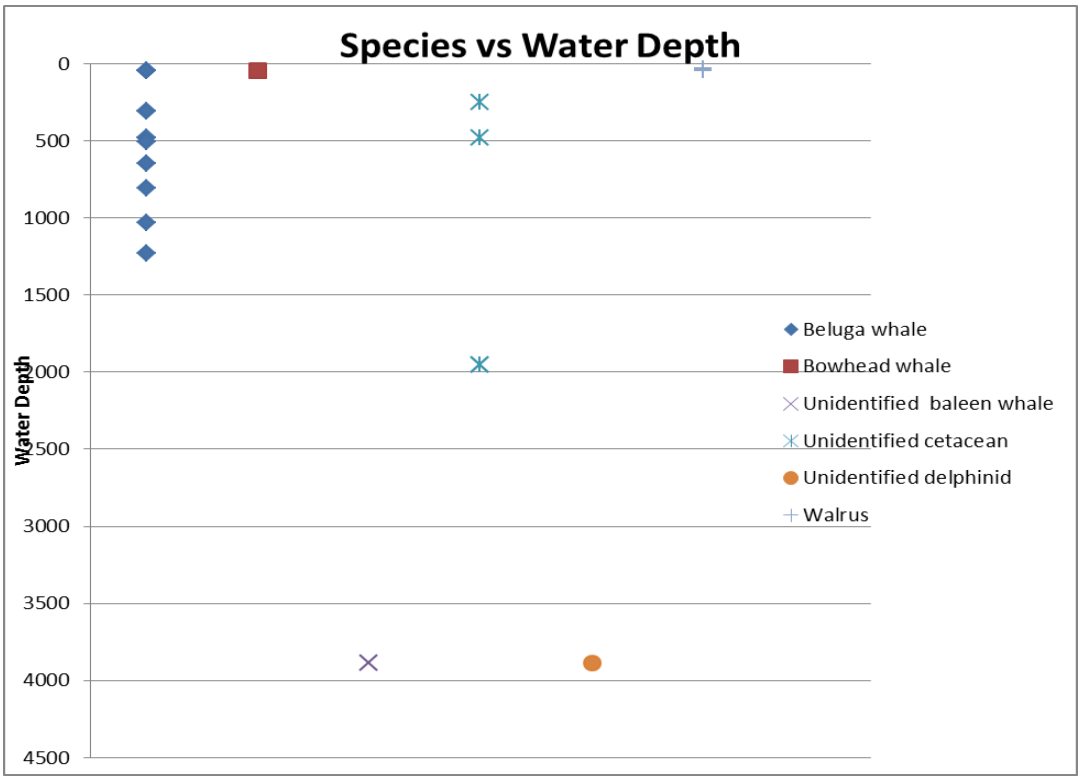

Figure 16: Species distribution across varying water depths

The acoustic encounter rate was also calculated for detections made while the acoustic source was operating at full volume and while the source was silent. A higher encounter rate was noted during periods of source silence, 0.0288 detections per hour of acoustic effort as compared 0.0179 detections per hour of acoustic effort during source silence. Source silence also includes mitigation source firing and periods of source testings. PAM Operators were not present on board the seismic source vessel and communication between PAM Operators on the Norseman and VPSOs on the Geo Arctic was limited such that it was difficult for Pam Operators to distinguish between actual periods of source silence and periods where the mitigation source was active or source tests were being conducted.

Table 6: Acoustic encounter rate at full volume and source silence

Acoustic Encounter Rate by Source Activity	
Full volume	
Number of acoustic detections	14
Hours of effort at full volume	779.1833
AER per hour	0.017968
AER per km	0.001940
Silent*	
Number of acoustic detections	12
Hours of effort during source silence	416.2000
AER per hour	0.028832
AER per km	0.003114

**Also includes mitigaiton source activity and source tests*

4.3. ACOUSTIC DETECTIONS CORRELATED WITH A VISUAL SIGHTING

There were five acoustic detections correlated with visual sightings, four walrus detections (Detections 1,2 and 20, 21, two detections on each of 10 September and 11 October) and the bowhead whale acoustic detection (Detection 26 on 27 October).

Acoustic detections 1 and 2 (visual sightings 28 and 29) of walrus, occurring on 10 September consisted of knocks' which were detected acoustically before the visual sighting was made by VPSOs. The vocalizations continued between 16:49 and 17:40 UTC but very few vocalizations were detected during that time period such that localization of the calls was not possible through the Pamguard software and an accurate distance estimation could not be made by the PAM Operator. VPSOs reported the walrus sightings at 150 and 1000 meters from the vessel. The second acoustic detection on 10 September occurred between 18:23 and 18:33 UTC (Table 8).

Acoustic detections 20 and 21 (visual sightings 199 and 203) also of walrus, both occurring on 10 October, also consisted of knocks, in one case detected acoustically before the visual sighting and in the other detection event, the visual sighting came two minutes before the acoustic detection. In both detection events the range was not localized acoustically but visual observers reported the sightings at a distance of 200 meters to the vessel.

The final acoustic detection of the survey, and the last detection accompanied by a visual sighting (sighting event 315) was a bowhead whale detected on 27 October. Vocalizations were detected one minute before the whale surfaced 400 metres off the bow of the vessel.

Table 7: Acoustic detections correlated with a visual sighting during the TGS Chukchi survey

Record No.	Date	Time (local)	Species	Vessel Position	Acoustic Detection Details	Visual Detection Details
1	10-Sep	16:49-17:40	Pacific walrus	71.72650°N 163.30305°W	Multiple "knocks" detected aurally and on Spectrogram from 1-7 kHz. Often the same rhythm was repeated multiple times. Short knock trains were detected several times on the LF click detector.	Correlates with visual detections 28 & 29.
2	10-Sep	18:23-18:33	Pacific walrus	71.79433°N 163.62018°W	Brief periods of light knocking heard aurally and detected on the LF Spectrogram.	Correlates with visual detection 32.
20	11 Oct	13:10-13:13	Pacific walrus	71.67213°N, 161.79588°W	Light knocking and tapping was aurally detected on PAMGuard. However no distinct patterns were visualized on any PAMGuard functions or during playback in Spectrogram 16.	Correlates with visual detection 199. At 13:08 one walrus was visually sighted 200m off bow, followed by a group of six walruses off bow, at 13:13 a walrus female and calf were visually detected off port, at 13:23 group of three walruses off starboard bow.
21	11 Oct	16:20-16:28	Pacific walrus	71.71398°N 161.31942°W	Light knocking and tapping was aurally detected by PAM Op. Several knocks detected by LF click detector at a bearing of 170°. These clicks were shown to be at the amplitude of ~125 dB.	Correlates with visual detection 203. At 16:48 two walruses were visually detected 200m off port bow
26	27 Oct	15:54-16:08	Bowhead whale	71.42715°N 165.54848°W	At 15:54 three short LF sounds (approx. 50 seconds apart) were detected aurally by PAM op and by whistle and moan detector on the mid-frequency Spectrogram. Each vocalization was a flat tonal call at ~100 Hz lasting 1.9 seconds, with a bit of an upsweep at the end of the third call. At 16:07 two more tonal calls were observed at 100 Hz.	Correlates with visual detection 315. One bowhead whale ~406m off the port bow at 15:55, the whale was observed again at 16:01 ~584m off port side traveling away from the vessel.

4.4. LOCALIZATION OF ACOUSTIC DETECTIONS

The bearings and distance to detected whistles and moans can be calculated using the time-of-arrival-distance (TOAD) method (the signal time delay between the arrival of a signal on each hydrophone is compared), and are presented on a radar display along with amplitude information for the detected signal as a proxy for range. The vessel's GPS connected to the LF laptop via serial USB and allowed delphinid whistles and other cetacean vocalizations to be plotted onto a map module where bearing and range to the vocalizing animal's position could be obtained.

When *Pamguard* does not have enough input of information to produce an estimated range, then range estimations for acoustic detections are primarily based upon operator experience and a subjective scale that was developed by Gannier et al (2002). Gannier *et al* monitored sperm whales in the Mediterranean both visually and acoustically and developed a scale based upon the strength or intensity of the sperm whale clicks at various distances. Although the scale is subjective and sounds produced in marine environments will vary according to local conditions, the scale provides a measure for approximating distances. The scale ranges from one through five, with one being the weakest and five being the strongest.

None of the acoustic detections made during the TGS Alaska survey program could be localized to an accurate enough range, either by Pamguard or by the PAM Operator such that an Operator could confidently implement a mitigation action. This survey program did not require the implementation of mitigation measures from acoustic monitoring and only acoustic detections with an accompanying visual sighting were to result in any mitigation action so this lack of localization did not impact the quality of the survey mitigation efforts.

The two major factors preventing localization of acoustic detections by either Pamguard or the Operator were the brevity of the detection events and the weakness of the detection signal. Nearly 70% of acoustic detections made during the survey had a duration of less than five minutes (Figure 17). In a detection event this short, there must be a high rate of calling by the vocalizing animal in order for a sufficient number of calls to be present to produce a reliable range on Pamguard or to allow the Operator sufficient time to compare the overall strength of the signal to other background noise and estimate the range. During many of the detection events with very short durations, especially those consisting of beluga whale vocalizations, the Pamguard Whistle Moan Detector recognized the calls and could plot bearing lines, but more vocalizations were needed to produce a range (Table 7). Some of the detection events with a longer duration consisted of too few calls, but spaced out over a longer period of time, resulting in the same inability to range.

Additionally, Pamguard cannot produce a range if the Whistle Moan Detector does not identify a vocalization that is present, usually due to the faintness of the signal or because it is being partially masked by other background noise. During these detections events, the Operator may visually identify a call on the Spectrogram or aurally, but without detection by the Whistle Moan Detector, no localization can be made by the software even if sufficient calls are present. If background noise levels are low, the Operator may be able to evaluate other aspects of the detection and the faint signal level may suggest that the vocalizations originate from a greater distance. This comparative evaluation can be made most accurately when the Operator has detected many vocalizations during that event and made many detections of that species or species group in the survey area and with so few detection events, this level of data was absent.

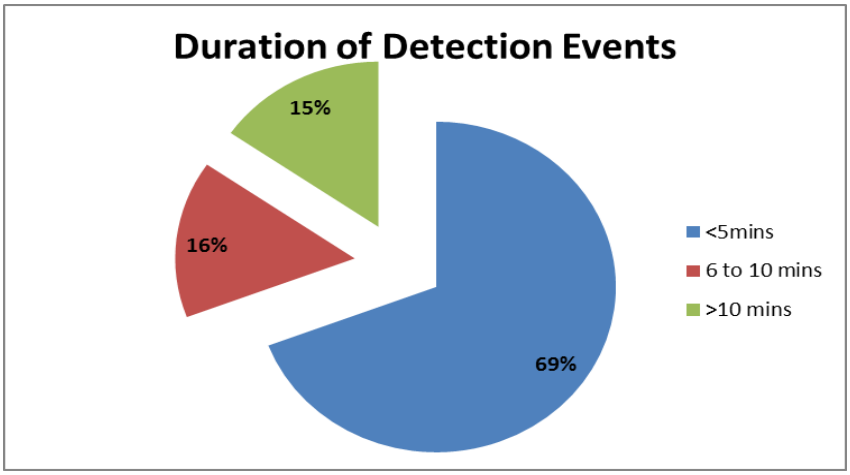

Figure 17: Duration of acoustic detection events during the TGS Chukchi 2D survey

Table 8: Localization of acoustic detections during the TGS Chukchi 2D survey program

Detection Number	Date	Species	Duration of detection	Localization Comments
1	2013-09-10	Walrus	0:51	Duration of detection was long, but number of knocks detected very few; Knocks detected on Click Detector, but insufficient data for localization by Pamguard or Operator.
2	2013-09-10	Walrus	0:10	Knocks detected on Click Detector, but insufficient data for localization by Pamguard or Operator.
3	2013-09-17	Unid baleen whale	0:01	Too few vocalizations were detected by the Pamguard WMD* to produce an accurate range, although bearing was determined. Detection was too brief for localization estimation by Operator.
4	2013-09-17	Delphinid	0:01	Detection was too brief for localization either by Pamguard or Operator
5	2013-09-21	Beluga whale	0:01	Detection was too brief for localization either by Pamguard or Operator
6	2013-09-27	Beluga whale	0:01	Detection was too brief for localization either by Pamguard or Operator
7	2013-09-27	Beluga whale	0:01	Detection was too brief for localization either by Pamguard or Operator
8	2013-09-28	Unid Cetacean	0:01	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator

**Pamguard Whistle Moan Detector (WMD)*

Detection Number	Date	Species	Duration of detection	Localization Comments
9	2013-09-28	Unid Cetacean	0:03	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator
10	2013-10-04	Unid Cetacean	0:00	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator
11	2013-10-04	Beluga whale	0:00	Only one single whistle detected; detected by the WMD, but insufficient data for localization by Pamguard or Operator. Bearing of 61 degrees.
12	2013-10-04	Beluga whale	0:07	Very faint whistles detected on three occasions; detected by the WMD, but insufficient data for localization by Pamguard or Operator. Bearing of 68 degrees.
13	2013-10-05	Beluga whale	0:00	Single whistle detected visually and by WMD. Detection was too brief for localization either by Pamguard or Operator
14	2013-10-05	Unid Cetacean	0:01	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator
15	2013-10-05	Beluga whale	0:01	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator
16	2013-10-05	Beluga whale	0:01	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator
17	2013-10-05	Beluga whale	0:03	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator
18	2013-10-05	Beluga whale	0:02	Signal strength was very weak, not detected by Pamguard WMD. Detection was too brief for localization either by Pamguard or Operator
19	2013-10-05	Beluga whale	0:01	Whistles detected aurally, some detected by the WMD, but insufficient data for localization by Pamguard or Operator

Detection Number	Date	Species	Duration of detection	Localization Comments
20	2013-10-11	Walrus	0:03	Knocks detected aurally, but very faint, very few also detected on Click Detector, but insufficient data for localization by Pamguard or Operator.
21	2013-10-11	Walrus	0:08	Knocks detected aurally, but very faint, very few also detected on Click Detector, but insufficient data for localization by Pamguard or Operator.
22	2013-10-15	Walrus	0:18	Knocks detected aurally, but very faint, very few also detected on Click Detector, but insufficient data for localization by Pamguard or Operator.
23	2013-10-24	Walrus	0:07	Knocks detected on Click Detector, but insufficient data for localization by Pamguard or Operator.
24	2013-10-27	Beluga whale	0:01	Whistles detected aurally, some detected by the WMD, but insufficient data for localization by Pamguard or Operator
25	2013-10-27	Walrus	0:21	Knocks detected on Click Detector, but insufficient data for localization by Pamguard or Operator. Bearings between 130 and 165 degrees
26	2013-10-27	Bowhead whale	0:14	Tonal calls detected on Spectrogram and by WMD but too few calls detected for localization by Pamguard or Operator

5. EVALUATION OF PAM SYSTEM PERFORMANCE

In order to evaluate the performance of the PAM system during the TGS Chukchi 2D marine seismic survey several factors were considered:

1. Was the system set-up and operated in such way that acoustic monitoring was maximized, with minimal downtime to PAM and survey operations?
2. Was the hydrophone deployment method relatively easy, well integrated with other towed equipment and able to maximize the acoustic range of the hydrophones?
3. Did the *Pamguard* detection software operate effectively?
4. Were acoustic detection rates of marine mammals as expected?

5.1. ACOUSTIC MONITORING DOWNTIME

For the purposes of evaluating the PAM system function during the survey, acoustic monitoring down-time is defined as time periods during which acoustic monitoring was suspended for reasons due the malfunction of software or hardware related to the system. The periods of time during which the cable was retrieved and monitoring was suspended for transit and time in port is not included.

Acoustic monitoring was suspended only briefly on three occasions, each for less than five minutes, and during each instance the Operator was able to aurally monitor the raw audio from the hydrophone cable while the PAM PC or the Pamguard program was re-started, which resolved the problem on each occasion.

5.2. HYDROPHONE DEPLOYMENT

The deployment configuration of the hydrophone cable on board *Norseman* was effective in several capacities:

1. Deployment and retrieval of the cable required only two crew members or the PAM operator with the assistance of one crew member.
2. Deployment and retrieval of the cable could be completed quickly, approximately 20 minutes.
3. Deployment and retrieval operations were relatively low risk and the risks present could be removed through use of the appropriate PPE (hard hats, safety gloves, steel toed boots and a safety harness for the crew member working close to the side of the vessel)
4. The deployment method was achieved using minimal equipment from the vessel: the winch was provided by RPS for the survey project and the vessel A-frame was utilized.

5.3. SOFTWARE

The *Pamguard* program operated continuously throughout the survey with minimal technical difficulties that impacted acoustic monitoring. The minor difficulties experienced by the PAM operator (occasional freezes to the Pamguard software) could generally be resolved with troubleshooting. The on-going freezing and re-starting of the software as it was overwhelmed by electrical interference from on-board appliances was minimized by configuration changes to the software, but could not be eliminated entirely.

5.4. ACOUSTIC DETECTION RATES

In order to evaluate whether acoustic detection rates were as they would have been expected, sufficient data regarding the historical vocalization behaviour of all species groups in this region and in the presence of a seismic operation of this nature. As this data is not available due to the infrequency of these operations in this geographical region, the most that can be concluded is that acoustic detection rates were significantly lower than visual sighting rates for each species group. However, it is unknown whether this is because these animals were not vocalizing such that they could be detected acoustically of whether vocalizations were present during detection events that were not detected by the system in use.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. CONCLUSION

6.1.1. PAM Systems Highlights

The Passive Acoustic Monitoring system installed on the *Norseman* for the duration of the TGS Chukchi 2D survey performed very well. Highlights to the system set-up and operation included:

- A hydrophone deployment configuration was developed that could be easily undertaken in a short amount of time with minimal crew
- A total of 1195 hours and 23 minutes of acoustic monitoring effort was achieved over the survey.
- A total of 26 acoustic detections made, including a bowhead whale, walrus and beluga whales
- Minimal acoustic monitoring downtime incurred due to problems with the PAM hardware, software or hydrophone cable deployment, suggesting that the system was integrated well into the vessel and software was configured effectively for the survey.

6.1.2. Potential Limitations to Acoustic Monitoring

The continuous operation of the PAM system throughout the survey also highlighted some of the well-known limitations to acoustic monitoring on a seismic survey:

- Marine mammals that are not vocalizing cannot be detected by the PAM system.
- It is possible to differentiate between Delphinid vocalizations and those of baleen whales, like the bowhead whale, but the species of dolphin cannot always be determined without a correlating visual sighting. Short detection events frequently cannot be identified to species level
- Short or faint detection events cannot be localized by Pamguard and rely on the Operator's experience level to subjectively evaluate signal strength in relation to other acoustic signals present and with a knowledge of the biology of the animal vocalizing in order to estimate distance
- The number of marine mammals present during a detection event cannot always be determined accurately.
- Behaviour of marine mammals cannot be observed including any reaction exhibited to the seismic source.

7. ACKNOWLEDGEMENTS

RPS would like to thank TGS Energy, for the opportunity to work on this project and for their support throughout the survey. We would also like to acknowledge Seiche Measurement Ltd. for supplying all passive acoustic monitoring equipment and a very special thank you to the crew of the *Norseman* for their excellent hard work and their warm hospitality.

8. LITERATURE CITED

Gannier A, Violaine D, Goold JC. 2002. Distribution and relative abundance of sperm whales in the Mediterranean Sea. Marine Ecology Progress Series 243:281-291.

APPENDIX A: INCIDENTAL HARASSMENT AUTHORIZATION

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

Incidental Harassment Authorization

TGS-NOPEC Geophysical Company ASA (TGS), 2500 City West Boulevard, Suite 2000, Houston, Texas 77042, 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 open-water 2D seismic surveys in the Chukchi Sea, contingent upon the following conditions:

1. This Authorization is valid from August 14 through October 31, 2013.

2. This Authorization is valid only for activities associated with open-water 2D seismic surveys and related activities in the Chukchi Sea. The specific areas where TGS' surveys will be conducted are within the Chukchi Sea, Alaska, as shown in Figure 1 of TGS' IHA application.

3. (a) The species authorized for incidental harassment takings, Level B harassment only, 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*).

The authorization for taking by harassment is limited to the following acoustic sources and from the following activities:

(i) 3,280 in^3 airgun arrays and other acoustic sources for 2D open-water seismic surveys; and

(ii) Vessel activities related to open-water seismic surveys listed in (i).

(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 and Conservation Division, Office of Protected Resources, NMFS, at (301) 427-8401, or his designee (301-427-8418).

4. The holder of this Authorization must notify the Chief of the Permits and Conservation 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. <u>Prohibitions</u>

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(a) The taking, by incidental harassment only, is limited to the species listed under condition 3(a) above and by the numbers listed in Table 1 (attached). 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 protected species observers (PSOs), required by condition 7(a)(i), are not onboard in conformance with condition 7(a)(i) of this Authorization.

6. Mitigation

(a) Establishing Exclusion and Disturbance Zones:

(i) Establish, and monitor with trained PSOs, preliminary exclusion zones for cetaceans surrounding the airgun array on the source vessel where the received level would be 180 dB (rms) re 1 μPa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 2,200, 2,500, and 2,400 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17-40, 40-100, and >100 m, respectively. The 180-dB radius from the single 60 in^3 airgun is estimated to be at 68 m from the source, regardless of water depth.

(ii) Establish, and monitor with trained PSOs, preliminary exclusion zones for pinnipeds surrounding the airgun array on the source vessel where the received level would be 190 dB (rms) re 1 μPa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 930, 920, and 430 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17-40, 40-100, and >100 m, respectively. The 190-dB radius from the single 60 in^3 airgun is estimated to be at 13 m from the source, regardless of water depth.

(iii) Establish a zone of influence (ZOIs) for cetaceans and pinnipeds surrounding the airgun array on the source vessel where the received level would be 160 dB (rms) re 1 μPa. For purposes of the field verification test described in condition 7(e)(i), these radii are estimated to be 8,500, 9,900, and 15,000 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17-40, 40-100, and > 100 m, respectively. The 160-dB radius from the single 60 in^3 airgun is estimated to be at 1,500 m from the source.

(iv) Immediately upon completion of data analysis of the field verification measurements required under condition 7(e)(i) below, the new 160-dB, 180-dB, and 190-dB marine mammal ZOIs and exclusion zones shall be established based on the sound source verification.

(b) Vessel and Helicopter Movement Mitigation:

(i) All vessels under the direction of TGS shall avoid concentrations or groups of whales (2 or more individuals). Operators of support vessels shoall, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.

(ii) Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

(A) Reducing vessel speed to less than 5 knots within 300 yards (900 feet or 274 m) of the whale(s);

(B) Steering around the whale(s) if possible;

(C) Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;

(D) Operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and

(E) Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged.

(iii) Reduce vessel speed to 5 knots when weather conditions require, such as when visibility drops, to avoid the likelihood of injury to whales.

(c) Mitigation Measures for Airgun Operations

(i) Ramp-up:

(A) A ramp up, starting from a cold start or following a complete shutdown of 10 minutes or more, can be applied if the exclusion zone has been free of marine mammals for a consecutive 30-minute period. The entire exclusion zone must have been visible during these 30 minutes. If the entire exclusion zone is not visible, then ramp up from a cold start cannot begin.

(B) If a marine mammal(s) is sighted within the exclusion zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the exclusion zone or the animal(s) is not sighted for at least 15-30 minutes: 15 minutes for small odontocetes (harbor porpoise) and pinnipeds, or 30 minutes for

baleen whales and large odontocetes (including beluga and killer whales and narwhal).

(C) If, for any reason, electrical power to the airgun array has been discontinued for a period of 10 minutes or more, ramp-up procedures shall be implemented when restarting. Only if the PSO watch has been suspended, a 30-minute clearance of the exclusion zone is required prior to commencing ramp-up. Discontinuation of airgun activity for less than 10 minutes does not require a ramp-up.

(D) The seismic operator and PSOs shall maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

(ii) Power-down/Shutdown:

(A) The airgun array shall be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun.

(B) If a marine mammal is already within the exclusion zone when first detected, the airguns shall be powered down immediately.

(C) Following a power-down, firing of the full airgun array shall not resume until the marine mammal has cleared the exclusion zone. The animal will be considered to have cleared the exclusion zone if it is visually observed to have left the exclusion zone of the full array, or has not been seen within the zone for 15 minutes (pinnipeds or small toothed whales) or 30 minutes (baleen whales or large toothed whales).

(D) If a marine mammal is sighted within or about to enter the 190 or 180 dB (rms) applicable exclusion zone of the single mitigation airgun, the airgun array shall be shutdown.

(E) Firing of the full airgun array or the mitigation gun shall not resume until the marine mammal has cleared the exclusion zone of the full array or mitigation gun, respectively. The animal will be considered to have cleared the exclusion zone as described above under ramp up procedures.

(iii) Poor Visibility Conditions:

(A) If during foggy conditions, heavy snow or rain, or darkness, the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down.

(B) If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible.

(iv) Use of a Small-Volume Airgun during Turns and Transits

(A) Throughout the seismic survey, particularly during turning movements, and short transits, TGS will employ the use of a small-volume airgun (i.e., 60 in^3 "mitigation airgun"). The mitigation airgun will be operated at approximately one shot per minute and will not be operated for longer than three hours in duration during daylight hours and good visibility. In cases when the next start-up after the turn is expected to be during lowlight or low visibility, use of the mitigation airgun may be initiated 30 minutes before darkness or low visibility conditions occur and may be operated until the start of the next sail line. The mitigation gun must still be operated at approximately one shot per minute.

(B) During turns or brief transits (e.g., less than three hours) between seismic tracklines, one mitigation airgun will continue operating. The ramp-up procedure will still be followed when increasing the source levels from one airgun to the full airgun array. However, keeping one airgun firing will avoid the prohibition of a "cold start" during darkness or other periods of poor visibility. Through the use of this approach, seismic surveys using the full array may resume without the 30 minute observation period of the full exclusion zone required for a "cold start". PSOs will be on duty whenever the airguns are firing during daylight, during the 30 minute periods prior to ramp-ups.

(d) Mitigation Measures for Subsistence Activities:

(i) TGS shall fully implement the following provisions, as described fully in the 2013 Conflict Avoidance Agreement (CAA) signed between TGS and the AEWC and its representing whaling communities of the Chukchi and Beaufort Seas:

(A) Section 202(a) and (c): Com-Center General Communication Scheme;

(B) Section 204: Standardized Log Books;

(C) Section 302: Barge and Transit Vessel Operations;

(D) Section 402: Sound Signature Tests;

(E) Section 501: General provisions for Avoiding Interference with Bowhead Whales or Subsistence Whale Hunting Activities;

(F) Section 502(b): Limitations on Geophysical Activity in the Chukchi Sea;

(G) Section 505: Termination of Operations and Transit Through the Bering Strait; and

(H) Title VI, Sections 601 and 602: Late Season Seismic Operations.

7. Monitoring:

(a) Vessel-based Visual Monitoring:

(i) Vessel-based visual monitoring for marine mammals shall be conducted by NMFS-approved protected species observers (PSOs) throughout the period of survey activities, and extends to 30 minutes after the survey is completed.

(ii) PSOs shall be stationed aboard the seismic survey vessel and supporting vessel through the duration of the surveys.

(iii) A sufficient number of PSOs shall be onboard the survey vessel to meet the following criteria:

(A) 100% monitoring coverage during all periods of survey operations in daylight;

(B) maximum of 4 consecutive hours on watch per PSO; and

(C) maximum of 12 hours of watch time per day per PSO.

(iv) The vessel-based marine mammal monitoring shall provide the basis for real-time mitigation measures as described in (6)(c) above.

(v) Results of the vessel-based marine mammal monitoring shall be used to calculate the estimation of the number of "takes" from the marine surveys.

(b) Protected Species Observers and Training

(i) PSO teams shall consist of Inupiat observers and NMFS-approved field biologists.

(ii) Experienced field crew leaders shall supervise the PSO teams in the field. New PSOs shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

(iii) Crew leaders and most other biologists serving as observers in 2013 shall be individuals with experience as observers during recent seismic or shallow hazards monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas in recent years.

(iv) Resumes for PSO candidates shall be provided to NMFS for review and acceptance of their qualifications. Inupiat observers shall be experienced in the region and familiar with the marine mammals of the area.

(v) All observers shall complete a NMFS-approved observer training course designed to familiarize individuals with monitoring and data collection procedures. The training course shall be completed before the anticipated start of the 2013 open-water season. The training session(s) shall be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs.

(vi) Training for both Alaska native PSOs and biologist PSOs shall be conducted at the same time in the same room. There shall not be separate training courses for the different PSOs.

(vii) Crew members shall not be used as primary PSOs because they have other duties and generally do not have the same level of expertise, experience, or training as PSOs, but they could be stationed on the fantail of the vessel to observe the near field, especially the area around the airgun array and implement a power down or shutdown if a marine mammal enters the safety zone (or exclusion zone).

(viii) If crew members meet the PSO qualifications and are to be used as PSOs, they shall go through some basic training consistent with the functions they will be asked to perform. The best approach would be for crew members and PSOs to go through the same training together.

(ix) PSOs shall be trained using visual aids (e.g., videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

(x) TGS shall train its PSOs to follow a scanning schedule that consistently distributes scanning effort according to the purpose and need for observations. All PSOs should follow the same schedule to ensure consistency in their scanning efforts.

(xi) PSOs shall be trained in documenting the behaviors of marine mammals. PSOs should simply record the primary behavioral state (i.e., traveling, socializing, feeding, resting, approaching or moving away from vessels) and relative location of the observed marine mammals.

(c) Marine Mammal Observation Protocol

(i) PSOs shall watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge.

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

(iii) PSOs 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 when needed.

(iv) Personnel on the bridge shall assist the marine mammal observer(s) in watching for marine mammals.

(v) PSOs aboard the marine survey vessel shall give particular attention to the areas within the marine mammal exclusion zones around the source vessel, as noted in (6)(a)(i) and (ii). 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 exclusion zone.

(vi) Monitoring shall consist of recording of the following information:

(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 (including pinnipeds hauled out on barrier islands), (II) at the start and end of each watch, and (III) during a watch (whenever there is a change in one or more variable);

(C) the identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted and the time observed;

(D) any identifiable marine mammal behavioral response (sighting data should be collected in a manner that will not detract from the PSO's ability to detect marine mammals);

(E) any adjustments made to operating procedures; and

(F) visibility during observation periods so that total estimates of take can be corrected accordingly.

(vii) Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7 x 50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water.

(viii) PSOs 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. For example, for an unidentified mysticete whale, the observers should record whether the animal had a dorsal fin.

(ix) Additional details about unidentified marine mammal sightings, such as "blow only", mysticete with (or without) a dorsal fin, "seal splash", etc., shall be recorded.

(x) When a marine mammal is seen approaching or within the exclusion zone applicable to that species, the marine survey crew shall be notified immediately so that mitigation measures described in (6) can be promptly implemented.

(xi) TGS shall use the best available technology to improve detection capability during periods of fog and other types of inclement weather. Such technology might include night-vision goggles or binoculars as well as other instruments that incorporate infrared technology.

(d) Field Data-Recording and Verification

(i) PSOs aboard the vessels shall maintain a digital log of seismic surveys, noting the date and time of all changes in seismic activity (ramp-up, power-down, changes in the active seismic source, shutdowns, etc.) and any corresponding changes in monitoring radii in a software spreadsheet.

(ii) PSOs shall utilize standardized format to record all marine mammal observations and mitigation actions (seismic source power-downs, shut-downs, and ramp-ups).

(iii) Information collected during marine mammal observations shall include the following:

(A) Vessel speed, position, and activity

(B) Date, time, and location of each marine mammal sighting

(C) Number of marine mammals observed, and group size, sex, and age categories

(D) Observer's name and contact information

(E) Weather, visibility, and ice conditions at the time of observation

(F) Estimated distance of marine mammals at closest approach

(G) Activity at the time of observation, including possible attractants present

(H) Animal behavior

(I) Description of the encounter

(J) Duration of encounter

(K) Mitigation action taken

(iv) Data shall be recorded directly into handheld computers or as a back-up, transferred from hard-copy data sheets into an electronic database.

(v) A system for quality control and verification of data shall be facilitated by the pre-season training, supervision by the lead PSOs, in-season data checks, and shall be built into the software.

(vi) Computerized data validity checks shall also be conducted, and the data shall be managed in such a way that it is easily summarized during and after the field program and transferred into statistical, graphical, or other programs for further processing.

(e) Passive Acoustic Monitoring

(i) Sound Source Measurements: Using a hydrophone system, the holder of this Authorization is required to conduct sound source verification tests for seismic airgun array(s) that are involved in the open-water seismic surveys.

(A) Sound source verification shall consist of distances where broadside and endfire directions at which broadband received levels reach 190, 180, 170, and 160 dB (rms) re 1 μPa for the airgun array(s). The configurations of airgun arrays shall include at least the full array

and the operation of a single source that will be used during power downs.

(B) The test results shall be reported to NMFS within 5 days of completing the test.

(ii) Real-time Passive Acoustic Monitoring (PAM)

(A) TGS shall conduct real-time passive acoustic monitoring by NMFS-approved passive acoustic monitor(s) using a towed hydrophone array from the support vessel throughout the open-water seismic surveys.

(B) Passive Acoustic Operator(s) and Monitor(s):

(I) Design and initial setup of PAM apparatus (including hardware and software) shall be done by experienced bioacoustician(s) with field experience in marine mammal passive acoustic monitoring and signal processing.

(II) Passive acoustic monitor(s) shall undergo basic training on PAM, and be able to operate independently once the PAM apparatus is set-up.

(III) Resumes for the bioacoustician(s) and passive acoustic monitor(s) candidates shall be provided to NMFS for review and acceptance of their qualifications.

(C) Specific sensor design and noise filters shall be used to maximize the system's ability to detect low frequency bowhead whales. To ensure the effectiveness of real-time PAM with a towed hydrophone array, the following requirements for PAM design and procedures are required:

(I) Limit towing speeds to 4-6 knots. Reduce speed appropriately, or change direction if necessary, so that if bowhead whales are detected so that bearing can be obtained. If greater speeds are necessary, slow down every 20-30 minutes to listen for animal calls for at least 5-10 minutes.

(II) Maintain a separation distance of at least several hundred meters (preferable more) from the seismic survey vessel.

(D) Best efforts shall be made without compromising data collection to localize vocalizing marine mammals.

(I) Use a signal conditioning system (i.e. filter and match signal gains) to allow software to effectively estimate bearings and/or localize.

(II) Use software designed exclusively for monitoring, localizing and plotting marine mammal calls.

(III) Design the sampling software to optimize overlap between monitoring the 180 and 160 dB isopleths.

(IV) Allow the support vessel to deviate from designated track-lines by 25-30 degrees (for brief periods) so that left/right ambiguity can be resolved if needed.

8. Data Analysis and Presentation in Reports

(a) Estimation of potential takes or exposures shall be improved for times with low visibility (such as during fog or darkness) through interpolation or possibly using a probability approach. Those data could be used to interpolate possible takes during periods of restricted visibility.

(b) To better assess impacts to marine mammals, data analysis shall be separated into periods when a seismic airgun array (or a single mitigation airgun) is operating and when it is not. Final report to NMFS should summarize and plot:

(i) Data for periods when a seismic array is active and when it is not; and

(ii) The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

(c) To help evaluate the effectiveness of PSOs and more effectively estimate take, if appropriate data are available, TGS shall perform analysis of sightability curves (detection functions) for distance-based analyses.

(d) The following data shall be obtained and provided electronically in the 90-day report:

(i) the location and time of each vessel-based sighting or acoustic detection;

(ii) position of the sighting or acoustic detection relative to ongoing operations (i.e., distance from sightings to seismic operation, etc.), if known;

(iii) the nature of activities at the time (e.g., seismic on/off);

(iv) any identifiable marine mammal behavioral response (sighting data should be collected in a manner that will not detract from the PSO of passive acoustic monitor's ability to detect marine mammals); and

(v) adjustments made to operating procedures.

(e) TGS shall provide useful summaries and interpretations of results of the various elements of the monitoring results, which shall include a clear timeline and spatial (map) representation/summary of operations and important observations. Any and all mitigation measures (e.g., vessel course deviations for animal avoidance, operational shut down) should be summarized. Additionally, an assessment of the efficacy of monitoring methods should be provided.

(f) TGS shall collaborate with other organizations operating in the Chukchi Sea and share visual and acoustic data to improve understanding of impacts from single and multiple operations and efficacy of mitigation measures.

9 Reporting

(a) Sound Source Verification Report: A report on the preliminary results of the sound source verification measurements, including the measured 190, 180, and 160 dB (rms) radii of the airgun sources and other acoustic survey equipment, shall be submitted within 14 days after collection of those measurements at the start of the field season. This report will specify the distances of the exclusion zones that were adopted for the survey.

(b) Throughout the survey program, PSOs shall prepare a report each day or at such other intervals, summarizing the recent results of the monitoring program. The reports shall summarize the species and numbers of marine mammals sighted. These reports shall be provided to NMFS Alaska Regional Office (brad.smith@noaa.gov) and NMFS Office of Protected Resources (shane.guan@noaa.gov).

(c) 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 TGS' 2013 open-water seismic surveys in the Chukchi Sea. The report will describe in detail:

(i) summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);

(ii) analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);

(iii) species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover;

(iv) data analysis that is separated into periods when an airgun array (or a single airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot:

(A) Data for periods when a seismic array is active and when it is not; and

(B) The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

(v) sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability), such as:

(A) initial sighting distances versus airgun activity state;

(B) closest point of approach versus airgun activity state;

(C) observed behaviors and types of movements versus airgun activity state;

(D) numbers of sightings/individuals seen versus airgun activity state;

(E) distribution around the survey vessel versus airgun activity state; and

(F) estimates of take by harassment.

(vi) reported results from all hypothesis tests, including estimates of the associated statistical power when practicable.

(vii) estimated uncertainty for all post-activity take estimates. Uncertainty could be expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, etc.; the exact approach would be selected based on the sampling method and data available.

(viii) The report should clearly compare authorized takes to the estimated takes based on actual levels of activity and marine mammal observations.

(d) The draft report shall 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.

10 (a) In the unanticipated event that survey operations clearly cause the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A

harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), TGS shall immediately cease survey operations and immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov). The report must include the following information:

(i) time, date, and location (latitude/longitude) of the incident;

(ii) the name and type of vessel involved;

(iii) the vessel's speed during and leading up to the incident;

(iv) description of the incident;

(v) status of all sound source use in the 24 hours preceding the incident;

(vi) water depth;

(vii) environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(viii) description of marine mammal observations in the 24 hours preceding the incident;

(ix) species identification or description of the animal(s) involved;

(x) the fate of the animal(s); and

(xi) photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with TGS to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. TGS may not resume their activities until notified by NMFS via letter, email, or telephone.

(b) In the event that TGS discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), TGS will immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the NMFS Alaska Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barabara.Mahoney@noaa.gov). The report must include the same information

identified in Condition 10(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with TGS to determine whether modifications in the activities are appropriate.

(c) In the event that TGS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 3 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), TGS shall report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the NMFS Alaska Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov), within 24 hours of the discovery. TGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. TGS can continue its operations under such a case.

11. 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.

12. 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.

13. 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.

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

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

Donna S. Wieting

Donna S. Wieting, Director
Office of Protected Resources
National Marine Fisheries Service

AUG 14 2013
Date

Table 1. Species/stocks and numbers of marine mammals allowed to be taken incidental to under this IHA.

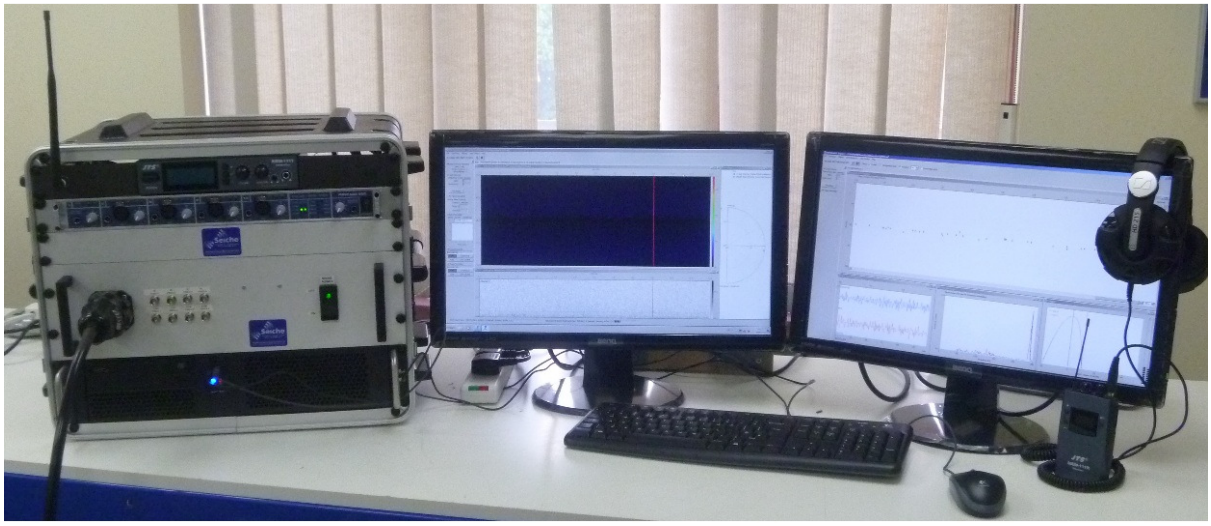
Species / Stocks	Take Allowed
Bowhead whale / Bering-Chukchi-Beaufort Sea	794
Gray whale / Eastern North Pacific	1,363
Fin whale / Northeast Pacific	5
Humpback whale / Western North Pacific	5
Minke whale / Alaska	5
Beluga whale / Eastern Chukchi Sea	412
Killer whale / Aleutian Island and Bering Sea	5
Harbor porpoise / Bering Sea	36
Ringed seal / Alaska	30,000
Bearded seal / Alaska	6,000
Spotted seal / Alaska	500
Ribbon seal / Alaska	100

APPENDIX B: PAM SYSTEM SPECIFICATIONS

Seiche Measurements Ltd
Bradworthy Industrial Estate
Langdon Road, Bradworthy
Holsworthy, Devon EX22 7SF
United Kingdom
Tel: +44 (0) 1409 404050
Fax: +44 (0) 1409 240276
Email: info@seiche.eu.com
Web: www.seiche.eu.com

Passive Acoustic Monitoring System Handbook

Super Broadband Heavy Tow Four Channel Array with PAM Base



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Section 1 System Overview

1.1 Introduction

The system is designed to give a flexible approach to the monitoring of marine noise from a vessel. The Super Broadband configuration consists of:

- 4-element hydrophone array and a depth gauge on a 125m long cable
- 230m long heavy-duty tow cable
- Deck cable
- Operator electronics inside the vessel (PAM Base).

The acquired sound signals from each hydrophone are separated into high frequency (HF) and low frequency (LF) components and then digitally sampled, before being processed and displayed by Pamguard software running on a rack-mounted computer. Remote computers and displays can also be included in this system as options.

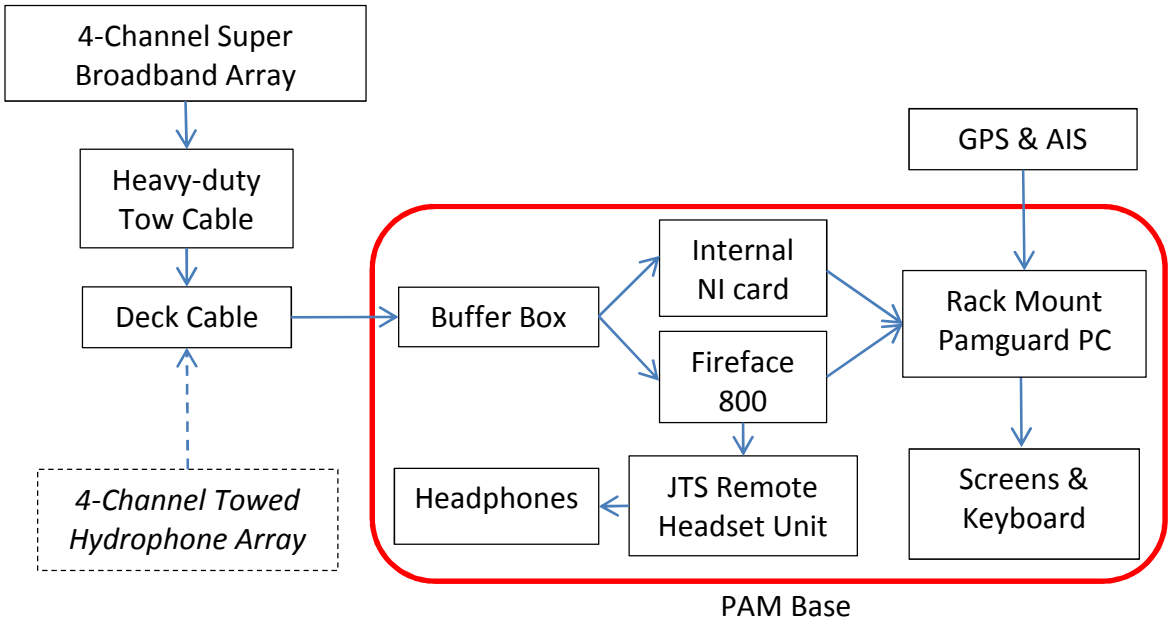

Figure 1: System Data Flow

The operation of the necessary software will be described in another document available from Seiche.

Back-up systems will normally be supplied that allow for full redundancy.

Section 2 Array

2.1 Super Broadband Four Channel Array

The Super Broadband Four Channel Array consists of three (H1 to 4) identical, spherical super broadband hydrophone elements (75Hz -200 kHz, -3 dB points) and a depth gauge. These are mounted on a 125m long cable terminated with a Seiche 36-pin connector. A 20m rope drogue can be fastened to the end of the array to promote a flat tow through the water.

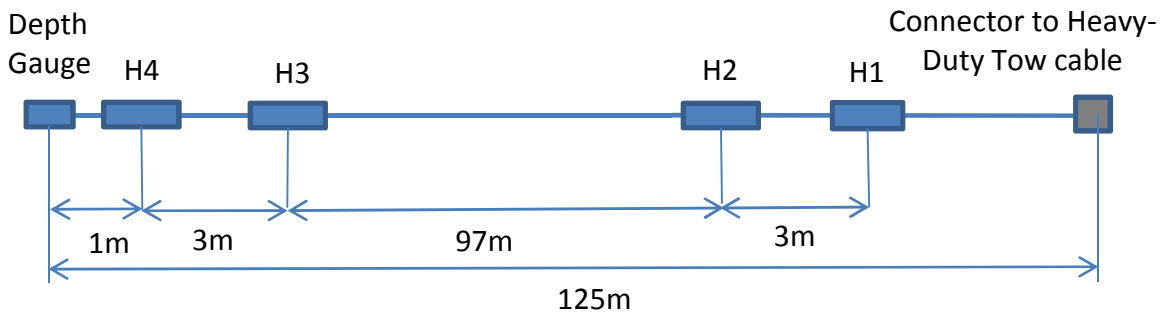

Figure 2: Super Broadband Four Channel Array detail

2.2 Mechanical Information

Length: 125m
Depth Rating: 100m (not connector)
Diameter: 17mm over cable, 32mm over mouldings, 65mm over connectors
Weight: 60kg
Connector: Seiche 36 pin

2.3 Hydrophone elements

H1-H4	Super Broadband	75Hz to 200 kHz (3dB points)

Spacing H1 - H2	3m
Spacing H2 - H3	97m
Spacing H3 - H4	3m

Section 3 Cabling

3.1 Heavy-duty Tow Cable

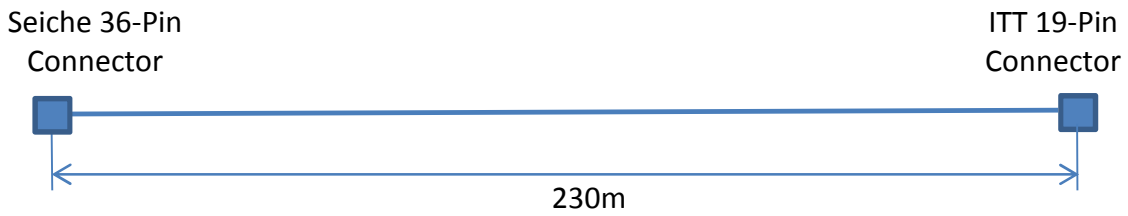

Figure 3: 230m Heavy-duty Tow cable detail

3.2 Mechanical Information

Length:	230m	
Diameter:	17mm over cable	32mm over mouldings
Connector:	Seiche 36 pin (tail end)	45mm over connectors
	ITT 19 pin (head end)	65mm over connectors
Weight:	100kg	

3.3 Connection process – Seiche 36-Pin Connector

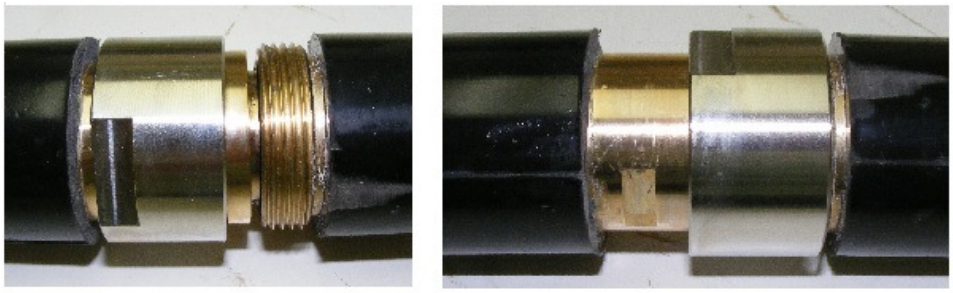

Figure 4: Seiche 36-Pin Connector mating

- Ensure that the three rubber O-rings are correctly located in the respective grooves on the connector.
- A minimal amount of silicon grease should be applied to these prior to mating, but care must be taken to ensure that no grease comes into contact with the signal pin/socket area of the connector.
- The male and female parts of the connector must be aligned and pushed together firmly before the locking ring can be tightened. This will bring the two mating faces of the connector together.
- It is recommended that 19mm wide electrical insulation tape is wound to one side of the locking ring to avoid vibration-induced loosening.

Figure 5: Seiche 36-Pin Connector open and secured

3.4 Deck Cable

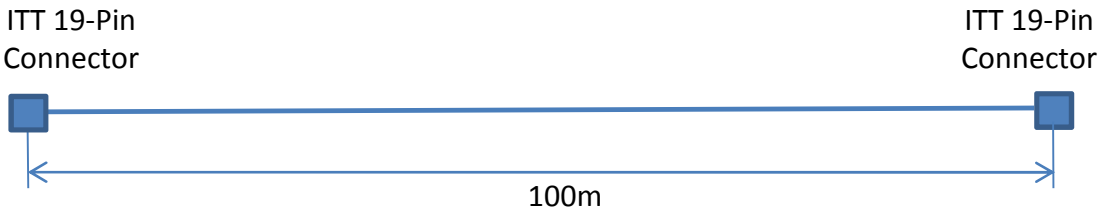

Figure 6: 100m deck cable detail

3.5 Mechanical Information

Cable Length:	100m
Diameter:	14mm
Connectors:	19 pin ITT/CEEP (one male, one female, 64mm diameter)
Weight:	40kg

3.6 Connection process – ITT/CEEP Connector

- Ensure that the orientation tab on the bottom of both parts are aligned
- Gently push the two parts together.
- The threaded ring can then be tightened.

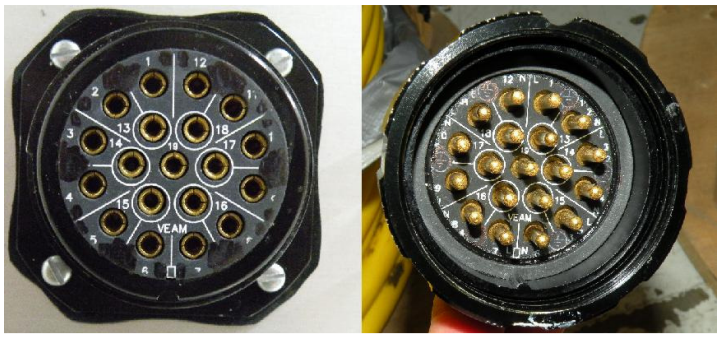

Figure 7: ITT Connectors (female on left)

Section 4 Operator Electronics

4.1 PAM Base

The PAM Base contains all the hardware required to acquire and observe signals from the hydrophone array. It provides a power and signal connection for the array cabling as well as frequency separation systems, analogue to digital convertors for high or low frequency (HF or LF) sound, and the Pamguard PC.

The PAM Base equipment is contained in an 8U, 19-inch rack housing and consists of:

- An array power, interface and signal processing unit ("Buffer Box") with an internal card for sampling high frequency (HF) sound.
- An external sound card ("Fireface 800") for digitally sampling Low Frequency (LF) sound.
- A rack mounted PC ("Pamguard PC") running one or more instances of Pamguard and the Fireface 800 controller software.
- A pair of computer displays. A rack mounted display with integral keyboard is also offered as an option.
- A JTS remote headset unit ("JTS Unit") for listening to the LF output from the Fireface 800 via a base station transmitter and belt-mounted receiver.
- External inputs of GPS, vessel heading and AIS information.

Power connections to each item should be 3-pin IEC (240V AC). Adaptors will be supplied if required. Note that the location of some connectors may differ between the images and what is provided.

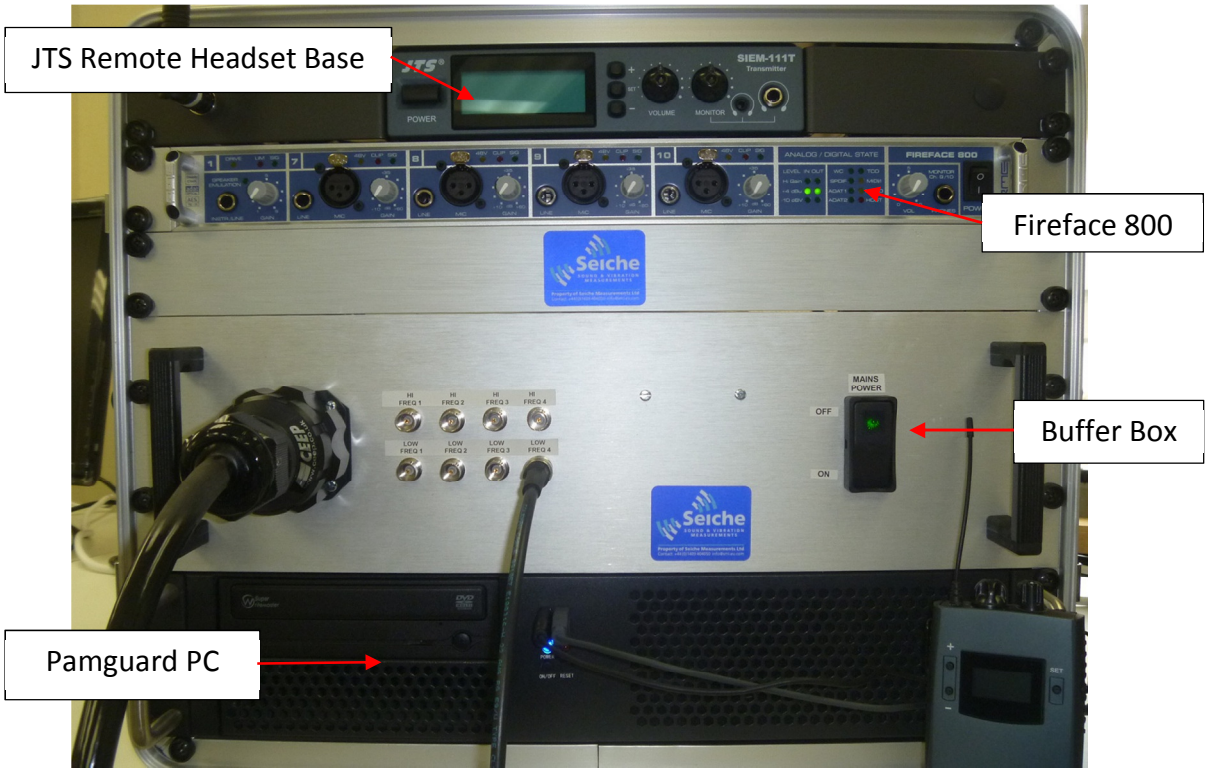

Figure 8: PAM Base (front)

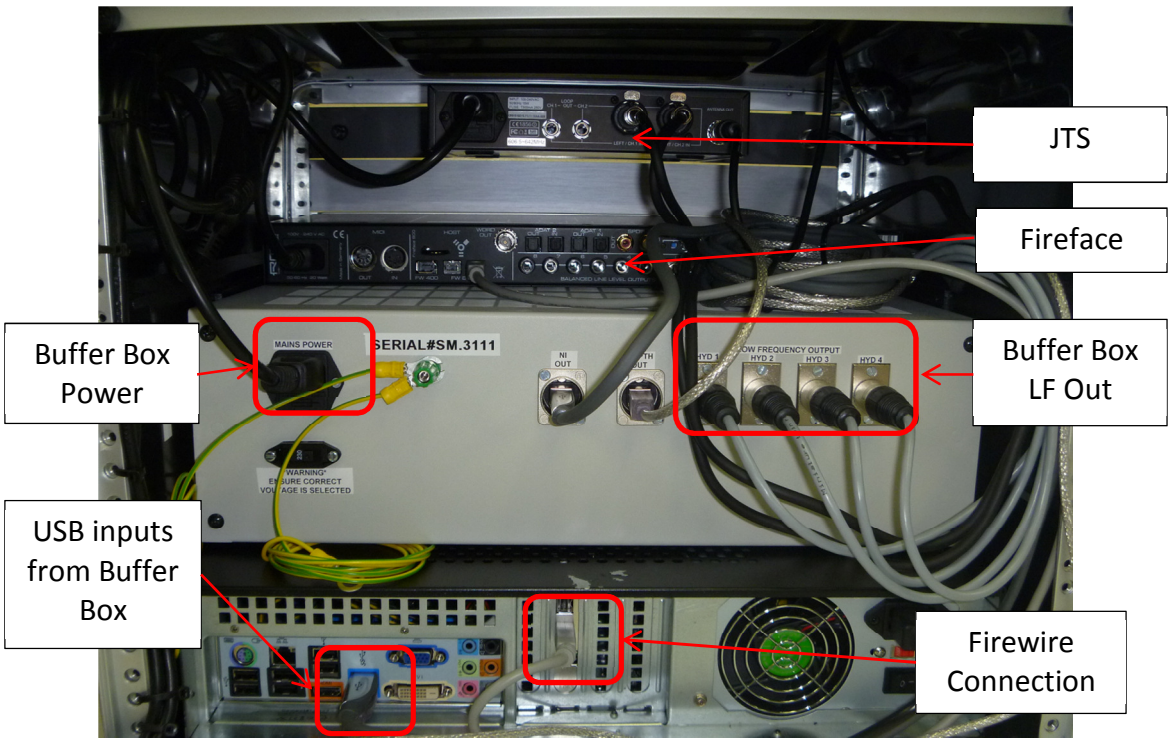

Figure 9: PAM Base (rear)

4.2 Buffer Box

This unit provides power and connection for the hydrophone array cable (via the ITT connector on the left of the front panel), and the transfer of the sound signal into high and low frequency ranges through internal circuitry to allow for further processing.

Figure 10: Buffer Box front panel

HF (analogue) sound from each of the hydrophones in the array is fed through an internal National Instruments USB-6251 sampling card and then fed out via a USB socket (labelled as "NI OUT") on the rear panel.

The pressure in the depth sensor at the end of the hydrophone array cable is expressed as a voltage (analogue) that is fed through an analogue to digital convertor and is available for use in Pamguard from a USB socket on the Buffer Box (labelled as "DEPTH OUT") on the rear panel.

Additional BNC connectors on the front panel allow LF and HF signals from each hydrophone to be available directly as required. An optional BNC to ¼" headphone socket cable allows direct monitoring of LF audio from individual hydrophones.

LF (analogue) sound from each of the hydrophones in the array is output to XLR connectors on the rear of the Buffer Box and then to an external Fireface 800 sound card where it is converted to digital format.

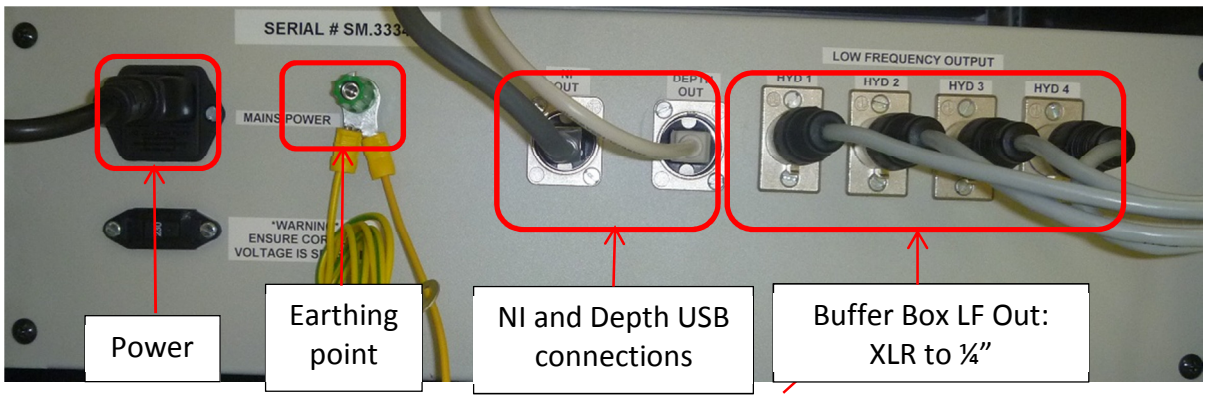

Figure 11: Buffer Box rear panel connections

Separate switches on the Buffer Box are used to control power supply to the National Instruments card and other electronics. Additional earthing may be added to the Buffer Box (to help reduce system noise) by means of an earthing point on the rear of the housing.

4.3 Fireface 800

The RME Fireface 800 contains a sound card that converts the LF (analogue) output from the Buffer Box into a digital format that can be used by the Pamguard PC via a Firewire 400 connection.

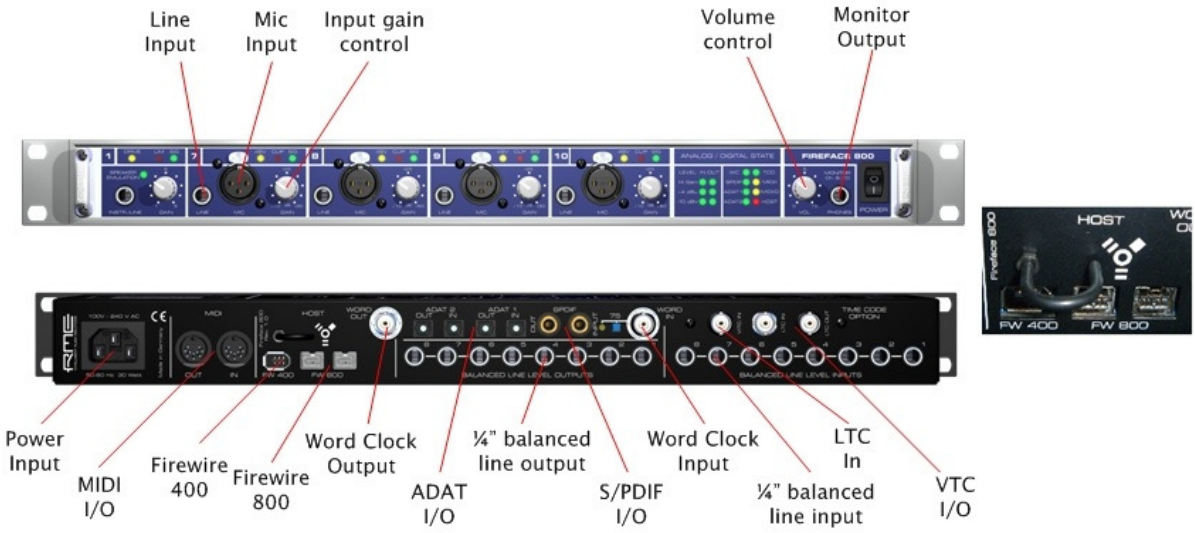

Figure 12: Fireface 800 front and rear panels, and Firewire connections

The Fireface software allows the PAM operator to control which hydrophone signals are monitored over headphones. The headphone mix can consist of the raw hydrophone signals or the processed playback signal from the laptop. The playback output has a veto that removes the sound of airgun shots.

4.4 JTS Remote Headset

The JTS Remote Headset system comprises of a base station transmitter and a remote (belt-mounted) receiver that is used to listen to the LF audio stream (limited to 16 kHz) as output from the Fireface 800.

Figure 13: JTS Remote Headset base station rear panel connections

4.5 Pamguard PC

The Pamguard PC has an Intel quad core i5 processor with 8Gb of RAM. This system can process and display HF and LF audio data through Pamguard simultaneously from up to 4 hydrophones. It is rack-mounted and can support multiple monitors and USB inputs.

4.6 GPS and AIS

The Pamguard PC receives NMEA format Global Positioning System (GPS) positioning information, and Automatic Identification System (AIS) information on vessel positions via their USB ports. This data may be available as a feed from vessel systems, or from dedicated receivers such as the USB GPS provided by Seiche. A 9-pin RS232 to USB convertor will enable use of NMEA feeds from equipment with a serial port.

APPENDIX C: HYDROPHONE DEPLOYMENT

Norseman PAM Hydrophone Deployment Procedures

03 September 2013

Overview

A 125 meter hydrophone array cable and a 230 meter hydrophone tow cable have been supplied for the survey. The linear hydrophone array contains four broadband elements (75 hertz to 200 kilohertz and a depth gauge (100 meter capacity) embedded directly into the cable. The four hydrophones have been positioned in two pairs, with the first pair positioned roughly 97 meters ahead of the second pair (near the depth gauge; Figure 1). One 100 meter deck cable is attached to the tow cable located on the stern winch. It is then routed through the ship to the data processing unit located on the main deck.

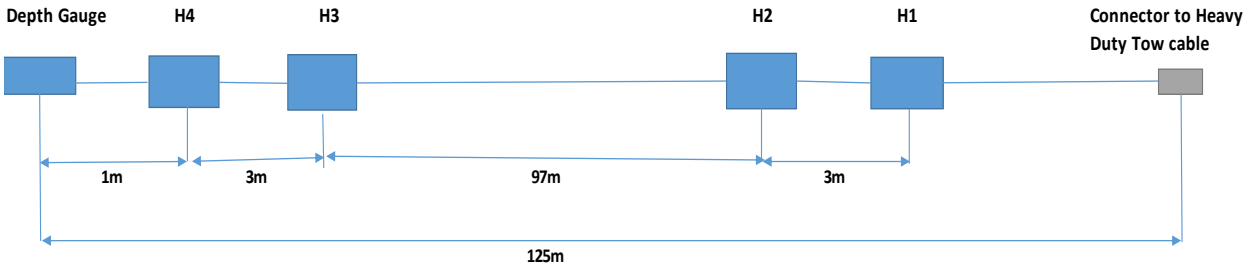

Figure 1: Schematic diagram of the hydrophone array cable indicating the position and separation of individual hydrophone elements and hydrophone pairs.

The hydrophone cable (black) and tow cable (yellow) are deployed directly off the stern of the *Norseman*. Approximately 225 meters of the hydrophone and tow cable combination is deployed from the stern with a Chinese finger (Figure 2). The Chinese finger is attached to the vessel's A-frame. The Chinese finger provides slack in the cable forward until the winch. Where the hydrophone cable lightly touches the rail, the rail has been wrapped in a protective plastic wrap to reduce possibility of chaffing on the cable. The remaining hydrophone tow cable has been wound on the winch (Figure 3A). On average, the end of the cable tows at a depth of 27 meters.

During deployment, the first 15 meters of the hydrophone array cable is paid out by hand and tossed out from the vessel. Then approximately 218 meters is paid out slowly and directly into the water. At about 218 meters, the Chinese finger is tied onto the cable and attached to the A-frame. Another seven meters is deployed placing the Chinese finger beyond the stern of the vessel. This provides the slack between the Chinese finger, vessel rail and the winch. This slack is needed due to the dramatic pitch and roll of the 108 foot (~33 meter) vessel. Prior to powering up the DPU, the hydrophone tow cable and deck cable are fastened at the connection located near the side of the winch (Figure 3B). Prior to the deployment, the deck cable had been run through the vessel deck and sealed water tight (Figure 4). A diagram of the complete deployment is located in Figure 5.

During retrieval, the hydrophone cable is slowly loaded onto the winch. After the Chinese finger is removed the remainder of the cable is recovered with the winch.

During periods of light ice, the bridge crew has agreed upon 150 meters of cable deployed to increase vessel maneuverability. During heavy ice, the cable will be recovered completely.

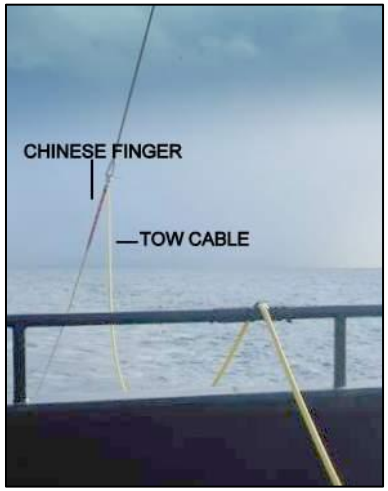

Figure 2: Chinese finger forming the tow point for the hydrophone cable from the A-frame on the stern.

Figure 3: PAM tow cable on winch (A) and tow cable connection to deck cable (B).

Figure 4: PAM deck cable routed through vessel and sealed water tight.

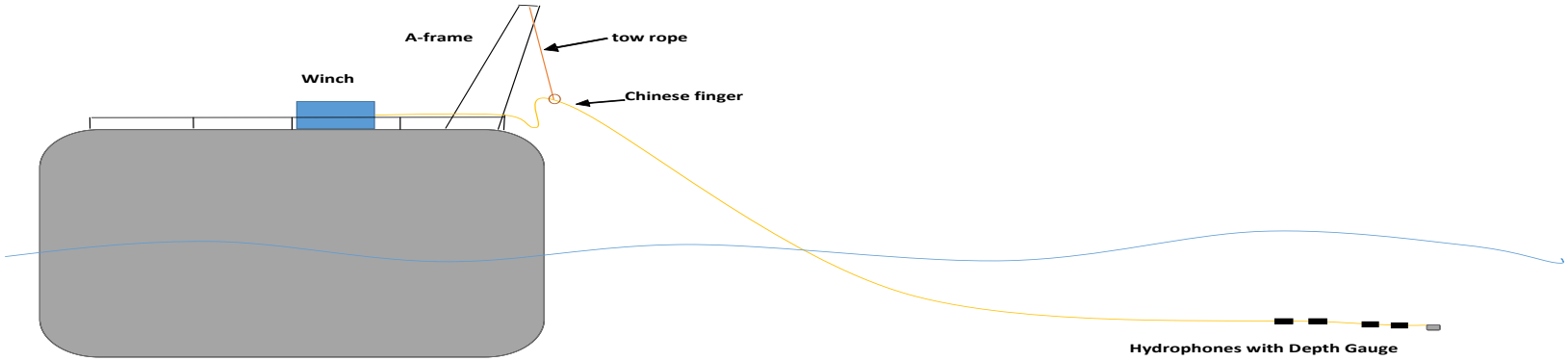

Figure 5: Sketch of the hydrophone deployment on the *Norseman* (~5m drogue rope not shown).

Pre-Deployment Tasks

The PAM data processing unit, laptop, and monitor had been setup on the main deck in the lab (Figure 6). A GPS feed (GPGGA string) was provided from the *Norseman*'s GPS. The data processing unit (DPU) had also been set up on the main deck (Figure 7). Both monitors and DPU have been secured in preparation for rough seas.

Figure 6: Passive acoustic monitoring station on the main deck including two monitors attached to the DPU.

Figure 7: DPU secured to deck.

One 100 meter deck cable has been routed from the main deck to the back deck.

- From the lab on the main deck, the deck cable was run from the DPU, up the wall, along the ceiling and into the bulkhead near the aft door.

- From inside the bulkhead, the cable ran through the deck, down one level onto the lazarette, an area used for storage and where the cable spools are stored.
- From the lazarette, the deck cable was run up through the poop deck, also known as the back deck. The opening was then secured with water tight sealant around the cable.
- From there, the deck cable can be attached and detached near the winch.
- The system was tested and the hydrophone depth gauge calibrated prior to initial deployment.

The hydrophone tow cable (yellow) was measured and marked in 6.5 meter lengths and then boldly marked every 25 meters. The hydrophone array was not marked, since desired deployment is greater than the length of the black array.

Deployment

- Ensure that the PAM electronics unit is powered down.
- JSA meeting with participating crew.
- Toolbox meeting with participating crew.
- Ensure the deck cable is disconnected from the hydrophone tow cable (place protective caps on both connectors to prevent corrosion).
- Open hydraulics and switch generator over (by *Norseman* crew).
- The first 15 meters of the hydrophone array cable (including approximately 5 meter drogue rope) is paid out by hand and tossed out from the vessel.
- Then approximately 218 meters is paid out slowly and directly into the water, slowing more to manually pass the tow/array cable connector and the hydrophones as they come over the stern rail.
- At about 218 meters, the Chinese finger is tied onto the cable and attached to the A-frame.
- Another seven meters is deployed placing the Chinese finger beyond the stern of the vessel, creating the total length of 225 meters deployed.
- Fasten the hydrophone tow cable and deck cable at the connection located near the side of the winch.
- Close the hydraulics for the winch and switch back generators (*Norseman* crew).
- Connect the deck cable to the hydrophone tow cable.
- Power up electronics in lab.

Retrieval

- Power down electronics in lab.
- JSA meeting with participating crew.
- Toolbox meeting with participating crew.
- Ensure the deck cable is disconnected from the hydrophone tow cable (place protective caps and tape on both connectors to prevent corrosion).
- Open hydraulics and switch generator over (by *Norseman* crew).

- Slowly bring in approximately seven meters to remove the Chinese finger from the cable.
- Then approximately 218 meters is brought in slowly, slowing even more in preparation to manually pass the tow/array cable connector and the hydrophones as they come over the stern rail.
- Secure drogue rope in place.
- Secure wrapped deck cable connector on top of the winch box with clamp to keep it off the wet deck.
- Close the hydraulics for the spreader rope winch (*Norseman crew).*

Always ensure the deck cable is disconnected from the tow cable before operating the winch.

HSE

In addition to the normal working deck PPE that is required (hard hat, steel toe boots, gloves and eye protection), a safety harness is required for the crew member near the stern. The operation carries a relatively low risk. Hazards include working close to the side of the vessel, trip hazards, and pinch points.

A Job Safety Analysis (JSA) has been completed for this task. The JSA will also require further review upon any additional modifications.

