Sound Sources Characterization for the 2012 Simpson Lagoon OBC Seismic Survey

90-Day Report

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Executive Summary

In 2012 BP Exploration (Alaska) Inc. conducted an ocean bottom cable (OBC) seismic survey in Simpson Lagoon, Harrison Bay, off the North Slope of Alaska. BP was required to monitor and report underwater sound levels from its survey operations including seismic airgun arrays and vessel activities as stipulated in its Incidental Harassment Authorization (IHA) from NMFS for this work. JASCO Applied Sciences carried out the sound monitoring studies on behalf of BP between July and September 2012. This report provides detailed descriptions of the methods used in the study and the results obtained. An overview of the experimental and analysis methods are given below.

BP's 2012 IHA required measurement of underwater sound levels near certain noise-generating sources. The measurements would be analyzed to determine the distances at which broadband sound levels reached Level A, auditory injury, and Level B, behavioral disturbance, take criterion thresholds. For the purposes of this authorization, the thresholds for impulsive sounds were 190 and 180 dB re 1 µPa (rms) for Level A takes of pinnipeds and cetaceans respectively. The Level B threshold was 160 dB re 1 µPa (rms). Due to an IHA requirement, distances corresponding to sound levels at 190, 180, 160, and 120 dB re 1 µPa (rms) were also measured.

The OBC survey program was performed with three source vessels: M/V *Margarita,* M/V *Resolution, and* M/V *Storm Warning.* These vessels were equipped with airgun array sources consisting of two 320 in^3 sub-arrays, each with eight 40 in^3 airguns, towed side by side behind the vessel. The M/V *Margarita* and M/V *Resolution* were used outside the barrier islands with either a single sub-array firing at a time or both sub-arrays firing in unison for a total source volume of 640 in^3. Both vessels, and the M/V *Storm Warning* were used inside the barrier islands with only 320 in^3 arrays operating. A single 40 in^3 airgun was used as a mitigation source during turns and on survey line approaches to ensure marine mammals would keep their distance, thus avoiding the risk of being exposed to higher-level sounds from the operational airgun sources (640 and 320 in^3 arrays) when they started operating.

The Sound Source Verification (for seismic sources, which had been previously modeled) and the Sound Source Characterization (for vessel sources) studies were conducted with three autonomous ocean bottom hydrophones, each sampling from two different hydrophones for low and high sensitivity. The acoustic data on each channel were sampled at 96 000 samples per second with 24-bit resolution.

Long-range measurements were conducted using a dipping hydrophone setup provided by JASCO, which consisted of a high-resolution digital recorder in a splash proof housing, programmed to record onto a solid-state drive at 96 000 samples per second and 24-bit resolution. The acoustic sensor, a high sensitivity hydrophone, was connected to the recorder via a ten-meter sealed cable that allowed it to be deployed over the side of a vessel.

Long-term measurements over the entire seismic survey period were conducted using three Autonomous Multichannel Acoustic Recorders (AMARs). Each AMAR recorded one channel continuously at 64 000 samples per second and 24-bit dynamic range using a high sensitivity omnidirectional hydrophone.

The Sound Source Verification studies yielded a complete set of threshold radii for management of the seismic sources both inside and outside the barrier islands. Comparing these to the pre-season modeling results showed that the water sound speed profile (SSP) played a significant

role in defining the propagation ranges, and that differences between the originally assumed SSP and what was measured in the field were a prime cause of discrepancies. The definitive ranges to sound level thresholds for the seismic sources used in the OBC survey, which when obtained from measurements were conservatively computed to fit 90% of the observed levels, are given in the tables below for operations outside and inside the barrier islands.

Outside barrier islands: Maximum threshold distances for the mitigation airgun and two airgun arrays. Distances are maximized over direction and environment and are based on the 90th percentile fits.

90% rms SPL Threshold (dB re 1 μPa)	Outside Barrier Islands, 90th Percentile Distance (m)		
	640 in^3	320 in^3	40 in^3
190	516	360	24
180	1386	1134	158*
160	4616	4265	1602
120	14 163	13 313	9221

*Actual maximum range from measurements.

Inside barrier islands: Maximum threshold distances for the mitigation airgun and 320 in^3 airgun array. Distances are maximized over direction and environment and are based on the 90th percentile fits except as noted.

90% rms SPL Threshold (dB re 1 μPa)	Inside Barrier Islands, 90th Percentile Distance (m)	
	320 in^3	40 in^3
190	260	138
180	472	293
160	1545	933
120	5700*	3242

*Based on pre-season model estimate (actual range from measurements was 2528 m).

The long-range acoustic monitoring performed with the dipping hydrophone system did not detect any seismic pulses in the recordings outside the barrier islands at times when seismic sources were active inshore of the islands; this fact was confirmed by analyzing the long-term AMAR recordings at matching times. The long-term measurement data from the AMARs over the duration of the OBC survey showed that the 320 in^3 airgun array sources operating inside the barrier islands never produced received pulse levels outside the islands that exceeded the 120 dB (90% rms SPL) threshold. These results indicate that the acoustic environment of the lagoon drastically attenuates the seismic source pulses as they propagate through the sub-bottom and emerge outside the barrier islands.

1. Introduction

This report presents the results of an underwater acoustic study designed to characterize the sound emissions of seismic sound sources involved in BP's 2012 ocean bottom cable (OBC) seismic survey in Simpson Lagoon, Harrison Bay, Alaska.

Under contract to BP, JASCO Applied Sciences (JASCO) measured underwater sound pressure levels (SPLs) as a function of distance and direction from BP's airgun array sound sources from 29 July to 1 August, 2012 inclusive. The data recorders were retrieved and data downloaded by 1 August, 2012 Alaska Daylight Time (AKDT).

The measured array sound levels were used to verify the pre-season estimates reported in *Acoustic Noise Modeling of BP's 2012 Seismic Program in Simpson Lagoon* (*Harrison Bay, AK*) (Warner and Hipsey 2011).

JASCO was also tasked with additional acoustics measurements to satisfy BP's Incidental Harassment Authorization (IHA), including dipping hydrophone measurements to be conducted after 25 August 2012 and long-term underwater acoustics measurements for the duration of the seismic survey that ended 7 September 2012.

1.1. Summary Goals of the Acoustics Program

JASCO was contracted to address the following acoustics program goals, consistent with the requirements outlined in the IHA:

Airgun Array Sound Source Verification (SSV) and Vessel Characterization (SSC):

- Measure 640 in^3 array, 320 in^3 array, and 40 in^3 mitigation airgun while operating to determine the 190, 180, 160, and 120 dB re 1 µPa (rms) SPL threshold distances in the broadside and endfire directions.
- Measure three vessels used by BP for towing the arrays to determine the 160, 140, and 120 dB re 1 µPa (rms) SPL threshold distances.
- Compare the distances obtained from the measurements with the corresponding distances in the IHA that were based on pre-season modeling.
- Assess threshold distances from acoustic measurements for impulsive and broadband sound levels between 190 and 120 dB re 1 µPa (rms) for each source type.

Monitoring (Dipping Hydrophone):

- Provide an over the side system and associated training to BP's subcontractor HDR Inc., in order that they obtain long-range measurements of seismic pulses outside the barrier islands.
- Analyze data to determine the peak and rms SPL levels received outside the barrier islands at discrete times during the seismic survey after 25 August.

Monitoring (Long-term):

- Measure sound levels inside and outside the barrier islands for up to 50 days over the course of BP's survey.

- Analyze the long-term data to determine the degree to which the barrier islands block seismic survey sound propagation. Compare the peak and rms SPL levels received at each AMAR, two of which were placed outside, and one inside, the barrier islands.
- Examine the contribution of the seismic survey to the acoustic environment over the period of the survey.

2. Methods

2.1. Sound Sources

2.1.1. Sound Source Verifications: Seismic Airguns

Three airgun source configurations were measured for Sound Source Verification: a 640 in^3 array, a 320 in^3 sub-array, and a 40 in^3 mitigation airgun.

The 640 in^3 airgun array consisted of two 320 in^3 sub-arrays (Figure 1), each with eight 40 in^3 airguns, towed side by side behind a survey vessel. The sub-arrays were towed at a 2 m depth outside the barrier islands and at a 1 m depth inside. The 40 in^3 mitigation airgun was a single airgun within one of the sub-arrays.

Figure 1. One of the 320 in^3 sub-arrays which consists of eight 40 in^3 airguns. The 640 in^3 array consisted of two identical 320 in^3 sub-arrays separated horizontally astern of the vessel.

2.1.2. Sound Source Characterizations: Vessels

Three source vessels were used during the seismic survey: the M/V *Resolution* (jet boat), the M/V *Margarita* (propeller boat), and the M/V *Storm Warning* (jet boat) (Figure 2). The *Resolution* and the *Margarita* were used to operate both 640 in^3 and 320 in^3 sources outside the barrier islands, whereas the *Storm Warning* was intended for use inside the islands to tow only

the 320 in³ airgun array. All three vessels operated inside the barrier islands, towing 320 in³ airgun arrays.

Figure 2. The three source vessels: (top) *Resolution*; (bottom left) *Margarita*; and (bottom right) *Storm Warning*.

2.2. Equipment

2.2.1. Sound Source Verifications and Characterizations: Ocean Bottom Hydrophones

For the Sound Source Verifications and Characterizations, underwater sound levels were measured with three autonomous ocean bottom hydrophones (OBHs; Figure 3), each sampling from two different hydrophones. The lower sensitivity hydrophones (TC4043 from RESON) have a nominal sensitivity of −201 dB re 1 V/µPa, and the higher sensitivity hydrophones (TC4032 from RESON), −170 dB re 1 V/µPa. The acoustic data were recorded on dual channels onto solid-state drives at 96 000 samples per second with high-resolution 24-bit digital recorders (model 722 from Sound Devices, LLC).

The OBHs in protective frames (Figure 3), weighing in total 32 kg in air, were deployed to the seabed at one end of a 75 m ground line, with a 5 kg weight at the other end. The equipment was retrieved by grappling; no components were left behind.

Figure 3. A JASCO ocean bottom hydrophone (OBH) system on the deck of the deployment vessel, M/V *Cape Fear*. The black housing holds the Sound Devices 722 recorder. The yellow housing is an inactive acoustic release, which was not required for these deployments.

2.2.2. Long-Range Measurements: Dipping Hydrophone

The dipping hydrophone setup provided by JASCO for this study consisted of a high-resolution digital recorder (model 722 from Sound Devices, LLC) in a splash proof housing, programmed to record at 96 000 samples per second, 24-bit resolution, onto a solid-state drive. The acoustic sensor, a high sensitivity hydrophone (TC4032 from RESON), −170 dB re 1 V/µPa, was connected to the recorder via a ten meter extension cable.

The system was designed so that the recorder in a weatherproof housing could be operated from the deck of the vessel, and the hydrophone on extension cable lowered over the side to a specified depth below the water surface. The apparatus did not provide instantaneous readings of pulse levels; it recorded full waveform acoustic data that were later processed by JASCO offsite.

2.2.3. Long-Term Measurements: AMAR

Three Autonomous Multichannel Acoustic Recorders (AMARs) were used to measure the entire seismic survey and ambient levels. Each AMAR recorded one channel continuously at 64 000 samples per second. The recording channel had a 24-bit dynamic range with a spectral noise floor of 20 dB re 1 μPa^2/Hz and a ceiling of 171 dB re 1 µPa. The recorder was fitted with an M8 omnidirectional hydrophone (−165 ± 3 dB re 1 V/µPa sensitivity, GeoSpectrum Technologies Inc.). Data were stored on the internal solid-state flash memory.

The AMARs in protective frames with no flotation components (Figure 4), weighing in total 32 kg in air, were deployed at one end of a 75 m grapple line, with a 5 kg weight at the other end. The equipment was retrieved by grappling; no components were left behind.

Figure 4. An Autonomous Multichannel Acoustic Recorder (AMAR; JASCO Applied Sciences).

2.2.4. Recorder Calibrations

Each recording system was calibrated with a GRAS 42AA pistonphone precision sound source, which generated a 250 Hz reference tone. The equivalent amplitude of the calibration signal in response to the reference tone depends on the type of hydrophone, but approximates 140 dB re 1 µPa. The tone was played directly to the hydrophone sensors with a customized adapter. Calibrations were performed shortly before each deployment and at the end of the active field period for each of the units. The pistonphone reference tone was sampled by the digital recorders and the resulting signal was analyzed to the provide end-to-end system calibration of the hydrophone, amplifiers, and digitization. The pressure sensitivity obtained from the calibration, combined with the manufacturer's sensitivity curves of the hydrophones, was used in the subsequent data analysis to precisely determine the recorded sound levels.

2.3. Data Acquisition

2.3.1. Sound Source Verifications and Characterizations

The test seismic trials program was conducted inside and outside the barrier islands at Simpson Lagoon, Harrison Bay, AK. Figures 5 and 6 show maps of the test areas, the source track lines, and the acoustic monitoring stations. Two track lines were defined for the seismic vessels to follow so their sound levels could be measured: in shallow water inside the barrier islands (2–3 m depth, Track 1) and in deeper water outside the barrier islands (12–14 m depth, Track 2).

Ocean bottom hydrophones (OBHs) deployed outside the barrier islands (A2, B2, and C2 in Figure 5) recorded sound levels while the sources transited Track 2. The OBHs were deployed perpendicular to the track lines extending away from the barrier islands. After measurements for Track 2 were complete, the OBHs were retrieved and redeployed inside the barrier islands for Track 1 measurements (A1, B1, and C1 in Figure 6).

The standard for measurement of vessel noise underwater ANSI/ASA S12.64-2009/Part 1 (ANSI, 2004) is not applicable to the measurement of vessels as part of this SSC due to the shallow water depth of the survey. The use of OBH systems for measuring vessel source levels is the most common technique used in the North Slope offshore environment, and is widely accepted for regulatory verification purposes.

Table 1 lists deployment details for each OBH. Table 2 lists the dates each measured sound source operated and the track lines that they transited.

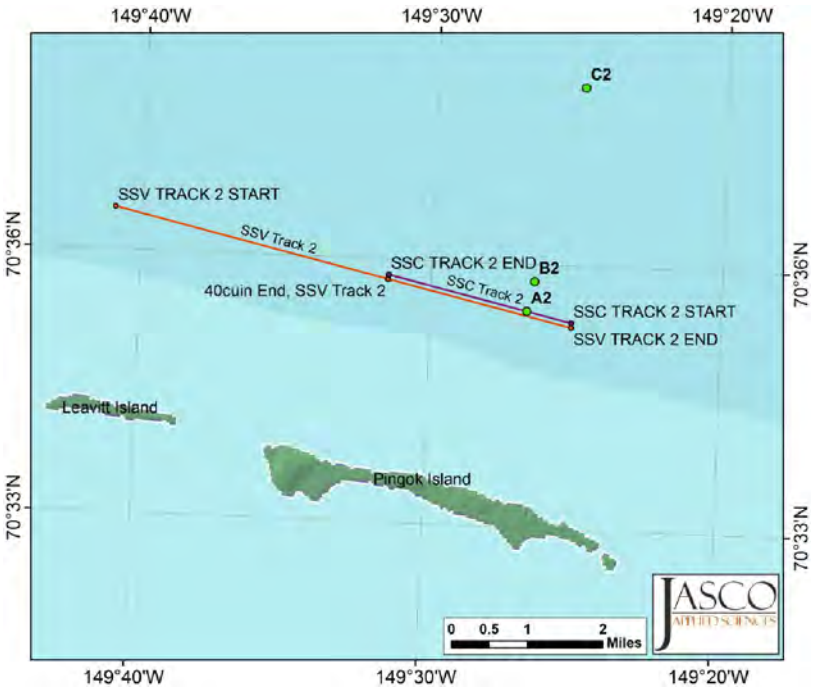

Figure 5. The Track 2 acoustic trial lines outside the Simpson Lagoon barrier islands and the locations of the acoustic recorders (OBHs A2, B2, and C2).

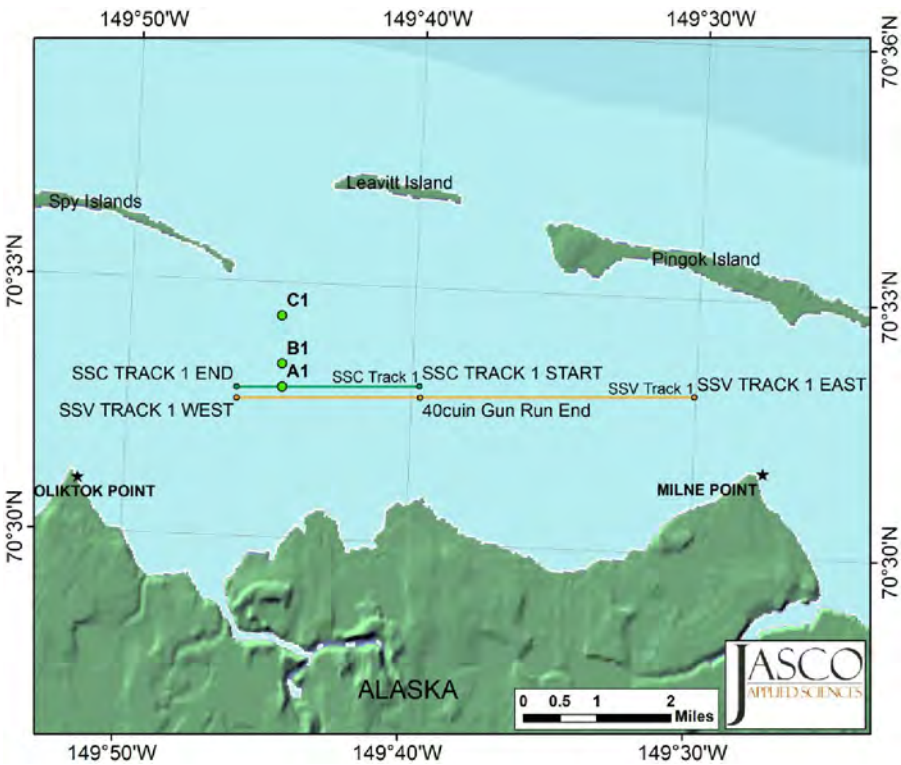

Figure 6. The Track 1 acoustic trial lines inside the Simpson Lagoon barrier islands and the locations of the acoustic recorders (OBHs A1, B1, and C1).

Table 1. Acoustic recorder locations (WGS-84) and deployment and retrieval times (AKDT) for the acoustic measurements at Simpson Lagoon. Water depths were measured at time of deployment.

OBH	Deployment	Retrieval	Latitude	Longitude	Water depth (m)	Range from track (m)	
						SSC	SSV
Outside barrier islands							
A2	29 Jul 03:11	31 Jul 01:09	70°35.472′ N	149°26.683′ W	13	0	100
B2	29 Jul 03:01	31 Jul 02:21	70°35.814′ N	149°26.442′ W	15	650	750
C2	29 Jul 01:37	31 Jul 03:53	70°38.047′ N	149°24.919′ W	18	4900	5000
Inside barrier islands							
A1	31 Jul 04:12	1 Aug 03:07	70°31.782′ N	149°44.562′ W	1.8	0	250
B1	31 Jul 02:46	1 Aug 03:50	70°32.050′ N	149°44.596′ W	1.95	500	750
C1	31 Jul 04:19	1 Aug 04:55	70°32.614′ N	149°44.679′ W	1.8	1550	1800

Table 2. Sound sources monitored during BP's Simpson Lagoon seismic survey, 30 July through 1 August, 2012. Dates and times are in AKDT.