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APPENDIX D: ACOUSTIC EFFORT DATA

RPS

PROTECTED SPECIES RECORDING FORM

EFFORT

Regulatory Reference Number 13-02

Project Number UMS04183

Vessel Name *Norseman*

Effort Page Number 1 of 25

Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-08-28	acoustic	LM	08:05	70.65505°N	163.86420°W	47	09:29	70.72578°N	163.73150°W	47	25	N	6	2-4	n/a	n/a
2013-08-28	acoustic	LH	09:29	70.72578°N	163.73150°W	47	12:00	70.67985°N	163.37868°W	42	25	N	6	2-4	n/a	n/a
2013-08-28	acoustic	BN	12:00	70.67985°N	163.37868°W	42	15:00	70.53222°N	163.82663°W	44	25	N	6	2-4	n/a	n/a
2013-08-28	acoustic	HI	15:00	70.53222°N	163.82663°W	44	18:00	70.38217°N	163.99772°W	41	18	N	5	2-4	n/a	n/a
2013-08-28	acoustic	BN	18:00	70.38217°N	163.99772°W	41	21:00	70.38527°N	164.46578°W	42	18	N	5	2-4	n/a	n/a
2013-08-28	acoustic	HI	21:00	70.38527°N	164.46578°W	42	24:00	70.46417°N	164.44350°W	45	16	N	4	<2	n/a	n/a
2013-08-29	acoustic	LM	00:00	70.46417°N	164.44350°W	45	03:00	70.37665°N	163.95777°W	39	15	NW	4	<2	n/a	n/a
2013-08-29	acoustic	LH	03:00	70.37665°N	163.95777°W	39	06:00	70.39533°N	163.84567°W	38	15	W	4	<2	n/a	n/a
2013-08-29	acoustic	LM	06:00	70.39533°N	163.84567°W	38	09:00	70.47600°N	163.67563°W	40	12	W	4	<2	n/a	n/a
2013-08-29	acoustic	LH	09:00	70.47600°N	163.67563°W	40	12:00	70.35318°N	164.09250°W	41	10	W	3	<2	n/a	n/a
2013-08-29	acoustic	BN	12:00	70.35318°N	164.09250°W	41	14:55	70.39115°N	164.50110°W	45	8	W	3	<2	n/a	n/a
2013-08-29	acoustic	HI	14:55	70.39115°N	164.50110°W	45	17:50	70.49150°N	165.04865°W	46	7	WNW	3	<2	n/a	n/a
2013-08-29	acoustic	BN	17:50	70.49150°N	165.04865°W	46	20:58	70.62100°N	165.02640°W	44	15	SW	4	<2	n/a	n/a
2013-08-29	acoustic	HI	20:58	70.62100°N	165.02640°W	44	24:00	70.44650°N	164.72333°W	47	10	SE	4	<2	n/a	n/a
2013-08-30	acoustic	LM	00:00	70.44650°N	164.72333°W	47	03:00	70.54543°N	165.39910°W	45	10	SW	3	<2	n/a	n/a
2013-08-30	acoustic	LH	03:00	70.54543°N	165.39910°W	45	06:00	70.66867°N	166.03467°W	43	5	SW	2	<2	n/a	n/a
2013-08-30	acoustic	LM	06:00	70.66867°N	166.03467°W	43	09:15	70.81412°N	166.65675°W	44	5	N	2	<2	n/a	n/a
2013-08-30	acoustic	LH	09:15	70.81412°N	166.65675°W	44	11:50	70.89545°N	167.11210°W	48	8	NW	3	<2	n/a	n/a
2013-08-30	acoustic	BN	11:50	70.89545°N	167.11210°W	48	14:57	71.01068°N	167.81222°W	48	5	W	2	<2	n/a	n/a
2013-08-30	acoustic	HI	14:57	71.01068°N	167.81222°W	48	17:45	71.10420°N	168.34062°W	52	5	W	2	<2	n/a	n/a
2013-08-30	acoustic	BN	17:45	71.10420°N	168.34062°W	52	20:56	71.12505°N	168.94212°W	48	10	W	3	<2	n/a	n/a
2013-08-30	acoustic	HI	20:56	71.12505°N	168.94212°W	48	24:00	70.93150°N	168.92250°W	43	5	W	2	<2	n/a	n/a
2013-08-31	acoustic	LM	00:00	70.93150°N	168.92250°W	43	02:55	70.77523°N	168.71075°W	39	8	NW	2	<2	n/a	n/a
2013-08-31	acoustic	LH	02:55	70.77523°N	168.71075°W	39	06:00	70.86500°N	168.50800°W	41	10	NW	3	<2	n/a	n/a
2013-08-31	acoustic	LM	06:00	70.86500°N	168.50800°W	41	09:06	70.75457°N	168.62645°W	41	10	NW	3	<2	n/a	n/a
2013-08-31	acoustic	LH	09:06	70.75457°N	168.62645°W	41	11:45	70.66645°N	168.09138°W	47	7	W	3	<2	n/a	n/a
2013-08-31	acoustic	BN	11:45	70.66645°N	168.09138°W	47	15:00	70.55343°N	167.41540°W	50	5	W	3	<2	n/a	n/a
2013-08-31	acoustic	HI	15:00	70.55343°N	167.41540°W	50	17:21	70.47495°N	166.98367°W	50	3	variable	1	<2	n/a	n/a
2013-08-31	acoustic	HI	17:21	70.47495°N	166.98367°W	50	17:42	70.46058°N	166.93065°W	51	3	variable	1	<2	n/a	n/a
2013-08-31	acoustic	BN	17:42	70.46058°N	166.93065°W	51	19:00	70.50028°N	167.20163°W	51	3	W	1	<2	n/a	n/a

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PROTECTED SPECIES RECORDING FORM

EFFORT

Regulatory Reference Number 13-02

Project Number UMS04183

Vessel Name *Norseman*

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-08-31	acoustic	BN	19:00	70.50028°N	167.20163°W	51	20:57	70.55103°N	167.42730°W	51	3	W	1	<2	n/a	n/a
2013-08-31	acoustic	HI	20:57	70.55103°N	167.42730°W	51	22:18	70.54372°N	167.43502°W	51	2	W	1	<2	n/a	n/a
2013-08-31	acoustic	HI	22:18	70.54372°N	167.43502°W	51	22:56	70.53615°N	167.30252°W	51	2	W	1	<2	n/a	n/a
2013-08-31	acoustic	HI	22:56	70.53615°N	167.30252°W	51	23:24	70.50310°N	167.24320°W	51	2	W	1	<2	n/a	n/a
2013-08-31	acoustic	HI	23:24	70.50310°N	167.24320°W	51	23:53	70.49665°N	167.13888°W	51	2	W	1	<2	n/a	n/a
2013-08-31	acoustic	HI	23:53	70.49665°N	167.13888°W	51	24:00	70.49700°N	167.09917°W	52	2	W	1	<2	n/a	n/a
2013-09-01	acoustic	LM	00:00	70.49700°N	167.09917°W	52	03:00	70.38063°N	166.54960°W	46	3	NE	1	<2	n/a	n/a
2013-09-01	acoustic	LH	03:00	70.38063°N	166.54960°W	46	06:00	70.27600°N	165.89383°W	45	2	W	1	<2	n/a	n/a
2013-09-01	acoustic	LM	06:00	70.27600°N	165.89383°W	45	09:00	70.15415°N	165.40467°W	43	2	E	1	<2	n/a	n/a
2013-09-01	acoustic	LH	09:00	70.15415°N	165.40467°W	43	09:30	70.14852°N	165.28860°W	43	9	E	3	<2	n/a	n/a
2013-09-01	acoustic	HI	22:49	70.36447°N	164.65745°W	44	23:50	70.42387°N	164.54160°W	44	15	NE	4	<2	n/a	n/a
2013-09-01	acoustic	HI	23:50	70.42387°N	164.54160°W	44	24:00	70.43583°N	164.52033°W	44	15	E	4	<2	n/a	n/a
2013-09-02	acoustic	LM	00:00	70.43583°N	164.52033°W	44	00:15	70.45183°N	164.48367°W	45	15	E	4	<2	n/a	n/a
2013-09-02	acoustic	LM	00:15	70.45183°N	164.48367°W	45	03:00	70.60053°N	164.19380°W	48	18	E	4	<2	n/a	n/a
2013-09-02	acoustic	LH	03:00	70.60053°N	164.19380°W	48	06:00	70.79950°N	163.86167°W	48	18	E	5	<2	n/a	n/a
2013-09-02	acoustic	LM	06:00	70.79950°N	163.86167°W	48	09:05	70.99325°N	163.48758°W	47	18	E	5	<2	n/a	n/a
2013-09-02	acoustic	LH	09:05	70.99325°N	163.48758°W	47	11:36	71.15050°N	163.16213°W	47	25	ENE	6	2-4	n/a	n/a
2013-09-02	acoustic	LH	11:44	71.16127°N	163.13867°W	47	11:52	71.16127°N	163.13867°W	47	15	NE	4	<2	n/a	n/a
2013-09-02	acoustic	BN	11:52	71.16127°N	163.13867°W	47	12:57	71.24065°N	162.98790°W	47	15	NE	4	<2	n/a	n/a
2013-09-04	acoustic	BN	19:16	70.66482°N	163.81942°W	46	20:24	70.69712°N	164.06303°W	46	25	NE	6	2-4	n/a	n/a
2013-09-04	acoustic	BN	20:24	70.69712°N	164.06303°W	46	20:48	70.70828°N	164.10000°W	46	25	NE	6	2-4	n/a	n/a
2013-09-04	acoustic	BN	20:48	70.70828°N	164.10000°W	46	21:00	70.71995°N	164.10542°W	48	25	NE	6	2-4	n/a	n/a
2013-09-04	acoustic	HI	21:00	70.71995°N	164.10542°W	48	24:00	70.83417°N	164.68317°W	37	25	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	LM	00:00	70.83417°N	164.68317°W	37	03:00	70.93477°N	165.27620°W	43	25	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	LH	03:00	70.93477°N	165.27620°W	43	06:00	71.06700°N	165.83350°W	45	22	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	LM	06:00	71.06700°N	165.83350°W	45	09:00	71.17358°N	166.45588°W	47	25	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	LH	09:00	71.17358°N	166.45588°W	47	12:05	71.00000°N	167.14020°W	48	25	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	BN	12:05	71.00000°N	167.14020°W	48	14:30	71.37158°N	167.63642°W	48	16	NE	4	2-4	n/a	n/a
2013-09-05	acoustic	BN	14:30	71.37158°N	167.63642°W	48	14:44	71.38017°N	167.68633°W	48	16	NE	4	2-4	n/a	n/a
2013-09-05	acoustic	BN	14:44	71.38017°N	167.68633°W	48	14:55	71.38797°N	167.67460°W	50	16	NE	4	2-4	n/a	n/a

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PROTECTED SPECIES RECORDING FORM

EFFORT

Regulatory Reference Number 13-02

Project Number UMS04183

Vessel Name *Norseman*

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-05	acoustic	HI	14:55	71.38797°N	167.67460°W	50	16:35	71.27528°N	167.81162°W	50	25	NE	5	2-4	n/a	n/a
2013-09-05	acoustic	HI	16:35	71.27528°N	167.81162°W	50	16:59	71.24968°N	167.89125°W	50	25	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	HI	16:59	71.24968°N	167.89125°W	50	17:50	71.19008°N	168.07323°W	49	25	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	BN	17:50	71.19008°N	168.07323°W	49	20:56	70.97028°N	168.42548°W	48	25	NE	6	2-4	n/a	n/a
2013-09-05	acoustic	HI	20:56	70.97028°N	168.42548°W	48	24:00	70.75867°N	168.77917°W	38	25	NE	6	2-4	n/a	n/a
2013-09-06	acoustic	LM	00:00	70.75867°N	168.77917°W	38	02:39	70.60833°N	168.83967°W	37	23	NE	6	2-4	n/a	n/a
2013-09-06	acoustic	LM	02:39	70.60833°N	168.83967°W	38	02:45	70.60400°N	168.82617°W	37	23	NE	6	2-4	n/a	n/a
2013-09-06	acoustic	LM	02:45	70.60400°N	168.82617°W	37	03:00	70.58865°N	168.81005°W	37	23	NE	6	2-4	n/a	n/a
2013-09-06	acoustic	LH	03:00	70.58865°N	168.81005°W	37	06:00	70.45733°N	168.41300°W	40	23	NE	6	2-4	n/a	n/a
2013-09-06	acoustic	LM	06:00	70.45733°N	168.41300°W	40	08:37	70.45700°N	168.02067°W	47	30	E	7	2-4	n/a	n/a
2013-09-06	acoustic	LM	08:37	70.45700°N	168.02067°W	47	09:00	70.48917°N	167.99328°W	46	30	E	7	2-4	n/a	n/a
2013-09-06	acoustic	LH	09:00	70.48917°N	167.99328°W	46	11:52	70.66928°N	167.66925°W	53	25	ENE	6	2-4	n/a	n/a
2013-09-06	acoustic	BN	11:52	70.66928°N	167.66925°W	53	12:16	70.69945°N	167.66843°W	53	25	NE	6	2-4	n/a	n/a
2013-09-06	acoustic	BN	12:16	70.69945°N	167.66843°W	53	15:57	70.60590°N	167.99608°W	48	25	NE	6	2-4	n/a	n/a
2013-09-06	acoustic	HI	15:57	70.60590°N	167.99608°W	48	17:23	70.62973°N	167.79048°W	48	25	ENE	6	2-4	n/a	n/a
2013-09-06	acoustic	HI	17:23	70.62973°N	167.79048°W	48	17:49	70.65863°N	167.74667°W	52	25	ENE	6	2-4	n/a	n/a
2013-09-06	acoustic	BN	17:49	70.65863°N	167.74667°W	52	18:39	70.71077°N	167.65598°W	52	20	SE	5	2-4	n/a	n/a
2013-09-06	acoustic	BN	18:39	70.71077°N	167.65598°W	52	20:57	70.62578°N	167.74430°W	52	20	SE	5	2-4	n/a	n/a
2013-09-06	acoustic	HI	20:57	70.62578°N	167.74430°W	52	22:13	70.55533°N	167.88763°W	52	10	SE	4	2-4	n/a	n/a
2013-09-06	acoustic	HI	22:13	70.55533°N	167.88763°W	52	23:33	70.62322°N	167.80183°W	52	10	SE	4	<2	n/a	n/a
2013-09-06	acoustic	HI	23:33	70.62322°N	167.80183°W	52	24:00	70.65733°N	167.74683°W	52	10	SE	3	<2	n/a	n/a
2013-09-07	acoustic	LM	00:00	70.65733°N	167.74683°W	52	03:00	70.84317°N	167.42110°W	52	10	S	3	<2	n/a	n/a
2013-09-07	acoustic	LH	03:00	70.84317°N	167.42110°W	52	06:00	71.04133°N	167.08783°W	44	10	S	3	<2	n/a	n/a
2013-09-07	acoustic	LM	06:00	71.04133°N	167.08783°W	44	07:30	71.15967°N	166.93400°W	47	12	S	3	<2	n/a	n/a
2013-09-07	acoustic	LM	07:30	71.15967°N	166.93400°W	47	08:10	71.21783°N	166.88483°W	47	12	S	3	<2	n/a	n/a
2013-09-07	acoustic	LM	08:10	71.21783°N	166.88483°W	47	09:00	71.28427°N	167.01933°W	47	10	S	3	<2	n/a	n/a
2013-09-07	acoustic	LH	09:00	71.28427°N	167.01933°W	47	10:14	71.33727°N	167.32960°W	47	10	S	3	<2	n/a	n/a
2013-09-07	acoustic	LH	10:14	71.33727°N	167.32960°W	47	11:55	71.40548°N	167.73757°W	49	10	S	3	<2	n/a	n/a
2013-09-07	acoustic	BN	11:55	71.40548°N	167.73757°W	49	14:57	71.52930°N	168.27042°W	50	10	SW	3	<2	n/a	n/a
2013-09-07	acoustic	HI	14:57	71.52930°N	168.27042°W	50	17:52	71.67292°N	168.87467°W	50	10	SW	3	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-07	acoustic	BN	17:52	71.67292°N	168.87467°W	50	19:16	71.77123°N	168.69368°W	50	10	SW	3	<2	n/a	n/a
2013-09-07	acoustic	BN	19:16	71.77123°N	168.69368°W	50	20:54	71.82737°N	168.52218°W	47	10	SW	3	<2	n/a	n/a
2013-09-07	acoustic	HI	20:54	71.82737°N	168.52218°W	47	21:08	71.82968°N	168.49960°W	47	10	SW	3	<2	n/a	n/a
2013-09-07	acoustic	HI	21:08	71.82968°N	168.49960°W	47	24:00	71.86050°N	168.15767°W	51	10	SW	3	<2	n/a	n/a
2013-09-08	acoustic	LM	00:00	71.86050°N	168.15767°W	51	00:20	71.83850°N	168.14100°W	51	10	SW	3	<2	n/a	n/a
2013-09-08	acoustic	LM	00:20	71.83850°N	168.14100°W	51	00:51	71.80583°N	168.14067°W	51	10	SW	3	<2	n/a	n/a
2013-09-08	acoustic	LM	00:51	71.80583°N	168.14067°W	51	03:00	71.64985°N	167.97985°W	50	10	SW	3	<2	n/a	n/a
2013-09-08	acoustic	LH	03:00	71.64985°N	167.97985°W	50	06:00	71.41567°N	167.80517°W	49	10	SW	3	<2	n/a	n/a
2013-09-08	acoustic	LM	06:00	71.41567°N	167.80517°W	49	09:00	71.19915°N	167.60417°W	48	10	SW	3	<2	n/a	n/a
2013-09-08	acoustic	LH	09:00	71.19915°N	167.60417°W	48	11:57	70.98735°N	167.45690°W	48	8	S	3	<2	n/a	n/a
2013-09-08	acoustic	BN	11:57	70.98735°N	167.45690°W	48	14:57	70.77635°N	167.29010°W	53	5	SW	2	<2	n/a	n/a
2013-09-08	acoustic	HI	14:57	70.77635°N	167.29010°W	53	17:14	70.60838°N	167.16752°W	53	5	SE	2	<2	n/a	n/a
2013-09-08	acoustic	HI	17:14	70.60838°N	167.16752°W	53	17:46	70.61067°N	167.19402°W	54	5	SE	2	<2	n/a	n/a
2013-09-08	acoustic	BN	17:46	70.61067°N	167.19402°W	54	20:53	70.75217°N	167.35772°W	55	10	E	3	<2	n/a	n/a
2013-09-08	acoustic	HI	20:53	70.75217°N	167.35772°W	55	21:14	70.78087°N	167.38335°W	55	10	E	3	<2	n/a	n/a
2013-09-08	acoustic	HI	21:14	70.78087°N	167.38335°W	55	23:24	70.70448°N	167.23380°W	55	10	E	3	<2	n/a	n/a
2013-09-08	acoustic	HI	23:24	70.70448°N	167.23380°W	55	23:51	70.67613°N	167.20530°W	55	10	E	3	<2	n/a	n/a
2013-09-08	acoustic	HI	23:51	70.67613°N	167.20530°W	55	24:00	70.66183°N	167.21900°W	54	10	E	3	<2	n/a	n/a
2013-09-09	acoustic	LM	00:00	70.66183°N	167.21900°W	54	03:00	70.44057°N	167.02615°W	51	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	LH	03:00	70.44057°N	167.02615°W	51	06:00	70.20133°N	166.91483°W	47	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	LM	06:00	70.20133°N	166.91483°W	47	06:13	70.18300°N	166.92417°W	47	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	LM	06:13	70.18300°N	166.92417°W	47	06:18	70.17867°N	166.91233°W	47	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	LM	06:18	70.17867°N	166.91233°W	47	09:03	70.08940°N	166.28623°W	47	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	LH	09:03	70.08940°N	166.28623°W	47	10:18	70.14565°N	166.21712°W	47	7	NE	3	<2	n/a	n/a
2013-09-09	acoustic	LH	10:18	70.14565°N	166.21712°W	47	10:40	70.17033°N	166.17520°W	47	8	NE	3	<2	n/a	n/a
2013-09-09	acoustic	LH	10:40	70.17033°N	166.17520°W	47	12:00	70.26502°N	166.04803°W	46	8	NE	3	<2	n/a	n/a
2013-09-09	acoustic	BN	12:00	70.26502°N	166.04803°W	46	14:59	70.42967°N	165.78617°W	46	5	NE	2	<2	n/a	n/a
2013-09-09	acoustic	HI	14:59	70.42967°N	165.78617°W	46	15:20	70.45202°N	165.74452°W	46	5	NE	2	<2	n/a	n/a
2013-09-09	acoustic	HI	15:20	70.45202°N	165.74452°W	46	17:48	70.44723°N	165.74430°W	46	5	NE	2	<2	n/a	n/a
2013-09-09	acoustic	BN	17:48	70.44723°N	165.74430°W	46	20:27	70.40707°N	165.75210°W	46	5	E	2	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-09	acoustic	BN	20:27	70.40707°N	165.75210°W	46	20:50	70.43908°N	165.74305°W	46	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	BN	20:50	70.43908°N	165.74305°W	46	20:54	70.44195°N	165.72818°W	46	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	BN	20:54	70.44195°N	165.72818°W	46	20:57	70.44420°N	165.71620°W	45	5	E	2	<2	n/a	n/a
2013-09-09	acoustic	HI	20:57	70.44420°N	165.71620°W	45	24:00	70.64050°N	165.37733°W	44	3	NE	1	<2	n/a	n/a
2013-09-10	acoustic	LM	00:00	70.64050°N	165.37733°W	44	03:00	70.83317°N	165.03925°W	41	2	N	1	<2	n/a	n/a
2013-09-10	acoustic	LH	03:00	70.83317°N	165.03925°W	41	06:00	71.02267°N	164.63950°W	40	1	N	1	<2	n/a	n/a
2013-09-10	acoustic	LM	06:00	71.02267°N	164.63950°W	40	09:00	71.22133°N	164.30333°W	44	1	N	1	<2	n/a	n/a
2013-09-10	acoustic	LH	09:00	71.22133°N	164.30333°W	44	11:55	71.41182°N	163.91162°W	46	3	ENE	1	<2	n/a	n/a
2013-09-10	acoustic	BN	11:55	71.41182°N	163.91162°W	46	14:56	71.59448°N	163.55718°W	43	5	NE	2	<2	n/a	n/a
2013-09-10	acoustic	HI	14:56	71.59448°N	163.55718°W	43	16:49	71.72650°N	163.30305°W	43	5	NE	2	<2	n/a	n/a
2013-09-10	acoustic	HI	16:49	71.72650°N	163.30305°W	43	16:54	71.73223°N	163.29228°W	43	5	NE	2	<2	n/a	n/a
2013-09-10	acoustic	HI	16:54	71.73223°N	163.29228°W	43	17:54	71.77493°N	163.51390°W	43	5	NE	2	<2	n/a	n/a
2013-09-10	acoustic	BN	17:54	71.77493°N	163.51390°W	43	18:45	71.83477°N	163.92980°W	43	5	NE	2	<2	n/a	n/a
2013-09-10	acoustic	BN	18:45	71.83477°N	163.92980°W	43	21:00	71.86265°N	164.26085°W	41	5	NE	2	<2	n/a	n/a
2013-09-10	acoustic	HI	21:00	71.86265°N	164.26085°W	41	24:00	71.80550°N	164.93200°W	42	5	NE	2	<2	n/a	n/a
2013-09-11	acoustic	LM	00:00	71.80550°N	164.93200°W	42	03:00	71.74923°N	165.63300°W	42	5	S	2	<2	n/a	n/a
2013-09-11	acoustic	LH	03:00	71.74923°N	165.63300°W	42	06:00	71.68283°N	166.30317°W	46	5	S	2	<2	n/a	n/a
2013-09-11	acoustic	LM	06:00	71.68283°N	166.30317°W	46	09:00	71.61257°N	167.00533°W	48	8	E	3	<2	n/a	n/a
2013-09-11	acoustic	LH	09:00	71.61257°N	167.00533°W	48	11:58	71.56007°N	167.68808°W	50	12	E	4	<2	n/a	n/a
2013-09-11	acoustic	BN	11:58	71.56007°N	167.68808°W	50	14:57	71.48602°N	168.36198°W	50	10	N	3	<2	n/a	n/a
2013-09-11	acoustic	HI	14:57	71.48602°N	168.36198°W	50	17:50	71.37852°N	168.90107°W	50	10	E	3	<2	n/a	n/a
2013-09-11	acoustic	BN	17:50	71.37852°N	168.90107°W	50	17:56	71.37225°N	168.90223°W	50	5	NE	2	<2	n/a	n/a
2013-09-11	acoustic	BN	17:56	71.37225°N	168.90223°W	50	20:56	71.16328°N	168.90413°W	50	5	NE	2	<2	n/a	n/a
2013-09-11	acoustic	HI	20:56	71.16328°N	168.90413°W	50	21:18	71.13270°N	168.89738°W	50	5	NE	2	<2	n/a	n/a
2013-09-11	acoustic	HI	21:18	71.13270°N	168.89738°W	50	23:29	71.10367°N	168.50332°W	50	5	NE	2	<2	n/a	n/a
2013-09-11	acoustic	HI	23:29	71.10367°N	168.50332°W	50	23:58	71.11283°N	168.41933°W	52	5	NE	2	<2	n/a	n/a
2013-09-11	acoustic	LM	23:58	71.11283°N	168.41933°W	52	24:00	71.11283°N	168.38567°W	52	5	NE	2	<2	n/a	n/a
2013-09-12	acoustic	LM	00:00	71.11283°N	168.38567°W	52	03:00	71.18503°N	167.75165°W	47	5	NE	2	<2	n/a	n/a
2013-09-12	acoustic	LH	03:00	71.18503°N	167.75165°W	47	06:00	71.25333°N	167.07783°W	48	10	SE	3	<2	n/a	n/a
2013-09-12	acoustic	LM	06:00	71.25333°N	167.07783°W	48	06:55	71.27650°N	166.88183°W	47	10	SE	3	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-12	acoustic	LM	06:55	71.27650°N	166.88183°W	47	09:04	71.20292°N	167.09067°W	48	10	SE	3	<2	n/a	n/a
2013-09-12	acoustic	LH	09:04	71.20292°N	167.09067°W	48	11:58	71.08838°N	167.79645°W	47	12	SW	4	<2	n/a	n/a
2013-09-12	acoustic	BN	11:58	71.08838°N	167.79645°W	47	14:59	71.29465°N	167.90755°W	48	5	W	2	<2	n/a	n/a
2013-09-12	acoustic	HI	14:59	71.29465°N	167.90755°W	48	15:25	71.31567°N	167.90447°W	48	5	SW	2	<2	n/a	n/a
2013-09-12	acoustic	HI	15:25	71.31567°N	167.90447°W	48	15:50	71.33755°N	167.83427°W	48	5	SW	2	<2	n/a	n/a
2013-09-12	acoustic	HI	15:50	71.33755°N	167.83427°W	48	17:50	71.45640°N	167.64060°W	49	5	SW	2	<2	n/a	n/a
2013-09-12	acoustic	BN	17:50	71.45640°N	167.64060°W	49	20:55	71.66078°N	167.30920°W	50	5	SW	2	<2	n/a	n/a
2013-09-12	acoustic	HI	20:55	71.66078°N	167.30920°W	50	24:00	71.87533°N	166.93617°W	49	5	E	2	<2	n/a	n/a
2013-09-13	acoustic	LM	00:00	71.87533°N	166.93617°W	49	03:00	72.06195°N	166.56775°W	49	5	E	2	<2	n/a	n/a
2013-09-13	acoustic	LH	03:00	72.06195°N	166.56775°W	49	06:00	72.26017°N	166.25200°W	50	8	NE	3	<2	n/a	n/a
2013-09-13	acoustic	LM	06:00	72.26017°N	166.25200°W	50	07:15	72.34117°N	166.05133°W	51	7	NE	3	<2	n/a	n/a
2013-09-13	acoustic	LM	07:15	72.34117°N	166.05133°W	51	09:00	72.30510°N	165.69270°W	50	7	NE	3	<2	n/a	n/a
2013-09-13	acoustic	LH	09:00	72.30510°N	165.69270°W	50	11:55	72.13140°N	165.11280°W	45	15	ENE	4	<2	n/a	n/a
2013-09-13	acoustic	BN	11:55	72.13140°N	165.11280°W	45	12:37	72.07573°N	165.22495°W	45	15	NE	4	<2	n/a	n/a
2013-09-13	acoustic	BN	12:37	72.07573°N	165.22495°W	45	13:02	72.04223°N	165.28933°W	45	15	NE	4	<2	n/a	n/a
2013-09-13	acoustic	BN	13:02	72.04223°N	165.28933°W	45	13:07	72.03627°N	165.30160°W	45	15	NE	4	<2	n/a	n/a
2013-09-13	acoustic	BN	13:07	72.03627°N	165.30160°W	45	14:58	71.91348°N	165.55003°W	45	15	NE	4	<2	n/a	n/a
2013-09-13	acoustic	HI	14:58	71.91348°N	165.55003°W	45	17:29	71.77450°N	165.82233°W	45	10	NE	3	<2	n/a	n/a
2013-09-13	acoustic	HI	17:29	71.77450°N	165.82233°W	45	17:45	71.75415°N	165.82565°W	45	10	NE	3	<2	n/a	n/a
2013-09-13	acoustic	BN	17:45	71.75415°N	165.82565°W	45	17:50	71.75185°N	165.83887°W	45	10	NE	3	<2	n/a	n/a
2013-09-13	acoustic	BN	17:50	71.75185°N	165.83887°W	45	18:05	71.74517°N	165.89098°W	45	10	NE	3	<2	n/a	n/a
2013-09-13	acoustic	BN	18:05	71.74517°N	165.89098°W	45	18:10	71.73792°N	165.89132°W	45	10	NE	3	<2	n/a	n/a
2013-09-13	acoustic	BN	18:10	71.73792°N	165.89132°W	45	20:55	71.56408°N	166.20663°W	46	10	NE	3	<2	n/a	n/a
2013-09-13	acoustic	HI	20:55	71.56408°N	166.20663°W	46	24:00	71.35667°N	166.56700°W	46	10	N	3	<2	n/a	n/a
2013-09-14	acoustic	LM	00:00	71.35667°N	166.56700°W	46	03:00	71.16013°N	166.91587°W	47	12	N	4	<2	n/a	n/a
2013-09-14	acoustic	LH	03:00	71.16013°N	166.91587°W	47	06:00	70.96733°N	167.21717°W	48	18	N	5	<2	n/a	n/a
2013-09-14	acoustic	LM	06:00	70.96733°N	167.21717°W	48	06:17	70.95217°N	167.29100°W	48	18	N	5	<2	n/a	n/a
2013-09-14	acoustic	LM	06:17	70.95217°N	167.29100°W	48	09:00	71.12320°N	167.23533°W	47	18	N	5	<2	n/a	n/a
2013-09-14	acoustic	LH	09:00	71.12320°N	167.23533°W	47	09:36	71.17927°N	167.27840°W	47	18	NW	5	<2	n/a	n/a
2013-09-14	acoustic	LH	09:36	71.17927°N	167.27840°W	47	10:45	71.24618°N	167.10053°W	48	18	NW	5	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-14	acoustic	LH	10:45	71.24618°N	167.10053°W	48	11:09	71.69982°N	166.99090°W	48	20	N	5	2-4		
2013-09-14	acoustic	LH	11:09	71.69982°N	166.99090°W	48	11:57	71.27020°N	166.82163°W	48	20	N	5	2-4	n/a	n/a
2013-09-14	acoustic	BN	11:57	71.27020°N	166.82163°W	48	14:57	71.33233°N	166.18477°W	45	20	N	5	2-4	n/a	n/a
2013-09-14	acoustic	HI	14:57	71.33233°N	166.18477°W	45	17:45	71.38878°N	165.54653°W	44	20	N	5	2-4	n/a	n/a
2013-09-14	acoustic	BN	17:45	71.38878°N	165.54653°W	44	20:56	71.45043°N	164.84737°W	44	15	N	4	2-4	n/a	n/a
2013-09-14	acoustic	HI	20:56	71.45043°N	164.84737°W	44	24:00	71.50217°N	164.11583°W	45	20	N	5	2-4	n/a	n/a
2013-09-15	acoustic	LM	00:00	71.50217°N	164.11583°W	45	03:00	71.56653°N	163.47395°W	45	18	NE	5	2-4	n/a	n/a
2013-09-15	acoustic	LH	03:00	71.56653°N	163.47395°W	45	03:38	71.57007°N	163.31908°W	45	15	NE	4	2-4	n/a	n/a
2013-09-15	acoustic	LH	03:38	71.57007°N	163.31908°W	45	04:26	71.60153°N	163.39467°W	45	15	NE	4	2-4	n/a	n/a
2013-09-15	acoustic	LH	04:29	71.60153°N	163.39467°W	45	06:00	71.53283°N	163.69100°W	45	15	NE	4	2-4	n/a	n/a
2013-09-15	acoustic	LM	06:00	71.53283°N	163.69100°W	45	07:44	71.65917°N	163.42183°W	42	15	NE	4	2-4	n/a	n/a
2013-09-15	acoustic	LM	07:44	71.65917°N	163.42183°W	42	08:14	71.69917°N	163.37550°W	42	15	NE	4	2-4	n/a	n/a
2013-09-15	acoustic	LM	08:14	71.69917°N	163.37550°W	42	09:00	71.74840°N	163.26467°W	43	15	NE	4	2-4	n/a	n/a
2013-09-15	acoustic	LH	09:00	71.74840°N	163.26467°W	43	12:00	71.91982°N	162.89977°W	40	12	NNE	4	<2	n/a	n/a
2013-09-15	acoustic	BN	12:00	71.91982°N	162.89977°W	40	14:57	72.10892°N	162.51420°W	37	15	NE	4	<2	n/a	n/a
2013-09-15	acoustic	HI	14:57	72.10892°N	162.51420°W	37	16:26	72.20378°N	162.30015°W	37	15	N	4	<2	n/a	n/a
2013-09-15	acoustic	HI	16:26	72.20378°N	162.30015°W	37	17:48	72.15842°N	162.36030°W	34	15	N	4	<2	n/a	n/a
2013-09-15	acoustic	BN	17:48	72.15842°N	162.36030°W	34	20:30	72.09685°N	162.52593°W	34	15	NE	4	<2	n/a	n/a
2013-09-15	acoustic	BN	20:30	72.09685°N	162.52593°W	34	20:54	72.12118°N	162.48983°W	37	15	NE	4	<2	n/a	n/a
2013-09-15	acoustic	HI	20:54	72.12118°N	162.48983°W	37	21:10	72.13323°N	162.44445°W	37	10	NE	3	<2	n/a	n/a
2013-09-15	acoustic	HI	21:10	72.13323°N	162.44445°W	37	21:35	72.15567°N	162.37170°W	37	10	NE	3	<2	n/a	n/a
2013-09-15	acoustic	HI	21:35	72.15567°N	162.37170°W	37	21:40	72.16148°N	162.36578°W	37	10	NE	3	<2	n/a	n/a
2013-09-15	acoustic	HI	21:40	72.16148°N	162.36578°W	37	24:00	72.32267°N	162.06133°W	40	10	NE	3	<2	n/a	n/a
2013-09-16	acoustic	LM	00:00	72.32267°N	162.06133°W	40	03:00	72.49715°N	161.62712°W	45	10	NE	3	<2	n/a	n/a
2013-09-16	acoustic	LH	03:00	72.49715°N	161.62712°W	45	06:00	72.69633°N	161.21583°W	50	12	NE	4	<2	n/a	n/a
2013-09-16	acoustic	LM	06:00	72.69633°N	161.21583°W	50	09:00	72.89027°N	160.74322°W	59	16	NE	4	<2	n/a	n/a
2013-09-16	acoustic	LH	09:00	72.89027°N	160.74322°W	59	11:28	73.03133°N	160.38473°W	169	9	NE	3	<2	n/a	n/a
2013-09-16	acoustic	LH	11:28	73.03133°N	160.38473°W	169	11:53	73.05403°N	160.33228°W	193	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	LH	11:53	73.05403°N	160.33228°W	193	12:00	73.03012°N	160.35302°W	193	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	BN	12:00	73.03012°N	160.35302°W	193	12:45	72.99190°N	160.41873°W	193	15	NE	4	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-16	acoustic	BN	12:45	72.99190°N	160.41873°W	193	14:08	72.94482°N	160.55287°W	193	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	BN	14:08	72.94482°N	160.55287°W	193	14:59	72.95817°N	160.58085°W	80	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	HI	14:59	72.95817°N	160.58085°W	80	16:20	72.97755°N	160.49685°W	80	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	HI	16:20	72.97755°N	160.49685°W	80	16:42	73.00503°N	160.49388°W	80	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	HI	16:42	73.00503°N	160.49388°W	80	16:47	73.00818°N	160.47882°W	80	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	HI	16:47	73.00818°N	160.47882°W	80	17:47	73.06227°N	160.32318°W	200	15	NE	4	<2	n/a	n/a
2013-09-16	acoustic	BN	17:47	73.06227°N	160.32318°W	200	20:57	73.25800°N	159.84350°W	960	20	NE	5	<2	n/a	n/a
2013-09-16	acoustic	HI	20:57	73.25800°N	159.84350°W	960	24:00	73.44600°N	159.36833°W	2100	20	NE	5	<2	n/a	n/a
2013-09-17	acoustic	LM	00:00	73.44600°N	159.36833°W	2100	03:00	73.61730°N	158.94432°W	3040	10	NE	4	<2	n/a	n/a
2013-09-17	acoustic	LH	03:00	73.61730°N	158.94432°W	3040	06:00	73.80183°N	158.40750°W	3748	12	NE	4	<2	n/a	n/a
2013-09-17	acoustic	LM	06:00	73.80183°N	158.40750°W	3748	09:05	73.98552°N	157.87837°W	3748	15	NE	4	<2	n/a	n/a
2013-09-17	acoustic	LH	09:05	73.98552°N	157.87837°W	3748	12:00	74.15493°N	157.40778°W	3850	15	NE	4	<2	n/a	n/a
2013-09-17	acoustic	BN	12:00	74.15493°N	157.40778°W	3850	13:18	74.24117°N	157.18850°W	3850	15	N	4	<2	n/a	n/a
2013-09-17	acoustic	BN	13:18	74.24117°N	157.18850°W	3850	13:22	74.24377°N	157.17452°W	3850	15	N	4	<2	n/a	n/a
2013-09-17	acoustic	BN	13:22	74.24377°N	157.17452°W	3850	14:57	74.18807°N	156.78502°W	3817	15	N	4	<2	n/a	n/a
2013-09-17	acoustic	HI	14:57	74.18807°N	156.78502°W	3817	17:48	74.05302°N	157.05510°W	3848	10	N	3	<2	n/a	n/a
2013-09-17	acoustic	BN	17:48	74.05302°N	157.05510°W	3848	21:01	73.19853°N	156.99268°W	3691	10	N	3	<2	n/a	n/a
2013-09-17	acoustic	HI	21:01	73.19853°N	156.99268°W	3691	21:05	73.84555°N	156.38822°W	3691	10	N	3	<2	n/a	n/a
2013-09-17	acoustic	HI	21:05	73.84555°N	156.38822°W	3691	22:42	73.86092°N	156.59325°W	3691	10	N	3	<2	n/a	n/a
2013-09-17	acoustic	HI	22:42	73.86092°N	156.59325°W	3691	23:05	73.87450°N	156.68975°W	3691	10	N	3	<2	n/a	n/a
2013-09-17	acoustic	HI	23:05	73.87450°N	156.68975°W	3691	23:11	73.88000°N	156.71257°W	3691	10	N	3	<2	n/a	n/a
2013-09-17	acoustic	HI	23:11	73.88000°N	156.71257°W	3691	24:00	73.89817°N	156.92950°W	3850	10	N	3	<2	n/a	n/a
2013-09-18	acoustic	LM	00:00	73.89817°N	156.92950°W	3850	03:00	73.98552°N	157.68157°W	3830	10	N	3	<2	n/a	n/a
2013-09-18	acoustic	LH	03:00	73.98552°N	157.68157°W	3830	06:00	74.08217°N	158.44633°W	3630	15	N	4	<2	n/a	n/a
2013-09-18	acoustic	LM	06:00	74.08217°N	158.44633°W	3630	08:02	74.14383°N	158.96817°W	2059	15	N	4	<2	n/a	n/a
2013-09-18	acoustic	BN	15:05	74.20990°N	160.43603°W	474	16:27	74.24352°N	160.92025°W	474	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	HI	16:27	74.24352°N	160.92025°W	474	17:20	74.27677°N	161.15928°W	474	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	HI	17:20	74.27677°N	161.15928°W	474	17:42	74.28963°N	161.28192°W	474	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	HI	17:42	74.28963°N	161.28192°W	474	17:59	74.29695°N	161.36668°W	1590	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	BN	17:59	74.29695°N	161.36668°W	1590	18:23	74.31693°N	161.46275°W	1590	15	NE	4	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-18	acoustic	BN	18:23	74.31693°N	161.46275°W	1590	18:27	74.32080°N	161.47387°W	1590	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	BN	18:27	74.32080°N	161.47387°W	1590	20:05	74.38122°N	161.85968°W	1590	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	BN	20:05	74.38122°N	161.85968°W	1590	20:50	74.41760°N	162.02307°W	1590	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	BN	20:50	74.41760°N	162.02307°W	1590	20:57	74.41802°N	162.06087°W	1555	15	NE	4	<2	n/a	n/a
2013-09-18	acoustic	HI	20:57	74.41802°N	162.06087°W	1555	22:12	74.45472°N	162.25647°W	1555	20	NE	5	<2	n/a	n/a
2013-09-18	acoustic	HI	22:12	74.45472°N	162.25647°W	1555	22:37	74.47742°N	162.31870°W	1555	20	NE	5	<2	n/a	n/a
2013-09-18	acoustic	HI	22:37	74.47742°N	162.31870°W	1555	22:41	74.48127°N	162.32633°W	1555	20	NE	5	<2	n/a	n/a
2013-09-18	acoustic	HI	22:41	74.48127°N	162.32633°W	1555	24:00	74.53433°N	162.65117°W	1496	20	NE	5	<2	n/a	n/a
2013-09-19	acoustic	LM	00:00	74.53433°N	162.65117°W	1496	03:00	74.65222°N	163.40042°W	1313	20	NE	5	<2	n/a	n/a
2013-09-19	acoustic	LH	03:00	74.65222°N	163.40042°W	1313	06:00	74.75750°N	164.15017°W	910	15	NE	4	<2	n/a	n/a
2013-09-19	acoustic	LM	06:00	74.75750°N	164.15017°W	910	09:03	74.87903°N	165.00497°W	499	20	NE	5	<2	n/a	n/a
2013-09-19	acoustic	LH	09:03	74.87903°N	165.00497°W	499	12:00	74.97493°N	165.71967°W	521	18	NE	5	<2	n/a	n/a
2013-09-19	acoustic	BN	12:00	74.97493°N	165.71967°W	521	14:55	75.03183°N	166.55038°W	472	20	NE	5	<2	n/a	n/a
2013-09-19	acoustic	HI	14:55	75.03183°N	166.55038°W	472	17:47	75.02453°N	167.38138°W	224	20	NE	5	<2	n/a	n/a
2013-09-19	acoustic	BN	17:47	75.02453°N	167.38138°W	224	20:59	75.01680°N	168.26075°W	170	20	NE	5	<2	n/a	n/a
2013-09-19	acoustic	HI	20:59	75.01680°N	168.26075°W	170	23:32	75.01057°N	168.99455°W	170	20	NE	5	<2	n/a	n/a
2013-09-19	acoustic	HI	23:32	75.01057°N	168.99455°W	170	24:00	74.98400°N	169.07683°W	225	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LM	00:00	74.98400°N	169.07683°W	225	01:42	74.82650°N	168.85917°W	209	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LM	01:42	74.82650°N	168.85917°W	209	01:58	74.80517°N	168.82383°W	205	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LM	01:58	74.80517°N	168.82383°W	205	03:00	74.72262°N	168.68967°W	212	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LH	03:00	74.72262°N	168.68967°W	212	04:11	74.69360°N	168.46155°W	212	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LH	04:11	74.69360°N	168.46155°W	212	04:43	74.67632°N	168.34875°W	212	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LH	04:43	74.67632°N	168.34875°W	212	06:00	74.64033°N	168.38583°W	217	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LM	06:00	74.64033°N	168.40250°W	217	09:00	74.69972°N	168.54307°W	196	20	NE	5	<2	n/a	n/a
2013-09-20	acoustic	LH	09:00	74.69972°N	168.54307°W	196	09:25	74.69055°N	168.43995°W	196	21	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	LH	09:25	74.69055°N	168.43995°W	196	09:55	74.68465°N	168.31370°W	196	21	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	LH	09:55	74.68465°N	168.31370°W	196	12:00	74.65070°N	167.73985°W	312	21	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	BN	12:00	74.65070°N	167.73985°W	312	12:27	74.64482°N	167.63487°W	312	25	NE	6	2-4	n/a	n/a
2013-09-20	acoustic	BN	12:27	74.64482°N	167.63487°W	312	14:56	74.67453°N	167.89357°W	290	25	NE	6	2-4	n/a	n/a
2013-09-20	acoustic	HI	14:56	74.67453°N	167.89357°W	290	15:49	74.69188°N	168.18757°W	290	25	NE	6	2-4	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-20	acoustic	HI	15:49	74.69188°N	168.18757°W	290	15:58	74.69515°N	168.24100°W	290	25	NE	6	2-4	n/a	n/a
2013-09-20	acoustic	HI	15:58	74.69515°N	168.24100°W	290	17:45	74.68073°N	168.25100°W	232	25	NE	6	2-4	n/a	n/a
2013-09-20	acoustic	BN	17:45	74.68073°N	168.25100°W	232	18:13	74.67512°N	168.12495°W	232	20	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	BN	18:21	74.67323°N	168.01848°W	232	18:56	74.66387°N	167.91158°W	232	20	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	BN	18:56	74.66387°N	167.91158°W	232	19:18	74.65793°N	167.80498°W	232	20	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	BN	19:18	74.65793°N	167.80498°W	232	19:26	74.65575°N	167.76957°W	232	20	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	BN	19:26	74.65575°N	167.76957°W	232	20:58	74.63163°W	167.31880°W	358	20	NE	5	2-4	n/a	n/a
2013-09-20	acoustic	HI	20:58	74.63163°W	167.31880°W	358	24:00	74.58267°N	166.50500°W	366	15	NE	4	<2	n/a	n/a
2013-09-21	acoustic	LM	00:00	74.58267°N	166.50500°W	366	03:00	74.53300°N	165.69623°W	410	10	NE	3	<2	n/a	n/a
2013-09-21	acoustic	LH	03:00	74.53300°N	165.69623°W	410	06:00	74.48067°N	164.88967°W	306	10	NE	3	<2	n/a	n/a
2013-09-21	acoustic	LM	06:00	74.48067°N	164.88967°W	306	09:00	74.42180°N	164.07078°W	501	10	NE	3	<2	n/a	n/a
2013-09-21	acoustic	LH	09:00	74.42180°N	164.07078°W	501	11:53	74.34718°N	163.30247°W	882	25	NE	6	<2	n/a	n/a
2013-09-21	acoustic	BN	11:53	74.34718°N	163.30247°W	882	14:57	74.28562°N	162.47427°W	1232	15	NE	4	<2	n/a	n/a
2013-09-21	acoustic	HI	14:57	74.28562°N	162.47427°W	1232	17:45	74.21862°N	161.74102°W	1300	15	NE	4	<2	n/a	n/a
2013-09-21	acoustic	BN	17:45	74.21862°N	161.74102°W	1300	20:56	74.05755°N	161.07537°W	568	15	NE	4	<2	n/a	n/a
2013-09-21	acoustic	HI	20:56	74.05755°N	161.07537°W	568	24:00	73.86617°N	160.56383°W	2267	15	NE	4	<2	n/a	n/a
2013-09-22	acoustic	LM	00:00	73.86617°N	160.56383°W	2267	03:00	73.71175°N	160.04967°W	2506	15	NE	4	<2	n/a	n/a
2013-09-22	acoustic	LH	03:00	73.71175°N	160.04967°W	2506	06:00	73.64483°N	159.24133°W	2740	8	NW	3	<2	n/a	n/a
2013-09-22	acoustic	LM	06:00	73.64483°N	159.24133°W	2740	09:06	73.57607°N	158.44472°W	2560	10	NW	3	<2	n/a	n/a
2013-09-22	acoustic	LH	09:06	73.57607°N	158.44472°W	2560	11:58	73.49210°N	157.74907°W	2890	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	BN	11:58	73.49210°N	157.74907°W	2890	14:56	73.42505°N	157.01062°W	3415	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	HI	14:56	73.42505°N	157.01062°W	3415	15:10	73.40600°N	156.95990°W	3415	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	HI	15:10	73.40600°N	156.95990°W	3415	15:19	73.40942°N	156.92515°W	3415	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	HI	15:19	73.40942°N	156.92515°W	3415	17:45	73.55507°N	157.28327°W	3044	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	BN	17:45	73.55507°N	157.28327°W	3044	18:29	73.53143°N	157.51457°W	3044	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	BN	18:29	73.53143°N	157.51457°W	3044	18:42	73.52508°N	157.54012°W	3044	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	BN	18:42	73.52508°N	157.54012°W	3044	19:11	73.47760°N	157.67440°W	3044	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	BN	19:11	73.47760°N	157.67440°W	3044	19:43	73.44383°N	157.79053°W	3044	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	BN	19:43	73.44383°N	157.79053°W	3044	20:55	73.37357°N	157.98945°W	2576	5	N	2	<2	n/a	n/a
2013-09-22	acoustic	HI	20:55	73.37357°N	157.98945°W	2576	24:00	73.19250°N	158.50950°W	1908	5	N	2	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-23	acoustic	LM	00:00	73.19250°N	158.50617°W	1908	02:57	73.00658°N	158.95222°W	500	5	N	2	<2	n/a	n/a
2013-09-23	acoustic	LH	02:57	73.00658°N	158.95222°W	500	06:00	72.81500°N	159.44383°W	161	5	N	2	<2	n/a	n/a
2013-09-23	acoustic	LM	06:00	72.81500°N	159.44383°W	161	08:55	72.64300°N	159.86633°W	58	5	N	2	<2	n/a	n/a
2013-09-23	acoustic	LM	08:55	72.64300°N	159.86633°W	58	09:00	72.63633°N	159.87900°W	60	5	N	2	<2	n/a	n/a
2013-09-23	acoustic	LM	09:00	72.63633°N	159.87900°W	60	09:07	72.63095°N	159.89765°W	60	8	N	3	<2	n/a	n/a
2013-09-23	acoustic	LH	09:07	72.63095°N	159.89765°W	60	11:58	72.75492°N	159.73258°W	80	8	N	3	<2	n/a	n/a
2013-09-23	acoustic	BN	11:58	72.75492°N	159.73258°W	80	14:03	72.71217°N	159.70970°W	80	10	NE	3	<2	n/a	n/a
2013-09-23	acoustic	BN	14:03	72.71217°N	159.70970°W	80	14:28	72.69630°N	159.78267°W	80	10	NE	3	<2	n/a	n/a
2013-09-23	acoustic	BN	14:28	72.69630°N	159.78267°W	80	14:32	72.69008°N	159.78980°W	80	10	NE	3	<2	n/a	n/a
2013-09-23	acoustic	BN	14:32	72.69008°N	159.78980°W	80	14:57	72.66057°N	159.84065°W	64	10	NE	3	<2	n/a	n/a
2013-09-23	acoustic	HI	14:57	72.66057°N	159.84065°W	64	17:55	72.47112°N	160.26360°W	49	10	NE	3	<2	n/a	n/a
2013-09-23	acoustic	BN	17:55	72.47112°N	160.26360°W	49	20:56	72.28617°N	160.73593°W	40	15	SE	4	<2	n/a	n/a
2013-09-23	acoustic	HI	20:56	72.28617°N	160.73593°W	40	24:00	72.09300°N	161.17133°W	33	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LM	00:00	72.09300°N	161.17133°W	33	00:44	72.05033°N	161.28483°W	34	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LM	00:44	72.05033°N	161.28483°W	34	00:48	72.04383°N	161.28467°W	34	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LM	00:48	72.04383°N	161.28467°W	34	01:25	72.01133°N	161.35650°W	35	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LM	01:25	72.01133°N	161.35650°W	35	01:52	71.99250°N	161.39650°W	35	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LM	01:52	71.99167°N	161.39650°W	35	01:55	71.98900°N	161.39750°W	35	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LM	01:55	71.98900°N	161.39750°W	35	03:00	71.93337°N	161.52432°W	39	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LH	03:00	71.93337°N	161.52432°W	39	06:00	71.76700°N	161.90000°W	44	12	S	4	<2	n/a	n/a
2013-09-24	acoustic	LM	06:00	71.76700°N	161.90000°W	44	09:04	71.55802°N	162.33342°W	39	15	S	4	<2	n/a	n/a
2013-09-24	acoustic	LH	09:04	71.55802°N	162.33342°W	39	11:58	71.37113°N	162.69782°W	48	20	S	5	2-4	n/a	n/a
2013-09-24	acoustic	BN	11:58	71.37113°N	162.69782°W	48	12:04	71.37252°N	162.71940°W	48	10	S	3	<2	n/a	n/a
2013-09-26	acoustic	LH	10:17	71.53747°N	165.00282°W	42	10:39	71.55028°N	164.91855°W	42	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	LH	10:39	71.55028°N	164.91855°W	42	10:48	71.56023°N	164.91347°W	42	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	LH	10:48	71.56023°N	164.91347°W	42	11:05	71.57793°N	164.93250°W	42	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	LH	11:05	71.57793°N	164.93250°W	42	11:15	71.57203°N	164.89278°W	42	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	LH	11:15	71.57203°N	164.89278°W	42	11:20	71.57235°N	164.87405°W	42	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	LH	11:20	71.57235°N	164.87405°W	42	11:22	71.57235°N	164.87405°W	42	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	LH	11:22	71.57235°N	164.87405°W	42	11:48	71.59677°N	164.85977°W	42	5	S	2	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-26	acoustic	LH	11:48	71.59677°N	164.85977°W	42	11:58	71.60135°N	164.81940°W	45	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	BN	11:58	71.60135°N	164.81940°W	45	14:56	71.79955°N	164.49158°W	41	5	S	2	<2	n/a	n/a
2013-09-26	acoustic	HI	14:56	71.79955°N	164.49158°W	41	15:43	71.84888°N	164.38410°W	41	10	SW	3	<2	n/a	n/a
2013-09-26	acoustic	HI	15:43	71.84888°N	164.38410°W	41	16:40	71.86550°N	164.28662°W	41	10	SW	3	<2	n/a	n/a
2013-09-26	acoustic	HI	16:44	71.86063°N	164.29250°W	41	17:45	71.80103°N	164.40085°W	40	10	SW	3	<2	n/a	n/a
2013-09-26	acoustic	BN	17:45	71.80103°N	164.40085°W	40	19:34	71.75667°N	164.52437°W	40	10	S	3	<2	n/a	n/a
2013-09-26	acoustic	BN	19:34	71.75667°N	164.52437°W	40	20:57	71.73100°N	164.57960°W	40	10	S	3	<2	n/a	n/a
2013-09-26	acoustic	HI	20:57	71.73100°N	164.57960°W	40	21:50	71.80172°N	164.49343°W	40	10	S	3	<2	n/a	n/a
2013-09-26	acoustic	HI	21:50	71.80172°N	164.49343°W	40	22:12	71.81167°N	164.44447°W	40	10	S	3	<2	n/a	n/a
2013-09-26	acoustic	HI	22:12	71.81167°N	164.44447°W	40	22:17	71.81388°N	164.43082°W	40	10	S	3	<2	n/a	n/a
2013-09-26	acoustic	HI	22:17	71.81388°N	164.43082°W	40	24:00	71.92100°N	164.21067°W	42	10	S	3	<2	n/a	n/a
2013-09-27	acoustic	LM	00:00	71.92100°N	164.21067°W	42	03:00	72.10633°N	163.82802°W	42	15	SW	4	<2	n/a	n/a
2013-09-27	acoustic	LH	03:00	72.10633°N	163.82802°W	42	06:00	72.30967°N	163.41417°W	43	15	SW	4	<2	n/a	n/a
2013-09-27	acoustic	LM	06:00	72.30967°N	162.41417°W	43	09:00	72.51077°N	163.04510°W	44	15	SE	4	<2	n/a	n/a
2013-09-27	acoustic	LH	09:00	72.51077°N	163.04510°W	44	12:00	72.70535°N	162.59373°W	46	15	E	4	<2	n/a	n/a
2013-09-27	acoustic	BN	12:00	72.70535°N	162.59373°W	46	14:56	72.88617°N	162.20922°W	80	15	SSE	4	<2	n/a	n/a
2013-09-27	acoustic	HI	14:56	72.88617°N	162.20922°W	80	17:45	73.05335°N	161.80565°W	152	10	S	3	<2	n/a	n/a
2013-09-27	acoustic	BN	17:45	73.05335°N	161.80565°W	152	20:54	73.24907°N	161.33730°W	305	15	SSE	4	<2	n/a	n/a
2013-09-27	acoustic	HI	20:54	73.24907°N	161.33730°W	305	24:00	73.45217°N	160.88033°W	402	15	SSE	4	<2	n/a	n/a
2013-09-28	acoustic	LM	00:00	73.45217°N	160.88033°W	402	00:46	73.50383°N	160.77167°W	843	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LM	00:46	73.50383°N	160.77167°W	843	00:55	73.51350°N	160.77700°W	844	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LM	00:55	73.51350°N	160.77700°W	844	02:00	73.59767°N	160.56783°W	1159	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LM	02:00	73.59767°N	160.56783°W	1159	02:06	73.60483°N	160.54917°W	1167	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LM	02:06	73.60483°N	160.54917°W	1167	03:00	73.66865°N	160.38407°W	1167	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LH	03:00	73.66865°N	160.38407°W	1167	06:00	73.51733°N	160.68350°W	1224	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LM	06:00	73.51733°N	160.68350°W	1224	06:30	73.46583°N	160.80217°W	485	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LM	06:30	73.46583°N	160.80217°W	485	07:02	73.43617°N	160.87767°W	402	10	NE	3	<2	n/a	n/a
2013-09-28	acoustic	LM	07:02	73.43617°N	160.87767°W	402	09:00	73.56428°N	160.61252°W	330	10	SW	3	<2	n/a	n/a
2013-09-28	acoustic	LH	09:00	73.56428°N	160.61252°W	330	12:00	73.74722°N	160.12495°W	2200	5	SW	2	<2	n/a	n/a
2013-09-28	acoustic	BN	12:00	73.74722°N	160.12495°W	2200	14:55	73.92767°N	159.67737°W	2150	10	S	3	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-28	acoustic	HI	14:55	73.92767°N	159.67737°W	2150	17:45	74.10233°N	159.21315°W	1950	10	SW	3	<2	n/a	n/a
2013-09-28	acoustic	BN	17:45	74.10233°N	159.21315°W	1950	20:25	74.26125°N	158.78313°W	1950	10	NW	3	<2	n/a	n/a
2013-09-28	acoustic	BN	20:25	74.26125°N	158.78313°W	1950	20:35	74.25390°N	158.76617°W	1950	10	NW	3	<2	n/a	n/a
2013-09-28	acoustic	BN	20:35	74.25390°N	158.76617°W	1950	20:54	74.26023°N	158.87907°W	980	10	NW	3	<2	n/a	n/a
2013-09-28	acoustic	HI	20:54	74.26023°N	158.87907°W	980	24:00	74.18533°N	159.78017°W	240	0	None	1	<2	n/a	n/a
2013-09-29	acoustic	LM	00:00	74.18533°N	159.78017°W	240	02:10	74.17950°N	160.51800°W	586	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	LM	02:10	74.17950°N	160.51800°W	586	02:44	74.16017°N	160.63400°W	521	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	LM	02:44	74.16017°N	160.63400°W	521	02:48	74.15283°N	160.63483°W	521	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	LM	02:48	74.15283°N	160.63483°W	521	03:00	74.15283°N	160.63483°W	521	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	LH	03:00	74.15283°N	160.63483°W	521	03:38	74.09628°N	160.79565°W	521	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	LH	03:38	74.09628°N	160.79565°W	521	06:00	73.94383°N	161.19150°W	460	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	LM	06:00	73.94383°N	161.19150°W	460	09:04	73.75315°N	161.65992°W	376	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	LH	09:04	73.75315°N	161.65992°W	376	12:00	73.56802°N	162.08243°W	216	8	SW	3	<2	n/a	n/a
2013-09-29	acoustic	BN	12:00	73.56802°N	162.08243°W	216	13:30	73.46557°N	162.30210°W	216	8	SW	3	<2	n/a	n/a
2013-09-29	acoustic	BN	13:30	73.46557°N	162.30210°W	216	13:34	73.46605°N	162.32340°W	216	8	SW	3	<2	n/a	n/a
2013-09-29	acoustic	BN	13:34	73.46605°N	162.32340°W	216	14:59	73.51748°N	162.06592°W	200	8	SW	3	<2	n/a	n/a
2013-09-29	acoustic	HI	14:59	73.51748°N	162.06592°W	200	17:47	73.58362°N	162.06230°W	219	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	BN	17:47	73.58362°N	162.06230°W	219	18:37	73.53848°N	162.19323°W	219	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	BN	18:37	73.53848°N	162.19323°W	219	19:01	73.50658°N	162.19765°W	219	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	BN	19:01	73.50658°N	162.19765°W	219	19:06	73.50253°N	162.21448°W	219	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	BN	19:06	73.50253°N	162.21448°W	219	20:57	73.38632°N	162.49360°W	138	5	SW	2	<2	n/a	n/a
2013-09-29	acoustic	HI	20:57	73.38632°N	162.49360°W	138	24:00	73.18117°N	162.92733°W	126	5	SW	2	<2	n/a	n/a
2013-09-30	acoustic	LM	00:00	73.18117°N	162.92733°W	126	03:00	72.99705°N	163.39392°W	85	5	SW	2	<2	n/a	n/a
2013-09-30	acoustic	LH	03:00	72.99705°N	163.39392°W	85	06:00	72.80250°N	163.78483°W	66	5	SW	2	<2	n/a	n/a
2013-09-30	acoustic	LM	06:00	72.80250°N	163.78483°W	66	08:45	72.62767°N	164.17067°W	56	7	N	2	<2	n/a	n/a
2013-09-30	acoustic	LH	09:15	72.58715°N	164.20507°W	54	12:00	72.41595°N	164.59853°W	50	8	N	3	<2	n/a	n/a
2013-09-30	acoustic	BN	12:00	72.41595°N	164.59853°W	50	13:30	72.37840°N	164.61795°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	BN	13:30	72.37840°N	164.61795°W	50	14:57	72.49167°N	164.40297°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	HI	14:57	72.49167°N	164.40297°W	50	17:26	72.45173°N	164.54667°W	50	2	variable	1	<2	n/a	n/a
2013-09-30	acoustic	HI	17:26	72.45173°N	164.54667°W	50	17:47	72.42287°N	164.54650°W	50	2	variable	1	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-09-30	acoustic	BN	17:47	72.42287°N	164.54650°W	50	17:49	72.42172°N	164.55367°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	BN	17:49	72.42172°N	164.55367°W	50	17:54	72.41828°N	164.57625°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	BN	17:54	72.41828°N	164.57625°W	50	18:29	72.37987°N	164.63188°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	BN	18:29	72.37987°N	164.63188°W	50	20:03	72.39887°N	164.58292°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	BN	20:03	72.39887°N	164.58292°W	50	20:04	72.40113°N	164.58262°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	BN	20:04	72.40113°N	164.58262°W	50	20:58	72.47022°N	164.47353°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	HI	20:58	72.47022°N	164.47353°W	50	23:44	72.45552°N	164.52538°W	50	5	N	2	<2	n/a	n/a
2013-09-30	acoustic	HI	23:44	72.45552°N	164.52538°W	50	24:00	72.44433°N	164.55583°W	50	5	N	2	<2	n/a	n/a
2013-10-01	acoustic	LM	00:00	72.44433°N	164.55583°W	50	00:20	72.41767°N	164.56050°W	50	5	N	2	<2	n/a	n/a
2013-10-01	acoustic	LM	00:20	72.41767°N	164.56050°W	50	03:00	72.25348°N	164.91930°W	50	5	N	2	<2	n/a	n/a
2013-10-01	acoustic	LH	03:00	72.25348°N	164.91930°W	50	06:00	72.05033°N	165.29367°W	45	5	N	2	<2	n/a	n/a
2013-10-01	acoustic	LM	06:00	72.05033°N	165.29367°W	45	09:03	71.86243°N	165.69473°W	45	3	S	2	<2	n/a	n/a
2013-10-01	acoustic	LH	09:03	71.86243°N	165.69473°W	45	11:27	71.70668°N	165.95803°W	45	5	E	2	<2	n/a	n/a
2013-10-01	acoustic	LH	11:27	71.70668°N	165.95803°W	45	12:00	71.70247°N	165.90765°W	45	5	E	2	<2	n/a	n/a
2013-10-01	acoustic	BN	12:00	71.70247°N	165.90765°W	46	14:56	71.97350°N	166.01097°W	47	5	NE	2	<2	n/a	n/a
2013-10-01	acoustic	HI	14:56	71.97350°N	166.01097°W	47	17:45	72.24625°N	166.22230°W	49	5	E	2	<2	n/a	n/a
2013-10-01	acoustic	BN	17:45	72.24625°N	166.22230°W	49	18:30	72.27742°N	166.21785°W	49	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	BN	18:30	72.27742°N	166.21785°W	49	18:58	72.30183°N	166.11603°W	49	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	BN	18:58	72.30183°N	166.11603°W	49	19:04	72.31080°N	166.11378°W	49	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	BN	19:04	72.31080°N	166.11378°W	49	20:03	72.38588°N	166.01267°W	49	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	BN	20:03	72.38588°N	166.01267°W	49	20:06	72.38828°N	166.01208°W	49	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	BN	20:06	72.38828°N	166.01208°W	49	20:14	72.39507°N	166.01322°W	49	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	BN	20:14	72.39507°N	166.01322°W	49	20:30	72.37962°N	165.96275°W	49	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	BN	20:30	72.37962°N	165.96275°W	49	20:56	72.34785°N	166.00922°W	50	10	E	3	<2	n/a	n/a
2013-10-01	acoustic	HI	20:56	72.34785°N	166.00922°W	50	24:00	72.23517°N	166.25900°W	49	10	E	3	<2	n/a	n/a
2013-10-02	acoustic	LM	00:00	72.23517°N	166.25900°W	49	01:43	72.28150°N	166.18100°W	50	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	LM	01:43	72.28150°N	166.18100°W	50	01:46	72.28517°N	166.18117°W	50	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	LM	01:46	72.28517°N	166.18117°W	50	02:09	72.30833°N	166.12667°W	50	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	LM	02:09	72.30833°N	166.12667°W	50	02:12	72.30983°N	166.11900°W	50	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	LM	02:12	72.30983°N	166.11900°W	50	03:00	72.36415°N	166.01333°W	50	15	E	4	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-02	acoustic	LH	03:00	72.36415°N	166.01333°W	50	06:00	72.56350°N	165.65300°W	53	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	LM	06:00	72.56350°N	165.65300°W	53	09:00	72.75917°N	165.26897°W	59	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	LH	09:00	72.75917°N	165.26897°W	59	12:00	72.01582°N	164.88247°W	66	12	E	4	<2	n/a	n/a
2013-10-02	acoustic	BN	12:00	72.01582°N	164.88247°W	66	14:54	73.14733°N	164.49378°W	74	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	HI	14:54	73.14733°N	164.49378°W	74	17:44	73.32145°N	164.06528°W	81	15	NE	4	<2	n/a	n/a
2013-10-02	acoustic	BN	17:44	73.32145°N	164.06528°W	81	20:55	73.53303°N	163.66287°W	229	15	E	4	<2	n/a	n/a
2013-10-02	acoustic	HI	20:55	73.53303°N	163.66287°W	229	24:00	73.73517°N	163.21767°W	194	15	E	4	<2	n/a	n/a
2013-10-03	acoustic	LM	00:00	73.73517°N	163.21767°W	194	03:00	73.91578°N	162.77792°W	436	15	E	4	<2	n/a	n/a
2013-10-03	acoustic	LH	03:00	73.91578°N	162.77792°W	436	05:17	74.06127°N	162.41700°W	436	10	E	4	<2	n/a	n/a
2013-10-03	acoustic	LH	05:17	74.06127°N	162.41700°W	436	06:00	74.08717°N	162.43350°W	622	5	E	3	<2	n/a	n/a
2013-10-03	acoustic	LM	06:00	74.08717°N	162.43350°W	622	08:16	74.01183°N	162.92483°W	338	7	E	3	<2	n/a	n/a
2013-10-03	acoustic	LM	08:16	74.01183°N	162.92483°W	338	08:19	74.01183°N	162.93733°W	338	7	E	3	<2	n/a	n/a
2013-10-03	acoustic	LM	08:19	74.01183°N	162.93733°W	338	08:48	74.01450°N	163.11983°W	323	7	E	3	<2	n/a	n/a
2013-10-03	acoustic	LM	08:48	74.01450°N	163.11983°W	323	08:49	74.01450°N	163.11983°W	323	7	E	3	<2	n/a	n/a
2013-10-03	acoustic	LM	08:49	74.01450°N	163.11983°W	323	09:05	74.01575°N	163.19767°W	321	7	E	3	<2	n/a	n/a
2013-10-03	acoustic	LH	09:05	74.01575°N	163.19767°W	321	12:00	74.04810°N	164.16293°W	266	5	E	2	<2	n/a	n/a
2013-10-03	acoustic	BN	12:00	74.04810°N	164.16293°W	266	12:25	74.07213°N	164.20878°W	266	5	E	2	<2	n/a	n/a
2013-10-03	acoustic	BN	12:25	74.07213°N	164.20878°W	266	14:02	74.16925°N	164.72000°W	266	5	E	2	<2	n/a	n/a
2013-10-03	acoustic	BN	14:02	74.16925°N	164.72000°W	266	14:56	74.19607°N	164.81445°W	278	5	E	2	<2	n/a	n/a
2013-10-03	acoustic	HI	14:56	74.19607°N	164.81445°W	278	17:47	74.20733°N	165.35277°W	263	2	variable	1	<2	n/a	n/a
2013-10-03	acoustic	BN	17:47	74.20733°N	165.35277°W	263	19:55	74.19117°N	165.31132°W	263	2	variable	1	<2	n/a	n/a
2013-10-03	acoustic	BN	19:55	74.19117°N	165.31132°W	263	20:09	74.18885°N	165.23913°W	263	10	N	3	<2	n/a	n/a
2013-10-03	acoustic	BN	20:09	74.18885°N	165.23913°W	263	20:17	74.18762°N	165.20245°W	263	10	N	3	<2	n/a	n/a
2013-10-03	acoustic	BN	20:17	74.18762°N	165.20245°W	263	20:19	74.18553°N	165.19138°W	263	10	N	3	<2	n/a	n/a
2013-10-03	acoustic	BN	20:19	74.18553°N	165.19138°W	263	20:42	74.16962°N	165.12487°W	263	10	N	3	<2	n/a	n/a
2013-10-03	acoustic	BN	20:42	74.16962°N	165.12487°W	263	20:47	74.17252°N	165.10372°W	263	10	N	3	<2	n/a	n/a
2013-10-03	acoustic	BN	20:47	74.17252°N	165.10372°W	263	20:57	74.16343°N	165.07172°W	255	10	N	3	<2	n/a	n/a
2013-10-03	acoustic	HI	20:57	74.16343°N	165.07172°W	255	24:00	74.04683°N	164.39767°W	257	0	None	0	<2	n/a	n/a
2013-10-04	acoustic	LM	00:00	74.04683°N	164.39767°W	257	02:55	73.94045°N	163.72115°W	256	7	NW	3	<2	n/a	n/a
2013-10-04	acoustic	LH	02:55	73.94045°N	163.72115°W	256	06:00	73.80100°N	163.00333°W	220	5	NW	2	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-04	acoustic	LM	06:00	73.80100°N	163.00333°W	220	09:03	73.69025°N	162.35230°W	220	2	S	1	<2	n/a	n/a
2013-10-04	acoustic	LH	09:03	73.69025°N	162.35230°W	220	10:44	73.61907°N	161.95352°W	220	2	S	1	<2	n/a	n/a
2013-10-04	acoustic	LH	10:44	73.61907°N	161.95352°W	220	11:47	73.64077°N	162.17968°W	221	2	S	1	<2	n/a	n/a
2013-10-04	acoustic	LH	11:47	73.64077°N	162.17968°W	221	12:00	73.65813°N	162.14928°W	221	5	S	2	<2	n/a	n/a
2013-10-04	acoustic	BN	12:00	73.65813°N	162.14928°W	221	14:58	73.68262°N	162.30980°W	227	5	S	2	<2	n/a	n/a
2013-10-04	acoustic	HI	14:58	73.68262°N	162.30980°W	227	15:32	73.66447°N	162.20280°W	227	5	S	2	<2	n/a	n/a
2013-10-04	acoustic	HI	15:32	73.66447°N	162.20280°W	227	15:58	73.65680°N	162.11427°W	227	5	S	2	<2	n/a	n/a
2013-10-04	acoustic	HI	15:58	73.65680°N	162.11427°W	227	16:02	73.65427°N	162.09958°W	227	5	S	2	<2	n/a	n/a
2013-10-04	acoustic	HI	16:02	73.65427°N	162.09958°W	227	17:43	73.58307°N	161.75575°W	251	5	S	2	<2	n/a	n/a
2013-10-04	acoustic	BN	17:43	73.58307°N	161.75575°W	251	20:05	73.45595°N	161.13680°W	310	5	S	2	<2	n/a	n/a
2013-10-04	acoustic	HI	20:05	73.45595°N	161.13680°W	310	24:00	73.33850°N	160.56667°W	809	2	variable	1	<2	n/a	n/a
2013-10-05	acoustic	LM	00:00	73.33850°N	160.56667°W	809	03:00	73.23155°N	159.95703°W		5	SW	2	<2	n/a	n/a
2013-10-05	acoustic	LH	03:00	73.23155°N	159.95703°W		06:00	73.10067°N	159.33350°W	479	5	SW	2	<2	n/a	n/a
2013-10-05	acoustic	LM	06:00	73.10067°N	159.33350°W	479	09:05	72.96898°N	158.76020°W	572	15	SW	4	<2	n/a	n/a
2013-10-05	acoustic	LH	09:05	72.96898°N	158.76020°W	572	12:00	72.82572°N	158.25213°W	530	20	SW	5	<2	n/a	n/a
2013-10-05	acoustic	BN	12:00	72.82572°N	158.25213°W	530	13:17	72.76107°N	158.42127°W	530	20	SE	5	<2	n/a	n/a
2013-10-05	acoustic	BN	13:17	72.76107°N	158.42127°W	530	13:25	72.75485°N	158.43823°W	530	20	SE	5	<2	n/a	n/a
2013-10-05	acoustic	HI	15:31	72.70808°N	158.64483°W	215	17:47	72.57713°N	158.88565°W	71	25	E	6	2-4	n/a	n/a
2013-10-05	acoustic	BN	17:47	72.57713°N	158.88565°W	71	20:05	72.44312°N	159.31988°W	71	20	E	5	2-4	n/a	n/a
2013-10-05	acoustic	BN	20:05	72.44312°N	159.31988°W	71	20:59	72.37038°N	159.41520°W	51	20	E	5	2-4	n/a	n/a
2013-10-05	acoustic	HI	20:59	72.37038°N	159.41520°W	51	23:25	72.29298°N	159.68307°W	51	15	E	4	2-4	n/a	n/a
2013-10-05	acoustic	HI	23:25	72.29298°N	159.68307°W	51	23:43	72.31150°N	159.70160°W	51	15	E	4	2-4	n/a	n/a
2013-10-05	acoustic	HI	23:43	72.31150°N	159.70160°W	51	24:00	72.30117°N	159.76450°W	49	15	E	4	<2	n/a	n/a
2013-10-06	acoustic	LM	00:00	72.30117°N	159.76450°W	49	00:13	72.31383°N	159.80400°W	50	10	S	3	<2	n/a	n/a
2013-10-06	acoustic	LM	00:13	72.31383°N	159.80400°W	50	00:15	72.31517°N	159.80550°W	50	10	S	3	<2	n/a	n/a
2013-10-06	acoustic	LM	00:15	72.31517°N	159.80550°W	50	03:00	72.44073°N	160.36612°W	48	10	S	3	<2	n/a	n/a
2013-10-06	acoustic	LH	03:00	72.44073°N	160.36612°W	48	06:00	72.58083°N	161.01750°W	50	10	S	3	<2	n/a	n/a
2013-10-06	acoustic	LM	06:00	72.58083°N	161.01750°W	50	09:05	72.70685°N	161.61565°W	50	5	NE	2	<2	n/a	n/a
2013-10-06	acoustic	LH	09:05	72.70685°N	161.61565°W	50	11:58	72.81265°N	162.20902°W	54	8	N	3	<2	n/a	n/a
2013-10-06	acoustic	BN	11:58	72.81265°N	162.20902°W	54	14:56	72.94930°N	162.84035°W	86	20	NW	5	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-06	acoustic	HI	14:56	72.94930°N	162.84035°W	86	17:45	73.07565°N	163.49932°W	112	20	NW	5	<2		
2013-10-06	acoustic	BN	17:45	73.07565°N	163.49932°W	112	20:55	73.18585°N	164.16638°W	74	20	N	5	<2	n/a	n/a
2013-10-06	acoustic	HI	20:55	73.18585°N	164.16638°W	74	24:00	73.29733°N	164.86850°W	79	20	N	5	<2	n/a	n/a
2013-10-07	acoustic	LM	00:00	73.29733°N	164.86850°W	79	02:58	73.42592°N	165.49372°W	89	20	N	5	<2	n/a	n/a
2013-10-07	acoustic	LH	02:58	73.42592°N	165.49372°W	89	06:00	73.52583°N	166.21217°W	95	20	N	5	<2	n/a	n/a
2013-10-07	acoustic	LM	06:00	73.52583°N	166.21217°W	95	08:30	73.63100°N	166.80517°W	132	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LM	08:30	73.63100°N	166.80517°W	132	08:32	73.63350°N	166.80917°W	132	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LM	08:32	73.63350°N	166.80917°W	132	09:05	73.60320°N	166.75598°W	129	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LH	09:05	73.60320°N	166.75598°W	129	09:53	73.56860°N	166.52648°W	105	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LH	09:53	73.56860°N	166.52648°W	105	10:02	73.56272°N	166.48633°W	105	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LH	10:02	73.56272°N	166.48633°W	105	10:08	73.55935°N	166.46203°W	105	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LH	10:08	73.55935°N	166.46203°W	105	10:39	73.56875°N	166.32055°W	105	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LH	10:39	73.56875°N	166.32055°W	105	10:47	73.57787°N	166.29722°W	105	20	N	0	<2	n/a	n/a
2013-10-07	acoustic	LH	10:47	73.57787°N	166.29722°W	105	12:00	73.62518°N	166.36692°W	112	15	NE	0	<2	n/a	n/a
2013-10-07	acoustic	BN	12:00	73.62518°N	166.36692°W	112	12:02	73.62185°N	166.37095°W	112	15	NE	0	<2	n/a	n/a
2013-10-07	acoustic	BN	12:02	73.62185°N	166.37095°W	112	12:15	73.59990°N	166.37498°W	112	15	NE	1	<2	n/a	n/a
2013-10-07	acoustic	BN	12:15	73.59990°N	166.37498°W	112	13:07	73.54640°N	166.47422°W	112	15	NE	1	<2	n/a	n/a
2013-10-07	acoustic	BN	13:07	73.54640°N	166.47422°W	112	13:11	73.54345°N	166.49653°W	112	15	NE	1	<2	n/a	n/a
2013-10-07	acoustic	BN	13:11	73.54345°N	166.49653°W	112	13:56	73.43608°N	166.70017°W	90	15	NE	2	<2	n/a	n/a
2013-10-07	acoustic	HI	13:56	73.43608°N	166.70017°W	90	17:45	73.25933°N	167.08377°W	71	12	NE	3	<2	n/a	n/a
2013-10-07	acoustic	BN	17:45	73.25933°N	167.08377°W	71	20:54	73.03713°N	167.44965°W	63	15	NE	4	<2	n/a	n/a
2013-10-07	acoustic	HI	20:54	73.03713°N	167.44965°W	63	24:00	72.83467°N	167.83383°W	62	25	NE	6	2-4	n/a	n/a
2013-10-08	acoustic	LM	00:00	72.83467°N	167.83383°W	62	03:00	72.64925°N	168.15858°W	62	25	E	6	2-4	n/a	n/a
2013-10-08	acoustic	LH	03:00	72.64925°N	168.15858°W	62	06:00	72.44783°N	168.52333°W	56	25	E	6	2-4	n/a	n/a
2013-10-08	acoustic	LM	06:00	72.44783°N	168.52333°W	56	08:43	72.26800°N	168.81633°W	57	30	NE	7	2-4	n/a	n/a
2013-10-08	acoustic	LM	08:43	72.26800°N	168.81633°W	57	09:00	72.25042°N	168.86385°W	58	30	NE	7	2-4	n/a	n/a
2013-10-08	acoustic	LH	09:00	72.25042°N	168.86385°W	58	11:31	72.44195°N	168.72373°W	60	30	NE	7	2-4	n/a	n/a
2013-10-08	acoustic	BN	11:31	72.44195°N	168.72373°W	60	12:00	72.43758°N	168.74037°W	62	30	NE	7	2-4	n/a	n/a
2013-10-08	acoustic	BN	12:00	72.43758°N	168.74037°W	62	12:06	72.43323°N	168.71382°W	62	25	E	6	2-4	n/a	n/a
2013-10-08	acoustic	BN	12:06	72.43323°N	168.71382°W	62	12:35	72.41327°N	168.61057°W	62	25	E	6	2-4	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-08	acoustic	BN	12:35	72.41327°N	168.61057°W	62	12:39	72.41167°N	168.60283°W	62	25	E	6	2-4	n/a	n/a
2013-10-08	acoustic	BN	12:39	72.41167°N	168.60283°W	62	14:58	72.31560°N	168.14517°W	54	25	E	6	2-4	n/a	n/a
2013-10-08	acoustic	HI	14:58	72.31560°N	168.14517°W	54	17:45	72.19977°N	167.59492°W	52	28	E	7	2-4	n/a	n/a
2013-10-08	acoustic	BN	17:45	72.19977°N	167.59492°W	52	20:58	72.07303°N	166.99388°W	50	25	ENE	6	2-4	n/a	n/a
2013-10-08	acoustic	HI	20:58	72.07303°N	166.99388°W	50	24:00	71.90900°N	166.41167°W	47	25	ENE	6	2-4	n/a	n/a
2013-10-09	acoustic	LM	00:00	71.95900°N	166.41167°W	47	03:00	71.85922°N	165.84870°W	47	20	ENE	6	2-4	n/a	n/a
2013-10-09	acoustic	LH	03:00	71.85922°N	165.84870°W	47	06:00	71.75350°N	165.23300°W	44	20	ENE	6	2-4	n/a	n/a
2013-10-09	acoustic	LM	06:00	71.75350°N	165.23300°W	44	09:08	71.64362°N	164.61187°W	41	20	ENE	6	2-4	n/a	n/a
2013-10-09	acoustic	LH	09:08	71.64362°N	164.61187°W	41	12:00	71.51247°N	164.03128°W	45	20	E	6	2-4	n/a	n/a
2013-10-09	acoustic	BN	12:00	71.51247°N	164.03128°W	45	14:57	71.40300°N	163.43100°W	47	15	NE	4	2-4	n/a	n/a
2013-10-09	acoustic	HI	14:57	71.40300°N	163.43100°W	47	17:44	71.28645°N	162.89937°W	48	10	NE	3	<2	n/a	n/a
2013-10-09	acoustic	BN	17:44	71.28645°N	162.89937°W	48	18:54	71.24855°N	162.64648°W	48	10	NE	3	<2	n/a	n/a
2013-10-09	acoustic	BN	18:54	71.24855°N	162.64648°W	48	19:55	71.25342°N	162.81215°W	48	10	NE	3	<2	n/a	n/a
2013-10-09	acoustic	BN	19:55	71.25342°N	162.81215°W	48	20:56	71.28010°N	162.96813°W	48	10	NE	3	<2	n/a	n/a
2013-10-09	acoustic	HI	20:56	71.28010°N	162.96813°W	48	24:00	71.29483°N	162.91450°W	49	10	NE	3	<2	n/a	n/a
2013-10-10	acoustic	LM	00:00	71.29483°N	162.91450°W	49	00:10	71.29500°N	162.86033°W	48	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LM	00:10	71.29500°N	162.86033°W	48	00:39	71.26333°N	162.79567°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LM	00:39	71.26333°N	162.79567°W	47	00:42	71.26200°N	162.78367°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LM	00:42	71.26200°N	162.78367°W	47	03:00	71.17162°N	162.31317°W	48	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	03:00	71.17162°N	162.31317°W	48	03:23	71.14973°N	162.24298°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	03:23	71.14973°N	162.24298°W	47	03:31	71.15673°N	162.21860°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	03:31	71.15673°N	162.21860°W	47	03:49	71.16712°N	162.26172°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	03:49	71.16712°N	162.26172°W	47	04:08	71.16553°N	162.34800°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	04:08	71.16553°N	162.34800°W	47	04:17	71.17040°N	162.38113°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	04:17	71.17040°N	162.38113°W	47	04:26	71.17882°N	162.41310°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	04:26	71.17882°N	162.41310°W	47	04:28	71.17882°N	162.41310°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	04:28	71.17882°N	162.41310°W	47	04:30	71.18503°N	162.42170°W	47	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LH	04:30	71.18503°N	162.42170°W	47	06:00	71.32483°N	162.42233°W	49	10	N	3	<2	n/a	n/a
2013-10-10	acoustic	LM	06:00	71.30817°N	162.42233°W	49	09:00	71.46347°N	162.52483°W	45	5	N	2	<2	n/a	n/a
2013-10-10	acoustic	LH	09:00	71.46347°N	162.52483°W	45	09:13	71.44793°N	162.55713°W	45	2	N	1	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-10	acoustic	LH	09:13	71.44793°N	162.55713°W	45	09:48	71.40440°N	162.64437°W	45	2	N	1	<2	n/a	n/a
2013-10-10	acoustic	LH	09:48	71.40440°N	162.64437°W	45	11:23	71.29252°N	162.83883°W	48	2	N	1	<2	n/a	n/a
2013-10-10	acoustic	LH	11:23	71.29252°N	162.83883°W	48	12:00	71.30653°N	162.89462°W	48	4	N	2	<2	n/a	n/a
2013-10-10	acoustic	BN	12:00	71.30653°N	162.89462°W	48	14:58	71.42925°N	162.56718°W	48	4	NE	2	<2	n/a	n/a
2013-10-10	acoustic	HI	14:58	71.42925°N	162.56718°W	48	16:21	71.37593°N	162.71393°W	48	1	NE	1	<2	n/a	n/a
2013-10-10	acoustic	HI	16:21	71.37593°N	162.71393°W	48	17:42	71.33092°N	162.88840°W	49	1	NE	1	<2	n/a	n/a
2013-10-10	acoustic	BN	17:42	71.33092°N	162.88840°W	49	20:03	71.45355°N	162.35595°W	49	1	NE	1	<2	n/a	n/a
2013-10-10	acoustic	BN	20:03	71.45355°N	162.35595°W	49	20:55	71.49440°N	162.12573°W	46	1	NE	1	<2	n/a	n/a
2013-10-10	acoustic	HI	20:55	71.49440°N	162.12573°W	46	24:00	71.62500°N	161.35633°W	48	1	NE	1	<2	n/a	n/a
2013-10-11	acoustic	LM	00:00	71.62500°N	161.35633°W	48	03:00	71.67283°N	160.86968°W	51	5	E	2	<2	n/a	n/a
2013-10-11	acoustic	LH	03:00	71.67283°N	160.86968°W	51	06:00	71.78583°N	160.34717°W	49	5	E	2	<2	n/a	n/a
2013-10-11	acoustic	LM	06:00	71.78583°N	160.34717°W	49	07:46	71.75900°N	160.67550°W	47	5	E	2	<2	n/a	n/a
2013-10-11	acoustic	LM	07:46	71.75900°N	160.67550°W	47	08:16	71.73133°N	160.81050°W	47	5	E	2	<2	n/a	n/a
2013-10-11	acoustic	LM	08:16	71.73133°N	160.81050°W	47	08:18	71.73150°N	160.81050°W	47	5	E	2	<2	n/a	n/a
2013-10-11	acoustic	LM	08:18	71.73150°N	160.81050°W	47	08:58	71.72320°N	160.98883°W	45	5	E	2	<2	n/a	n/a
2013-10-11	acoustic	LH	08:58	71.72320°N	160.98883°W	45	12:00	71.68113°N	161.69982°W	47	5	NE	2	<2	n/a	n/a
2013-10-11	acoustic	BN	12:00	71.68113°N	161.69982°W	47	12:22	71.67213°N	161.79588°W	47	10	NE	3	<2	n/a	n/a
2013-10-11	acoustic	BN	12:22	71.67213°N	161.79588°W	47	14:56	71.71345°N	161.42880°W	46	10	NE	3	<2	n/a	n/a
2013-10-11	acoustic	HI	14:56	71.71345°N	161.42880°W	46	17:40	71.69433°N	161.61058°W	47	10	E	3	<2	n/a	n/a
2013-10-11	acoustic	BN	17:40	71.69433°N	161.61058°W	47	18:47	71.79412°N	161.64965°W	47	10	E	3	<2	n/a	n/a
2013-10-11	acoustic	BN	18:47	71.79412°N	161.64965°W	47	20:30	71.95008°N	161.51632°W	47	10	E	3	<2	n/a	n/a
2013-10-11	acoustic	BN	20:30	71.95008°N	161.51632°W	47	20:44	71.97033°N	161.47238°W	47	10	E	3	<2	n/a	n/a
2013-10-11	acoustic	BN	20:44	71.97033°N	161.47238°W	47	20:56	71.98497°N	161.43693°W	35	10	E	3	<2	n/a	n/a
2013-10-11	acoustic	HI	20:56	71.98497°N	161.43693°W	35	21:13	71.99973°N	161.37975°W	35	15	E	4	<2	n/a	n/a
2013-10-11	acoustic	HI	21:13	71.99973°N	161.37975°W	35	21:19	72.00712°N	161.33907°W	35	15	E	4	<2	n/a	n/a
2013-10-11	acoustic	HI	21:19	72.00712°N	161.33907°W	35	24:00	72.17550°N	161.00933°W	37	15	E	4	<2	n/a	n/a
2013-10-12	acoustic	LM	00:00	72.17550°N	161.00933°W	37	01:26	72.26117°N	160.77100°W	41	15	E	4	<2	n/a	n/a
2013-10-12	acoustic	LM	01:26	72.26117°N	160.77100°W	41	03:00	72.34013°N	160.86622°W	43	15	E	4	<2	n/a	n/a
2013-10-12	acoustic	LH	03:00	72.34013°N	160.86622°W	43	06:00	72.10967°N	160.57000°W	40	15	E	4	<2	n/a	n/a
2013-10-12	acoustic	LM	06:00	72.10967°N	160.57000°W	40	06:46	72.09650°N	160.78217°W	37	15	NE	4	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-12	acoustic	LM	06:46	72.09650°N	160.78217°W	37	07:15	72.09250°N	160.88700°W	39	15	NE	4	<2	n/a	n/a
2013-10-12	acoustic	LM	07:15	72.09250°N	160.88700°W	39	07:18	72.09350°N	160.89767°W	39	15	NE	4	<2	n/a	n/a
2013-10-12	acoustic	LM	07:18	72.09350°N	160.89767°W	39	09:00	72.06998°N	161.32418°W	33	15	NE	4	<2	n/a	n/a
2013-10-12	acoustic	LH	09:00	72.06998°N	161.32418°W	33	12:00	72.02053°N	161.99650°W	29	15	NE	4	<2	n/a	n/a
2013-10-12	acoustic	BN	12:00	72.02053°N	161.99650°W	29	14:57	71.97117°N	162.72477°W	41	15	N	4	<2	n/a	n/a
2013-10-12	acoustic	HI	14:57	71.97117°N	162.72477°W	41	17:45	71.91723°N	163.37777°W	41	15	N	4	<2	n/a	n/a
2013-10-12	acoustic	BN	17:45	71.91723°N	163.37777°W	41	20:57	71.86193°N	164.14433°W	42	20	N	5	<2	n/a	n/a
2013-10-12	acoustic	HI	20:57	71.86193°N	164.14433°W	42	22:21	71.80128°N	164.14433°N	42	15	N	4	<2	n/a	n/a
2013-10-12	acoustic	HI	22:21	71.80128°N	164.14433°N	42	22:26	71.80348°N	164.29490°W	42	15	N	4	<2	n/a	n/a
2013-10-12	acoustic	HI	22:26	71.80348°N	164.29490°W	42	24:00	71.68500°N	164.05300°W	40	15	N	4	<2	n/a	n/a
2013-10-13	acoustic	LM	00:00	71.68500°N	164.05300°W	40	03:00	71.53895°N	163.69892°W	45	15	N	4	<2	n/a	n/a
2013-10-13	acoustic	LH	03:00	71.53895°N	163.69892°W	45	03:41	71.55088°N	163.55077°W	45	15	N	4	<2	n/a	n/a
2013-10-13	acoustic	LH	03:41	71.55088°N	163.55077°W	45	04:09	71.56177°N	163.46433°W	45	15	N	4	<2	n/a	n/a
2013-10-13	acoustic	LH	04:09	71.56177°N	163.46433°W	45	04:10	71.56262°N	163.46147°W	45	15	N	4	<2	n/a	n/a
2013-10-13	acoustic	LH	04:10	71.56262°N	163.46147°W	45	06:00	71.59267°N	162.99600°W	44	15	NW	4	<2	n/a	n/a
2013-10-13	acoustic	LM	06:00	71.59267°N	162.99600°W	44	09:00	71.64417°N	162.32920°W	45	15	NW	4	<2	n/a	n/a
2013-10-13	acoustic	LH	09:00	71.64417°N	162.32920°W	45	09:59	71.72822°N	162.87940°W	45	15	NW	4	<2	n/a	n/a
2013-10-13	acoustic	LH	09:59	71.72822°N	162.87940°W	45	12:00	71.61328°N	162.53798°W	45	15	NW	4	<2	n/a	n/a
2013-10-13	acoustic	BN	12:00	71.61328°N	162.53798°W	45	14:41	71.63295°N	162.35275°W	45	20	NE	5	<2	n/a	n/a
2013-10-13	acoustic	BN	14:41	71.63295°N	162.35275°W	45	14:56	71.64780°N	162.29615°W	45	20	NE	5	<2	n/a	n/a
2013-10-13	acoustic	HI	14:56	71.64780°N	162.29615°W	45	15:10	71.65213°N	162.24427°W	45	25	N	6	2-4	n/a	n/a
2013-10-13	acoustic	HI	15:10	71.65213°N	162.24427°W	45	15:15	71.64932°N	162.21438°W	45	25	N	6	2-4	n/a	n/a
2013-10-13	acoustic	HI	15:15	71.64932°N	162.21438°W	45	17:45	71.68232°N	161.65833°W	47	25	N	6	2-4	n/a	n/a
2013-10-13	acoustic	BN	17:45	71.68232°N	161.65833°W	47	20:38	71.72522°N	161.06443°W	47	30	NE	7	2-4	n/a	n/a
2013-10-13	acoustic	BN	20:38	71.72522°N	161.06443°W	47	20:42	71.72048°N	161.05858°W	47	30	NE	7	2-4	n/a	n/a
2013-10-13	acoustic	BN	20:42	71.72048°N	161.05858°W	47	20:46	71.71580°N	161.07780°W	47	30	NE	7	2-4	n/a	n/a
2013-10-13	acoustic	BN	20:46	71.71580°N	161.07780°W	47	20:52	71.70980°N	161.10320°W	47	30	NE	7	2-4	n/a	n/a
2013-10-13	acoustic	BN	20:52	71.70980°N	161.10320°W	47	20:57	71.65213°N	161.12505°W	47	30	NE	7	2-4	n/a	n/a
2013-10-13	acoustic	HI	20:57	71.65213°N	161.12505°W	47	24:00	71.55300°N	161.98033°W	47	35	NE	8	2-4	n/a	n/a
2013-10-14	acoustic	LM	00:00	71.55300°N	161.98033°W	47	03:00	71.48868°N	162.37577°W	47	30	NE	7	2-4	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-14	acoustic	LH	03:00	71.48868°N	162.37577°W	47	06:00	71.37733°N	162.91083°W	46	30	NE	7	2-4	n/a	n/a
2013-10-14	acoustic	LM	06:00	71.37733°N	162.91083°W	46	09:00	71.21103°N	163.56955°W	46	30	NE	7	2-4	n/a	n/a
2013-10-14	acoustic	LH	09:00	71.21103°N	163.56955°W	46	10:02	71.26340°N	163.40105°W	46	40	N	8	2-4	n/a	n/a
2013-10-14	acoustic	LH	10:02	71.26340°N	163.40105°W	46	12:00	71.21630°N	163.57570°W	47	45	N	9	2-4	n/a	n/a
2013-10-14	acoustic	BN	12:00	71.21630°N	163.57570°W	47	14:57	71.15807°N	163.83277°W	45	35	NNE	8	2-4	n/a	n/a
2013-10-14	acoustic	HI	14:57	71.15807°N	163.83277°W	45	17:45	71.01523°N	163.58693°W	46	30	N	7	2-4	n/a	n/a
2013-10-14	acoustic	BN	17:45	71.01523°N	163.58693°W	46	19:42	71.09815°N	163.28282°W	46	25	N	6	2-4	n/a	n/a
2013-10-14	acoustic	BN	19:42	71.09815°N	163.28282°W	46	20:57	71.14920°N	163.15342°W	47	25	N	6	2-4	n/a	n/a
2013-10-14	acoustic	HI	20:57	71.14920°N	163.15342°W	47	24:00	71.05283°N	163.32383°W	46	25	N	6	2-4	n/a	n/a
2013-10-15	acoustic	LM	00:00	71.05283°N	163.32383°W	46	03:00	71.13102°N	163.13183°W	46	20	N	5	2-4	n/a	n/a
2013-10-15	acoustic	LH	03:00	71.13102°N	163.13183°W	46	06:00	71.04183°N	163.32200°W	47	20	N	5	2-4	n/a	n/a
2013-10-15	acoustic	LM	06:00	71.04183°N	163.32200°W	47	07:28	71.16283°N	163.32200°W	47	15	N	4	2-4	n/a	n/a
2013-10-15	acoustic	LM	07:28	71.16283°N	163.32200°W	47	07:58	71.18967°N	163.05650°W	48	15	N	4	2-4	n/a	n/a
2013-10-15	acoustic	LM	07:58	71.18967°N	163.05650°W	48	07:59	71.19133°N	163.05517°W	48	15	N	4	2-4	n/a	n/a
2013-10-15	acoustic	LM	07:59	71.19133°N	163.05517°W	48	09:00	71.24785°N	162.93257°W	48	15	N	4	2-4	n/a	n/a
2013-10-15	acoustic	LH	09:00	71.24785°N	162.93257°W	48	12:00	71.45150°N	162.81667°W	46	15	N	4	2-4	n/a	n/a
2013-10-15	acoustic	BN	12:00	71.45150°N	162.81667°W	46	13:45	71.52275°N	162.30257°W	46	10	N	3	<2	n/a	n/a
2013-10-15	acoustic	BN	13:45	71.52275°N	162.30257°W	46	14:57	71.45510°N	162.07527°W	48	10	N	3	<2	n/a	n/a
2013-10-15	acoustic	HI	14:57	71.45510°N	162.07527°W	48	17:43	71.33502°N	161.52902°W	49	10	NE	3	<2	n/a	n/a
2013-10-15	acoustic	BN	17:43	71.33502°N	161.52902°W	49	19:21	71.33165°N	161.66510°W	49	10	N	3	<2	n/a	n/a
2013-10-15	acoustic	BN	19:21	71.33165°N	161.66510°W	49	19:46	71.24022°N	161.74957°W	49	10	N	3	<2	n/a	n/a
2013-10-15	acoustic	BN	19:46	71.24022°N	161.74957°W	49	20:08	71.32165°N	161.84663°W	49	10	N	3	<2	n/a	n/a
2013-10-15	acoustic	BN	20:08	71.32165°N	161.84663°W	49	20:15	71.31718°N	161.85827°W	49	10	N	3	<2	n/a	n/a
2013-10-15	acoustic	BN	20:15	71.31718°N	161.85827°W	49	20:55	71.31422°N	162.01970°W	48	10	N	3	<2	n/a	n/a
2013-10-15	acoustic	HI	20:55	71.31422°N	162.01970°W	48	24:00	71.25133°N	162.72667°W	48	10	N	3	<2	n/a	n/a
2013-10-16	acoustic	LM	00:00	71.25133°N	162.72667°W	48	03:00	71.20580°N	163.37638°W	47	10	N	3	<2	n/a	n/a
2013-10-16	acoustic	LH	03:00	71.20580°N	163.37638°W	47	06:00	71.15883°N	164.08067°W	45	15	NE	4	<2	n/a	n/a
2013-10-16	acoustic	LM	06:00	71.15883°N	164.08067°W	45	07:04	71.13083°N	164.34583°W	45	10	N	3	<2	n/a	n/a
2013-10-16	acoustic	LM	07:04	71.13083°N	164.34583°W	45	07:14	71.13083°N	164.34583°W	45	10	N	3	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-22	acoustic	LH	09:55	72.62883°N	165.75865°W	55	10:29	72.62828°N	165.60240°W	55	5	N	1	<2	n/a	n/a
2013-10-22	acoustic	LH	10:29	72.62828°N	165.60240°W	55	10:45	72.61823°N	165.54102°W	55	5	N	1	<2	n/a	n/a
2013-10-22	acoustic	LH	10:45	72.61823°N	165.54102°W	55	11:11	72.60853°N	165.45485°W	55	5	NE	1	<2	n/a	n/a
2013-10-22	acoustic	LH	11:11	72.60853°N	165.45485°W	55	11:13	72.60853°N	165.45485°W	55	5	NE	1	<2	n/a	n/a
2013-10-22	acoustic	LH	11:13	72.60853°N	165.45485°W	55	12:00	72.57662°N	165.33495°W	54	5	NE	1	<2	n/a	n/a
2013-10-22	acoustic	BN	12:00	72.57662°N	165.33495°W	54	13:40	72.50460°N	165.08220°W	54	1	NE	1	<2	n/a	n/a
2013-10-22	acoustic	BN	13:40	72.50460°N	165.08220°W	54	13:51	72.50527°N	165.03437°W	54	1	NE	1	<2	n/a	n/a
2013-10-22	acoustic	BN	13:51	72.50527°N	165.03437°W	54	14:10	72.49003°N	164.99467°W	54	1	NE	1	<2	n/a	n/a
2013-10-22	acoustic	BN	14:10	72.49003°N	164.99467°W	54	14:50	72.40882°N	164.82910°W	54	1	NE	1	<2	n/a	n/a
2013-10-22	acoustic	BN	14:50	72.40882°N	164.82910°W	54	14:54	72.48753°N	164.81558°W	54	1	NE	1	<2	n/a	n/a
2013-10-22	acoustic	BN	14:54	72.48753°N	164.81558°W	54	14:57	72.48288°N	164.81090°W	52	1	NE	1	<2	n/a	n/a
2013-10-22	acoustic	HI	14:57	72.48288°N	164.81090°W	52	16:11	72.43963°N	164.57303°W	52	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	HI	16:11	72.43963°N	164.57303°W	52	16:28	72.42698°N	164.53967°W	52	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	HI	16:28	72.42698°N	164.53967°W	52	16:54	72.41975°N	164.41768°W	52	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	HI	16:54	72.41975°N	164.41768°W	52	17:10	72.39813°N	164.38892°W	52	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	HI	17:10	72.39813°N	164.38892°W	52	17:40	72.38522°N	164.25633°W	48	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	BN	17:40	72.38522°N	164.25633°W	48	17:43	72.38435°N	164.24122°W	48	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	BN	17:43	72.38435°N	164.24122°W	48	17:46	72.38363°N	164.22890°W	48	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	BN	17:46	72.38363°N	164.22890°W	48	18:51	72.28915°N	164.21817°W	48	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	BN	18:51	72.28915°N	164.21817°W	48	20:57	72.08352°N	164.23520°W	41	0	None	0	<2	n/a	n/a
2013-10-22	acoustic	HI	20:57	72.08352°N	164.23520°W	41	24:00	71.93383°N	164.21050°W	42	0	None	0	<2	n/a	n/a
2013-10-23	acoustic	LM	00:00	71.93383°N	164.21050°W	42	03:00	71.76390°N	164.44290°W	40	5	NE	1	<2	n/a	n/a
2013-10-23	acoustic	LH	03:00	71.76390°N	164.44290°W	40	03:13	71.75517°N	164.49660°W	40	5	NE	2	<2	n/a	n/a
2013-10-23	acoustic	LH	03:13	71.75517°N	164.49660°W	40	03:42	71.72550°N	164.61910°W	40	5	NE	2	<2	n/a	n/a
2013-10-23	acoustic	LH	03:42	71.72550°N	164.61910°W	40	03:45	71.72550°N	164.61910°W	40	5	NE	2	<2	n/a	n/a
2013-10-23	acoustic	LH	03:45	71.72550°N	164.61910°W	40	06:00	71.58867°N	164.89933°W	45	5	NE	2	<2	n/a	n/a
2013-10-23	acoustic	LM	06:00	71.58867°N	164.89933°W	40	08:32	71.418688°N	165.18178°W	42	5	N	2	<2	n/a	n/a
2013-10-23	acoustic	LM	08:35	71.41372°N	165.182365°W	42	08:37	71.410945°N	165.18261°W	42	5	N	2	<2	n/a	n/a
2013-10-23	acoustic	LM	08:39	71.407107°N	165.183106°W	42	09:06	71.38328°N	165.27977°W	42	15	NW	4	<2	n/a	n/a
2013-10-23	acoustic	LH	09:06	71.38328°N	165.27977°W	42	09:07	71.38328°N	165.27977°W	42	15	NW	4	<2	n/a	n/a