Source	Track	Run	Date	Start	End
Outside barrier islands					
640 in^3 airgun array	SSV Track 2	1	30 Jul	14:01	15:21
320 in^3 airgun array	SSV Track 2	3	29 Jul	16:48	18:30
40 in^3 airgun	SSV Track 2	3	29 Jul	16:48	18:30
M/V *Resolution*	SSC Track 2	2	29 Jul	19:06	19:29
M/V *Margarita*	SSC Track 2	4	30 Jul	02:15	02:32
Inside barrier islands					
320 in^3 airgun array	SSV Track 1	6	31 Jul	13:34	17:12
40 in^3 airgun	SSV Track 1	7	31 Jul	12:07	12:45
M/V *Storm Warning*	SSC Track 1	5	1 Aug	01:19	01:39

2.3.2. Long-Range Measurements

The dipping hydrophone was used by HDR Inc. outside the barrier islands after 25 August 2012 as part of fulfilling the IHA requirements to measure received levels from the survey at locations along the bowhead whale migration route outside the islands after the nominal start of the bowhead migration.

HDR Inc. conducted the measurements at locations M1-M8 (Figure 7) and detailed in Table 3. These locations were selected to align with the AMAR deployment locations. Eight measurements were conducted, and relevant non-acoustic data were duly logged. The settings of the supplied recording instrument, however, were altered by its operators during the acquisition program in an attempt to address a perceived lack of signal, leading to one measurement not producing valid data. After the conclusion of the survey, JASCO sourced the navigation data from CCGVeritas and NCS-Subsea and correlated the recording times with vessel movements.

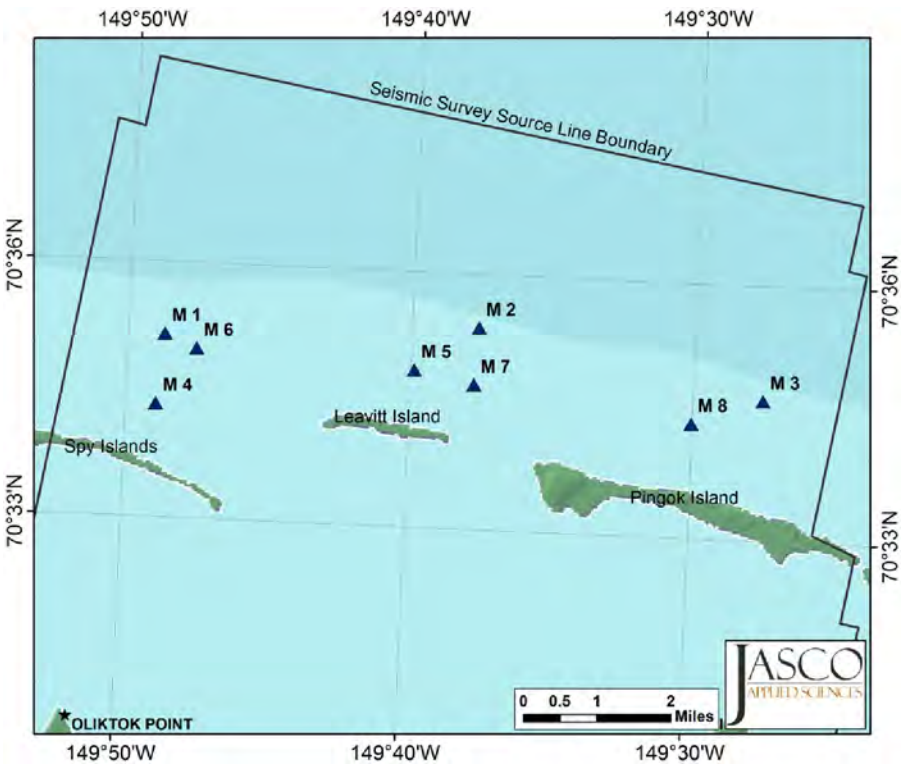

Figure 7. Dipping hydrophone sample locations; recommended (P1, P2, and P3) and measured (M1–M8).

Table 3. Dipping hydrophone locations (WGS-84), deployment, and retrieval times for the long-range measurements. Dates and times are in Alaska Daylight Time. Water depths were as measured at time of deployment.

Rec No.	Location	Date (AKDT)	Deployment (AKDT)	Retrieval (AKDT)	Latitude	Longitude	Water depth (m)
1	3	29 Aug	12:24	12:39	70°35.157′	149°48.710′	11.6
2	2	29 Aug	13:00	13:14	70°35.380′	149°37.630′	12.2
3	1	29 Aug	13:35	13:50	70°34.653′	149°27.513′	11.0
4	3	1 Sept	12:38	12:52	70°34.334′	149°48.929′	6.4
5	2	1 Sept	13:34	13:47	70°34.857′	149°39.856′	10.4
6	3	5 Sept	13:48	14:02	70°35.000′	149°47.560′	8.5
7	2	5 Sept	15:02	15:18	70°34.713′	149°37.738′	9.1
8	1	5 Sept	15:33	15:48	70°34.357′	149°30.023′	8.2

2.3.3. Long-Term Measurements

The AMARs for long-term measurements were deployed in strategic locations within the seismic survey area (Figure 8) with the primary goal of examining the degree to which the barrier islands block seismic survey sound propagation. This was achieved by comparing the peak and rms SPL levels received at three AMAR locations: two outside and one inside the barrier islands. These locations were selected so that AMAR 1 and AMAR 2 were aligned with a navigable channel between the islands, while AMAR 3 was positioned so that it could only receive sound that travelled out of the lagoon passing through an island.

Data from the AMARs were also used to examine the contribution of the seismic survey to the acoustic environment over the survey period. The AMARs were deployed one day prior to the seismic survey start (28 July), and retrieved 2-3 days after the survey had ended (6 Sep).

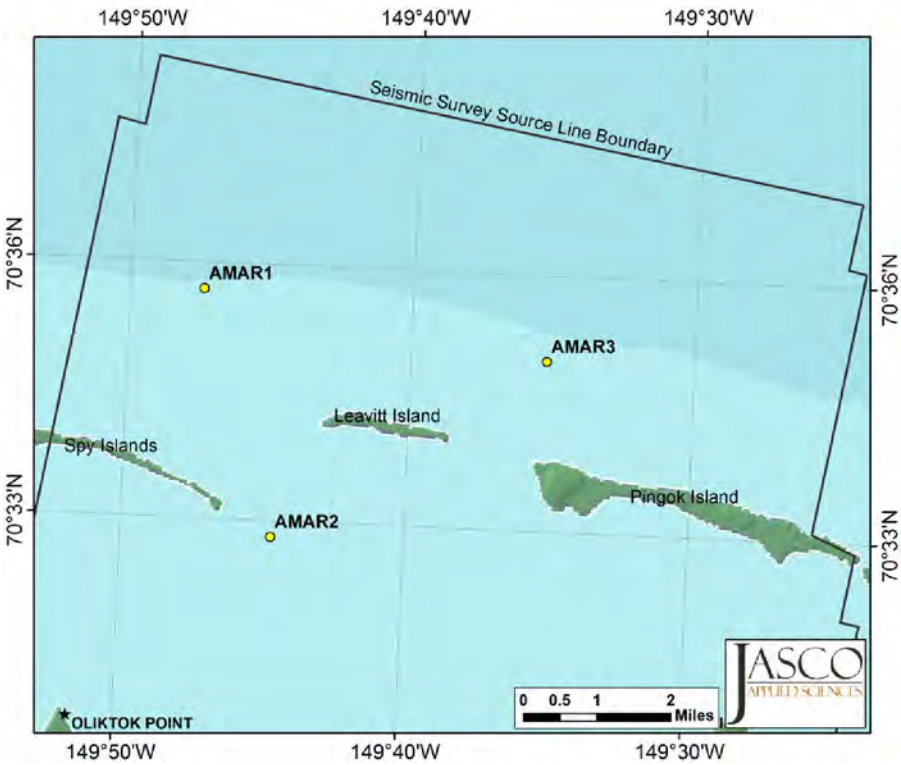

Figure 8. AMAR deployment locations in the seismic survey area.

Table 4. AMAR location (WGS-84) and deployment and retrieval times (AKDT) for the acoustic measurements. Water depths were measured at time of deployment.

AMAR	Deployment	Retrieval	Latitude	Longitude	Water depth (m)
1	27 Jul 13:39	9 Sep 08:50	70°35.695′ N	149°47.414′ W	12.2
2	27 Jul 12:57	7 Sep 12:01	70°32.821′ N	149°44.676′ W	2.8
3	27 Jul 15:05	9 Sep 09:33	70°34.992′ N	149°35.208′ W	12.5

2.4. Data Analysis

2.4.1. Noise Metrics

Underwater sound amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_o = 1 µPa; however, the magnitude of impulsive noise, e.g., from seismic airguns, is not, in general, proportional to instantaneous acoustic pressure and so several sound level metrics are commonly used to evaluate the magnitude 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 impulse, $p(t)$:

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

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:

$$L_p = 10\log_{10}\left(\frac{1}{T}\frac{\int_T p^2(t)dt}{p_{\text{o}}^2}\right) \tag{2}$$

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 more spread out in time have a lower rms SPL for the same total acoustic energy.

By convention, when computing airgun safety radii, T is often defined as the "90% energy pulse duration", containing the central 90% (from 5% to 95% of the total) of the cumulative square pressure (or energy) of the pulse, rather than over a fixed time window (Malme et al. 1986, Greene 1997, McCauley et al. 1998). The 90% rms SPL (L_{p90}, dB re 1 µPa) in a stated frequency band is calculated over this 90% energy time window, T_{90}:

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

The SEL (L_E, dB re 1 µPa^2·s) is the time integral of the squared pressure in a stated frequency band over a stated time interval or event. The per-pulse SEL is calculated over the time window containing the entire pulse (i.e., 100% of the acoustic energy), T_{100}:

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

where T_{o} is a reference time interval of 1 s. The per-pulse SEL, with units of dB re 1 µPa·√s, or equivalently dB re 1 µPa^2·s, represents the total acoustic energy delivered over the duration of the acoustic event at a receiver location. It is a measure of sound energy (or exposure) rather than sound pressure, although it is not measured in energy units. SEL can be a cumulative metric if it is calculated over periods containing multiple pulses.

2.4.2. Seismic Airgun SSVs: Per-Shot Pulse Levels

The magnitude of each recorded pulse from the airgun was quantified by computing the three noise metrics described above: peak SPL, 90% rms SPL, and SEL.

Each pulse was analyzed as follows:

1. Convert digital recording units to micropascals (µPa) by applying hydrophone sensitivity, analogue circuit frequency response, and digital conversion gain.

2. Determine start time of the impulsive pressure signal with an automatic power-threshold detector.
3. Compute peak SPL (symbol L_{pk}) according to Equation 1.
4. Compute cumulative square pressure over the duration of the pulse.
5. Determine the 90% time window length (T90) and compute 90% rms SPL (symbol L_{p90}) according to Equation 3.
6. Compute SEL (symbol L_E) according to Equation 4 over the duration of the pulse.

Sound levels shown were recorded on the more sensitive TC4032 hydrophone unless clipping or non-linear effects near saturation were observed, in which case sound levels from the less sensitive TC4043 hydrophone were substituted. These higher levels generally occurred within 1000 m of the closest point of approach (CPA) of the source to the recorder.

2.4.3. Vessel SSCs: Continuous Sound Levels

The continuous (non-impulsive) noise produced by the survey vessels was quantified by computing rms SPLs over consecutive 1-second time windows by computing Equation 2 with T = 1 s.

2.4.4. SSVs and SSCs: Sound Level versus Range and SPL Threshold Radii

Acoustic data were analyzed using custom processing software to determine peak and rms SPLs and per-pulse sound exposure levels (SELs) versus range from the airgun sources. The data were processed as follows:

1. Airgun pulses in the OBH recordings were identified using an automated detection algorithm.
2. Waveform data were converted to units of µPa using the calibrated hydrophone sensitivity of each OBH.
3. For each pulse, the distance to the airgun array was computed from the GPS deployment coordinates of the OBHs and the time-referenced navigation logs of the survey vessel.
4. The airgun pulses were processed to determine peak sound pressure level (Peak SPL), 90% rms sound pressure level, (SPL) and sound exposure level (SEL) at the receiver location.

The noise metrics computed for each source are presented as a function of source-receiver range. To estimate the distance to sound level thresholds and the source level for each monitored sound source, the 90% rms SPL (L_{p90}) as a function of range (R, in meters) were fit with an empirical transmission loss function of the form:

$$L_{p90} = \mathrm{SL} - n \log R - \alpha R, \text{ or} \tag{7}$$

$$L_{p90} = \mathrm{SL} - n \log R \tag{8}$$

where SL is the source level term (dB re 1 µPa @ 1 m), n is the geometric spreading loss coefficient, and α is the absorption loss coefficient, and these coefficients are determined by

least-squares regression. Equation 7 is used if absorptive losses are present or if apparent curvature exists in the received level versus log(R) data trend, whereas Equation 8 is used if no significant absorptive losses exist.

The best-fit line was shifted upward (in dB) to exceed 90% of the rms SPL data points, yielding the 90th percentile fit. The 90th percentile best-fit values for SL, n, and α are shown in the SPL plot annotations in the following sections. The distances to the SPL thresholds (120-190 dB re 1 μPa in 10 dB increments) are tabulated for each source, for both the best-fit and 90th percentile fit lines.

2.4.5. Spectral Analysis

The broadband frequency content of each source was presented in three formats:

- spectrogram
- spectral density over a specified time window
- 1/3–octave band levels

For 1/3–octave band analysis of impulsive sources, the sound data were band-pass filtered into several adjacent frequency bins, and the SEL of each bin computed. The acoustics community has adopted standard 1/3–octave frequencies (more precisely, these are 10th decade band frequencies) (ISO R 266 and ANSI S1.6-1984) to help researchers compare between studies; the central frequency of the *i*th standard passband is:

$$f_{ci} = 10^{i/10},\ i = 1, 2, 3, \ldots \tag{9}$$

The bandwidth of a single 1/3–octave band is approximately 23% of the central frequency of the band. Third-octave band analysis was applied to both continuous and impulsive noise sources.

The spectral analysis is useful in the context of sound source verification as it enables a more complete interpretation of the results. This includes relative amplitude comparison and examination of how the pulse changes with travelled distance in both the frequency and time domains.

2.4.6. Automated Processing

A specialized computing platform operating at about 800 times greater than real-time recording (e.g., 800 h of recorded data could be analyzed in 1 h of computing time) was used to analyze ambient noise. The following section provides an overview of the processing stages; more information is in Appendix A.

2.4.6.1. Ambient Data Analysis and Time Series Analysis

The frequency domain ambient analysis provides 1 Hz resolution spectral density values for each minute of a recording. These values are directly comparable to the Wenz curves (Figure 9; Wenz 1962), which are representative of typical sound levels in the ocean. The ambient analysis also provides 1/3-octave and decade sound pressure levels for each minute of data.

SpectroPlotter's time series toolchain, which finds the peak amplitudes, peak-to-peak amplitudes, and rms amplitudes of the time series for each minute of data, performed time-domain ambient analysis.

This information is presented as percentiles, spectrograms and 1/3-octave band level plots.

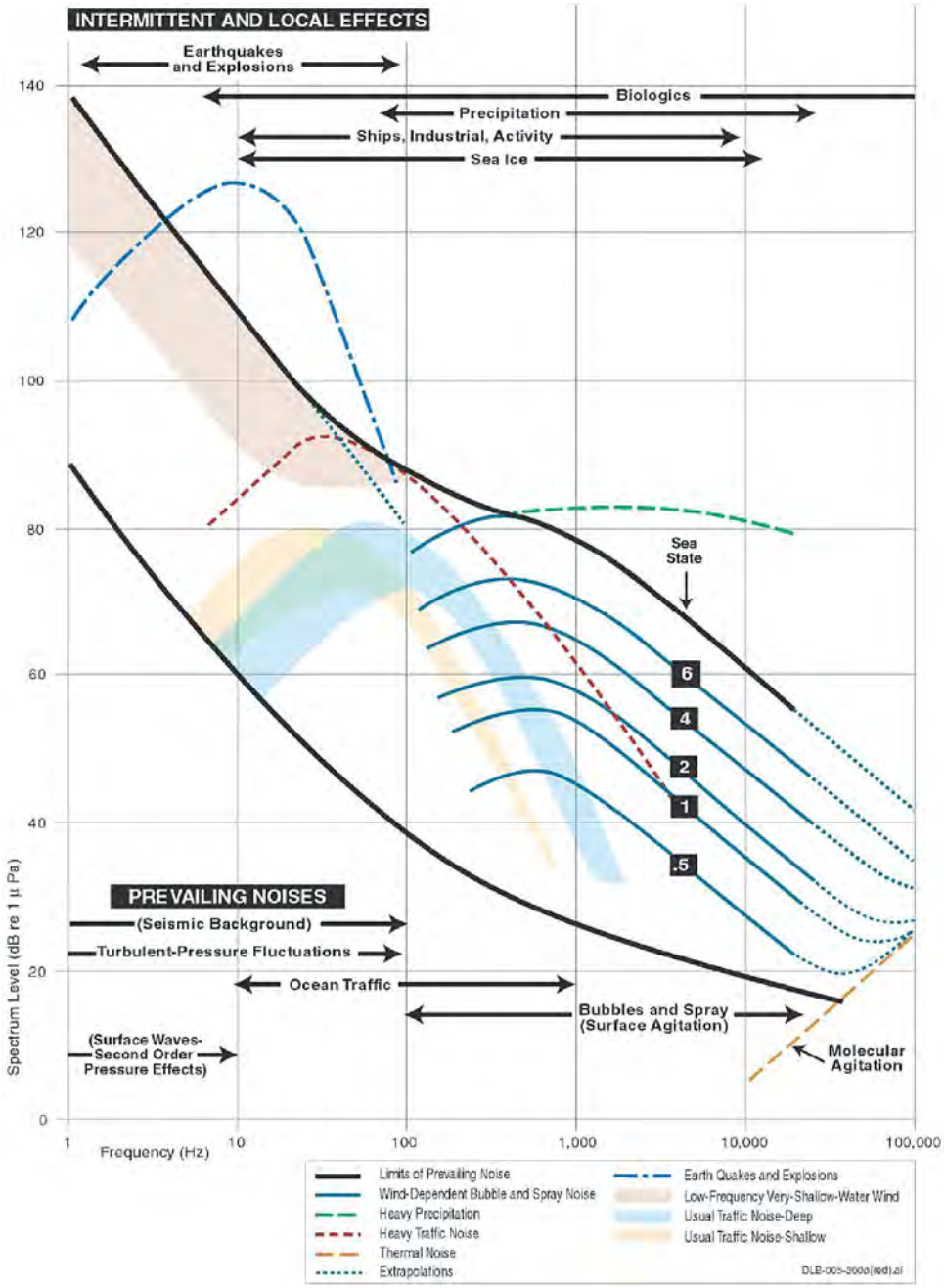

Figure 9. The Wenz curves describing pressure spectral density levels of marine ambient noise from weather, wind, geologic activity, and commercial shipping (Ocean Studies Board 2003 adapted from Wenz 1962). Thick lines indicate limits of prevailing noise.