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			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-23	acoustic	LH	09:09	71.38328°N	165.27977°W	45	11:57	71.18478°N	165.58733°W	45	15	NW	4	<2	n/a	n/a
2013-10-23	acoustic	BN	11:57	71.18478°N	165.58733°W	45	14:58	70.99502°N	165.93682°W	45	10	N	3	<2	n/a	n/a
2013-10-23	acoustic	HI	14:58	70.99502°N	165.93682°W	43	17:44	70.81620°N	166.29818°W	43	10	N	3	<2	n/a	n/a
2013-10-23	acoustic	BN	17:44	70.81620°N	166.29818°W	48	20:57	70.61060°N	166.63927°W	48	15	N	4	<2	n/a	n/a
2013-10-23	acoustic	HI	20:57	70.61060°N	166.63927°W	50	24:00	70.43783°N	166.93567°W	50	15	N	4	<2	n/a	n/a
2013-10-24	acoustic	LM	00:00	70.43783°N	166.93567°W	50	02:57	70.28827°N	167.17752°W	50	15	NW	4	<2	n/a	n/a
2013-10-24	acoustic	LH	02:57	70.28827°N	167.17752°W	50	04:30	70.23435°N	167.24535°W	50	15	NW	4	<2	n/a	n/a
2013-10-24	acoustic	LH	04:30	70.23435°N	167.24535°W	50	04:34	70.21862°N	167.30028°W	50	20	NW	5	2-4	n/a	n/a
2013-10-24	acoustic	LH	04:34	70.21862°N	167.30028°W	50	04:36	70.21862°N	167.30028°W	50	20	NW	5	2-4	n/a	n/a
2013-10-24	acoustic	LH	05:09	70.21693°N	167.18002°W	50	05:22	70.24143°N	167.13597°W	50	20	NW	5	2-4	n/a	n/a
2013-10-24	acoustic	LH	05:22	70.24143°N	167.13597°W	50	05:53	70.28472°N	167.19677°W	50	20	NW	5	2-4	n/a	n/a
2013-10-24	acoustic	LH	05:53	70.28472°N	167.19677°W	50	06:00	70.29133°N	167.22283°W	50	20	NW	5	2-4	n/a	n/a
2013-10-24	acoustic	LM	06:00	70.29133°N	167.22283°W	50	09:00	70.45408°N	167.86573°W	62	25	NW	6	2-4	n/a	n/a
2013-10-24	acoustic	LH	09:00	70.45408°N	167.86573°W	62	10:36	70.53562°N	168.18168°W	46	25	NW	6	2-4	n/a	n/a
2013-10-24	acoustic	LH	10:36	70.53562°N	168.18168°W	46	11:09	70.55570°N	168.25632°W	46	25	NW	6	2-4	n/a	n/a
2013-10-24	acoustic	BN	13:00	70.64128°N	168.63293°W	41	13:30	70.66662°N	168.73072°W	33	20	NW	5	<2	n/a	n/a
2013-10-24	acoustic	BN	13:45	70.67643°N	168.78485°W	41	15:00	70.70955°N	168.78493°W	33	20	NW	5	<2	n/a	n/a
2013-10-24	acoustic	HI	15:00	70.70955°N	168.78493°W	33	15:44	70.72248°N	168.64767°W	33	15	N	4	<2	n/a	n/a
2013-10-24	acoustic	HI	15:44	70.72248°N	168.64767°W	33	16:08	70.73067°N	168.55097°W	43	15	N	4	<2	n/a	n/a
2013-10-24	acoustic	HI	16:08	70.73067°N	168.55097°W	33	16:13	70.73385°N	168.54083°W	54	15	N	4	<2	n/a	n/a
2013-10-24	acoustic	HI	16:13	70.73385°N	168.54083°W	33	17:45	70.76858°N	168.20413°W	47	15	N	4	<2	n/a	n/a
2013-10-24	acoustic	BN	17:45	70.76858°N	168.20413°W	43	20:58	70.83328°N	167.51248°W	47	15	NE	4	<2	n/a	n/a
2013-10-24	acoustic	HI	20:58	70.83328°N	167.51248°W	54	24:00	70.91783°N	166.83667°W	47	20	NE	5	<2	n/a	n/a
2013-10-25	acoustic	LM	00:00	70.91783°N	166.83667°W	47	03:00	70.97940°N	166.15668°W	47	15	NE	4	<2	n/a	n/a
2013-10-25	acoustic	LH	03:00	70.97940°N	166.15668°W	47	06:00	71.03400°N	165.50817°W	44	15	NE	4	<2	n/a	n/a
2013-10-25	acoustic	LM	06:00	71.03400°N	165.50817°W	44	09:05	71.08427°N	164.85478°W	44	25	NE	6	2-4	n/a	n/a
2013-10-25	acoustic	LH	09:05	71.08427°N	164.85478°W	44	12:00	71.14240°N	164.23118°W	45	23	NE	6	2-4	n/a	n/a
2013-10-25	acoustic	BN	12:00	71.14240°N	164.23118°W	45	14:38	71.17877°N	163.65170°W	45	25	NE	6	2-4	n/a	n/a
2013-10-25	acoustic	BN	14:38	71.17877°N	163.65170°W	45	14:57	71.15908°N	163.61595°W	45	25	NE	6	2-4	n/a	n/a
2013-10-25	acoustic	HI	14:57	71.15908°N	163.61595°W	45	17:43	70.97000°N	163.33323°W	47	20	E	5	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-25	acoustic	BN	17:43	70.97000°N	163.33323°W	47	18:29	70.96405°N	163.31995°W	47	20	E	5	<2	n/a	n/a
2013-10-25	acoustic	BN	18:29	70.96405°N	163.31995°W	47	19:40	70.97523°N	163.37460°W	47	20	E	5	<2	n/a	n/a
2013-10-25	acoustic	BN	19:40	70.97523°N	163.37460°W	47	20:05	70.98908°N	163.43422°W	47	20	E	5	<2	n/a	n/a
2013-10-25	acoustic	BN	20:05	70.98908°N	163.43422°W	47	20:32	71.01178°N	163.51573°W	47	20	E	5	<2	n/a	n/a
2013-10-25	acoustic	BN	20:32	71.01178°N	163.51573°W	47	20:35	71.01575°N	163.52473°W	47	20	E	5	<2	n/a	n/a
2013-10-25	acoustic	BN	20:35	71.01575°N	163.52473°W	47	20:56	71.02183°N	163.61300°W	46	20	E	5	<2	n/a	n/a
2013-10-25	acoustic	HI	20:56	71.02183°N	163.61300°W	46	24:00	71.14483°N	164.22850°W	44	20	E	5	<2	n/a	n/a
2013-10-26	acoustic	LM	00:00	71.14483°N	164.22850°W	44	03:04	71.26175°N	164.84867°W	44	15	E	4	<2	n/a	n/a
2013-10-26	acoustic	LH	03:04	71.26175°N	164.84867°W	44	06:00	71.37700°N	165.40033°W	43	15	E	4	<2	n/a	n/a
2013-10-26	acoustic	LM	06:00	71.37700°N	165.41700°W	43	09:00	71.49003°N	166.05490°W	45	10	SE	3	<2	n/a	n/a
2013-10-26	acoustic	LH	09:00	71.49003°N	166.05490°W	45	11:33	71.58412°N	166.60517°W	47	15	SE	4	<2	n/a	n/a
2013-10-26	acoustic	LH	11:33	71.58412°N	166.60517°W	47	12:00	71.59865°N	166.66038°W	47	10	SE	3	<2	n/a	n/a
2013-10-26	acoustic	BN	12:00	71.59865°N	166.66038°W	47	14:56	71.48672°N	166.12503°W	47	10	NE	3	<2	n/a	n/a
2013-10-26	acoustic	HI	14:56	71.48672°N	166.12503°W	47	16:03	71.49593°N	166.14905°W	47	15	E	4	<2	n/a	n/a
2013-10-26	acoustic	HI	16:03	71.49593°N	166.14905°W	47	17:04	71.54440°N	166.36828°W	47	15	E	4	<2	n/a	n/a
2013-10-26	acoustic	HI	17:04	71.54440°N	166.36828°W	47	17:32	71.56777°N	166.43702°W	47	15	E	4	<2	n/a	n/a
2013-10-26	acoustic	HI	17:32	71.56777°N	166.43702°W	47	17:36	71.57268°N	166.46097°W	47	15	E	4	<2	n/a	n/a
2013-10-26	acoustic	HI	17:36	71.57268°N	166.46097°W	47	17:43	71.57305°N	166.48797°W	47	15	E	4	<2	n/a	n/a
2013-10-26	acoustic	BN	17:43	71.57305°N	166.48797°W	47	20:57	71.70118°N	167.20275°W	49	20	E	5	<2	n/a	n/a
2013-10-26	acoustic	HI	20:57	71.70118°N	167.20275°W	49	22:39	71.76897°N	167.39090°W	49	20	E	5	<2	n/a	n/a
2013-10-26	acoustic	HI	22:39	71.76897°N	167.39090°W	49	22:45	71.77935°N	167.36455°W	49	20	E	5	<2	n/a	n/a
2013-10-26	acoustic	HI	22:45	71.77935°N	167.36455°W	49	23:07	71.79425°N	167.29333°W	49	20	E	5	2-4	n/a	n/a
2013-10-26	acoustic	HI	23:07	71.79425°N	167.29333°W	49	23:20	71.80827°N	167.22390°W	49	20	E	5	2-4	n/a	n/a
2013-10-26	acoustic	HI	23:20	71.80827°N	167.22390°W	49	24:00	71.83500°N	167.08217°W	50	20	E	5	2-4	n/a	n/a
2013-10-27	acoustic	LM	00:00	71.83500°N	167.08217°W	50	03:01	72.05670°N	166.60708°W	50	20	NW	5	<2	n/a	n/a
2013-10-27	acoustic	LH	03:01	72.05670°N	166.60708°W	50	06:00	72.01400°N	165.96383°W	48	20	NW	5	<2	n/a	n/a
2013-10-27	acoustic	LM	06:00	72.01400°N	165.96383°W	48	06:55	71.93367°N	165.91833°W	47	15	NE	4	<2	n/a	n/a
2013-10-27	acoustic	LM	06:55	71.93367°N	165.96117°W	47	07:25	71.90633°N	165.96117°W	47	15	NE	4	<2	n/a	n/a
2013-10-27	acoustic	LM	07:25	71.90633°N	165.96117°W	47	07:27	71.90483°N	165.97917°W	47	15	NE	4	<2	n/a	n/a
2013-10-27	acoustic	LM	07:27	71.90483°N	165.97917°W	47	09:05	71.80402°N	165.99618°W	47	15	SE	4	<2	n/a	n/a

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Date	Visual or Acoustic	Observers' Initials	Start of Watch				End of Watch				Wind Speed (knots)	Wind Direction	Beaufort Scale	Swell (m)	Visibility (km)	Glare Severity
			Time	Latitude	Longitude	Depth (m)	Time	Latitude	Longitude	Depth (m)						
2013-10-27	acoustic	LH	09:05	71.80402°N	165.99618°W	47	12:00	71.58903°N	165.74373°W	45	15	SE	4	<2	n/a	n/a
2013-10-27	acoustic	BN	12:00	71.58903°N	165.74373°W	45	14:56	71.51248°N	165.62230°W	43	10	SE	3	<2	n/a	n/a
2013-10-27	acoustic	HI	14:56	71.51248°N	165.62230°W	43	16:21	71.41107°N	165.51007°W	43	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	HI	16:21	71.41107°N	165.51007°W	43	16:35	71.39427°N	165.52840°W	43	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	HI	16:35	71.39427°N	165.52840°W	43	16:39	71.39427°N	165.52840°W	43	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	HI	16:39	71.39427°N	165.52840°W	43	17:05	71.36195°N	165.48015°W	43	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	HI	17:05	71.36195°N	165.48015°W	43	17:26	71.33173°N	165.50767°W	43	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	HI	17:26	71.33173°N	165.50767°W	43	17:28	71.33215°N	165.51003°W	43	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	HI	17:28	71.33215°N	165.51003°W	43	17:45	71.31382°N	165.50118°W	44	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	BN	17:45	71.31382°N	165.50118°W	43	20:56	71.08237°N	165.00768°W	45	10	E	3	<2	n/a	n/a
2013-10-27	acoustic	HI	20:56	71.08237°N	165.00768°W	45	24:00	70.85350°N	165.14600°W	43	10	E	3	<2	n/a	n/a
2013-10-28	acoustic	LM	00:00	70.85350°N	165.14600°W	43	03:00	70.62617°N	165.05167°W	43	10	SE	3	<2	n/a	n/a
2013-10-28	acoustic	LH	03:00	70.62617°N	165.05167°W	43	06:00	70.43217°N	164.89800°N	47	10	SE	3	<2	n/a	n/a
2013-10-28	acoustic	LM	06:00	70.43217°N	164.89800°W	47	08:02	70.28967°N	164.83100°W	45	8	N	3	<2	n/a	n/a
2013-10-28	acoustic	BN	18:48	71.02207°N	162.98903°W	48	20:06	71.09643°N	163.04762°W	48	20	N	5	<2	n/a	n/a
2013-10-28	acoustic	BN	20:06	71.09643°N	163.04762°W	48	20:31	71.12883°N	163.03853°W	48	20	N	5	<2	n/a	n/a
2013-10-28	acoustic	BN	20:31	71.12883°N	163.03853°W	48	20:34	71.13258°N	163.04942°W	48	20	N	5	<2	n/a	n/a
2013-10-28	acoustic	BN	20:34	71.13258°N	163.04942°W	48	20:58	71.16098°N	163.11862°W	46	20	N	5	<2	n/a	n/a
2013-10-28	acoustic	HI	20:58	71.16098°N	163.11862°W	46	23:20	71.34180°N	163.20408°W	46	20	N	5	<2	n/a	n/a
2013-10-28	acoustic	HI	23:20	71.34180°N	163.20408°W	46	23:34	71.33525°N	163.18067°W	46	20	N	5	<2	n/a	n/a

APPENDIX E: ACOUSTIC EFFORT DATA WITH VESSEL SPEED AND HEADING

RPS

PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number 13-02

Project Number UMS04183

Vessel Name *Norseman*

Effort Page Number 1 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
8/28/2013	16:00	70.65145	-163.86745	2.8	360	8/29/2013	4:00	70.35375	-164.31015	3.6	306	8/29/2013	15:30	70.45206	-163.49400	4.7	20
8/28/2013	16:30	70.67817	-163.83418	3.9	24	8/29/2013	4:30	70.36797	-164.38226	3.6	298	8/29/2013	16:00	70.48491	-163.50282	3.5	325
8/28/2013	17:00	70.70707	-163.79578	3.3	27	8/29/2013	5:00	70.38386	-164.45906	3.8	303	8/29/2013	16:30	70.48977	-163.57694	4.1	251
8/28/2013	17:30	70.72573	-163.72593	4.9	93	8/29/2013	5:30	70.39928	-164.54309	4.1	297	8/29/2013	17:00	70.47778	-163.66698	4	238
8/28/2013	18:00	70.72297	-163.60099	5	92	8/29/2013	6:00	70.41628	-164.62926	4.1	298	8/29/2013	17:30	70.45882	-163.75035	3.7	233
8/28/2013	19:00	70.75322	-163.40287	5.2	74	8/29/2013	6:30	70.43312	-164.71829	3.9	298	8/29/2013	18:00	70.43767	-163.82853	3.5	211
8/28/2013	19:30	70.72515	-163.38348	5.3	180	8/29/2013	7:00	70.45300	-164.62614	5.6	66	8/29/2013	18:30	70.41520	-163.84616	2.1	205
8/28/2013	20:00	70.68309	-163.37776	5.1	190	8/29/2013	7:30	70.48396	-164.58272	4.7	55	8/29/2013	19:00	70.39010	-163.91740	4.4	216
8/28/2013	20:30	70.64829	-163.43536	4.7	217	8/29/2013	8:00	70.46593	-164.45005	6	133	8/29/2013	19:30	70.36695	-163.99572	4.8	234
8/28/2013	21:00	70.61962	-163.51656	5	227	8/29/2013	8:30	70.43895	-164.34799	5.5	90	8/29/2013	20:00	70.35309	-164.09419	4.4	261
8/28/2013	21:30	70.59740	-163.59875	3.4	257	8/29/2013	9:00	70.43820	-164.24019	4.6	94	8/29/2013	20:30	70.34536	-164.19106	5	163
8/28/2013	22:00	70.57340	-163.67543	4.2	227	8/29/2013	9:30	70.43741	-164.13832	3.9	92	8/29/2013	21:00	70.35290	-164.24151	4.2	259
8/28/2013	22:30	70.56018	-163.74986	3.6	236	8/29/2013	10:00	70.41005	-164.11027	4.7	185	8/29/2013	21:30	70.34655	-164.27895	4.7	303
8/28/2013	23:00	70.53296	-163.82459	4.7	213	8/29/2013	10:30	70.39075	-164.05489	3.6	94	8/29/2013	22:00	70.36852	-164.37739	4.7	307
8/28/2013	23:30	70.49985	-163.88305	4.6	210	8/29/2013	11:00	70.37626	-163.95593	4.8	118	8/29/2013	22:30	70.37533	-164.40522	4.9	304
8/29/2013	0:00	70.48268	-163.92028	5	82	8/29/2013	11:30	70.35340	-163.91922	3	272	8/29/2013	23:00	70.39395	-164.51572	4.8	298
8/29/2013	0:30	70.46968	-163.94681	5.5	77	8/29/2013	12:00	70.34998	-164.00188	3.6	258	8/29/2013	23:30	70.41437	-164.62188	4.9	300
8/29/2013	1:00	70.42981	-163.89921	5.3	172	8/29/2013	12:30	70.34494	-164.08396	3.5	257	8/30/2013	0:00	70.42967	-164.72930	4.7	262
8/29/2013	1:30	70.39368	-163.91949	2.7	270	8/29/2013	13:00	70.35922	-164.10291	5.7	53	8/30/2013	0:30	70.45081	-164.80124	4.8	261
8/29/2013	2:00	70.38248	-163.99640	4.3	222	8/29/2013	13:30	70.38132	-163.98065	5.8	73	8/30/2013	1:00	70.47168	-164.88386	5.5	303
8/29/2013	2:30	70.36727	-164.07105	3.6	261	8/29/2013	14:00	70.39540	-163.84613	5.7	72	8/30/2013	1:30	70.48244	-164.97833	5.7	348
8/29/2013	3:00	70.34187	-164.12668	4.4	266	8/29/2013	14:30	70.40746	-163.71236	5.6	73	8/30/2013	2:00	70.48980	-165.07468	4.8	261
8/29/2013	3:30	70.34114	-164.22486	3.7	274	8/29/2013	15:00	70.42059	-163.58072	5.5	61	8/30/2013	2:30	70.51574	-165.14851	4.8	259

RPS

PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	2 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
8/30/2013	3:00	70.53444	-165.23232	5.1	301	8/30/2013	14:00	70.66689	-166.03196	5.6	337	8/31/2013	1:30	71.10129	-168.28735	5.6	340
8/30/2013	3:30	70.55842	-165.34227	5.3	301	8/30/2013	14:30	70.68911	-166.12754	5.6	268	8/31/2013	2:00	71.11247	-168.39147	5.5	345
8/30/2013	4:00	70.59661	-165.28582	5.8	31	8/30/2013	15:00	70.71573	-166.21692	5.6	290	8/31/2013	2:30	71.12601	-168.49244	5.2	299
8/30/2013	4:30	70.62418	-165.16644	6.3	78	8/30/2013	15:30	70.72838	-166.33008	5.5	336	8/31/2013	3:00	71.14779	-168.60535	4.9	296
8/30/2013	5:00	70.62001	-165.02122	6.1	118	8/30/2013	16:00	70.77079	-166.38474	5.7	335	8/31/2013	3:30	71.16227	-168.72231	5	281
8/30/2013	18:30	70.60773	-164.94536	6.1	121	8/30/2013	16:30	70.77129	-166.51790	5.6	269	8/31/2013	4:00	71.17878	-168.83981	5	280
8/30/2013	5:30	70.59725	-164.88737	6.1	118	8/30/2013	17:00	70.79979	-166.60737	5.8	339	8/31/2013	4:30	71.16097	-168.94362	5	215
8/30/2013	6:00	70.57277	-164.75741	5.8	137	8/30/2013	17:30	70.81214	-166.71781	5.5	265	8/31/2013	5:00	71.12407	-168.92712	5.5	68
8/30/2013	6:30	70.53668	-164.66399	5.9	137	8/30/2013	18:00	70.79894	-166.80777	5.8	339	8/31/2013	5:30	71.10818	-168.93998	5.4	148
8/30/2013	7:00	70.50396	-164.56122	5	122	8/30/2013	18:30	70.84329	-166.85326	5.7	345	8/31/2013	6:30	71.04977	-168.93016	5.2	171
8/30/2013	7:30	70.47156	-164.54413	6.6	218	8/30/2013	19:00	70.85332	-166.96235	5.5	297	8/31/2013	7:00	71.00619	-168.92355	5.3	181
8/30/2013	8:00	70.44757	-164.69623	7.4	263	8/30/2013	19:30	70.87343	-167.05593	5.4	261	8/31/2013	7:30	70.98371	-168.91429	4.7	300
8/30/2013	8:30	70.46137	-164.87078	7.7	297	8/30/2013	20:00	70.90614	-167.13700	5.6	303	8/31/2013	8:00	70.94306	-168.92723	5.2	184
8/30/2013	9:00	70.48634	-165.01045	5	298	8/30/2013	20:30	70.91961	-167.26526	5.2	270	8/31/2013	8:30	70.90958	-168.87868	5.2	263
8/30/2013	9:30	70.50611	-165.12009	4.5	304	8/30/2013	21:00	70.93464	-167.39373	5.8	323	8/31/2013	9:00	70.88195	-168.91961	5.4	135
8/30/2013	10:00	70.53132	-165.20480	4.5	262	8/30/2013	21:30	70.96519	-167.49583	5.3	286	8/31/2013	9:30	70.84508	-168.94376	5.3	181
8/30/2013	10:30	70.54031	-165.29705	5.5	348	8/30/2013	22:00	70.97859	-167.60557	5.9	344	8/31/2013	10:00	70.80523	-168.92824	5.7	92
8/30/2013	11:00	70.54556	-165.39972	5.3	287	8/30/2013	22:30	70.99025	-167.71858	5.9	332	8/31/2013	10:30	70.79187	-168.80277	5.7	144
8/30/2013	11:30	70.57325	-165.47869	5	272	8/30/2013	23:00	71.01060	-167.81965	5	269	8/31/2013	11:00	70.77284	-168.71068	5.3	178
8/30/2013	12:00	70.59745	-165.57181	5.3	306	8/30/2013	23:30	71.03940	-167.89752	5.3	287	8/31/2013	11:30	70.75021	-168.63715	5.4	89
8/30/2013	12:30	70.60659	-165.69846	5.3	283	8/31/2013	0:00	71.04597	-168.00882	5.7	345	8/31/2013	12:00	70.74642	-168.50806	5.2	153
8/30/2013	13:00	70.63168	-165.79973	5.5	321	8/31/2013	0:30	71.06190	-168.10427	5.1	266	8/31/2013	12:30	70.72109	-168.43128	5.7	52
8/30/2013	13:30	70.65289	-165.90920	5.3	280	8/31/2013	1:00	71.08160	-168.19701	5	264	8/31/2013	13:00	70.76938	-168.39282	6.7	358

RPS

PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	3 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
8/31/2013	13:30	70.82521	-168.40033	6.6	354	9/1/2013	1:00	70.47313	-167.08070	4.9	88	9/1/2013	12:30	70.31604	-166.25372	5.7	120
8/31/2013	14:00	70.86292	-168.49214	6.1	292	9/1/2013	1:30	70.47492	-166.95971	4.8	124	9/1/2013	13:00	70.31528	-166.11392	5.6	89
8/31/2013	14:30	70.86959	-168.46891	5.9	121	9/1/2013	2:00	70.46208	-166.97293	6.1	300	9/1/2013	13:30	70.28093	-166.03565	5.6	150
8/31/2013	15:00	70.83722	-168.44367	5.7	256	9/1/2013	2:30	70.47481	-167.09291	5.2	302	9/1/2013	14:00	70.27491	-165.91326	5.8	81
8/31/2013	15:30	70.82414	-168.57958	5.8	255	9/1/2013	3:00	70.50045	-167.19582	5.1	300	9/1/2013	14:30	70.24398	-165.84622	5.5	166
8/31/2013	16:00	70.80896	-168.72052	6	248	9/1/2013	3:30	70.48839	-167.11483	5.1	312	9/1/2013	15:00	70.23834	-165.74186	5.7	74
8/31/2013	16:30	70.78031	-168.77364	5.7	119	9/1/2013	4:00	70.51099	-167.22052	4.8	299	9/1/2013	15:30	70.21739	-165.66800	5.1	167
8/31/2013	17:00	70.75890	-168.65217	5.2	116	9/1/2013	4:30	70.53111	-167.32620	5	303	9/1/2013	16:00	70.19637	-165.58772	5.3	88
8/31/2013	17:30	70.73922	-168.53778	5.1	116	9/1/2013	5:00	70.55239	-167.43522	5.2	296	9/1/2013	16:30	70.19327	-165.46421	5.2	156
8/31/2013	18:00	70.71009	-168.45853	5	92	9/1/2013	5:30	70.56281	-167.55218	4.8	272	9/1/2013	17:00	70.15651	-165.40833	5	154
8/31/2013	18:30	70.70884	-168.33232	5.1	91	9/1/2013	6:00	70.56497	-167.47555	4.8	147	9/1/2013	17:30	70.14854	-165.29023	5.5	92
8/31/2013	19:00	70.68432	-168.24781	4.9	151	9/1/2013	6:30	70.53139	-167.40882	4.8	145	9/2/2013	7:00	70.37516	-164.63758	4.4	32
8/31/2013	19:30	70.66617	-168.15761	4.9	89	9/1/2013	7:00	70.53507	-167.29729	4.9	146	9/2/2013	7:30	70.40473	-164.58250	4.6	27
8/31/2013	20:00	70.66333	-168.03545	5	148	9/1/2013	7:30	70.49847	-167.23602	5	151	9/2/2013	8:00	70.43352	-164.52495	4.7	30
8/31/2013	20:30	70.63793	-167.95251	4.8	105	9/1/2013	8:00	70.49696	-167.11347	5	88	9/2/2013	8:30	70.45813	-164.45534	3	51
8/31/2013	21:00	70.61951	-167.84476	4.7	116	9/1/2013	8:30	70.47182	-167.03303	4.8	146	9/2/2013	9:00	70.48836	-164.41457	3	28
8/31/2013	21:30	70.60085	-167.74004	4.9	122	9/1/2013	9:00	70.45491	-166.93818	5	86	9/2/2013	9:30	70.51235	-164.36821	3.9	32
8/31/2013	22:00	70.58248	-167.63352	4.7	120	9/1/2013	9:30	70.44598	-166.83288	4.6	149	9/2/2013	10:00	70.54254	-164.32452	5.9	357
8/31/2013	22:30	70.56436	-167.53078	4.7	118	9/1/2013	10:00	70.41401	-166.76464	5.3	119	9/2/2013	10:30	70.57471	-164.28195	4.4	60
8/31/2013	23:00	70.55429	-167.41732	4.6	149	9/1/2013	10:30	70.40971	-166.63133	5.5	89	9/2/2013	11:00	70.60281	-164.19396	5.8	360
8/31/2013	23:30	70.52207	-167.35476	4.5	149	9/1/2013	11:00	70.38089	-166.55038	5	147	9/2/2013	11:30	70.63871	-164.16084	3.7	57
9/1/2013	0:00	70.51652	-167.24306	5	88	9/1/2013	11:30	70.35712	-166.45931	5.7	87	9/2/2013	12:00	70.66203	-164.07313	5.7	21
9/1/2013	0:30	70.49710	-167.15697	4.4	148	9/1/2013	12:00	70.35484	-166.32364	5.5	147	9/2/2013	12:30	70.70778	-164.05862	4.8	49

RPS

PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	4 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/2/2013	13:00	70.72801	-163.96705	4.5	60	9/5/2013	7:00	70.78998	-164.49413	5.4	288	9/5/2013	18:30	71.21496	-166.78465	4.4	321
9/2/2013	13:30	70.76201	-163.91232	5.9	1	9/5/2013	7:30	70.81434	-164.57814	4	324	9/5/2013	19:00	71.24691	-166.86863	5.1	315
9/2/2013	14:00	70.79757	-163.87260	4.2	56	9/5/2013	8:00	70.83418	-164.68218	5.2	291	9/5/2013	19:30	71.26757	-166.97808	5.5	277
9/2/2013	14:30	70.81568	-163.77406	5.6	58	9/5/2013	8:30	70.84186	-164.81323	4.6	329	9/5/2013	20:00	71.27522	-167.11838	4.7	327
9/2/2013	15:00	70.85146	-163.71799	5.2	31	9/5/2013	9:00	70.87364	-164.84780	5.4	295	9/5/2013	20:30	71.30339	-167.20841	4.7	310
9/2/2013	15:30	70.88655	-163.64656	4.2	33	9/5/2013	9:30	70.87573	-164.98835	5.4	290	9/5/2013	21:00	71.31975	-167.32306	5.6	282
9/2/2013	16:00	70.92865	-163.61833	5.1	6	9/5/2013	10:00	70.90582	-165.05399	4.8	328	9/5/2013	21:30	71.33667	-167.40628	3.7	3
9/2/2013	16:30	70.95515	-163.54063	5	61	9/5/2013	10:30	70.93601	-165.13461	5.7	268	9/5/2013	22:00	71.35573	-167.50034	5.3	290
9/2/2013	17:00	70.98879	-163.48673	6	358	9/5/2013	11:00	70.93478	-165.27853	5.7	271	9/5/2013	22:30	71.37081	-167.62953	5.4	289
9/2/2013	17:30	71.01927	-163.43634	4.6	55	9/5/2013	11:30	70.95876	-165.36412	4.4	327	9/5/2013	23:00	71.38776	-167.66491	3.4	97
9/2/2013	18:00	71.04778	-163.34622	5.5	356	9/5/2013	12:00	70.99339	-165.43360	5.1	326	9/5/2013	23:30	71.36043	-167.73501	6.3	227
9/2/2013	18:30	71.08370	-163.31305	4.8	58	9/5/2013	12:30	71.00188	-165.55921	5.2	274	9/6/2013	0:00	71.31941	-167.75567	4.1	179
9/2/2013	19:00	71.11077	-163.23762	5.1	31	9/5/2013	13:00	71.01012	-165.68608	4.6	324	9/6/2013	0:30	71.28326	-167.80054	4.9	211
9/2/2013	19:30	71.14563	-163.17259	4.9	32	9/5/2013	13:30	71.04189	-165.75313	4.7	339	9/6/2013	1:00	71.24926	-167.89232	5.6	226
9/2/2013	20:00	71.17945	-163.10111	4.6	32	9/5/2013	14:00	71.06714	-165.84904	5.8	274	9/6/2013	1:30	71.21426	-167.99968	6	223
9/2/2013	20:30	71.21053	-163.03899	4.5	34	9/5/2013	14:30	71.06952	-165.98707	5.7	270	9/6/2013	2:00	71.18177	-168.09875	5.3	224
9/5/2013	3:30	70.66643	-163.86977	3.9	348	9/5/2013	15:00	71.08055	-166.09515	3.9	328	9/6/2013	2:30	71.14557	-168.15508	5	204
9/5/2013	4:00	70.68949	-163.91651	5.5	279	9/5/2013	15:30	71.11138	-166.18573	5.4	316	9/6/2013	3:00	71.10762	-168.20400	5	203
9/5/2013	4:30	70.69677	-164.05214	5.4	279	9/5/2013	16:00	71.12190	-166.31354	5.4	270	9/6/2013	3:30	71.07392	-168.27819	5.4	231
9/5/2013	5:00	70.71699	-164.10515	3.7	357	9/5/2013	16:30	71.14054	-166.41438	4.4	313	9/6/2013	4:00	71.03934	-168.33902	4.8	201
9/5/2013	5:30	70.73380	-164.18437	5.2	291	9/5/2013	17:00	71.17209	-166.45534	5.3	352	9/6/2013	4:30	71.00155	-168.38288	5.2	195
9/5/2013	6:00	70.74933	-164.30756	5.3	293	9/5/2013	17:30	71.18738	-166.56185	5.4	275	9/6/2013	5:00	70.96758	-168.44127	5.2	244
9/5/2013	6:30	70.77661	-164.36687	5.5	284	9/5/2013	18:00	71.19176	-166.69944	5	275	9/6/2013	5:30	70.93746	-168.51209	4.9	201

RPS

PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	5 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/6/2013	6:00	70.89898	-168.55616	5	200	9/6/2013	17:30	70.52785	-167.97548	5.4	5	9/7/2013	5:00	70.62395	-167.74799	3.7	209
9/6/2013	6:30	70.86124	-168.59919	4.6	194	9/6/2013	18:00	70.54881	-167.89508	4.9	61	9/7/2013	5:30	70.59491	-167.79292	4.3	211
9/6/2013	7:00	70.83535	-168.67113	5.3	260	9/6/2013	18:30	70.58248	-167.83652	5.3	12	9/7/2013	6:00	70.56087	-167.84315	5.2	206
9/6/2013	7:30	70.80141	-168.72821	5	205	9/6/2013	19:00	70.62377	-167.82318	4.3	2	9/7/2013	6:30	70.57156	-167.90076	5.3	347
9/6/2013	8:00	70.76268	-168.77485	5.2	197	9/6/2013	19:30	70.64976	-167.74899	5.4	70	9/7/2013	7:00	70.59361	-167.86093	5.1	335
9/6/2013	8:30	70.72386	-168.80642	5.2	224	9/6/2013	20:00	70.67614	-167.67031	5.5	357	9/7/2013	7:30	70.61907	-167.80847	4.7	28
9/6/2013	9:00	70.69647	-168.90823	5.1	233	9/6/2013	20:30	70.71296	-167.65482	3.7	32	9/7/2013	8:00	70.65501	-167.75113	4.8	32
9/6/2013	9:30	70.66914	-168.99204	4.3	172	9/6/2013	21:00	70.71156	-167.72067	4.8	234	9/7/2013	8:30	70.69436	-167.72346	5	3
9/6/2013	10:00	70.64457	-168.93899	4	143	9/6/2013	21:30	70.68791	-167.80994	4.6	234	9/7/2013	9:00	70.73734	-167.72875	5.3	26
9/6/2013	10:30	70.61869	-168.86740	4.5	135	9/6/2013	22:00	70.66139	-167.88052	4.2	214	9/7/2013	9:00	70.73757	-167.72837	5.2	27
9/6/2013	11:00	70.59027	-168.80784	5.9	205	9/6/2013	22:30	70.63163	-167.94290	4.5	216	9/7/2013	9:00	70.73780	-167.72794	5.2	31
9/6/2013	11:30	70.55901	-168.79885	3.9	120	9/6/2013	23:00	70.60325	-168.00059	4	206	9/7/2013	9:00	70.73802	-167.72748	5.2	34
9/6/2013	12:00	70.55621	-168.68448	5.3	91	9/6/2013	23:30	70.57828	-168.04735	3.4	216	9/7/2013	9:00	70.73821	-167.72704	5.2	36
9/6/2013	12:30	70.53610	-168.61811	6	187	9/7/2013	0:00	70.56729	-168.01465	3.4	72	9/7/2013	9:30	70.75938	-167.63178	4.7	56
9/6/2013	13:00	70.50039	-168.58927	4.5	108	9/7/2013	0:30	70.58530	-167.92820	4.3	68	9/7/2013	10:00	70.78080	-167.53054	4.6	57
9/6/2013	13:30	70.48388	-168.47917	3.6	107	9/7/2013	1:00	70.60643	-167.83638	4.5	46	9/7/2013	10:30	70.80294	-167.43035	5.1	36
9/6/2013	14:00	70.45748	-168.41497	5.4	94	9/7/2013	1:30	70.63632	-167.77924	4.4	27	9/7/2013	11:00	70.84639	-167.42046	5.3	4
9/6/2013	14:30	70.44871	-168.30137	5.6	128	9/7/2013	2:00	70.66908	-167.73218	4.5	34	9/7/2013	11:30	70.89009	-167.41646	5.1	1
9/6/2013	15:00	70.42874	-168.22401	3.8	141	9/7/2013	2:30	70.70076	-167.67417	4.4	32	9/7/2013	12:00	70.93369	-167.40541	5	40
9/6/2013	15:30	70.41124	-168.14732	3.8	122	9/7/2013	3:00	70.72484	-167.62359	3.1	186	9/7/2013	12:30	70.95546	-167.30353	4.6	55
9/6/2013	16:00	70.41648	-168.07337	4.4	33	9/7/2013	3:30	70.69727	-167.64668	3.7	204	9/7/2013	13:00	70.97652	-167.20114	4.5	61
9/6/2013	16:30	70.44862	-168.03166	4	24	9/7/2013	4:00	70.66963	-167.66701	2.9	215	9/7/2013	13:30	70.99699	-167.09701	5.1	43
9/6/2013	17:00	70.48508	-167.99517	5.2	9	9/7/2013	4:30	70.64751	-167.69787	3.3	220	9/7/2013	14:00	71.03973	-167.08818	5.3	2

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	6 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/7/2013	14:30	71.08301	-167.08199	5.2	2	9/8/2013	2:00	71.68334	-168.87288	5.3	3	9/8/2013	13:30	71.45877	-167.80737	5.4	190
9/7/2013	15:00	71.12136	-167.01872	5.3	35	9/8/2013	2:30	71.72621	-168.85561	5.4	24	9/8/2013	14:00	71.41784	-167.81272	5.4	131
9/7/2013	15:30	71.15766	-166.93890	5.6	34	9/8/2013	3:00	71.75536	-168.75681	5.1	49	9/8/2013	14:30	71.38237	-167.77245	5	200
9/7/2013	16:00	71.19707	-166.87183	5.9	1	9/8/2013	3:30	71.77117	-168.71647	3.5	241	9/8/2013	15:00	71.34766	-167.72839	5.1	132
9/7/2013	16:30	71.24098	-166.92581	5.7	329	9/8/2013	4:00	71.77687	-168.71572	5.2	51	9/8/2013	15:30	71.31069	-167.73631	5.1	196
9/7/2013	17:00	71.27924	-167.00517	5.6	319	9/8/2013	4:30	71.80473	-168.61198	5.4	52	9/8/2013	16:00	71.27494	-167.68233	5.5	136
9/7/2013	17:30	71.30430	-167.13251	6.1	295	9/8/2013	5:00	71.83180	-168.50332	5.1	52	9/8/2013	16:30	71.23719	-167.66460	5	194
9/7/2013	18:00	71.32729	-167.26359	5.8	301	9/8/2013	5:30	71.83598	-168.49960	5.1	51	9/8/2013	17:00	71.20322	-167.60103	5	180
9/7/2013	18:30	71.34285	-167.40349	6	283	9/8/2013	6:00	71.86270	-168.40519	3.9	277	9/8/2013	17:30	71.16487	-167.60494	5.2	132
9/7/2013	19:00	71.35047	-167.55292	5.7	277	9/8/2013	6:30	71.88226	-168.33859	4.9	69	9/8/2013	18:00	71.13070	-167.56689	5	194
9/7/2013	19:30	71.37030	-167.67506	5.7	330	9/8/2013	7:00	71.90409	-168.24662	5.3	39	9/8/2013	18:30	71.09620	-167.52152	5.3	131
9/7/2013	20:00	71.40606	-167.75235	4.9	276	9/8/2013	7:30	71.89234	-168.18314	4.1	162	9/8/2013	19:00	71.05767	-167.52336	5.2	195
9/7/2013	20:30	71.41202	-167.87299	4.9	353	9/8/2013	8:00	71.86132	-168.15834	4.1	171	9/8/2013	19:30	71.02298	-167.46007	5	194
9/7/2013	21:00	71.44443	-167.91694	4.3	275	9/8/2013	8:30	71.83077	-168.13553	4.1	168	9/8/2013	20:00	70.98592	-167.45121	5.2	128
9/7/2013	21:30	71.45411	-168.01728	5.1	359	9/8/2013	9:00	71.79721	-168.12089	5.5	131	9/8/2013	20:30	70.94879	-167.44960	5	144
9/7/2013	22:00	71.48153	-168.09756	5	293	9/8/2013	9:30	71.76247	-168.07759	4.7	194	9/8/2013	21:00	70.91170	-167.38486	5	149
9/7/2013	22:30	71.50256	-168.19900	5.7	352	9/8/2013	10:00	71.72720	-168.03778	5.6	134	9/8/2013	21:30	70.87301	-167.38837	5.1	198
9/7/2013	23:00	71.53145	-168.28376	5.4	296	9/8/2013	10:30	71.68585	-168.04311	5.8	134	9/8/2013	22:00	70.84432	-167.30670	4.9	162
9/7/2013	23:30	71.55062	-168.40651	5.3	298	9/8/2013	11:00	71.65033	-167.97916	5.5	199	9/8/2013	22:30	70.80503	-167.33631	5	132
9/8/2013	0:00	71.58256	-168.47812	5.3	295	9/8/2013	11:30	71.61241	-167.95016	5.7	135	9/8/2013	23:00	70.77257	-167.29410	5.1	200
9/8/2013	0:30	71.60208	-168.60171	5.4	297	9/8/2013	12:00	71.57391	-167.91526	5.6	197	9/8/2013	23:30	70.74101	-167.24639	5	129
9/8/2013	1:00	71.63465	-168.67195	5.2	299	9/8/2013	12:30	71.53491	-167.88522	5.6	134	9/9/2013	0:00	70.70137	-167.25745	5.2	153
9/8/2013	1:30	71.65407	-168.79551	5.2	296	9/8/2013	13:00	71.49535	-167.87467	5.5	198	9/9/2013	0:30	70.66356	-167.19704	5.2	152

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	7 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/9/2013	1:00	70.62328	-167.19925	5.2	198	9/9/2013	12:30	70.32587	-166.93359	5.6	147	9/10/2013	0:00	70.46611	-165.72266	5.3	210
9/9/2013	1:30	70.59394	-167.14189	4.7	231	9/9/2013	13:00	70.28296	-166.94486	5.4	135	9/10/2013	0:30	70.44836	-165.76160	4.8	32
9/9/2013	2:00	70.59814	-167.16656	4.5	167	9/9/2013	13:30	70.24773	-166.87490	5.6	195	9/10/2013	1:00	70.45810	-165.74819	5.4	209
9/9/2013	2:30	70.59992	-167.24553	5.1	344	9/9/2013	14:00	70.20376	-166.91275	5.4	197	9/10/2013	1:30	70.42583	-165.78542	4.5	60
9/9/2013	3:00	70.61825	-167.27283	4.4	167	9/9/2013	14:30	70.16812	-166.87863	5.2	130	9/10/2013	2:00	70.44070	-165.77123	5.4	211
9/9/2013	3:30	70.63157	-167.27626	5.2	350	9/9/2013	15:00	70.13988	-166.77940	5.6	130	9/10/2013	2:30	70.40262	-165.83813	5.3	209
9/9/2013	4:00	70.67420	-167.30433	5.4	349	9/9/2013	15:30	70.10974	-166.67677	5.5	133	9/10/2013	3:00	70.36150	-165.87367	5.2	193
9/9/2013	4:30	70.71741	-167.33349	5.5	347	9/9/2013	16:00	70.08077	-166.57679	5.2	128	9/10/2013	3:30	70.34725	-165.86024	4.7	62
9/9/2013	5:00	70.76098	-167.36366	5.5	346	9/9/2013	16:30	70.07372	-166.45144	5.6	79	9/10/2013	4:00	70.38668	-165.83734	5.1	35
9/9/2013	5:30	70.77783	-167.37510	5.1	23	9/9/2013	17:00	70.08613	-166.31954	5.7	74	9/10/2013	4:30	70.41085	-165.75170	5	1
9/9/2013	6:00	70.79108	-167.30951	4.2	185	9/9/2013	17:30	70.08980	-166.30900	5.3	354	9/10/2013	5:00	70.44535	-165.71019	4.8	62
9/9/2013	6:30	70.76505	-167.26536	4.4	129	9/9/2013	18:00	70.12494	-166.25866	4.5	32	9/10/2013	5:30	70.47888	-165.66733	5.5	3
9/9/2013	7:00	70.73113	-167.28138	4.4	148	9/9/2013	18:30	70.15717	-166.19653	4.7	33	9/10/2013	6:00	70.50544	-165.57943	5.3	3
9/9/2013	7:30	70.69846	-167.22435	4.7	149	9/9/2013	19:00	70.19637	-166.16858	5.2	54	9/10/2013	6:30	70.54472	-165.54922	5	61
9/9/2013	8:00	70.66371	-167.21740	4.7	198	9/9/2013	19:30	70.21588	-166.05973	4.7	44	9/10/2013	7:00	70.57232	-165.49226	5.4	3
9/9/2013	8:30	70.63319	-167.16285	4.9	133	9/9/2013	20:00	70.26136	-166.04848	5.8	2	9/10/2013	7:30	70.60128	-165.41219	5	62
9/9/2013	9:00	70.59300	-167.18188	5.3	164	9/9/2013	20:30	70.28776	-165.95968	5.3	1	9/10/2013	8:00	70.64021	-165.37960	5.4	63
9/9/2013	9:30	70.55773	-167.11197	5.5	196	9/9/2013	21:00	70.32613	-165.91713	5.4	60	9/10/2013	8:30	70.67011	-165.31304	5.2	0
9/9/2013	10:00	70.51771	-167.10176	5.5	134	9/9/2013	21:30	70.35146	-165.90228	6	263	9/10/2013	9:00	70.69925	-165.24335	4.8	64
9/9/2013	10:30	70.47788	-167.08736	5.7	197	9/9/2013	22:00	70.36093	-165.91279	4.9	30	9/10/2013	9:30	70.73834	-165.21929	5	50
9/9/2013	11:00	70.44194	-167.02481	5.6	198	9/9/2013	22:30	70.39383	-165.85226	4.8	32	9/10/2013	10:00	70.76486	-165.13482	5.2	1
9/9/2013	11:30	70.40083	-167.02095	5.3	136	9/9/2013	23:00	70.43074	-165.78448	5.6	31	9/10/2013	10:30	70.79738	-165.07847	5	63
9/9/2013	12:00	70.36238	-166.99667	5.6	196	9/9/2013	23:30	70.47164	-165.70719	5.9	35	9/10/2013	11:00	70.83335	-165.03929	5.3	358