3. Results

3.1. SSV/SSC Outside Barrier Islands

All airgun configuration trials outside the barrier islands were towed at 2 meters, the planned operational depth. Recorders were approximately placed at the 190, 180 and 160 dB isopleths in the across-track (broadside) direction as estimated in pre-season modeling. Because no direct broadside measurements were made near the 120 dB sound level, the analysis was based on data extrapolated from curves fitted to the measured data to determine the range at this level.

3.1.1. Sound Speed Profiles

The sound speed profile was measured in three locations outside the barrier islands (Figures 10 through 12), distributed across the area (Figure 13). The profile is reasonably similar at all locations, indicating a faster surface duct above approximately 4 m of nearly 1439 m/s and a constant speed below 6m of 1436 m/s. The surface duct is substantially faster at the Cast 4 site, between 1445 and 1455 m/s, compared to 1439 m/s at the Cast 1 and 2 sites.

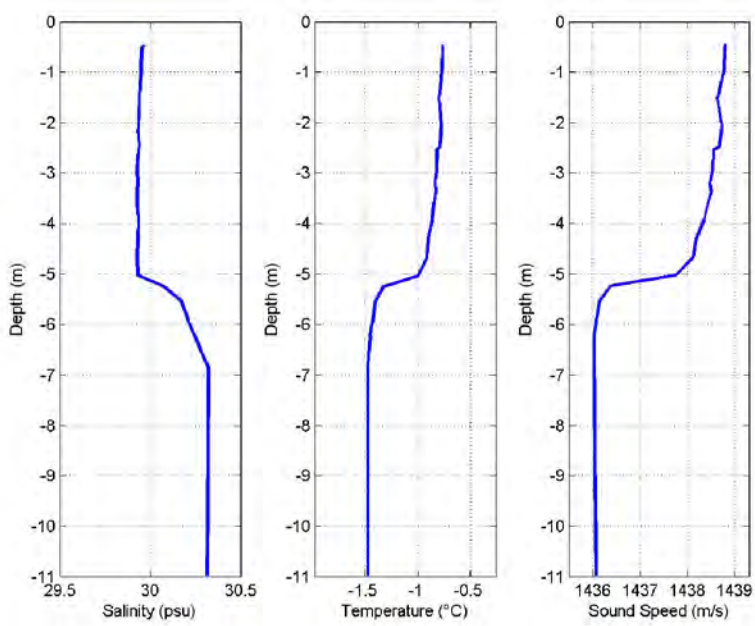

Figure 10. (left) Salinity, (center) temperature, and (right) sound speed profiles from CTD Cast 1 at 09:47:38 AKDT, 26 Jul 2012 at 70° 35.685' N, 149° 47.698' W, outside the barrier islands.

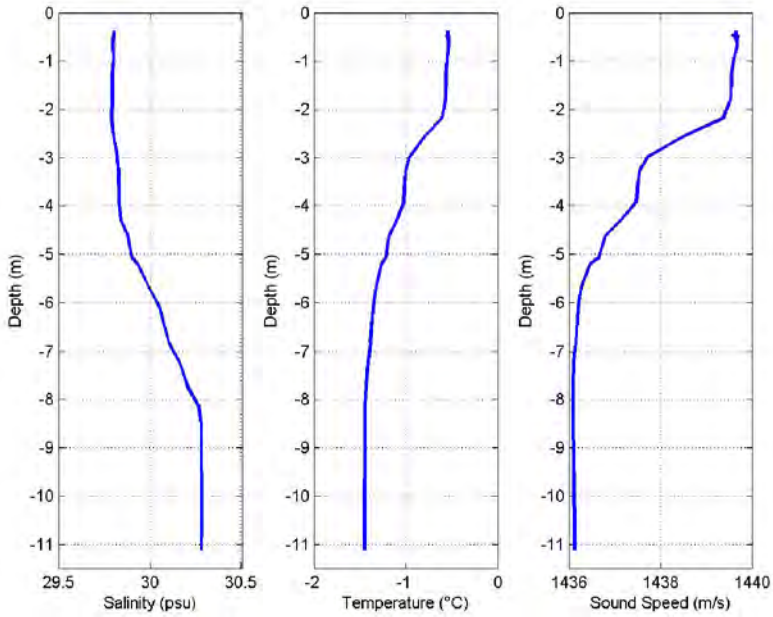

Figure 11. (left) Salinity, (center) temperature, and (right) sound speed profiles from CTD Cast 2 at 10:43:04 AKDT, 27 Jul 2012 at 70° 34.973' N, 149° 35.134' W, outside the barrier islands.

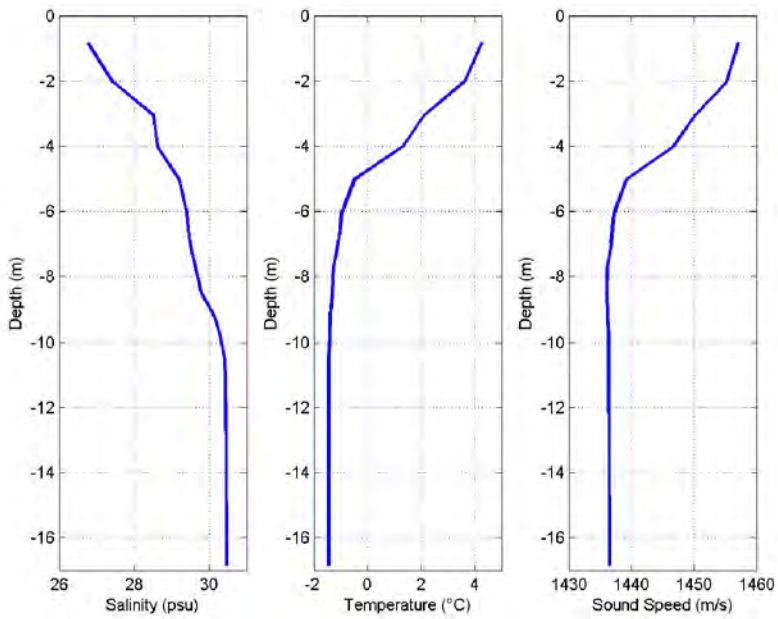

Figure 12. (left) Salinity, (center) temperature, and (right) sound speed profiles from CTD Cast 4 at 01:23:47 AKDT, 29 Jul 2012 at 70° 37.995' N, 149° 25.141' W, outside the barrier islands.

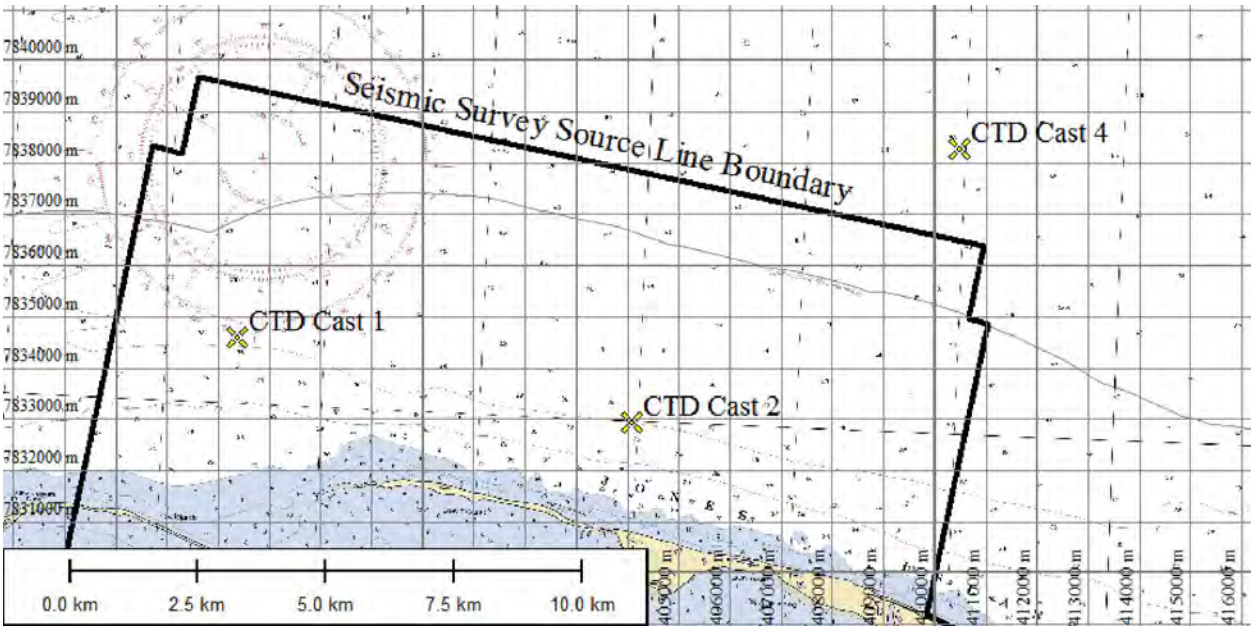

Figure 13. Sound speed profile measurement locations, outside the barrier islands.

3.1.2. 640 in³ Airgun Array

Peak SPL, 90% rms SPL, and SEL for each pulse were computed from acoustic data recorded on OBHs A2 through C2. Figure 14 shows sound levels from the 640 in³ airgun versus slant range measured in the endfire (along the direction of tow) and broadside (across track) directions for SSV Track 2. The closest broadside measurements, from OBH A2 were included in the endfire calculations. Tables 5 and 6 list ranges to various rms SPL thresholds for each of the fits in Figure 14. Figures 15 and 16 show the spectrograms for the endfire and broadside orientations, Figures 17 and 18 show the waveform and spectra.

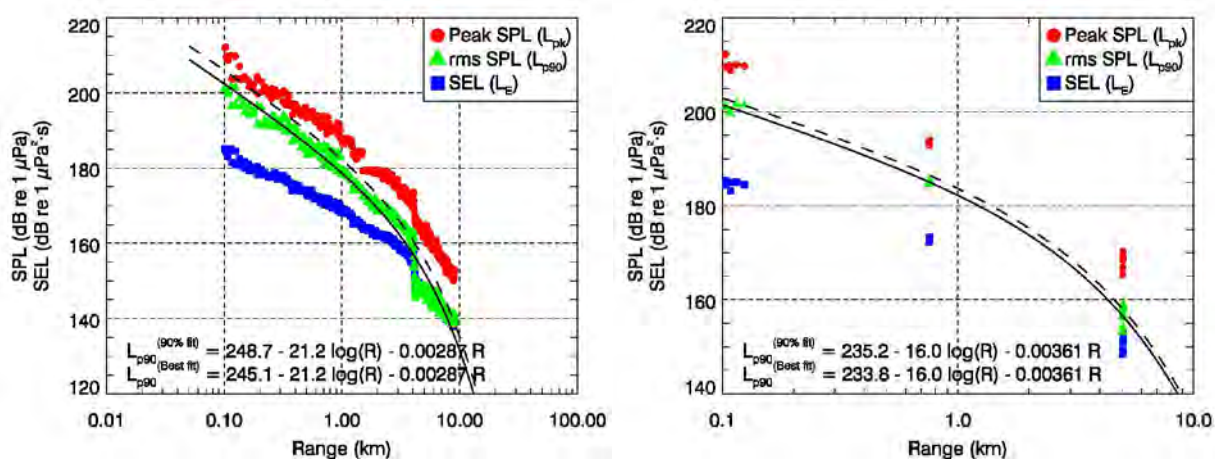

Figure 14. Peak SPL, rms SPL, and sound exposure level (SEL) versus slant range for the 640 in³ airgun pulses: (left) Endfire and (right) broadside directions, outside the barrier islands. Solid line is the best-fit line to the 90% rms SPL. Dashed line is the best-fit adjusted to exceed 90% of the 90% rms SPL.

Table 5. *Endfire threshold radii:* Distance from the 640 in^3 airgun array, outside the barrier islands, to 90% rms SPL thresholds determined from the best-fit lines in Figure 14.

Endfire Distance in meters (outside barrier islands)		
Threshold (dB re 1 µPa)	*Best-Fit*	*90th Percentile*
190	355	502
180	891	1196
170	1916	2420
160	3483	4163
120	13 150	14 163

Table 6. *Broadside threshold radii*: Distance from the 640 in^3 airgun array, outside the barrier islands, to 90% rms SPL thresholds determined from the best-fit lines in Figure 14.

Broadside Distance in meters (outside barrier islands)		
Threshold (dB re 1 µPa)	*Best-Fit*	*90th Percentile*
190	436	516
180	1223	1386
170	2568	2803
160	4334	4616
120	13 270	13 624

Figures 15 and 16 show pulse spectrograms from measurements taken at ranges close to the 190 dB modeled threshold radius of 120 m (Figure 16, endfire range 101 m) and 180 dB modeled threshold radius of 950m (Figure 15, endfire range 997 m, and Figure 16, broadside range 754 m). The broadside range of 754 m is the closest point of approach (CPA) range for OBH B1, deployed at that lateral offset perpendicular to the array tow path, and the closest point to the 180 dB modeled threshold radius of 950 m.

These measurements indicate strong water and substrate propagation at these distances, observable through the frequency range of the detected pulses (1 Hz to 10 kHz), with minimal difference in the head wave arrival time, which was barely noticeable in the 997 m and 754 m plots in front of the main pulse and below 150 Hz. The pulses at these ranges had a shorter 90% rms SPL length than the model predicted, partly because the difference between the rms SPL and SEL levels was larger than expected.

The measurement location close to the 160 dB modeled threshold (Figure 15, endfire range 5010 m), showed the pulse beginning to separate into different propagation modes, with the formation of a clear head wave from sound travelling through the bottom. The actual pulse length (Figure 17) is greater than predicted by the model, which resulted in a smaller difference between the rms SPL and SEL levels, contributing to a smaller threshold radius than the model predicted.

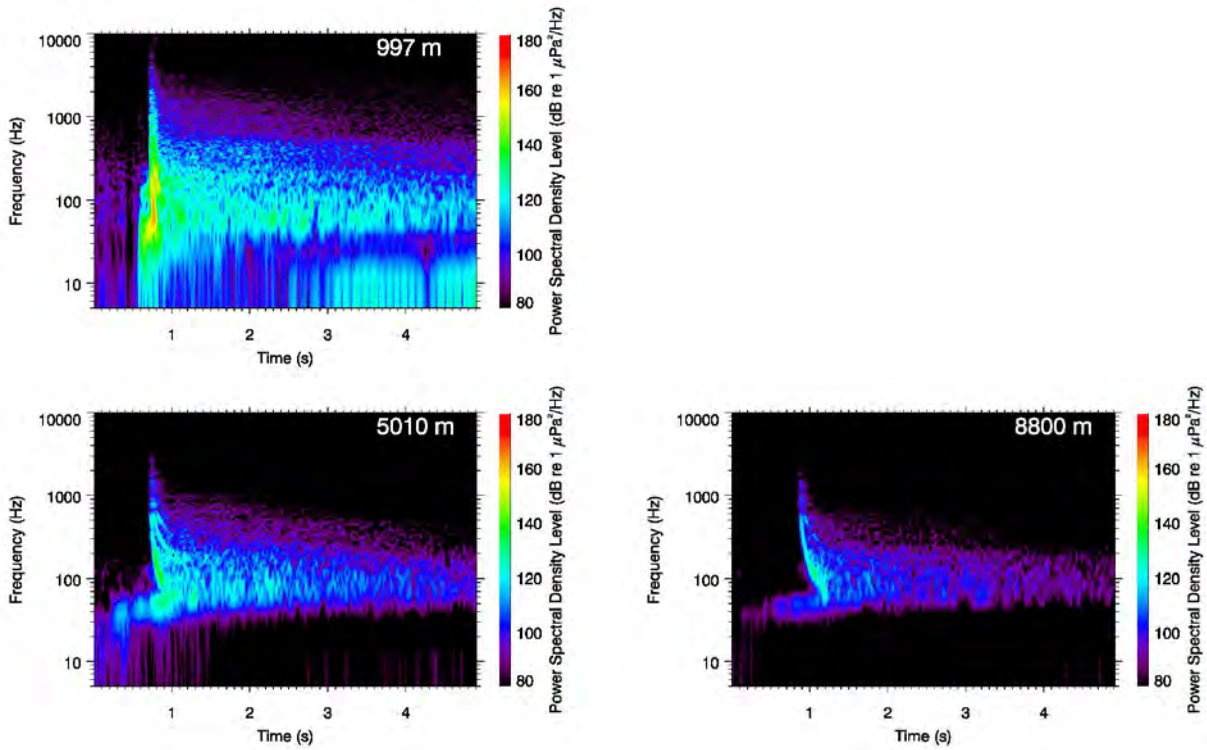

Figure 15. *Endfire*: Spectrograms of airgun pulses from the 640 in³ airgun array recorded on OBH A2 at three distances, 997 m, 5010 m and 8800 m; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

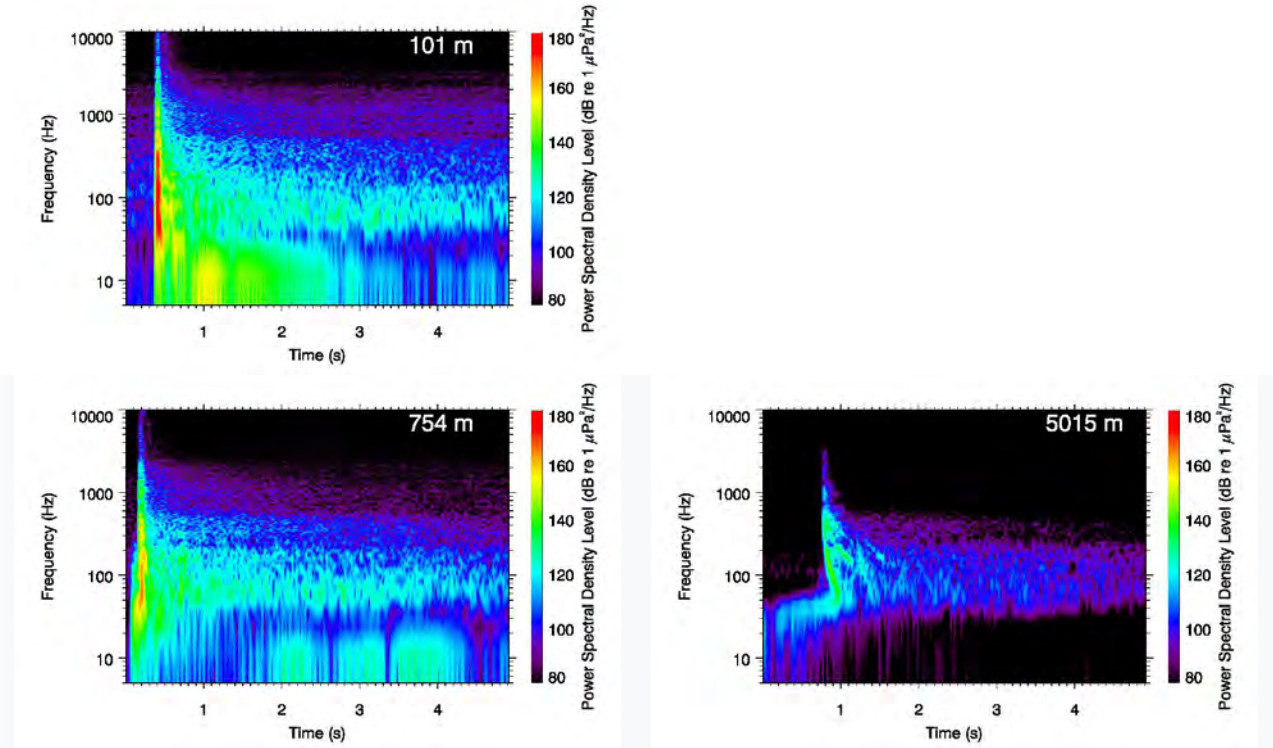

Figure 16. *Broadside*: Spectrograms of airgun pulses from the 640 in³ airgun array at the CPA for each OBH, 101 m to A2, 754 m to B2, 5015 m to C2; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

The SEL spectral density of the pulses at the distances noted in Figures 17 and 18, show a diminishing trend, in the low frequency components and the components above 200 Hz, with distance from the source. Low frequency components are those below 50 Hz, but the diminishing trend was strongest below 10 Hz due to the head waves of the pulse. This results in the 80-200 Hz components dominating the received signal at distances farther than about a kilometer from the source.