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	8 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/10/2013	11:30	70.86043	-164.96415	5.1	1	9/10/2013	23:00	71.59670	-163.55695	4.5	0	9/11/2013	10:30	71.75597	-165.50643	5.5	225
9/10/2013	12:00	70.89442	-164.91313	5.4	61	9/10/2013	23:30	71.62901	-163.50008	4.1	33	9/11/2013	11:00	71.74887	-165.62877	5.3	287
9/10/2013	12:30	70.93163	-164.87177	5.5	0	9/11/2013	0:00	71.66201	-163.42942	4.9	31	9/11/2013	11:30	71.72541	-165.74281	4.9	257
9/10/2013	13:00	70.95786	-164.77766	5.4	4	9/11/2013	0:30	71.69912	-163.35580	5.4	33	9/11/2013	12:00	71.72709	-165.86649	5.5	229
9/10/2013	13:30	71.00094	-164.76327	5.1	62	9/11/2013	1:00	71.73629	-163.28538	4.8	29	9/11/2013	12:30	71.71332	-165.98466	5.7	281
9/10/2013	14:00	71.02025	-164.64531	5.5	63	9/11/2013	1:30	71.76602	-163.38038	5.7	262	9/11/2013	13:00	71.69712	-166.10647	5.6	271
9/10/2013	14:30	71.05927	-164.61426	5.2	60	9/11/2013	2:00	71.77765	-163.52122	5.7	318	9/11/2013	13:30	71.71209	-166.23586	4.2	27
9/10/2013	15:00	71.09034	-164.54285	5.6	360	9/11/2013	2:30	71.79559	-163.65538	6.2	278	9/11/2013	14:00	71.68305	-166.30211	5.5	225
9/10/2013	15:30	71.12058	-164.47382	5.2	63	9/11/2013	3:00	71.81000	-163.80469	5.9	295	9/11/2013	14:30	71.68338	-166.43131	5.6	285
9/10/2013	16:00	71.15863	-164.44210	5.4	359	9/11/2013	3:30	71.83640	-163.92924	5.7	11	9/11/2013	15:00	71.66375	-166.54513	5.3	226
9/10/2013	16:30	71.18779	-164.36369	5.4	358	9/11/2013	4:00	71.87139	-164.00234	5.7	340	9/11/2013	15:30	71.66257	-166.68011	5.7	284
9/10/2013	17:00	71.22102	-164.30500	5.3	62	9/11/2013	4:30	71.86561	-164.13199	5.4	229	9/11/2013	16:00	71.64210	-166.79464	5.5	224
9/10/2013	17:30	71.25635	-164.25024	5.5	61	9/11/2013	5:00	71.86265	-164.26033	5.4	284	9/11/2013	16:30	71.64234	-166.93040	5.7	287
9/10/2013	18:00	71.29399	-164.20207	5.9	2	9/11/2013	5:30	71.84221	-164.31436	5.4	283	9/11/2013	17:00	71.61463	-166.99686	5.5	232
9/10/2013	18:30	71.31701	-164.09105	5.3	65	9/11/2013	6:00	71.84255	-164.46791	5.5	226	9/11/2013	17:30	71.61568	-167.13257	5.2	227
9/10/2013	19:00	71.35585	-164.05383	5.7	4	9/11/2013	6:30	71.84090	-164.58800	5.3	274	9/11/2013	18:00	71.59363	-167.24142	5.7	290
9/10/2013	19:30	71.38823	-163.98980	5.2	63	9/11/2013	7:00	71.82690	-164.69216	5.4	297	9/11/2013	18:30	71.58545	-167.35785	5.1	230
9/10/2013	20:00	71.41770	-163.91111	5.5	2	9/11/2013	7:30	71.80962	-164.79774	4.9	225	9/11/2013	19:00	71.57973	-167.47895	5.5	289
9/10/2013	20:30	71.44254	-163.83865	5.8	359	9/11/2013	8:00	71.81110	-164.91329	5	225	9/11/2013	19:30	71.55303	-167.56983	5.2	219
9/10/2013	21:00	71.47605	-163.79213	5	86	9/11/2013	8:30	71.79876	-165.02441	5.3	293	9/11/2013	20:00	71.56086	-167.69527	5.2	288
9/10/2013	21:30	71.51124	-163.75623	5	53	9/11/2013	9:00	71.78154	-165.13496	5.2	226	9/11/2013	20:30	71.53347	-167.79631	5.2	262
9/10/2013	22:00	71.53502	-163.66137	5.1	2	9/11/2013	9:30	71.78347	-165.26834	5.3	240	9/11/2013	21:00	71.53500	-167.91608	5	232
9/10/2013	22:30	71.57180	-163.62898	4.8	64	9/11/2013	10:00	71.76154	-165.37883	5.4	286	9/11/2013	21:30	71.51721	-168.01992	5	288

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	9 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/11/2013	22:00	71.51000	-168.13330	5.2	252	9/12/2013	9:30	71.14548	-168.07154	5.2	105	9/12/2013	21:00	71.19378	-167.78313	6.4	337
9/11/2013	22:30	71.49637	-168.26289	5.2	254	9/12/2013	10:00	71.16282	-167.98260	5.2	103	9/12/2013	21:30	71.21299	-167.90854	5.9	278
9/11/2013	23:00	71.48693	-168.37162	5	285	9/12/2013	10:30	71.16829	-167.86448	5.4	44	9/12/2013	22:00	71.23617	-167.98441	5.7	11
9/11/2013	23:30	71.46913	-168.47475	5.2	227	9/12/2013	11:00	71.18549	-167.75728	5.1	104	9/12/2013	22:30	71.26066	-167.97112	5.5	30
9/12/2013	0:00	71.46842	-168.59368	5.2	229	9/12/2013	11:30	71.19760	-167.64759	5.1	46	9/12/2013	23:00	71.29491	-167.90660	5.3	59
9/12/2013	0:30	71.44783	-168.70134	5.1	285	9/12/2013	12:00	71.19681	-167.52807	4.9	73	9/12/2013	23:30	71.31876	-167.88818	5.4	61
9/12/2013	1:00	71.44210	-168.81867	5.3	226	9/12/2013	12:30	71.21690	-167.42319	5.5	104	9/13/2013	0:00	71.35206	-167.84088	5.3	352
9/12/2013	1:30	71.40848	-168.89647	4.9	183	9/12/2013	13:00	71.22758	-167.30903	5.1	45	9/13/2013	0:30	71.37758	-167.76627	5.5	342
9/12/2013	2:00	71.36695	-168.90322	5.1	185	9/12/2013	13:30	71.22637	-167.18775	5.2	104	9/13/2013	1:00	71.40539	-167.71164	5.3	70
9/12/2013	2:30	71.32443	-168.90673	5.1	180	9/12/2013	14:00	71.25102	-167.08661	5.2	47	9/13/2013	1:30	71.43964	-167.68822	5.4	69
9/12/2013	3:00	71.30599	-168.90643	5	182	9/12/2013	14:30	71.25051	-166.96787	5	46	9/13/2013	2:00	71.47117	-167.65302	5.4	8
9/12/2013	3:30	71.26460	-168.90097	5.2	181	9/12/2013	15:00	71.27959	-166.87251	5.2	46	9/13/2013	2:30	71.49719	-167.57004	5.4	2
9/12/2013	4:00	71.24173	-168.90167	5.2	222	9/12/2013	15:30	71.27147	-166.78839	4.3	180	9/13/2013	3:00	71.53098	-167.50986	5.2	61
9/12/2013	4:30	71.20000	-168.90570	5.1	179	9/12/2013	16:00	71.23490	-166.82400	5.2	232	9/13/2013	3:30	71.57017	-167.47577	5.6	1
9/12/2013	5:00	71.15829	-168.90345	4.9	177	9/12/2013	16:30	71.21810	-166.94425	4.7	252	9/13/2013	4:00	71.59761	-167.38501	5.4	352
9/12/2013	5:30	71.11815	-168.89138	4.7	171	9/12/2013	17:00	71.20500	-167.07170	5.1	250	9/13/2013	4:30	71.63132	-167.34133	5	58
9/12/2013	6:00	71.07895	-168.87407	4.8	173	9/12/2013	17:30	71.18831	-167.19579	5.3	242	9/13/2013	5:00	71.66727	-167.31166	5.1	18
9/12/2013	6:30	71.07583	-168.77951	4.8	72	9/12/2013	18:00	71.16569	-167.31559	5.5	240	9/13/2013	5:30	71.69253	-167.21451	5.6	359
9/12/2013	7:00	71.08752	-168.66289	5	72	9/12/2013	18:30	71.14316	-167.44151	5.6	242	9/13/2013	6:00	71.72899	-167.18073	4.7	59
9/12/2013	7:30	71.09957	-168.54009	5.2	74	9/12/2013	19:00	71.12132	-167.56665	5.4	241	9/13/2013	6:30	71.76276	-167.13241	5.6	356
9/12/2013	8:00	71.11338	-168.41533	5.3	71	9/12/2013	19:30	71.09819	-167.69258	5.6	240	9/13/2013	7:00	71.79489	-167.05887	5.3	30
9/12/2013	8:30	71.12789	-168.30238	5.1	106	9/12/2013	20:00	71.09087	-167.79535	6.6	6	9/13/2013	7:30	71.83368	-166.99049	5.3	26
9/12/2013	9:00	71.13606	-168.18809	5.4	45	9/12/2013	20:30	71.14351	-167.79211	6.4	12	9/13/2013	8:00	71.87403	-166.94350	5.1	56

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	10 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/13/2013	8:30	71.90205	-166.85571	5.3	1	9/13/2013	20:00	72.12641	-165.12354	5.7	211	9/14/2013	7:30	71.39626	-166.51798	5.2	186
9/13/2013	9:00	71.93648	-166.81034	5.1	62	9/13/2013	20:30	72.08673	-165.20388	5.5	211	9/14/2013	8:00	71.35876	-166.55620	5	239
9/13/2013	9:30	71.96946	-166.76076	5.2	0	9/13/2013	21:00	72.04612	-165.28106	5.8	215	9/14/2013	8:30	71.32704	-166.62315	5.3	184
9/13/2013	10:00	71.99631	-166.68061	4.8	60	9/13/2013	21:30	72.01044	-165.35776	4.9	216	9/14/2013	9:00	71.29483	-166.68391	4.9	236
9/13/2013	10:30	72.03641	-166.66244	5.1	64	9/13/2013	22:00	71.97728	-165.43557	5	216	9/14/2013	9:30	71.25706	-166.72157	5.6	180
9/13/2013	11:00	72.06219	-166.56774	5.2	2	9/13/2013	22:30	71.94144	-165.49802	5.1	182	9/14/2013	10:00	71.23056	-166.81760	5.5	183
9/13/2013	11:30	72.10099	-166.53303	5.3	61	9/13/2013	23:00	71.91161	-165.56986	5	212	9/14/2013	10:30	71.19008	-166.84918	4.8	237
9/13/2013	12:00	72.12971	-166.45346	5	3	9/13/2013	23:30	71.87568	-165.63810	4.9	211	9/14/2013	11:00	71.16150	-166.91585	5.2	181
9/13/2013	12:30	72.16232	-166.40419	5.1	64	9/14/2013	0:00	71.84410	-165.69348	5.1	183	9/14/2013	11:30	71.13098	-166.97116	4.6	240
9/13/2013	13:00	72.19329	-166.34943	4.9	1	9/14/2013	0:30	71.82130	-165.76177	5.1	182	9/14/2013	12:00	71.09538	-167.00334	5.1	182
9/13/2013	13:30	72.21990	-166.27781	4.3	61	9/14/2013	1:00	71.78633	-165.75198	4.3	44	9/14/2013	12:30	71.07129	-167.08567	4.4	237
9/13/2013	14:00	72.25863	-166.25261	5.5	1	9/14/2013	1:30	71.77504	-165.82230	5	184	9/14/2013	13:00	71.03152	-167.10119	4.3	239
9/13/2013	14:30	72.28526	-166.15171	5.6	358	9/14/2013	2:00	71.75232	-165.88839	4.9	231	9/14/2013	13:30	71.01088	-167.19465	5.3	197
9/13/2013	15:00	72.32213	-166.10219	5.5	60	9/14/2013	2:30	71.71254	-165.91784	5.3	235	9/14/2013	14:00	70.96815	-167.21254	4.8	242
9/13/2013	15:30	72.35781	-166.05023	4.5	0	9/14/2013	3:00	71.67868	-165.98570	5.4	181	9/14/2013	14:30	70.94114	-167.30853	5.6	196
9/13/2013	16:00	72.36459	-165.96428	5.8	128	9/14/2013	3:30	71.65484	-166.06402	5.4	184	9/14/2013	15:00	70.93689	-167.18670	4.8	56
9/13/2013	16:30	72.33597	-165.82846	5.8	123	9/14/2013	4:00	71.61399	-166.08387	5.1	269	9/14/2013	15:30	70.96968	-167.13812	5.2	355
9/13/2013	17:00	72.30751	-165.70321	5.6	128	9/14/2013	4:30	71.58852	-166.15187	5.2	183	9/14/2013	16:00	71.01813	-167.15763	6.6	349
9/13/2013	17:30	72.27683	-165.57798	6.5	130	9/14/2013	5:00	71.56195	-166.22102	4.7	246	9/14/2013	16:30	71.07026	-167.19559	6.8	351
9/13/2013	18:00	72.24386	-165.43857	6.3	130	9/14/2013	5:30	71.52322	-166.25442	5	239	9/14/2013	17:00	71.12125	-167.23383	6.7	342
9/13/2013	18:30	72.21565	-165.31598	6.4	125	9/14/2013	6:00	71.49289	-166.32995	5.5	186	9/14/2013	17:30	71.17277	-167.27322	6.8	346
9/13/2013	19:00	72.18753	-165.18612	6.5	125	9/14/2013	6:30	71.45950	-166.39565	4.8	240	9/14/2013	18:00	71.22035	-167.33384	6.1	8
9/13/2013	19:30	72.15758	-165.04929	4.9	124	9/14/2013	7:00	71.42250	-166.42939	5.2	180	9/14/2013	18:30	71.23930	-167.17558	6.6	74

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	11 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/14/2013	19:00	71.24819	-167.02960	4.9	106	9/15/2013	6:30	71.48110	-164.46960	4.8	78	9/15/2013	19:30	71.88183	-162.95879	5.5	7
9/14/2013	19:30	71.26873	-166.93788	4.9	40	9/15/2013	7:00	71.48981	-164.34828	4.4	79	9/15/2013	20:00	71.91817	-162.90324	5.1	32
9/14/2013	20:00	71.26967	-166.81259	5.4	98	9/15/2013	7:30	71.49903	-164.23185	4.4	76	9/15/2013	20:30	71.95600	-162.85699	5.2	8
9/14/2013	20:30	71.28620	-166.71412	4.3	49	9/15/2013	8:00	71.50301	-164.12345	5	114	9/15/2013	21:00	71.97629	-162.74993	5	59
9/14/2013	21:00	71.29285	-166.60566	5.3	101	9/15/2013	8:30	71.51888	-164.03659	4.3	48	9/15/2013	21:30	72.01518	-162.73106	4.2	41
9/14/2013	21:30	71.30364	-166.50630	4.5	46	9/15/2013	9:00	71.51759	-163.91494	4.6	78	9/15/2013	22:00	72.04330	-162.64549	4.9	35
9/14/2013	22:00	71.31374	-166.40374	4.8	94	9/15/2013	9:30	71.54243	-163.82430	5.5	105	9/15/2013	22:30	72.07759	-162.57238	5.6	348
9/14/2013	22:30	71.32263	-166.28758	4.5	75	9/15/2013	11:00	71.56467	-163.48032	4.9	48	9/15/2013	23:00	72.11076	-162.50818	5	48
9/14/2013	23:00	71.33300	-166.17709	4.8	75	9/15/2013	11:30	71.56159	-163.35104	5.5	79	9/15/2013	23:30	72.13865	-162.41010	5	47
9/14/2013	23:30	71.34331	-166.06346	3.9	75	9/15/2013	12:30	71.60310	-163.37866	5.5	254	9/16/2013	0:00	72.17695	-162.38676	4.5	45
9/15/2013	0:00	71.35250	-165.95384	4.4	75	9/15/2013	13:00	71.58589	-163.51128	5.3	246	9/16/2013	0:30	72.20575	-162.29427	5	44
9/15/2013	0:30	71.36275	-165.84076	4.8	72	9/15/2013	13:30	71.56412	-163.63370	5.5	243	9/16/2013	1:00	72.19746	-162.25372	5.1	213
9/15/2013	1:00	71.37375	-165.72452	4.9	73	9/15/2013	14:00	71.53399	-163.69644	4.8	126	9/16/2013	1:30	72.18083	-162.30474	5.4	220
9/15/2013	1:30	71.38358	-165.60848	4.4	68	9/15/2013	14:30	71.56080	-163.61727	5.3	33	9/16/2013	2:00	72.16249	-162.35430	5.4	280
9/15/2013	2:00	71.39322	-165.49369	4.5	77	9/15/2013	15:00	71.59961	-163.53847	5.9	33	9/16/2013	2:30	72.14669	-162.40288	5.1	214
9/15/2013	2:30	71.40249	-165.38592	4.5	67	9/15/2013	15:30	71.63862	-163.46110	5.6	33	9/16/2013	3:00	72.10938	-162.47977	5.5	210
9/15/2013	3:00	71.41228	-165.28007	4.5	73	9/15/2013	16:00	71.67863	-163.38911	5.7	25	9/16/2013	3:30	72.07114	-162.54827	5.2	212
9/15/2013	3:30	71.42148	-165.16864	4.4	71	9/15/2013	16:30	71.71328	-163.32431	5.4	63	9/16/2013	4:00	72.08588	-162.58255	4.6	24
9/15/2013	4:00	71.43192	-165.05981	4	75	9/15/2013	17:00	71.74589	-163.26511	5	357	9/16/2013	4:30	72.09665	-162.52553	4.9	328
9/15/2013	4:30	71.44122	-164.95058	3.5	74	9/15/2013	17:30	71.76667	-163.18570	4.5	63	9/16/2013	5:00	72.12509	-162.47504	4.1	51
9/15/2013	5:00	71.45170	-164.83167	4.3	80	9/15/2013	18:00	71.80090	-163.17507	4.4	359	9/16/2013	5:30	72.14925	-162.38639	4.5	47
9/15/2013	5:30	71.46195	-164.71140	5	75	9/15/2013	18:30	71.82038	-163.08742	5.2	64	9/16/2013	6:00	72.18455	-162.33668	4.5	30
9/15/2013	6:00	71.47170	-164.59204	5.1	77	9/15/2013	19:00	71.85758	-163.05996	5.3	3	9/16/2013	6:30	72.21682	-162.26488	5.1	35

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	12 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/16/2013	7:00	72.25350	-162.20407	5	47	9/16/2013	18:30	72.97856	-160.54344	5.3	69	9/17/2013	6:00	73.32829	-159.67204	4.3	37
9/16/2013	7:30	72.27961	-162.10403	5	50	9/16/2013	19:00	73.00552	-160.46373	4.9	4	9/17/2013	6:30	73.35830	-159.59250	4.6	34
9/16/2013	8:00	72.31915	-162.06899	4.9	47	9/16/2013	19:30	73.03058	-160.38512	4.6	12	9/17/2013	7:00	73.38724	-159.51907	4.5	36
9/16/2013	8:30	72.35421	-161.99949	4.8	32	9/16/2013	20:00	73.05265	-160.32794	5.2	144	9/17/2013	7:30	73.41577	-159.44803	4.1	37
9/16/2013	9:00	72.37683	-161.90019	4.3	60	9/16/2013	20:30	73.01105	-160.37047	5.7	216	9/17/2013	8:00	73.44468	-159.37245	4.3	34
9/16/2013	9:30	72.41479	-161.87236	5.1	27	9/16/2013	21:00	72.97812	-160.42753	3.9	33	9/17/2013	8:30	73.47293	-159.30180	3.9	38
9/16/2013	10:00	72.43553	-161.76453	4.6	55	9/16/2013	21:30	72.97298	-160.47466	5.2	185	9/17/2013	9:00	73.50128	-159.23227	3.9	39
9/16/2013	10:30	72.47387	-161.73641	4.8	59	9/16/2013	22:00	72.95505	-160.52696	5.6	216	9/17/2013	9:30	73.52853	-159.16114	4	39
9/16/2013	11:00	72.49601	-161.62667	5.3	359	9/16/2013	22:30	72.94046	-160.55041	4	41	9/17/2013	10:00	73.55654	-159.08658	4.2	39
9/16/2013	11:30	72.53345	-161.59218	4.9	60	9/16/2013	23:00	72.95934	-160.58275	5.1	333	9/17/2013	10:30	73.57942	-158.99955	5.1	65
9/16/2013	12:00	72.56068	-161.50668	5.6	359	9/16/2013	23:30	72.96468	-160.51613	4.2	152	9/17/2013	11:00	73.61659	-158.94985	5.2	64
9/16/2013	12:30	72.59601	-161.44057	5.4	58	9/17/2013	0:00	72.96926	-160.55546	3.9	68	9/17/2013	11:30	73.63886	-158.83554	5.3	32
9/16/2013	13:00	72.62819	-161.35963	5.7	2	9/17/2013	0:30	72.98831	-160.49908	5	356	9/17/2013	12:00	73.68183	-158.79167	5.1	27
9/16/2013	13:30	72.65785	-161.27567	5	64	9/17/2013	1:00	73.01574	-160.44309	4.4	56	9/17/2013	12:30	73.70533	-158.68109	4.8	65
9/16/2013	14:00	72.69535	-161.22235	4.5	58	9/17/2013	1:30	73.04407	-160.36697	4.3	39	9/17/2013	13:00	73.74232	-158.62147	5.6	27
9/16/2013	14:30	72.72343	-161.11938	6.3	2	9/17/2013	2:00	73.07552	-160.29272	5.1	33	9/17/2013	13:30	73.76584	-158.50069	6.2	1
9/16/2013	15:00	72.75790	-161.04095	5.7	62	9/17/2013	2:30	73.10683	-160.21957	4.8	42	9/17/2013	14:00	73.80109	-158.41555	5.5	65
9/16/2013	15:30	72.79663	-160.99083	5.7	62	9/17/2013	3:00	73.13210	-160.13374	4.2	56	9/17/2013	14:30	73.84030	-158.34867	5.7	61
9/16/2013	16:00	72.82573	-160.88426	5.7	2	9/17/2013	3:30	73.16363	-160.09012	6.1	69	9/17/2013	15:00	73.87032	-158.23721	6	8
9/16/2013	16:30	72.85361	-160.79895	4.6	67	9/17/2013	4:00	73.19533	-160.00278	5	37	9/17/2013	15:30	73.89748	-158.14578	5.2	67
9/16/2013	17:00	72.88889	-160.75276	5	62	9/17/2013	4:30	73.22766	-159.92094	4.9	35	9/17/2013	16:00	73.93262	-158.08992	5	70
9/16/2013	17:30	72.91666	-160.67165	5.1	3	9/17/2013	5:00	73.26114	-159.83651	4.9	32	9/17/2013	16:30	73.95649	-157.99380	5	3
9/16/2013	18:00	72.94256	-160.58359	5.1	67	9/17/2013	5:30	73.29610	-159.75301	5.1	34	9/17/2013	17:00	73.98233	-157.90481	5	65

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	13 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/17/2013	17:30	74.01725	-157.85644	5	71	9/18/2013	5:00	73.85011	-156.41608	5.2	123	9/18/2013	23:30	74.21306	-160.59464	6.3	282
9/17/2013	18:00	74.04462	-157.75643	5.2	3	9/18/2013	5:30	73.82125	-156.31863	5.8	188	9/19/2013	0:00	74.22670	-160.77601	6.4	286
9/17/2013	18:30	74.06694	-157.64690	5.3	5	9/18/2013	6:00	73.83940	-156.41131	5.6	254	9/19/2013	0:30	74.24572	-160.92927	5.2	309
9/17/2013	19:00	74.10112	-157.58812	4.9	71	9/18/2013	6:30	73.86168	-156.51556	5.6	269	9/19/2013	1:00	74.27142	-161.04264	5.7	262
9/17/2013	19:30	74.13248	-157.51357	4.9	50	9/18/2013	7:00	73.86670	-156.67802	5.5	306	9/19/2013	1:30	74.28185	-161.20724	5.7	292
9/17/2013	20:00	74.15806	-157.40698	5.3	4	9/18/2013	7:30	73.87919	-156.81077	5.6	268	9/19/2013	2:00	74.29805	-161.36905	5.7	289
9/17/2013	20:30	74.19123	-157.33114	5	57	9/18/2013	8:00	73.89832	-156.92698	5.6	258	9/19/2013	2:30	74.32382	-161.48193	5	326
9/17/2013	21:00	74.22214	-157.24454	5.5	4	9/18/2013	8:30	73.92103	-157.03316	5.2	331	9/19/2013	3:00	74.34833	-161.59282	5.6	272
9/17/2013	21:30	74.24913	-157.14182	4.9	63	9/18/2013	9:00	73.92505	-157.17544	5.1	332	9/19/2013	3:30	74.37014	-161.70607	4.9	334
9/17/2013	22:00	74.24446	-156.99109	5.4	111	9/18/2013	9:30	73.93829	-157.29324	5.5	257	9/19/2013	4:00	74.38118	-161.85861	5.4	297
9/17/2013	22:30	74.22703	-156.84059	5.4	124	9/18/2013	10:00	73.96085	-157.39976	5.6	265	9/19/2013	4:30	74.41435	-161.90796	5.5	288
9/17/2013	23:00	74.19518	-156.76582	5.9	197	9/18/2013	10:30	73.97446	-157.53388	5.1	322	9/19/2013	5:00	74.42143	-162.06811	4.8	346
9/17/2013	23:30	74.19476	-156.93286	6.2	284	9/18/2013	11:00	73.98567	-157.67249	5.5	266	9/19/2013	5:30	74.43947	-162.12420	5.5	267
9/18/2013	0:00	74.18241	-157.08512	5.9	217	9/18/2013	11:30	74.01161	-157.78268	5	322	9/19/2013	6:00	74.46028	-162.18947	2.4	130
9/18/2013	0:30	74.14300	-157.19254	5.8	205	9/18/2013	12:00	74.01476	-157.93868	5.1	324	9/19/2013	6:30	74.46598	-162.29990	5	333
9/18/2013	1:00	74.09949	-157.23023	5.2	174	9/18/2013	12:30	74.03965	-158.04639	5.5	266	9/19/2013	7:00	74.48239	-162.42630	5.6	272
9/18/2013	1:30	74.06733	-157.14142	5.2	120	9/18/2013	13:00	74.05168	-158.18047	5	329	9/19/2013	7:30	74.51027	-162.52821	5.8	270
9/18/2013	2:00	74.04099	-157.01937	5.2	142	9/18/2013	13:30	74.06417	-158.31411	5.5	269	9/19/2013	8:00	74.53168	-162.64557	5.1	331
9/18/2013	2:30	74.01062	-156.90798	5.2	131	9/18/2013	14:00	74.08027	-158.44094	5.1	323	9/19/2013	8:30	74.54397	-162.79130	5.2	333
9/18/2013	3:00	73.97781	-156.80526	5.2	143	9/18/2013	14:30	74.09194	-158.57772	5.6	267	9/19/2013	9:00	74.57077	-162.90547	6.2	275
9/18/2013	3:30	73.94368	-156.70833	5.3	142	9/18/2013	15:00	74.11174	-158.69139	4.8	335	9/19/2013	9:30	74.59270	-163.03135	5	333
9/18/2013	4:00	73.91083	-156.60360	5.2	139	9/18/2013	15:30	74.11785	-158.83842	5.5	266	9/19/2013	10:00	74.60537	-163.17521	4.9	327
9/18/2013	4:30	73.87892	-156.49874	5.2	134	9/18/2013	16:00	74.13518	-158.95448	4.8	333	9/19/2013	10:30	74.62522	-163.29341	6	265

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	14 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/19/2013	11:00	74.65004	-163.39600	4.8	333	9/19/2013	22:30	75.02295	-166.42539	5.3	284	9/20/2013	10:00	74.80454	-168.82309	5.4	155
9/19/2013	11:30	74.65941	-163.54079	4.9	333	9/19/2013	23:00	75.03205	-166.59645	5.7	272	9/20/2013	10:30	74.76147	-168.75502	5.6	155
9/19/2013	12:00	74.68674	-163.64243	6.1	263	9/19/2013	23:30	75.04125	-166.69917	5.6	289	9/20/2013	11:00	74.72234	-168.68945	4.5	159
9/19/2013	12:30	74.69961	-163.77561	4.7	339	9/20/2013	0:00	75.04022	-166.86289	5.6	236	9/20/2013	11:30	74.69481	-168.61687	2	89
9/19/2013	13:00	74.71088	-163.90715	5.7	262	9/20/2013	0:30	75.01802	-167.01205	5.3	311	9/20/2013	12:00	74.69528	-168.50623	4	93
9/19/2013	13:30	74.74406	-163.98877	5.1	322	9/20/2013	1:00	75.02270	-167.15507	5.6	238	9/20/2013	12:30	74.68907	-168.38792	3.2	99
9/19/2013	14:00	74.75611	-164.14685	5.4	333	9/20/2013	1:30	75.02698	-167.29751	5.5	237	9/20/2013	13:00	74.66024	-168.31520	4	151
9/19/2013	14:30	74.77354	-164.29062	5.4	323	9/20/2013	2:00	75.03150	-167.43645	5.2	244	9/20/2013	13:30	74.62711	-168.26435	5	177
9/19/2013	15:00	74.79735	-164.43844	5.5	299	9/20/2013	2:30	75.02276	-167.58801	5	310	9/20/2013	14:00	74.64012	-168.40076	5.7	316
9/19/2013	15:30	74.81865	-164.57144	5.5	269	9/20/2013	3:00	75.02361	-167.72993	5.5	245	9/20/2013	14:30	74.67346	-168.52095	5.6	317
9/19/2013	16:00	74.83963	-164.69049	4.8	296	9/20/2013	3:30	75.02579	-167.87426	5.1	310	9/20/2013	15:00	74.69443	-168.66206	5	296
9/19/2013	16:30	74.86632	-164.80566	4.9	326	9/20/2013	4:00	75.01443	-168.02548	4.9	302	9/20/2013	15:30	74.70877	-168.80560	5.7	263
9/19/2013	17:00	74.88022	-164.96925	6.4	261	9/20/2013	4:30	75.02207	-168.11865	5.1	243	9/20/2013	16:00	74.71875	-168.86910	3.5	99
9/19/2013	17:30	74.88920	-165.10928	4.3	337	9/20/2013	5:00	75.01691	-168.26082	4.9	311	9/20/2013	16:30	74.70319	-168.70055	4.9	110
9/19/2013	18:00	74.92402	-165.16634	6	266	9/20/2013	5:30	75.00752	-168.40793	5	288	9/20/2013	17:00	74.69901	-168.55180	3.9	69
9/19/2013	18:30	74.91411	-165.34896	5.8	260	9/20/2013	6:00	75.01443	-168.54603	5.5	242	9/20/2013	17:30	74.68629	-168.42285	5.6	132
9/19/2013	19:00	74.94680	-165.41867	5.8	327	9/20/2013	6:30	75.01381	-168.68428	4.8	308	9/20/2013	18:00	74.68631	-168.29260	3.8	68
9/19/2013	19:30	74.97169	-165.55108	5.8	269	9/20/2013	7:00	75.00112	-168.83249	5.3	254	9/20/2013	18:30	74.67145	-168.17388	4.6	132
9/19/2013	20:00	74.97422	-165.71813	4.5	331	9/20/2013	7:30	75.01254	-168.97215	5.6	250	9/20/2013	19:00	74.67364	-168.03155	5.7	68
9/19/2013	20:30	75.00065	-165.81631	5.4	272	9/20/2013	8:00	74.98670	-169.08043	6.4	164	9/20/2013	19:30	74.65442	-167.88092	5.9	67
9/19/2013	21:00	75.00627	-165.98700	5.2	278	9/20/2013	8:30	74.93214	-169.02054	6.9	166	9/20/2013	20:00	74.65093	-167.74329	4.6	107
9/19/2013	21:30	75.01391	-166.15890	5.4	277	9/20/2013	9:00	74.88844	-168.96239	5.6	161	9/20/2013	20:30	74.64452	-167.62792	3.9	98
9/19/2013	22:00	75.01870	-166.32893	5.2	283	9/20/2013	9:30	74.84534	-168.89451	5.8	156	9/20/2013	21:00	74.63815	-167.51071	3.9	103

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	15 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/20/2013	21:30	74.64895	-167.42925	4.9	320	9/21/2013	9:00	74.56018	-166.27473	4.5	67	9/21/2013	20:30	74.34289	-163.13103	5	126
9/20/2013	22:00	74.65862	-167.58896	5.2	280	9/21/2013	9:30	74.56274	-166.13056	4.8	131	9/21/2013	21:00	74.32632	-163.00229	5.1	76
9/20/2013	22:30	74.66666	-167.75016	5.3	280	9/21/2013	10:00	74.54060	-166.00528	5.3	102	9/21/2013	21:30	74.32152	-162.86377	4.9	120
9/20/2013	23:00	74.67567	-167.91401	5.3	281	9/21/2013	10:30	74.54614	-165.84754	5.4	129	9/21/2013	22:00	74.30393	-162.73463	5	75
9/20/2013	23:30	74.68509	-168.07939	5.4	282	9/21/2013	11:00	74.53164	-165.71078	5.7	71	9/21/2013	22:30	74.30389	-162.59275	4.9	120
9/21/2013	0:00	74.69525	-168.24248	5.4	281	9/21/2013	11:30	74.51870	-165.57664	5.4	133	9/21/2013	23:00	74.28410	-162.46502	4.8	122
9/21/2013	0:30	74.70182	-168.40774	5.3	278	9/21/2013	12:00	74.52152	-165.42639	5.5	119	9/21/2013	23:30	74.28349	-162.32259	4.9	132
9/21/2013	1:00	74.69342	-168.48594	3.4	98	9/21/2013	12:30	74.49747	-165.30048	4.9	73	9/22/2013	0:00	74.25758	-162.20843	5.1	79
9/21/2013	1:30	74.68271	-168.33141	6.4	109	9/21/2013	13:00	74.49442	-165.16646	5.3	132	9/22/2013	0:30	74.25488	-162.06380	5.3	132
9/21/2013	2:00	74.67777	-168.18727	4.1	101	9/21/2013	13:30	74.49134	-165.03408	5	73	9/22/2013	1:00	74.24398	-161.93311	5.7	66
9/21/2013	2:30	74.67103	-168.04773	4.5	101	9/21/2013	14:00	74.48004	-164.88788	4.6	138	9/22/2013	1:30	74.22307	-161.81069	4.9	133
9/21/2013	3:00	74.66293	-167.89572	4.6	105	9/21/2013	14:30	74.46162	-164.74841	6	71	9/22/2013	2:00	74.21531	-161.67340	5.8	70
9/21/2013	3:30	74.65432	-167.74655	5	99	9/21/2013	15:00	74.44557	-164.60239	6.5	135	9/22/2013	2:30	74.18575	-161.55689	5.3	136
9/21/2013	4:00	74.64720	-167.59374	5.2	101	9/21/2013	15:30	74.44202	-164.44292	4.6	139	9/22/2013	3:00	74.15760	-161.45863	4.7	98
9/21/2013	4:30	74.63995	-167.45727	3.6	106	9/21/2013	16:00	74.43612	-164.32771	4.8	68	9/22/2013	3:30	74.12083	-161.39565	5.4	120
9/21/2013	5:00	74.63127	-167.31220	4.8	100	9/21/2013	16:30	74.42249	-164.21053	5.1	132	9/22/2013	4:00	74.10977	-161.25616	5.6	82
9/21/2013	5:30	74.62442	-167.16855	4.8	100	9/21/2013	17:00	74.42390	-164.07827	5	132	9/22/2013	4:30	74.08477	-161.15097	5.4	82
9/21/2013	6:00	74.61758	-167.03484	4.6	99	9/21/2013	17:30	74.40670	-163.94251	5.5	102	9/22/2013	5:00	74.05513	-161.06253	5.1	91
9/21/2013	6:30	74.60712	-166.90836	4.6	124	9/21/2013	18:00	74.39528	-163.78707	5.6	129	9/22/2013	5:30	74.03709	-160.94381	5.6	150
9/21/2013	7:00	74.59503	-166.78396	3.8	103	9/21/2013	18:30	74.38353	-163.65767	5.4	66	9/22/2013	6:00	74.01485	-160.83935	6.3	182
9/21/2013	7:30	74.58976	-166.65073	4.2	103	9/21/2013	19:00	74.37521	-163.52108	5.5	131	9/22/2013	6:30	73.96516	-160.84995	6	186
9/21/2013	8:00	74.58305	-166.51448	4.3	99	9/21/2013	19:30	74.36828	-163.39017	4.7	132	9/22/2013	7:00	73.93576	-160.73592	5.2	132
9/21/2013	8:30	74.57942	-166.38554	4.4	133	9/21/2013	20:00	74.34514	-163.27347	5.4	75	9/22/2013	7:30	73.90619	-160.61943	5.6	131

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	16 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/22/2013	8:00	73.86737	-160.56670	5.1	148	9/22/2013	19:30	73.51763	-157.85951	5.5	78	9/23/2013	7:00	73.25482	-158.35893	6.1	264
9/22/2013	8:30	73.84297	-160.44905	4.6	120	9/22/2013	20:00	73.49246	-157.74115	5.5	80	9/23/2013	7:30	73.21805	-158.40739	5.4	189
9/22/2013	9:00	73.81080	-160.39734	4.7	116	9/22/2013	20:30	73.48061	-157.60674	5.7	144	9/23/2013	8:00	73.19362	-158.50562	5.2	188
9/22/2013	9:30	73.78873	-160.30279	5.4	186	9/22/2013	21:00	73.47183	-157.46834	5.4	81	9/23/2013	8:30	73.16989	-158.59926	5.9	244
9/22/2013	10:00	73.76611	-160.22450	4.7	104	9/22/2013	21:30	73.45400	-157.35743	5.5	69	9/23/2013	9:00	73.12967	-158.66850	5.4	183
9/22/2013	10:30	73.73381	-160.16878	5.6	112	9/22/2013	22:00	73.43658	-157.24847	5.4	80	9/23/2013	9:30	73.11052	-158.79346	6.4	260
9/22/2013	11:00	73.71174	-160.04968	5	103	9/22/2013	22:30	73.42767	-157.12742	5.6	151	9/23/2013	10:00	73.07031	-158.82933	5.5	183
9/22/2013	11:30	73.72029	-159.86666	5	67	9/22/2013	23:00	73.41971	-157.00065	5.7	151	9/23/2013	10:30	73.03843	-158.90958	5.6	256
9/22/2013	12:00	73.69703	-159.76047	5.5	145	9/22/2013	23:30	73.41494	-156.87073	5.7	71	9/23/2013	11:00	73.00298	-158.95290	4.9	183
9/22/2013	12:30	73.68540	-159.63368	5.5	148	9/23/2013	0:00	73.46048	-156.84787	5.7	7	9/23/2013	11:30	72.98672	-159.07055	5.7	184
9/22/2013	13:00	73.68629	-159.49573	5.3	146	9/23/2013	0:30	73.50612	-156.86778	5.8	306	9/23/2013	12:00	72.95139	-159.14198	6.1	248
9/22/2013	13:30	73.66196	-159.38366	5.7	73	9/23/2013	1:00	73.52959	-157.02196	6.1	300	9/23/2013	12:30	72.91137	-159.19691	5.8	188
9/22/2013	14:00	73.64425	-159.26108	5.7	139	9/23/2013	1:30	73.54943	-157.18693	6.3	280	9/23/2013	13:00	72.88114	-159.30278	5.4	187
9/22/2013	14:30	73.65036	-159.10387	6.1	143	9/23/2013	2:00	73.55976	-157.36819	6.3	272	9/23/2013	13:30	72.85354	-159.40306	5.8	251
9/22/2013	15:00	73.63425	-158.96961	5.9	72	9/23/2013	2:30	73.53123	-157.51503	6.3	227	9/23/2013	14:00	72.81570	-159.43653	5.9	251
9/22/2013	15:30	73.61370	-158.84739	5.7	145	9/23/2013	3:00	73.49148	-157.63548	6.5	217	9/23/2013	14:30	72.79093	-159.53636	4.7	175
9/22/2013	16:00	73.61855	-158.70265	5.7	139	9/23/2013	3:30	73.45308	-157.75270	5.7	251	9/23/2013	15:00	72.76728	-159.61790	5.7	257
9/22/2013	16:30	73.59862	-158.57383	5.7	70	9/23/2013	4:00	73.41616	-157.80555	5.8	268	9/23/2013	15:30	72.72900	-159.66254	6.3	247
9/22/2013	17:00	73.58518	-158.46105	5.3	152	9/23/2013	4:30	73.40850	-157.97635	5.9	262	9/23/2013	16:00	72.69963	-159.74055	5	179
9/22/2013	17:30	73.55657	-158.36757	5.2	76	9/23/2013	5:00	73.36782	-157.99647	5.9	263	9/23/2013	16:30	72.67276	-159.82288	5.4	246
9/22/2013	18:00	73.56331	-158.23138	5.4	150	9/23/2013	5:30	73.33810	-158.08094	5.7	183	9/23/2013	17:00	72.63881	-159.87099	5.2	219
9/22/2013	18:30	73.53590	-158.12933	5.4	79	9/23/2013	6:00	73.31299	-158.18482	5.7	184	9/23/2013	17:30	72.61610	-159.96225	5.3	0
9/22/2013	19:00	73.52511	-157.99733	5.7	146	9/23/2013	6:30	73.28681	-158.28339	5.6	186	9/23/2013	18:00	72.65989	-159.93893	5.3	31

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	17 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/23/2013	18:30	72.69566	-159.85818	5.1	32	9/24/2013	6:00	72.21921	-160.87115	5	239	9/24/2013	17:30	71.52888	-162.36640	6	180
9/23/2013	19:00	72.73285	-159.79383	5.1	28	9/24/2013	6:30	72.19047	-160.95191	5	186	9/24/2013	18:00	71.49415	-162.45606	6.4	181
9/23/2013	19:30	72.76391	-159.72455	3.6	71	9/24/2013	7:00	72.16013	-161.02606	5.2	240	9/24/2013	18:30	71.46134	-162.55798	6	214
9/23/2013	20:00	72.75607	-159.73112	4.4	23	9/24/2013	7:30	72.12442	-161.06716	5.5	178	9/24/2013	19:00	71.42422	-162.57661	5.4	238
9/23/2013	20:30	72.77947	-159.65774	3.8	101	9/24/2013	8:00	72.09798	-161.17119	5.4	179	9/24/2013	19:30	71.40114	-162.66899	4.2	178
9/23/2013	21:00	72.76580	-159.58275	4.3	194	9/24/2013	8:30	72.06320	-161.22661	5.7	247	9/24/2013	20:00	71.37133	-162.70311	3.9	275
9/23/2013	21:30	72.74654	-159.67500	4.2	206	9/24/2013	9:00	72.02857	-161.28347	5.5	179	9/25/2013	18:30	70.60240	-160.36292	3.2	187
9/23/2013	22:00	72.71296	-159.68428	4.7	230	9/24/2013	9:30	72.03873	-161.31819	8.3	125	9/26/2013	18:30	71.54653	-164.95996	5.3	73
9/23/2013	22:30	72.69336	-159.78582	4.7	198	9/24/2013	10:00	71.98914	-161.39743	4.8	185	9/26/2013	19:00	71.57291	-164.94174	4.6	305
9/23/2013	23:00	72.65830	-159.84596	4.9	216	9/24/2013	10:30	71.96407	-161.47275	4.9	249	9/26/2013	19:30	71.58020	-164.89887	5	360
9/23/2013	23:30	72.62916	-159.93545	5	238	9/24/2013	11:00	71.93561	-161.52349	4.6	187	9/26/2013	20:00	71.60333	-164.81889	5.4	4
9/24/2013	0:00	72.59568	-159.99262	5	196	9/24/2013	11:30	71.90986	-161.59400	5.3	251	9/26/2013	20:30	71.64149	-164.78969	5.4	60
9/24/2013	0:30	72.56638	-160.08430	5.4	247	9/24/2013	12:00	71.87948	-161.63325	5.2	176	9/26/2013	21:00	71.67167	-164.70965	5.1	7
9/24/2013	1:00	72.53098	-160.13657	5.1	192	9/24/2013	12:30	71.85754	-161.72787	5.4	251	9/26/2013	21:30	71.70598	-164.65037	5.3	61
9/24/2013	1:30	72.50592	-160.24507	5.3	245	9/24/2013	13:00	71.82300	-161.73918	5.4	210	9/26/2013	22:00	71.73907	-164.59155	5.3	1
9/24/2013	2:00	72.46706	-160.27632	5.3	263	9/24/2013	13:30	71.79058	-161.82102	5.2	252	9/26/2013	22:30	71.76329	-164.50370	5.2	71
9/24/2013	2:30	72.44361	-160.36590	5.3	192	9/24/2013	14:00	71.76974	-161.90012	4.7	180	9/26/2013	23:00	71.80358	-164.48998	4.9	25
9/24/2013	3:00	72.41047	-160.44323	5.1	241	9/24/2013	14:30	71.73038	-161.96379	5.3	217	9/26/2013	23:30	71.82837	-164.38866	5.1	4
9/24/2013	3:30	72.37542	-160.49940	5.6	171	9/24/2013	15:00	71.69846	-162.07244	5.9	215	9/27/2013	0:00	71.86366	-164.34580	5.3	74
9/24/2013	4:00	72.35211	-160.61056	5.6	165	9/24/2013	15:30	71.65474	-162.10027	5.8	244	9/27/2013	0:30	71.87527	-164.30093	5.3	101
9/24/2013	4:30	72.31456	-160.66027	5.5	241	9/24/2013	16:00	71.62179	-162.18015	5.6	176	9/27/2013	1:00	71.84618	-164.29266	4.1	206
9/24/2013	5:00	72.28135	-160.73679	5.6	183	9/24/2013	16:30	71.59820	-162.26390	6.2	253	9/27/2013	1:30	71.82141	-164.36415	4.8	208
9/24/2013	5:30	72.25585	-160.83622	5	181	9/24/2013	17:00	71.56065	-162.31391	4.5	248	9/27/2013	2:00	71.80010	-164.38314	5.2	32

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	18 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/27/2013	2:30	71.82786	-164.37587	4.3	251	9/27/2013	14:00	72.30822	-163.42424	5.2	66	9/28/2013	1:30	73.04117	-161.86171	4.6	54
9/27/2013	3:00	71.79760	-164.44479	4.8	212	9/27/2013	14:30	72.34137	-163.38789	5.3	70	9/28/2013	2:00	73.06416	-161.75438	4.7	54
9/27/2013	3:30	71.76243	-164.51257	4.9	211	9/27/2013	15:00	72.37121	-163.32074	5.3	354	9/28/2013	2:30	73.10245	-161.72083	5.2	57
9/27/2013	4:00	71.72781	-164.58406	5.1	213	9/27/2013	15:30	72.39389	-163.22980	5.5	355	9/28/2013	3:00	73.12662	-161.60623	5.5	1
9/27/2013	4:30	71.71435	-164.66703	4.8	41	9/27/2013	16:00	72.43220	-163.19344	5.3	70	9/28/2013	3:30	73.16506	-161.56438	5.1	61
9/27/2013	5:00	71.73562	-164.57999	5.2	357	9/27/2013	16:30	72.46567	-163.12210	6.1	26	9/28/2013	4:00	73.19207	-161.47028	5.2	0
9/27/2013	5:30	71.76468	-164.52092	4.9	74	9/27/2013	17:00	72.50997	-163.04773	5.8	40	9/28/2013	4:30	73.22550	-161.40887	5.2	57
9/27/2013	6:00	71.80095	-164.49352	5.3	2	9/27/2013	17:30	72.54415	-162.97275	5.5	335	9/28/2013	5:00	73.25785	-161.33721	5.5	0
9/27/2013	6:30	71.82512	-164.38821	5.4	1	9/27/2013	18:00	72.57442	-162.87139	5.3	53	9/28/2013	5:30	73.28780	-161.24876	5	60
9/27/2013	7:00	71.86275	-164.35246	5.1	69	9/27/2013	18:30	72.60709	-162.83513	5.6	336	9/28/2013	6:00	73.32382	-161.19317	5.6	357
9/27/2013	7:30	71.89357	-164.30001	5.5	355	9/27/2013	19:00	72.63400	-162.74714	4.3	89	9/28/2013	6:30	73.35079	-161.09453	4.9	56
9/27/2013	8:00	71.91823	-164.21144	5.4	3	9/27/2013	19:30	72.66371	-162.71347	5.3	56	9/28/2013	7:00	73.38661	-161.05735	4.9	55
9/27/2013	8:30	71.95420	-164.16437	5	68	9/27/2013	20:00	72.68847	-162.59442	5.4	33	9/28/2013	7:30	73.40972	-160.93506	5.2	56
9/27/2013	9:00	71.98732	-164.11658	5.6	357	9/27/2013	20:30	72.72619	-162.55482	5.3	61	9/28/2013	8:00	73.44948	-160.89440	5.2	54
9/27/2013	9:30	72.01122	-164.02676	5.6	357	9/27/2013	21:00	72.75873	-162.49032	5.7	354	9/28/2013	8:30	73.47574	-160.77584	5.8	359
9/27/2013	10:00	72.04550	-163.98284	5.3	77	9/27/2013	21:30	72.78650	-162.39261	5.1	57	9/28/2013	9:00	73.51859	-160.77120	5.7	38
9/27/2013	10:30	72.07833	-163.93707	5.9	355	9/27/2013	22:00	72.82804	-162.36026	5.1	61	9/28/2013	9:30	73.55605	-160.67532	5.5	37
9/27/2013	11:00	72.10240	-163.82728	5.8	357	9/27/2013	22:30	72.85172	-162.23573	5.4	56	9/28/2013	10:00	73.59270	-160.58180	5.4	37
9/27/2013	11:30	72.14658	-163.79256	5.9	29	9/27/2013	23:00	72.88775	-162.19588	5.2	69	9/28/2013	10:30	73.62953	-160.48372	5.6	36
9/27/2013	12:00	72.17794	-163.69871	5.6	57	9/27/2013	23:30	72.91974	-162.14094	5.5	351	9/28/2013	11:00	73.66688	-160.38879	5.5	37
9/27/2013	12:30	72.22004	-163.66847	5.7	41	9/28/2013	0:00	72.94565	-162.03425	4.7	57	9/28/2013	11:30	73.70345	-160.28983	6.1	62
9/27/2013	13:00	72.24872	-163.56922	5.6	2	9/28/2013	0:30	72.98220	-162.00154	4.9	55	9/28/2013	12:00	73.65896	-160.34568	4.7	213
9/27/2013	13:30	72.28008	-163.49297	5.5	350	9/28/2013	1:00	73.00550	-161.88535	4.9	55	9/28/2013	12:30	73.62526	-160.42784	4.7	215

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	19 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/28/2013	13:00	73.59121	-160.50359	4.8	215	9/29/2013	0:30	74.02145	-159.42116	5.7	61	9/29/2013	12:00	74.07327	-160.86089	5.1	248
9/28/2013	13:30	73.55431	-160.59320	5	214	9/29/2013	1:00	74.05370	-159.34682	5.3	353	9/29/2013	12:30	74.03941	-160.93209	5.4	190
9/28/2013	14:00	73.51737	-160.68336	5.1	218	9/29/2013	1:30	74.08090	-159.22883	5.5	60	9/29/2013	13:00	74.01329	-161.04182	4.9	249
9/28/2013	14:30	73.47841	-160.77297	5.6	215	9/29/2013	2:00	74.11625	-159.17698	5.6	70	9/29/2013	13:30	73.97303	-161.08168	5.2	241
9/28/2013	15:00	73.43893	-160.85981	5.5	211	9/29/2013	2:30	74.14705	-159.10918	5.5	352	9/29/2013	14:00	73.94727	-161.19037	5.6	185
9/28/2013	15:30	73.47066	-160.83686	5.8	67	9/29/2013	3:00	74.17111	-158.99343	5.5	354	9/29/2013	14:30	73.91077	-161.25979	5.7	244
9/28/2013	16:00	73.50130	-160.75469	5.2	354	9/29/2013	3:30	74.20017	-158.90981	5.9	72	9/29/2013	15:00	73.87403	-161.31104	5.5	180
9/28/2013	16:30	73.52514	-160.65242	5.2	65	9/29/2013	4:00	74.23397	-158.85515	5.7	73	9/29/2013	15:30	73.85405	-161.44105	5.1	190
9/28/2013	17:00	73.56289	-160.62334	5	63	9/29/2013	4:30	74.26025	-158.77106	5.5	133	9/29/2013	16:00	73.81298	-161.46842	5.2	193
9/28/2013	17:30	73.58529	-160.50613	5.1	0	9/29/2013	5:00	74.25122	-158.86764	6.4	171	9/29/2013	16:30	73.79273	-161.59024	4.9	186
9/28/2013	18:00	73.61919	-160.45544	5.3	63	9/29/2013	5:30	74.20222	-158.88684	6.1	216	9/29/2013	17:00	73.75549	-161.63572	5.6	253
9/28/2013	18:30	73.65163	-160.38664	5.5	1	9/29/2013	6:00	74.19662	-159.06287	5.9	249	9/29/2013	17:30	73.72476	-161.71469	5.3	182
9/28/2013	19:00	73.67270	-160.26653	5.2	58	9/29/2013	6:30	74.18894	-159.23796	6	270	9/29/2013	18:00	73.69558	-161.79372	5	247
9/28/2013	19:30	73.71452	-160.23357	5.9	60	9/29/2013	7:00	74.18831	-159.41446	5.6	271	9/29/2013	18:30	73.66489	-161.86822	5.5	183
9/28/2013	20:00	73.74104	-160.12362	5.5	355	9/29/2013	7:30	74.18810	-159.59068	5.7	267	9/29/2013	19:00	73.63557	-161.94847	5.2	249
9/28/2013	20:30	73.77496	-160.05328	5.4	59	9/29/2013	8:00	74.18562	-159.76181	5.9	268	9/29/2013	19:30	73.60424	-162.02743	5.4	189
9/28/2013	21:00	73.80809	-159.96281	5.8	2	9/29/2013	8:30	74.18396	-159.92945	5.6	268	9/29/2013	20:00	73.56826	-162.07979	5.7	250
9/28/2013	21:30	73.83635	-159.87892	5.2	67	9/29/2013	9:00	74.18321	-160.10065	5.4	272	9/29/2013	20:30	73.53585	-162.15789	5.4	195
9/28/2013	22:00	73.87288	-159.83608	5.3	57	9/29/2013	9:30	74.18194	-160.26927	5.1	268	9/29/2013	21:00	73.50817	-162.25869	5.1	201
9/28/2013	22:30	73.89747	-159.71328	5.5	349	9/29/2013	10:00	74.18034	-160.44020	5.8	268	9/29/2013	21:30	73.46545	-162.29655	5.2	271
9/28/2013	23:00	73.93137	-159.65532	5.3	56	9/29/2013	10:30	74.17874	-160.60464	5.3	267	9/29/2013	22:00	73.48596	-162.34113	5.9	26
9/28/2013	23:30	73.96446	-159.59599	5.4	351	9/29/2013	11:00	74.13530	-160.66742	6.3	216	9/29/2013	22:30	73.52478	-162.22794	6.2	41
9/29/2013	0:00	73.98809	-159.48503	5.4	349	9/29/2013	11:30	74.10956	-160.79184	5.8	184	9/29/2013	23:00	73.51823	-162.06533	5.6	92

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	20 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
9/29/2013	23:30	73.51697	-161.94679	5.5	95	9/30/2013	10:30	73.02664	-163.29411	5.2	185	9/30/2013	22:30	72.45402	-164.48343	5.9	31
9/30/2013	0:00	73.53634	-161.87354	5.5	33	9/30/2013	11:00	72.99929	-163.39302	5.4	186	9/30/2013	23:00	72.49588	-164.39504	5.9	31
9/30/2013	0:30	73.56837	-161.92734	5.5	310	9/30/2013	11:30	72.96684	-163.45853	5.6	255	9/30/2013	23:30	72.53682	-164.31315	5.8	31
9/30/2013	1:00	73.60322	-162.00461	5.6	5	9/30/2013	12:00	72.93194	-163.51103	5.4	182	10/1/2013	0:00	72.53506	-164.38086	5.2	166
9/30/2013	1:30	73.59828	-161.98706	5.1	185	9/30/2013	12:30	72.90741	-163.61433	5.2	248	10/1/2013	0:30	72.50267	-164.41277	4.6	243
9/30/2013	2:00	73.57482	-162.10146	5.1	184	9/30/2013	13:00	72.86628	-163.63236	5.2	182	10/1/2013	1:00	72.47057	-164.45813	5.6	173
9/30/2013	2:30	73.54178	-162.15389	5	254	9/30/2013	13:30	72.84137	-163.73687	5.4	243	10/1/2013	1:30	72.44822	-164.54569	5.5	176
9/30/2013	3:00	73.50911	-162.19751	5.3	180	9/30/2013	14:00	72.80316	-163.78109	5.2	244	10/1/2013	2:00	72.41530	-164.59616	5	243
9/30/2013	3:30	73.48554	-162.30559	5.1	193	9/30/2013	14:30	72.77167	-163.85558	5.4	181	10/1/2013	2:30	72.37843	-164.63416	5.2	215
9/30/2013	4:00	73.44529	-162.34303	4.9	242	9/30/2013	15:00	72.74211	-163.93343	5	242	10/1/2013	3:00	72.35179	-164.72702	5.3	133
9/30/2013	4:30	73.41962	-162.44086	5.2	190	9/30/2013	15:30	72.70622	-163.98337	5.4	182	10/1/2013	3:30	72.35258	-164.61788	5.4	29
9/30/2013	5:00	73.38452	-162.50467	5.1	244	9/30/2013	16:00	72.67908	-164.07375	5.2	244	10/1/2013	4:00	72.39404	-164.58363	5.3	3
9/30/2013	5:00	73.38442	-162.50541	5.1	243	9/30/2013	16:30	72.63733	-164.10284	5.5	245	10/1/2013	4:30	72.43406	-164.54998	5.1	35
9/30/2013	5:30	73.35205	-162.57638	5.3	189	9/30/2013	17:30	72.57825	-164.26699	5.4	245	10/1/2013	5:00	72.46994	-164.47419	5.2	28
9/30/2013	6:00	73.32178	-162.66712	5.1	242	9/30/2013	18:00	72.53853	-164.30103	5.5	186	10/1/2013	5:30	72.50831	-164.40905	5.2	26
9/30/2013	6:30	73.28215	-162.71506	5.5	192	9/30/2013	18:30	72.51305	-164.40091	5.3	183	10/1/2013	6:00	72.54392	-164.33030	5.1	67
9/30/2013	7:00	73.25489	-162.81590	5.4	183	9/30/2013	19:00	72.47776	-164.45384	5.3	254	10/1/2013	6:30	72.54142	-164.36262	5.4	182
9/30/2013	7:30	73.22182	-162.88283	5.3	244	9/30/2013	19:30	72.44619	-164.51501	5.2	187	10/1/2013	7:00	72.50454	-164.40717	5.7	254
9/30/2013	8:00	73.18257	-162.92092	5.4	188	9/30/2013	20:00	72.41704	-164.59106	5.2	244	10/1/2013	7:30	72.47227	-164.46064	5	182
9/30/2013	8:30	73.15864	-163.04278	5.5	185	9/30/2013	20:30	72.37863	-164.61746	5.1	194	10/1/2013	8:00	72.44639	-164.55554	4.9	182
9/30/2013	9:00	73.11997	-163.08507	5.4	249	9/30/2013	21:00	72.36324	-164.61096	5.5	30	10/1/2013	8:30	72.40998	-164.59137	5.2	246
9/30/2013	9:30	73.08926	-163.16434	5.4	183	9/30/2013	21:30	72.40244	-164.53079	5.7	32	10/1/2013	9:00	72.37957	-164.65745	5.1	181
9/30/2013	10:00	73.06533	-163.25945	5.4	257	9/30/2013	22:00	72.41525	-164.53634	5.2	300	10/1/2013	9:30	72.35293	-164.74408	5.1	245

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	21 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/1/2013	10:00	72.31437	-164.76669	5.1	180	10/1/2013	21:30	71.83602	-165.90410	6	346	10/2/2013	9:00	72.23555	-166.25887	5.4	312
10/1/2013	10:30	72.29073	-164.86194	5.1	181	10/1/2013	22:00	71.88428	-165.94217	6	347	10/2/2013	9:30	72.26088	-166.20423	5.4	59
10/1/2013	11:00	72.25519	-164.90788	5.2	243	10/1/2013	22:30	71.93184	-165.97382	5.8	346	10/2/2013	10:00	72.30137	-166.16592	4.6	58
10/1/2013	11:30	72.22138	-164.96625	5.3	181	10/1/2013	23:00	71.97878	-166.01499	6	346	10/2/2013	10:30	72.32938	-166.07906	5.9	4
10/1/2013	12:00	72.19517	-165.06165	5.2	241	10/1/2013	23:30	72.02731	-166.05123	6	346	10/2/2013	11:00	72.36336	-166.01832	5.1	63
10/1/2013	12:30	72.15456	-165.09293	5.2	241	10/2/2013	0:00	72.07634	-166.08597	6	347	10/2/2013	11:30	72.39537	-165.95540	5.7	359
10/1/2013	13:00	72.12470	-165.17192	5.4	182	10/2/2013	0:30	72.12449	-166.12299	6.1	346	10/2/2013	12:00	72.42637	-165.89337	4.8	58
10/1/2013	13:30	72.09279	-165.24564	5.3	240	10/2/2013	1:00	72.17446	-166.16167	6.2	347	10/2/2013	12:30	72.46473	-165.85669	5.7	359
10/1/2013	14:00	72.05333	-165.27686	5.2	238	10/2/2013	1:30	72.22170	-166.19981	5.7	345	10/2/2013	13:00	72.48916	-165.76081	5	64
10/1/2013	14:30	72.02973	-165.38780	5.4	183	10/2/2013	2:00	72.25547	-166.26417	4.7	206	10/2/2013	13:30	72.52981	-165.73399	4.6	61
10/1/2013	15:00	71.98958	-165.41700	5.3	242	10/2/2013	2:30	72.27529	-166.21803	5.6	2	10/2/2013	14:00	72.55469	-165.65190	5.3	1
10/1/2013	15:30	71.95898	-165.49015	5.3	181	10/2/2013	3:00	72.30369	-166.11559	5.5	3	10/2/2013	14:30	72.58775	-165.59507	4.9	61
10/1/2013	16:00	71.92809	-165.56004	5.3	243	10/2/2013	3:30	72.34440	-166.07413	5.6	61	10/2/2013	15:00	72.62018	-165.54489	5.6	350
10/1/2013	16:30	71.89100	-165.58614	5.1	244	10/2/2013	4:00	72.37883	-166.00985	5.6	355	10/2/2013	15:30	72.64823	-165.45964	4.4	53
10/1/2013	17:00	71.86884	-165.69447	5.2	181	10/2/2013	4:30	72.38148	-165.96058	4.8	179	10/2/2013	16:00	72.68783	-165.43092	5.2	48
10/1/2013	17:30	71.82638	-165.69389	5.2	179	10/2/2013	5:00	72.34418	-166.01538	4.9	212	10/2/2013	16:30	72.71681	-165.32640	5.2	49
10/1/2013	18:00	71.79861	-165.77259	5.2	244	10/2/2013	5:30	72.30924	-166.08086	4.6	216	10/2/2013	17:00	72.75056	-165.30542	5.2	53
10/1/2013	18:30	71.77535	-165.87321	5.1	181	10/2/2013	6:00	72.27609	-166.14975	4.7	212	10/2/2013	17:30	72.77806	-165.19065	5.3	50
10/1/2013	19:00	71.73270	-165.87365	5.1	181	10/2/2013	6:30	72.24303	-166.21548	5.2	277	10/2/2013	18:00	72.81798	-165.16457	5	50
10/1/2013	19:30	71.70596	-165.96212	5.3	243	10/2/2013	7:00	72.25507	-166.21164	4	121	10/2/2013	18:30	72.84559	-165.06328	5.3	28
10/1/2013	20:00	71.70025	-165.91237	5.6	29	10/2/2013	7:30	72.25913	-166.25738	4.9	33	10/2/2013	19:00	72.88304	-165.03831	5.1	52
10/1/2013	20:30	71.74101	-165.83266	5.9	33	10/2/2013	8:00	72.23595	-166.25755	4.6	207	10/2/2013	19:30	72.91060	-164.93109	5.8	1
10/1/2013	21:00	71.78835	-165.86729	5.9	344	10/2/2013	8:30	72.20715	-166.29533	5.2	302	10/2/2013	20:00	72.94851	-164.88650	4.6	58

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	22 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/2/2013	20:30	72.98118	-164.81878	5.9	0	10/3/2013	8:00	73.73215	-163.21662	5.6	355	10/3/2013	19:30	74.02147	-164.02621	5.8	306
10/2/2013	21:00	73.01005	-164.72815	5.1	57	10/3/2013	8:30	73.75603	-163.13253	4.3	56	10/3/2013	20:00	74.04922	-164.16820	5.8	304
10/2/2013	21:30	73.05228	-164.68932	5.1	54	10/3/2013	9:00	73.78747	-163.06016	5.9	359	10/3/2013	20:30	74.07550	-164.31363	5.8	303
10/2/2013	22:00	73.08418	-164.60724	6.3	351	10/3/2013	9:30	73.81747	-162.99150	4.8	53	10/3/2013	21:00	74.10259	-164.45548	5.7	310
10/2/2013	22:30	73.10975	-164.50793	5.2	38	10/3/2013	10:00	73.84939	-162.91832	5.8	355	10/3/2013	21:30	74.13367	-164.58049	5.5	310
10/2/2013	23:00	73.15067	-164.47356	4.3	61	10/3/2013	10:30	73.88214	-162.85559	4.9	61	10/3/2013	22:00	74.16520	-164.70495	5.6	313
10/2/2013	23:30	73.17858	-164.38984	5.9	355	10/3/2013	11:00	73.91287	-162.77668	6	352	10/3/2013	22:30	74.18371	-164.76484	5.4	312
10/3/2013	0:00	73.21089	-164.32458	4.5	60	10/3/2013	11:30	73.94388	-162.69950	5	65	10/3/2013	23:00	74.19873	-164.83146	5.3	304
10/3/2013	0:30	73.24874	-164.27080	6.1	2	10/3/2013	12:00	73.98395	-162.65318	5.8	1	10/3/2013	23:30	74.21166	-164.90145	5.3	348
10/3/2013	1:00	73.27335	-164.16273	5.5	43	10/3/2013	12:30	74.00752	-162.53532	4.7	54	10/4/2013	0:00	74.23382	-165.03566	5.1	303
10/3/2013	1:30	73.31075	-164.11936	4.9	66	10/3/2013	13:00	74.04794	-162.50015	4.9	61	10/4/2013	0:30	74.25394	-165.16551	4.8	297
10/3/2013	2:00	73.34694	-164.07592	5.6	22	10/3/2013	13:30	74.06839	-162.37283	4.6	57	10/4/2013	1:00	74.22341	-165.24699	4.8	209
10/3/2013	2:30	73.37109	-163.96531	6.1	0	10/3/2013	14:00	74.08751	-162.43120	5.6	247	10/4/2013	1:30	74.19492	-165.33799	5.1	270
10/3/2013	3:00	73.40801	-163.90976	4.7	65	10/3/2013	14:30	74.05446	-162.53353	5.3	212	10/4/2013	2:00	74.21217	-165.39294	4.8	266
10/3/2013	3:30	73.44377	-163.85261	5.9	2	10/3/2013	15:00	74.01779	-162.62063	5.4	214	10/4/2013	2:30	74.22741	-165.50346	4.6	331
10/3/2013	4:00	73.46926	-163.75327	5.7	351	10/3/2013	15:30	74.00052	-162.67606	5	32	10/4/2013	3:00	74.22445	-165.53020	4.9	96
10/3/2013	4:30	73.50098	-163.69974	5	68	10/3/2013	16:00	74.01088	-162.80309	6.1	270	10/4/2013	4:00	74.19049	-165.28969	4.8	96
10/3/2013	5:00	73.53967	-163.66204	5.4	12	10/3/2013	16:30	74.01248	-162.98548	6	271	10/4/2013	4:30	74.17253	-165.17103	5.4	155
10/3/2013	5:30	73.56121	-163.55943	5.6	360	10/3/2013	17:00	74.01523	-163.16587	5.8	272	10/4/2013	5:00	74.16003	-165.06569	5.3	151
10/3/2013	6:00	73.59570	-163.50352	4.7	56	10/3/2013	17:30	74.01793	-163.34510	5.8	271	10/4/2013	5:30	74.14552	-164.94090	4.9	92
10/3/2013	6:30	73.62893	-163.43820	5.7	355	10/3/2013	18:00	74.01265	-163.51183	6.5	245	10/4/2013	6:00	74.11864	-164.84531	4.9	93
10/3/2013	7:00	73.66141	-163.36094	5	46	10/3/2013	18:30	73.96554	-163.69459	9	256	10/4/2013	6:30	74.10545	-164.71596	5.3	154
10/3/2013	7:30	73.69226	-163.25724	5.2	43	10/3/2013	19:00	73.99381	-163.87589	6.1	304	10/4/2013	7:00	74.09092	-164.59265	5.1	91

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	23 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/4/2013	7:30	74.07130	-164.50350	5	88	10/4/2013	19:30	73.62344	-162.09823	5.8	307	10/5/2013	7:30	73.36352	-160.66942	5	85
10/4/2013	8:00	74.04661	-164.40613	4.7	80	10/4/2013	20:00	73.65771	-162.15036	5.7	28	10/5/2013	8:00	73.34292	-160.57402	4.9	156
10/4/2013	8:30	74.03386	-164.28055	4.9	154	10/4/2013	20:30	73.67100	-162.26913	5.5	276	10/5/2013	8:30	73.33576	-160.44522	5	157
10/4/2013	9:00	74.01926	-164.15591	5.4	93	10/4/2013	21:00	73.69321	-162.33885	5.5	277	10/5/2013	9:00	73.30234	-160.37998	4.8	91
10/4/2013	9:30	73.99097	-164.06340	5.4	86	10/4/2013	21:30	73.71636	-162.41706	5.1	274	10/5/2013	9:30	73.29099	-160.26028	4.7	150
10/4/2013	10:30	73.96374	-163.80734	5.5	91	10/4/2013	22:00	73.71220	-162.47622	5.3	84	10/5/2013	10:00	73.26636	-160.17386	4.9	93
10/4/2013	11:00	73.93519	-163.71251	5.2	154	10/4/2013	22:30	73.69357	-162.40346	5.1	85	10/5/2013	10:30	73.24697	-160.07564	4.7	152
10/4/2013	11:30	73.91905	-163.58811	5.4	91	10/4/2013	23:00	73.68055	-162.31000	4.8	182	10/5/2013	11:00	73.23149	-159.96416	5.5	89
10/4/2013	12:00	73.89063	-163.48976	5.4	96	10/4/2013	23:30	73.66929	-162.20163	4.8	184	10/5/2013	11:30	73.20368	-159.89582	4.3	159
10/4/2013	12:30	73.87101	-163.35675	5.9	153	10/5/2013	0:00	73.65690	-162.10789	5	95	10/5/2013	12:00	73.19065	-159.77224	5.1	153
10/4/2013	13:00	73.85590	-163.22247	5.6	89	10/5/2013	0:30	73.62394	-162.03309	5.3	80	10/5/2013	12:30	73.15890	-159.69569	5.3	102
10/4/2013	13:30	73.82930	-163.11610	5.5	85	10/5/2013	1:00	73.61078	-161.91810	4.9	153	10/5/2013	13:00	73.14617	-159.55634	4.8	142
10/4/2013	14:00	73.80328	-163.01586	6.1	163	10/5/2013	1:30	73.59657	-161.80143	5.3	83	10/5/2013	13:30	73.11438	-159.47983	4.6	150
10/4/2013	14:30	73.79451	-162.89715	5.4	161	10/5/2013	2:00	73.56634	-161.70973	4.8	142	10/5/2013	14:00	73.10106	-159.34062	5.6	100
10/4/2013	15:00	73.77670	-162.79156	5.4	80	10/5/2013	3:00	73.52070	-161.49826	5.1	156	10/5/2013	14:30	73.07239	-159.26397	3.9	149
10/4/2013	15:30	73.74642	-162.70715	5.1	114	10/5/2013	3:30	73.50935	-161.38178	5.3	176	10/5/2013	15:00	73.05485	-159.17473	3.8	118
10/4/2013	16:00	73.73445	-162.58595	5.1	154	10/5/2013	4:00	73.49572	-161.29601	5.1	157	10/5/2013	15:30	73.04563	-159.04970	3.9	152
10/4/2013	16:30	73.71963	-162.46459	5.5	93	10/5/2013	4:30	73.47789	-161.20164	5.2	75	10/5/2013	16:00	73.00829	-158.98415	5.4	154
10/4/2013	17:00	73.69032	-162.37043	5.4	91	10/5/2013	5:00	73.45727	-161.12227	5.3	72	10/5/2013	16:30	72.99690	-158.87391	4.3	96
10/4/2013	17:30	73.67266	-162.24785	5.3	153	10/5/2013	5:30	73.43645	-161.04620	5.7	68	10/5/2013	17:00	72.97604	-158.77646	5.5	148
10/4/2013	18:00	73.65842	-162.11548	5.3	134	10/5/2013	6:00	73.41674	-160.96801	4.8	163	10/5/2013	17:30	72.94615	-158.68765	3.9	95
10/4/2013	18:30	73.62135	-162.02599	5.3	147	10/5/2013	6:30	73.40381	-160.85113	5	154	10/5/2013	18:00	72.93267	-158.55548	5.3	144
10/4/2013	19:00	73.61105	-161.91521	8.2	221	10/5/2013	7:00	73.39272	-160.74658	4.8	131	10/5/2013	18:30	72.89924	-158.49085	4.7	150

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	24 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/5/2013	19:00	72.88694	-158.33772	5.9	99	10/6/2013	8:30	72.33461	-159.83408	5.6	337	10/6/2013	20:00	72.81257	-162.21195	5.1	271
10/5/2013	19:30	72.85654	-158.26919	4.6	148	10/6/2013	9:00	72.34921	-159.94205	5.5	337	10/6/2013	20:30	72.84098	-162.30721	4.3	307
10/5/2013	20:00	72.82651	-158.24994	3.3	221	10/6/2013	9:30	72.37644	-160.03581	5.4	277	10/6/2013	21:00	72.87168	-162.41992	5.2	270
10/5/2013	20:30	72.80227	-158.31108	4.1	215	10/6/2013	10:00	72.40535	-160.12475	5.7	338	10/6/2013	21:30	72.88066	-162.56285	6	289
10/5/2013	21:00	72.77681	-158.37799	4.6	216	10/6/2013	10:30	72.41859	-160.24867	5.4	337	10/6/2013	22:00	72.91318	-162.65375	6.1	285
10/5/2013	23:30	72.70913	-158.64262	3.5	212	10/6/2013	11:00	72.44042	-160.35545	5.3	278	10/6/2013	22:30	72.92350	-162.78543	4.3	282
10/6/2013	0:00	72.68096	-158.69417	3.9	217	10/6/2013	11:30	72.47285	-160.43983	5.4	279	10/6/2013	23:00	72.95250	-162.84721	4.3	295
10/6/2013	0:30	72.65140	-158.75920	3.7	204	10/6/2013	12:00	72.49080	-160.56136	5.4	333	10/6/2013	23:30	72.96584	-162.97123	6.4	307
10/6/2013	1:00	72.62389	-158.81038	3.9	206	10/6/2013	12:30	72.50761	-160.68470	5.5	276	10/7/2013	0:00	72.99404	-163.11527	7	301
10/6/2013	1:30	72.59533	-158.85339	4.2	199	10/6/2013	13:00	72.53945	-160.77131	5.4	272	10/7/2013	0:30	73.01209	-163.25608	5.3	285
10/6/2013	2:00	72.56489	-158.90687	4.8	207	10/6/2013	13:30	72.56169	-160.87347	5.4	341	10/7/2013	1:00	73.04333	-163.34348	5.6	324
10/6/2013	2:30	72.53275	-158.96739	4.4	210	10/6/2013	14:00	72.57505	-161.00917	5.8	285	10/7/2013	1:30	73.05292	-163.48069	4.5	308
10/6/2013	3:00	72.50775	-159.07057	5.4	239	10/6/2013	14:30	72.59650	-161.09018	5.6	255	10/7/2013	2:00	73.07829	-163.56514	5.5	278
10/6/2013	3:30	72.48346	-159.20252	5.9	235	10/6/2013	15:00	72.62075	-161.16481	5.5	274	10/7/2013	2:30	73.10164	-163.65667	5.1	337
10/6/2013	4:00	72.45048	-159.30611	5.4	205	10/6/2013	15:30	72.64292	-161.27247	5.3	336	10/7/2013	3:00	73.11086	-163.79203	5.1	282
10/6/2013	4:30	72.41047	-159.36612	5.3	201	10/6/2013	16:00	72.66182	-161.38702	5.5	276	10/7/2013	3:30	73.14060	-163.86564	4.8	323
10/6/2013	5:00	72.37000	-159.41544	5.4	199	10/6/2013	16:30	72.68877	-161.47410	5.5	345	10/7/2013	4:00	73.14947	-163.99139	4.8	280
10/6/2013	5:30	72.32968	-159.46072	5.2	201	10/6/2013	17:00	72.69880	-161.59590	5.3	268	10/7/2013	4:30	73.17824	-164.06386	4.8	326
10/6/2013	6:00	72.28879	-159.51205	5.3	200	10/6/2013	17:30	72.72318	-161.68685	5.2	274	10/7/2013	5:00	73.18705	-164.18699	4.4	283
10/6/2013	6:30	72.27443	-159.55680	5.3	7	10/6/2013	18:00	72.74716	-161.77088	4.9	347	10/7/2013	5:30	73.20675	-164.28642	4	318
10/6/2013	7:00	72.28159	-159.62876	5.3	352	10/6/2013	18:30	72.75154	-161.90910	5.5	276	10/7/2013	6:00	73.23216	-164.37398	4.5	313
10/6/2013	7:30	72.29527	-159.68901	5.2	354	10/6/2013	19:00	72.78559	-161.98497	5.2	272	10/7/2013	6:30	73.24047	-164.51610	4.3	278
10/6/2013	8:00	72.30219	-159.75573	5	242	10/6/2013	19:30	72.80200	-162.09443	5	335	10/7/2013	7:00	73.26296	-164.60803	4	321

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	25 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/7/2013	7:30	73.28601	-164.70895	6.1	283	10/7/2013	19:00	73.59207	-166.26584	5.1	31	10/8/2013	6:30	72.93022	-167.67678	5.3	226
10/7/2013	8:00	73.29687	-164.86070	5.7	285	10/7/2013	19:30	73.62797	-166.22721	5.3	300	10/8/2013	7:00	72.89837	-167.71088	3.9	161
10/7/2013	8:30	73.32303	-164.96198	4.6	323	10/7/2013	20:00	73.62492	-166.36837	5.7	241	10/8/2013	7:30	72.86663	-167.78722	5.3	223
10/7/2013	9:00	73.34848	-165.06932	6.1	286	10/7/2013	20:30	73.58429	-166.39925	5.7	252	10/8/2013	8:00	72.83678	-167.83988	3.3	141
10/7/2013	9:30	73.36088	-165.22289	4.7	339	10/7/2013	21:00	73.55317	-166.45220	5.1	172	10/8/2013	8:30	72.80979	-167.85517	6	234
10/7/2013	10:00	73.39455	-165.29343	5.6	274	10/7/2013	21:30	73.52572	-166.54273	5	177	10/8/2013	9:00	72.78094	-167.98102	5.7	233
10/7/2013	10:30	73.39961	-165.43427	4.3	346	10/7/2013	22:00	73.49868	-166.62045	5	194	10/8/2013	9:30	72.74612	-168.00142	4.1	164
10/7/2013	11:00	73.42580	-165.50047	5.5	265	10/7/2013	22:30	73.46484	-166.65611	5.2	243	10/8/2013	10:00	72.71284	-168.02980	5.6	232
10/7/2013	11:30	73.43928	-165.61500	4.9	341	10/7/2013	23:00	73.43182	-166.69788	5.1	169	10/8/2013	10:30	72.68483	-168.15721	5.7	234
10/7/2013	12:00	73.45528	-165.72400	5.9	266	10/7/2013	23:30	73.40308	-166.80411	5.4	232	10/8/2013	11:00	72.65123	-168.16027	4.1	148
10/7/2013	12:30	73.47890	-165.83171	4.6	337	10/8/2013	0:00	73.36971	-166.83271	5.1	241	10/8/2013	11:30	72.61847	-168.20316	5.6	230
10/7/2013	13:00	73.48995	-165.96411	6.1	264	10/8/2013	0:30	73.33825	-166.89309	5	179	10/8/2013	12:00	72.58973	-168.32899	5.8	232
10/7/2013	13:30	73.52358	-166.04846	5.6	337	10/8/2013	1:00	73.31110	-166.98775	5.1	214	10/8/2013	12:30	72.54442	-168.28212	6.5	175
10/7/2013	14:00	73.52644	-166.21259	5.8	345	10/8/2013	1:30	73.27203	-167.01392	5.6	241	10/8/2013	13:00	72.51366	-168.39251	5.5	230
10/7/2013	14:30	73.55207	-166.30830	5.9	264	10/8/2013	2:00	73.23961	-167.08688	5.3	184	10/8/2013	13:30	72.48474	-168.50280	5.1	218
10/7/2013	15:00	73.58075	-166.40100	5.8	354	10/8/2013	2:30	73.20830	-167.17727	5.7	240	10/8/2013	14:00	72.44642	-168.52389	4.9	185
10/7/2013	15:30	73.58165	-166.56511	6.1	261	10/8/2013	3:00	73.16729	-167.19598	5	183	10/8/2013	14:30	72.40599	-168.53198	4.9	187
10/7/2013	16:00	73.61223	-166.67357	6.2	271	10/8/2013	3:30	73.13974	-167.30155	5.2	188	10/8/2013	15:00	72.37585	-168.63016	5.3	230
10/7/2013	16:30	73.62943	-166.80263	5.3	337	10/8/2013	4:00	73.09917	-167.32896	5.6	248	10/8/2013	15:30	72.34754	-168.72962	4.8	220
10/7/2013	17:00	73.60747	-166.78094	5.7	125	10/8/2013	4:30	73.06994	-167.41686	5.2	194	10/8/2013	16:00	72.31387	-168.76300	4.1	189
10/7/2013	17:30	73.58513	-166.64048	5.3	117	10/8/2013	5:00	73.02983	-167.45709	5.1	197	10/8/2013	16:30	72.28133	-168.77639	3.9	186
10/7/2013	18:00	73.56505	-166.50236	5.3	117	10/8/2013	5:30	73.00559	-167.55692	5	201	10/8/2013	17:00	72.25442	-168.86527	4.5	201
10/7/2013	18:30	73.56144	-166.35918	5.2	66	10/8/2013	6:00	72.96641	-167.60857	5	202	10/8/2013	17:30	72.26594	-168.78372	4.8	27

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	26 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/8/2013	18:00	72.30271	-168.72755	5.3	27	10/9/2013	5:30	72.05215	-166.89656	4.2	129	10/9/2013	17:00	71.64798	-164.64644	5.1	109
10/8/2013	18:30	72.34207	-168.66760	5.9	6	10/9/2013	6:00	72.03236	-166.80299	4.6	126	10/9/2013	17:30	71.61815	-164.56177	5.4	146
10/8/2013	19:00	72.39028	-168.69530	5.9	350	10/9/2013	6:30	72.01243	-166.70713	5.3	114	10/9/2013	18:00	71.60108	-164.45284	5.1	106
10/8/2013	19:30	72.43777	-168.72114	6	346	10/9/2013	7:00	71.99432	-166.61214	4.5	132	10/9/2013	18:30	71.58406	-164.34005	5.5	142
10/8/2013	20:00	72.43863	-168.74498	4.6	139	10/9/2013	7:30	71.97646	-166.51726	4.4	120	10/9/2013	19:00	71.55238	-164.24516	4.4	105
10/8/2013	20:30	72.41848	-168.63542	4.7	127	10/9/2013	8:00	71.95984	-166.41618	4.5	118	10/9/2013	19:30	71.54124	-164.11591	5.3	106
10/8/2013	21:00	72.39668	-168.53444	4.2	130	10/9/2013	8:30	71.94335	-166.31803	4.1	110	10/9/2013	20:00	71.51248	-164.03423	4.9	92
10/8/2013	21:30	72.37606	-168.43415	4.2	116	10/9/2013	9:00	71.92912	-166.21912	4.5	115	10/9/2013	20:30	71.50418	-163.92817	5.4	154
10/8/2013	22:00	72.35565	-168.33612	4.3	118	10/9/2013	9:30	71.91400	-166.12512	3.9	121	10/9/2013	21:00	71.47894	-163.83951	4.9	105
10/8/2013	22:30	72.33573	-168.24139	4.7	125	10/9/2013	10:00	71.88884	-166.03875	4.9	146	10/9/2013	21:30	71.45929	-163.72362	6	154
10/8/2013	23:00	72.31481	-168.14170	5	128	10/9/2013	10:30	71.86973	-165.94750	5	105	10/9/2013	22:00	71.44213	-163.61025	4.7	92
10/8/2013	23:30	72.29366	-168.04094	4.4	123	10/9/2013	11:00	71.85854	-165.84109	5.4	102	10/9/2013	22:30	71.41469	-163.52942	4.6	94
10/9/2013	0:00	72.27364	-167.94797	4.6	121	10/9/2013	11:30	71.83505	-165.72862	5.3	159	10/9/2013	23:00	71.40070	-163.42761	5.7	152
10/9/2013	0:30	72.25378	-167.84828	4.3	125	10/9/2013	12:00	71.81166	-165.63957	5.4	106	10/9/2013	23:30	71.38170	-163.32956	4.1	96
10/9/2013	1:00	72.23082	-167.74931	4.6	127	10/9/2013	12:30	71.80121	-165.49253	5.3	104	10/10/2013	0:00	71.35343	-163.24370	5.5	154
10/9/2013	1:30	72.21091	-167.65002	4.3	123	10/9/2013	13:00	71.77508	-165.39875	5.1	152	10/10/2013	0:30	71.34733	-163.12975	4.2	94
10/9/2013	2:00	72.19042	-167.55055	4.6	125	10/9/2013	13:30	71.75849	-165.32283	3.9	98	10/10/2013	1:00	71.31656	-163.04695	4.6	93
10/9/2013	2:30	72.17033	-167.45223	4.5	116	10/9/2013	14:00	71.75372	-165.23720	3.5	100	10/10/2013	1:30	71.30237	-162.93941	5.6	154
10/9/2013	3:00	72.14993	-167.35437	4.6	122	10/9/2013	14:30	71.73166	-165.16599	4.7	151	10/10/2013	2:00	71.28605	-162.83630	5.3	91
10/9/2013	3:30	72.12941	-167.26126	4.1	117	10/9/2013	15:00	71.71512	-165.05515	5	101	10/10/2013	2:30	71.25509	-162.75115	5.2	89
10/9/2013	4:00	72.11386	-167.16030	3.5	109	10/9/2013	15:30	71.69559	-164.94182	4.7	159	10/10/2013	3:00	71.24217	-162.63204	5.6	142
10/9/2013	4:30	72.09107	-167.08688	4.5	118	10/9/2013	16:00	71.67422	-164.86158	4.3	109	10/10/2013	3:30	71.23352	-162.71375	5.7	300
10/9/2013	5:00	72.07240	-166.99102	4.3	119	10/9/2013	16:30	71.66139	-164.75943	3.8	114	10/10/2013	4:00	71.25765	-162.83177	5.2	305

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	27 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/10/2013	4:30	71.27016	-162.88910	5.3	301	10/10/2013	15:30	71.47616	-162.42593	5.9	2	10/11/2013	3:00	71.40661	-162.63340	5.7	62
10/10/2013	5:00	71.28252	-162.95565	4.7	34	10/10/2013	16:00	71.52208	-162.47502	5.9	335	10/11/2013	3:30	71.42799	-162.50000	5.9	61
10/10/2013	5:30	71.30975	-163.03029	5.3	303	10/10/2013	16:30	71.51399	-162.41923	6.8	193	10/11/2013	4:00	71.45100	-162.37071	5.8	60
10/10/2013	6:00	71.32261	-163.11493	4.9	78	10/10/2013	17:00	71.47107	-162.50865	5	213	10/11/2013	4:30	71.47428	-162.24043	5.7	61
10/10/2013	6:30	71.34130	-163.20381	5	187	10/10/2013	17:30	71.43109	-162.58986	5.6	211	10/11/2013	5:00	71.49761	-162.10808	5.8	60
10/10/2013	7:00	71.33599	-163.11041	5.3	153	10/10/2013	18:00	71.39737	-162.68731	5.7	243	10/11/2013	5:30	71.52028	-161.97787	5.8	62
10/10/2013	7:30	71.32253	-163.00405	5.1	90	10/10/2013	18:30	71.35186	-162.70613	5.7	182	10/11/2013	6:00	71.54211	-161.84219	5.8	63
10/10/2013	8:00	71.29492	-162.91986	5	88	10/10/2013	19:00	71.32846	-162.82224	5.4	248	10/11/2013	6:30	71.56447	-161.70821	5.2	61
10/10/2013	8:30	71.27571	-162.82009	5.3	151	10/10/2013	19:30	71.28617	-162.84884	5.5	260	10/11/2013	7:00	71.58423	-161.59134	5.1	60
10/10/2013	9:00	71.26210	-162.71153	4.8	89	10/10/2013	20:00	71.30640	-162.89514	5.1	34	10/11/2013	7:30	71.60462	-161.47727	5	61
10/10/2013	9:30	71.22716	-162.63140	5.9	137	10/10/2013	20:30	71.34123	-162.82752	4.8	32	10/11/2013	8:00	71.62396	-161.36421	4.9	64
10/10/2013	10:00	71.21971	-162.50980	5	153	10/10/2013	21:00	71.37652	-162.76065	4.6	33	10/11/2013	9:00	71.66377	-161.14161	4.9	61
10/10/2013	10:30	71.20099	-162.40337	5.3	91	10/10/2013	21:30	71.36661	-162.79166	5.1	136	10/11/2013	9:30	71.68346	-161.03012	4.6	62
10/10/2013	11:00	71.17308	-162.31590	5.5	153	10/10/2013	22:00	71.38815	-162.70879	5.1	33	10/11/2013	10:00	71.70612	-160.93728	5.1	327
10/10/2013	11:30	71.15454	-162.22152	5.1	29	10/10/2013	22:30	71.42307	-162.63784	5	32	10/11/2013	10:30	71.68075	-161.01730	5.6	158
10/10/2013	12:00	71.16337	-162.30055	5.4	261	10/10/2013	23:00	71.42885	-162.57491	5.2	260	10/11/2013	11:00	71.67238	-160.89593	4.9	87
10/10/2013	12:30	71.18247	-162.41882	5.6	337	10/10/2013	23:30	71.40813	-162.61440	5.1	270	10/11/2013	11:30	71.67434	-160.76486	5.1	88
10/10/2013	13:00	71.23048	-162.43164	6.2	357	10/11/2013	0:00	71.38653	-162.64805	5	249	10/11/2013	12:00	71.67722	-160.63121	5	85
10/10/2013	13:00	71.23076	-162.43171	6.2	355	10/11/2013	0:30	71.36314	-162.71709	5.5	185	10/11/2013	12:30	71.68194	-160.50033	4.9	73
10/10/2013	13:30	71.28035	-162.43138	6	2	10/11/2013	1:00	71.34070	-162.79923	5.4	169	10/11/2013	13:00	71.70350	-160.39158	4.9	43
10/10/2013	14:00	71.32880	-162.42227	5.9	2	10/11/2013	1:30	71.31715	-162.84366	5.5	342	10/11/2013	14:30	71.80198	-160.45771	5.7	223
10/10/2013	14:30	71.37882	-162.42381	5.9	358	10/11/2013	2:00	71.35316	-162.86948	5.8	36	10/11/2013	15:00	71.75854	-160.48261	5.6	202
10/10/2013	15:00	71.42757	-162.42707	5.9	358	10/11/2013	2:30	71.38583	-162.76547	5.8	63	10/11/2013	15:30	71.74916	-160.59162	5.5	294

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	28 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/11/2013	16:00	71.74966	-160.72694	6	235	10/12/2013	4:00	71.90804	-161.60875	5.9	35	10/12/2013	15:30	72.09531	-160.94926	5.4	228
10/11/2013	17:00	71.72146	-160.99541	5.9	231	10/12/2013	4:30	71.94852	-161.51842	6	33	10/12/2013	16:00	72.07503	-161.06710	5.2	287
10/11/2013	17:30	71.72522	-161.13174	5.6	230	10/12/2013	5:00	71.98946	-161.42688	6.1	35	10/12/2013	16:30	72.07229	-161.19739	5.7	232
10/11/2013	18:00	71.71317	-161.22343	5.4	290	10/12/2013	5:30	72.01566	-161.31178	5.6	357	10/12/2013	17:00	72.06792	-161.32132	4.9	336
10/11/2013	18:30	71.70139	-161.34542	5.5	230	10/12/2013	6:00	72.04982	-161.25969	5	62	10/12/2013	17:30	72.04976	-161.43264	5.6	233
10/11/2013	19:00	71.70854	-161.46689	5.4	298	10/12/2013	6:30	72.08308	-161.21327	5.4	358	10/12/2013	18:00	72.05165	-161.56028	5.5	222
10/11/2013	19:30	71.68640	-161.57334	5.5	286	10/12/2013	7:00	72.10677	-161.10600	5.3	359	10/12/2013	18:30	72.04345	-161.67173	5.2	298
10/11/2013	20:00	71.68142	-161.69821	5.6	232	10/12/2013	7:30	72.14063	-161.05192	5.3	60	10/12/2013	19:00	72.02480	-161.77032	4.5	298
10/11/2013	20:30	71.66608	-161.81901	5.4	231	10/12/2013	8:00	72.17623	-161.00941	5.3	360	10/12/2013	19:30	72.03274	-161.88536	5.3	222
10/11/2013	21:00	71.68905	-161.83844	4.7	81	10/12/2013	8:30	72.19542	-160.89507	4.9	56	10/12/2013	20:00	72.02039	-161.99454	5.2	287
10/11/2013	21:30	71.69647	-161.71815	4.6	78	10/12/2013	9:00	72.23763	-160.86915	4.9	61	10/12/2013	20:30	72.00869	-162.12126	5.8	230
10/11/2013	22:00	71.69894	-161.65272	4.6	80	10/12/2013	9:30	72.26061	-160.77110	5.5	3	10/12/2013	21:00	72.01143	-162.25262	5	286
10/11/2013	22:30	71.70569	-161.53345	4.4	77	10/12/2013	10:00	72.30293	-160.76842	4.7	358	10/12/2013	21:30	71.99019	-162.36625	4.6	283
10/11/2013	23:00	71.71421	-161.41866	4.4	75	10/12/2013	10:30	72.34162	-160.76690	4.8	1	10/12/2013	22:00	71.99413	-162.49062	5.7	228
10/11/2013	23:30	71.72219	-161.30482	4.4	77	10/12/2013	11:00	72.34306	-160.86108	5.9	216	10/12/2013	23:00	71.96902	-162.73171	5.7	228
10/12/2013	0:00	71.70539	-161.23911	4.8	171	10/12/2013	11:30	72.29935	-160.86051	5.4	180	10/12/2013	23:30	71.96934	-162.84013	4	286
10/12/2013	0:30	71.70832	-161.34832	5.2	222	10/12/2013	12:00	72.25861	-160.82524	5.3	143	10/13/2013	0:00	71.94732	-162.95192	5.1	269
10/12/2013	1:00	71.70332	-161.45677	5.3	301	10/12/2013	12:30	72.22188	-160.74142	5.4	146	10/13/2013	0:30	71.95520	-163.07459	6.1	234
10/12/2013	1:30	71.68556	-161.55993	5.3	301	10/12/2013	13:00	72.18602	-160.65610	5.6	140	10/13/2013	1:00	71.93574	-163.19470	4.8	284
10/12/2013	2:00	71.71696	-161.64300	5.8	359	10/12/2013	13:30	72.15058	-160.56728	4.9	146	10/13/2013	1:30	71.93102	-163.31141	6.1	229
10/12/2013	2:30	71.76606	-161.64675	6	357	10/12/2013	14:00	72.10987	-160.56802	6	263	10/13/2013	2:00	71.92100	-163.43163	5	284
10/12/2013	3:00	71.81480	-161.65090	5.9	358	10/12/2013	14:30	72.10360	-160.71739	5.2	286	10/13/2013	2:30	71.90773	-163.55316	6.3	224
10/12/2013	3:30	71.86326	-161.65505	5.8	358	10/12/2013	15:00	72.08690	-160.81984	5.2	232	10/13/2013	3:00	71.91103	-163.66810	3.9	285

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	29 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/13/2013	3:30	71.88894	-163.78753	5.1	284	10/13/2013	15:00	71.61471	-162.78008	4.9	47	10/14/2013	2:30	71.69478	-161.50369	4	79
10/13/2013	4:00	71.89073	-163.91109	6.3	230	10/13/2013	15:30	71.61540	-162.66065	5.2	106	10/14/2013	3:00	71.70287	-161.40014	4.4	80
10/13/2013	4:30	71.87794	-164.03199	4.8	289	10/13/2013	16:00	71.63131	-162.55028	4.7	55	10/14/2013	3:30	71.71023	-161.29882	4.1	85
10/13/2013	5:00	71.85950	-164.15619	5.7	262	10/13/2013	16:30	71.63137	-162.43302	5.3	112	10/14/2013	4:00	71.71741	-161.19895	3.8	83
10/13/2013	5:30	71.86681	-164.27960	3.9	275	10/13/2013	17:00	71.64429	-162.32903	4.7	51	10/14/2013	4:30	71.72397	-161.09820	3.9	86
10/13/2013	6:00	71.83538	-164.36040	5.4	148	10/13/2013	17:30	71.64848	-162.22336	5	112	10/14/2013	5:00	71.70239	-161.13540	6.1	231
10/13/2013	6:30	71.79730	-164.28255	5.4	149	10/13/2013	18:00	71.65618	-162.11773	4.7	52	10/14/2013	5:30	71.67711	-161.27855	6.2	246
10/13/2013	7:00	71.75857	-164.20624	5.5	145	10/13/2013	18:30	71.64976	-162.12949	6.1	232	10/14/2013	6:00	71.65093	-161.41557	5.8	234
10/13/2013	7:30	71.72090	-164.13189	5.4	151	10/13/2013	19:00	71.62658	-162.26340	5.9	241	10/14/2013	6:30	71.62411	-161.55270	5.7	238
10/13/2013	8:00	71.68450	-164.05209	5.4	145	10/13/2013	19:30	71.60852	-162.39849	5.3	277	10/14/2013	7:00	71.59726	-161.68684	5.8	240
10/13/2013	8:30	71.64827	-163.99370	5.4	202	10/13/2013	20:00	71.61319	-162.53460	5.1	277	10/14/2013	7:30	71.57210	-161.82407	6.2	240
10/13/2013	9:00	71.60638	-164.04877	5.6	202	10/13/2013	20:30	71.61314	-162.49891	3.6	75	10/14/2013	8:00	71.55351	-161.97339	6.3	257
10/13/2013	9:30	71.56326	-164.05145	5.3	150	10/13/2013	21:00	71.61564	-162.56349	5.5	256	10/14/2013	8:30	71.53651	-162.11551	5.9	231
10/13/2013	10:00	71.53981	-163.94347	5.1	111	10/13/2013	21:30	71.62679	-162.60723	4.4	131	10/14/2013	9:00	71.50867	-162.23859	5.8	237
10/13/2013	10:30	71.53224	-163.82021	4.7	91	10/13/2013	22:00	71.62783	-162.51413	4.4	54	10/14/2013	9:30	71.48084	-162.36154	5.7	236
10/13/2013	11:00	71.53881	-163.70118	4.5	76	10/13/2013	22:30	71.63479	-162.40824	6.1	103	10/14/2013	10:00	71.45286	-162.48553	6.1	240
10/13/2013	11:30	71.55633	-163.60224	5	90	10/13/2013	23:00	71.65141	-162.28322	5.8	49	10/14/2013	10:30	71.46645	-162.45767	2.5	48
10/13/2013	12:00	71.55425	-163.48879	4.2	43	10/13/2013	23:30	71.64740	-162.15507	5.1	47	10/14/2013	11:00	71.48803	-162.37836	4.7	48
10/13/2013	12:30	71.57469	-163.40360	5.4	112	10/14/2013	0:00	71.66029	-162.04554	3.9	83	10/14/2013	11:30	71.49393	-162.34945	6.3	244
10/13/2013	13:00	71.57046	-163.28404	4.3	39	10/14/2013	0:30	71.66757	-161.93457	3.6	71	10/14/2013	12:00	71.47310	-162.46049	3.7	235
10/13/2013	13:30	71.58302	-163.17033	7.4	104	10/14/2013	1:00	71.67272	-161.82892	3.8	88	10/14/2013	12:30	71.44993	-162.56289	4.4	253
10/13/2013	14:00	71.59076	-163.00345	5.3	47	10/14/2013	1:30	71.67896	-161.71798	3.7	84	10/14/2013	13:00	71.42474	-162.68950	5.8	240
10/13/2013	14:30	71.60383	-162.88574	5.3	114	10/14/2013	2:00	71.68593	-161.61039	5.2	72	10/14/2013	13:30	71.40356	-162.78834	5.7	240

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	30 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/14/2013	14:00	71.37983	-162.89706	5.7	240	10/15/2013	2:00	71.02789	-163.54093	4	51	10/15/2013	13:30	70.98444	-163.35187	5.2	358
10/14/2013	14:30	71.35670	-163.00589	5.4	241	10/15/2013	2:30	71.04948	-163.45918	3.4	55	10/15/2013	14:00	71.03622	-163.32763	7.5	16
10/14/2013	15:00	71.33160	-163.12583	5.6	243	10/15/2013	3:00	71.06914	-163.38596	3.9	46	10/15/2013	14:30	71.09231	-163.26814	5	25
10/14/2013	15:30	71.30513	-163.24293	5.4	229	10/15/2013	3:30	71.08966	-163.31441	3.4	48	10/15/2013	15:00	71.13464	-163.17095	4.9	346
10/14/2013	16:00	71.27541	-163.35184	5.4	226	10/15/2013	4:00	71.10875	-163.24546	2.6	37	10/15/2013	15:30	71.16346	-163.13211	5.2	63
10/14/2013	17:00	71.21315	-163.56255	5.3	226	10/15/2013	4:30	71.13147	-163.20457	3.7	13	10/15/2013	16:00	71.19174	-163.05523	5.1	11
10/14/2013	17:30	71.23184	-163.49636	4	46	10/15/2013	5:00	71.14972	-163.14950	3.8	76	10/15/2013	16:30	71.23106	-163.03193	4.9	11
10/14/2013	18:00	71.25890	-163.41540	4.6	47	10/15/2013	5:30	71.17088	-163.12202	3.1	7	10/15/2013	17:00	71.25153	-162.92982	5	12
10/14/2013	18:30	71.28545	-163.33420	4.5	50	10/15/2013	6:00	71.17855	-163.10547	5.2	180	10/15/2013	17:30	71.28929	-162.90153	4.8	16
10/14/2013	19:00	71.28277	-163.33892	6.1	233	10/15/2013	6:30	71.13768	-163.13305	5.2	210	10/15/2013	18:00	71.31976	-162.81035	5.6	58
10/14/2013	19:30	71.25013	-163.45655	5.8	225	10/15/2013	7:00	71.10149	-163.20216	5.8	217	10/15/2013	18:30	71.35515	-162.76293	4.9	3
10/14/2013	20:00	71.21684	-163.57359	5.9	226	10/15/2013	7:30	71.06571	-163.27637	5.3	212	10/15/2013	19:00	71.38591	-162.68617	5.3	55
10/14/2013	20:30	71.18138	-163.68422	6.2	224	10/15/2013	8:00	71.05281	-163.32387	3.3	2	10/15/2013	19:30	71.41839	-162.61359	4.9	3
10/14/2013	21:00	71.14600	-163.79653	6	229	10/15/2013	8:30	71.06394	-163.33600	4.7	83	10/15/2013	20:00	71.45126	-162.55539	5	53
10/14/2013	21:30	71.11121	-163.90791	6.3	229	10/15/2013	9:00	71.07490	-163.27710	4.4	40	10/15/2013	20:30	71.48501	-162.50012	5	2
10/14/2013	22:00	71.12027	-163.90564	2.1	36	10/15/2013	9:30	71.10794	-163.26979	3.5	354	10/15/2013	21:00	71.48714	-162.40517	6	127
10/14/2013	22:30	71.13929	-163.86848	3.4	32	10/15/2013	10:00	71.12616	-163.19510	4.3	76	10/15/2013	21:30	71.50896	-162.33626	4	38
10/14/2013	23:00	71.15966	-163.83003	3.1	24	10/15/2013	10:30	71.15635	-163.17874	4.1	359	10/15/2013	22:00	71.51260	-162.25575	5.3	137
10/14/2013	23:30	71.16780	-163.78684	5.5	168	10/15/2013	11:00	71.13508	-163.13247	5.2	177	10/15/2013	22:30	71.48224	-162.16169	5.2	134
10/15/2013	0:00	71.12392	-163.75392	6.3	164	10/15/2013	11:30	71.09168	-163.12721	5.1	173	10/15/2013	23:00	71.45216	-162.06600	5.4	133
10/15/2013	0:30	71.08069	-163.72071	5.5	162	10/15/2013	12:00	71.05288	-163.17004	5.1	212	10/15/2013	23:30	71.42236	-161.96745	5.2	134
10/15/2013	1:00	71.03616	-163.68877	5.6	166	10/15/2013	12:30	71.01767	-163.23765	5	213	10/16/2013	0:00	71.39231	-161.86762	5.3	134
10/15/2013	1:30	70.99938	-163.64807	5.5	59	10/15/2013	13:00	70.98238	-163.30935	5.2	213	10/16/2013	0:30	71.36240	-161.76967	5.1	132

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	31 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/16/2013	1:00	71.33171	-161.66796	5.5	135	10/16/2013	12:30	71.17759	-163.73287	5.3	240	10/23/2013	9:30	71.87430	-164.41741	5.8	220
10/16/2013	1:30	71.34485	-161.58685	5.1	118	10/16/2013	13:00	71.17752	-163.85317	5	291	10/23/2013	10:00	71.83496	-164.40277	5.8	147
10/16/2013	2:00	71.34718	-161.51504	3.8	356	10/16/2013	13:30	71.15650	-163.96853	5.3	232	10/23/2013	10:30	71.80125	-164.43405	5.5	234
10/16/2013	2:30	71.34345	-161.51506	4.5	335	10/16/2013	14:00	71.15659	-164.08955	5.6	231	10/23/2013	11:00	71.76565	-164.44188	5.8	167
10/16/2013	3:00	71.33473	-161.59173	4.7	305	10/16/2013	14:30	71.14672	-164.20496	5.2	290	10/23/2013	11:30	71.74420	-164.56566	5.4	244
10/16/2013	3:30	71.32344	-161.68478	5.3	219	10/16/2013	15:00	71.13858	-164.31801	5.3	220	10/23/2013	12:00	71.70748	-164.61946	5.8	182
10/16/2013	4:00	71.32692	-161.80699	4.8	279	10/22/2013	18:30	72.62846	-165.59834	5.1	83	10/23/2013	12:30	71.67874	-164.70905	5.7	180
10/16/2013	4:30	71.30819	-161.90948	4.9	281	10/22/2013	19:00	72.59838	-165.51353	5.7	169	10/23/2013	13:00	71.64494	-164.76565	5.2	251
10/16/2013	5:00	71.31055	-162.03303	5.3	231	10/22/2013	19:30	72.59420	-165.43146	5.6	166	10/23/2013	13:30	71.61248	-164.81055	5.8	171
10/16/2013	5:30	71.29382	-162.14200	4.8	277	10/22/2013	20:00	72.58287	-165.34100	5.6	163	10/23/2013	14:00	71.58998	-164.90014	5.8	172
10/16/2013	6:00	71.29212	-162.25918	5.3	229	10/22/2013	20:30	72.55703	-165.25980	5.5	163	10/23/2013	14:30	71.55575	-164.94541	5.3	245
10/16/2013	6:30	71.27803	-162.37332	5.2	279	10/22/2013	21:00	72.53556	-165.17730	5.5	165	10/23/2013	15:00	71.51877	-164.98078	5.9	174
10/16/2013	7:00	71.27250	-162.49250	5.4	228	10/22/2013	21:30	72.52116	-165.07959	5.5	183	10/23/2013	15:30	71.49304	-165.07845	5.7	178
10/16/2013	7:30	71.26222	-162.60785	4.9	280	10/22/2013	22:00	72.50638	-164.99607	5	115	10/23/2013	16:00	71.45241	-165.10975	5.3	242
10/16/2013	8:00	71.25263	-162.72179	5.3	229	10/22/2013	22:30	72.48723	-164.92126	5.1	82	10/23/2013	16:30	71.42086	-165.18145	5.6	184
10/16/2013	8:30	71.24968	-162.83277	4.8	290	10/22/2013	23:00	72.48015	-164.80832	5.3	163	10/23/2013	17:00	71.39141	-165.25827	5	239
10/16/2013	9:00	71.23259	-162.93871	5.4	229	10/22/2013	23:30	72.46893	-164.70015	5.4	182	10/23/2013	17:30	71.35205	-165.28681	5	236
10/16/2013	9:30	71.23838	-163.05358	5.4	229	10/23/2013	0:00	72.44902	-164.62109	5	89	10/23/2013	18:00	71.32480	-165.38169	5.8	184
10/16/2013	10:00	71.21791	-163.16097	4.5	291	10/23/2013	7:00	71.99076	-164.22668	5.1	2	10/23/2013	18:30	71.28703	-165.42832	5.3	241
10/16/2013	10:30	71.21647	-163.27143	5.3	232	10/23/2013	7:30	71.97974	-164.20576	5.7	183	10/23/2013	19:00	71.25206	-165.48698	5.8	180
10/16/2013	11:00	71.20670	-163.38399	4.9	289	10/23/2013	8:00	71.93285	-164.21066	5.8	182	10/23/2013	19:30	71.22277	-165.56767	5.2	236
10/16/2013	11:30	71.19449	-163.49831	5.3	231	10/23/2013	8:30	71.88518	-164.21494	5.5	195	10/23/2013	20:00	71.18190	-165.59450	5.2	239
10/16/2013	12:00	71.19748	-163.61295	4.9	294	10/23/2013	9:00	71.90634	-164.30550	5.5	257	10/23/2013	20:30	71.15452	-165.68396	5.6	172

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PROTECTED SPECIES LOCATION AND EFFORT

Vessel Speed and Heading

Regulatory Reference Number	13-02	**Vessel Name**	*Norseman*
Project Number	UMS04183	**Effort Page Number**	32 of 35

GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/23/2013	21:00	71.12471	-165.74196	4.8	246	10/24/2013	9:00	70.38900	-167.00858	4.1	249	10/25/2013	1:00	70.74969	-168.37425	5.4	48
10/23/2013	21:30	71.08752	-165.76818	5.2	237	10/24/2013	10:00	70.33687	-167.08431	4.2	256	10/25/2013	1:30	70.75180	-168.25576	5.4	92
10/23/2013	22:00	71.06009	-165.85144	5.6	170	10/24/2013	11:00	70.28710	-167.18595	4.2	244	10/25/2013	2:00	70.78208	-168.16346	5	47
10/23/2013	22:30	71.02763	-165.90277	5	239	10/24/2013	11:30	70.26514	-167.22829	5.6	145	10/25/2013	2:30	70.77717	-168.05140	5	51
10/23/2013	23:00	70.99184	-165.93519	5.6	169	10/24/2013	12:00	70.23665	-167.22310	3.5	255	10/25/2013	3:00	70.79601	-167.94817	5.1	110
10/23/2013	23:30	70.96696	-166.03655	5.4	179	10/24/2013	12:30	70.22401	-167.30098	5	180	10/25/2013	3:30	70.80213	-167.84374	5	49
10/24/2013	0:00	70.93293	-166.09159	5	236	10/24/2013	14:00	70.29088	-167.22051	5.7	307	10/25/2013	4:00	70.81324	-167.73744	5	97
10/24/2013	0:30	70.89261	-166.11880	5.1	235	10/24/2013	14:30	70.31940	-167.33191	4.7	305	10/25/2013	4:30	70.82974	-167.62806	5.5	43
10/24/2013	1:00	70.86568	-166.20966	5.6	181	10/24/2013	15:00	70.34670	-167.44197	6	305	10/25/2013	5:00	70.83305	-167.50852	5.1	96
10/24/2013	1:30	70.82902	-166.24988	5.1	239	10/24/2013	15:30	70.37573	-167.55401	5.6	307	10/25/2013	5:30	70.85274	-167.40110	5	56
10/24/2013	2:00	70.79392	-166.29727	5.4	178	10/24/2013	16:00	70.40516	-167.67148	5.1	307	10/25/2013	6:00	70.85822	-167.28692	4.3	103
10/24/2013	2:30	70.76574	-166.37450	5.1	239	10/24/2013	16:30	70.42862	-167.76393	5.4	306	10/25/2013	6:30	70.87267	-167.19049	4.1	56
10/24/2013	3:00	70.72644	-166.39867	5.3	180	10/24/2013	17:00	70.45269	-167.85965	5.3	306	10/25/2013	7:00	70.88405	-167.08668	4.7	92
10/24/2013	3:30	70.70221	-166.48975	5.2	180	10/24/2013	17:30	70.47631	-167.95799	4.6	299	10/25/2013	7:30	70.88913	-166.96376	4.2	46
10/24/2013	4:00	70.66626	-166.52326	4.9	243	10/24/2013	18:00	70.50074	-168.05523	4.8	307	10/25/2013	8:00	70.91280	-166.85509	6.6	50
10/24/2013	4:30	70.63495	-166.57580	5	180	10/24/2013	18:30	70.52673	-168.14943	5.3	310	10/25/2013	8:30	70.91521	-166.74037	3.5	112
10/24/2013	5:00	70.60912	-166.64691	4.5	238	10/24/2013	19:00	70.55094	-168.23797	4.4	312	10/25/2013	9:00	70.92031	-166.65036	3.4	60
10/24/2013	5:30	70.57074	-166.66551	4.8	230	10/24/2013	22:00	70.68932	-168.84108	5.7	303	10/25/2013	9:30	70.93930	-166.55138	5.1	60
10/24/2013	6:00	70.54540	-166.75803	4.9	232	10/24/2013	22:30	70.69589	-168.81815	5.4	165	10/25/2013	10:00	70.95064	-166.42434	6.1	95
10/24/2013	7:00	70.48330	-166.80775	4.7	215	10/24/2013	23:00	70.70964	-168.78562	5.3	129	10/25/2013	10:30	70.95533	-166.29464	6	62
10/24/2013	7:30	70.46204	-166.87693	5.4	155	10/24/2013	23:30	70.71922	-168.70041	5.2	34	10/25/2013	11:00	70.97730	-166.16898	5.3	62
10/24/2013	8:00	70.43884	-166.92671	4.2	252	10/25/2013	0:00	70.71940	-168.58658	5	44	10/25/2013	11:30	70.97372	-166.03920	6.4	59
10/24/2013	8:30	70.41082	-166.95049	5.3	158	10/25/2013	0:30	70.74076	-168.48610	5.5	108	10/25/2013	12:00	70.99907	-165.93516	4.1	113

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10/25/2013	12:30	70.99220	-165.84702	3.6	79	10/26/2013	0:00	71.07320	-163.50736	5.4	158	10/26/2013	12:00	71.30544	-164.99694	5.3	339
10/25/2013	13:00	71.01875	-165.75725	5.4	41	10/26/2013	0:30	71.03331	-163.45567	3.9	153	10/26/2013	12:30	71.31327	-165.12304	5.6	269
10/25/2013	13:30	71.01093	-165.63012	5.7	47	10/26/2013	1:00	71.00250	-163.40397	4.2	146	10/26/2013	13:00	71.34690	-165.19619	5.3	263
10/25/2013	14:00	71.03483	-165.51394	5.8	112	10/26/2013	1:30	70.97167	-163.35597	4.6	151	10/26/2013	13:30	71.35761	-165.31816	5.2	330
10/25/2013	14:30	71.04796	-165.39182	5.9	42	10/26/2013	2:00	70.98704	-163.30085	4.8	34	10/26/2013	14:00	71.37717	-165.42151	5.5	272
10/25/2013	15:00	71.04799	-165.29197	3.6	102	10/26/2013	2:30	70.96325	-163.32106	3.6	14	10/26/2013	14:30	71.40344	-165.51529	5.3	330
10/25/2013	15:30	71.05209	-165.19561	4	62	10/26/2013	3:30	70.97489	-163.34660	5.6	221	10/26/2013	15:00	71.41086	-165.64895	5.4	311
10/25/2013	16:00	71.06963	-165.10393	4.1	54	10/26/2013	4:00	70.99054	-163.40841	5.9	257	10/26/2013	15:30	71.43658	-165.73740	5.3	266
10/25/2013	16:30	71.07727	-165.01207	4.7	97	10/26/2013	4:30	71.00939	-163.50981	5	323	10/26/2013	16:00	71.45990	-165.82881	5.2	332
10/25/2013	17:00	71.07886	-164.87573	6.2	72	10/26/2013	5:00	71.02166	-163.62977	5.8	267	10/26/2013	16:30	71.46995	-165.94729	5.2	334
10/25/2013	17:30	71.09934	-164.75537	5.4	112	10/26/2013	5:30	71.05483	-163.70463	5.4	294	10/26/2013	17:00	71.48998	-166.04519	5.3	272
10/25/2013	18:00	71.10145	-164.63077	6.2	45	10/26/2013	6:00	71.06701	-163.81683	4.7	335	10/26/2013	17:30	71.51500	-166.13784	5.2	331
10/25/2013	18:30	71.12021	-164.50570	6.2	120	10/26/2013	6:30	71.08146	-163.92740	5.9	272	10/26/2013	18:00	71.52377	-166.26593	5.3	332
10/25/2013	19:00	71.13460	-164.40059	4.3	119	10/26/2013	7:00	71.10702	-164.01193	5.8	270	10/26/2013	18:30	71.55050	-166.35886	5.5	271
10/25/2013	19:30	71.13733	-164.31543	4.8	36	10/26/2013	7:30	71.13053	-164.10728	4.8	332	10/26/2013	19:00	71.56804	-166.46978	5.2	330
10/25/2013	20:00	71.14189	-164.22637	4.1	107	10/26/2013	8:00	71.14333	-164.22551	5	328	10/26/2013	19:30	71.58392	-166.58171	5.5	271
10/25/2013	20:30	71.15602	-164.11818	6.4	54	10/26/2013	8:30	71.16637	-164.32121	5.6	271	10/26/2013	20:00	71.59945	-166.65804	5.1	215
10/25/2013	21:00	71.15854	-163.98553	4.2	103	10/26/2013	9:00	71.19041	-164.41293	4.9	334	10/26/2013	20:30	71.57597	-166.62055	4.4	119
10/25/2013	21:30	71.16728	-163.88634	3.1	114	10/26/2013	9:30	71.19536	-164.53062	5.2	329	10/26/2013	21:00	71.55664	-166.52119	4.5	123
10/25/2013	22:00	71.16880	-163.79122	3.5	80	10/26/2013	10:00	71.23058	-164.60206	5.3	271	10/26/2013	21:30	71.53689	-166.41875	4.6	121
10/25/2013	22:30	71.17652	-163.68105	4.4	75	10/26/2013	10:30	71.24345	-164.71834	5.2	331	10/26/2013	22:00	71.51845	-166.31521	4.5	115
10/25/2013	23:00	71.15605	-163.61201	5.4	155	10/26/2013	11:00	71.26138	-164.82538	5.4	274	10/26/2013	22:30	71.50137	-166.21127	3.5	114
10/25/2013	23:30	71.11513	-163.55875	5.8	159	10/26/2013	11:30	71.28632	-164.90653	5.4	260	10/26/2013	23:00	71.48467	-166.11314	3.8	119

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10/26/2013	23:30	71.49738	-166.05102	4.8	212	10/27/2013	11:00	72.05516	-166.61113	5.9	37	10/27/2013	22:30	71.51287	-165.60714	5.3	77
10/27/2013	0:00	71.49139	-166.13729	5.6	307	10/27/2013	11:30	72.08749	-166.51787	5.7	26	10/27/2013	23:00	71.51330	-165.60563	5.5	78
10/27/2013	0:30	71.52169	-166.23956	5.4	333	10/27/2013	12:00	72.08869	-166.40132	5.6	150	10/27/2013	23:30	71.47873	-165.58240	5.5	170
10/27/2013	1:00	71.54414	-166.33959	5.4	269	10/27/2013	12:30	72.08269	-166.27401	5.3	80	10/28/2013	0:00	71.43676	-165.57202	5.2	143
10/27/2013	1:30	71.56677	-166.43612	4.9	333	10/27/2013	13:00	72.07519	-166.14307	5.2	132	10/28/2013	0:30	71.40085	-165.52001	5.4	201
10/27/2013	2:00	71.57504	-166.56550	5.3	324	10/27/2013	13:30	72.04645	-166.03634	5.2	130	10/28/2013	1:00	71.36832	-165.49829	5	122
10/27/2013	2:30	71.60427	-166.65398	5.7	273	10/27/2013	14:00	72.01046	-165.96210	5.4	171	10/28/2013	1:30	71.33156	-165.50709	5	122
10/27/2013	3:00	71.62102	-166.76970	5.3	328	10/27/2013	14:30	71.96690	-165.93518	4.1	167	10/28/2013	2:00	71.30001	-165.45521	5	130
10/27/2013	3:30	71.63702	-166.88627	5.6	274	10/27/2013	15:00	71.92896	-165.92179	5.1	192	10/28/2013	2:30	71.26211	-165.46441	5.1	149
10/27/2013	4:00	71.66520	-166.97786	5.5	269	10/27/2013	15:30	71.90341	-165.98850	6	246	10/28/2013	3:00	71.22696	-165.39943	5	202
10/27/2013	4:30	71.67758	-167.10620	5.1	334	10/27/2013	16:00	71.88356	-165.90129	6.3	100	10/28/2013	3:30	71.18877	-165.39250	5.5	139
10/27/2013	5:00	71.70143	-167.21234	5.5	277	10/27/2013	16:30	71.84107	-165.90278	6.1	233	10/28/2013	4:00	71.15106	-165.37388	5.1	199
10/27/2013	5:30	71.72078	-167.31508	5.1	339	10/27/2013	17:00	71.81258	-166.00545	5.8	161	10/28/2013	4:30	71.11628	-165.32058	5.1	136
10/27/2013	6:00	71.73605	-167.42165	5.3	339	10/27/2013	17:30	71.78316	-166.02654	5.2	264	10/28/2013	5:00	71.07844	-165.34233	5	146
10/27/2013	6:30	71.76883	-167.42013	4.1	57	10/27/2013	18:00	71.75258	-166.09199	5	187	10/28/2013	5:30	71.04535	-165.28155	5.2	192
10/27/2013	7:00	71.79010	-167.31101	5	53	10/27/2013	18:30	71.71325	-166.02904	5.2	154	10/28/2013	6:00	71.00408	-165.28305	5.4	150
10/27/2013	7:30	71.81261	-167.20020	3.9	53	10/27/2013	19:00	71.67022	-165.93896	7.7	121	10/28/2013	6:30	70.96605	-165.22305	5.2	203
10/27/2013	8:00	71.83347	-167.09202	4.5	59	10/27/2013	19:30	71.63281	-165.84537	4.9	145	10/28/2013	7:00	70.92782	-165.22481	5.3	137
10/27/2013	8:30	71.86558	-167.01358	4.3	27	10/27/2013	20:00	71.58914	-165.74408	5.6	145	10/28/2013	7:30	70.89130	-165.20169	5.3	200
10/27/2013	9:00	71.90265	-166.94402	5.4	34	10/27/2013	20:30	71.55470	-165.66806	5.1	144	10/28/2013	8:00	70.85578	-165.14830	5.5	139
10/27/2013	9:30	71.94055	-166.86687	5.4	30	10/27/2013	21:00	71.57732	-165.63927	6	262	10/28/2013	8:30	70.81714	-165.17267	5.2	136
10/27/2013	10:00	71.97822	-166.78639	5.5	36	10/27/2013	21:30	71.54141	-165.66180	5.2	169	10/28/2013	9:00	70.78462	-165.10601	4.7	196
10/27/2013	10:30	72.01578	-166.70185	5.8	35	10/27/2013	22:00	71.52111	-165.58502	5.3	172	10/28/2013	9:30	70.74600	-165.12301	5.5	133

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GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG	GPS Date	UTC Time	Latitude	Longitude	Speed (kts)	HDG
10/28/2013	10:00	70.71018	-165.07412	5.3	195	10/28/2013	14:30	70.39746	-164.88538	4.9	189	10/29/2013	5:00	71.16251	-163.11694	5.5	21
10/28/2013	10:30	70.67167	-165.04061	5.9	136	10/28/2013	15:00	70.36196	-164.86951	5.5	135	10/29/2013	5:30	71.20026	-163.12232	5.5	316
10/28/2013	11:00	70.62791	-165.05038	5.5	193	10/28/2013	15:30	70.32728	-164.84915	5	195	10/29/2013	6:00	71.23799	-163.13049	5.7	24
10/28/2013	11:30	70.59510	-165.00089	5.3	206	10/28/2013	16:00	70.29248	-164.82905	4.7	199	10/29/2013	6:30	71.27333	-163.19138	5.7	22
10/28/2013	12:00	70.56096	-164.96760	5.8	129	10/29/2013	3:00	71.03368	-162.95887	4.7	30	10/29/2013	7:00	71.31333	-163.20444	5.5	340
10/28/2013	12:30	70.52682	-164.95913	5.1	213	10/29/2013	3:30	71.05796	-163.03118	4.6	24	10/29/2013	7:30	71.33821	-163.18619	6.4	139
10/28/2013	13:30	70.46375	-164.92953	3.5	197	10/29/2013	4:00	71.08971	-163.02592	5.1	316						
10/28/2013	14:00	70.43201	-164.89805	4.9	137	10/29/2013	4:30	71.12684	-163.03452	5.5	4						

APPENDIX F: SCREENSHOTS OF ACOUSTIC DETECTIONS

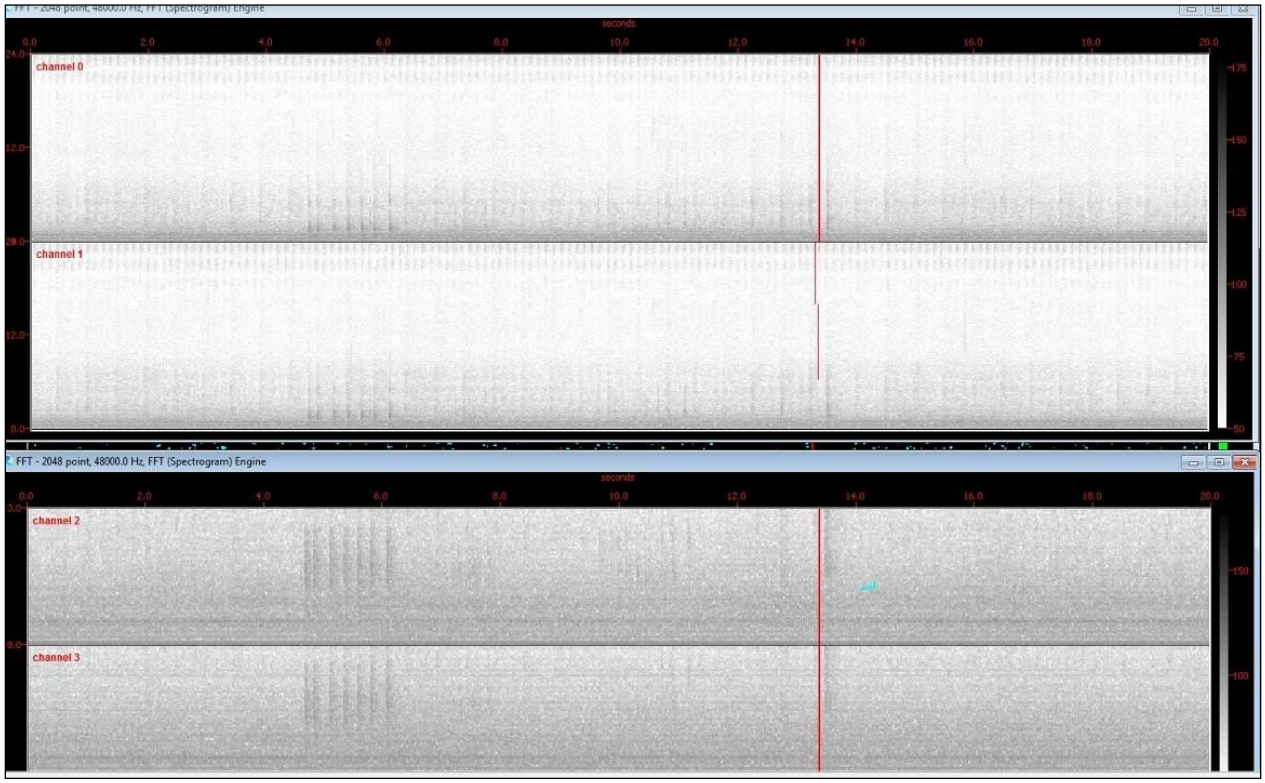

Figure 1. Walrus "knocks" heard on 10 September shown on the low frequency spectrogram (AD 1).

Figure 2. Brief click train from walrus knocks shown on the low frequency click detector (AD 1).

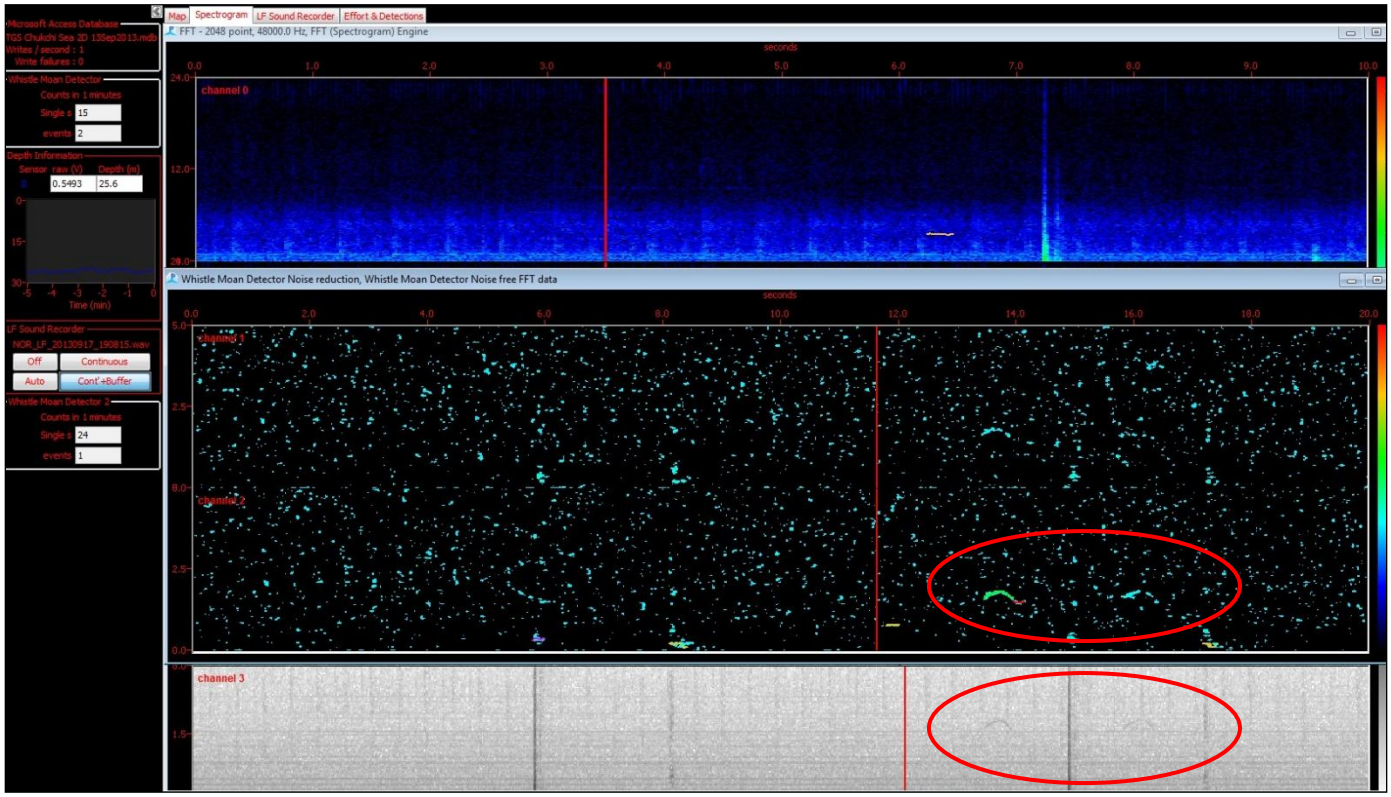

Figure 3: Tonal calls high-lighted on Pamguard's whistle moan detector & visible on the LF spectrogram (AD3).

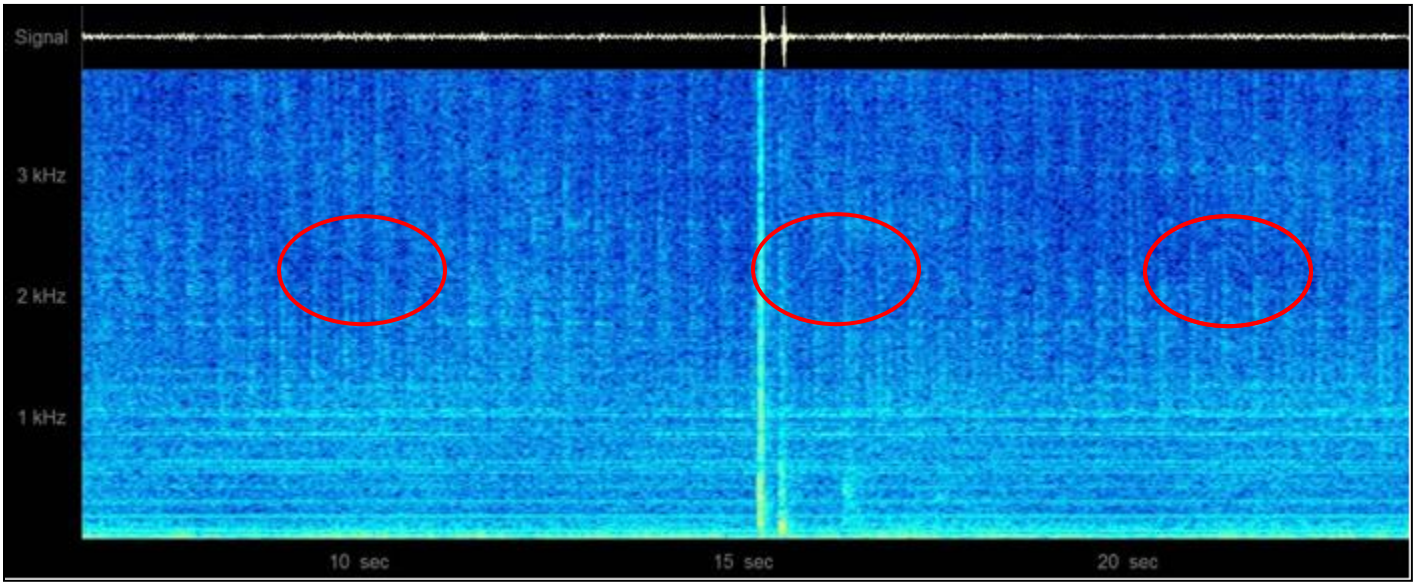

Figure 4: Faint vocalizations from an unidentified baleen whale shown through playback on Spectrogram16 (AD3).

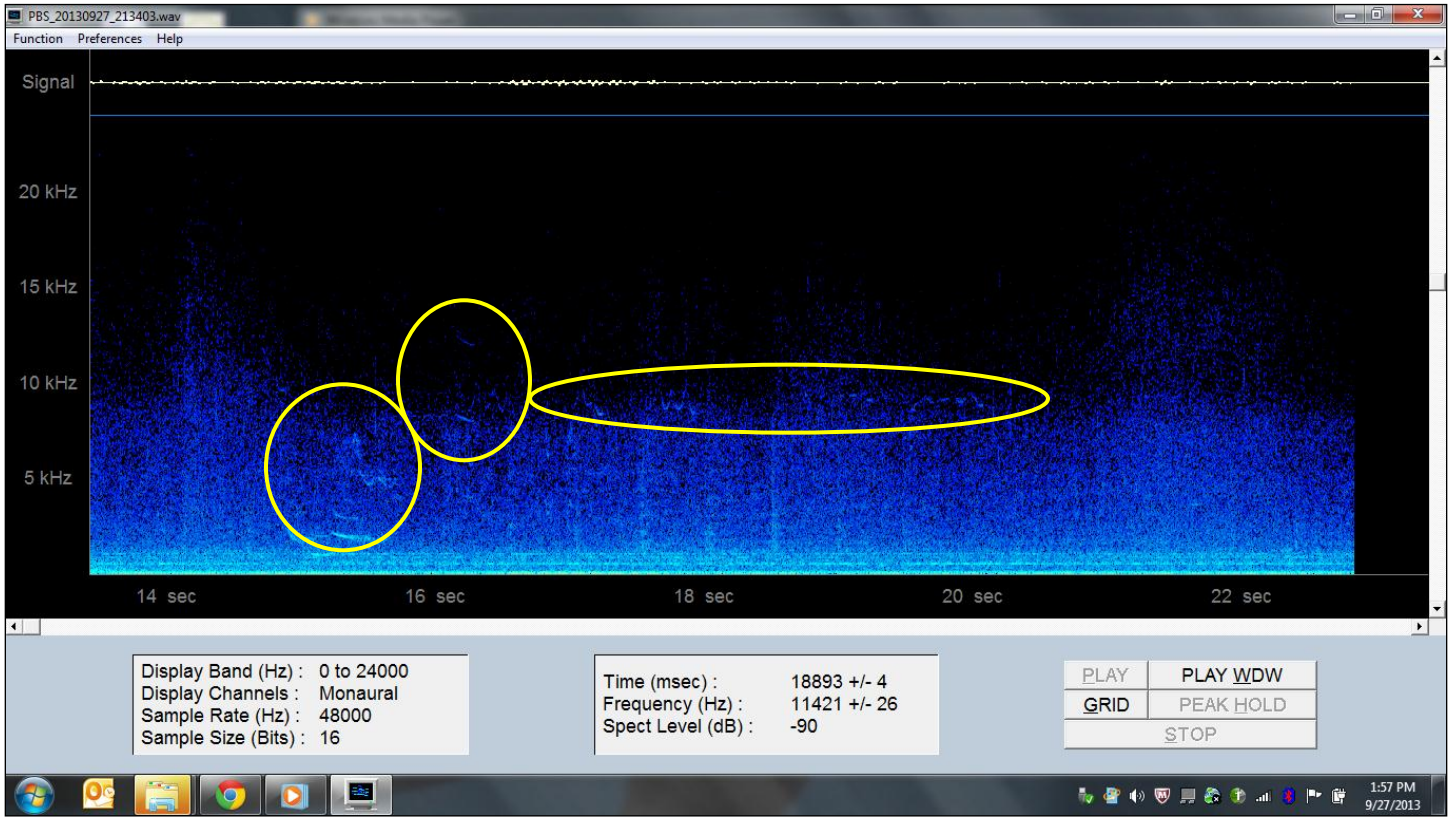

Figure 5. Possible beluga whale vocalizations depicted on Spectrogram 16 (AD6).

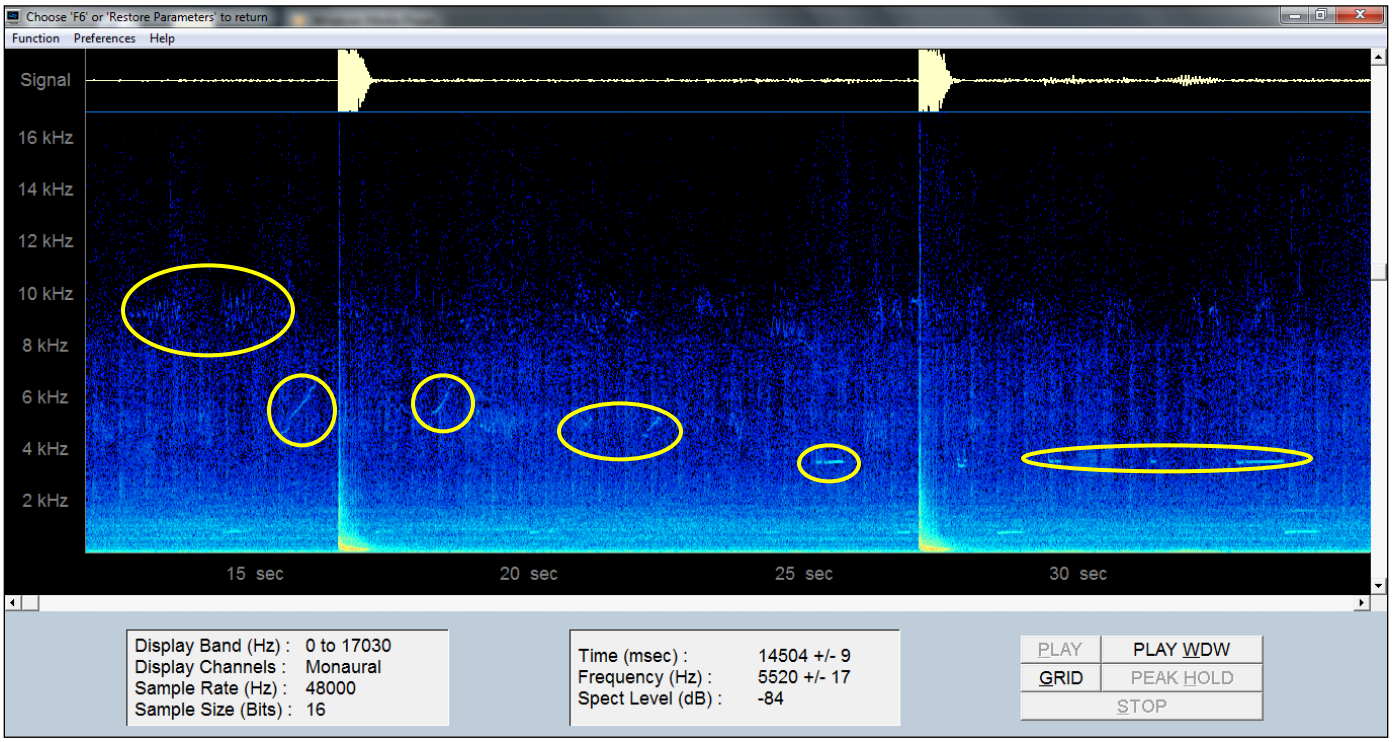

Figure 6. Possible beluga whale vocalizations depicted on Spectrogram 16 (AD7).

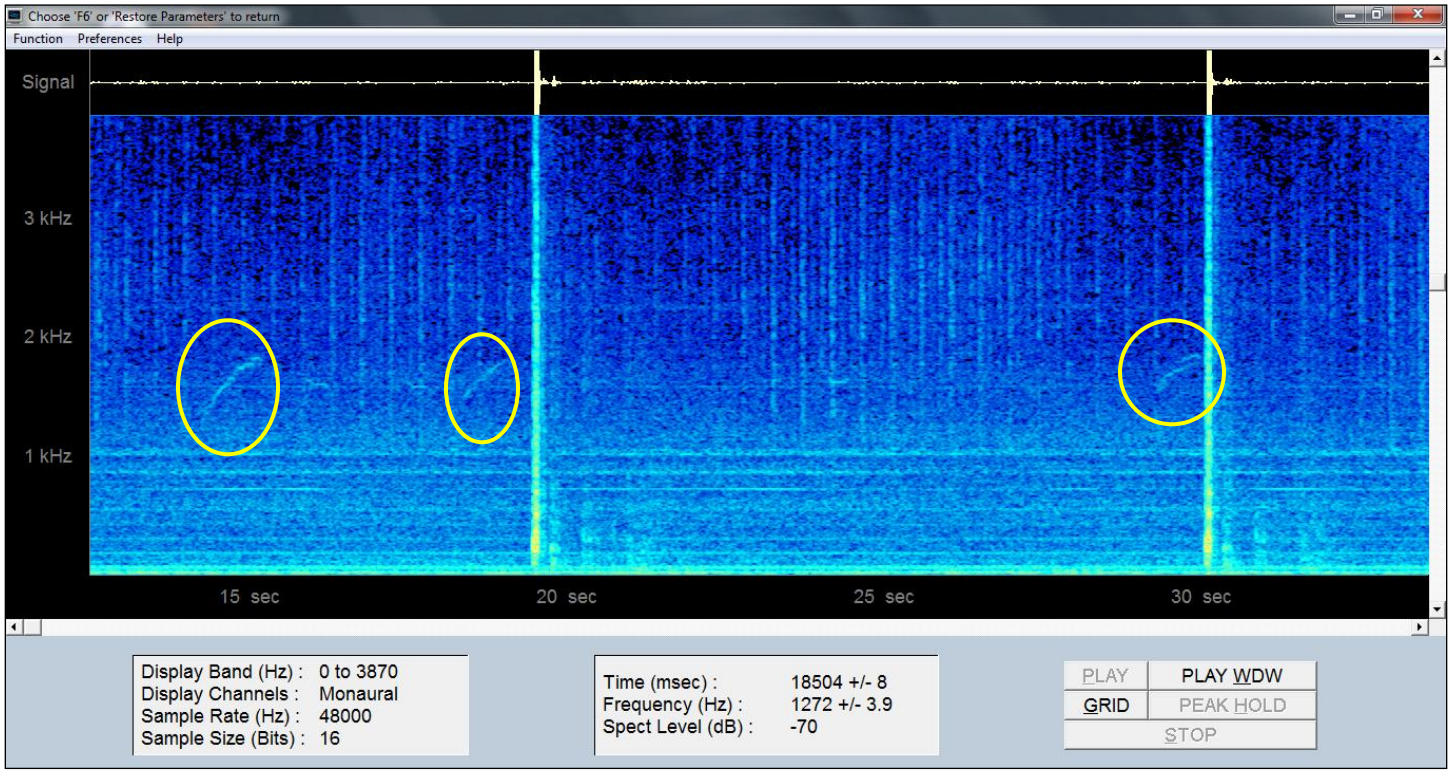

Figure 7. Beluga whale vocalizations depicted on Spectrogram 16 (AD8).

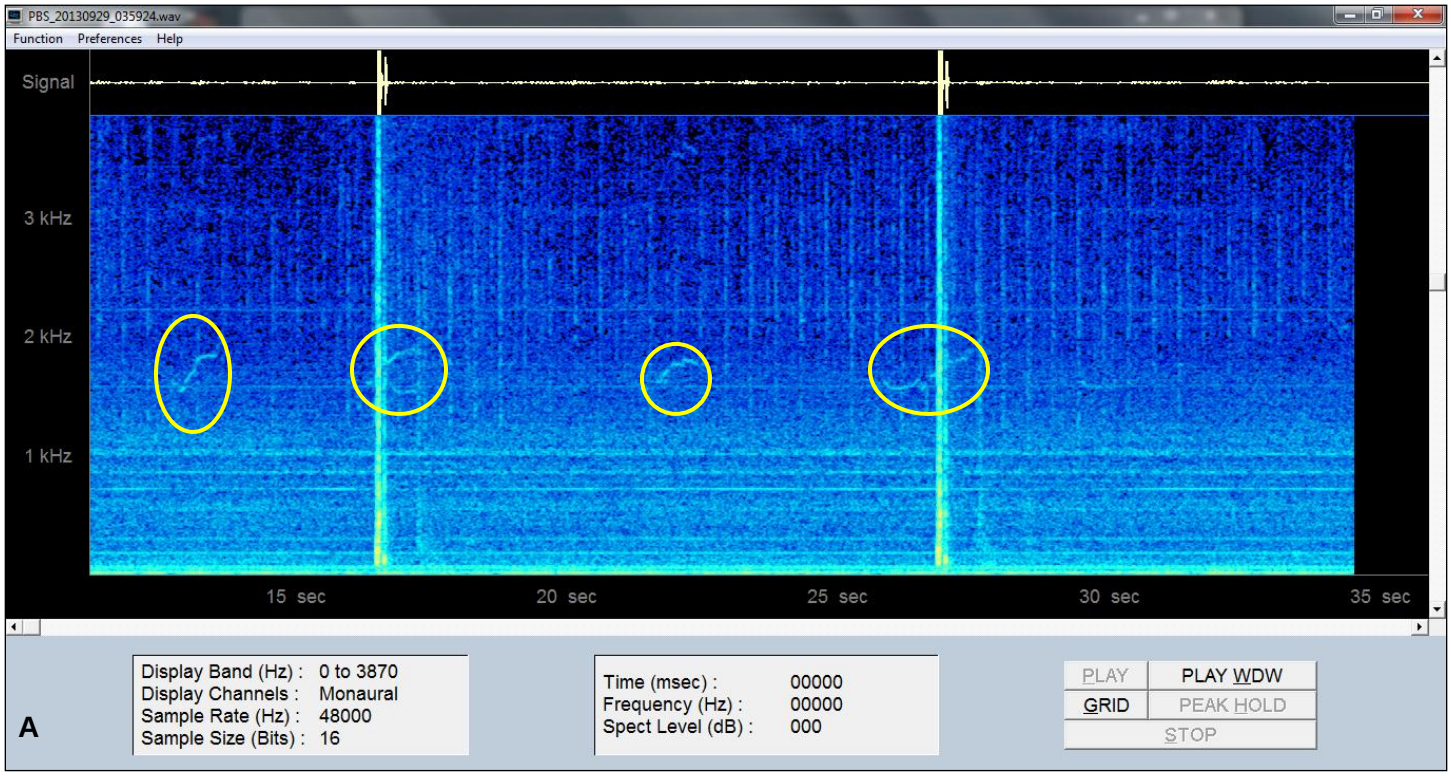

Figure 8. Beluga whale vocalizations depicted on Spectrogram 16 (AD 8)

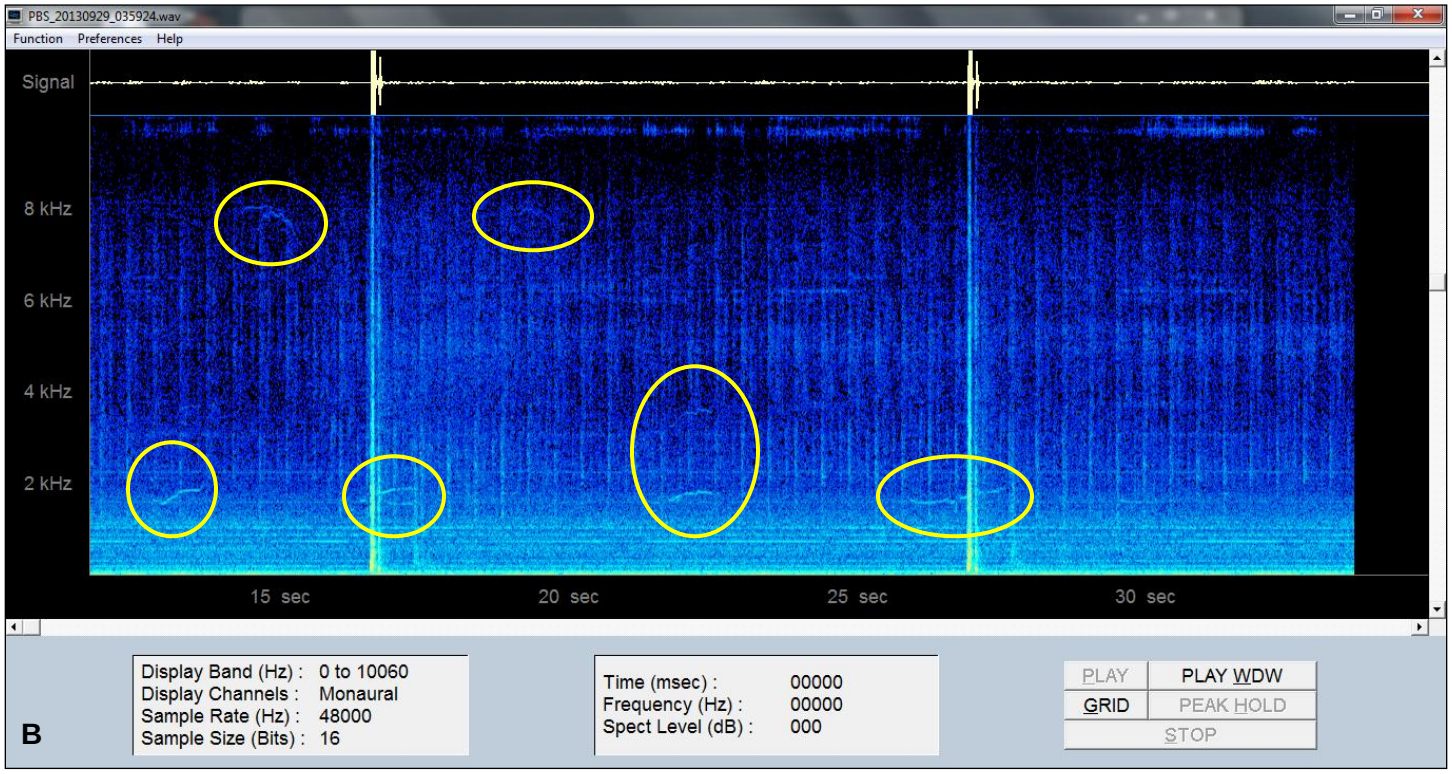

Figure 9. Beluga vocalizations depicted on Spectrogram 16 (AD 8)

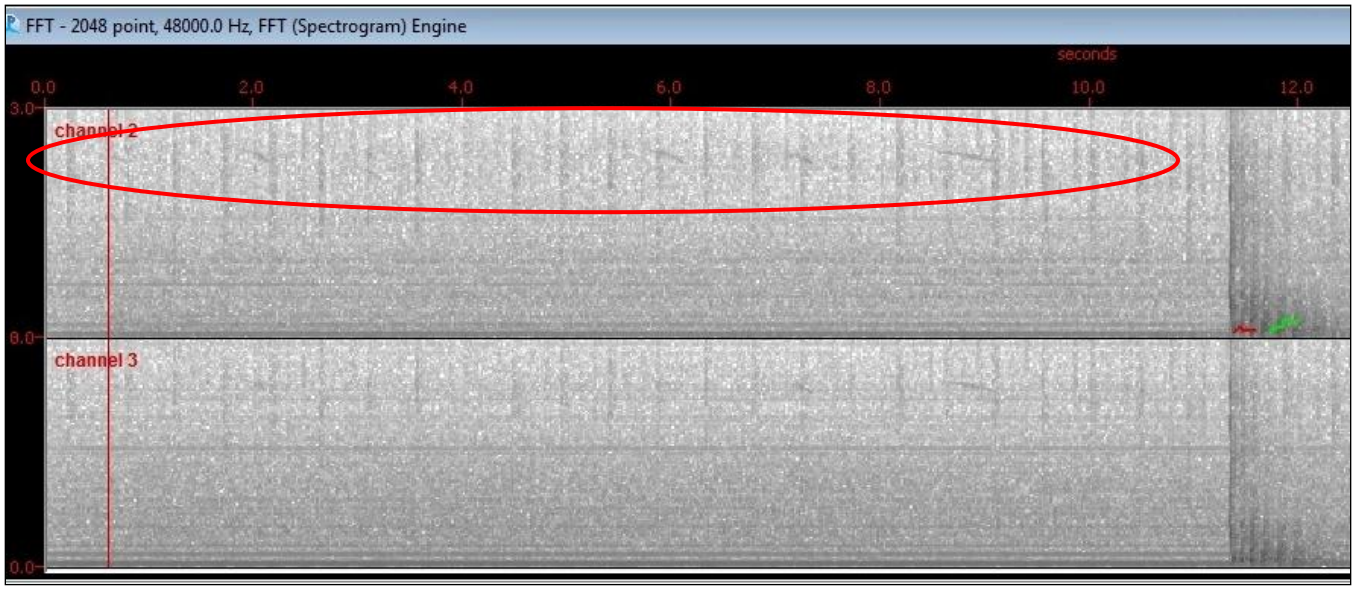

Figure 10. Multiple down-sweeps from approximately 2.5-2.3 kHz observed during acoustic detection 10.