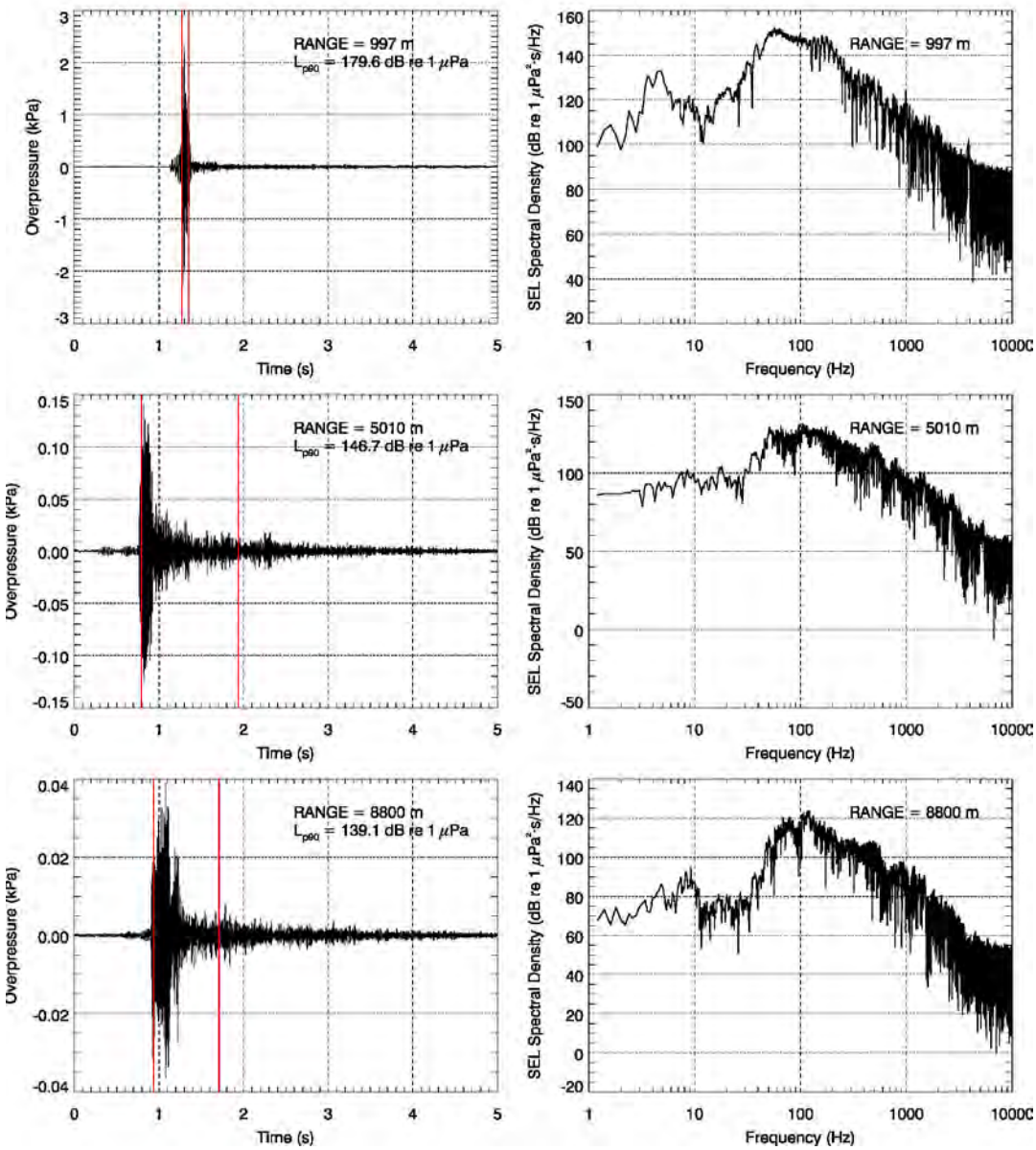

Figure 17. *Endfire*: (left) Waveform and spectra (right) corresponding SEL spectral density of 640 in³ airgun array pulses at three distances from OBH A2, 997 m, 5010 m, and 8800 m. The red bars on the waveform indicate the 90% energy pulse duration.

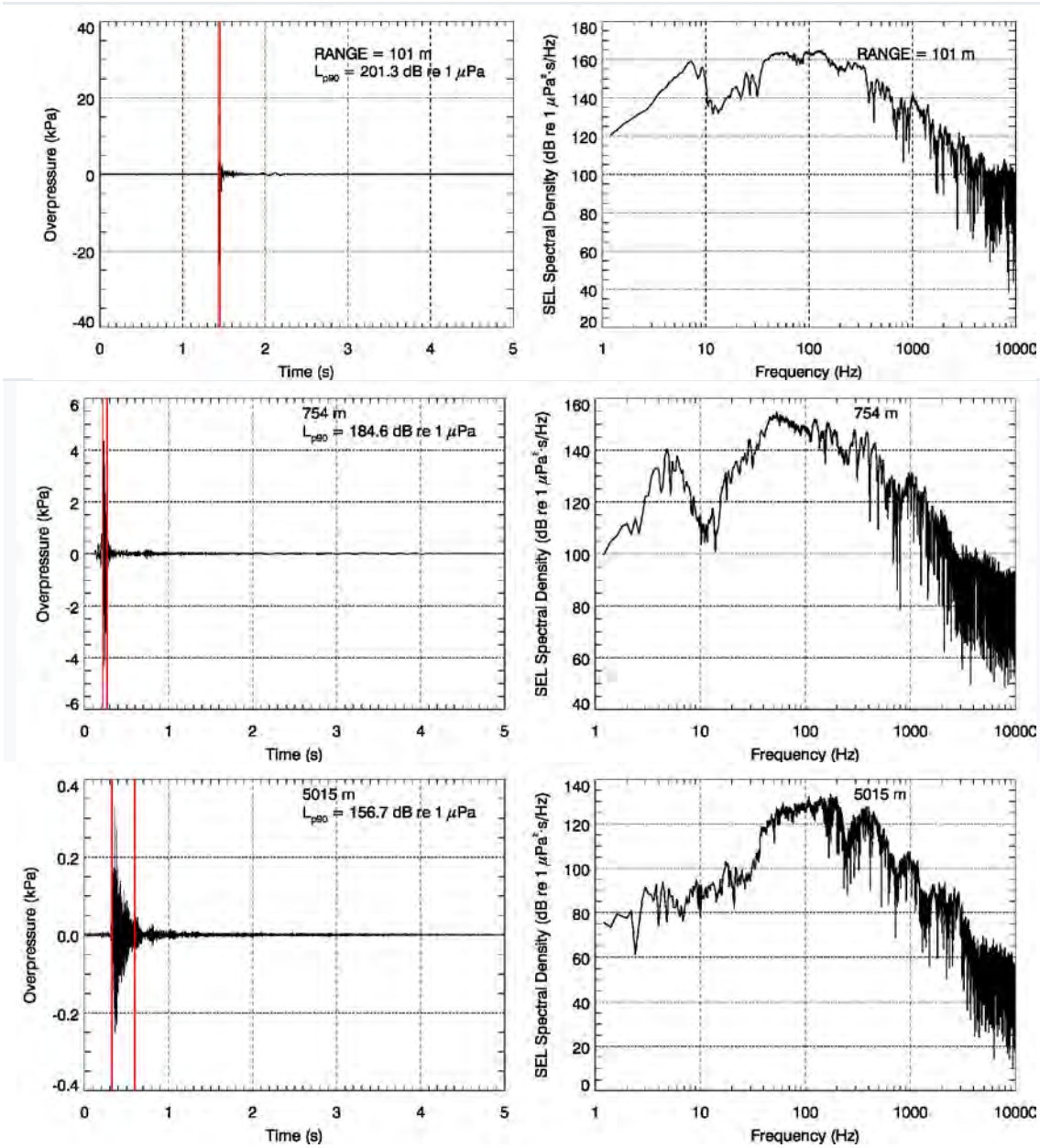

Figure 18. *Broadside*: (left) Waveform and spectra (right) corresponding SEL spectral density (right) plots of 640 in³ airgun array pulses array at the CPA for each OBH, 101 m to A2, 754 m to B2, 5015 m to C2. The red bars on the waveform indicate the 90% energy pulse duration.

3.1.3. 320 in³ Airgun Array

Peak SPL, 90% rms SPL and SEL for each shot were computed from acoustic data recorded on OBHs A2 through C2. Figure 19 shows sound levels from the 320 in³ airgun versus slant range measured in the endfire and broadside directions for SSV Track 2. The closest broadside measurements, from OBH A2 were included in the endfire calculations. Tables 7 and 8 list ranges to various rms SPL thresholds for each of the fits in Figure 19. Figures 20 and 21 show the spectrograms for the endfire and broadside orientations, Figures 22 and 23 show the waveform and spectra.

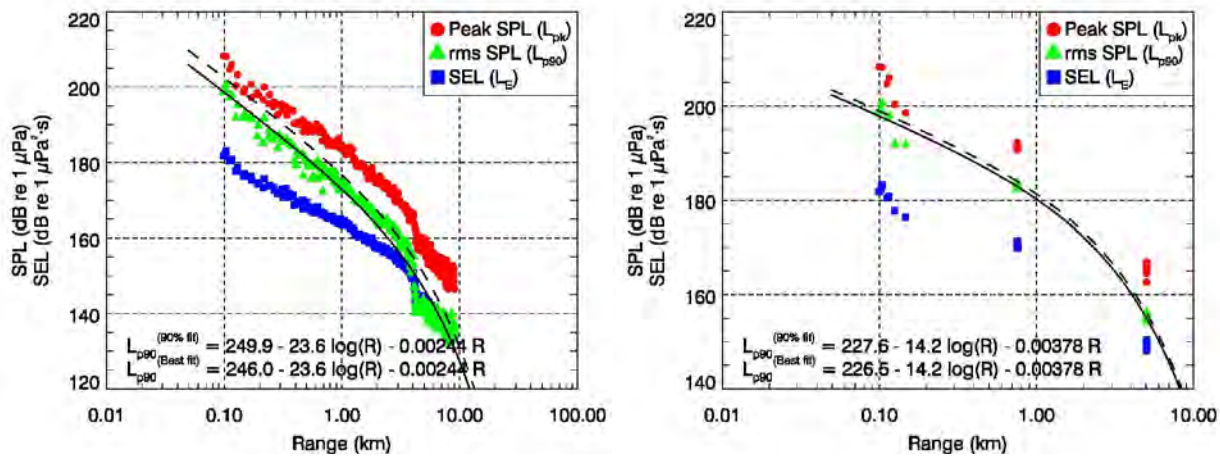

Figure 19. Peak SPL, rms SPL, and sound exposure level (SEL) versus slant range for the 320 in^3 airgun pulses in the (left) endfire and (right) broadside directions, outside the barrier islands. Solid line is the best-fit line to the 90% rms SPL. Dashed line is the best-fit adjusted to exceed 90% of the 90% rms SPL.

Table 7. *Endfire threshold radii*: Distance from the 320 in^3 airgun array, outside the barrier islands, to 90% rms SPL thresholds determined from best-fit lines in Figure 19.

Endfire Distance in meters (outside barrier islands)		
Threshold (dB re 1 μPa)	*Best-Fit*	*90th Percentile*
190	224	318
180	550	760
170	1238	1636
160	2456	3078
120	12 132	13 313

Table 8. *Broadside threshold radii*: Distance from the 320 in^3 airgun array, outside the barrier islands, to 90% rms SPL thresholds determined from the best-fit lines in Figure 19.

Broadside Distance in meters (outside barrier islands)		
Threshold (dB re 1 μPa)	*Best-Fit*	*90th Percentile*
190	311	360
180	1019	1134
170	2322	2484
160	4058	4265
120	12 771	13 027

Figures 20 and 21 show pulse spectrograms from measurements taken at close ranges: Figure 21, broadside range 99 m; Figure 20, endfire range 995 m; and Figure 21, broadside range 751 m. The broadside range of 751 m is the closest point of approach (CPA) for OBH B1, which was deployed at that lateral offset perpendicular to the array tow path. These measurements indicate strong water and substrate borne propagation at these distances, observable through the frequency range of the detected pulses (1 Hz to 10 kHz). There is also minimal delay in the head wave arrival time, barely noticeable in the 995 m and 751 m plots in front of the main pulse and below 150 Hz.

The measurement at endfire range 5084 m (Figure 20) showed the pulse beginning to separate into different propagation modes; a clear head wave formed.

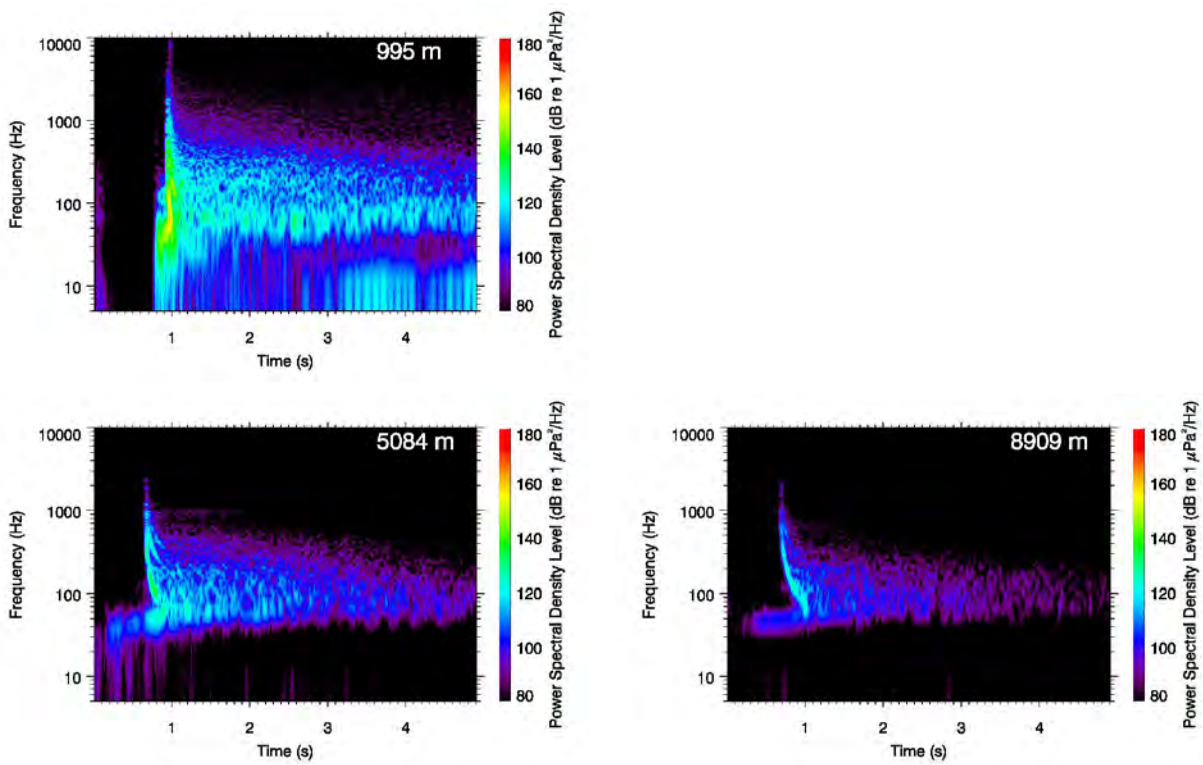

Figure 20. *Endfire*: Spectrograms of airgun pulses from the 320 in³ airgun array at three distances from OBH A2, 998 m, 5084 m, and 8909 m; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

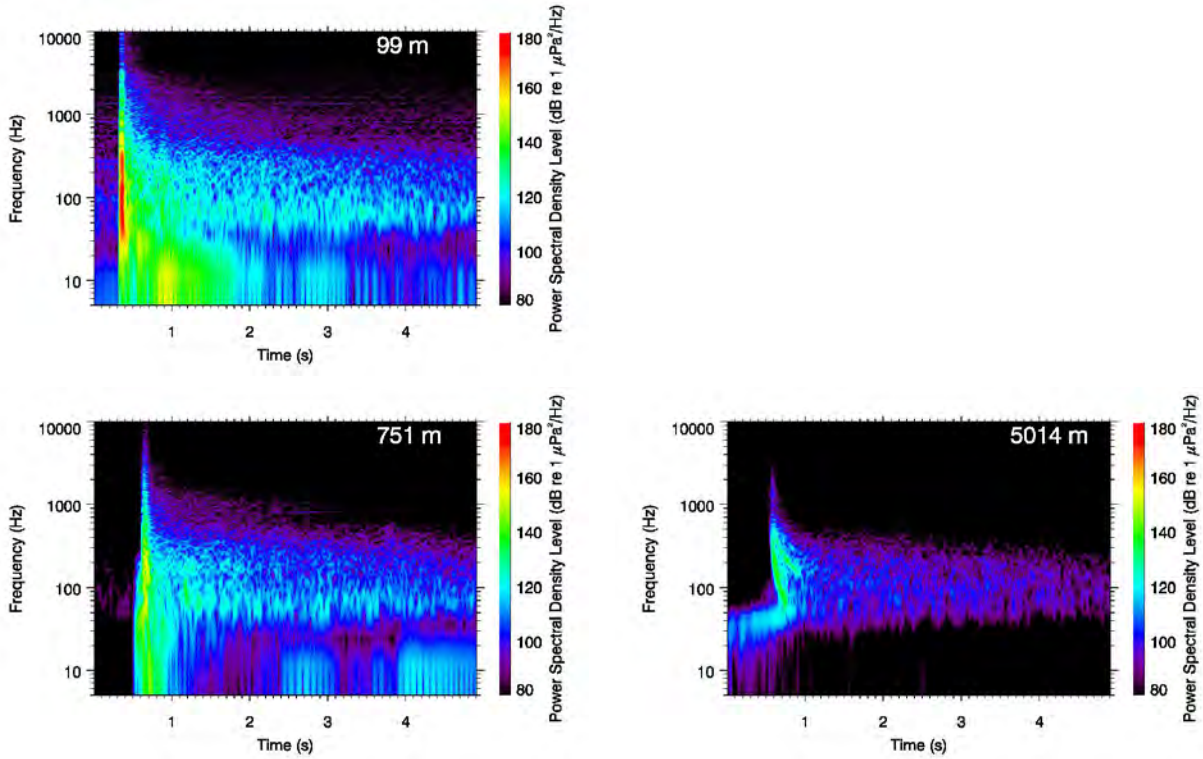

Figure 21. *Broadside*: Spectrograms of airgun pulses from the 320 in³ airgun array at the CPA to each OBH, 99 m to A2, 751 m to B2, 5014 m to C2; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

The SEL spectral density of the pulses at the distances noted in Figures 22 and 23 show a diminishing trend in the low frequency components with distance from the source. Low frequency components are those below 50 Hz, but the diminishing trend was strongest below 10 Hz due to the head waves of the pulse. This results in the 80–200 Hz components dominating the received signal at distances farther than about a kilometer from the source.

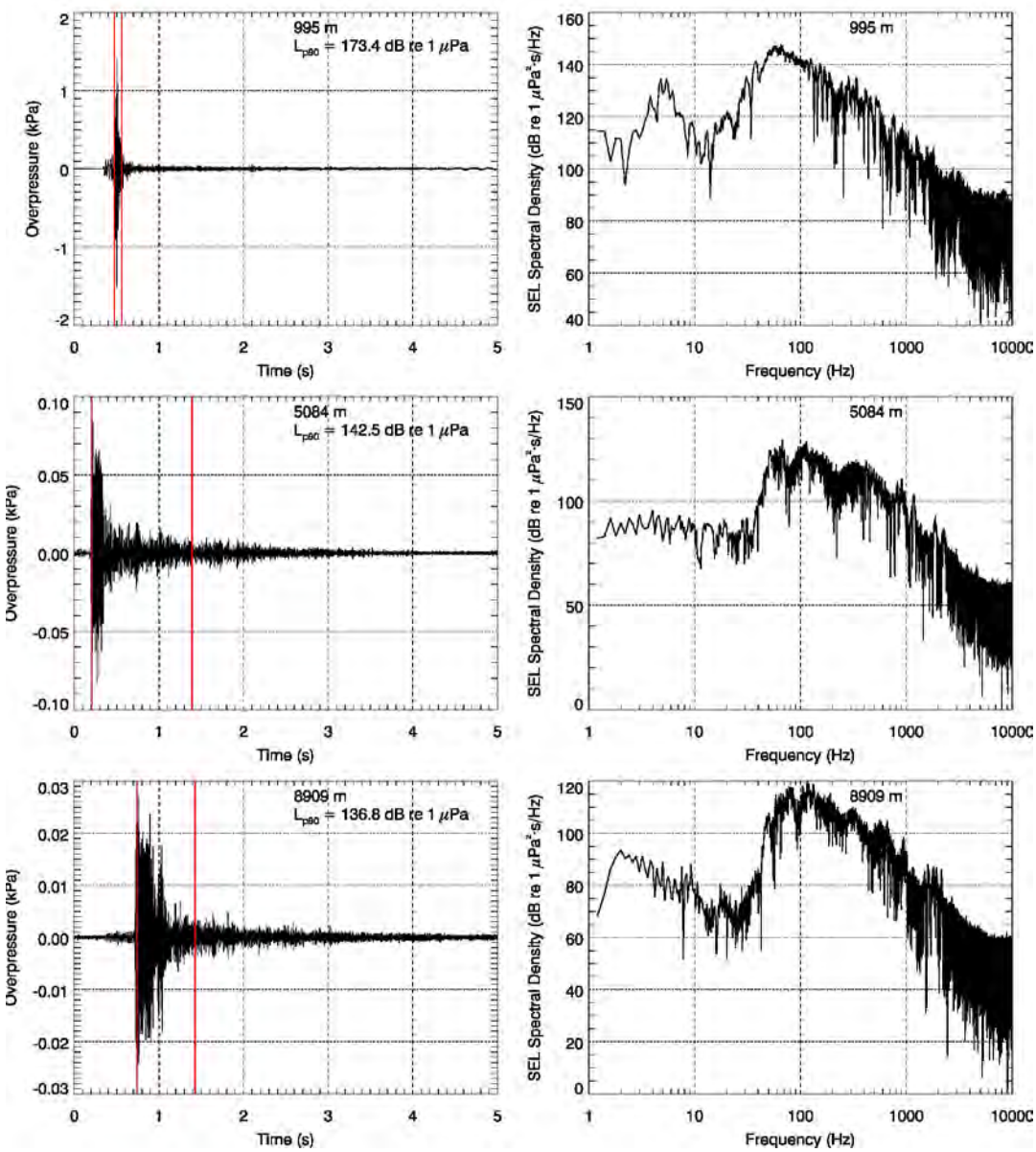

Figure 22. *Endfire*: (left) Waveform and spectra (right) corresponding SEL spectral density of 320 in³ airgun array pulses at three distances to OBH A2, 998 m, 5084 m, and 8909 m. The red bars on the waveform indicate the 90% energy pulse duration.

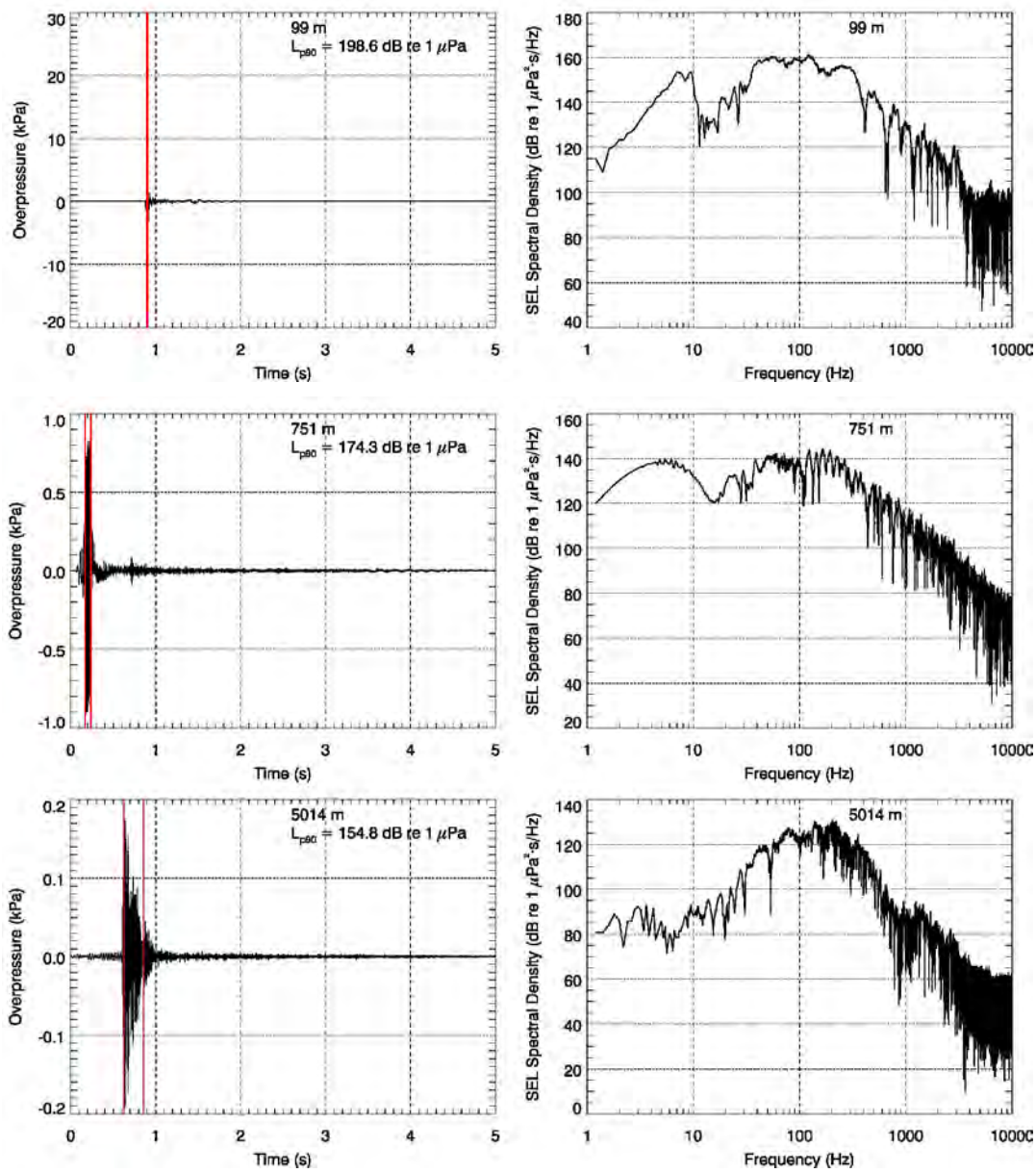

Figure 23. *Broadside*: (left) Waveform and spectra (right) corresponding SEL spectral density of 320 in³ airgun array pulses at the CPA to each OBH, 99 m to A2, 751 m to B2, 5014 m to C2. The red bars on the waveform indicate the 90% energy pulse duration.

3.1.4. 40 in³ Mitigation Airgun

Peak SPL, 90% rms SPL, and SEL for each shot were computed from acoustic data recorded on OBHs A2 through C2. Figure 24 shows sound levels from the 40 in³ mitigation airgun versus slant range measured for SSV Track 2 in the endfire direction. Table 9 lists ranges to various rms SPL thresholds for each of the fits in Figure 24. The closest broadside measurements, from OBH A2 were included in the endfire calculations. The endfire and broadside results presented do not have any connection with source directionality (a single airgun is omnidirectional) and the different levels at matching distances are only an effect of the propagation environment as will be discussed in Section 4.1.

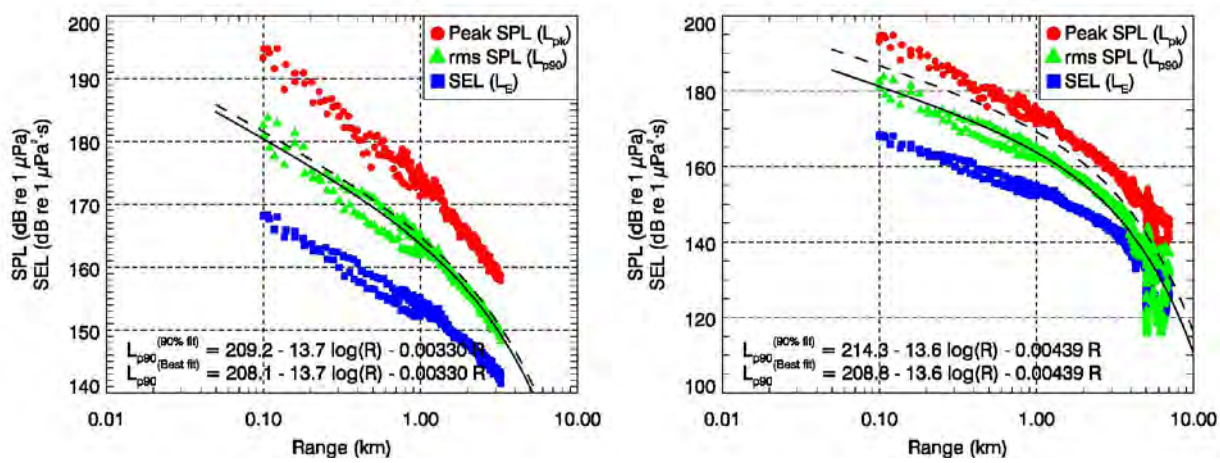

Figure 24. Peak SPL, rms SPL, and sound exposure level (SEL) versus slant range for the 40 in^3 mitigation airgun pulses in the endfire direction, outside the barrier islands. (left) Fit for 190–160 dB re 1 μPa, based only on measurements within a 3.5km range, (right) Fit for 150–120 dB re 1 μPa, based on all measurements. Solid line is the best-fit line to the 90% rms SPL. Dashed line is the best-fit adjusted to exceed 90% of the 90% rms SPL.

Table 9. Threshold radii for the 40 in^3 mitigation airgun, outside barrier islands as determined from best-fit lines to the 90% rms SPL versus distance data in Figure 24 (combination of left and right plots).

Distance in meters (outside barrier islands)		
Threshold (dB re 1 μPa)	*90% rms SPL Best-Fit 40 in^3*	*90% rms SPL 90th Percentile 40 in^3*
190	20	24
180	105	158*
170	465	539
160	1448	1602
120	8 133	9 221

*Actual maximum range from measurements.

Figures 25 and 26 show pulse spectrograms from measurements taken at ranges close to the 190 and 180 dB modeled threshold radius of <50 m (Figure 26, broadside range 99 m) and 160 dB modeled threshold radius of 810 m (Figure 25, endfire range 981 m; Figure 26, broadside range 751 m). The broadside range of 751 m is the closest point of approach (CPA) for OBH B1, deployed at that lateral offset perpendicular to the array tow path, and the closest point to the 160 dB modeled threshold radius of 810 m.

These measurements indicate strong water and substrate propagation at these distances, observable through the frequency range of the detected pulses (1 Hz to 10 kHz), with minimal difference in the head wave arrival time, which was barely noticeable in the 981 m and 751 m in front of the main pulse and below 150 Hz. The pulses at these ranges had a shorter 90% rms SPL length than the model predicted, partly because the difference between the rms SPL and SEL levels was larger than expected.

A comparison between the endfire and broadband recorded pulse structures at equivalent ranges (Figure 25, endfire range 5016 m, and Figure 26, broadside range 5000 m) demonstrated that the

received pulses have similar structure, but are different in received levels. The 40 in^3 mitigation airgun is omnidirectional at the source, therefore the different received levels are caused by propagation effects, a main contributor would be the sound speed profile combined with the increasing depth in the broadside direction.

The measurement location close to the 120 dB modeled threshold (Figure 25, endfire range 9 221 m), showed the pulse beginning to separate into different propagation modes when a faint but clear head wave formed. The actual pulse length (Figure 27) is greater than predicted by the model, which resulted in a smaller difference between the rms SPL and SEL levels, contributing to a smaller threshold radius than the model predicted.

The SEL spectral density of the pulses at the aforementioned distances (Figures 27 and 28) showed a diminishing trend with distance from the source in the low frequency components (below 200 Hz) and the components above 1 kHz. This resulted in the 200–1 000 Hz components dominating the received signal at distances from the source beyond about a kilometer, which is different to outside the islands which has a much wider spectral pulse width.

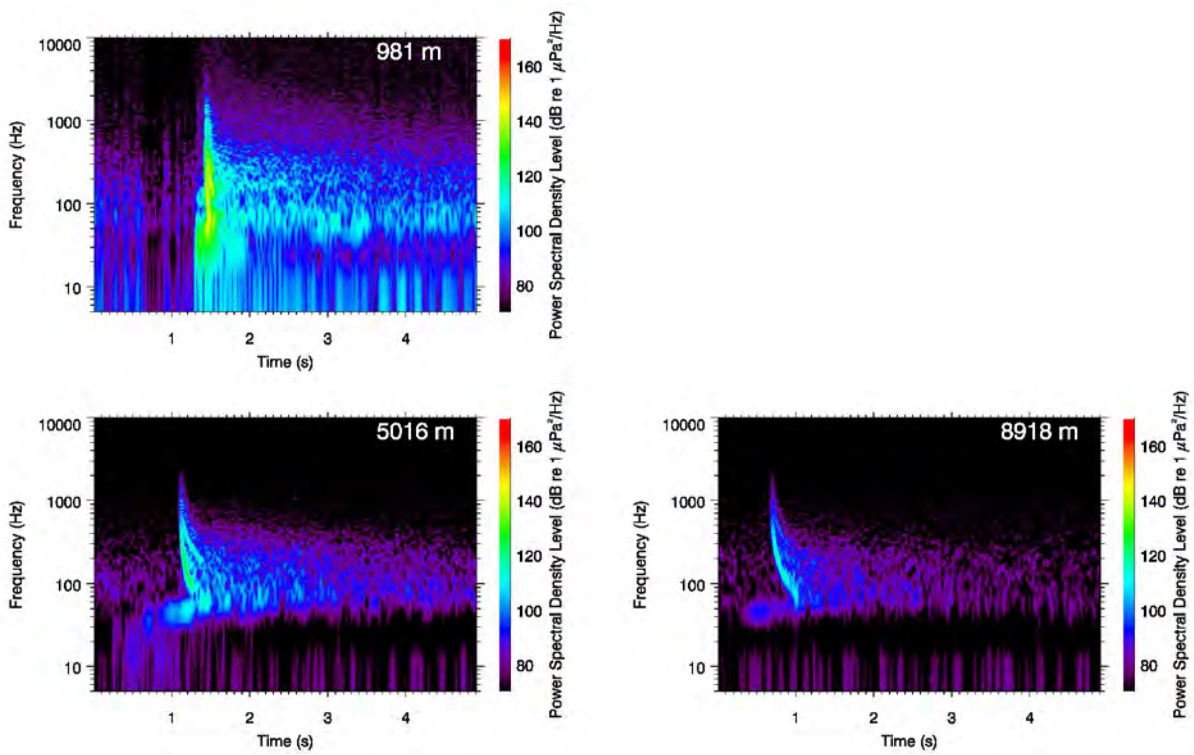

Figure 25. *Endfire*: Spectrograms of airgun pulses from the 40 in^3 mitigation airgun at three distances, 981 m, 5016 m, and 8918 m, 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap. Endfire only specified to differentiate measurement orientation.