Figure 11. A single concave arc ranging from approximately 2.7-2.9 kHz observed during acoustic detection 11.

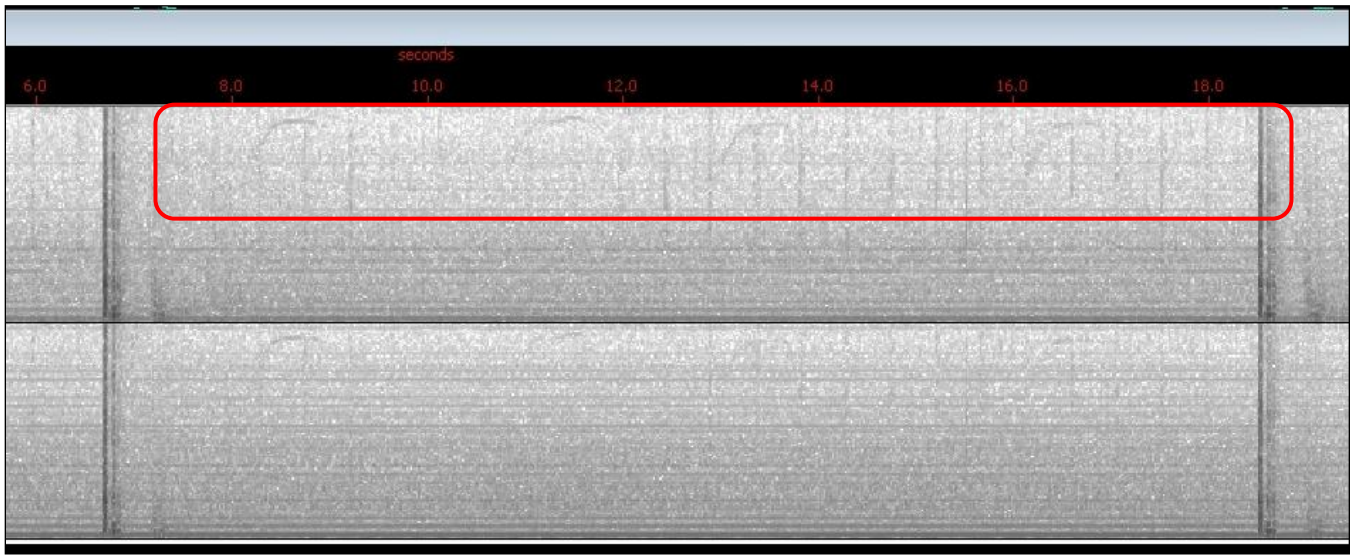

Figure 12. Four upsweeps from approximately 2.2-2.8 kHz observed during acoustic detection 12.

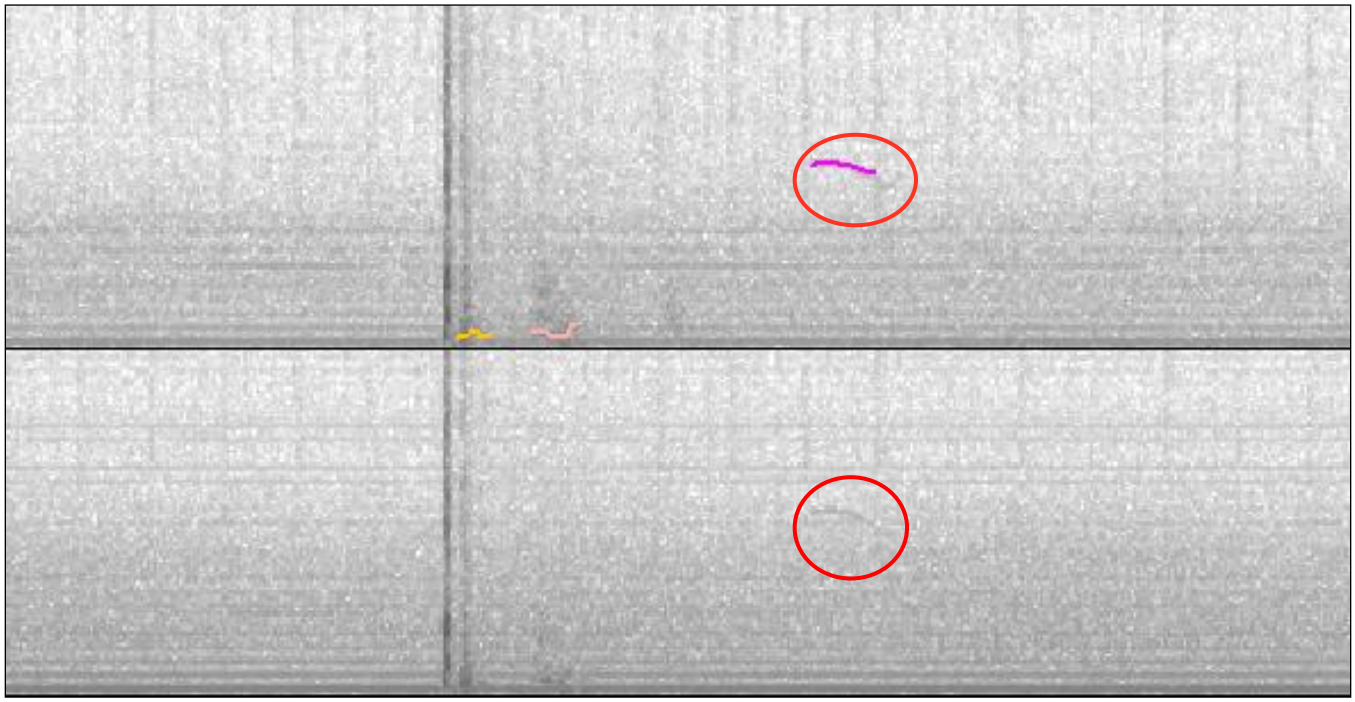

Figure 13. Single down-sweep from acoustic detection 13.

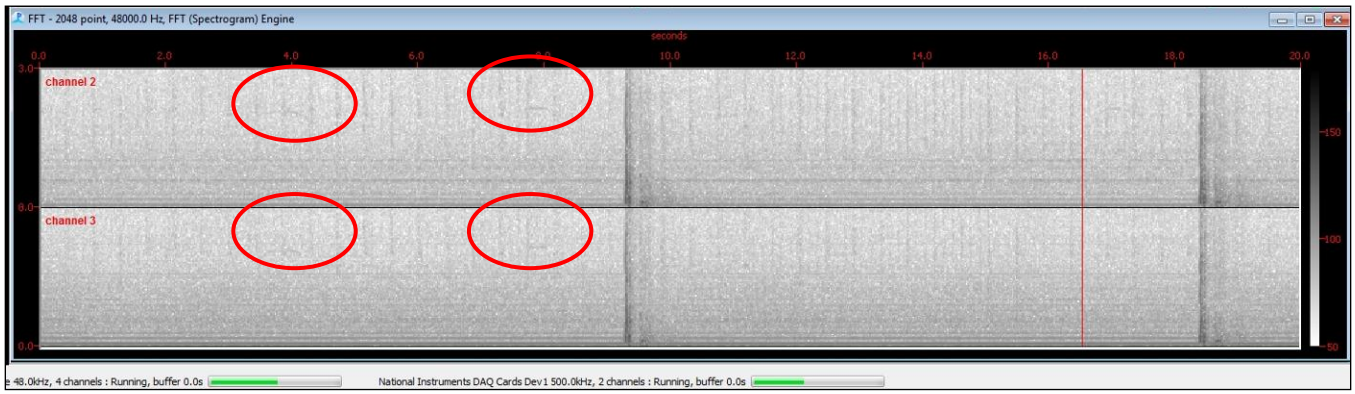

Figure 14. Spectrogram showing low frequency vocalizations near 1.6 to 2.29kHz as viewed through hydrophones 3 & 4 via channels 2 & 3 respectively (AD15) .

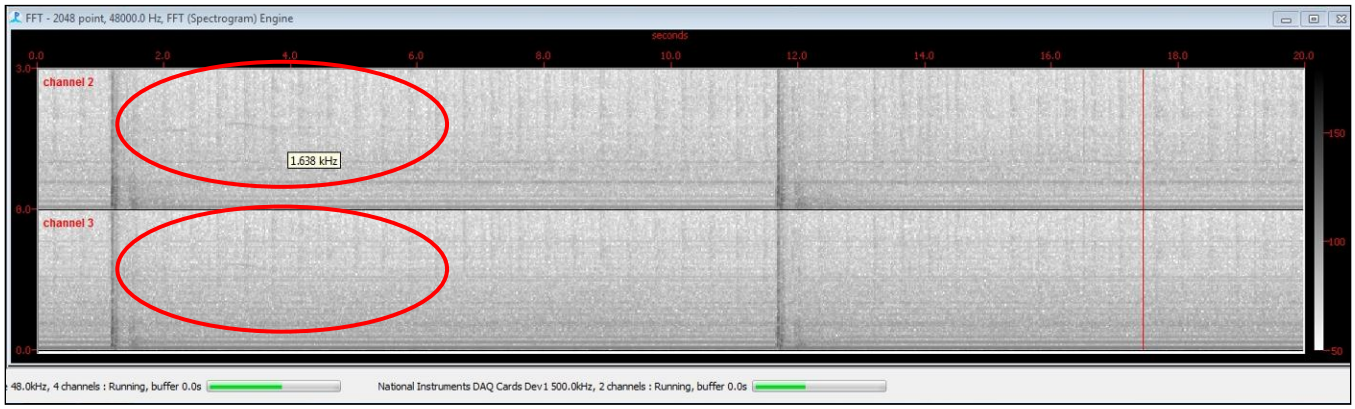

Figure 15. Pamguard spectrogram showing low frequency vocalizations near 1.6 kHz as viewed through hydrophones 3 & 4 via channels 2 & 3 respectively (AD15) .

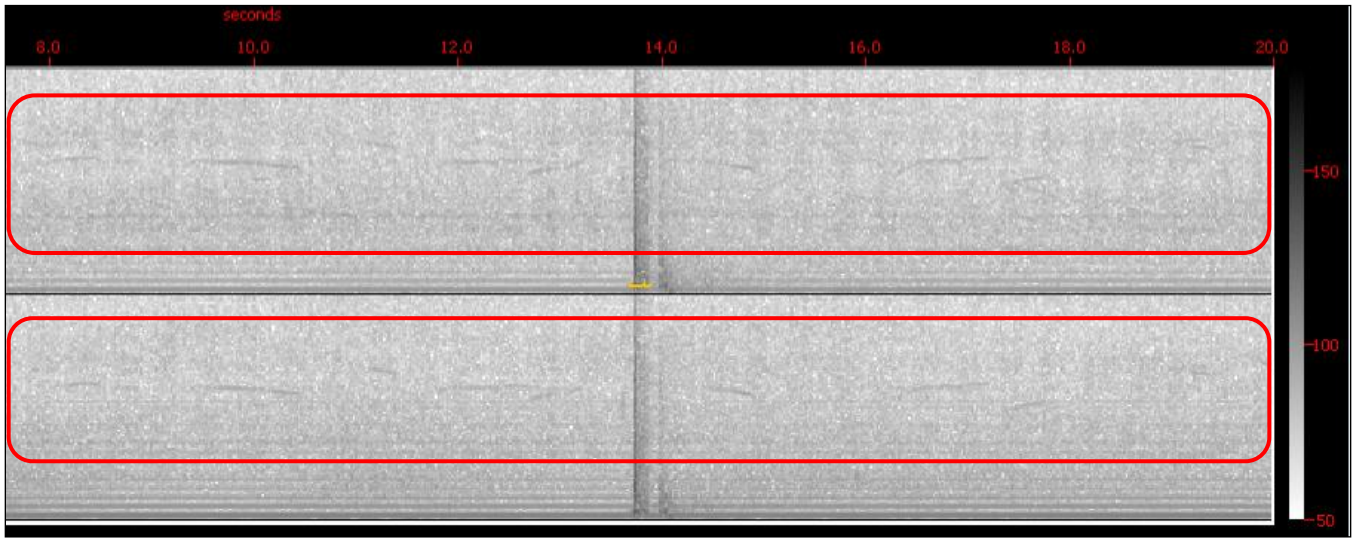

Figure 16. Multiple downsweeps and arc vocalizations during acoustic detection 17.

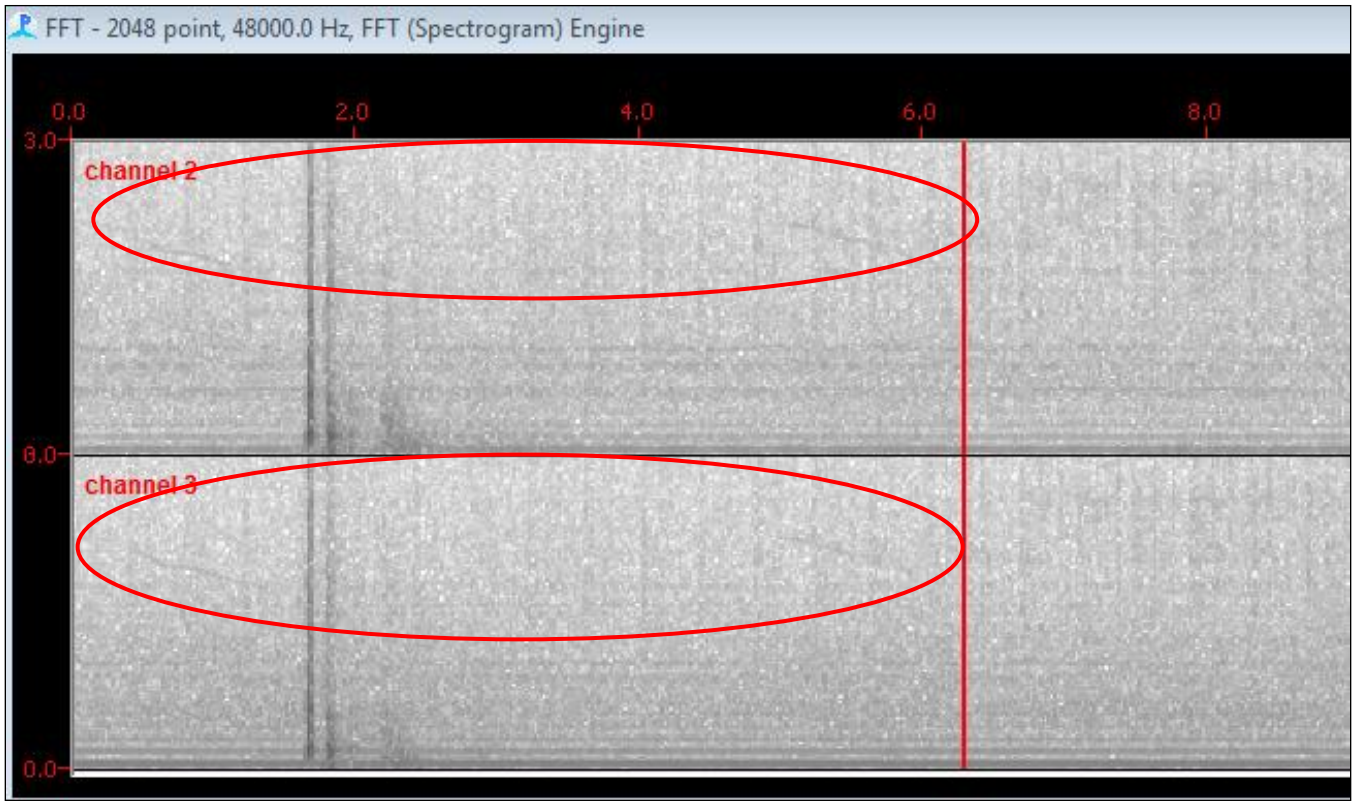

Figure 17. Acoustic detection 18 down-sweeps from 2.4 – 1.8 kHz.

Figure 18. AD19 partially high-lighted in green by Pamguard Whistle Moan Detector

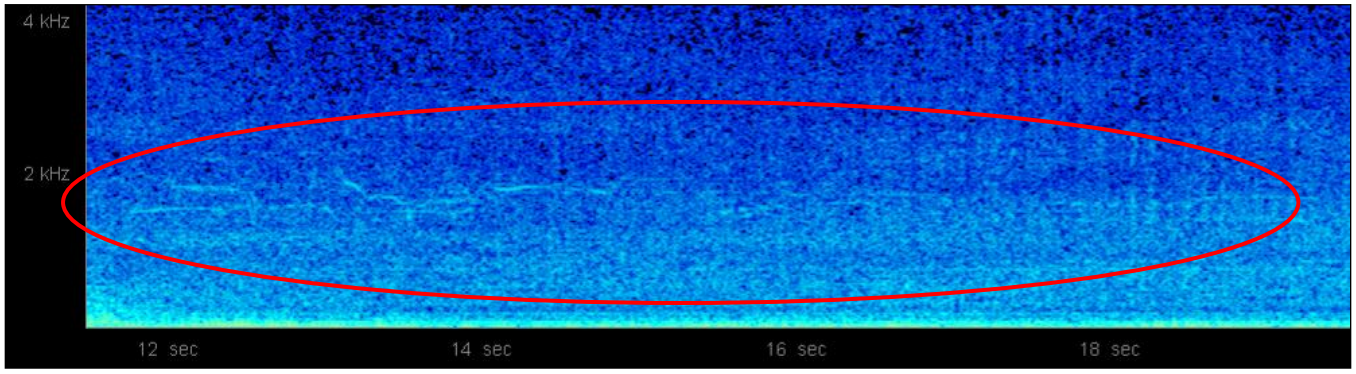

Figure 19. AD19 viewed through Spectrogram 16 software revealing multiple vocalizations.

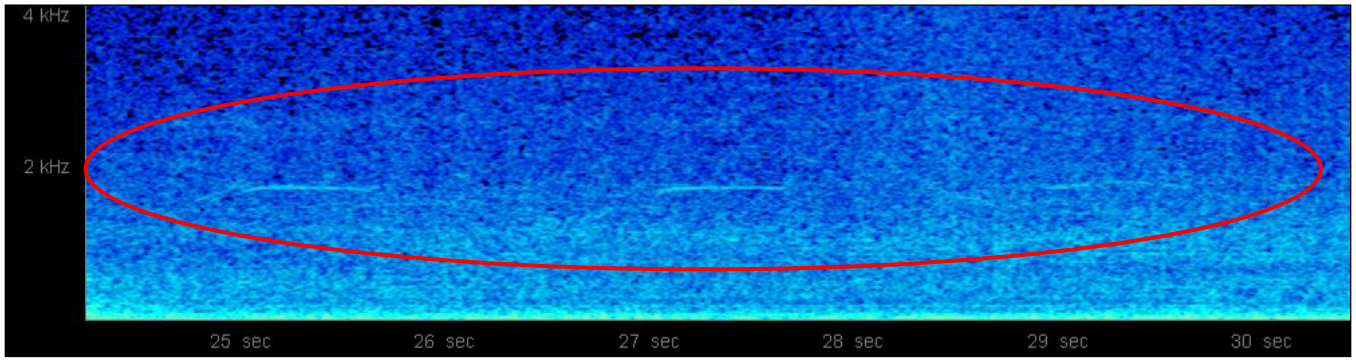

Figure 20. AD19 through Spectrogram 16 software revealing nearly constant vocalizations at ~1.7kHz.

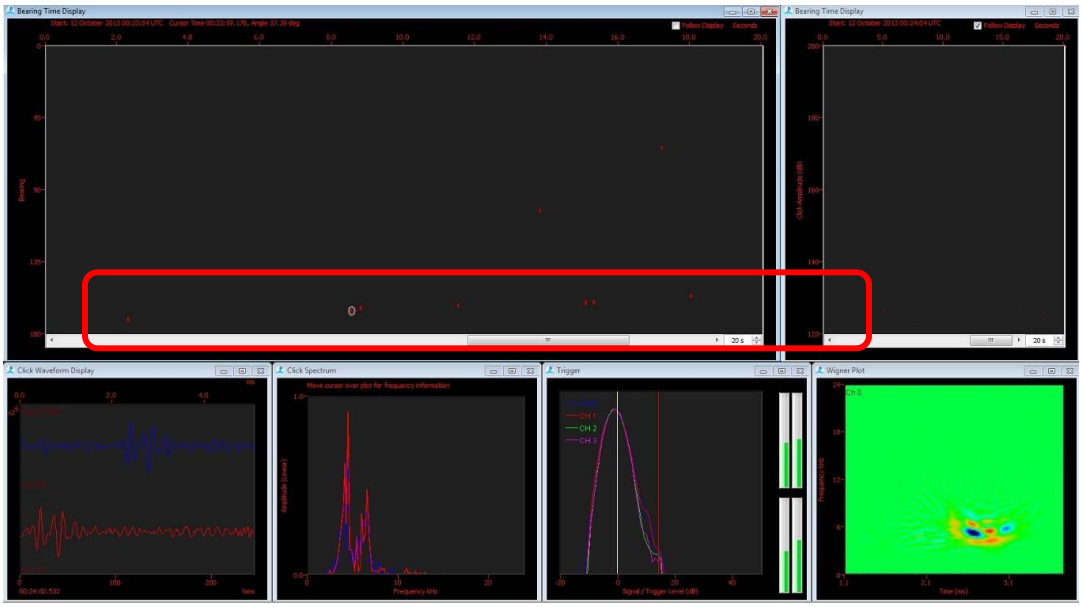

Figure 21. Walrus knocks shown (in red box) on low-frequency click detector during AD 21 on 11 October.

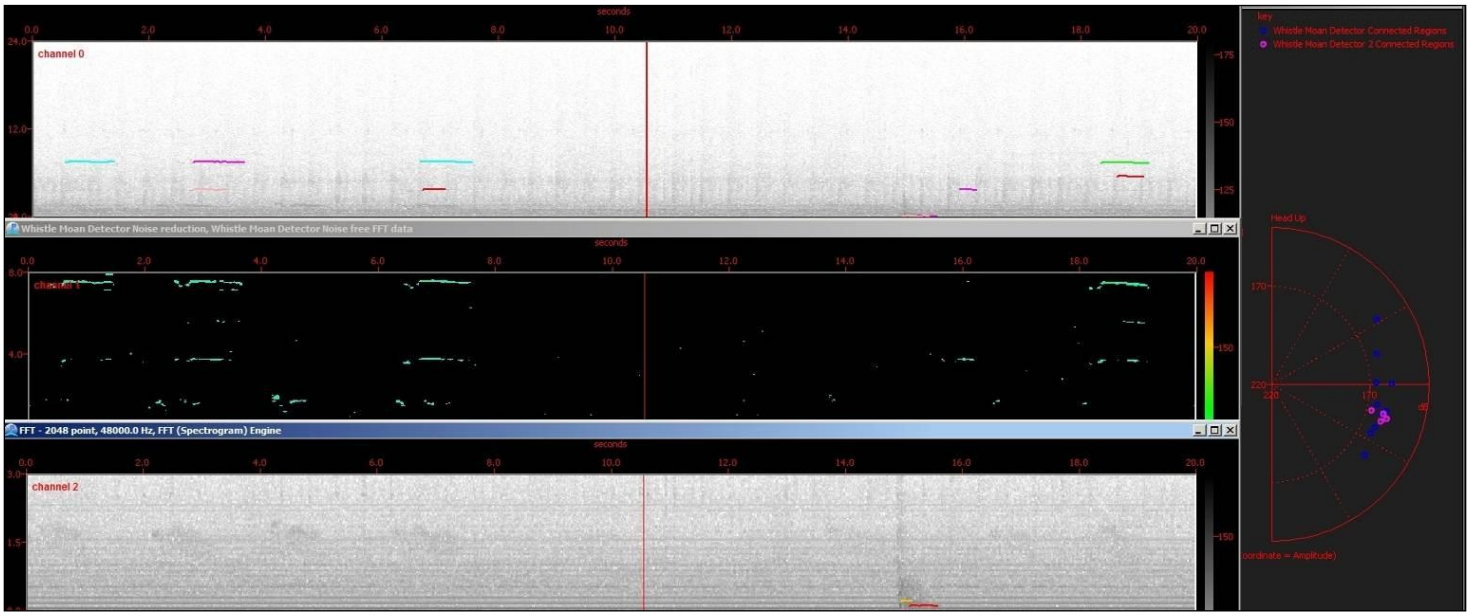

Figure 22. Vocalizations shown on spectrogram and high-lighted by the whistle and moan detector (AD 24).

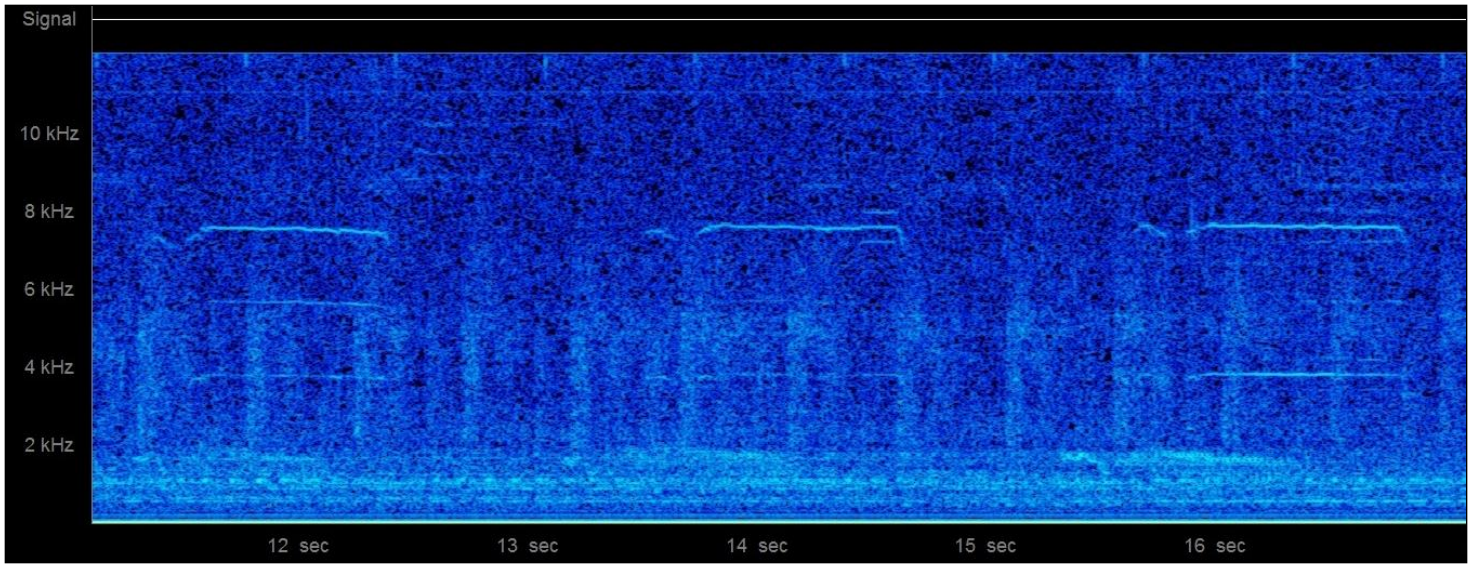

Figure 23. Vocalizations from acoustic detection 24 as viewed through Spectrogram16.

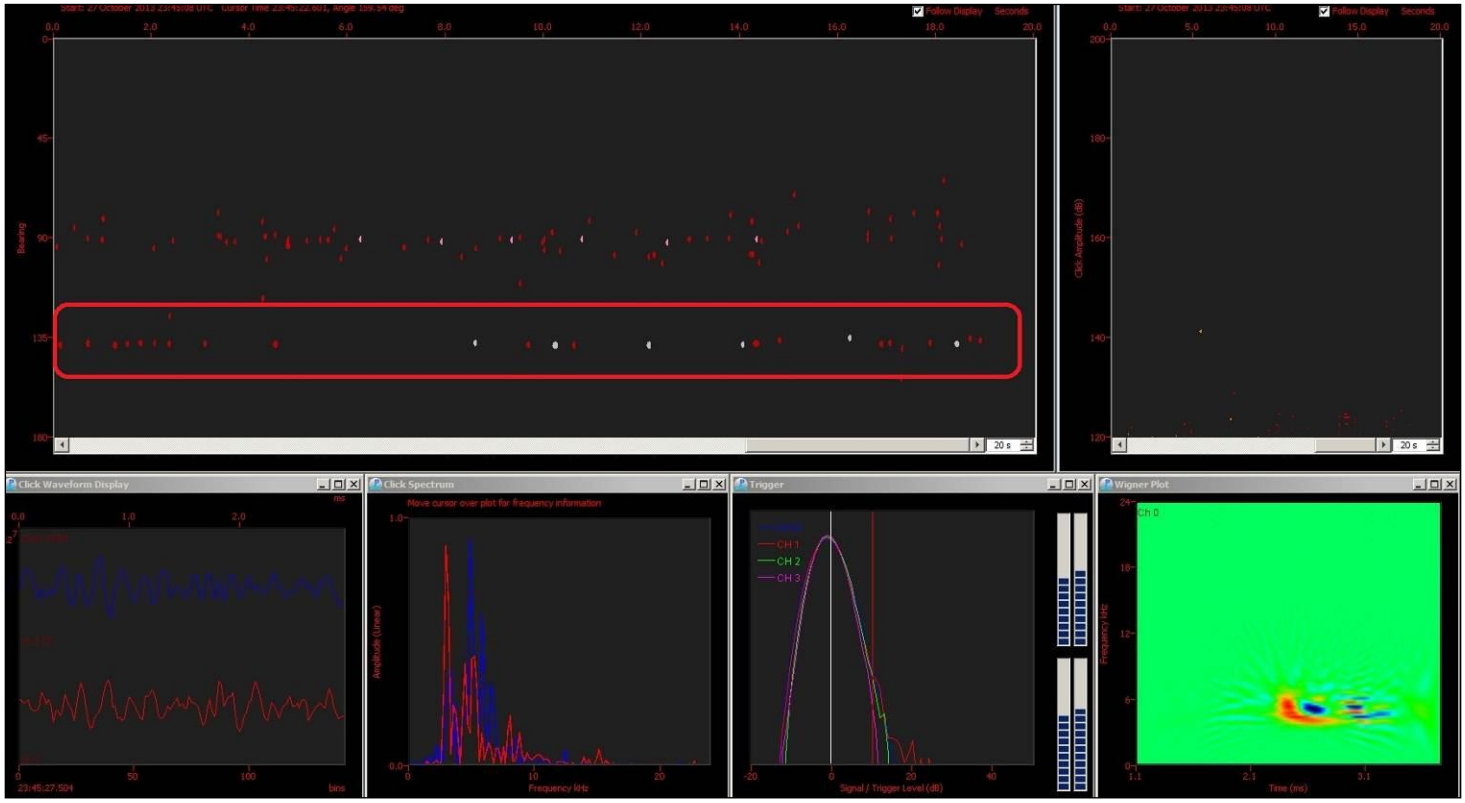

Figure24. Walrus knock shown (in red box) at a bearing of ~135 on the low frequency click detector (AD 25).

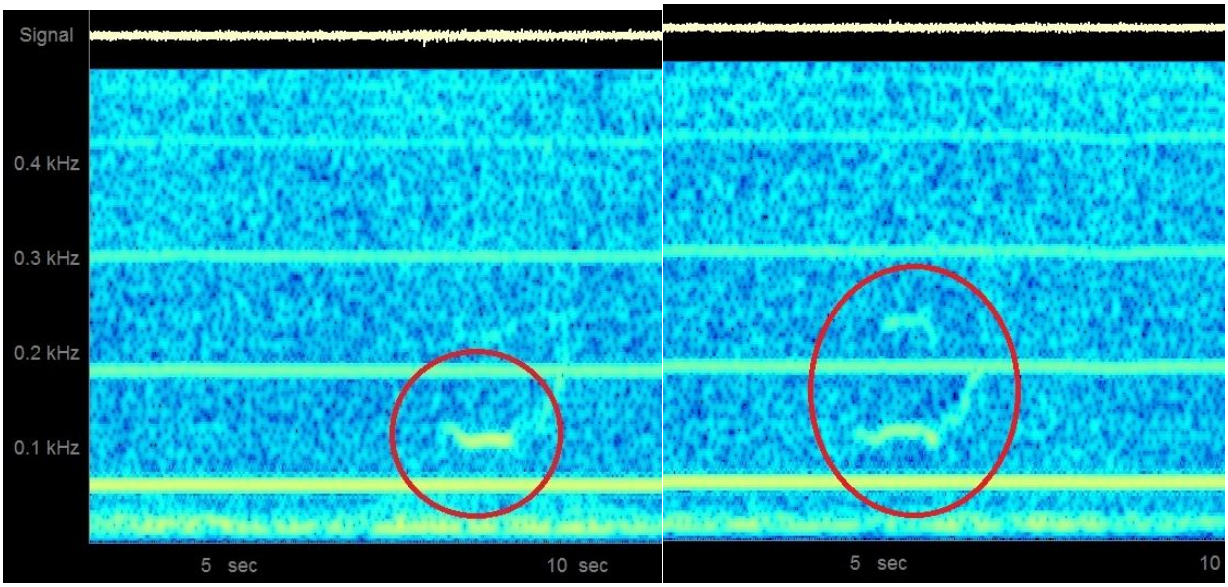

Figure25. Two of the tonal bowhead whale calls at approximately 100 Hz shown on Spectrogram16 (AD 26).

Appendix D
Copy of the NMFS issued IHA,
USFWS Issued LOA,
BOEM issued G&G for TGS

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

Incidental Harassment Authorization

TGS-NOPEC Geophysical Company ASA (TGS), 2500 City West Boulevard, Suite 2000, Houston, Texas 77042, 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 open-water 2D seismic surveys in the Chukchi Sea, contingent upon the following conditions:

1. This Authorization is valid from August 14 through October 31, 2013.

2. This Authorization is valid only for activities associated with open-water 2D seismic surveys and related activities in the Chukchi Sea. The specific areas where TGS' surveys will be conducted are within the Chukchi Sea, Alaska, as shown in Figure 1 of TGS' IHA application.

3. (a) The species authorized for incidental harassment takings, Level B harassment only, 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*).

The authorization for taking by harassment is limited to the following acoustic sources and from the following activities:

(i) 3,280 in^3 airgun arrays and other acoustic sources for 2D open-water seismic surveys; and

(ii) Vessel activities related to open-water seismic surveys listed in (i).

(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 and Conservation Division, Office of Protected Resources, NMFS, at (301) 427-8401, or his designee (301-427-8418).

4. The holder of this Authorization must notify the Chief of the Permits and Conservation 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. <u>Prohibitions</u>

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(a) The taking, by incidental harassment only, is limited to the species listed under condition 3(a) above and by the numbers listed in Table 1 (attached). 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 protected species observers (PSOs), required by condition 7(a)(i), are not onboard in conformance with condition 7(a)(i) of this Authorization.

6. Mitigation

(a) Establishing Exclusion and Disturbance Zones:

(i) Establish, and monitor with trained PSOs, preliminary exclusion zones for cetaceans surrounding the airgun array on the source vessel where the received level would be 180 dB (rms) re 1 μPa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 2,200, 2,500, and 2,400 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17-40, 40-100, and >100 m, respectively. The 180-dB radius from the single 60 in^3 airgun is estimated to be at 68 m from the source, regardless of water depth.

(ii) Establish, and monitor with trained PSOs, preliminary exclusion zones for pinnipeds surrounding the airgun array on the source vessel where the received level would be 190 dB (rms) re 1 μPa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 930, 920, and 430 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17-40, 40-100, and >100 m, respectively. The 190-dB radius from the single 60 in^3 airgun is estimated to be at 13 m from the source, regardless of water depth.

(iii) Establish a zone of influence (ZOIs) for cetaceans and pinnipeds surrounding the airgun array on the source vessel where the received level would be 160 dB (rms) re 1 μPa. For purposes of the field verification test described in condition 7(e)(i), these radii are estimated to be 8,500, 9,900, and 15,000 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17-40, 40-100, and > 100 m, respectively. The 160-dB radius from the single 60 in^3 airgun is estimated to be at 1,500 m from the source.

(iv) Immediately upon completion of data analysis of the field verification measurements required under condition 7(e)(i) below, the new 160-dB, 180-dB, and 190-dB marine mammal ZOIs and exclusion zones shall be established based on the sound source verification.

(b) Vessel and Helicopter Movement Mitigation:

(i) All vessels under the direction of TGS shall avoid concentrations or groups of whales (2 or more individuals). Operators of support vessels shoall, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.

(ii) Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

(A) Reducing vessel speed to less than 5 knots within 300 yards (900 feet or 274 m) of the whale(s);

(B) Steering around the whale(s) if possible;

(C) Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;

(D) Operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and

(E) Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged.

(iii) Reduce vessel speed to 5 knots when weather conditions require, such as when visibility drops, to avoid the likelihood of injury to whales.

(c) Mitigation Measures for Airgun Operations

(i) Ramp-up:

(A) A ramp up, starting from a cold start or following a complete shutdown of 10 minutes or more, can be applied if the exclusion zone has been free of marine mammals for a consecutive 30-minute period. The entire exclusion zone must have been visible during these 30 minutes. If the entire exclusion zone is not visible, then ramp up from a cold start cannot begin.

(B) If a marine mammal(s) is sighted within the exclusion zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the exclusion zone or the animal(s) is not sighted for at least 15-30 minutes: 15 minutes for small odontocetes (harbor porpoise) and pinnipeds, or 30 minutes for

baleen whales and large odontocetes (including beluga and killer whales and narwhal).

(C) If, for any reason, electrical power to the airgun array has been discontinued for a period of 10 minutes or more, ramp-up procedures shall be implemented when restarting. Only if the PSO watch has been suspended, a 30-minute clearance of the exclusion zone is required prior to commencing ramp-up. Discontinuation of airgun activity for less than 10 minutes does not require a ramp-up.

(D) The seismic operator and PSOs shall maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

(ii) Power-down/Shutdown:

(A) The airgun array shall be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun.

(B) If a marine mammal is already within the exclusion zone when first detected, the airguns shall be powered down immediately.

(C) Following a power-down, firing of the full airgun array shall not resume until the marine mammal has cleared the exclusion zone. The animal will be considered to have cleared the exclusion zone if it is visually observed to have left the exclusion zone of the full array, or has not been seen within the zone for 15 minutes (pinnipeds or small toothed whales) or 30 minutes (baleen whales or large toothed whales).

(D) If a marine mammal is sighted within or about to enter the 190 or 180 dB (rms) applicable exclusion zone of the single mitigation airgun, the airgun array shall be shutdown.

(E) Firing of the full airgun array or the mitigation gun shall not resume until the marine mammal has cleared the exclusion zone of the full array or mitigation gun, respectively. The animal will be considered to have cleared the exclusion zone as described above under ramp up procedures.

(iii) Poor Visibility Conditions:

(A) If during foggy conditions, heavy snow or rain, or darkness, the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down.

(B) If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible.

(iv) Use of a Small-Volume Airgun during Turns and Transits

(A) Throughout the seismic survey, particularly during turning movements, and short transits, TGS will employ the use of a small-volume airgun (i.e., 60 in^3 "mitigation airgun"). The mitigation airgun will be operated at approximately one shot per minute and will not be operated for longer than three hours in duration during daylight hours and good visibility. In cases when the next start-up after the turn is expected to be during lowlight or low visibility, use of the mitigation airgun may be initiated 30 minutes before darkness or low visibility conditions occur and may be operated until the start of the next sail line. The mitigation gun must still be operated at approximately one shot per minute.

(B) During turns or brief transits (e.g., less than three hours) between seismic tracklines, one mitigation airgun will continue operating. The ramp-up procedure will still be followed when increasing the source levels from one airgun to the full airgun array. However, keeping one airgun firing will avoid the prohibition of a "cold start" during darkness or other periods of poor visibility. Through the use of this approach, seismic surveys using the full array may resume without the 30 minute observation period of the full exclusion zone required for a "cold start". PSOs will be on duty whenever the airguns are firing during daylight, during the 30 minute periods prior to ramp-ups.

(d) Mitigation Measures for Subsistence Activities:

(i) TGS shall fully implement the following provisions, as described fully in the 2013 Conflict Avoidance Agreement (CAA) signed between TGS and the AEWC and its representing whaling communities of the Chukchi and Beaufort Seas:

(A) Section 202(a) and (c): Com-Center General Communication Scheme;

(B) Section 204: Standardized Log Books;

(C) Section 302: Barge and Transit Vessel Operations;

(D) Section 402: Sound Signature Tests;

(E) Section 501: General provisions for Avoiding Interference with Bowhead Whales or Subsistence Whale Hunting Activities;

(F) Section 502(b): Limitations on Geophysical Activity in the Chukchi Sea;

(G) Section 505: Termination of Operations and Transit Through the Bering Strait; and

(H) Title VI, Sections 601 and 602: Late Season Seismic Operations.

7. Monitoring:

(a) Vessel-based Visual Monitoring:

(i) Vessel-based visual monitoring for marine mammals shall be conducted by NMFS-approved protected species observers (PSOs) throughout the period of survey activities, and extends to 30 minutes after the survey is completed.

(ii) PSOs shall be stationed aboard the seismic survey vessel and supporting vessel through the duration of the surveys.

(iii) A sufficient number of PSOs shall be onboard the survey vessel to meet the following criteria:

(A) 100% monitoring coverage during all periods of survey operations in daylight;

(B) maximum of 4 consecutive hours on watch per PSO; and

(C) maximum of 12 hours of watch time per day per PSO.

(iv) The vessel-based marine mammal monitoring shall provide the basis for real-time mitigation measures as described in (6)(c) above.

(v) Results of the vessel-based marine mammal monitoring shall be used to calculate the estimation of the number of "takes" from the marine surveys.

(b) Protected Species Observers and Training

(i) PSO teams shall consist of Inupiat observers and NMFS-approved field biologists.

(ii) Experienced field crew leaders shall supervise the PSO teams in the field. New PSOs shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

(iii) Crew leaders and most other biologists serving as observers in 2013 shall be individuals with experience as observers during recent seismic or shallow hazards monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas in recent years.

(iv) Resumes for PSO candidates shall be provided to NMFS for review and acceptance of their qualifications. Inupiat observers shall be experienced in the region and familiar with the marine mammals of the area.

(v) All observers shall complete a NMFS-approved observer training course designed to familiarize individuals with monitoring and data collection procedures. The training course shall be completed before the anticipated start of the 2013 open-water season. The training session(s) shall be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs.

(vi) Training for both Alaska native PSOs and biologist PSOs shall be conducted at the same time in the same room. There shall not be separate training courses for the different PSOs.

(vii) Crew members shall not be used as primary PSOs because they have other duties and generally do not have the same level of expertise, experience, or training as PSOs, but they could be stationed on the fantail of the vessel to observe the near field, especially the area around the airgun array and implement a power down or shutdown if a marine mammal enters the safety zone (or exclusion zone).

(viii) If crew members meet the PSO qualifications and are to be used as PSOs, they shall go through some basic training consistent with the functions they will be asked to perform. The best approach would be for crew members and PSOs to go through the same training together.

(ix) PSOs shall be trained using visual aids (e.g., videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

(x) TGS shall train its PSOs to follow a scanning schedule that consistently distributes scanning effort according to the purpose and need for observations. All PSOs should follow the same schedule to ensure consistency in their scanning efforts.

(xi) PSOs shall be trained in documenting the behaviors of marine mammals. PSOs should simply record the primary behavioral state (i.e., traveling, socializing, feeding, resting, approaching or moving away from vessels) and relative location of the observed marine mammals.

(c) Marine Mammal Observation Protocol

(i) PSOs shall watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge.

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

(iii) PSOs 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 when needed.

(iv) Personnel on the bridge shall assist the marine mammal observer(s) in watching for marine mammals.

(v) PSOs aboard the marine survey vessel shall give particular attention to the areas within the marine mammal exclusion zones around the source vessel, as noted in (6)(a)(i) and (ii). 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 exclusion zone.

(vi) Monitoring shall consist of recording of the following information:

(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 (including pinnipeds hauled out on barrier islands), (II) at the start and end of each watch, and (III) during a watch (whenever there is a change in one or more variable);

(C) the identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted and the time observed;

(D) any identifiable marine mammal behavioral response (sighting data should be collected in a manner that will not detract from the PSO's ability to detect marine mammals);

(E) any adjustments made to operating procedures; and

(F) visibility during observation periods so that total estimates of take can be corrected accordingly.

(vii) Distances to nearby marine mammals will be estimated with binoculars (Fujinon 7 x 50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water.

(viii) PSOs 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. For example, for an unidentified mysticete whale, the observers should record whether the animal had a dorsal fin.

(ix) Additional details about unidentified marine mammal sightings, such as "blow only", mysticete with (or without) a dorsal fin, "seal splash", etc., shall be recorded.

(x) When a marine mammal is seen approaching or within the exclusion zone applicable to that species, the marine survey crew shall be notified immediately so that mitigation measures described in (6) can be promptly implemented.

(xi) TGS shall use the best available technology to improve detection capability during periods of fog and other types of inclement weather. Such technology might include night-vision goggles or binoculars as well as other instruments that incorporate infrared technology.

(d) Field Data-Recording and Verification

(i) PSOs aboard the vessels shall maintain a digital log of seismic surveys, noting the date and time of all changes in seismic activity (ramp-up, power-down, changes in the active seismic source, shutdowns, etc.) and any corresponding changes in monitoring radii in a software spreadsheet.

(ii) PSOs shall utilize standardized format to record all marine mammal observations and mitigation actions (seismic source power-downs, shut-downs, and ramp-ups).

(iii) Information collected during marine mammal observations shall include the following:

(A) Vessel speed, position, and activity

(B) Date, time, and location of each marine mammal sighting

(C) Number of marine mammals observed, and group size, sex, and age categories

(D) Observer's name and contact information

(E) Weather, visibility, and ice conditions at the time of observation

(F) Estimated distance of marine mammals at closest approach

(G) Activity at the time of observation, including possible attractants present

(H) Animal behavior

(I) Description of the encounter

(J) Duration of encounter

(K) Mitigation action taken

(iv) Data shall be recorded directly into handheld computers or as a back-up, transferred from hard-copy data sheets into an electronic database.

(v) A system for quality control and verification of data shall be facilitated by the pre-season training, supervision by the lead PSOs, in-season data checks, and shall be built into the software.

(vi) Computerized data validity checks shall also be conducted, and the data shall be managed in such a way that it is easily summarized during and after the field program and transferred into statistical, graphical, or other programs for further processing.

(e) Passive Acoustic Monitoring

(i) Sound Source Measurements: Using a hydrophone system, the holder of this Authorization is required to conduct sound source verification tests for seismic airgun array(s) that are involved in the open-water seismic surveys.

(A) Sound source verification shall consist of distances where broadside and endfire directions at which broadband received levels reach 190, 180, 170, and 160 dB (rms) re 1 μPa for the airgun array(s). The configurations of airgun arrays shall include at least the full array

and the operation of a single source that will be used during power downs.

(B) The test results shall be reported to NMFS within 5 days of completing the test.

(ii) Real-time Passive Acoustic Monitoring (PAM)

(A) TGS shall conduct real-time passive acoustic monitoring by NMFS-approved passive acoustic monitor(s) using a towed hydrophone array from the support vessel throughout the open-water seismic surveys.

(B) Passive Acoustic Operator(s) and Monitor(s):

(I) Design and initial setup of PAM apparatus (including hardware and software) shall be done by experienced bioacoustician(s) with field experience in marine mammal passive acoustic monitoring and signal processing.

(II) Passive acoustic monitor(s) shall undergo basic training on PAM, and be able to operate independently once the PAM apparatus is set-up.

(III) Resumes for the bioacoustician(s) and passive acoustic monitor(s) candidates shall be provided to NMFS for review and acceptance of their qualifications.

(C) Specific sensor design and noise filters shall be used to maximize the system's ability to detect low frequency bowhead whales. To ensure the effectiveness of real-time PAM with a towed hydrophone array, the following requirements for PAM design and procedures are required:

(I) Limit towing speeds to 4-6 knots. Reduce speed appropriately, or change direction if necessary, so that if bowhead whales are detected so that bearing can be obtained. If greater speeds are necessary, slow down every 20-30 minutes to listen for animal calls for at least 5-10 minutes.

(II) Maintain a separation distance of at least several hundred meters (preferable more) from the seismic survey vessel.

(D) Best efforts shall be made without compromising data collection to localize vocalizing marine mammals.

(I) Use a signal conditioning system (i.e. filter and match signal gains) to allow software to effectively estimate bearings and/or localize.

(II) Use software designed exclusively for monitoring, localizing and plotting marine mammal calls.

(III) Design the sampling software to optimize overlap between monitoring the 180 and 160 dB isopleths.

(IV) Allow the support vessel to deviate from designated track-lines by 25-30 degrees (for brief periods) so that left/right ambiguity can be resolved if needed.

8. Data Analysis and Presentation in Reports

(a) Estimation of potential takes or exposures shall be improved for times with low visibility (such as during fog or darkness) through interpolation or possibly using a probability approach. Those data could be used to interpolate possible takes during periods of restricted visibility.

(b) To better assess impacts to marine mammals, data analysis shall be separated into periods when a seismic airgun array (or a single mitigation airgun) is operating and when it is not. Final report to NMFS should summarize and plot:

(i) Data for periods when a seismic array is active and when it is not; and

(ii) The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

(c) To help evaluate the effectiveness of PSOs and more effectively estimate take, if appropriate data are available, TGS shall perform analysis of sightability curves (detection functions) for distance-based analyses.

(d) The following data shall be obtained and provided electronically in the 90-day report:

(i) the location and time of each vessel-based sighting or acoustic detection;

(ii) position of the sighting or acoustic detection relative to ongoing operations (i.e., distance from sightings to seismic operation, etc.), if known;

(iii) the nature of activities at the time (e.g., seismic on/off);

(iv) any identifiable marine mammal behavioral response (sighting data should be collected in a manner that will not detract from the PSO of passive acoustic monitor's ability to detect marine mammals); and

(v) adjustments made to operating procedures.

(e) TGS shall provide useful summaries and interpretations of results of the various elements of the monitoring results, which shall include a clear timeline and spatial (map) representation/summary of operations and important observations. Any and all mitigation measures (e.g., vessel course deviations for animal avoidance, operational shut down) should be summarized. Additionally, an assessment of the efficacy of monitoring methods should be provided.

(f) TGS shall collaborate with other organizations operating in the Chukchi Sea and share visual and acoustic data to improve understanding of impacts from single and multiple operations and efficacy of mitigation measures.

9 Reporting

(a) Sound Source Verification Report: A report on the preliminary results of the sound source verification measurements, including the measured 190, 180, and 160 dB (rms) radii of the airgun sources and other acoustic survey equipment, shall be submitted within 14 days after collection of those measurements at the start of the field season. This report will specify the distances of the exclusion zones that were adopted for the survey.

(b) Throughout the survey program, PSOs shall prepare a report each day or at such other intervals, summarizing the recent results of the monitoring program. The reports shall summarize the species and numbers of marine mammals sighted. These reports shall be provided to NMFS Alaska Regional Office (brad.smith@noaa.gov) and NMFS Office of Protected Resources (shane.guan@noaa.gov).

(c) 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 TGS' 2013 open-water seismic surveys in the Chukchi Sea. The report will describe in detail:

(i) summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);

(ii) analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);

(iii) species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover;

(iv) data analysis that is separated into periods when an airgun array (or a single airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot:

(A) Data for periods when a seismic array is active and when it is not; and

(B) The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

(v) sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability), such as:

(A) initial sighting distances versus airgun activity state;

(B) closest point of approach versus airgun activity state;

(C) observed behaviors and types of movements versus airgun activity state;

(D) numbers of sightings/individuals seen versus airgun activity state;

(E) distribution around the survey vessel versus airgun activity state; and

(F) estimates of take by harassment.

(vi) reported results from all hypothesis tests, including estimates of the associated statistical power when practicable.

(vii) estimated uncertainty for all post-activity take estimates. Uncertainty could be expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, etc.; the exact approach would be selected based on the sampling method and data available.

(viii) The report should clearly compare authorized takes to the estimated takes based on actual levels of activity and marine mammal observations.

(d) The draft report shall 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.

10 (a) In the unanticipated event that survey operations clearly cause the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A

harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), TGS shall immediately cease survey operations and immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov). The report must include the following information:

(i) time, date, and location (latitude/longitude) of the incident;

(ii) the name and type of vessel involved;

(iii) the vessel's speed during and leading up to the incident;

(iv) description of the incident;

(v) status of all sound source use in the 24 hours preceding the incident;

(vi) water depth;

(vii) environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(viii) description of marine mammal observations in the 24 hours preceding the incident;

(ix) species identification or description of the animal(s) involved;

(x) the fate of the animal(s); and

(xi) photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with TGS to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. TGS may not resume their activities until notified by NMFS via letter, email, or telephone.

(b) In the event that TGS discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), TGS will immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the NMFS Alaska Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barabara.Mahoney@noaa.gov). The report must include the same information

identified in Condition 10(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with TGS to determine whether modifications in the activities are appropriate.

(c) In the event that TGS discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 3 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), TGS shall report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the NMFS Alaska Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov), within 24 hours of the discovery. TGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. TGS can continue its operations under such a case.

11. 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.

12. 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.

13. 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.

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

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

Donna S. Wieting

Donna S. Wieting, Director
Office of Protected Resources
National Marine Fisheries Service

AUG 14 2013
Date

Table 1. Species/stocks and numbers of marine mammals allowed to be taken incidental to under this IHA.

Species / Stocks	Take Allowed
Bowhead whale / Bering-Chukchi-Beaufort Sea	794
Gray whale / Eastern North Pacific	1,363
Fin whale / Northeast Pacific	5
Humpback whale / Western North Pacific	5
Minke whale / Alaska	5
Beluga whale / Eastern Chukchi Sea	412
Killer whale / Aleutian Island and Bering Sea	5
Harbor porpoise / Bering Sea	36
Ringed seal / Alaska	30,000
Bearded seal / Alaska	6,000
Spotted seal / Alaska	500
Ribbon seal / Alaska	100

Mr. Troy Nelson

IN REPLY REFER TO:

United States Department of the Interior

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

JUN 28 2013

AFES/MMM

Mr. Troy Nelson
TGS
2500 CityWest Boulevard, Suite 200
Houston, Texas 77042

Dear Mr. Nelson:

We have received your request dated April 18, 2013, for a Letter of Authorization (LOA) for the incidental take of polar bears and Pacific walruses during activities associated with the TGS 2013 Two-Dimensional Seismic Acquisition, Chukchi Sea, Alaska Program.

In response, enclosed is LOA 13-CS-03 granting TGS authority to take small numbers of polar bears and Pacific walruses incidental to the activities identified in your request.

TGS proposes to conduct approximately 9,600 kilometer (km) (5,965.1 miles [mi]) of 2D marine seismic surveys along pre-determined lines in U.S. Federal waters and international waters of the Chukchi Sea during the 2013 open water season. The purpose of the proposed seismic program is to gather geophysical data using a 53,792 cubic centimeters (cm^3) (3,280 cubic inch [in^3]) seismic source array and an 8,100-meter (m) (26,575 feet) long hydrophone solid streamer towed by the seismic vessel. Results of the 2D seismic program will be used to identify and map potential hydrocarbon-bearing formations and the geologic structures that surround them. Throughout the duration of the program, a second vessel will act as a dedicated monitoring (i.e., scout) vessel.

A detailed description of the proposed activities is found in TGS's *2013 2D Seismic Program Request for Letter of Authorization, Chukchi Sea, Alaska (April 2013)* including the *Polar Bear and Walrus Awareness and Interaction Plan* (Section 4.0), *Detailed Plan of Operations (Appendix A), Plan Of Cooperation (Appendix C)*, as well as the *TGS 2013 2D Seismic Program Marine Mammal Monitoring and Mitigation Plan Chukchi Sea, Alaska (April 2013)*. All provisions contained within these plans are incorporated by reference into this LOA. This authorization is issued in accordance with the Incidental Take Regulations published in the *Federal Register* (78 FR 35364), dated June 12, 2013.

TGS must provide monitoring data of polar bears and Pacific walruses throughout the project and a complete report of all observations at the conclusion of the project in accordance with 50 CFR §18.118. This final report must be provided to the U.S. Fish and Wildlife Service

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(Service), Marine Mammals Management Office (MMM) within 90 days after completion of the project.

If questions or concerns arise during the project period, Service, MMM biologists are available for consultation at the phone numbers listed below and noted in your Interaction Plan. If any changes develop in your project, such as activities or location, the MMM must be notified prior to the planned operation. This will allow us to evaluate the activity and, if appropriate, amend the LOA.

The Service has completed intra-Service consultation and conference under the Endangered Species Act of 1973, as amended (ESA), on the issuance of these LOAs and has determined that issuance is not likely to jeopardize the continuing existence of polar bears and Pacific walruses. Therefore, no additional authorization under the ESA is required.

If you have any further questions, please contact Mr. Craig Perham or Mr. Christopher Putnam of our Marine Mammals Management Office, at (907) 786-3810 or (907) 786-3844, respectively.

Sincerely,

Acting Chief, Marine Mammals Management

Enclosure

cc: Ms. Elizabeth Benson, ASRC Energy Services
Mr. Richard Shideler, Alaska Department of Fish and Game (email)
U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office
U.S. Fish and Wildlife Service, Office of Law Enforcement
North Slope Borough, Department of Law

United States Department of the Interior

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

IN REPLY REFER TO:

AFES/MMM

U.S. Fish and Wildlife

LETTER OF AUTHORIZATION
(13-CS-03)

ISSUED: June 28, 2013
EXPIRES: October 31, 2013

TGS is hereby authorized to take small numbers of polar bears and Pacific walruses incidental to activities occurring during the 2013 Two-Dimensional Seismic Acquisition, Chukchi Sea, Alaska Program. This authorization is issued in accordance with the Incidental Take Regulations published in the *Federal Register* (78 FR 35364), dated June 12, 2013.

TGS proposes to conduct approximately 9,600 kilometer (km) (5,965.1 miles [mi]) of 2D marine seismic surveys along pre-determined lines in U.S. Federal waters and international waters of the Chukchi Sea during the 2013 open water season. The purpose of the proposed seismic program is to gather geophysical data using a 3,280 cubic inch seismic source array and an 8,100-meter (m) (26,575 feet [ft]) long hydrophone solid streamer towed by the seismic vessel. Results of the 2D seismic program will be used to identify and map potential hydrocarbon-bearing formations and the geologic structures that surround them. Throughout the duration of the program, a second vessel will act as a dedicated monitoring (i.e., scout) vessel.

A detailed description of the proposed activities is found in TGS's *2013 2D Seismic Program Request for Letter of Authorization, Chukchi Sea, Alaska (April 2013)* including the *Polar Bear and Walrus Awareness and Interaction Plan* (Section 4.0), *Detailed Plan of Operations (Appendix A),* and *Plan Of Cooperation (Appendix C)*, as well as the *TGS 2013 2D Seismic Program Marine Mammal Monitoring and Mitigation Plan Chukchi Sea, Alaska (April 2013).*

This Letter of Authorization (LOA) and the required conditions below include contractors of TGS performing TGS-approved work under the scope of operations to be conducted. The LOA is subject to the following conditions:

1. Intentional take is prohibited under this LOA.

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

TAKE PRIDE IN AMERICA

3. The species authorized for takings, by Level B Harassment only, are: Pacific walrus (*Odobenus rosmarus divergens*), and polar bear (*Ursus maritimus*). The taking of any walrus or polar bear in a manner prohibited under this authorization must be reported within 24 hours of the taking to the U.S. Fish and Wildlife Service (Service), Marine Mammals Management Office (MMM), Incidental Take Coordinator in Anchorage, Alaska at (907) 786-3800, or their designee.

4. This authorization is valid only for those activities identified in the request for a Letter of Authorization, *2013 2D Seismic Program Request for Letter of Authorization, Chukchi Sea, Alaska* dated April 18, 2013.

5. The TGS *2013 2D Seismic Program, Request for Letter of Authorization, Chukchi Sea, Alaska (April 2013)* including the *Polar Bear and Walrus Awareness and Interaction Plan* (Section 4.0), *Detailed Plan of Operations (Appendix A), Plan Of Cooperation (Appendix C)*, as well as the *TGS 2013 2D Seismic Program Marine Mammal Monitoring and Mitigation Plan Chukchi Sea, Alaska (April 2013)* are approved. All provisions contained within these plans are incorporated by reference into this LOA. All provisions must be complied with unless specifically noted otherwise in this LOA. A copy of these plans must be available on site for all personnel. A copy of this LOA and these plans must be in the possession of the operators of all vessels and aircraft engaged in any activity operating under the authority of this LOA.

6. TGS is required to cooperate with the Service and any other Federal, State or local agency monitoring the impacts of the activity on Pacific walruses and polar bears.

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

8. If any changes develop in your project during the 2013 Two-Dimensional Seismic Acquisition, Chukchi Sea, Alaska Program, such as activities or location; notify the Service, MMM prior to the planned operation.

9. TGS must comply with mitigation, monitoring and reporting requirements in accordance with 50 CFR §18.118. Mitigation, monitoring and reporting requirements include, but may not be limited to:

   A. Mitigation Requirements.

      i. At all times, vessels must maintain the maximum distance possible from concentrations of walruses or polar bears. Under no circumstances, other than an emergency, should any vessel approach within an 805-m (0.5-mi) radius of walruses or polar bears observed on ice. Under no circumstances, other than an emergency, should any vessel approach within 1,610 m (1 mi) of groups of walruses observed on land or within an 805-m (0.5-mi) radius of polar bears observed on land.

ii. Vessel operators must take every precaution to avoid harassment of concentrations of feeding walruses when a vessel is operating near these animals. Vessels should reduce speed and maintain a minimum 805-m (0.5-mi) operational exclusion zone around groups of 12 or more walruses encountered in the water. Vessels may not be operated in such a way as to separate members of a group of walruses from other members of the group. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to walruses.

iii. Operators of support aircraft should, at all times, conduct their activities at the maximum distance possible from concentrations of walruses or polar bears.

iv. Under no circumstances, other than an emergency, should fixed wing aircraft operate at an altitude lower than 457 m (1,500 ft) within 805 m (0.5 mi) of walrus groups observed on ice, or within 1,610 m (1 mi) of walrus groups observed on land. Under no circumstances, other than an emergency, should rotary winged aircraft (helicopters) operate at an altitude lower than 914 m (3,000 ft) within 1,610 m (1 mi) of walrus groups observed on land. Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 457 m (1,500 ft) within 805 m (0.5 mi) of polar bears observed on ice or land. Helicopters may not hover or circle above such areas or within 805 m (0.5 mi) of such areas. When weather conditions do not allow a 457-m (1,500-ft) flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the required altitudes stipulated above. However, when aircraft are operated at altitudes below 457 m (1,500 ft) because of weather conditions, the operator must avoid areas of known walrus and polar bear concentrations and should take precautions to avoid flying directly over or within 805 m (0.5 mi) of these areas.

v. All vessels must avoid areas of active or anticipated subsistence hunting for walrus or polar bear as determined through community consultations. Plan all aircraft routes to minimize any potential conflict with active or anticipated walrus or polar bear hunting activity as determined through community consultations.

B. Additional mitigation measures for offshore exploration activities.

i. Offshore exploration activities will be authorized only during the open-water season, defined as the period July 1 to November 30.

ii. Operators must maintain a minimum spacing of 24 kilometers (15 mi) between other seismic source vessels during exploration activities to avoid significant synergistic or cumulative effects from multiple oil and gas exploration activities on foraging or migrating walruses. This does not include support vessels for these operations.

iii. TGS may not transit through or conduct seismic operations in areas of the Hanna Shoal Walrus Use Area (HSWUA) between July 1 and September 30 unless the area

is outside of the monthly 50% utilization distribution contours[1] (UDs) for Pacific Walruses during the month of transit or seismic operations.

C. Additional mitigation measures for offshore seismic surveys. Any offshore exploration activity expected to include the production of pulsed underwater sounds with sound source levels ≥160 dB re 1 μPa will be required to establish and monitor acoustic exclusion and disturbance zones and implement adaptive mitigation measures as follows:

i. Monitor zones. Establish and monitor with trained marine mammal observers an acoustically verified exclusion zone for walruses surrounding seismic airgun arrays where the received level will be ≥ 180 dB re 1 μPa; an acoustically verified exclusion zone for polar bear surrounding seismic airgun arrays where the received level will be ≥ 190 dB re 1 μPa; and an acoustically verified walrus disturbance zone ahead of and perpendicular to the seismic vessel track where the received level will be ≥ 160 dB re 1 μPa.

ii. Ramp-up procedures. For all seismic surveys, including airgun testing, use the following ramp-up procedures to allow marine mammals to depart the exclusion zone before seismic surveying begins:

a. Visually monitor the exclusion zone and adjacent waters for the absence of polar bears and walruses for at least 30 minutes before initiating ramp-up procedures. If no polar bears or walruses are detected, you may initiate ramp-up procedures. Do not initiate ramp-up procedures at night or when you cannot visually monitor the exclusion zone for marine mammals;
b. Initiate ramp-up procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output (dB) and volume (in^3);
c. Continue ramp-up by gradually activating additional airguns over a period of at least 20 minutes, but no longer than 40 minutes, until the desired operating level of the airgun array is obtained.

iii. Power down/Shutdown. Immediately power down or shutdown the seismic airgun array and/or other acoustic sources whenever any walruses are sighted approaching close to or within the area delineated by the 180 dB re 1 μPa walrus exclusion zone, or polar bears are sighted approaching close to or within the area delineated by the 190 dB re 1 μPa polar bear exclusion zone. If the power down operation cannot reduce the received sound pressure level to 180 dB re 1 μPa (walrus) or 190 dB re 1 μPa (polar bear), the operator must immediately shutdown the seismic airgun array and/or other acoustic sources.

iv. Emergency shutdown. If observations are made or credible reports are received that

[1] The 50 % UDs is described in 78 FR 35364 (June 12, 2013) and based on, Jay, C.V., A.S. Fischbach, and A.A. Kochnev. 2012. Walrus areas of use in the Chukchi Sea during sparse sea ice cover. Marine Ecology Progress Series Vol. 468: 1–13, 2012) (GIS files available at, https://www.erma.unh.edu/arctic/erma.htm).

one or more walruses and/or polar bears are within the area of the seismic survey and are in an injured or mortal state, or are indicating acute distress due to seismic noise, the seismic airgun array will be immediately shutdown and the Service contacted. The airgun array will not be restarted until review and approval has been given by the Service. The ramp-up procedures must be followed when restarting.

v. Adaptive response for walrus aggregations. Whenever an aggregation of 12 or more walruses are detected within an acoustically verified 160 dB re 1 μPa disturbance zone ahead of or perpendicular to the seismic vessel track, the holder of this LOA must:

   a. Immediately power down or shutdown the seismic airgun array and/or other acoustic sources to ensure sound pressure levels at the shortest distance to the aggregation do not exceed 160–dB re 1 μPa;
   b. Not proceed with powering up the seismic airgun array until it can be established that there are no walrus aggregations within the 160 dB zone based upon ship course, direction, and distance from last sighting. If shutdown was required, the ramp-up procedures must be followed when restarting.

D. Monitoring Requirements. Depending on the siting, timing, and nature of Industry activities, holders of Letters of Authorization will be required to:

   i. Maintain trained, Service-approved, on-site observers to carry out monitoring programs for polar bears and walruses necessary for initiating adaptive mitigation responses.

   ii. Marine Mammal Observers (MMOs) will be required on board all operational and support vessels to alert crew of the presence of walruses and polar bears, initiate adaptive mitigation responses, and carry out specified monitoring activities identified in the marine mammal monitoring and mitigation plan necessary to evaluate the impact of authorized activities on walruses, polar bears, and the subsistence use of these subsistence resources. The MMOs must have completed a marine mammal observer training course approved by the Service.

E. Reporting requirements.

   i. In-season monitoring reports. Activity progress reports. Operators must keep the Service informed on the progress of authorized activities by:

      a. Notifying the Service at least 48 hours prior to the onset of activities;
      b. Providing weekly progress reports of authorized activities noting any significant changes in operating state and or location;
      c. Notifying the Service within 48 hours of ending activity.

ii. Walrus observation reports. The operator must report, on a weekly basis, all observations of walruses during any Industry operation. Information within the observation report will include, but is not limited to:
   a. Date, time, and location of each walrus sighting;
   b. Number, sex, and age of walruses (if determinable);
   c. Observer name, company name, vessel name or aircraft number, LOA number, and contact information;
   d. Weather, visibility, and ice conditions at the time of observation;
   e. Estimated distance from the animal or group when initially sighted, at closest approach, and end of the encounter;
   f. Industry activity at time of sighting and throughout the encounter. If a seismic survey, record the estimated radius of the zone of ensonification;
   g. Behavior of animals at initial sighting, any change in behavior during the observation period, and distance from the observers associated with those behavioral changes;
   h. Detailed description of the encounter;
   i. Duration of the encounter;
   j. Duration of any behavioral response (e.g., time and distance of a flight response)
   k. Actions taken.

iii. Polar bear observation reports. The operator must report, within 24 hours, all observations of polar bears during any Industry operation. Information within the observation report will include, but is not limited to:

   a. Date, time, and location of observation;
   b. Number, sex, and age of bears (if determinable);
   c. Observer name, company name, vessel name, LOA number, and contact information;
   d. Weather, visibility, and ice conditions at the time of observation;
   e. Estimated closest point of approach for bears from personnel and/or vessel/facilities;
   f. Industry activity at time of sighting, and possible attractants present;
   g. Behavior of animals at initial sighting and after contact;
   h. Description of the encounter;
   i. Duration of the encounter;
   j. Actions taken.

iv. Notification of incident report. Reports should include all information specified under the species observation report, as well as a full written description of the encounter and actions taken by the operator. The operator must report to the Service within 24 hours:

   a. Any incidental lethal take or injury of a polar bear or walrus;
   b. Observations of walruses or polar bears within prescribed mitigation monitoring zones.

vi. After-action monitoring reports. The results of monitoring efforts identified in the marine mammal monitoring and mitigation plan must be submitted to the Service for review within 90 days of completing the year's activities. Results must include, but are not limited to, the following information:

a. A summary of monitoring effort including: Total hours, total distances, and distribution through study period of each vessel and aircraft;
b. Analysis of factors affecting the visibility and detectability of walruses and polar bears by specified monitoring;
c. Analysis of the distribution, abundance, and behavior of walrus and polar bear sightings in relation to date, location, ice conditions, and operational state;
d. Estimates of take based on the number of animals encountered/kilometer of vessel and aircraft operations by behavioral response (no response, moved away, dove, etc.), and animals encountered per day by behavioral response for stationary drilling operations;
e. Raw data in electronic format (i.e., Excel spreadsheet) as specified by the Service in consultation with Industry representatives.

F. A report on the Plan of Cooperation, including the notification of the affected communities, measures taken to ensure that exploratory activities did not interfere with subsistence activities, and follow-up notification after the season, shall be submitted to the Service no later than 90 days after the end of the 2013 Two-Dimensional Seismic Acquisition, Chukchi Sea, Alaska Program. A copy of the report shall be sent to affected local subsistence communities, the Alaska Nanuuq Commission, the Eskimo Walrus Commission and the North Slope Borough Wildlife Department as well as to the Service.

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.

This Letter of Authorization is valid for the period indicated above, unless extended or terminated in writing by the U.S. Fish and Wildlife Service.

Acting Chief, Marine Mammals Management

JUN 28 2013
Date

United States Department of the Interior

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

IN REPLY REFER TO:

AFES/MMM

SEP 11 2013

Mr. Troy Nelson
TGS
2500 CityWest Boulevard, Suite 200
Houston, Texas 77042

Dear Mr. Nelson:

On June 28, 2013, the U.S. Fish & Wildlife Service, Marine Mammals Management office (Service) issued TGS a Letter of Authorization (LOA 13-CS-03) granting authorization to take small numbers of polar bears and Pacific walruses incidental to activities associated with the TGS 2013 Two-Dimensional Seismic Acquisition, Chukchi Sea, Alaska Program. The LOA is effective from June 28, 2013, through October 31, 2013. Stipulation 9(B)(iii) in LOA 13-CS-03 states that "TGS may not transit through or conduct seismic operations in areas of the Hanna Shoal Walrus Use Area (HSWUA) between July 1 and September 30 unless the area is outside of the monthly 50% utilization distribution contours[1] (UDs) for Pacific Walruses during the month of transit or seismic operations."

During a meeting on August 29, 2013, TGS agreed to provide the Service at least 48 hours notice prior to entering into any area within the outer boundary of the HSWUA through September 30, 2013. On September 7, 2013, the Service received email communication from the TGS contracted vessel *Geo Arctic* that she was prepared to enter into the HSWUA within approximately 62 hours along survey line 3021 at roughly 71°30" North and 163°50" West. The Service is not able to provide more specific information at this time on Pacific Walrus locations than what TGS currently has available. If the Service develops new information on walrus locations we will communicate it to TGS.

Based on the most recent information the Service has on Pacific walrus distributions and densities in the Chukchi Sea, the Service anticipates that TGS may encounter large concentrations of walruses along the proposed seismic data acquisition lines within the HSWUA. If TGS proceeds with the proposed seismic data acquisition lines within the HSWUA, because, as noted below, strict compliance with the stipulations of this LOA and the mitigation measures at 50 CFR §18.118 are required, you may not be able to conduct some of your planned operations in the proposed area within the HSWUA.

[1] The 50 % UDs is described in 78 FR 35364 (June 12, 2013) and based on, Jay, C.V., A.S. Fischbach, and A.A. Kochnev. 2012. Walrus areas of use in the Chukchi Sea during sparse sea ice cover. Marine Ecology Progress Series Vol. 468: 1–13, 2012. GIS files available at, https://www.erma.unh.edu/arctic/erma.htm.

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Authorization to operate within the HSWUA is contingent upon strict compliance with 50 CFR §18.118 and all stipulations described LOA 13-CS-03. Specifically, the Service places emphasis upon the following stipulations found in LOA 13-CS-03:

- 9(A)(i), At all times, vessels must maintain the maximum distance possible from concentrations of walruses or polar bears. Under no circumstances, other than an emergency, should any vessel approach within an 805-meter (m) (0.5-mile [mi]) radius of walruses or polar bears observed on ice. Under no circumstances, other than an emergency, should any vessel approach within 1,610 m (1 mi) of groups of walruses observed on land or within an 805-m (0.5-mi) radius of polar bears observed on land;

- 9(A)(ii), Vessel operators must take every precaution to avoid harassment of concentrations of feeding walruses when a vessel is operating near these animals. Vessels should reduce speed and maintain a minimum 805-m (0.5-mi) operational exclusion zone around groups of 12 or more walruses encountered in the water. Vessels may not be operated in such a way as to separate members of a group of walruses from other members of the group. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to walruses;

- 9(C)(v), Adaptive response for walrus aggregations. Whenever an aggregation of 12 or more walruses are detected within an acoustically verified 160 dB re 1 μPa disturbance zone ahead of or perpendicular to the seismic vessel track, the holder of this LOA must;
  (a) Immediately power down or shutdown the seismic airgun array and/or other acoustic sources to ensure sound pressure levels at the shortest distance to the aggregation do not exceed 160–dB re 1 μPa;
  (b) Not proceed with powering up the seismic airgun array until it can be established that there are no walrus aggregations within the 160 dB zone based upon ship course, direction, and distance from last sighting. If shutdown was required, the ramp-up procedures must be followed when restarting;

- 9(E)(iv), Notification of incident report. Reports should include all information specified under the species observation report, as well as a full written description of the encounter and actions taken by the operator. The operator must report to the Service within 24 hours;
  (a) Any incidental lethal take or injury of a polar bear or walrus;
  (b) Observations of walruses or polar bears within prescribed mitigation monitoring zones.

The following additional mitigation and monitoring stipulations are amended to LOA 13-CS-03 during TGS activities within the HSWUA in accordance with 50 CFR §18.118(a)(4)(v):

- TGS must increase observation for Pacific walruses to include a 360° observation radius around all vessels and report on the behavior of observable walruses within that radius

with particular attention to behavior before, during and after a vessel moves past observed walruses;

- TGS must notify the Service within 24 hours if walruses are observed within ½ mile (805 meters) of a vessel;

- TGS must notify the Service within 24 hours if 500 or more walruses are observed within 9.3 mi (15 kilometers) within a 24 hour period (each 24 hour period beginning at midnight of a calendar day) of a vessel; and

- If TGS is not able to implement a mitigation measure the Service must be notified immediately (or as soon as possible) for each incident.

Failure to comply with the stipulations in LOA 13-CS-03 and this letter may result in, but may not be limited to, additional monitoring and mitigation measures, a Notice of Violation from the Service, revocation of authorization to operate within the HSWUA and/or revocation of incidental take authorization for Pacific walruses.

The Service acknowledges the limited information currently available to further specify Pacific walrus locations, distributions and densities in the HSWUA. If TGS is able to provide additional information regarding Pacific walrus locations in addition to the vessel based observations, such as could be gained by reconnaissance, the Service is willing to work cooperatively with TGS to design and implement appropriate cooperative aerial surveys for Pacific walruses, or other survey actions. The Service may be able to modify monitoring and mitigation measures based on any additional information we receive regarding the location, density and distribution of Pacific walruses in the Chukchi Sea and the HSWUA specifically.

The additional monitoring and mitigation requirements to LOA13-CS-03 contained within this letter are effective through October 31, 2013 unless further modified by the Service.

If you have any further questions, please contact Mr. Craig Perham or Mr. Christopher Putnam of our Marine Mammals Management Office, at (907) 786-3810 or (907) 786-3844, respectively.

Sincerely,

Acting Chief, Marine Mammals Management

Enclosure

cc: Ms. Elizabeth Benson, ASRC Energy Services (email)
Ms. Megan Blees, ASRC Energy Services (email)
U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office
U.S. Fish and Wildlife Service, Office of Law Enforcement
North Slope Borough, Department of Law

United States Department of the Interior

BUREAU OF OCEAN ENERGY MANAGEMENT
Alaska OCS Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

AUG - 5 2013

Mr. Troy Nelson
Arcis Seismic Solutions
A TGS company
250 5th Street SW, Suite 2100
Calgary, Alberta T2P 0R4, Canada

Dear Mr. Nelson:

On February 12, 2013, TGS submitted an application to BOEM to obtain a Geological and Geophysical (G&G) permit under the 30 CFR 551 regulations to conduct geophysical exploration operations on certain in Outer Continental Shelf (OCS) lands. The activity is in the Chukchi Sea area shown on the map accompanying your application. TGS will conduct the subject operations using the vessels described in the Operation Plan. Operations are proposed to begin on or after July 15, 2013, and will be completed on or before October 31, 2013. The proposed program is a 2D marine seismic acquisition using airguns as an energy source.

Your application submittal states that TGS has requested an Incidental Harassment Authorization (IHA) from National Marine Fisheries Service (NMFS) for whales and pinnipeds, and a Letter of Authorization (LOA) from US Fish and Wildlife Service (USFWS) for polar bears and walrus. BOEM requires a copy of the IHA and LOA and the Incidental Take Statements (ITS) prior to conducting seismic operations. The IHA and the LOA are in place to resolve subsistence-related concerns and to insure that impacts to marine mammals are not significant. The procedures outlined in these authorizations are required to avoid conflict with subsistence activities which may be conducted during a portion of the time proposed for this seismic operation.

OCS Permit 13-02 is hereby granted to conduct geophysical exploration operations on the OCS in the area and manner described in the application. A detailed track map of planned operations must be submitted to this office prior to the start of seismic operations. All operations are subject to the enclosed stipulations (see attachment 1) and approved Permit for Geophysical Exploration for Mineral Resources on the OCS. In all cases, the specific mitigating measures identified in the NMFS IHA and USFWS LOA will apply and shall supersede any differing BOEM requirements related to marine mammals, including protocols for monitoring programs. Information related to compliance with the provisions in the IHA and LOA and of the Endangered Species Act and the Marine Mammal Protection Act may be obtained from the

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

And from the

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

Regulation 30 CFR 551.6(a)1 requires that your G&G operations must not interfere with or endanger operations being conducted under any lease, right-of-way, easement, right-of-use, Notice, or permit issued or maintained under the OCS Lands Act.

This permit is effective from the date of approval until October 31 2013, or the completion of the survey, whichever occurs earlier. Please be advised that this office requires a weekly report of daily operations (see attachment 2). We will require a completion report as detailed in the permit within 30 days following cessation of field operations.

Sincerely,

Rance R. Wall
Regional Supervisor
Resource Evaluation

Attachment 1
Stipulations
Attachment 2
Weekly Operations Report
Attachment 3
Guidance on Bird Encounter Reporting
Attachment 4
Forms BOEM-0327 and BOEM-0328 Permit

Bureau of Ocean Energy Management
Alaska OCS Region
Seismic Survey G&G Permit Stipulations for Permit 13-02

- No solid or liquid explosives shall be used without specific approval.
- Permittee operations shall be conducted in a manner to ensure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses of the area. If any difficulties are encountered with other uses of the area or any of the above mentioned scenarios occur during operations under this permit, they shall be reported to the Regional Supervisor/Resource Evaluation. Serious or emergency conditions shall be reported without delay.
- The Permittee shall maintain a minimum spacing of 15 miles (24.1 km) between their seismic-source vessels and any other concurrently operating seismic-source vessel to prevent sound interference between surveys. If there is not 15 miles (24.1 km) between seismic-source vessels, one source vessel must cease operations. The BOEM must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum distance.
- Permittee operators shall use the lowest sound levels feasible to accomplish their data-collection needs.
- Vessels and aircraft shall avoid concentrations or groups of marine mammals. Permittee operators shall, at all times, conduct their activities at a maximum distance from such concentrations of marine mammals. Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,500 feet above sea level (ASL) when within 1,500 lateral feet of groups of whales. Helicopters shall not hover or circle above such areas or within 1,500 lateral feet of such areas.
- When weather conditions do not allow a 1,500-foot ASL flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,500-foot ASL altitude stipulated above. However, when aircraft are operated at altitudes below 1,500 feet ASL because of weather conditions, the operator must avoid known marine mammal concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of marine mammals.
- When the Permittee operates a vessel near a concentration of marine mammals, every effort and precaution shall be taken to avoid harassment of these animals. Therefore, vessels shall reduce speed when within 900 feet (274 m) of marine mammals and those vessels capable of steering around such groups should do so. Vessels shall not be operated in such a way as to separate members of a group of marine mammals from other members of the group. This stipulation applies to normal vessel operation while the airguns are not operational.
- Vessel operators shall avoid multiple changes in direction and speed when within 900 feet (274 m) of marine mammals. In addition, operators shall check the waters immediately adjacent to a vessel to ensure that no marine

mammals will be injured when the vessel's propellers (or screws) are engaged.

- Small boats shall not be operated at such a speed as to make collisions with marine mammals likely. When weather conditions require, such as when visibility drops, vessels shall adjust speed accordingly to avoid the likelihood of injury to marine mammals.
- When any operator becomes aware of the potentially harassing effects of operations on marine mammals, or when any operator is unsure of the best course of action to avoid harassment of marine mammals, every measure to avoid further harassment shall be taken until the National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS) is consulted for instructions or directions. However, human safety shall take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of marine mammals.
- The Permittee shall notify BOEM, NMFS, and USFWS in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals and other wildlife resources.
- To help avoid causing bird collisions with seismic survey and support vessels, seismic and surface support vessels will minimize the use of high-intensity work lights, especially within the 20-meter-bathymetric contour. High-intensity lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog), otherwise they shall be turned off. Deck lights, interior lights, and lights used during navigation could remain on for safety.[1]
- All bird collisions (with vessels and aircraft) shall be documented and reported within 3 days to BOEM and BSEE EED (see attachment 3). Each report shall include:
    - Date and time the bird was first observed
    - Location of vessel in decimal degrees
    - Species, identified to lowest possible taxonomic level using standardized AOU codes
    - Weather (at time bird was first observed): wind speed, fog, rain/snow
    - General weather 24 hours prior to bird observation
    - Photographs of each bird labeled according to each record, if practicable. For dead birds, clear images of wing spread, top and bottom, and head views should be provided
    - Vessel operational status: at anchor/adrift or underway/in transit
    - Any indications that lighting may have factored into attracting birds to the vessel (e.g. was extra lighting on because it was dark or a specific activity was ongoing?)
    - Any additional comments on bird behavior, physical description, injury or fate

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

The following monitoring and mitigation measures are related to the requirements of the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA). The mitigation and monitoring requirements defined in any NMFS (the Federal agency having MMPA jurisdiction for cetaceans and pinnipeds, less Pacific walrus) and USFWS (the Federal agency having MMPA jurisdiction for Pacific walrus, polar bear, and sea otter) Incidental Take Authorization (ITA) obtained by the seismic survey operator shall replace and supersede any differing provisions concerning marine mammal measures listed below.

- **Exclusion Zone** – Any exclusion zones specified in ITAs for protection of marine mammals from harassment will be enforced by the BOEM and BSEE EED. The exclusion zones shall be free of marine mammals before the survey can begin and must remain free of marine mammals during the survey. The next four mitigation measures pertain to enforcement of an exclusion zone.
    - **Monitoring of the Exclusion Zone** – Individuals (marine mammal biologists and/or trained observers as designated by the regulating agencies) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free exclusion zone and monitor for avoidance or take behaviors. Visual observers monitor the exclusion zone to ensure that marine mammals do not enter the exclusion zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic-survey work after shut down. The NMFS will set specific requirements for the marine mammal monitoring program and observers.
    - **Shut Down/Power Down** – A seismic survey shall be suspended until the exclusion zone is free of marine mammals. All observers shall have the authority to, and will, instruct the vessel operators to immediately shut down the airgun array whenever a marine mammal is seen within the exclusion zone or to power down to a sound level where the marine mammal in no longer in the exclusion zone. If the airgun array is shut down for any reason during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the exclusion zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.
    - **Ramp Up** – Ramp up is the gradual introduction of sound to deter marine mammals from potentially damaging sound intensities and from approaching the exclusion zone. This technique involves the gradual increase in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of 20 to 40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated when monitoring the exclusion zone is not possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line transects, for maintenance needs or during

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

- **Reporting Requirements** –Operators must report within 24 hours any shut downs/power downs due to a marine mammal entering the exclusion zones and provide the regulating agencies and BOEM and BSEE EED with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the exclusion zones.

- **Spring Lead System** – In order to provide bowhead whale and walrus cow/calf pairs additional protection, and unless authorized under the MMPA by NMFS and FWS, seismic surveys shall not occur in the Chukchi Sea spring lead system before July 1.
- **Ledyard Bay Critical Habitat Unit (LBCHU)** – Except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations or transits shall avoid travel within the Unit between July 1 and November 15. To the maximum extent practicable, aircraft supporting seismic survey operations shall avoid operating below 1,500 feet ASL over the Unit between July 1 and November 15. Vessel travel within the Unit and altitude deviations by aircraft over the Unit for emergencies or human safety shall be reported within 24 hours to BOEM and BSEE EED.
- **Walrus** – Seismic survey operators shall adhere to any mitigation measures identified by the USFWS to protect walruses from being harassed and/or injured.
- **Polar Bear** – Seismic survey operators shall adhere to any mitigation measures identified by the USFWS to protect polar bears from being harassed and/or injured.

Weekly Operations Report for submittal to BOEM

- Weekly Summary Report
  - Map showing data collected to date
  - Summary of operating time by categories listed below
  - Compilation of line Kms or miles and/or sq Kms or sq miles collected
  - Daily record of weather – seas, winds, ice

- Daily operation records will include
  - All dates and times in AK local time
  - Survey name
  - Track line # that data were collected on
  - Start and end time plus total time in that mode for the following categories:
    - Ramp-up
    - Full array on
    - Mitigation gun only
    - Power down; record output in cubic inches if possible
    - Shut down (no guns operating)
  - Reason for shutdowns/power downs – marine mammals (include species if possible), weather, ice, equipment failure, etc.
  - Also provide shape files of the track lines collected during the reporting period including all of the daily information listed above as metadata on a weekly basis.

- Safety Incident Report including any spillage of petroleum products (if applicable) for same time period
- PSO Report for same time period

Send to Pete Sloan, G&G Permitting Coordinator, Alaska Region, BOEM, Pete.Sloan@boem.gov or call 907-334-5328 (office) or 907-382-1134 (cell)

Bureau of Ocean Energy Management
Alaska OCS Region
Guidance on Bird Encounter Reporting

A bird encounter includes any bird found dead or alive on a vessel or those observed contacting the vessel and flying off. A bird perching on ship structures is considered an encounter. Complete a Bird Encounter Form for each of these birds and relay it within 3 days to BOEM.

Routine deck searches for dead or injured birds should be performed, especially during or following periods of darkness or inclement weather (strong winds, rain, fog, etc.) because most vessel:bird encounters occur during periods of darkness and/or inclement weather.

Additional considerations regarding bird handling:

If a bird is on the vessel and remains alive, leave the bird to recover if it is in an area that does not interfere with operations. Make sure the bird can leave the vessel if it wants to or will not move into harm's way. Birds perching on ship structures (such as antennas or rigging) should be allowed to rest and depart on their own.

If a bird needs to be moved, gently place it in a sheltered area (or a cardboard box set on its side) and let the bird depart on its own; about 8 hours should be sufficient. Make sure the bird is in a place where it can depart if it wants to. If the bird does not depart after about 8 hours but is still alive, give it more time if it is not interfering with operations. Eventually, if still alive, gently return a seabird (marine species) to the sea surface. Don't intentionally kill any birds.

Be advised, however, the FWS has asked (not required) that any dead seaducks, **especially spectacled eiders, Steller's eiders, or yellow-billed loons**, be labeled with collision data, packaged, frozen and shipped (usually via GoldStreak – with instructions on the outside of the box to be kept chilled when it arrives in Fairbanks) to:

Chris Latty or **Angela Matz**
U.S. Fish and Wildlife Service
Fairbanks Field Office
101 12th Ave., Room 110
Fairbanks, AK 99701
907-456-0291 or 907-456-0499

It is fine to wait until the end of the survey to ship the frozen birds. Prior to shipping, call one of the numbers listed above to notify someone that a shipment is coming or if there are any questions.

Appendix E
AEWC's CAA

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2013 OPEN WATER SEASON PROGRAMMATIC CONFLICT AVOIDANCE AGREEMENT

BETWEEN

BP EXPLORATION (ALASKA), INC.
ENI US OPERATING COMPANY, INC.
EXXON MOBIL CORPORATION
GX TECHNOLOGY CORP.
PIONEER NATURAL RESOURCES ALASKA, INC.
SAExploration
SHELL OFFSHORE, INC
TGS

AND

THE ALASKA ESKIMO WHALING COMMISSION
THE BARROW WHALING CAPTAINS' ASSOCIATION
THE GAMBELL WHALING CAPTAINS' ASSOCIATION
THE KAKTOVIK WHALING CAPTAINS' ASSOCIATION
THE KIVALINA WHALING CAPTAINS' ASSOCIATION
THE LITTLE DIOMEDE WHALING CAPTAINS' ASSOCIATION
THE NUIQSUT WHALING CAPTAINS' ASSOCIATION
THE PT. HOPE WHALING CAPTAINS' ASSOCIATION
THE PT. LAY WHALING CAPTAINS' ASSOCIATION
THE SAVOONGA WHALING CAPTAINS' ASSOCIATION
THE WAINWRIGHT WHALING CAPTAINS' ASSOCIATION
THE WALES WHALING CAPTAINS' ASSOCIATION

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TITLE I – GENERAL PROVISIONS

SECTION 101. APPLICATION.

Title I applies to all Participants, except as provided in Title VI.

Title II applies to all Participants, except as provided in Titles III or VI.

Title III applies to those Participants who operate barge or transit vessels in the Beaufort Sea or Chukchi Sea.

Titles IV and V apply only to those Participants who engage in oil and gas operations, except as provided in Title VI.

Title VI applies to those Participants who engage exclusively in geophysical activities that are conducted at least 5 miles or more from the Alaska coast in the Beaufort Sea or Chukchi Sea and begin on or after October 1, 2013.

Provisions that apply to a specific activity or are designated as specific to either the Beaufort Sea or Chukchi Sea apply only to Participants that engage in that activity or operate in that area, and provisions applicable to activities a Participant does not engage in or areas in which a Participant does not operate do not apply to that Participant.

SECTION 102. PURPOSE.

The purpose of this Agreement is to provide:

(1) Equipment and procedures for communications between Subsistence Participants and Industry Participants;

(2) Avoidance guidelines and other mitigation measures to be followed by the Industry Participants working in or transiting the vicinity of active subsistence hunters, in areas where subsistence hunters anticipate hunting, or in areas that are in sufficient proximity to areas expected to be used for subsistence hunting that the planned activities could potentially adversely affect the subsistence bowhead whale hunt through effects on bowhead whales;

(3) Measures to be taken in the event of an emergency occurring during the term of this Agreement; and

(4) Dispute resolution procedures.

SECTION 103. DEFINITIONS.

(a) Defined Terms.

For the purposes of this Agreement:

(1) The term “Agreement” means this 2013 Open Water Season Programmatic Conflict Avoidance Agreement and any attachments to such agreement.

(2) The term “at-sea oil and gas operations” does not include gravel islands or fixed platform developments located near shore (for example Northstar or Oooguruk) or Near Shore Operations Support Vessels.

(3) The term “barge” means a non-powered vessel that is pushed or towed, and the accompanying pushing or towing vessel, which is used solely to transport materials through the Beaufort Sea or Chukchi Sea. Such term does not include any vessel used to provide supplies or support to at-sea oil and gas operations or Near Shore Operations Support Vessels.

(4) The term “Com-Center” means a communications systems coordination center established under Section 203.

(5) The term “geophysical activity” means any activity the purpose of which is to gather data for imaging the marine subsurface environment, including but not limited to use of air guns, sonar, and other geophysical equipment used for seismic exploration or shallow hazard identification. “Geophysical activity” does not include support vessels that are not actively employing geophysical equipment, or other supporting activities that do not generate sound waves for the purposes of imaging the subsurface marine environment.

(6) The term “geophysical equipment” means equipment, such as air gun arrays over 300 cubic inches or sparker arrays over 20,000 kJ, employed on a vessel or a towed array, that generates sound waves for the purpose of imaging the subsurface marine environment for exploration and development purposes. The term does not include vessel engines, generators, or sources such as fathometers, fish finders, side-scan sonar, or other sources intended for engineering and /or transportation purposes.

(7) The term “Industry Participants” means all parties to this Agreement who are not Subsistence Participants.

(8) The term “Marine Mammal Observer / Inupiat Communicator” or “MMO/IC” means an observer hired by an Industry Participant for the purpose of spotting and identifying marine mammals in the area of that Industry Participant’s operations during the Open Water Season. The MMO/IC also serves as the on-board Inupiat communicator who can communicate directly with whaling crews.[1]

(9) The term “Near Shore Operations Support Vessels” means vessels (including aircraft) used to support related activities (such as supply, re-supply, crew movement, and facility maintenance) for near shore oil and gas operations by an Industry Participant.

(10) The terms “NSB” and “NSB DWM” mean the North Slope Borough and the North Slope Borough Department of Wildlife Management, respectively.

(11) The term “oil and gas operations” means all oil and gas exploration, development, or production activities (including, but not limited to, geophysical activity, exploratory drilling, development activities (such as dredging or construction), production drilling, or production, and related activities (such as supply, re-supply, crew movements, and facility maintenance) by or for any Industry Participant, including aircraft and vessels of whatever kind used in support of such activities, occurring in the Beaufort Sea or Chukchi Sea, whether occurring near shore or offshore, but does not include barge traffic, transit vessel traffic, cable laying vessel traffic, or research vessel traffic (i.e. traffic by a vessel which is only conducting research and is not conducting any geophysical activities) by or for any Participant.

(12) The term “Open Water Season” means the period of the year when ice conditions permit navigation or oil and gas operations to occur in the Beaufort Sea or Chukchi Sea, as appropriate.

[1] Following the 2013 CAA meeting, a request was put in to change the title of MMO/IC to “Protected Species Observer,” to make the term consistent with the terminology used by the National Science Foundation. The AEWC will raise this suggestion during the 2014 CAA meeting.

(13) The term “Participants” means all parties identified in this Agreement by name and whose representative(s) has signed the Agreement, and all contractors of such parties. When used alone the term includes both Industry Participants and Subsistence Participants.

(14) The term “Primary Sound Source Vessel” means a vessel owned or operated by or for an Industry Participant that (A) employs air gun arrays greater than 300 cubic inches or sparkers greater that 20,000 kJ, for imaging the subsurface environment, (B) is used to monitor any safety zone around a vessel described in subsection (A), (C) is engaged in ice-breaking, or (D) is the lead vessel in a group of barge or transit vessels.

(15) The term “sonar” means equipment, employed as hull mounted or towed array, intended for the active location of surface or underwater vessels. The term does not include vessel engines, generators, or sources such as fathometers, fish finders, side-scan sonar, or other sources intended for engineering, cable laying or routing, and/or transportation purposes.

(16) The term “Subsistence Participants” means the Alaska Eskimo Whaling Commission (AEWC) and its members, including the whaling captains’ associations identified on the cover of this Agreement, as well as any individual members of those associations.

(17) The term “transit vessel” means a powered vessel that is used solely to transport materials through the Beaufort Sea or Chukchi Sea. Such term does not include a vessel used to provide supplies or other support to at-sea oil and gas operations or Near Shore Operations Support Vessels.

(b) Geographically Limited Terms.

For the purposes of this Agreement:

(1) The term “Beaufort Sea” means all waters off the northern coast of Alaska from Point Barrow to the Canadian border.

(2) The term “Chukchi Sea” means all waters off the western and northern coasts of Alaska from Cape Prince of Wales to Point Barrow.

SECTION 104. TERM, SCOPE, AND LIMITATIONS.

(a) Term.

The term of this Agreement shall commence with the signing of this document by the Participants and shall terminate upon completion of the Nuiqsut, Kaktovik, Barrow, Wainwright, Pt Lay, and Pt. Hope Fall Bowhead Hunts or the Beaufort Sea Post Season Meeting required under Section 108(a) and Chukchi Sea Post-Season Meetings in Barrow, Wainwright, Pt. Lay, and Pt. Hope required under Section 108(b), whichever is later.

(b) Scope.

The Participants agree that, unless otherwise specified:

(1) The mitigation measures identified in this Agreement, which are intended to mitigate interference by oil and gas operations and barge and transit vessel traffic with the Alaskan Eskimo subsistence bowhead whale hunt, are designed to apply to all activities of each Participant during the 2013 Open Water Season, whether referenced specifically or by category, and to all vessels and locations covered by this Agreement, whether referenced specifically or by category.

(2) This Agreement is intended to apply to all oil and gas operations and barge and transit vessel traffic during the 2013 Open Water Season in the Beaufort Sea or Chukchi Sea.

(3) Vessels and locations covered by this Agreement include those identified in the Agreement, as well as any other vessels or locations that are employed by or for the Industry Participants in the Beaufort Sea or Chukchi Sea during the 2013 Open Water Season.

(c) Limitations of Obligations.

The following limitations apply to this Agreement.

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

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

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

(4) In the event additional parties engage in oil and gas operations in the Beaufort Sea or Chukchi Sea during the summer or fall of 2013 the Participants shall exercise their good-faith efforts to encourage those parties to enter into this Agreement. Should additional parties enter into this Agreement at a date subsequent to the date of the signing of this document and before the termination of the 2013 bowhead whale subsistence hunting season, the AEWC will provide to all Participants a supplement to this document with the added signatures.

(5) No Participant is responsible for enlisting additional parties to adhere to the terms and conditions of the Agreement. Similarly, **THE AEWC IS NOT RESPONSIBLE FOR, OR A PARTY TO, ANY AGREEMENT AMONG THE INDUSTRY PARTICIPANTS** concerning the apportionment of expenses necessary for the implementation of this Agreement.

(6) In adhering to this Agreement, none of the Participants waives any rights existing at law. All Participants agree that the provisions of this document do not establish any precedent as between them or with any regulatory or permitting authority.

(7) **PARTICIPANTS' OBLIGATIONS SHALL BE SEPARABLE**: All Participants to this Agreement understand that each Participant represents a separate entity. The failure of any Participant to adhere to this Agreement or to abide by the terms and conditions of this Agreement shall not affect the obligation of other Participants to adhere to this Agreement and to proceed accordingly with all activities covered by this Agreement. Nor shall any Participant's adherence to this Agreement affect that Participant's duties, liabilities, or other obligations with respect to any other Participant beyond those stated in this Agreement. If an Industry Participant does not receive permit approvals from regulatory agencies to conduct its proposed activities, then that company may withdraw from this Agreement.

SECTION 105. REGULATORY COMPLIANCE.

(a) United States Coast Guard Requirements.

The Participants shall comply with all applicable United States Coast Guard requirements for safety, navigation, and notice.

(b) Environmental Regulations and Statutes.

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

(c) Other Regulatory Requirements.

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

SECTION 106. DISPUTE RESOLUTION.

Subject to the terms of Section 104(c)(7) of this Agreement, all disputes arising between any Industry Participants and any Subsistence Participants shall be addressed as follows:

(1) The dispute shall first be addressed between the affected Participant(s) in consultation with the affected village Whaling Captains' Association and the Industry Participant(s)' Local Representative.

(2) If the dispute cannot be resolved to the satisfaction of all affected Participants, then the dispute shall be addressed with the affected Participants in consultation with the AEWC.

(3) If the dispute cannot be satisfactorily resolved in accordance with paragraphs (1) and (2) above, then the dispute shall be addressed with the AEWC and the affected Participants in consultation with representatives of NOAA Fisheries.

(4) All Participants shall seek to resolve any disputes in a timely manner, and shall work to ensure that requests for information or decisions are responded to promptly.

SECTON 107. EMERGENCY AND OTHER NECESSARY ASSISTANCE.

(a) Emergency Communications.

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

(b) Emergency Assistance for Subsistence Whale Hunters.

Section 403 of Public Law 107-372 (16 U.S.C. 916c note) provides that "Notwithstanding any provision of law, the use of a vessel to tow a whale, taken in a traditional subsistence whale hunt permitted by Federal law and conducted in waters off the coast of Alaska is authorized, if such towing is performed upon a request for emergency assistance made by a subsistence whale hunting organization formally recognized by an agency of the United States government, or made by a member of such an organization, to prevent the loss of a whale." Industry Participants will advise their vessel captains that, under the circumstances described above, assistance to tow a whale is permitted under law when requested by a Subsistence Participant. Under the circumstances described above, Industry Participants will provide such assistance upon a request for emergency assistance from a Subsistence Participant, if conditions permit the Industry Participant's vessel to safely do so.

SECTION 108. POST-SEASON REVIEW / PRESEASON INTRODUCTION.

(a) Beaufort Sea Post-Season Joint Meeting.

Following the end of the fall 2013 bowhead whale subsistence hunt and prior to the 2013 Pre-Season Introduction Meetings, the Industry Participant that establishes the Deadhorse and Kaktovik Com Centers will offer to the AEWC Chairman to host a joint meeting with all whaling captains of the Villages of Nuiqsut, Kaktovik and Barrow, the Marine Mammal Observer / Inupiat Communicators stationed on the Industry Participants' vessels in the Beaufort Sea, and with the Chairman and Executive Director of the AEWC, at a mutually agreed upon time and place on the North Slope of Alaska, to review the results of the 2013 Beaufort Sea Open Water Season, unless it is agreed by all designated individuals or their representatives that such a meeting is not necessary.

(b) Chukchi Sea Post-Season Village Meetings.

Following the completion of the 2013 Chukchi Sea Open Water Season and prior to the 2014 Pre-Season Introduction Meetings, the Industry Participants involved, if requested by the AEWC or the Whaling Captain's Association of each village, will host a meeting in each of the following villages: Wainwright, Pt. Lay, Pt. Hope, Kivalina, Little Diomede, Wales, Savoonga, and Barrow (or a joint meeting of the whaling captains from all of these villages if the whaling captains agree to a joint meeting) to review the results of the 2013 operations and to discuss any concerns residents of those villages might have regarding the operations. The meetings will include the Marine Mammal Observer / Inupiat Communicators stationed on the Industry Participants' vessels in the Chukchi Sea. The Chairman and Executive Director of the AEWC will be invited to attend the meeting(s).

(c) Pre-season Introduction Meetings.

(1) Immediately following each of the above meetings, and at the same location, the Industry Participants will provide a brief introduction to their planned operations for the 2014 Open Water Season. Each Industry Participant should provide hand-outs explaining their planned activities that the whaling captains can review.

(2) Subsistence Participants understand that any planned operations discussed at these Pre-Season Introduction Meetings, and the corresponding maps, will represent the Industry Participant's best estimate at that time of its planned operations for the coming year, but that these planned operations are preliminary, and are subject to change prior to the 2014 Open Water Season Meeting.

(d) Map of Planned Industry Participant Activities.

As practicable, Industry Participants shall jointly prepare and provide the AEWC with a large-scale map of the Beaufort and Chukchi Seas showing the locations and types of oil and gas and barge and transit activities planned by each Industry Participant. This map will be for use by the AEWC and Industry Participants during the 2014 CAA Meeting.

SECTON 109. INDIVIDUAL NOTIFICATION.

In the event that any Industry Participant does not become a signatory to this Agreement, the local Whaling Captains' Associations shall be notified by the AEWC, no later than March 31, 2013, so that the local Whaling Captains' Associations can prepare to talk with the non-signatories to avoid conflict during that association's fall subsistence bowhead whaling season.

TITLE II -- OPEN WATER SEASON COMMUNICATIONS

SECTION 201. MARINE MAMMAL OBSERVERS / INUPIAT COMMUNICATORS.

(a) Marine Mammal Observer / Inupiat Communicator Required.

(1) In General. Each Industry Participant agrees to employ a Marine Mammal Observer / Inupiat Communicator (MMO/IC) on board each Primary Sound Source Vessel owned or operated by such Industry Participant in the Beaufort Sea or Chukchi Sea. Native residents of the eleven villages represented by the Alaska Eskimo Whaling Commission shall be given preference in hiring for MMO/IC positions.

(2) Special Rule for Inside Beaufort Sea Barrier Islands. Industry Participants whose seismic acquisition operations are limited to an area exclusively within the barrier islands need employ an MMO/IC on one Primary Sound Source Vessel only.

(3) Near Shore Operations Support Vessels. Industry Participants are not required to employ an MMO/IC on Near Shore Operations Support Vessels.

(4) Sealift Operations. For Industry Participants conducting sealift operations in which two tugs towing barges are accompanied within ½ mile by a third light tug at all times, a MMO/IC is required to be employed on the light tug only.

(b) Duties of Marine Mammal Observer / Inupiat Communicator.

(1) Each MMO/IC is to be employed as an observer and Inupiat communicator for the duration of the 2013 Open Water Season on the vessel on which he or she is stationed.

(2) As a member of the crew, the MMO/IC will be subject to the regular code of employee conduct on board the vessel and will be subject to discipline, termination, suspension, layoff, or firing under the same conditions as other employees of the vessel operator or appropriate contractor.

(3) Once the source vessel on which the MMO/IC is employed is in the vicinity of a whaling area and the whalers have launched their boats, the MMO/IC's primary duty will be to carry out the communications responsibilities set out in this Title.

(4) At all other times, the MMO/IC will be responsible for keeping a lookout for bowhead whales and/or other marine mammals in the vicinity of the vessel to assist the vessel captain in avoiding harm to the whales and other marine mammals.

(5) It is the MMO/IC's responsibility to call the appropriate Com-Center as set out in Sections 202 and 203.

(6) The MMO/IC will be responsible for all radio contacts between vessels owned or operated by each of the Industry Participants and whaling boats covered under Section 207 of this Agreement and shall interpret communications as needed to allow the vessel operator to take such action as may be necessary pursuant to this Agreement.

(7) The MMO/IC shall contact directly subsistence whaling boats that may be in the vicinity to ensure that conflicts are avoided to the greatest possible extent.

(8) The MMO/IC will maintain a record of his or her communications with each Com-Center and the subsistence whaling boats, as well as any marine mammal sightings by the MMO/IC.

SECTION 202. COM-CENTER GENERAL COMMUNICATIONS SCHEME.

(a) Reporting Positions for Vessels Owned or Operated by the Industry Participants.

(1) All vessels (other than vessels covered under sections 302 and 602) shall report to the appropriate Com-Center at least once every six hours commencing with a call at approximately 06:00 hours. Each call shall report the following information:

(A) Vessel name, operator of vessel, charter or owner of vessel, and the project the vessel is working on.

(B) Vessel location, speed, and direction.

C) Plans for vessel movement between the time of the call and the time of the next call. The final call of the day shall include a statement of the vessel's general area of expected operations for the following day, if known at that time.

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

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

(3) In the event that the Industry Participant's operation includes seismic data acquisition, the operator reserves the right to restrict exact vessel location information and provide more general location information.

(b) Reporting Positions for Subsistence Whale Hunting Crews.

(1) All subsistence whaling captains shall report to the appropriate Com-Center at the time they launch their boats from shore and again when they return to shore.

(2) All subsistence whaling captains shall report to such Com-Center the initial GPS coordinates of their whaling camps.

(3) Additional communications shall be made on an as needed basis.

(4) Each call shall report the following information:

(A) The crew's location and general direction of travel.

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

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

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

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

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

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

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

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

(c) Responsibilities of Participants.

(1) Monitoring VHF Channel 16.

All vessels covered by Sections 207, 301, and 401 of this Agreement shall monitor marine VHF Channel 16 at all times.

(2) Avoidance of Whale Hunting Crews and Areas

It is the responsibility of each vessel owned or operated by any of the Industry Participants and covered by Sections 301 or 401 of this Agreement to determine the positions of all of their vessels and to exercise due care in avoiding any areas where subsistence whale hunting is active.

(3) Vessel-to-Vessel Communication

After any vessel owned or operated by any of the Industry Participants and covered by Sections 301 or 401 of this Agreement has been informed of or has determined the location of subsistence whale hunting boats in its vicinity, the MMO/IC shall contact those boats in order to coordinate movement and take necessary avoidance precautions.

SECTION 203. THE COMMUNICATIONS SYSTEM COORDINATION CENTERS (COM-CENTERS).

(a) Chukchi Lead System Included in Com-Center Coverage.

In addition to the Beaufort Sea and Chukchi Sea, the communications scheme shall apply in the Chukchi Sea lead system, as identified and excluded from leasing in the current MMS Five-Year Leasing Program, 2007-2012.

(b) Set Up and Operation.

(1) Subject to the terms of Section 104(c) and Section 601 of this Agreement, the Industry Participants conducting operations during the Com-Center operational window specified in Section 203(c) in:

(A) the Beaufort Sea jointly will arrange for the funding of Com-Centers in Deadhorse and Kaktovik; and

(B) the Chukchi Sea jointly will arrange for the funding of Com-Centers in Barrow, Wainwright, Pt. Lay, Pt. Hope, Kivalina, Wales, and St. Lawrence Island.

(2) All nine Com-Centers will be staffed by Inupiat operators. **GROUND TRANSPORTATION MUST BE PROVIDED FOR COM-CENTER OPERATIONS IN KAKTOVIK FOR POLAR BEAR AND BROWN BEAR SAFETY**. The Com-Centers will be operated 24 hours per day during the 2013 subsistence bowhead whale hunt. One Industry Participant in the Beaufort Sea and one Industry Participant in the Chukchi Sea, or their respective contractor, will be designated as the operator of the Com-Centers for that Sea, in consultation with the AEWC.

(3) Each Industry Participant shall contribute to the funding of the Com-Centers covering the areas in which it conducts oil and gas operations. The level of funding for the Com-Centers provided by each of the Industry Participants is intended to be in proportion to the scale of their respective activities, and shall be mutually agreed by the Industry Participants.

(4) The procedures to be followed by the Com-Center operators are set forth in subsection (d) below.

(c) Staffing.

(1) Each Com-Center shall have an Inupiat operator ("Com-Center operator") on duty 24 hours per day from August 15, or one week before the start of the fall bowhead whale hunt in each respective village, until the end of the bowhead whale subsistence hunt in villages listed in subparagraphs (A) through (G) and until the completion of all Industry Participant vessel transits (other than a vessel covered under Title V) in villages listed in subparagraphs (G) through (I):

(A) Kaktovik for the Kaktovik Com-Center;

(B) Nuiqsut for the Deadhorse Com-Center;

(C) Barrow for the Barrow Com-Center;

(D) Wainwright for the Wainwright Com-Center.

(E) Pt. Lay for the Pt. Lay Com-Center, which will be located in the Pt. Lay Whaling Captains' Association building; and

(F) Pt. Hope for the Pt. Hope Com-Center, which will be located in the Pt. Hope Whaling Captains' Association building.

(G) Kivalina for the Kivalina Com-Center.

(H) Wales for the Wales Com-Center.

(I) Gambell or Savoonga for the St. Lawrence Island Com-Center.

(2) All Com-Center staff shall be local hire.

(d) Duties of the Com-Center Operators.

(1) The Com-Center operators shall be available to receive radio and telephone calls and to call vessels as described below. A record shall be made of all calls from every vessel covered by Sections 207, 301, and 401 of this Agreement. Information reported regarding whales struck, lost, landed, or the location of whales struck, lost, or landed, or the number of strikes remaining, shall be confidential and shall not be disclosed to anyone other than the AEWC or the local Whaling Captains' Association. The record of all reporting calls should contain the following information:

(A) Industry Participant Vessel:

(i) Name of caller and vessel.

(ii) Vessel location, speed, and direction.

(iii) Time of call.

(iv) Anticipated movements between this call and the next report.

(v) Reports of any industry or subsistence activities.

(B) Subsistence Whale Hunting Boat:

(i) Name of caller.

(ii) Location of boat or camp.

(iii) Time of call.

(iv) Plans for travel.

(v) Any special information such as caught whale, whale to be towed, or industry vessel conflicts with whale or whaler. Any report of the number of whales struck, lost, or landed, or of the number of strikes remaining, shall be kept confidential and shall not be disclosed by the Com-Center or any Com-Center operator to anyone other than the AEWC or the local Whaling Captains' Association. The location of whales struck, lost, or landed shall be kept confidential and shall not be disclosed except to the extent needed to avoid an Industry/Subsistence Whale Hunter conflict.

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

(A) Name of industry vessel.

(B) Name of subsistence whaling captain.

(C) Location of vessels.

(D) Nature of conflict, data, and time.

(3) If all vessels and boats covered by Sections 207, 301, and 401 of this Agreement have not reported to the appropriate Com-Center within one hour of the recommended time, that Com-Center operator shall attempt to call all non-reporting vessels to determine the information set out above under the Duties of the Com-Center operator.

(4) As soon as location information is provided by a vessel covered by Sections 207, 301, or 401 of this Agreement, the appropriate Com-Center operator shall plot the location and area of probable operations on the large map provided at the Com-Center.

(5) If, in receiving information or plotting it, a Com-Center operator observes that operations by Industry Participants might conflict with subsistence whaling activities, such Com-Center operator shall contact the industry vessel involved and advise the Industry Participant's Local Representative(s) and the vessel operators of the potential conflict.

SECTION 204. STANDARDIZED LOG BOOKS.

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

SECTION 205. COMMUNICATIONS EQUIPMENT.

(a) Communications Equipment to be Provided to Subsistence Whale Hunting Crews.

(1) In General. The Industry Participants will provide (or participate in the provision of) the communications equipment described in paragraphs (4) and (6) of this subsection and subsection (b) of this section.

(2) Beaufort Sea. The Industry Participants funding Com-Centers in Deadhorse and Kaktovik will fund the provision of communications equipment for the whaling captains of Kaktovik and Nuiqsut in the same proportion as they fund those Com-Centers.

(3) Chukchi Sea. The Industry participants conducting operations in the Chukchi Sea will coordinate with each other to participate in funding the provision of communications equipment for the whaling captains of Barrow, Wainwright, Pt. Hope, and Pt. Lay.

(4) All-Channel, Water-Resistant VHF Radios.

These VHF radios are specifically designed for marine use and allow monitoring of Channel 16 while using or listening to another channel.

(A) Kaktovik Subsistence Whaling Boats: 8

(B) Kaktovik Base and Search and Rescue: 2

(C) Nuiqsut Subsistence Whaling Boats: 12

(D) Nuiqsut Base and Search and Rescue: 3

(E) Barrow Base and Search and Rescue: 2

(F) Wainwright Base and Search and Rescue: 2

(G) Wainwright Subsistence Whaling Boats: 4

(H) Pt. Hope Base and Search and Rescue: 2

(I) Pt. Hope Subsistence Whaling Boats: 10

(J) Pt. Lay Base and Search and Rescue: 2

(K) Pt. Lay Subsistence Whaling Boats: 4

(5) Specific VHF Channels For Each Village.

The whaling boats from each of the villages have been assigned individual VHF channels for vessel-to-vessel and vessel-to-Com-Center communications as follows:

(A) Nuiqsut whaling crews will use Channel 68.

(B) Kaktovik whaling crews will use Channel 69.

(C) Barrow whaling crews will use Channel 72.

(D) Wainwright Whaling Crews will use Channel 12.

(E) Pt. Lay Whaling Crews will use Channel 72.

(F) Pt. Hope Whaling Crews will use Channel 68.

(6) Satellite Telephones.

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

A. Kaktovik Base Phones: 2

B. Kaktovik Subsistence Whaling Boats: 8

C. Nuiqsut Base Phones: 2

D. Nuiqsut Subsistence Whaling Boats: 12

E. Barrow Subsistence Whaling Boats: 2

F. Wainwright Subsistence Whaling Boats: 4

G. Pt. Lay Subsistence Whaling Boats: 2

(7) Distribution and Return of Equipment.

The distribution of the VHF radios and satellite telephone equipment to whaling captains for use during the 2013 fall bowhead subsistence whale hunting season shall be completed no later than August 15, 2013. All such units and telephone equipment provided under this Agreement, whether in this section or otherwise, will be returned promptly by the Subsistence Participants to the Industry Participant or the person providing such units and equipment at the end of each Village's 2013 fall bowhead whale subsistence hunt.

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

The Marine Mammal Observer / Inupiat Communicators onboard source vessels owned or operated by the Industry Participants and/or their contractors will also be supplied with all-channel VHF radios. The MMO/ICs have been assigned Channel 7 for their exclusive use in communicating with the Com-Center. Such radios shall be returned upon the completion or termination of the MMO/IC's assignment.

(c) Radio Installation and User Training.

The Whaling Captains of Nuiqsut, Kaktovik, Wainwright, Pt. Lay, and Pt. Hope, with assistance from the Industry Participants, will be responsible for the installation of the VHF radio equipment. The Industry participants will provide (or participate in the provision of) on-site user training for the VHF and satellite telephone equipment on or before August 15, 2013, if requested and as scheduled by the Whaling Captains' Associations of Nuiqsut, Kaktovik, Barrow, Wainwright, Pt. Lay, and Pt. Hope, and the Industry Participant operating the Beaufort Sea Com-Centers or Chukchi Sea Com-Centers**,** as appropriate.

SECTION 206. INDIVIDUALS TO CONTACT.

Listed below are the primary contact names and phone numbers for each of the Participants.

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

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

(2) ENI's Local Representative

Robert Province: Robert.Province@enipetroleum.com 907-865-3350

(3) Exxon Mobil's Local Representative

Anthony Pennino: Anthony.pennino@exxonmobile.com (907) 334-2929

Brien Reep: Brien.e.reep@exxonmobil.com (907) 564-3617

(4) GX Technology's Local Representative

Ed Nelson (832) 344-6852

(5) Pioneer Natural Resources' (Pioneer) Local Representative

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

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

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

(7) STATOIL's Local Representative

Ella Ede: eede@statoil.com (907) 444-3473

(8) SAExploration

TBD

(9) TGS

TBD

(10) The Village of Kaktovik

For purposes of this Agreement, the individuals to contact for the Village of Kaktovik will be: JOSEPH KALEAK at (907) 640-6213 or 640-6515, and CHARLIE M. BROWER at (907) 640-4163 (home), (907) 640-2092 (work), or (907) 640-0052 (cell).

(11) The Village of Nuiqsut

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

(12) The Village of Barrow

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

(13) The Village of Wainwright

For purposes of this Agreement, the individuals to contact for the Village of Wainwright will be: ROSSMAN PEETOOK at (907) 763-4774, and WALTER NAYAKIK at (907)763-2915 (Work).

(14) The Village of Pt. Hope

For purposes of this Agreement, the individuals to contact for the Village of Pt. Hope will be: CHESTER FRANKSON, SR. at (907) 368-2054 (Home).

(15) The Village of Pt. Lay

For purposes of this Agreement, the individuals to contact for the Village of Pt. Lay will be: JULIUS REXFORD (907) 833-4592 (Home), (907) 833-2214 (Work), (907) 833-2320 (Fax), THOMAS NUKAPIAK (907) 833-6467 (Home), (907) 833-3838.

(16) The Village of Kivilina

For the purposes of this Agreement, the individuals to contact for the Village of Kivilina will be: _____.

(17) The Village of Little Diomede

For the purposes of this Agreement, the individuals to contact for the Village of LIttle Diomede will be: _____.

(18) The Village of Wales

For the purposes of this Agreement, the individuals to contact for the Village of Wales will be: _____.

(19) The Village of Savoonga

For the purposes of this Agreement, the individuals to contact for the Village of Savoonga will be: George Noonwook at (907) 984-2461 and Isaac Kulowiyi at (907)984-6123.

(20) The Village of Gambell

For the purposes of this Agreement, the individuals to contact for the Village of Gambell will be: .Merlin Koonooka at (907) 985-5113 or (907) 434-1180 (cell), and Bruce Boolowon at (907) 985-5212.

(21) The AEWC

For purposes of this Agreement, the individuals to contact for the AEWC shall be: JOHNNY AIKEN at (907) 852-2392.

SECTION 207. SUBSISTENCE WHALE HUNTING BOATS.

The following is a list of the number of boats each of the Subsistence Participants plan to use:

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

The subsistence whaling crews of the Village of Nuiqsut plan to use (16) twelve boats for subsistence whale hunting during the late summer and fall of 2013.

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

The subsistence whaling crews of the Village of Kaktovik plan to use (6) eight boats for subsistence whale hunting during the late summer and fall of 2013.

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

The subsistence whaling crews of the Village of Barrow plan to use (34) forty boats for subsistence whale hunting during the late summer and fall of 2013.

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

The subsistence whaling crews of the Village of Wainwright plan to use (4) four boats for subsistence whale hunting during the fall of 2013.

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

The subsistence whaling crews of the Village of Pt. Hope plan to use (14) ten boats for subsistence whale hunting during the late fall of 2013.

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

The subsistence whaling crews of the Village of Pt. Lay plan to use (4) four boats for subsistence whale hunting during the fall of 2013.

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

TITLE III – BARGE AND TRANSIT VESSEL OPERATIONS

SECTION 301. IN GENERAL.

A Participant may employ barges or transit vessels to transport materials through the Beaufort Sea or Chukchi Sea during the term of this Agreement. Any Industry Participant who employs a barge or transit vessel to transport materials through the Beaufort Sea or Chukchi Sea during the term of this Agreement shall require the barge or transit vessel operator to comply with Sections 201, 205(b) and 302 of this Agreement while providing services to that Industry Participant.

SECTION 302. BARGE AND TRANSIT VESSEL OPERATIONS.

(a) Reporting Positions for Barge or Transit Vessels Owned or Operated by industry Participants.

(1) All barge, transit, or cable laying vessels shall report to the appropriate Com-Center at least once every six hours commencing with a call at approximately 06:00 hours. Each call shall report the following information:

(A) Barge, transit, or cable laying vessel name, operator of vessel, charterer or owner of vessel, and the project or entity the vessel is transporting materials for.

(B) Barge, transit, or cable laying vessel location, speed, and direction.

(C) Plans for barge, transit, or cable laying vessel movement between the time of the call and the time of the next call. The final call of the day shall include a statement of the barge or transit vessel's general area of expected operations for the following day, if known at that time.

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

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

(b) Operator Duties.

All barge or transit vessel operators are responsible for the following requirements.

(1) Monitoring VHF Channel 16. All barge and transit vessel operators shall monitor marine VHF Channel 16 at all times.

(2) Avoidance of Whale Hunting Crews and Areas. It is the responsibility of each Industry Participant and barge or transit vessel operator to determine the positions of their barge or transit vessels and to exercise due care in avoiding any areas where subsistence whale hunting is active.

(3) Vessel-to-Vessel Communication. After any barge or transit vessel owned or operated by any Industry Participant has been informed of or has determined the location of subsistence whale hunting boats in its vicinity, the Marine Mammal Observer / Inupiat Communicator shall contact those boats in order to coordinate movement and take necessary avoidance precautions.

(c) Routing Barge and Transit Vessels.

(1) All barge or transit vessel routes shall be planned so as to minimize any potential conflict with bowhead whales or subsistence whaling activities. All barges and transit vessels shall avoid areas of active or anticipated whaling activity, as reported pursuant to Section 202.

(2) Beaufort Sea. Vessels transiting east of Bullen Point to the Canadian border should remain at least five (5) miles offshore during transit along the coast, provided ice and sea conditions allow.

(3) Chukchi Sea. Vessels should remain as far offshore as weather and ice conditions allow, and at all times at least five (5) miles offshore during transit.

(4) Safe Harbor / Loitering. Notwithstanding paragraphs 2 and 3, from August 31 to October 31 vessels in the Chukchi Sea or Beaufort Sea shall remain at least 20 miles offshore of the coast of Alaska from Icy Cape in the Chukchi Sea to Pitt Point on the east side of Smith Bay in the Beaufort Sea whether in transit or engaging in activities in support of oil and gas operations, unless ice conditions or an emergency that threatens the safety of the vessel or crew prevents compliance with this requirement. This paragraph shall not apply to vessels actively engaged in transit to or from a coastal community to conduct crew changes or logistical support operations.

(d) Vessel Speeds.

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

(e) Vessels Operating in Proximity of Bowhead Whales.

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

(1) reducing vessel speed to less than 5 knots within 900 feet of the whale(s);

(2) steering around the whale(s) if possible;

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

(4) operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and

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

(f) Marine Mammal Sighting Data.

Industry Participants whose operations are limited exclusively to barge or vessel traffic will submit to the AEWC and NSB DWM all marine mammal sighting data.

TITLE IV – VESSELS, TESTING, AND MONITORING

SECTION 401. INDUSTRY PARTICIPANT VESSELS AND EQUIPMENT.

(a) List of Vessels and Equipment Required.

Each Industry Participant engaged in oil and gas operations shall provide a list identifying all vessels or other equipment (including but not limited to boats, barges, aircraft, or similar craft) that are owned and/or operated by, or that are under contract to the Industry Participants, for use in the Beaufort Sea or Chukchi Sea for oil and gas operations or for implementation of such Industry Participant's monitoring plan. Vessels and equipment used for oil and gas operations shall be listed in Attachment II, and vessels and equipment used for monitoring plans shall be listed in Attachment III.

(b) Only Listed Vessels and Equipment (or Like Vessels and Like Equipment) May Be Used.

(1) **NONE OF THE INDUSTRY PARTICIPANTS INTENDS TO OPERATE ANY VESSEL OR EQUIPMENT (EXCEPT FOR LIKE VESSELS OR LIKE EQUIPMENT) NOT IDENTIFIED IN THE LISTS REQUIRED UNDER SUBSECTION (a) DURING THE TERM OF THIS AGREEMENT.**

(2) Notwithstanding paragraph 1, if any Industry Participant decides to use different vessels or equipment or additional vessels or equipment, such vessels and equipment shall be used only for purposes identified in Attachments II or III; and the AEWC and the whaling captains of Nuiqsut, Kaktovik, Barrow, Wainwright, Pt. Hope, and Pt. Lay shall be notified promptly through the appropriate Com-Center, as identified in Section 203 of this Agreement, and in writing, of their identity and their intended use, including location of use.

SECTION 402. SOUND SIGNATURE TESTS.

(a) Sound Source Verification Testing.

(1) Geophysical Equipment. For purposes of obtaining a sound signature for Industry Participants' geophysical equipment, the Industry Participants shall have initiated a test of all geophysical equipment within 72 hours of initiating or having initiated operations in the Beaufort Sea or Chukchi Sea. Such tests shall be conducted as set forth in section 402(b).

(2) Vessels. For vessels engaged in geophysical activity, Industry Participants will conduct a sound source verification test for all geophysical equipment used for geophysical activity. Each Industry Participant shall establish a sound source verification range or Industry Participants may participate jointly in establishing a range for the Chukchi Sea and Beaufort Sea, or both. A separate range shall be used for the Chukchi Sea and Beaufort Sea, and vessels shall use the appropriate range for each sea in which they operate. For testing each vessel shall proceed through the range and record information on the date, time, vessel speed, vessel route, vessel load, weather conditions, and equipment operating on the vessel (all noise generating equipment on the vessel, other than geophysical equipment subject to separate testing under paragraph (1), shall be in operation while the vessel is proceeding through the range). The range should be established near a location where details on wind speed and direction are regularly monitored and archived.

(b) Mutual Agreement on Site for Testing; Advance Notice Required.

(1) In General. Each geophysical equipment sound signature test shall be conducted at a site mutually agreed upon by the Industry Participant conducting such test and the AEWC. Each Industry Participant conducting such sound signature test(s) will make a good faith effort to provide three (3) weeks advance notice to the AEWC and the NSB DWM of its intent to perform each test.

(2) Beaufort Sea Testing. For geophysical equipment sound signature tests conducted in the Beaufort Sea, the Industry Participant conducting such tests shall provide transportation for an appropriate number of representatives from: the AEWC, the whaling captains of the Villages of Barrow, Nuiqsut, and Kaktovik, and the NSB DWM to observe the sound signature tests.

(3) Chukchi Sea Testing. For geophysical equipment sound signature tests conducted on vessels to be used in the Chukchi Sea, the Industry Participant(s) conducting such tests shall provide transportation for an appropriate number of representatives from: the AEWC, the whaling captains of the Villages of Barrow, Wainwright, Pt. Lay, and Pt. Hope, and the NSB DWM to observe the sound signature tests.

(c) Sound Signature Data to be Made Available.

(1) Within fourteen (14) days of completing the sound signature field tests for geophysical equipment and within thirty (30) days of the end of the operating season for sound source verification ranges, each Industry Participant and/or its contractor conducting such test(s) will make preliminary and final quality controlled results of the sound signature test(s) available upon request to the AEWC and the NSB DWM. The Industry Participant and/or its contractor will also provide the AEWC and the NSB DWM the preliminary analysis of that data, as well as any other applicable sound signature data that is available and that the AEWC, the NSB DWM, and the Industry Participant agree is relevant to understanding the potential noise impacts of the proposed operations to migrating bowhead whales or other affected marine mammals.

(2) Once completed the final data analysis will be provided to the AEWC and the NSB DWM upon request. The final data report for the sound source verification testing shall be provided to the NSB DWM and the AEWC no later than December 31, 2013.

(3) Any Industry Participant who prepares a model of the sound signature of its vessels and operations, whether before or after the sound signature test, will provide copies of those models and any related analysis to the AEWC and the NSB DWM upon request.

SECTION 403. MONITORING PLANS.

(a) Monitoring Plan Required.

(1) Each Industry Participant agrees to prepare and implement a monitoring plan to collect data designed to determine the potential effects of its oil and gas operations on fall migrating bowhead whales.

(2) The monitoring plans shall be designed in cooperation with the AEWC, the NSB DWM, and NOAA Fisheries, together with the Bureau of Ocean Energy Management (BOEM) when operating in Federal waters. If additional outside review is requested by any of the above entities, the Industry Participant will evaluate the request on a case by case basis.

(b) Beaufort Sea Monitoring Plans.

In the Beaufort Sea, the monitoring plans should focus on the identity, timing, location, and numbers of marine mammals and their behavioral responses to the noise source. The monitoring plans will place emphasis on understanding potential impacts from industrial sounds on bowhead whales.

(c) Chukchi Sea Monitoring Plans.

In the Chukchi Sea, the monitoring plans should focus on the identity, timing, location, and numbers of marine mammals and their behavioral responses to the noise source. The monitoring plans will place emphasis on understanding potential impacts from industrial sounds on bowhead whales.

(d) Use of Prior Information and Peer Reviewed Data.

(1) Prior impact study results shall be incorporated into the monitoring plans prepared by each Industry Participant as applicable.

(2) Each monitoring plan for oil and gas operations shall be subject to peer review by stakeholders on a peer review panel identified by NOAA Fisheries at the 2013 Open Water Season Peer Review Meeting, convened by NOAA Fisheries. Draft plans will be submitted to the NSB DWM and AEWC no later than two weeks prior to the 2013 Open Water Peer Review Meeting.

(e) Raw Data, Communication, and Summary Required.

(1) Each Industry Participant conducting site-specific monitoring will:

(A) after quality control reviews are completed, make electronic data, available to the NSB DWM at the end of the season.

(B) permit and encourage open communications among their contractors and the AEWC and NSB DWM.

(2) Each Industry Participant will submit a summary of monitoring plan results and progress to the AEWC and NSB DWM every two weeks during the operating season.

SECTION 404. CUMULATIVE NOISE IMPACTS STUDY.

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

The study design for the Cumulative Impacts Study shall be developed through a Cumulative Impacts Workshop to be organized by the North Slope Borough in the winter of 2013/2014. The results of this workshop will be presented at the 2014 Open Water Meeting.

TITLE V – AVOIDING CONFLICTS DURING THE OPEN WATER SEASON

Industry Participants are reminded that Sections 101(a)(5)(A) and (D) of the Marine Mammal Protection Act provide, among other things, that the Secretary can authorize the incidental taking of small numbers of marine mammals of a species or population stock if the Secretary finds, among other things, that the total of such takings during the authorized period **will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.**

The following Operating Guidelines apply in the Beaufort Sea and Chukchi Sea, except as otherwise specified and in all cases with due regard to environmental conditions and operational safety. These Operating Guidelines are in addition to any permit restrictions or stipulations imposed by the applicable governmental agencies.

SECTION 501. GENERAL PROVISIONS FOR AVOIDING INTERFERENCE WITH BOWHEAD WHALES OR SUBSISTENCE WHALE HUNTING ACTIVITIES.

(a) Routing Vessels and Aircraft.

(1) All vessel and aircraft routes shall be planned so as to minimize any potential conflict with bowhead whales or bowhead subsistence whaling activities. All vessels shall avoid areas of active or anticipated whaling activity (as reported pursuant to Section 202).

(2) Beaufort Sea. Vessels transiting east of Bullen Point to the Canadian border should remain at least five (5) miles offshore during transit along the coast, provided ice and sea conditions allow.

(3) Chukchi Sea. Vessels should remain as far offshore as weather and ice conditions allow, and at least five (5) miles offshore during transit.

(4) Safe Harbor / Loitering. Notwithstanding paragraphs 2 and 3, from August 31 to October 31 vessels in the Chukchi Sea or Beaufort Sea shall remain at least 20 miles offshore of the coast of Alaska from Icy Cape in the Chukchi Sea to Pitt Point on the east side of Smith Bay in the Beaufort Sea whether in transit or engaging in activities in support of oil and gas operations unless ice conditions or an emergency that threatens the safety of the vessel or crew prevents compliance with this requirement. This paragraph shall not apply to vessels actively engaged in transit to or from a coastal community to conduct crew changes or logistical support operations.

(b) Aircraft Altitude Floor and Flight Path.

(1) AIRCRAFT SHALL NOT OPERATE BELOW 1500 FEET unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or any other emergency situations. Aircraft engaged in marine mammal monitoring shall not operate below 1500 feet in areas of active whaling; such areas to be identified through communications with the Com-Centers.

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

(c) Vessel Speeds.

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

(d) Vessels Operating in Proximity of Bowhead Whales.

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

(1) reducing vessel speed to less than 5 knots within 900 feet of the whale(s);

(2) steering around the whale(s) if possible;

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

(4) operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and

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

SECTION 502. GEOPHYSICAL ACTIVITY LIMITATIONS.

The following operating limitations are to be observed and the operations are to be accompanied by a monitoring plan as set forth in Section 403 and Attachment III of this Agreement. The Industry Participants conducting geophysical activity agree to coordinate the timing and location of such activity so as to reduce, by the greatest extent reasonably possible, the level of noise energy entering the water from such activity at any given time and at any given location.

(a) Limitations on Geophysical Activity in the Beaufort Sea.

All geophysical activity in the Beaufort Sea shall be conducted in accordance with the terms set forth below.

(1) Kaktovik: No geophysical activity from the Canadian Border to the Canning River (146 deg. 4 min. W) from 25 August to close of the fall bowhead whale hunt in Kaktovik and Nuiqsut.[2] From August 10 to August 25, Industry Participants will communicate and collaborate with AEWC on any planned vessel movement in and around Kaktovik and Cross Island to avoid impacts to whale hunt.

(2) Nuiqsut:

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

(i) *Inside the Barrier Islands*: No geophysical activity prior to July 25. Geophysical activity is allowed from July 25 until completion of operations[3]

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

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[2] The bowhead whale subsistence hunt will be considered closed for a particular village when the village Whaling Captains' Association declares the hunt ended or the village quota has been exhausted (as announced by the village Whaling Captains' Association or the AEWC), whichever occurs earlier.

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

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

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

(b) Limitations on Geophysical Activity in the Chukchi Sea.

All geophysical activity in the Chukchi Sea shall be conducted in accordance with the terms set forth below.

(1) Beginning September 15, and ending with the close of the fall bowhead whale hunt,[4] if Wainwright, Pt. Lay, or Pt. Hope intend to whale in the Chukchi Sea, no more than two geophysical activities employing geophysical equipment will occur at any one time in the Chukchi Sea. During the fall bowhead whale hunt, geophysical equipment will not be used by Participants within 30 miles of any point along the Chukchi Sea coastline. Industry Participants will contact the Whaling Captains' Associations of each of those villages to determine if a village is prepared to whale and will notify the AEWC of any response.

(2) Safe harbor will be at sites selected by the Industry Participants and the AEWC. Safe harbor sites will be agreed upon no later than the beginning of operations and shall be listed in Attachment IV. However, a vessel captain will seek safety for his assets (vessel and personnel) as is his duty under the Law of the Sea.

(3) Any vessel operating within 60 miles of the Chukchi Sea coast will follow the communications procedures set forth in Title II of this Agreement. All vessels will adhere to the conflict avoidance measures set forth in Section 501 of this Agreement.

(4) If a dispute should arise, the resolution process set forth in Section 106 of this Agreement shall apply.

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[4] The bowhead whale subsistence hunt will be considered closed when village Whaling Captains' Associations of Wainwright, Pt. Lay, and Pt. Hope have each declared that (A) they do not intend to hunt, (B) their village hunt has ended, or (C) the village quota has been exhausted (as announced by the village Whaling Captains' Association or the AEWC), whichever occurs earlier.

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

(6) Notwithstanding any other provision of this Agreement, any Industry Participant who engages exclusively in geophysical activities that are conducted at least 45 miles or more from the Alaska coast in the Chukchi Sea shall only be responsible for complying with Title I (excluding Sections 104(c)(4) and 108(a) and (b)) and Sections 201, 205(b), 206, 501, and this subsection 502(b) of this Agreement. For the avoidance of doubt, an Industry Participant described in this subsection 502(b) shall be subject to the requirements of Section 203 only to the extent of one Com-Center at the closest community to the seismic acquisition area.

SECTION 503. DRILLING AND PRODUCTION.

(a) Camden Bay.

For exploratory drilling and production between 144 deg. W and the Canning River (~146 deg. 4 min. W), zero discharge of:

(1) drilling fluids;

(2) cuttings after 20” casing;

(3) treated sanitary and gray water; and

(4) ballast and bilge water.

(b) Drilling Operations in the Beaufort Sea East of Cross Island.

No drilling equipment or related vessels used for at-sea oil and gas operations shall be onsite at any offshore drilling location east of Cross Island from 25 August until the close of the bowhead whale hunt in Nuiqsut and Kaktovik. However, such equipment may remain within the Beaufort Sea in the vicinity of 71 degrees 25 minutes N and 146 degrees 4 minutes W., or at the edge of the Arctic ice pack, whichever is closer to shore.

(c) Drilling Operations in the Beaufort Sea West of Cross Island.

In 2013, no drilling equipment or related vessels used for at-sea oil and gas operations shall be moved onsite at any location outside the barrier islands west of Cross Island until the close of the bowhead whale hunt in Barrow.

(d) Oil Spill Mitigation Agreement.

Industry Participants engaged in drilling operations agree to enter into a binding oil spill mitigation agreement with the Alaska Eskimo Whaling Commission, the North Slope Borough, and the Inupiat Community of the Arctic Slope to provide for hunter transport to alternate hunting locations in the event of an oil spill. The agreement shall be attached as Attachment V.

SECTION 504. SHORE-BASED SERVICE AND SUPPLY AREAS.

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

SECTION 505. TERMINATION OF OPERATIONS AND TRANSIT THROUGH THE BERING STRAIT.

Except as provided in Title VI, all Industry Participant vessels shall complete operations in time to allow such vessels to complete transit through the Bering Strait to a point south of 59 degrees North latitude no later than November 15, 2013. Any Industry Participant vessel that encounters weather or ice that will prevent compliance with the date in the preceding sentence shall coordinate its transit through the Bering Strait to a point south of 59 degrees North latitude with the appropriate Com-Centers listed in Section 203. All Industry Participant vessels shall, weather and ice permitting, transit east of St. Lawrence Island and no closer than 10 miles from the shore of St. Lawrence Island.

TITLE VI – LATE SEASON SEISMIC OPERATIONS

SECTION 601. IN GENERAL.

Notwithstanding any other provision of this Agreement, any Industry Participant who engages exclusively in geophysical activities that are conducted at least 5 miles or more from the Alaska coast in the Beaufort Sea or Chukchi Sea and begin on or after October 1, 2013 shall only be responsible to comply with Title I (excluding Sections 104(c)(4) and 108(a) and (b)) and Sections 201, 205(b), 206, 502(a), and 602 of this Agreement. For the avoidance of doubt, an Industry Participant described in this Section 601 shall not be subject to the requirements of Section 203 including but not limited to funding of Com-Centers, providing certain equipment, training and providing representatives as designated operators of Com-Centers.

SECTION 602. VESSEL OPERATIONS.

(a) Reporting Positions When Vessels Come Within 40 Miles of the Coast.

(1) A vessel subject to this section operating within 40 miles of the Alaska coast shall report to the appropriate Com-Center, if open, at least once every six hours commencing with a call at approximately 06:00 hours. Each call shall report the following information:

(A) Vessel name, operator of vessel, charter or owner of vessel, and the project or entity the vessel is conducting operations for.

(B) Vessel location, speed, and direction.

(C) Plans for vessel movement between the time of the call and the time of the next call. The final call of the day shall include a statement of the vessel's general area of expected operations for the following day, if known at that time.

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

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

(b) Operator Duties.

All vessel operators subject to this title are responsible for the following requirements.

(1) Monitoring VHF Channel 16. All vessel operators shall monitor marine VHF Channel 16 at all times.

(2) Avoidance of Whale Hunting Crews and Areas. It is the responsibility of each Industry Participant and vessel operator to determine the positions of their vessels and to exercise due care in avoiding any areas where subsistence whale hunting is active.

(3) Vessel-to-Vessel Communication. After any vessel owned or operated by any Industry Participant has been informed of or has determined the location of subsistence whale hunting boats in its vicinity**,** the Marine Mammal Observer / Inupiat Communicator shall contact those boats in order to coordinate movement and take necessary avoidance precautions.

(c) Routing Vessels.

(1) All vessel routes within 40 miles of the Alaska coast shall be planned so as to minimize any potential conflict with bowhead whales or subsistence whaling activities. All vessels shall avoid areas of active or anticipated whaling activity, as reported pursuant to Section 202.

(2) Beaufort Sea. Vessels transiting east of Bullen Point to the Canadian border should remain at least five (5) miles offshore during transit along the coast, provided ice and sea conditions allow.

(3) Chukchi Sea. Vessels should remain as far offshore as weather and ice conditions allow, and at all times at least five (5) miles offshore during transit.

(4) Safe Harbor / Loitering. Notwithstanding paragraphs 2 and 3, from August 31 to October 31 vessels in the Chukchi Sea or Beaufort Sea shall remain at least 20 miles offshore of the coast of Alaska from Icy Cape in the Chukchi Sea to Pitt Point on the east side of Smith Bay in the Beaufort Sea whether in transit or engaging in activities in support of oil and gas operations unless ice conditions or an emergency that threatens the safety of the vessel or crew prevents compliance with this requirement.

(d) Vessel Speeds.

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

(e) Vessels Operating in Proximity of Bowhead Whales.

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

(1) reducing vessel speed to less than 5 knots within 900 feet of the whale(s);

(2) steering around the whale(s) if possible;

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

(4) operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and

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

(f) Marine Mammal Sighting Data.

Industry Participants whose operations are subject to this title will submit to the AEWC and NSB DWM all marine mammal sighting data.

TITLE VII – PARTICIPANTS

This Agreement shall be binding and effective when signed by the duly authorized representatives of the Participants. Signatures may be by facsimile on separate pages.

George Noongwook
AEWC Chairman
Dated: _____

Harry Brower, Jr.
AEWC Commissioner for Barrow
Dated: _____

Merlin Koonooka
AEWC Commissioner for Gambell
Dated: 03/13/13

Joseph Kaleak
AEWC Commissioner for Kaktovik
Dated: _____

Raymond Hawley
AEWC Commissioner for Kivalina
Dated: _____

Ronald Ozenna, Jr.
AEWC Commissioner for Little Diomede
Dated: _____

TITLE V!I – PARTICIPANTS

This Agreement shall be binding and effective when signed by the duly authorized representatives of the Participants. Signatures may be by facsimile on separate pages.