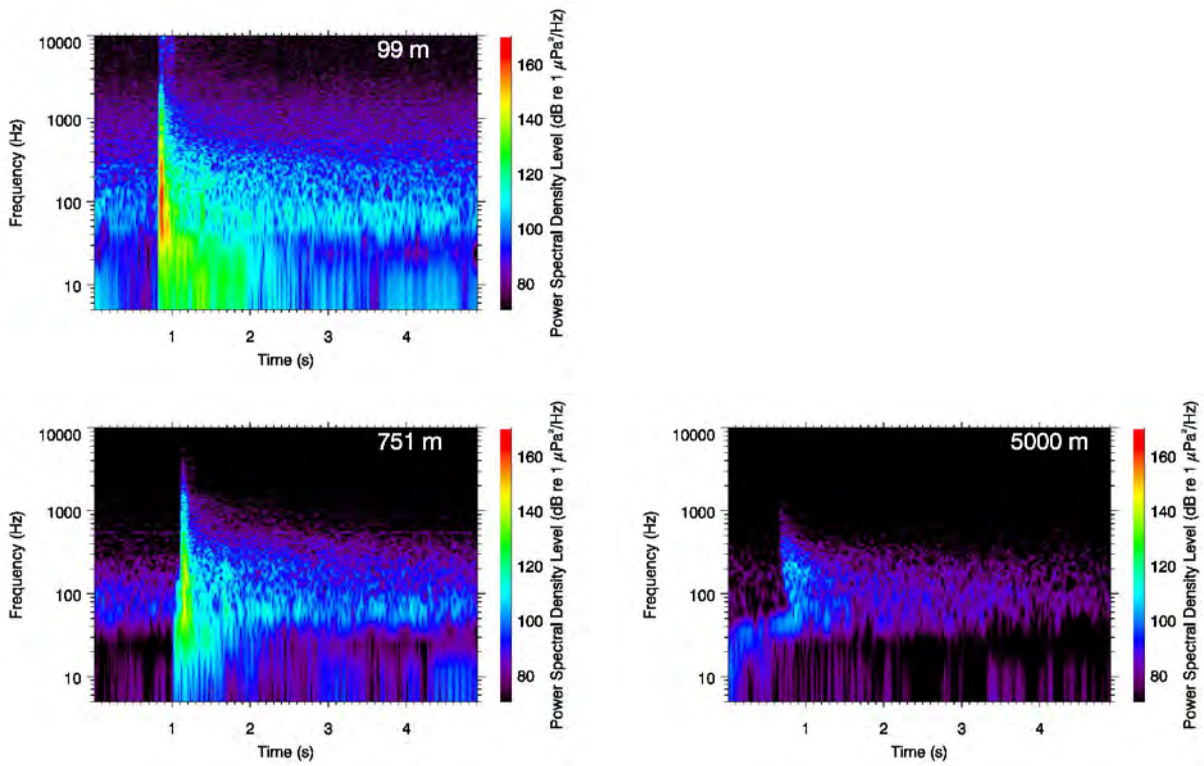

Figure 26. *Broadside*: Spectrograms of airgun pulses from the 40 in^3 mitigation airgun at the CPA to each OBH, 99 m to A2, 751 m to B2, 5000 m to C2; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap. Broadside only specified to differentiate measurement orientation.

The SEL spectral density of the pulses at the distances noted in Figures 27 and 28, show a diminishing trend with distance from the source in the low frequency components (below 100 Hz) and the components above 200 Hz. This results in the 80–200 Hz components dominating the received signal at distances farther than about a kilometer from the source.

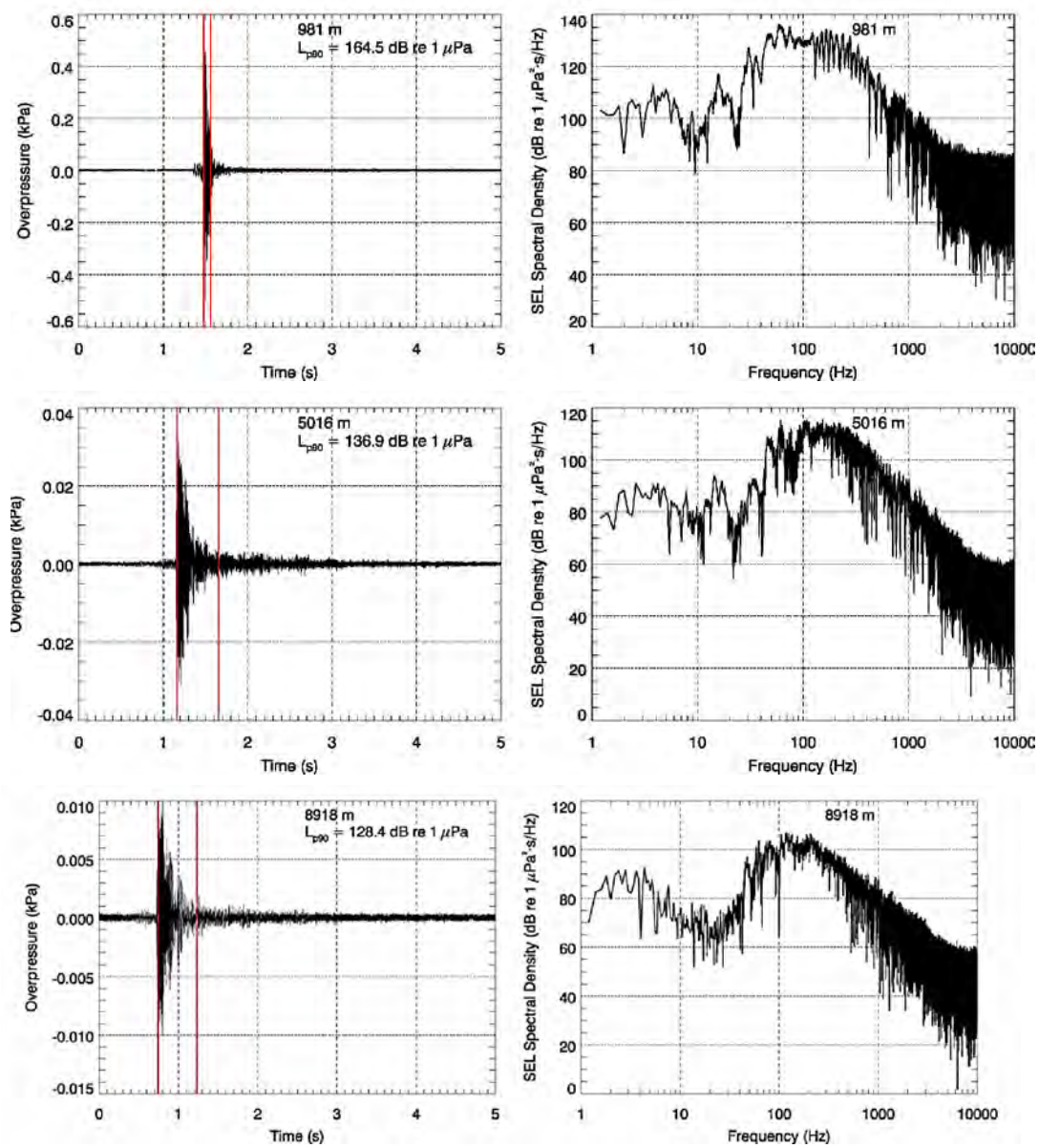

Figure 27. *Endfire*: (left) Waveform and spectra (right) corresponding SEL spectral density of 40 in^3 mitigation airgun pulses at three distances from OBH A2, 981 m, 5016 m, and 8918 m. The red bars on the waveform indicate the 90% energy pulse duration. Endfire only specified to differentiate measurement orientation.

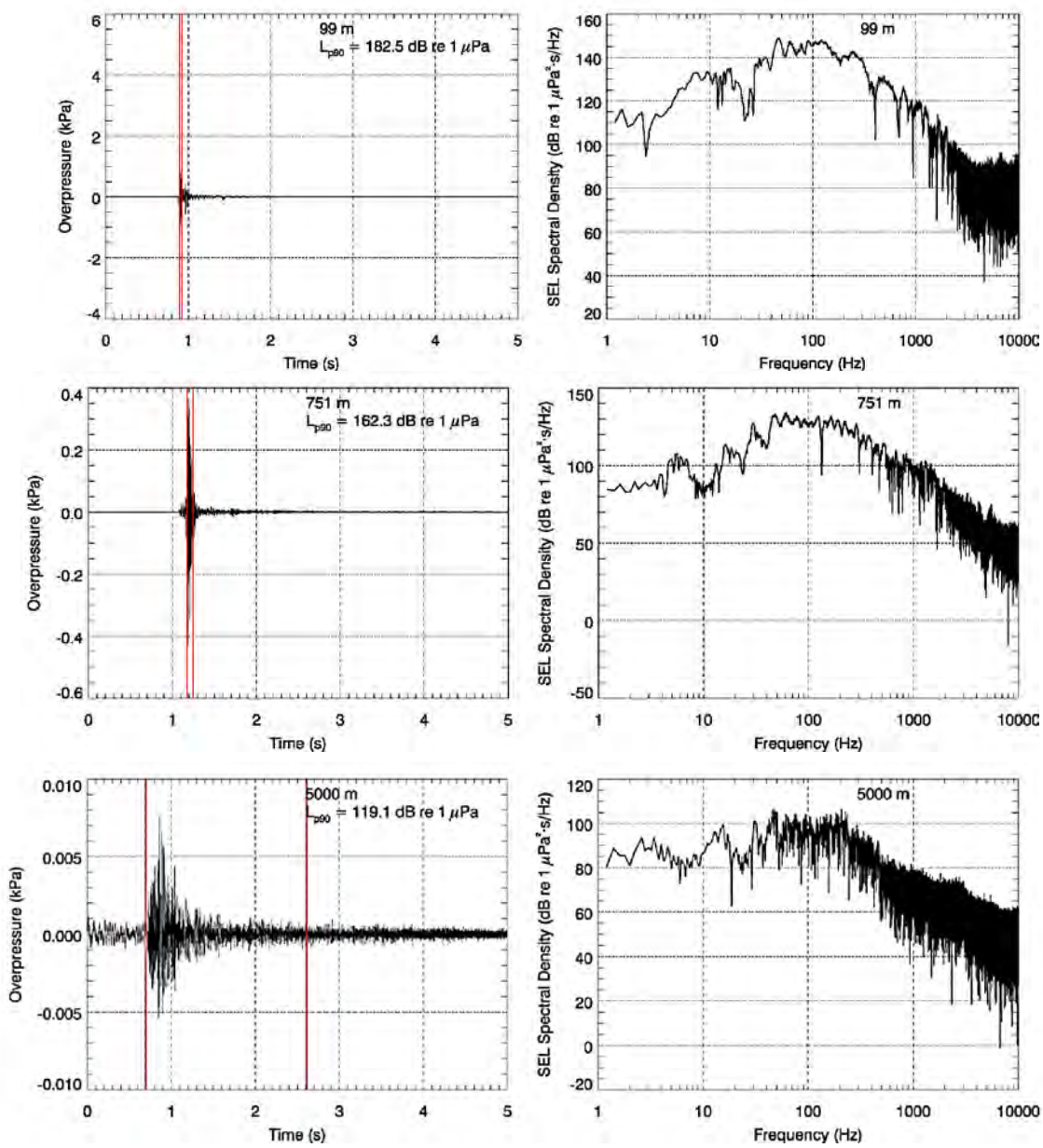

Figure 28. *Broadside*: (left) Waveform and spectra (right) corresponding SEL spectral density of 40 in^3 mitigation airgun pulses at the CPA to each OBH, 99 m to A2, 751 m to B2, 5000 m to C2. The red bars on the waveform indicate the 90% energy pulse duration. Broadside only specified to differentiate measurement orientation.

3.1.5. Resolution

SPLs were computed for the *Resolution*'s vessel noise during its transit along SSC Track 2 from the closest point of approach (CPA) to the end of the track. This section of SSC Track 2 was selected as most representative of the vessel noise characteristics in terms of signal quality and consistency. The water depth along the track (from cartographic records) ranges between 12.8 m and 13.4 m. The continuous noise levels were computed after low-pass filtering at 10 kHz in consecutive 1-second time windows, a standard processing step that eliminates potential contribution from high frequency non-vessel sounds.

Figure 29 shows the rms SPL levels versus time for the jetboat *Resolution* transiting at 5.5 kts, while Figure 30 presents the sound pressure levels versus range, with the best-fit and 90th percentile trend lines. To achieve the most accurate fits, data were analyzed in two sections: near-range (14 to 300 m), and far-range (300 to 3020 m). Data presented in the Figure 30 plots were recorded from the higher sensitivity TC4032 hydrophone. The ranges to the sound level thresholds of 160 to 120 dB re 1 µPa (rms) for the *Resolution* traveling at 5.5 kts are listed in Table 10. The vessel appears as a distributed sound source rather than a point at shorter ranges; therefore, reported radii that are within the near-field of the source should only be considered notional. The near-field threshold distance is proportional to the square of the source size divided by the wavelength of the sound; as a rough estimate, for a 20 m vessel and a fundamental tonal frequency of 75Hz the near-field threshold is at about 20 m. Levels measured at less than that range are still meaningful but may not represent the total acoustic output of the vessel. Figure 31 shows the spectrograms for the closest two OBHs; Figure 32 shows the corresponding power spectra at CPA.

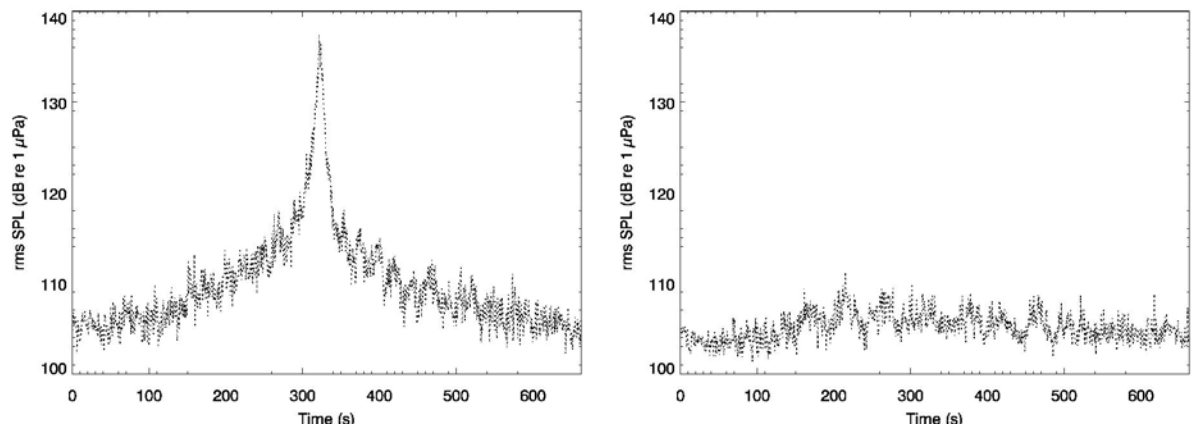

Figure 29. *Resolution* rms SPL versus time, in 1 s intervals while transiting at 5.5 kts (left) measured by OBH A2 with a 14.3 m CPA, and (right) B2 with a 664 m CPA.

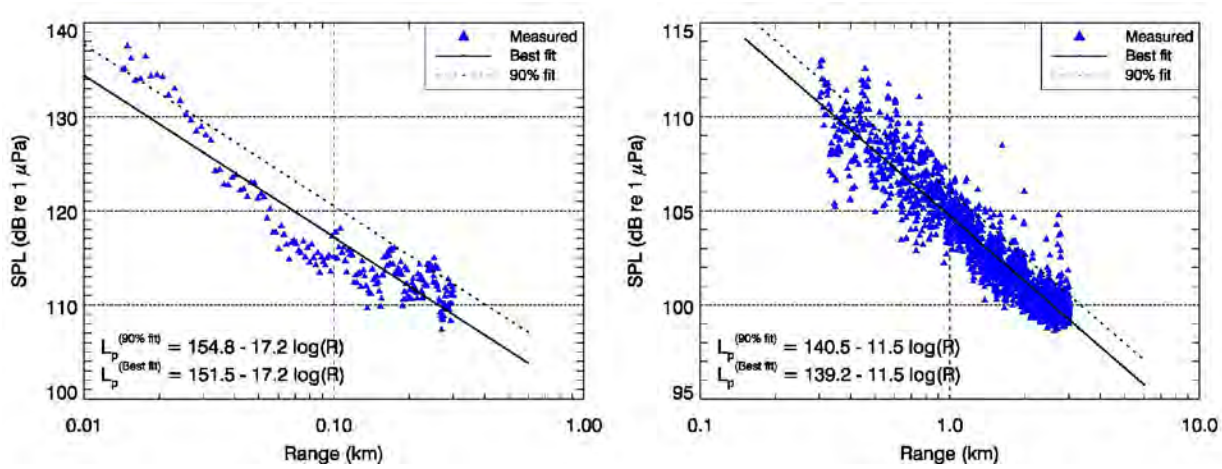

Figure 30. Sound pressure level (rms) versus slant range produced by the *Resolution* while it transited OBH A2 at 5.5 kts outside the barrier islands. (left) Fit for 160–130 dB re 1 µPa, based only on measurements between 14 and 300 m range, (right) fit for 120 dB re 1 µPa, based on measurements 300 to 3020 m. Solid line is the best-fit line to SPL data. Dashed line is the best-fit adjusted to exceed 90% of the SPL data.

Table 10. Threshold radii for the *Resolution* transiting at 5.5 kts at the SSC site, as determined from function fit to SPL versus distance data in Figure 30.

Threshold (dB re 1 µPa)	Best-Fit Line Radius (m)	90th Percentile Radius (m)
160	<1*	1*
150	1*	2*
140	5*	7*
130	17	28
120	47	61

*Extrapolated from minimum measurement range of 14.3 m. These distances are well inside the near-field of such a distributed source, and should be considered only as notional values.

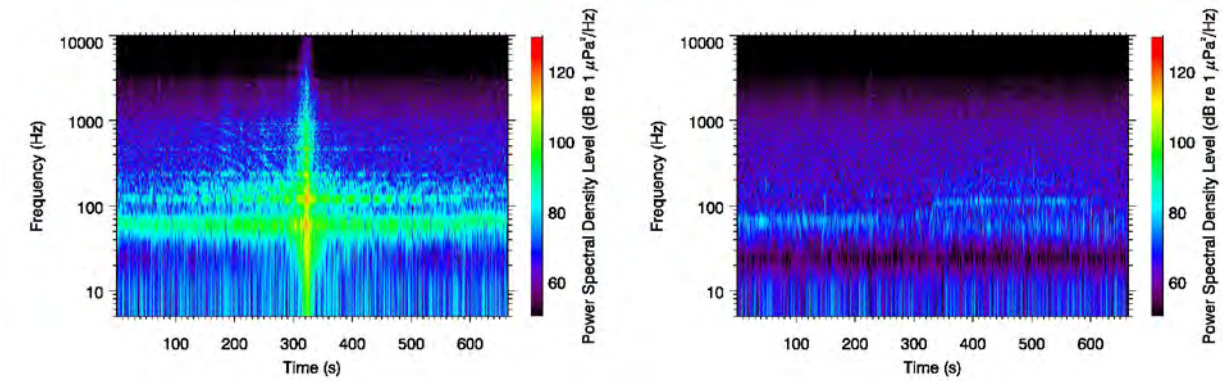

Figure 31. Spectrograms of the *Resolution* transiting at 5.5 kts, (left) from 1000 m either side of A2, with a CPA of 14.3 m, and (right) for the same interval from B2, with a CPA of 664 m. 8192 pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

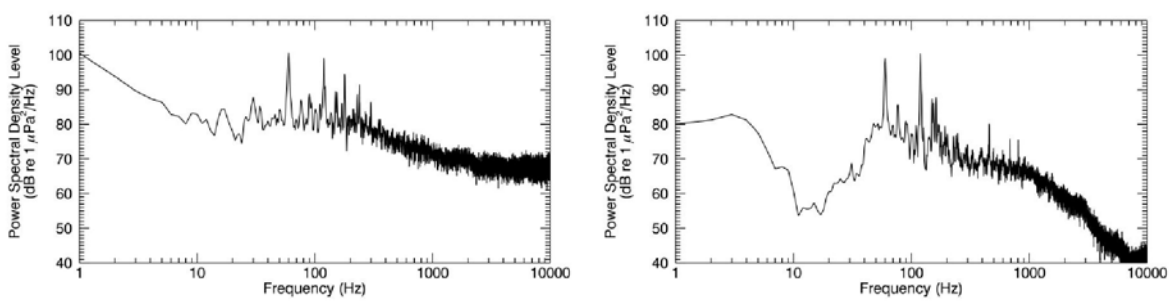

Figure 32. Average power spectral density (PSD) of the *Resolution* transiting at 5.5 kts from average of ten 1 s Hanning-windowed spectra centered at 14.3 m (left) and centered at 664 m (right) distance.