_____	Harry Brower
George Noongwook	Harry Brower, Jr.
AEWC Chairman	AEWC Commissioner for Barrow
Dated: _____	Dated: 6 March 2013
_____	_____
Merlin Koonooka	Joseph Kaleak
AEWC Commissioner for Gambell	AEWC Commissioner for Kaktovik
Dated: _____	Dated: _____
_____	_____
Raymond Hawley	Ronald Ozenna, Jr.
AEWC Commissioner for Kivalina	AEWC Commissioner for Little Diomede
Dated: _____	Dated: _____

907-852-2505 FAX

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_____	_____
George Noongwook	Harry Brower, Jr.
AEWC Chairman	AEWC Commissioner for Barrow
Dated: _____	Dated: _____
_____	Joseph Kaleak
Merlin Koonooka	Joseph Kaleak
AEWC Commissioner for Gambell	AEWC Commissioner for Kaktovik
Dated: _____	Dated: 3-12-13
_____	_____
Raymond Hawley	Ronald Ozenna, Jr.
AEWC Commissioner for Kivalina	AEWC Commissioner for Little Diomede
Dated: _____	Dated: _____

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AEWC Chairman
Dated: _____

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AEWC Commissioner for Barrow
Dated: _____

Merlin Koonooka
AEWC Commissioner for Gambell
Dated: _____

Joseph Kaleak
AEWC Commissioner for Kaktovik
Dated: _____

Raymond Hawley
AEWC Commissioner for Kivalina
Dated: 3-14-13

Ronald Ozenna, Jr.
AEWC Commissioner for Little Diomede
Dated: _____

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AEWC Chairman
Dated: _____

Harry Brower, Jr.
AEWC Commissioner for Barrow
Dated: _____

Merlin Koonooka
AEWC Commissioner for Gambell
Dated: _____

Joseph Kaleak
AEWC Commissioner for Kaktovik
Dated: _____

Raymond Hawley
AEWC Commissioner for Kivalina
Dated: _____

Ronald Ozenna
Ronald Ozenna, Jr.
AEWC Commissioner for Little Diomede
Dated: March 27-13

Isaac Nukapigak
AEWC Commissioner for Nuiqsut
Dated: 3/11/13

Rex A. Rock, Sr.
AEWC Commissioner for Pt. Hope
Dated: _____

Julius Rexford
AEWC Commissioner for Pt. Lay
Dated: _____

John Hopson, Jr.
AEWC Commissioner for Wainwright
Dated: _____

Luther Komonaseak
AEWC Commissioner for Wales
Dated: _____

Isaac Nukapigak
AEWC Commissioner for Nuiqsut
Dated: _____

Rex A. Rock, Sr.
AEWC Commissioner for Pt. Hope
Dated: 3/15/2013

Julius Rexford
AEWC Commissioner for Pt. Lay
Dated: _____

John Hopson, Jr.
AEWC Commissioner for Wainwright
Dated: _____

Luther Komonaseak
AEWC Commissioner for Wales
Dated: _____

Isaac Nukapigak
AEWC Commissioner for Nuiqsut
Dated: _____

Rex A. Rock, Sr.
AEWC Commissioner for Pt. Hope
Dated: _____

Julius Rexford
AEWC Commissioner for Pt. Lay
Dated: _____

John Hopson, Jr.
AEWC Commissioner for Wainwright
Dated: _____

Luther Komonaseak
AEWC Commissioner for Wales
Dated: _____

Isaac Nukapigak
AEWC Commissioner for Nuiqsut
Dated: _____

Rex A. Rock, Sr.
AEWC Commissioner for Pt. Hope
Dated: _____

Julius Rexford
AEWC Commissioner for Pt. Lay
Dated: _____

John Hopson, Jr.
AEWC Commissioner for Wainwright
Dated: 3/12/13

Luther Komonaseak
AEWC Commissioner for Wales
Dated: _____

Isaac Nukapigak
AEWC Commissioner for Nuiqsut
Dated: _____

Rex A. Rock, Sr.
AEWC Commissioner for Pt. Hope
Dated: _____

Julius Rexford
AEWC Commissioner for Pt. Lay
Dated: _____

John Hopson, Jr.
AEWC Commissioner for Wainwright
Dated: _____

Luther Komonaseak
AEWC Commissioner for Wales
Dated: 03-14-13

Name:
BP Exploration (Alaska) Inc.
Dated: _____

Name:
ENI US Operating Company
Dated: _____

Name:
Exxon Mobil Corporation
Dated: _____

Name:
GX Technology Corp.
Dated: _____

Name:
Pioneer Natural Resources Alaska
Dated: _____

Name:
Shell Offshore, Inc.
Dated: _____

Name:
SAExploration
Dated: _____

Name:
TGS-NOPEC Geophysical Company
Dated: 21·MAY·2013

ATTACHMENT I -- LOCAL SAR CONTACTS

LOCAL SEARCH AND RESCUE ORGANIZATIONS -

CONTACT PERSONS
(IN EMERGENCIES, ALWAYS DIAL 911)

North Slope Borough
Search and Rescue (Pilots)

Director Hugh Patkotak		852-2822 WK
		852-4844 Home

Barrow Volunteer
Search and Rescue Station 852-2808 OFS

President	Oliver Leavitt	852-7032 WK
		852-7032 Home
Vice-Pres.	Price Brower	852-8633 WK
		852-7848 Home
Secretary	Lucille Adams	852-0250 Wk
		852-7200 Home
Treasurer	Eli Solomon	852-2808 Wk
		852-6261 Home
Coordinator	Arnold Brower, Jr.	852-0290 WK
		852-5060 Home
Director	Jimmy Nayakik	852-0200 WK
		852-JENS Home

Director	Johnny Adams	852-0250 WK 852-7724 Home

Nuiqsut Volunteer
Search and Rescue Station 480-6613 (Fire Hall)

Kaktovik Volunteer
Search and Rescue Station 640-6212 (Fire Hall)

President	Lee Kayotuk	640-5893 Wk 640-6213 Home
Vice-Pres.	Tom Gordon	640-
Secretary	Nathan Gordon	640-6925
Treasurer	Don Kayotuk	640-2947
Fire Chief	George T. Tagarook	640-6212 WK 640-6728 Home

Wainwright Volunteer Search and Rescue

President	Joe Ahmaogak Jr.	763-2826 Home
Vice President	John Hopson, Jr.	763-3464 Home
Secretary	Raymond Negovanna	763-2102 Home
Treasurer	Ben Ahmaogak, Jr.	763-3030 Home
Director	Artic Kittick	763-2534 Home
Director	John Akpik	Unlisted

Pt. Hope Volunteer Search and Rescue

Coordinator	Willard Hunnicutt, Jr.	368-2774Work
Fire Chief	Willard Hunnicutt, Jr.	368-2774 Work (Note: Only contact for Pt. Hope)

North Slope Borough Disaster Relief Coordinator

Frederick Brower	852-0284 OFS

ATTACHMENT II -- OPERATIONS VESSELS

VESSELS TO BE USED FOR AND IN SUPPORT OF INDUSTRY PARTICIPANTS' OPERATIONS AS IDENTIFIED IN SECTION 401(b)(1)(B)

[ALL VESSELS TO BE IDENTIFIED BY COMPANY]

NOTE:

COPY OF PRESENTATION OF THE INDUSTRY PARTICIPANT ATTACHED

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

ATTACHMENT III -- MONITORING VESSELS

VESSELS TO BE USED
FOR AND IN SUPPORT
OF THE INDUSTRY PARTICIPANTS MONITORING PLANS
AS IDENTIFIED IN SECTION 401(b)(1)(B)

[ALL VESSELS TO BE IDENTIFIED BY COMPANY]

NOTE:

COPY OF PRESENTATION OF THE INDUSTRY PARTICIPANT

ATTACHED

IDENTIFYING VESSELS TO BE USED FOR AND IN SUPPORT OF THE

INDUSTRY PARTICIPANTS' MONITORING PLAN.

ATTACHMENT IV -- SAFE HARBOR

ATTACHMENT V -- OIL SPILL MITIGATION

Appendix F
Sighting Table

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Table F-1: Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
26-Aug-2013	Geo Arctic	Other	1	Unid. whale	1	1,026	Breach	None
27-Aug-2013	Norseman	Other	1	Minke whale	1	*200*	Breach	None
27-Aug-2013	Geo Arctic	Other	2	Gray whale	3	624	Travel	None
27-Aug-2013	Geo Arctic	Other	3	Unid. whale	1	1,983	Travel	None
27-Aug-2013	Geo Arctic	Other	4	Gray whale	3	1,209	Travel	None
27-Aug-2013	Norseman	Other	2	Spotted seal	2	*183*	Look	Look at Vessel
27-Aug-2013	Norseman	Other	3	Spotted seal	1	*161*	Look	Look at Vessel
27-Aug-2013	Geo Arctic	Other	5	Unid. seal	2	390	Swim	None
27-Aug-2013	Geo Arctic	Other	6	Spotted seal	1	180	Travel	Change Direction
28-Aug-2013	Norseman	Other	4	Ringed seal	1	*50*	Look	Change Direction
28-Aug-2013	Norseman	Other	5	Minke whale	1	*5*	Dive	None
28-Aug-2013	Geo Arctic	Deploying Gear	7	Unid. whale	1	10,126	Unknown	None
28-Aug-2013	Geo Arctic	Seismic Testing (3,280)	8	Unid. whale	2	2,911	Blow	None
29-Aug-2013	Norseman	Other	6	Unid. mysticete whale	2	*749*	Swim	None
29-Aug-2013	Geo Arctic	Other	9	Unid. whale	1	1,744	Swim	None
30-Aug-2013	Norseman	Other	7	Pacific walrus	1	*1,744*	Dead	None
31-Aug-2013	Norseman	Other	8	Unid. seal	1	*75*	Look	Look at Vessel
31-Aug-2013	Geo Arctic	Line Shooting (3,280)	10	Bearded seal	1	179	Swim	Look at Vessel
1-Sep-2013	Geo Arctic	Other	11	Minke whale	1	267	Porpoise	None
2-Sep-2013	Norseman	Other	9	Unid. seal	1	*100*	Rest	Rush
2-Sep-2013	Norseman	Other	10	Spotted seal	1	*75*	Look	Look at Vessel
4-Sep-2013	Norseman	Other	11	Spotted seal	1	*50*	Look	Look at Vessel
4-Sep-2013	Norseman	Other	12	Bearded seal	1	*100*	Look	Look at Vessel
4-Sep-2013	Norseman	Other	13	Bowhead whale	1	*200*	Travel	None
4-Sep-2013	Norseman	Other	14	Unid. seal	1	*100*	Look	Look at Vessel
4-Sep-2013	Norseman	Other	15	Unid. seal	1	*150*	Dive	Increase Speed
4-Sep-2013	Norseman	Other	16	Spotted seal	1	*100*	Surface Active - Travel	Increase Speed
5-Sep-2013	Geo Arctic	Line Shooting (3,280)	12	Pacific walrus	1	551	Swim	None
8-Sep-2013	Norseman	Other	17	Spotted seal	1	*50*	Look	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
9-Sep-2013	Geo Arctic	Ramp-up (3,280)	13	Unid. seal	1	858	Swim	None
9-Sep-2013	Norseman	Other	18	Unid. seal	1	*100*	Swim	Look at Vessel
9-Sep-2013	Geo Arctic	Line Shooting (3,280)	14	Unid. seal	1	182	Swim	None
9-Sep-2013	Norseman	Other	19	Spotted seal	1	*100*	Swim	Look at Vessel
9-Sep-2013	Geo Arctic	Shooting Off-line (60)	15	Unid. seal	1	460	Look	Look at Vessel
9-Sep-2013	Norseman	Other	20	Unid. seal	1	*200*	Travel	None
9-Sep-2013	Norseman	Other	21	Spotted seal	1	*212*	Look	None
9-Sep-2013	Norseman	Other	22	Spotted seal	1	*252*	Look	None
9-Sep-2013	Norseman	Other	23	Spotted seal	1	*200*	Look	None
9-Sep-2013	Norseman	Other	24	Spotted seal	1	*25*	Surface Active - Travel	None
9-Sep-2013	Norseman	Other	25	Spotted seal	1	*118*	Look	Look at Vessel
9-Sep-2013	Norseman	Other	26	Spotted seal	2	*100*	Look	Look at Vessel
10-Sep-2013	Norseman	Other	27	Unid. pinniped	1	*150*	Look	Look at Vessel
10-Sep-2013	Norseman	Other	28	Pacific walrus	2	*150*	Look	Change Direction
10-Sep-2013	Norseman	Other	29	Pacific walrus	20	*1,000*	Rest	None
10-Sep-2013	Norseman	Other	30	Pacific walrus	5	*200*	Surface Active	None
10-Sep-2013	Norseman	Other	31	Pacific walrus	3	*2,000*	Rest	None
10-Sep-2013	Norseman	Other	32	Pacific walrus	1	*108*	Surface Active - Travel	Change Direction
10-Sep-2013	Norseman	Other	33	Pacific walrus	1	*311*	Blow	None
10-Sep-2013	Norseman	Other	34	Pacific walrus	1	*300*	Surface Active	Look at Vessel
10-Sep-2013	Norseman	Other	35	Pacific walrus	1	*1,046*	Blow	None
12-Sep-2013	Norseman	Other	36	Spotted seal	1	*100*	Surface Active	Look at Vessel
13-Sep-2013	Norseman	Other	37	Pacific walrus	6	*749*	Surface Active	None
13-Sep-2013	Geo Arctic	Line Shooting (3,280)	16	Pacific walrus	5	639	Swim	None
13-Sep-2013	Geo Arctic	Other	17	Pacific walrus	3	401	Rest	None
13-Sep-2013	Geo Arctic	Other	18	Bearded seal	1	423	Swim	None
13-Sep-2013	Norseman	Other	38	Pacific walrus	2	*406*	Surface Active	Look at Vessel
14-Sep-2013	Geo Arctic	Line Shooting (3,280)	19	Unid. pinniped	1	164	Dead	None
15-Sep-2013	Norseman	Other	39	Pacific walrus	3	*75*	Sink	Increase Speed

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
15-Sep-2013	Norseman	Other	40	Pacific walrus	1	*250*	Travel	None
15-Sep-2013	Norseman	Other	41	Pacific walrus	1	*311*	Look	None
15-Sep-2013	Norseman	Other	42	Unid. pinniped	2	*252*	Look	None
15-Sep-2013	Norseman	Other	43	Pacific walrus	2	*200*	Surface Active	Increase Speed
15-Sep-2013	Norseman	Other	44	Pacific walrus	3	*406*	Surface Active	None
15-Sep-2013	Norseman	Other	45	Pacific walrus	1	*406*	Surface Active	None
15-Sep-2013	Geo Arctic	Line Shooting (3,280)	20	Pacific walrus	2.00	510	Swim	Look at Vessel
15-Sep-2013	Norseman	Other	46	Unid. mysticete whale	1	*1,744*	Travel	None
15-Sep-2013	Norseman	Other	47	Unid. pinniped	1	*200*	Look	None
15-Sep-2013	Norseman	Other	48	Pacific walrus	2	*252*	Surface Active	Increase Speed
15-Sep-2013	Geo Arctic	Other	21	Pacific walrus	3.00	371	Swim	None
15-Sep-2013	Geo Arctic	Shooting Off-line (60)	22	Pacific walrus	2.00	193	Swim	Look at Vessel
16-Sep-2013	Norseman	Other	49	Bowhead whale	2	*1,046*	Travel	None
16-Sep-2013	Geo Arctic	Line Shooting (3,280)	23	Unid. whale	2.00	8,526	Swim	None
16-Sep-2013	Norseman	Other	50	Bowhead whale	2	*1,744*	Travel	None
18-Sep-2013	Norseman	Other	51	Unid. seal	1.00	*75*	Surface Active - Travel	Increase Speed
23-Sep-2013	Norseman	Other	52	Unid. seal	1	*100*	Surface Active - Travel	None
23-Sep-2013	Geo Arctic	Line Shooting (3,280)	24	Unid. whale	2	4,930	Surface Active - Travel	None
24-Sep-2013	Norseman	Other	53	Bowhead whale	2	*1,744*	Travel	None
24-Sep-2013	Norseman	Other	54	Bowhead whale	3	*1,046*	Travel	None
24-Sep-2013	Norseman	Other	55	Unid. mysticete whale	2	*900*	Surface Active - Travel	None
24-Sep-2013	Norseman	Other	59	Bowhead whale	5	*1,500*	Fluke	None
24-Sep-2013	Norseman	Other	56	Bowhead whale	2	*900*	Blow	None
24-Sep-2013	Norseman	Other	58	Unid. mysticete whale	1	*1,000*	Swim	None
24-Sep-2013	Geo Arctic	Recovering Gear	25	Unid. whale	2	4,466	Blow	None
24-Sep-2013	Norseman	Other	57	Bowhead whale	6	*2,000*	Blow	None
24-Sep-2013	Norseman	Other	60	Bowhead whale	1	*2,000*	Travel	None
24-Sep-2013	Norseman	Other	61	Bowhead whale	1	*1,000*	Blow	None
24-Sep-2013	Norseman	Other	62	Bowhead whale	1	*300*	Blow	None

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
24-Sep-2013	Norseman	Other	63	Bowhead whale	1	*300*	Blow	None
24-Sep-2013	Norseman	Other	64	Bowhead whale	2	*500*	Blow	None
24-Sep-2013	Norseman	Other	68	Unid. mysticete whale	1	*2,000*	Blow	None
24-Sep-2013	Norseman	Other	65	Unid. mysticete whale	1	*1,046*	Blow	None
24-Sep-2013	Norseman	Other	66	Unid. mysticete whale	1	*2,668*	Blow	None
24-Sep-2013	Norseman	Other	67	Bowhead whale	3	*1,000*	Surface Active	None
24-Sep-2013	Norseman	Other	69	Bowhead whale	2	*200*	Swim	None
24-Sep-2013	Norseman	Other	70	Bowhead whale	2	*300*	Blow	None
24-Sep-2013	Norseman	Other	71	Bowhead whale	2	*400*	Surface Active	None
24-Sep-2013	Norseman	Other	72	Bowhead whale	4	*1,744*	Fluke	None
24-Sep-2013	Norseman	Other	73	Unid. mysticete whale	3	*1,000*	Blow	None
24-Sep-2013	Norseman	Other	74	Bowhead whale	2	*400*	Blow	None
24-Sep-2013	Norseman	Other	75	Unid. mysticete whale	1	*1,000*	Blow	None
24-Sep-2013	Norseman	Other	76	Bowhead whale	1	*700*	Blow	None
24-Sep-2013	Norseman	Other	77	Bowhead whale	1	*100*	Surface Active - Travel	Change Direction
24-Sep-2013	Norseman	Other	78	Bowhead whale	1	*500*	Surface Active - Travel	None
24-Sep-2013	Norseman	Other	79	Unid. mysticete whale	2	*1,200*	Blow	None
24-Sep-2013	Norseman	Other	80	Unid. mysticete whale	1	*1,000*	Blow	None
24-Sep-2013	Norseman	Other	81	Bowhead whale	3	*584*	Blow	None
24-Sep-2013	Norseman	Other	82	Bowhead whale	3	*300*	Blow	None
24-Sep-2013	Norseman	Other	83	Bowhead whale	2	*300*	Surface Active - Travel	None
24-Sep-2013	Norseman	Other	84	Bowhead whale	2	*406*	Travel	None
24-Sep-2013	Norseman	Other	85	Bowhead whale	1	*749*	Blow	None
24-Sep-2013	Norseman	Other	86	Unid. mysticete whale	4	*2,500*	Surface Active - Travel	None
24-Sep-2013	Geo Arctic	Recovering Gear	26	Unid. whale	1	4,364	Blow	None
24-Sep-2013	Norseman	Other	87	Bowhead whale	2	*700*	Surface Active - Travel	None
24-Sep-2013	Norseman	Other	88	Bowhead whale	1	*500*	Blow	None
24-Sep-2013	Norseman	Other	89	Bowhead whale	1	*700*	Surface Active - Travel	None
24-Sep-2013	Norseman	Other	90	Bowhead whale	3	*406*	Surface Active - Travel	None

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
24-Sep-2013	Norseman	Other	91	Bowhead whale	1	*1,000*	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	27	Unid. whale	1	12,593	Breach	None
24-Sep-2013	Norseman	Other	92	Pacific walrus	2	*400*	Swim	Look at Vessel
24-Sep-2013	Norseman	Other	93	Bearded seal	1	*100*	Look	Look at Vessel
24-Sep-2013	Geo Arctic	Recovering Gear	28	Unid. whale	2	4,750	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	29	Unid. whale	1	3,266	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	30	Unid. whale	5	4,899	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	31	Unid. whale	2	569	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	32	Unid. whale	1	1,038	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	33	Unid. whale	2	1,954	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	34	Unid. whale	1	1,181	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	35	Unid. whale	2	6,409	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	36	Unid. whale	2	1,807	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	37	Unid. whale	2	4,050	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	38	Unid. whale	4	1,983	Blow	None
24-Sep-2013	Norseman	Other	94	Bowhead whale	1.00	*1,046*	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	39	Unid. whale	1	2,226	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	40	Unid. whale	1	2,848	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	41	Unid. whale	1	4,216	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	42	Bowhead whale	1	732	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	43	Unid. whale	1	2,911	Blow	None
24-Sep-2013	Geo Arctic	Recovering Gear	44	Unid. whale	1	4,088	Blow	None
25-Sep-2013	Norseman	Other	95	Unid. seal	1	*50*	Dive	None
25-Sep-2013	Norseman	Other	96	Unid. seal	1	*50*	Dive	None
25-Sep-2013	Norseman	Other	97	Unid. seal	1	*399*	Look	None
25-Sep-2013	Norseman	Other	98	Spotted seal	1	*230*	Look	Look at Vessel
25-Sep-2013	Norseman	Other	99	Unid. seal	1	*584*	Swim	Look at Vessel
25-Sep-2013	Norseman	Other	100	Unid. seal	1	*50*	Look	None
25-Sep-2013	Norseman	Other	101	Unid. seal	1	*252*	Look	None

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
25-Sep-2013	Norseman	Other	102	Unid. seal	1	*250*	Look	Look at Vessel
25-Sep-2013	Norseman	Other	103	Spotted seal	1	*252*	Travel	None
25-Sep-2013	Norseman	Other	104	Unid. seal	1	*130*	Swim	None
25-Sep-2013	Geo Arctic	Other	45	Pacific walrus	2	448	Swim	Look at Vessel
25-Sep-2013	Geo Arctic	Other	46	Pacific walrus	2	300	Swim	Change Direction
25-Sep-2013	Geo Arctic	Other	47	Pacific walrus	4	793	Swim	None
25-Sep-2013	Geo Arctic	Other	48	Unid. mysticete whale	3	667	Blow	None
25-Sep-2013	Geo Arctic	Other	49	Pacific walrus	4	240	Surface Active - Travel	Increase Speed
25-Sep-2013	Norseman	Other	105	Pacific walrus	2	*30*	Swim	None
25-Sep-2013	Norseman	Other	106	Pacific walrus	2	*406*	Swim	None
25-Sep-2013	Norseman	Other	107	Pacific walrus	7	*100*	Travel	None
25-Sep-2013	Geo Arctic	Other	50	Pacific walrus	2	177	Look	Look at Vessel
25-Sep-2013	Norseman	Other	108	Pacific walrus	3	*252*	Travel	None
25-Sep-2013	Norseman	Other	109	Spotted seal	1	*100*	Look	None
25-Sep-2013	Geo Arctic	Other	51	Humpback whale	2	265	Blow	None
25-Sep-2013	Norseman	Other	110	Bearded seal	1	*12*	Swim	Look at Vessel
25-Sep-2013	Geo Arctic	Other	52	Pacific walrus	1	181	Look	Look at Vessel
26-Sep-2013	Norseman	Other	111	Unid. pinniped	2	*406*	Look	Look at Vessel
26-Sep-2013	Norseman	Other	112	Unid. seal	2	*20*	Look	Look at Vessel
26-Sep-2013	Norseman	Other	113	Unid. seal	1	*50*	Look	None
26-Sep-2013	Norseman	Other	114	Unid. seal	1	*50*	Dive	None
26-Sep-2013	Norseman	Other	115	Unid. seal	1	*386*	Look	Look at Vessel
26-Sep-2013	Norseman	Other	116	Unid. seal	1	*100*	Swim	Look at Vessel
26-Sep-2013	Norseman	Other	117	Ringed seal	1	*30*	Look	Look at Vessel
26-Sep-2013	Norseman	Other	118	Unid. seal	1	*100*	Look	Look at Vessel
29-Sep-2013	Geo Arctic	Line Shooting (3,280)	53	Unid. seal	1	205	Swim	None
29-Sep-2013	Geo Arctic	Shooting Off-line (60)	54	Bearded seal	1	315	Look	Look at Vessel
29-Sep-2013	Geo Arctic	Shooting Off-line (60)	55	Pacific walrus	1	205	Swim	None
29-Sep-2013	Norseman	Other	119	Unid. seal	1	*130*	Look	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
29-Sep-2013	Norseman	Other	120	Unid. seal	1	*311*	Look	Look at Vessel
30-Sep-2013	Norseman	Other	121	Pacific walrus	2	*311*	Look	Look at Vessel
30-Sep-2013	Norseman	Other	122	Unid. mysticete whale	2	*1,744*	Rest	None
30-Sep-2013	Norseman	Other	123	Unid. seal	1	*311*	Look	Look at Vessel
30-Sep-2013	Norseman	Other	124	Ringed seal	1	*20*	Travel	None
30-Sep-2013	Norseman	Other	125	Ringed seal	1	*150*	Look	None
30-Sep-2013	Geo Arctic	Line Shooting (3,280)	56	Pacific walrus	2	401	Swim	None
30-Sep-2013	Geo Arctic	Other	57	Pacific walrus	1	729	Swim	None
30-Sep-2013	Geo Arctic	Other	58	Unid. pinniped	1	403	Swim	None
30-Sep-2013	Norseman	Other	126	Unid. seal	1	*584*	Look	None
30-Sep-2013	Norseman	Other	127	Unid. seal	1	*252*	Swim	None
30-Sep-2013	Geo Arctic	Other	59	Pacific walrus	1	909	Swim	None
30-Sep-2013	Norseman	Other	128	Unid. seal	1	*250*	Look	None
30-Sep-2013	Norseman	Other	129	Unid. seal	1	*75*	Swim	Look at Vessel
30-Sep-2013	Geo Arctic	Other	60	Pacific walrus	1	1,975	Swim	None
30-Sep-2013	Norseman	Other	130	Spotted seal	1	*100*	Swim	Look at Vessel
30-Sep-2013	Norseman	Other	131	Unid. seal	1	*183*	Swim	None
30-Sep-2013	Norseman	Other	132	Unid. seal	1	*150*	Look	None
30-Sep-2013	Norseman	Other	133	Pacific walrus	1	*252*	Swim	None
30-Sep-2013	Norseman	Other	134	Spotted seal	1	*100*	Look	Look at Vessel
30-Sep-2013	Geo Arctic	Line Shooting (3,280)	61	Pacific walrus	2	141	Swim	Look at Vessel
30-Sep-2013	Norseman	Other	135	Unid. seal	1	*212*	Look	Look at Vessel
1-Oct-2013	Norseman	Other	136	Unid. seal	1	*100*	Look	Look at Vessel
1-Oct-2013	Norseman	Other	137	Ringed seal	1	*120*	Look	Look at Vessel
1-Oct-2013	Norseman	Other	138	Spotted seal	1	*120*	Look	Look at Vessel
1-Oct-2013	Norseman	Other	139	Unid. seal	1	*75*	Look	Look at Vessel
1-Oct-2013	Geo Arctic	Line Shooting (3,280)	62	Pacific walrus	2	141	Swim	Look at Vessel
2-Oct-2013	Norseman	Other	140	Unid. mysticete whale	2.00	*1,744*	Rest	None
2-Oct-2013	Norseman	Other	141	Spotted seal	1.00	*20*	Swim	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
2-Oct-2013	Norseman	Other	142	Unid. seal	1.00	*50*	Swim	Look at Vessel
4-Oct-2013	Norseman	Other	143	Ringed seal	1	*200*	Look	Look at Vessel
4-Oct-2013	Geo Arctic	Line Shooting (3,280)	63	Spotted seal	1	361	Swim	Look at Vessel
4-Oct-2013	Geo Arctic	Shooting Off-line (60)	64	Spotted seal	1	439	Swim	Look at Vessel
5-Oct-2013	Norseman	Other	144	Unid. seal	1	*120*	Look	Look at Vessel
6-Oct-2013	Norseman	Other	145	Unid. seal	1	*183*	Swim	Look at Vessel
6-Oct-2013	Norseman	Other	146	Unid. seal	1	*50*	Look	Look at Vessel
7-Oct-2013	Norseman	Other	147	Spotted seal	1	*161*	Look	Look at Vessel
7-Oct-2013	Norseman	Other	148	Spotted seal	1	*100*	Look	Look at Vessel
7-Oct-2013	Norseman	Other	149	Unid. seal	1	*100*	Look	Look at Vessel
7-Oct-2013	Norseman	Other	150	Unid. seal	1	*50*	Dive	Splash
7-Oct-2013	Norseman	Other	151	Spotted seal	1	*20*	Look	Splash
9-Oct-2013	Norseman	Other	152	Unid. seal	1	*20*	Dive	Splash
9-Oct-2013	Norseman	Other	153	Bowhead whale	3	*161*	Surface Active	None
9-Oct-2013	Norseman	Other	154	Bowhead whale	1	*1,744*	Travel	None
9-Oct-2013	Norseman	Other	155	Unid. seal	1	*130*	Look	Look at Vessel
9-Oct-2013	Norseman	Other	156	Pacific walrus	1	*50*	Look	Look at Vessel
9-Oct-2013	Geo Arctic	Line Shooting (3,280)	65	Pacific walrus	2	1,038	Swim	None
10-Oct-2013	Norseman	Other	157	Pacific walrus	3	*100*	Dive	Look at Vessel
10-Oct-2013	Norseman	Other	158	Pacific walrus	2	*100*	Dive	Look at Vessel
10-Oct-2013	Norseman	Other	159	Unid. seal	1	*50*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	160	Unid. pinniped	1	*311*	Rest	Look at Vessel
10-Oct-2013	Norseman	Other	161	Unid. pinniped	1	*300*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	162	Unid. seal	1	*75*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	163	Unid. seal	1	*252*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	164	Unid. seal	1	*150*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	165	Spotted seal	1	*20*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	166	Pacific walrus	3	*584*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	167	Pacific walrus	2	*250*	Look	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
10-Oct-2013	Geo Arctic	Line Shooting (3,280)	66	Pacific walrus	2	904	Swim	None
10-Oct-2013	Geo Arctic	Other	67	Unid. seal	1	401	Swim	None
10-Oct-2013	Norseman	Other	168	Bearded seal	1	*15*	Dive	Look at Vessel
10-Oct-2013	Geo Arctic	Other	68	Pacific walrus	2	809	Swim	None
10-Oct-2013	Geo Arctic	Other	69	Unid. seal	1	463	Look	None
10-Oct-2013	Norseman	Other	169	Unid. pinniped	1	*279*	Look	Look at Vessel
10-Oct-2013	Geo Arctic	Other	70	Unid. seal	2	341	Surface Active - Travel	None
10-Oct-2013	Geo Arctic	Other	71	Unid. seal	1	200	Swim	None
10-Oct-2013	Norseman	Other	170	Bearded seal	1	*743*	Rest	Look at Vessel
10-Oct-2013	Norseman	Other	171	Bearded seal	1	*399*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	72	Unid. pinniped	1	569	Swim	None
10-Oct-2013	Norseman	Other	172	Unid. seal	1	*75*	Look	Look at Vessel
10-Oct-2013	Geo Arctic	Other	73	Spotted seal	1	160	Look	None
10-Oct-2013	Geo Arctic	Other	74	Bearded seal	1	83	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	75	Pacific walrus	1	248	Swim	None
10-Oct-2013	Norseman	Other	173	Unid. seal	1	*150*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	174	Unid. seal	1	*352*	Swim	Look at Vessel
10-Oct-2013	Norseman	Other	175	Unid. seal	1	*252*	Swim	Look at Vessel
10-Oct-2013	Norseman	Other	176	Unid. seal	1	*406*	Look	Look at Vessel
10-Oct-2013	Geo Arctic	Other	76	Unid. seal	1	476	Swim	None
10-Oct-2013	Norseman	Other	177	Unid. seal	1	*311*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	178	Unid. seal	1	*300*	Swim	Look at Vessel
10-Oct-2013	Norseman	Other	179	Unid. seal	1	*120*	Look	Look at Vessel
10-Oct-2013	Geo Arctic	Other	77	Bearded seal	1	1,833	Swim	None
10-Oct-2013	Norseman	Other	180	Unid. seal	1	*50*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	78	Unid. seal	1	288	Swim	None
10-Oct-2013	Geo Arctic	Other	79	Pacific walrus	2	974	Swim	None
10-Oct-2013	Geo Arctic	Other	80	Pacific walrus	3	590	Swim	None
10-Oct-2013	Geo Arctic	Other	81	Unid. seal	1	223	Swim	None

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
10-Oct-2013	Geo Arctic	Other	82	Unid. seal	1	557	Look	Look at Vessel
10-Oct-2013	Norseman	Other	181	Pacific walrus	2	*584*	Look	Look at Vessel
10-Oct-2013	Geo Arctic	Other	83	Unid. seal	1	551	Look	None
10-Oct-2013	Geo Arctic	Other	84	Unid. seal	1	1,032	Swim	None
10-Oct-2013	Norseman	Other	182	Bearded seal	1	*406*	Look	Look at Vessel
10-Oct-2013	Norseman	Other	183	Ringed seal	1	*120*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	85	Unid. pinniped	1	1,215	Look	None
10-Oct-2013	Norseman	Other	184	Unid. seal	1	*212*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	86	Unid. seal	1	141	Look	None
10-Oct-2013	Norseman	Other	185	Bearded seal	1	*212*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	87	Pacific walrus	2	1,954	Look	None
10-Oct-2013	Geo Arctic	Other	88	Spotted seal	1	777	Look	None
10-Oct-2013	Norseman	Other	186	Pacific walrus	2	*406*	Swim	Look at Vessel
10-Oct-2013	Norseman	Other	187	Unid. seal	1	*212*	Swim	Look at Vessel
10-Oct-2013	Norseman	Other	188	Pacific walrus	2	*212*	Swim	Look at Vessel
10-Oct-2013	Norseman	Other	189	Unid. seal	1	*20*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	89	Pacific walrus	2	557	Swim	None
10-Oct-2013	Geo Arctic	Other	90	Unid. pinniped	1	1,954	Swim	None
10-Oct-2013	Geo Arctic	Other	91	Unid. seal	1	704	Look	None
10-Oct-2013	Norseman	Other	190	Unid. seal	1	*50*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	92	Pacific walrus	5	569	Swim	None
10-Oct-2013	Geo Arctic	Other	93	Unid. seal	1	427	Dive	None
10-Oct-2013	Norseman	Other	191	Pacific walrus	2	*75*	Swim	Look at Vessel
10-Oct-2013	Geo Arctic	Other	94	Unid. seal	1	557	Swim	None
10-Oct-2013	Norseman	Other	192	Unid. seal	1	*30*	Look	Look at Vessel
10-Oct-2013	Geo Arctic	Other	95	Pacific walrus	2	431	Swim	None
10-Oct-2013	Norseman	Other	193	Bearded seal	1	*130*	Look	Look at Vessel
10-Oct-2013	Geo Arctic	Other	96	Pacific walrus	1	858	Look	None
10-Oct-2013	Geo Arctic	Other	97	Bearded seal	1	315	Swim	Splash

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
11-Oct-2013	Norseman	Other	194	Pacific walrus	2	*749*	Rest	Look at Vessel
11-Oct-2013	Norseman	Other	195	Pacific walrus	2	*212*	Rest	Look at Vessel
11-Oct-2013	Norseman	Other	196	Pacific walrus	2	*749*	Swim	None
11-Oct-2013	Norseman	Other	197	Pacific walrus	2	*212*	Swim	None
11-Oct-2013	Norseman	Other	198	Pacific walrus	12	*311*	Swim	Look at Vessel
11-Oct-2013	Geo Arctic	Other	98	Pacific walrus	4	646	Look	None
11-Oct-2013	Norseman	Other	199	Pacific walrus	1	*949*	Look	Look at Vessel
11-Oct-2013	Norseman	Other	200	Pacific walrus	6	*207*	Look	Look at Vessel
11-Oct-2013	Norseman	Other	201	Pacific walrus	2	*324*	Rest	Look at Vessel
11-Oct-2013	Norseman	Other	202	Pacific walrus	3	*311*	Swim	Look at Vessel
11-Oct-2013	Norseman	Other	203	Pacific walrus	1	*200*	Swim	Look at Vessel
11-Oct-2013	Geo Arctic	Other	99	Pacific walrus	2	262	Swim	None
13-Oct-2013	Geo Arctic	Line Shooting (3,280)	100	Pacific walrus	2	262	Swim	None
13-Oct-2013	Geo Arctic	Other	101	Pacific walrus	2	401	Swim	None
13-Oct-2013	Norseman	Other	204	Bearded seal	1	*50*	Look	Look at Vessel
13-Oct-2013	Geo Arctic	Other	102	Pacific walrus	2	195	Surface Active - Travel	Increase Speed
13-Oct-2013	Norseman	Other	205	Unid. seal	1	*50*	Look	Look at Vessel
13-Oct-2013	Geo Arctic	Other	103	Unid. pinniped	1	634	Look	None
14-Oct-2013	Norseman	Other	206	Unid. seal	1	*30*	Dive	Look at Vessel
15-Oct-2013	Norseman	Other	207	Unid. seal	1	*212*	Look	Look at Vessel
15-Oct-2013	Geo Arctic	Other	104	Unid. pinniped	1	179	Thrash	None
15-Oct-2013	Norseman	Other	208	Unid. seal	1	*200*	Swim	None
15-Oct-2013	Norseman	Other	209	Unid. seal	1	*70*	Look	Look at Vessel
15-Oct-2013	Geo Arctic	Other	105	Unid. seal	1	336	Swim	None
17-Oct-2013	Geo Arctic	Other	106	Gray whale	1	448	Swim	None
17-Oct-2013	Geo Arctic	Other	107	Gray whale	2	634	Swim	None
17-Oct-2013	Geo Arctic	Other	108	Unid. mysticete whale	5	1,675	Swim	None
17-Oct-2013	Geo Arctic	Other	109	Unid. mysticete whale	4	594	Swim	None
17-Oct-2013	Geo Arctic	Other	110	Gray whale	2	704	Swim	None

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
17-Oct-2013	Norseman	Other	210	Unid. seal	1	*50*	Look	Look at Vessel
17-Oct-2013	Geo Arctic	Other	111	Unid. whale	4	2,252	Blow	None
17-Oct-2013	Norseman	Other	211	Unid. pinniped	1	*100*	Look	Look at Vessel
17-Oct-2013	Norseman	Other	212	Unid. pinniped	1	*150*	Look	Look at Vessel
17-Oct-2013	Norseman	Other	213	Unid. pinniped	1	*130*	Look	Look at Vessel
17-Oct-2013	Geo Arctic	Other	112	Unid. seal	1	629	Look	None
17-Oct-2013	Geo Arctic	Other	113	Unid. seal	1	406	Look	None
17-Oct-2013	Norseman	Other	214	Ribbon seal	1	*100*	Look	Look at Vessel
17-Oct-2013	Geo Arctic	Other	114	Unid. pinniped	1	165	Dive	None
19-Oct-2013	Norseman	Other	215	Harbor porpoise	2	*100*	Swim	None
19-Oct-2013	Norseman	Other	216	Unid. seal	1	*75*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	217	Unid. seal	1	*300*	Swim	None
19-Oct-2013	Norseman	Other	218	Unid. seal	1	*400*	Swim	None
19-Oct-2013	Norseman	Other	219	Unid. seal	1	*406*	Look	None
19-Oct-2013	Norseman	Other	220	Unid. seal	1	*250*	Swim	None
19-Oct-2013	Norseman	Other	221	Unid. seal	1	*100*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	222	Unid. seal	2	*300*	Look	None
19-Oct-2013	Norseman	Other	223	Unid. seal	1	*300*	Look	None
19-Oct-2013	Norseman	Other	224	Spotted seal	1	*200*	Swim	Look at Vessel
19-Oct-2013	Norseman	Other	225	Spotted seal	1	*200*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	226	Spotted seal	1	*100*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	227	Unid. seal	1	*200*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	228	Spotted seal	1	*100*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	229	Spotted seal	2	*100*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	230	Unid. seal	2	*120*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	231	Spotted seal	1	*100*	Swim	Look at Vessel
19-Oct-2013	Norseman	Other	232	Unid. seal	1	*150*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	233	Spotted seal	2	*150*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	234	Unid. seal	1	*200*	Rest	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
19-Oct-2013	Norseman	Other	235	Spotted seal	1	*252*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	236	Spotted seal	1	*40*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	237	Unid. seal	1	*30*	Dive	None
19-Oct-2013	Norseman	Other	238	Spotted seal	1	*100*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	239	Spotted seal	1	*200*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	240	Spotted seal	1	*20*	Swim	None
19-Oct-2013	Norseman	Other	241	Spotted seal	1	*183*	Swim	Look at Vessel
19-Oct-2013	Norseman	Other	242	Spotted seal	1	*100*	Swim	None
19-Oct-2013	Norseman	Other	243	Unid. seal	2	*406*	Look	None
19-Oct-2013	Norseman	Other	244	Unid. seal	1	*212*	Swim	Look at Vessel
19-Oct-2013	Norseman	Other	245	Unid. seal	1	*100*	Look	None
19-Oct-2013	Norseman	Other	246	Unid. seal	1	*200*	Swim	None
19-Oct-2013	Norseman	Other	247	Unid. seal	1	*150*	Swim	None
19-Oct-2013	Norseman	Other	248	Unid. seal	1	*75*	Look	Look at Vessel
19-Oct-2013	Norseman	Other	249	Unid. seal	1	*100*	Look	Look at Vessel
20-Oct-2013	Norseman	Other	250	Unid. seal	1	*50*	Dive	None
20-Oct-2013	Norseman	Other	251	Unid. pinniped	1	*20*	Dive	Splash
20-Oct-2013	Norseman	Other	252	Unid. pinniped	1	*100*	Dive	Splash
20-Oct-2013	Norseman	Other	253	Unid. seal	1	*20*	Swim	None
20-Oct-2013	Norseman	Other	254	Unid. seal	1	*200*	Look	None
20-Oct-2013	Norseman	Other	255	Unid. pinniped	1	*100*	Swim	Look at Vessel
20-Oct-2013	Norseman	Other	256	Unid. pinniped	1	*250*	Look	Look at Vessel
20-Oct-2013	Norseman	Other	257	Unid. seal	1	*150*	Swim	Look at Vessel
20-Oct-2013	Norseman	Other	258	Bearded seal	1	*200*	Look	Look at Vessel
20-Oct-2013	Norseman	Other	259	Unid. seal	1	*75*	Dive	Splash
20-Oct-2013	Norseman	Other	260	Unid. seal	1	*200*	Look	Look at Vessel
20-Oct-2013	Norseman	Other	261	Unid. seal	1	*250*	Look	Look at Vessel
20-Oct-2013	Norseman	Other	262	Unid. seal	1	*75*	Swim	None
20-Oct-2013	Norseman	Other	263	Bearded seal	1	*75*	Swim	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
20-Oct-2013	Norseman	Other	264	Bearded seal	1	*100*	Swim	Look at Vessel
20-Oct-2013	Norseman	Other	265	Unid. seal	1	*40*	Look	Look at Vessel
20-Oct-2013	Norseman	Other	266	Spotted seal	1	*50*	Look	Look at Vessel
20-Oct-2013	Norseman	Other	267	Unid. seal	1	*300*	Look	Look at Vessel
20-Oct-2013	Geo Arctic	Other	115	Unid. seal	1	291	Swim	None
20-Oct-2013	Geo Arctic	Other	116	Unid. pinniped	1	318	Look	None
20-Oct-2013	Geo Arctic	Other	117	Unid. seal	1	270	Look	None
21-Oct-2013	Norseman	Other	268	Bowhead whale	2	*479*	Travel	None
21-Oct-2013	Geo Arctic	Other	118	Bowhead whale	1	915	Swim	None
21-Oct-2013	Geo Arctic	Other	119	Unid. whale	2	915	Blow	None
21-Oct-2013	Geo Arctic	Other	120	Unid. whale	1	1,014	Blow	None
21-Oct-2013	Geo Arctic	Other	121	Unid. whale	1	3,096	Blow	None
21-Oct-2013	Geo Arctic	Other	122	Unid. whale	1	1,161	Blow	None
21-Oct-2013	Geo Arctic	Other	123	Unid. whale	1	3,059	Blow	None
21-Oct-2013	Geo Arctic	Other	124	Unid. whale	1	3,059	Blow	None
21-Oct-2013	Geo Arctic	Other	125	Unid. whale	2	2,411	Blow	None
21-Oct-2013	Geo Arctic	Other	126	Bowhead whale	1	1,462	Blow	None
22-Oct-2013	Norseman	Other	269	Unid. seal	1	*250*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	270	Unid. seal	1	*311*	Swim	Look at Vessel
22-Oct-2013	Geo Arctic	Line Shooting (3,280)	127	Unid. seal	1	531	Look	None
22-Oct-2013	Norseman	Other	271	Unid.	1	*479*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	272	Unid. seal	1	*100*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	273	Spotted seal	1	*100*	Swim	Look at Vessel
22-Oct-2013	Norseman	Other	274	Spotted seal	1	*50*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	275	Unid. seal	1	*252*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	276	Bearded seal	1	*50*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	277	Unid. seal	1	*100*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	278	Pacific walrus	2	*311*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	279	Unid. seal	1	*75*	Look	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
22-Oct-2013	Norseman	Other	280	Unid. seal	1	*584*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	281	Unid. seal	1	*311*	Look	Look at Vessel
22-Oct-2013	Geo Arctic	Line Shooting (3,280)	128	Unid. seal	1	310	Look	None
22-Oct-2013	Norseman	Other	282	Unid. seal	1	*641*	Look	None
22-Oct-2013	Norseman	Other	283	Unid. seal	1	*161*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	284	Unid. seal	1	*279*	Look	None
22-Oct-2013	Norseman	Other	285	Unid. seal	1	*150*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	286	Spotted seal	1	*183*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	287	Unid. seal	1	*406*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	288	Unid. seal	1	*749*	Look	None
22-Oct-2013	Geo Arctic	Line Shooting (3,280)	129	Unid. seal	1	381	Swim	None
22-Oct-2013	Geo Arctic	Shooting Off-line (60)	130	Unid. seal	1	667	Swim	None
22-Oct-2013	Norseman	Other	289	Unid. seal	1	*161*	Swim	Look at Vessel
22-Oct-2013	Geo Arctic	Shooting Off-line (60)	131	Unid. seal	1	197	Dive	None
22-Oct-2013	Norseman	Other	290	Unid. seal	1	*406*	Look	None
22-Oct-2013	Norseman	Other	291	Unid. seal	1	*1,744*	Look	None
22-Oct-2013	Norseman	Other	292	Unid. seal	1	*406*	Look	Look at Vessel
22-Oct-2013	Geo Arctic	Other	132	Unid. seal	1	1,523	Look	None
22-Oct-2013	Geo Arctic	Other	133	Unid. seal	1	458	Swim	None
22-Oct-2013	Geo Arctic	Other	134	Unid. seal	1	336	Look	None
22-Oct-2013	Geo Arctic	Other	135	Unid. seal	1	528	Surface Active - Travel	None
22-Oct-2013	Norseman	Other	293	Unid. seal	1	*252*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	294	Unid. seal	1	*212*	Look	Look at Vessel
22-Oct-2013	Geo Arctic	Other	136	Unid. seal	1	401	Look	None
22-Oct-2013	Geo Arctic	Other	137	Unid. pinniped	1	551	Look	None
22-Oct-2013	Norseman	Other	295	Unid. seal	1	*161*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	296	Unid. seal	1	*150*	Look	Look at Vessel
22-Oct-2013	Norseman	Other	297	Ringed seal	1	*20*	Rest	None
22-Oct-2013	Norseman	Other	298	Unid. seal	1	*161*	Look	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
22-Oct-2013	Norseman	Other	299	Unid. seal	1	*100*	Look	Look at Vessel
22-Oct-2013	Geo Arctic	Shooting Off-line (60)	138	Unid. seal	1	498	Look	None
22-Oct-2013	Norseman	Other	300	Unid. seal	1	*50*	Look	Look at Vessel
23-Oct-2013	Norseman	Other	301	Unid. mysticete whale	1	*584*	Blow	None
23-Oct-2013	Norseman	Other	302	Unid. mysticete whale	2	*2,668*	Blow	None
23-Oct-2013	Norseman	Other	303	Bowhead whale	2	*1,046*	Travel	None
24-Oct-2013	Norseman	Other	304	Bowhead whale	1	*100*	Blow	None
24-Oct-2013	Norseman	Other	305	Unid. seal	1	*75*	Look	Look at Vessel
25-Oct-2013	Norseman	Other	306	Spotted seal	1	*30*	Look	Look at Vessel
25-Oct-2013	Geo Arctic	Other	139	Unid. seal	1	250	Look	None
26-Oct-2013	Norseman	Other	307	Bowhead whale	3	*75*	Travel	None
26-Oct-2013	Geo Arctic	Line Shooting (3,280)	140	Unid. whale	1	4,466	Blow	None
26-Oct-2013	Geo Arctic	Line Shooting (3,280)	141	Unid. whale	3	2,411	Blow	None
26-Oct-2013	Norseman	Other	308	Unid. mysticete whale	3	*300*	Blow	None
26-Oct-2013	Norseman	Other	309	Unid. mysticete whale	1	*1,046*	Blow	None
26-Oct-2013	Norseman	Other	310	Unid. seal	1	*183*	Look	Look at Vessel
27-Oct-2013	Norseman	Other	311	Ringed seal	1	*50*	Look	Look at Vessel
27-Oct-2013	Norseman	Other	312	Unid. pinniped	1	*311*	Swim	None
27-Oct-2013	Norseman	Other	313	Unid. seal	1	*200*	Look	Look at Vessel
27-Oct-2013	Norseman	Other	314	Unid. seal	1	*100*	Look	Look at Vessel
27-Oct-2013	Norseman	Other	315	Bowhead whale	1	*406*	Blow	None
27-Oct-2013	Geo Arctic	Ramp-up (3,280)	142	Bowhead whale	1	1,744	Blow	None
27-Oct-2013	Geo Arctic	Shooting Off-line (60)	143	Bowhead whale	1	1,343	Swim	None
27-Oct-2013	Norseman	Other	316	Bowhead whale	1	*150*	Travel	None
28-Oct-2013	Norseman	Other	317	Bowhead whale	2	*1,046*	Travel	None
28-Oct-2013	Norseman	Other	318	Bowhead whale	1	*300*	Travel	None
28-Oct-2013	Norseman	Other	319	Unid. seal	1	*50*	Swim	Look at Vessel
28-Oct-2013	Norseman	Other	320	Unid. seal	1	*75*	Look	Look at Vessel
28-Oct-2013	Norseman	Other	321	Unid. seal	1	*75*	Look	Look at Vessel

Table F-1 (continued): Summary of all sightings observed visually by protected species observers during TGS' 2D Seismic Survey in the Chukchi Sea during 2013 open water season.

Date[1]	Vessel Name	Vessel Activity (Seismic Array Volume [in^3])[2]	Sighting Number[3]	Species[4]	Number of Animals[5]	CPA (m)[6]	Behavior[7]	Reaction[8]
28-Oct-2013	Norseman	Other	322	Bearded seal	1	*10*	Swim	Look at Vessel
28-Oct-2013	Norseman	Other	323	Unid. seal	1	*50*	Look	Look at Vessel
28-Oct-2013	Norseman	Other	324	Unid. seal	1	*100*	Look	None
28-Oct-2013	Norseman	Other	325	Unid. seal	1	*50*	Look	Look at Vessel
28-Oct-2013	Norseman	Other	326	Unid. seal	1	*150*	Look	Look at Vessel
30-Oct-2013	Geo Arctic	Other	144	Unid. seal	1	463	Swim	None
30-Oct-2013	Geo Arctic	Other	145	Unid. seal	1	270	Swim	None
30-Oct-2013	Norseman	Other	327	Spotted seal	1	*50*	Look	Look at Vessel
30-Oct-2013	Geo Arctic	Other	146	Unid. seal	1	239	Swim	None
30-Oct-2013	Geo Arctic	Other	147	Bearded seal	1	370	Swim	Look at Vessel
30-Oct-2013	Norseman	Other	328	Unid. seal	1	*150*	Look	Look at Vessel
30-Oct-2013	Geo Arctic	Other	148	Unid. seal	1	677	Look	None
30-Oct-2013	Geo Arctic	Other	149	Bearded seal	1	735	Swim	Look at Vessel
30-Oct-2013	Geo Arctic	Other	150	Unid. seal	1	569	Swim	None
30-Oct-2013	Norseman	Other	329	Unid. seal	1	*100*	Look	Look at Vessel
30-Oct-2013	Geo Arctic	Other	151	Spotted seal	1	215	Swim	Look at Vessel

1 Date in Alaska Daylight time zone.
2 Seismic array volume for Geo Arctic only. During activities where the array volume was unknown (seismic testing and ramp up) the full array volume was indicated. (3,280 = Full array 60 = Mitigation airgun)
3 Sighting number starts at 1 for each vessel.
4 Species identified by trained protected species observers. Unid. = Unidentified, myst. = mysticete
5 Best count of the number of individual animals for sighting.
6 CPA = Closest point of approach to the airguns for the Geo Arctic and to the observers for sightings from the Norseman (in italics).
7 Behavior of animal at initial time of sighting.
8 Most energetically expensive initial reaction of sighting (e.g., Increasing speed is more energetically expensive than looking).

Appendix G
Vessel Specifications

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NORSEMAN

108 ft. Research Vessel

DIMENSIONS & REGULATORY INFORMATION

Length:	108 ft.	**Beam:**	28 ft.	**Draft:**	13ft.
Gross Tons:	197	**Deck Levels:**	3		

Documentation:	United States
Sewage Treatment System:	Type II MSD Coast Guard Approved

PERFORMANCE & PROPOLSION

Speed:	10 Knots
Endurance:	90+ Days
Range:	10,000 Miles
Propulsion:	850 HP Cat Diesel
Fuel Consumption: (@ 8 knots)	400 Gallons per Day

MACHINERY

Electric Generators:	1-NL 40 KW 1-CAT 90 KW 1-CAT135 KW
Electric Power:	110 Volt AC 208 Volt AC 3 Phase 480 Volt AC 3 Phase

CAPACITY

Fuel Capacity:	38,000 gal.
Fresh Water Making:	1,000 gal.
Fresh Water Holding:	3,600 gal.
Walk in Cooler:	400 cu ft.
Walk in Freezer:	500 cu ft.
Open Deck Area:	1,400 sq. ft.

ACCOMODATIONS

Berths:	5 researcher cabins capable of sleeping 18 guest, plus separate quarters for 7 crew
Bathrooms:	7 units each with toilet, shower, and vanity
Dinning:	Separate guest and crew messes

SPECIAL FEATURES

Hydraulic Boom Crane:	20,000 lbs. SWL @ 20' 10,000 Lbs.
Stern Mounted A-Frame:	SWL 5,000 lbs.
Hydraulic Winch:	2,000 lbs., line pull 1,000 ft., 3/8 wire
Anchor Winch:	115 Fathoms Ground Gear
Small Boat Launching Ability:	Up to 23' Rigid

ELECTRONICS & COMMUNICATIONS

Radar: Two Furuno FR1510D, JVC GPS Compass, Furuno Navnet VX2 radar & plotter; **GPS**: Furuno GP-32, Northstar 952X; **AIS**: Furuno FA-150; **Depth Sounders**: Furuno FCV-292 color sounder, Furuno FE 881 II recording sounder, Personal Locator Beacon
Communications: Furuno FS4000 SSB, Furuno FS4001, Three Standard VHFs, Iridium Satellite Open Port Data & Voice, Handheld VHFs with GPS capability.

7683 SE 27th St., Suite 476 Mercer Island, WA 98040 – PH: (206) 403-3630
www.norsemanmaritime.com – email: info@norsemanmaritime.com

Geo Arctic

2D Seismic Survey Vessel

Geo Arctic is a state-of-the-art 2D seismic survey vessel specifically equipped and configured for worldwide operations and long endurance periods.

Geo Arctic is equipped with Input/Output's MSX 24-bit system, MSX digital streamers and Sodera G-guns seismic sources.

Geo Arctic's primary features include:

- Full 2D capability
- 848 channels, 10,600m streamer cable
- Sodera G-gun seismic sources
- Full underway seismic data processing capability
- Accommodation for up to 55 persons
- Dual, independent DGPS positioning systems

www.fugro.com

Geo Arctic

2D Seismic Survey Vessel

NAME	R/V Geo Arctic	CLASS REGISTRATION	M-42019
OWNER AND OPERATOR	Amige SE, Murmansk	CALL SIGN	UGXK
PORT OF REGISTRATION	Murmansk	IMO NO	8409018
FLAG	Russian	MMSI	273458600
CLASS	KM ULI A2	YEAR BUILT / REBUILT	1988 Poland / 1997 Norway

Dimensions

Length overall	81.85m
Breadth	14.8m
Draught, loaded	5.23m
Tonnage	3225T, 967NetT
Cruising speed	Max 14.5 knots, cruising 12.5 knots
Operation range	60 days cruising
Endurance (seismic)	72 days

Machinery

Main engine	3090kW Zgoda-Zulcer 6ZL 40/48
Gearbox	Zamech MA90-10, ratio 505/222,6
Propulsion	Zamen, 4-blade stainless steel controllable pitch
Steering gear	Zamech M200-11-2
Bow Thruster	600hp/441kW Brunvoll FU-45-LTC-1225
Main engine monitoring	Polish
Electrical Power	Total power: 2,200 kW Voltage: 3x 380(220)Vac, 50Hz. Shaft generator: 1x 1,200kW Generator: 2x 500kW
Emergency generator	217 PMa-39H6, 121kW
Clean power	INV SitePro, 40kW UPS

Capacities

Fuel capacity	1000m^3
Fuel consumption	Sailing 12T, working 10T, in port 2.8T
Fresh water capacity	200T
Fresh water generator	VY 125 AD, 10T full speed
Sewage treatment plant	2x LK-30
Black water	9.9 m^3
Bilge water	12.0 m^3
Sludge	13.1 m^3
Waste water	3.2 m^3
Lub oil	16.9 m^3
Dirty oil	11.0 m^3

Deck Machinery

Crane	4T, 12.5m max., 2.5m min. radius 1x provisions crane front deck 1x 1T folding crane, aft Helideck
A-frame	None
Winch	2x streamer, 7000m aft reel, 3600m fwd reel. Spare streamer, 2x 2000m Gravity / FF Magnetometer

Deck Machinery (cont.)

Hydraulic power pack	Hydrakraft A/S. 2x 45kW. 2x 130l/min. 220 Bar.

Navigation

Auto Pilot	Polish (TS-75)
GPS	Furuno GP50 MK II
Differential GPS	Starfix.MN8 DGPS & Starfix.SPOT DGPS
Radar	1x Kelvin Hughes; 6000, Nucleus 2, ARPA, 10 cm 1x Furuno FR 2015. ARPA. 3 cm.
Gyrocompass	1x Plath, Navigat II with Lehmkuhl LR40 gyro repeater. 1x SG Brown 1000G
Speedlog	1x Atlas Dolog 1x IEL-2M (Russian)
Wind sensor	Aanderaa 3017 Speed, direction and temperature
Nav. Echo Sounder	GEL-3
Navtex	Furuno NX-500
Weather fax	None

Communications

GMDSS	A1, A2 and A3
Satellite fixed line	Telenor Sealink Light. NorSat. Phone, modem and fax.
Inmarsat	Saturn B, Phone, high speed data modem; 64kB and fax
GSM	Telephone
WAN	Data modem
M/F, H/F	Skanti TRP 7201
VHF stationary	Skanti VHF 3000 Sailor VHF RT2047D Sailor VHF RM2042. (GMDSS)
VHF portable	3x Tron VHF Max 4W Band 156-162 MHz 3x Tron GMDSS VHF Max 4W band 150-163 MHz
UHF helicopter communication	Jotron TR-7510
Non-directional beacon	AS Tele Supply TS-20B
Watchkeeper	Sailor GMDSS A3
Internal communication	Stationary all rooms.
Internet access via Norsat	10 networked PC's including Client cabin

Accommodation

Accommodation	Single cabins 17 + 2 hospital Double cabins 18 Total capacity 55 persons
Mess	Seating capacity: 31 Size 42 m^2
Day room	1 x Smoking / 1 x Non-smoking 17m^2 and 16m^2
Exercise room	21m^2
Air conditioning	Tropical
Helicopter landing zone:	Superpuma 9.8 ton D-Value 19.5m

Safety

Safety manning level	55 persons
Covered lifeboat	JY-QFN-8.50 63 persons
Rescue /MOB Boat	63 Persons (Covered lifeboat)
Work boat	Norpower 22, 6 persons
Inflatable Life Rafts	11 x 10 persons
Man overboard Liferaft	2 x 6 man life-rafts (2 x Jonbuoy as backup)
Survival Suits	100% (60)
Life Jackets	100% (60)
Life rings	8x Life rings
Smoke hoods	100%
Work vest	4 x Crewsaver
Emergency radios	Sailor GMDSS A3
Emergency beacons	1 x McMurdo E3 EPIB
Radar transponders	2 x Jotron TronSart
Fire detector system:	INCO UCPP-20
Fire pumps	1 x 100 t Electrical driven 1 x 40 t, Electrical driven
Fire suits	4x Fire suits
Halon systems	Engine room
CO2 systems	Compressor room and streamer store
Foam systems	Streamer deck, Helideck.

Fugro NV

10 Veurse Achterweg, PO Box 41, 2260 AA Leidschendam, The Netherlands

Tel: +31 70 311 1422 Fax: +31 70 320 2703

www.fugro.com

This specification is subject to change without prior notification. The particulars are believed to be correct, but are not guaranteed.

NO OTHER COMPANY CAN PROVIDE THE SAME COMPREHENSIVE RANGE OF GEOTECHNICAL, SURVEY AND GEOSCIENCE SERVICES

Appendix H
Stranding Reports

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MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

FIELD #: _____ **NMFS REGIONAL #:** _____ (NMFS USE) **NATIONAL DATABASE#:** _____ (NMFS USE)

COMMON NAME: Pacific Walrus **GENUS:** Odobenus **SPECIES:** rosmarus

EXAMINER Name: Jenipher Cate/ Ray Hooper Affiliation: ASRC Energy/TGS

Address: 3900 C Street, Suite 701 Phone: 907-339-5469 (Megan Blees)

Stranding Agreement or Authority: _____

LOCATION OF INITIAL OBSERVATION

State: AK County: _____

City: _____

Body of Water: Chukchi Sea

Locality Details: _____

Lat (DD): 70.7923 . _____ N

Long (DD): 166.770 . _____ W

☒ Actual ☐ Estimated

How Determined: (check ONE)

☒ GPS ☐ Map ☐ Internet/Software

OCURRENCE DETAILS ☐ Restrand GE# _____

Group Event: ☐ YES ☒ NO (NMFS Use)

If Yes, Type: ☐ Cow/Calf Pair ☐ Mass Stranding # Animals: _____ ☐ Actual ☐ Estimated

Findings of Human Interaction: ☐ YES ☐ NO ☒ Could Not Be Determined (CBD)

If Yes, Choose one or more: ☐ 1. Boat Collision ☐ 2. Shot ☐ 3. Fishery Interaction

☐ 4. Other Human Interaction: _____

How Determined (Check one or more): ☐ External Exam ☐ Internal Exam ☐ Necropsy

☐ Other: _____

Gear Collected? ☐ YES ☒ NO Gear Disposition: _____

Other Findings Upon Level A: ☐ YES ☐ NO ☒ Could Not Be Determined (CBD)

If Yes, Choose one or more: ☐ 1. Illness ☐ 2. Injury ☐ 3. Pregnant ☐ 4.Other: _____

How Determined (Check one or more): ☐ External Exam ☐ Internal Exam ☐ Necropsy

☐ Other: _____

INITIAL OBSERVATION

Date: Year: 2013 Month: august Day: 30

First Observed: ☐ Beach or Land ☒ Floating ☐ Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)

☐ 1. Alive ☐ 4. Advanced Decomposition

☐ 2. Fresh dead ☐ 5. Mummified/Skeletal

☒ 3. Moderate decomposition ☐ 6. Condition Unknown

LEVEL A EXAMINATION ☒ Not Able to Examine

Date: Year: 2013 Month: August Day: 30

CONDITION AT EXAMINATION (Check ONE)

☐ 1. Alive ☐ 4. Advanced Decomposition

☐ 2. Fresh dead ☐ 5. Mummified/Skeletal

☐ 3. Moderate decomposition ☐ 6. Unknown

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)

☐ 1. Left at Site ☐ 6. Euthanized at Site

☐ 2. Immediate Release at Site ☐ 7. Transferred to Rehabilitation:

☐ 3. Relocated Date: Year:_____ Month:_____ Day:___

Facility:_____

☐ 4. Disentangled ☐ 8. Died during Transport

☐ 5. Died at Site ☐ 9. Euthanized during Transport

☐ 10. Other:_____

CONDITION/DETERMINATION (Check one or more)

☐ 1. Sick 7. Location Hazardous

☐ 2. Injured ☐ a. To animal

☐ 3. Out of Habitat ☐ b. To public

☐ 4. Deemed Releasable ☐ 8. Unknown/CBD

☐ 5. Abandoned/Orphaned ☐ 9.Other_____

☐ 6. Inaccessible _____

MORPHOLOGICAL DATA

SEX (Check ONE)

☐ 1. Male

☐ 2. Female

☒ 3. Unknown

AGE CLASS (Check ONE)

☒ 1. Adult ☐ 4. Pup/Calf

☐ 2. Subadult ☐ 5. Unknown

☐ 3. Yearling

☒ Whole Carcass ☐ Partial Carcass

Straight length:_____ ☐ cm ☐ in ☐ actual ☐ estimated

Weight:_____ ☐ kg ☐ lb ☐ actual ☐ estimated

PHOTOS/VIDEOS TAKEN: ☐ YES ☒ NO

Photo/Video Disposition: _____

TAG DATA Tags Were:

Present at Time of Stranding (Pre-existing): ☐ YES ☒ NO

Applied during Stranding Response: ☐ YES ☒ NO

ID#	Color	Type	Placement* (CHOOSE ONE)	Applied	Present
				☐	☐
				☐	☐
				☐	☐

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

CARCASS STATUS (Check one or more)

☒ 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 ☒ NO ☐ YES ☐ Limited ☐ Complete

☐ Carcass Fresh ☐ Carcass Frozen/Thawed

NECROPSIED BY: _____

Date: Year: _____ **Month:**_____ **Day:**_____

PLEASE USE BACK SIDE OF THIS FORM FOR ADDITONAL REMARKS

ADDITIONAL REMARKS

ADDITIONAL IDENTIFIER: Ray Hooper (If animal is re-branded, please indicate any previous field numbers here)

Write additional comments below:

Saw birds on a floating object about 0.5 miles to our port side. Went to see what the object was and noticed it was a Pacific Walrus carcass in a moderate state of decomposition. Could not determine if head was present, but the death of the animal was not due to our activity.

Weather at time of sighting: Good visibility, no sea ice, Beaufort wind force 2.

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 INFORMATION, INCLUDING SUGGESTIONS FOR REDUCING THE BURDEN TO: CHIEF, MARINE MAMMAL AND SEA TURTLE 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, NOR SHALL ANY PERSON BE SUBJECT 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.

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

FIELD #: _____ **NMFS REGIONAL #:** _____ (NMFS USE) **NATIONAL DATABASE#:** _____ (NMFS USE)

COMMON NAME: Unknown **GENUS:** Unknown **SPECIES:** Unknown

EXAMINER Name: Renee Hobson Affiliation: PSO

Address: ASRC Energy Services, 3900 C St. Anchorage, AK 99503 Phone: Megan Blees: 907-339-5469

Stranding Agreement or Authority: _____

LOCATION OF INITIAL OBSERVATION

State: AK County: USA

City: _____

Body of Water: Chukchi Sea

Locality Details: _____

Lat (DD): 71 . 26.2 N

Long (DD): 165 . 2.0 W

☒ Actual ☐ Estimated

How Determined: (check ONE)

☒ GPS ☐ Map ☐ Internet/Software

OCURRENCE DETAILS ☐ Restrand GE# _____

Group Event: ☐ YES ☒ NO (NMFS Use)

If Yes, Type: ☐ Cow/Calf Pair ☐ Mass Stranding # Animals: 1 ☒ Actual ☐ Estimated

Findings of Human Interaction: ☐ YES ☐ NO ☒ Could Not Be Determined (CBD)

If Yes, Choose one or more: ☐ 1. Boat Collision ☐ 2. Shot ☐ 3. Fishery Interaction

☐ 4. Other Human Interaction: _____

How Determined (Check one or more): ☐ External Exam ☐ Internal Exam ☐ Necropsy

☒ Other: visual exam

Gear Collected? ☐ YES ☒ NO Gear Disposition: _____

Other Findings Upon Level A: ☐ YES ☐ NO ☒ Could Not Be Determined (CBD)

If Yes, Choose one or more: ☐ 1. Illness ☐ 2. Injury ☐ 3. Pregnant ☐ 4.Other: _____

How Determined (Check one or more): ☐ External Exam ☐ Internal Exam ☐ Necropsy

☐ Other: _____

INITIAL OBSERVATION

Date: Year: 2013 Month: September Day: 14

First Observed: ☐ Beach or Land ☒ Floating ☐ Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)

☐ 1. Alive ☒ 4. Advanced Decomposition

☐ 2. Fresh dead ☐ 5. Mummified/Skeletal

☐ 3. Moderate decomposition ☐ 6. Condition Unknown

LEVEL A EXAMINATION ☒ 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 ☐ 6. Unknown

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)

☐ 1. Left at Site ☐ 6. Euthanized at Site

☐ 2. Immediate Release at Site ☐ 7. Transferred to Rehabilitation:

☐ 3. Relocated Date: Year:_____ Month:_____ Day:___

Facility:_____

☐ 4. Disentangled ☐ 8. Died during Transport

☐ 5. Died at Site ☐ 9. Euthanized during Transport

☐ 10. Other:_____

CONDITION/DETERMINATION (Check one or more)

☐ 1. Sick 7. Location Hazardous

☐ 2. Injured ☐ a. To animal

☐ 3. Out of Habitat ☐ b. To public

☐ 4. Deemed Releasable ☐ 8. Unknown/CBD

☐ 5. Abandoned/Orphaned ☐ 9.Other_____

☐ 6. Inaccessible _____

MORPHOLOGICAL DATA

SEX (Check ONE)

☐ 1. Male

☐ 2. Female

☒ 3. Unknown

AGE CLASS (Check ONE)

☐ 1. Adult ☐ 4. Pup/Calf

☐ 2. Subadult ☐ 5. Unknown

☐ 3. Yearling

☒ Whole Carcass ☐ Partial Carcass

Straight length:_____ ☐ cm ☐ in ☐ actual ☐ estimated

Weight:_____ ☐ kg ☐ lb ☐ actual ☐ estimated

PHOTOS/VIDEOS TAKEN: ☒ YES ☐ NO

Photo/Video Disposition: 2 photos taken

TAG DATA Tags Were:

Present at Time of Stranding (Pre-existing): ☐ YES ☐ NO

Applied during Stranding Response: ☐ YES ☐ NO

ID#	Color	Type	Placement* (CHOOSE ONE)	Applied	Present
				☐	☐
				☐	☐
				☐	☐

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

CARCASS STATUS (Check one or more)

☒ 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 ☐ NO ☐ YES ☐ Limited ☐ Complete

☐ Carcass Fresh ☐ Carcass Frozen/Thawed

NECROPSIED BY: _____

Date: Year: _____ **Month:**_____ **Day:**_____

PLEASE USE BACK SIDE OF THIS FORM FOR ADDITONAL REMARKS

ADDITIONAL REMARKS

ADDITIONAL IDENTIFIER: _____ (If animal is re-branded, please indicate any previous field numbers here)

Write additional comments below:

Saw something floating in the water, was not to sure if it was a buoy or mammal. Watched longer, determined it was a dead seal or walrus, head was under water, body was badly bloated. Determined it was dead for a period of time, nothing related to the research of the vessel. Did take pictures.

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 INFORMATION, INCLUDING SUGGESTIONS FOR REDUCING THE BURDEN TO: CHIEF, MARINE MAMMAL AND SEA TURTLE 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, 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.

Appendix I
Beaufort Sea State Definitions

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Beaufort Sea State (Wind Force)

Beaufort Wind Force	Wind (knots)	Wind (mph)	WMO Classification	Conditions on the Water
0	< 1	0-1	Calm	Sea surface smooth and mirror-like
1	1-3	1-3	Light Air	Scaly ripples, no foam crests
2	4-6	4-7	Light Breeze	Small wavelets, crests glassy, no breaking
3	7-10	8-12	Gentle Breeze	Lave wavelets, crests begin to break, scattered whitecaps
4	11-16	13-18	Moderate Breeze	Small waves 1-4 ft becoming longer, numerous whitecaps
5	17-21	19-24	Fresh Breeze	Moderate waves 4-8 ft taking longer form, many whitecaps, some spray
6	22-27	25-31	Strong Breeze	Larger waves 8-13 ft, whitecaps common, more spray
7	28-33	32-38	Near Gale	Sea heaps up, waves 13-19 feet, white foam streaks off breakers
8	34-40	39-46	Gale	Moderately high (18-25 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks
9	41-47	47-54	Strong Gale	High waves (23-32 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility
10	48-55	55-63	Storm	Very high waves (29-41 ft) with overhanging crests, sea white with densely blown foam, heave rolling, lowered visibility
11	56-63	64-72	Violent Storm	Exceptionally high (37-52 ft) waves, foam patches cover sea, visibility more reduced
12	64 +	73-83	Hurricane	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced

http://www.spc.noaa.gov/faq/tornado/beaufort.html

Appendix J
Density From Other Chukchi Sea Studies

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Table 1. Summary of estimated annual and seasonal bowhead whale densities (# individuals/ km^2 [ind/km^2]) during the 2008-2012 CSESP surveys in the northeastern Chukchi Sea. The highest bowhead density estimate shown below for "Fall" was used to estimate potential number of exposures during the 2013 TGS 2D seismic survey because the sample size for the density estimated from the actual survey data was considered too small and thus associated with a high degree of uncertainty. Summer = July/August, fall = September/October. UCL = 95% upper confidence limit, LCL = 95% lower confidence limit.

Year	**ind/km^2**	**UCL**	**LCL**
2012	0.004	0.008	0.002
2011	0.001	0.003	0
2010	0.001	0	0.004
2009	0	0.001	0
2008	0	1.769	0
Season			
Summer	0.001	0.002	0
Fall	0.002	0.003	0.001

*Tables from Aerts et al. 2013b

Table 2. Summary of estimated annual and seasonal ringed/spotted seal densities (# individuals/ km^2 [ind/km^2]) for each study area and season during the 2008-2012 CSESP surveys in the northeastern Chukchi Sea. The highest density estimate shown below for 2012 (i.e., "Summer") was used to estimate potential number of exposures during the 2013 TGS 2D seismic survey because the CSESP sample size was considerably higher and thus associated with less uncertainty than the sample size used to estimate density for the TGS 2013 survey, and because 2012 was the most recent available density estimate. Summer = July/August, fall = September/October. UCL = 95% upper confidence limit, LCL = 95% lower confidence limit.

		Klondike	Burger	Statoil	GHS	Summer	Fall
2012	ind/km^2	0.019	0.051	0.075	0.022	0.057	0.022
	UCL	0.048	0.117	0.163	0.035	0.117	0.035
	LCL	0.008	0.023	0.035	0.014	0.028	0.014
2011	ind/km^2	0.030	0.013	0.088	0.063	0.046	0.063
	UCL	0.068	0.026	0.152	0.094	0.084	0.094
	LCL	0.013	0.007	0.051	0.042	0.025	0.042
2010	ind/km^2	0.018	0.011	0.028	not surveyed	0.008	0.026
	UCL	0.030	0.024	0.054		0.016	0.040
	LCL	0.011	0.005	0.015		0.004	0.017
2009	ind/km^2	0.018	0.023	not surveyed	not surveyed	0.004	0.028
	UCL	0.046	0.039			0.010	0.049
	LCL	0.007	0.013			0.002	0.016
2008	ind/km^2	0.112	0.042	not surveyed	not surveyed	0.127	0.029
	UCL	0.193	0.062			0.210	0.048
	LCL	0.065	0.028			0.077	0.018

*Table from Aerts et al. 2013b

Table 3. Summary of estimated annual and seasonal bearded seal densities (# individuals/ km^2 [ind/km^2]) for each study area and season during the 2008-2012 CSESP surveys in the northeastern Chukchi Sea. The highest density estimate shown below for 2012 (i.e., "Fall") was used to estimate potential number of exposures during the 2013 TGS 2D seismic survey because the CSESP sample size was considerably higher and thus associated with less uncertainty than the sample size used to estimate density from the TGS 2013 survey data, and because 2012 was the most recent available density estimate. Summer = July/August, fall = September/October. UCL = 95% upper confidence limit, LCL = 95% lower confidence limit**.**

		Klondike	Burger	Statoil	GHS	Summer	Fall
2012	ind/km^2	0.018	0.042	0.074	0.039	0.032	0.039
	UCL	0.037	0.079	0.124	0.056	0.058	0.056
	LCL	0.009	0.022	0.044	0.027	0.017	0.027
2011	ind/km^2	0.030	0.013	0.072	0.020	0.049	0.020
	UCL	0.065	0.021	0.138	0.031	0.086	0.031
	LCL	0.013	0.008	0.037	0.013	0.028	0.013
2010	ind/km^2	0.007	0.022	0.058	not surveyed	0.007	0.044
	UCL	0.016	0.039	0.100		0.013	0.068
	LCL	0.003	0.012	0.033		0.004	0.028
2009	ind/km^2	0.004	0.010	not surveyed	not surveyed	0.004	0.009
	UCL	0.010	0.020			0.012	0.017
	LCL	0.001	0.005			0.001	0.005
2008	ind/km^2	0.016	0.026	not surveyed	not surveyed	0.032	0.013
	UCL	0.029	0.040			0.051	0.022
	LCL	0.009	0.016			0.019	0.008

*Table from Aerts et al. 2013b