3.1.6. Margarita

SPLs were computed for the propeller driven *Margarita*'s vessel noise during its transit along SSC Track 2 from the closest point of approach (CPA) to the end of the track. This section of SSC Track 2 was selected as most representative of the vessel noise characteristics in terms of signal quality and consistency. The water depth along the track (from cartographic records) ranges between 12.8 m and 13.4 m. The continuous noise levels were computed after low-pass filtering at 10 kHz in consecutive 1-second time windows, a standard processing step that eliminates potential contribution from high frequency non-vessel sounds. Figure 33 shows the

rms SPL levels versus time for the *Margarita* transiting at 7.7 kts, while Figure 34 presents the sound pressure levels versus range, with the best-fit and 90th percentile trend lines. To achieve the most accurate fits, data were analyzed in two sections: near-range (15 to 300 m), and far-range (300 to 3030 m). Data presented in the Figure 34 plots were recorded from the higher sensitivity TC4032 hydrophone. The ranges to the sound level thresholds of 160 to 120 dB re 1 µPa (rms) for the *Margarita* traveling at 7.7 kts are listed in Table 11. The vessel appears as a distributed sound source rather than a point at shorter ranges; therefore, radii smaller than about 20 m should be only considered notional (see Section 3.1.5). Figure 35 shows the spectrograms for the closest two OBHs, and Figure 36 shows the corresponding power spectra at CPA.

The *Resolution* and the *Margarita* have the same hull design; however, the *Resolution* is a jetboat, which influences the sound signature in both magnitude and structure. The *Margarita* has a definitive Lloyd mirror type pattern (Figure 35) when compared to the *Resolution* (Figure 31), due to cavitation of the propeller and the vessel propulsion system.

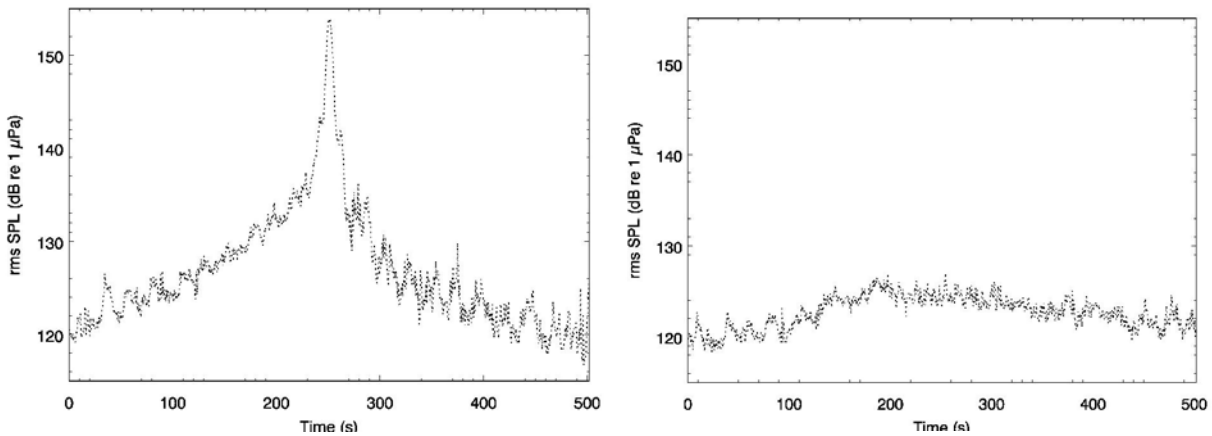

Figure 33. *Margarita* rms SPL versus time, in 1 s intervals while transiting at 7.7 kts measured by OBH A2 with a 15.5 m CPA (left) and by B2 with a 660 m CPA (right).

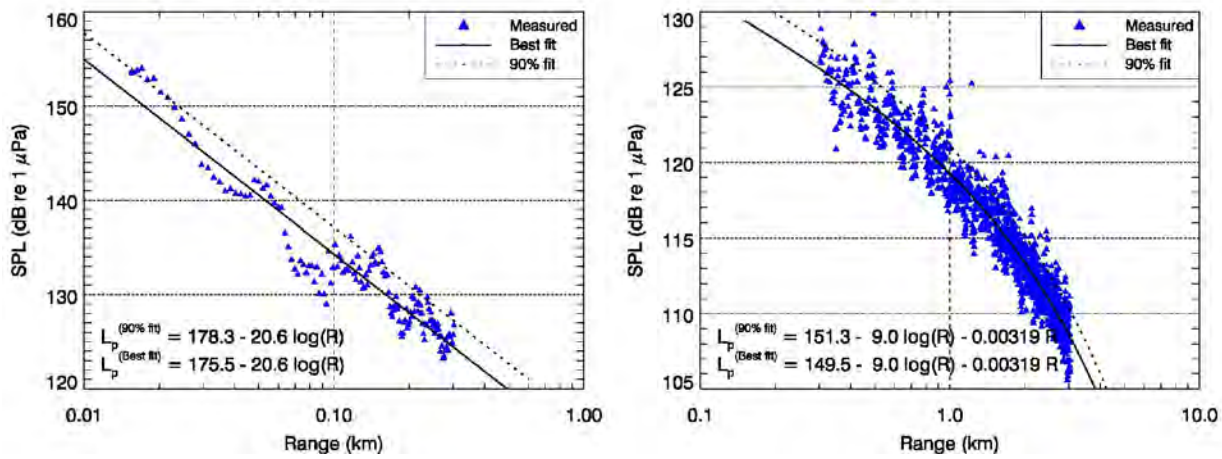

Figure 34. Sound pressure level (rms) versus slant range produced by the *Margarita* while it transited by OBH A2 at 7.7 kts outside the barrier islands. (left) Fit for 160–130 dB re 1 μPa, based only on measurements between 15 and 300 m range, (right) Fit for 120 dB re 1 μPa, based on measurements 300 to 3030 m. Solid line is the best-fit line to SPL data. Dashed line is the best-fit adjusted to exceed 90% of the SPL data.

Table 11. Threshold radii for the *Margarita* transiting at 7.7 kts at the SSC site, as determined from function fit to SPL versus distance data in Figure 34.

Threshold (dB re 1 μPa)	Best-Fit Line Radius (m)	90th Percentile Radius (m)
160	6*	8*
150	17	24
140	53	73
130	162	222
120	889	1151

*Extrapolated from minimum measurement range of 15.5 m. These distances are well inside the near-field of such a distributed source, and should be considered only as notional values.

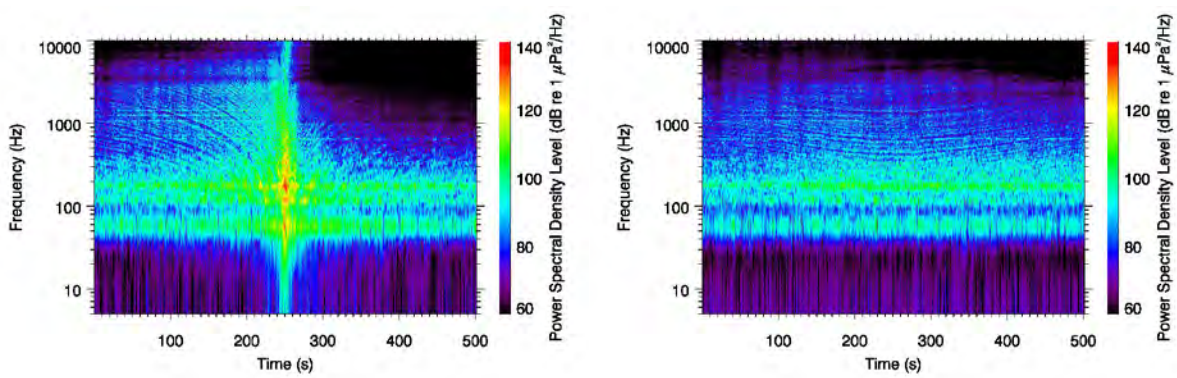

Figure 35. Spectrograms of the *Margarita* transiting at an average of 7.7 kts, (left) from 1000 m either side of A2, with a CPA of 15.5 m, and (right) for the same interval from B2, with a CPA of 660 m. 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

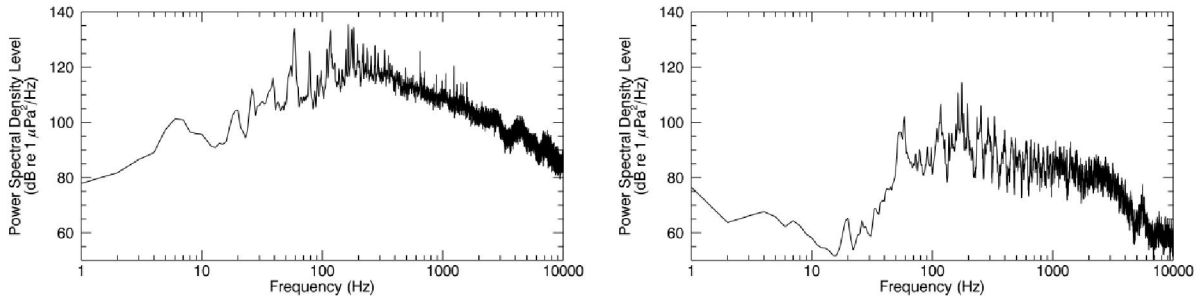

Figure 36. Average power spectral density (PSD) of the *Margarita* transiting at 7.7 kts from average of ten 1 s Hanning-windowed spectra centered at 15.5 m (left) and centered at 660 m (right) distance.

3.2. SSV/SSC Inside Barrier Islands

All airgun configuration trials inside the barrier islands were towed at 1 meter, the planned operational depth. Recorders were approximately placed at the 190, 180, and 160 dB isopleths in the across-track (broadside) direction as estimated in pre-season modeling. Because no direct broadside measurements were made near the 120 dB isopleth, the analysis was based on data extrapolated from curves fitted to the measured data to determine the range at this level.

3.2.1. Sound Speed Profiles

The sound speed profile was measured in one location inside the barrier islands (Figure 37). The profile has a faster surface duct above approximately 1 m of nearly 1470 m/s, a decreasing speed down to 1441 m/s as the depth increases from 1 and 2 m, and a constant speed below 2m of nearly 1441 m/s.

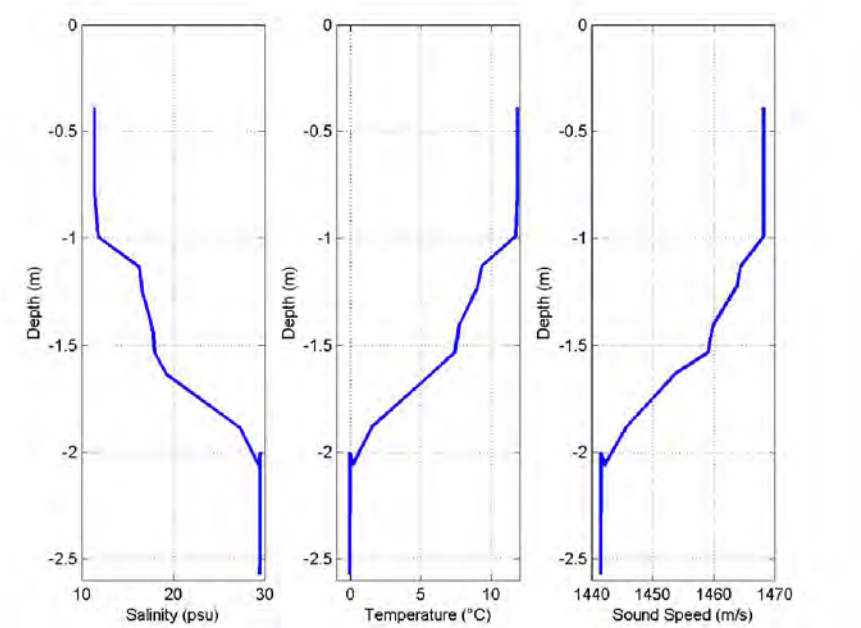

Figure 37. (left) Salinity, (center) temperature, and (right) sound speed profiles from CTD Cast 3 at 00:19:12 AKDT, 27 Jul 2012 at 70°32.114' N, 149°44.397' W, inside the barrier islands.

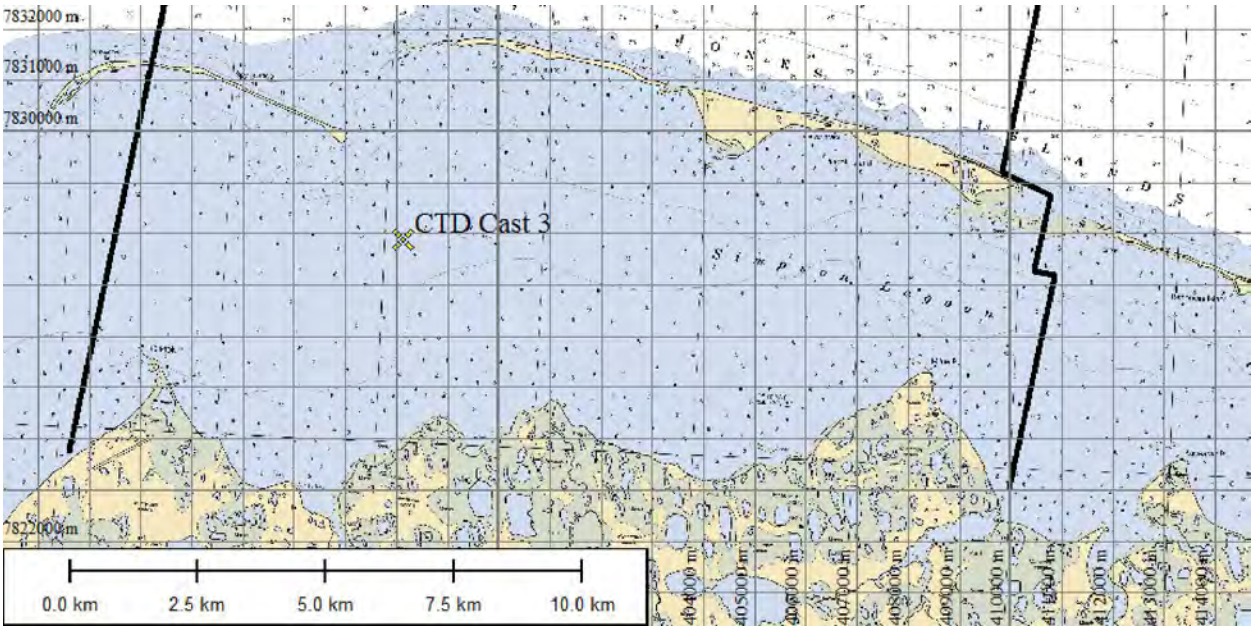

Figure 38. Sound speed profile measurement location, inside barrier islands.

3.2.2. 320 in³ Airgun Array

Peak SPL, 90% rms SPL, and SEL for each shot were computed from acoustic data recorded on OBHs A1-C1. Figure 39 shows sound levels from the 320 in³ airgun versus slant range measured in the endfire and broadside directions for SSV Track 1. The closest broadside measurements, from OBH A1 were included in the endfire calculations. Tables 12 and 13 list ranges to various rms SPL thresholds for each of the fits in Figure 39. Figures 42 and 43 show the spectrograms for the endfire and broadside orientations; Figures 45 and 46 show the waveform and spectra.

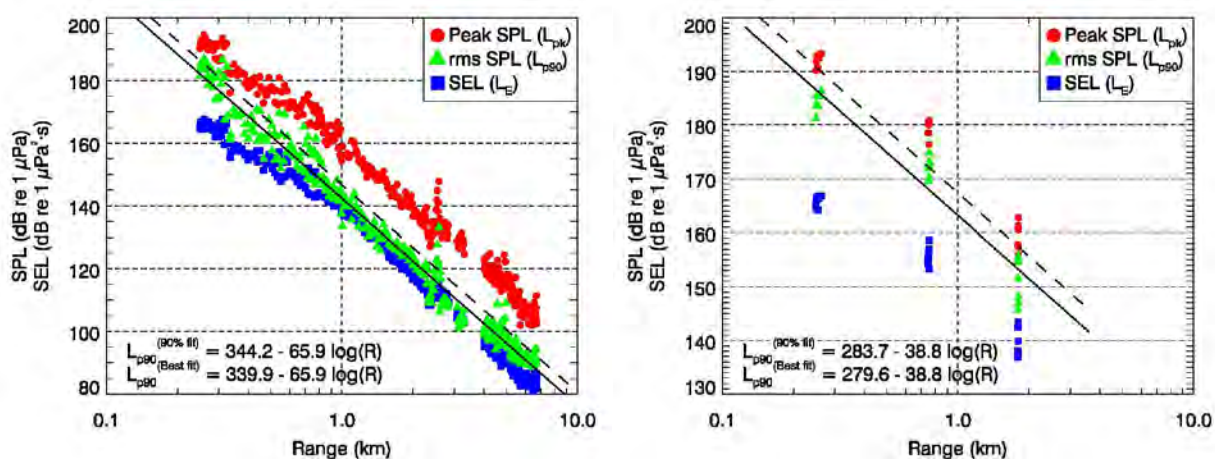

Figure 39. Peak SPL, rms SPL, and sound exposure level (SEL) versus slant range for the 320 in³ airgun pulses in the (left) endfire and (right) broadside directions, inside the barrier islands. Solid line is the best-fit function to the 90% rms SPL. Dashed line is the best-fit adjusted to exceed 90% of the 90% rms SPL.

We examined the time series data for the approach of the 320 in³ airgun array to OBH A1 (Figure 40) to determine what caused an the propagation of raised levels between 2304–2392 s

into the file which captured the approach, corresponding to approximately 2.5 km (Figure 41) from the CPA. Spectrograms of four pulses in this section were also examined (Figure 42). These were investigated from the endfire direction (Figure 42); we determined that they are due to a propagation artifact that allows for better transmission of the waterborne sound above 200 Hz. This artifact only occurs when the vessel is in a particular section of the track and therefore is potentially due to bathymetric conditions not shown on the available charts. Due to the limited number of data points that relate to this event, and therefore the minimal impact, the radii calculated have not been re-adjusted to account for their removal.

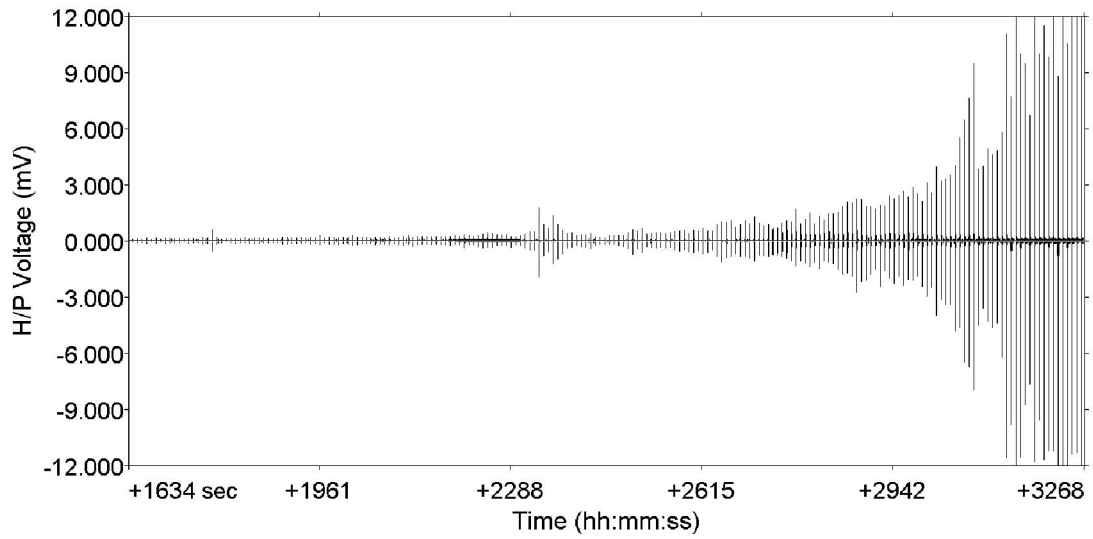

Figure 40. Time series representation of 320 in³ airgun pulses in the endfire direction showing approach and CPA of airgun on Channel 0 of OBH A1.

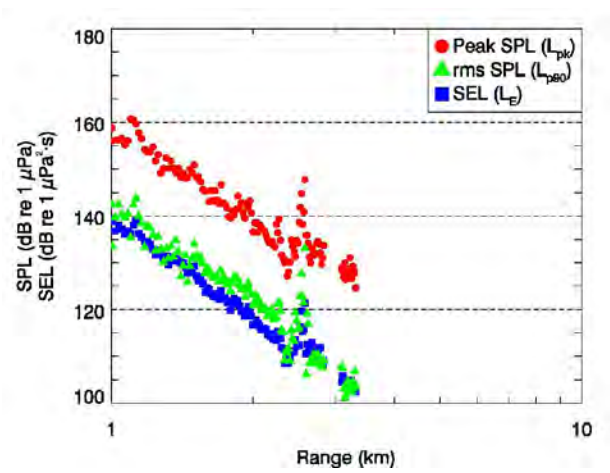

Figure 41. Peak SPL, rms SPL, and sound exposure level (SEL) versus slant range for the 320 in^3 airgun pulses in the endfire direction inside barrier islands ranging from 1–3.5 km.

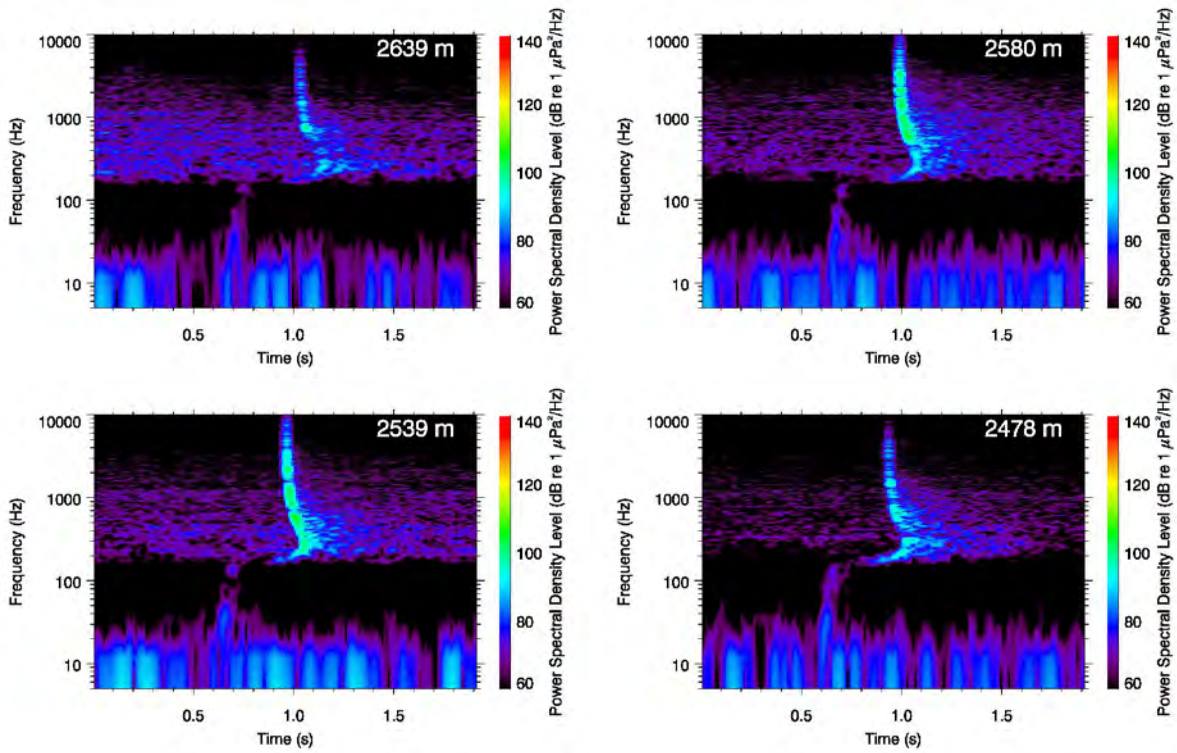

Figure 42. *Endfire*: Spectrograms of airgun pulses from the 320 in³ airgun array investigating section of raised levels: (top left) before raised section (2639 m, 2304 s into file), (top right) start of raised section (2580 m, 2336 s into file), (bottom left) toward end of raised section (2539 m, 2360 s into file), and (bottom right) after raised section (2478 m, 2392 s into file); 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

Table 12. *Endfire*: Threshold radii for the 320 in^3 airgun array, inside barrier islands as determined from best-fit lines to 90% rms SPL versus distance data in Figure 39.

Endfire Distance in meters (inside barrier islands)		
Threshold (dB re 1 μPa)	*Best-Fit*	*90th Percentile*
190	189	219
180	267	311
170	379	441
160	538	625
120	2177	2528

Table 13. *Broadside*: Threshold radii for the 320 in^3 airgun array, inside barrier islands as determined from best-fit lines to 90% rms SPL versus distance data in Figure 39.

Broadside Distance in meters (inside barrier islands)		
Threshold (dB re 1 µPa)	*Best-Fit*	*90th Percentile*
190	203	260
180	368	472
170	667	854
160	1207	1545
120	12 964	16 598

Figure 43 and Figure 44 show pulse spectrograms from measurements taken at strategic locations along the track line. The closest broadside measurement, from OBH A1, was close to the 190 dB modeled threshold radius of 160 m (Figure 44, broadside range 249 m). The other measurements are distributed along the track line to provide indication of the pulse shape as the distance increases. The other two broadside CPA's, perpendicular to the array axis, occurred at 746 m from B1 and 1796 m from C1, with the measurement at C1 being the closest to the 160 dB modeled threshold of 1500 m.

These measurements indicate strong water and substrate propagation within 1000 m, including the 190 and 180 dB distances, this feature is observable through the frequency range of the detected pulse (1 Hz to 10 kHz). By the time the modeled 160 dB threshold distance is reached, the substrate propagation is noticeably less and the head wave has distinctively split from the waterborne component. The head wave arrival time at 1796 m is 0.2 s in front of the main pulse and below 100 Hz.

The pulses at these ranges have a shorter 90% rms SPL length than the model predicted; partly because of this, we saw a greater than expected difference between the rms SPL and SEL levels. The measurement location closest to the 120 dB modeled threshold of 5700 m is 4016 m (Figure 43, endfire range), at which distance the pulse is barely distinguishable from the background noise. The actual length of this pulse (Figure 45) is greater than expected from the modeling, resulting in a smaller difference between the rms SPL and SEL level that contributes to a smaller threshold radius than predicted.

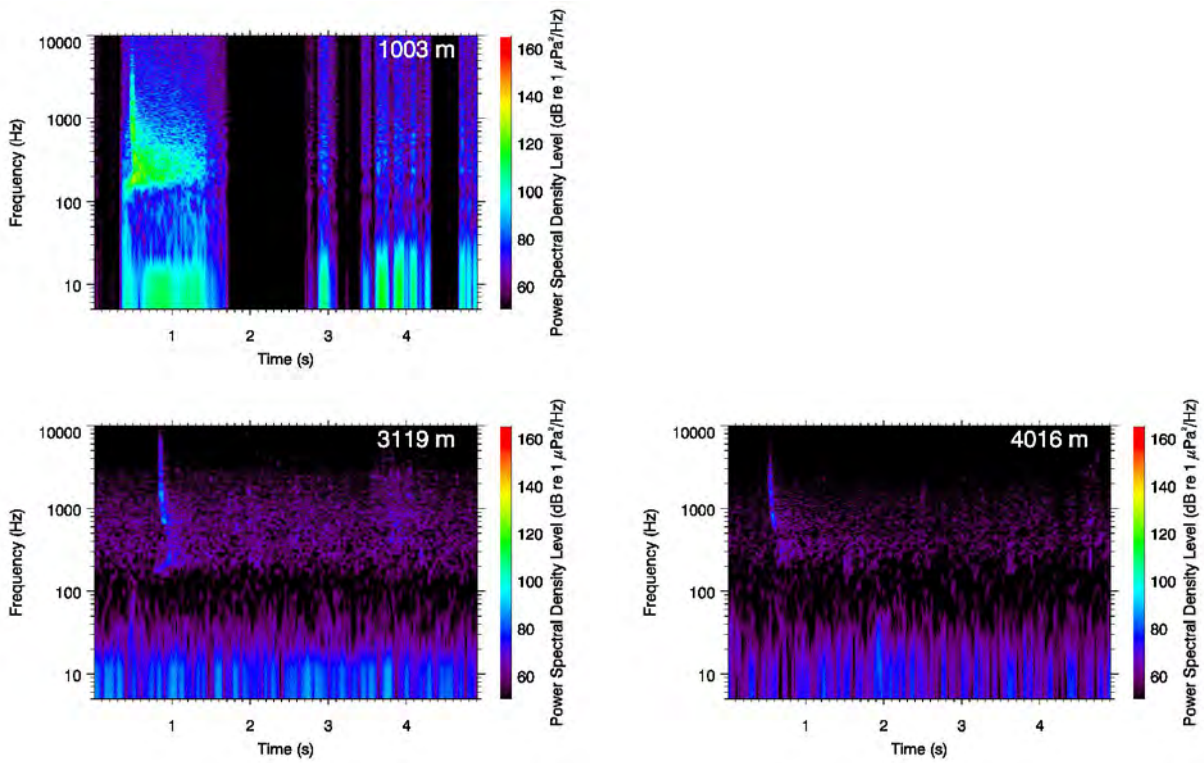

Figure 43. *Endfire*: Spectrograms of airgun pulses from the 320 in³ airgun array at three distances from OBH A1, 1003 m, 3119 m and 4016 m; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

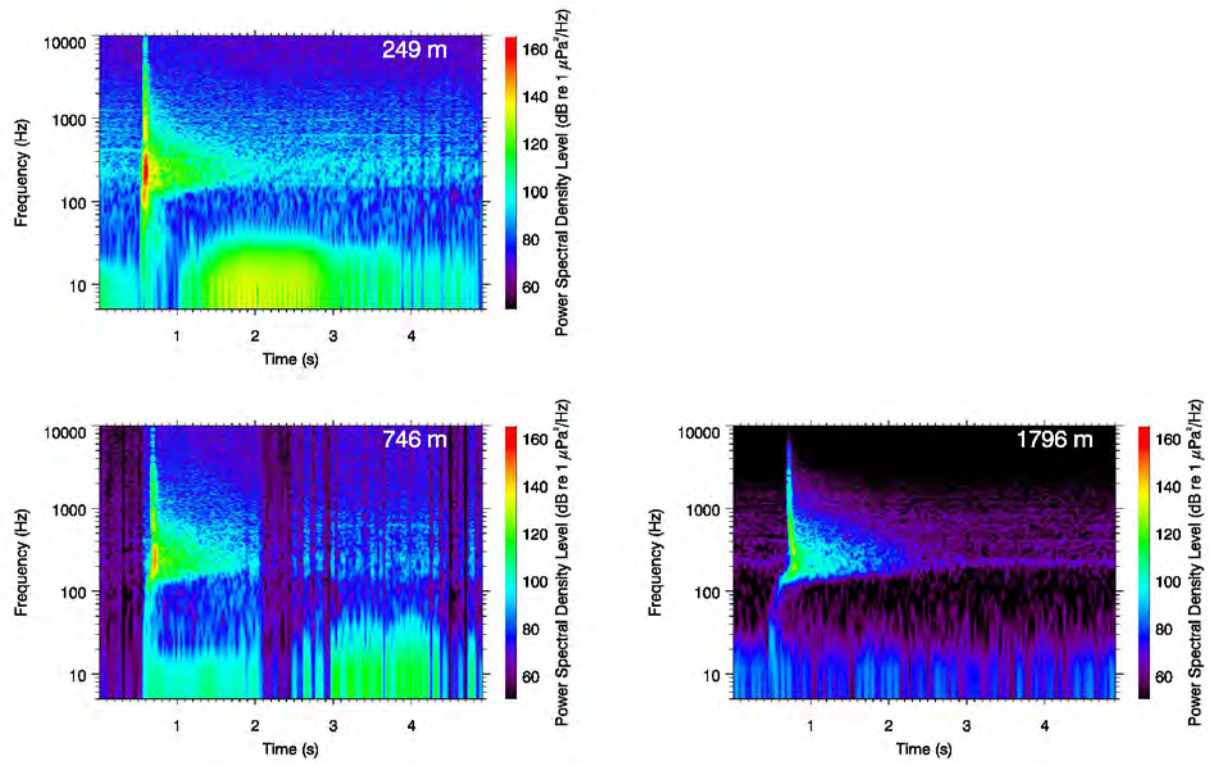

Figure 44. *Broadside*: Spectrograms of airgun pulses from the 320 in³ airgun array at the CPA to each OBH, 249 m to A1, 746 m to B1, 1796 m to C1; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

The SEL spectral density of the pulses (Figures 45 and 46) show the contribution of low frequency ambient noise in the shallow environment. Within 1796 m, the main contribution to the pulse energy is between 100 and 1000 Hz; however, as the distance increases, the pulses become restricted to between 500 Hz and 4 000 Hz.

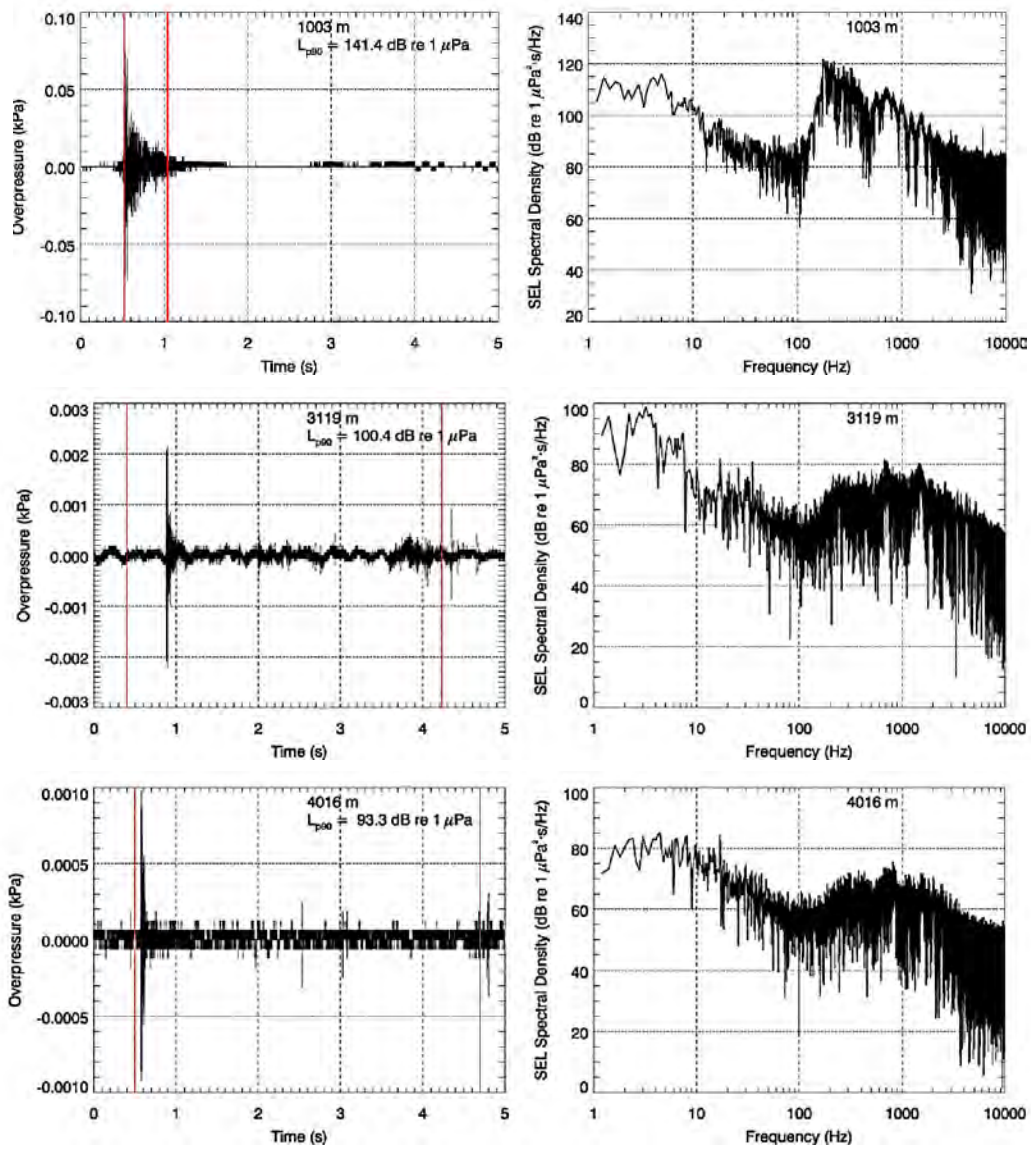

Figure 45. *Endfire*: (left) Waveform and spectra (right) corresponding SEL spectral density of 320 in³ airgun array pulses at three distances from OBH A1, 1003 m, 3119 m, and 4016 m. The red bars on the waveform indicate the 90% energy pulse duration.

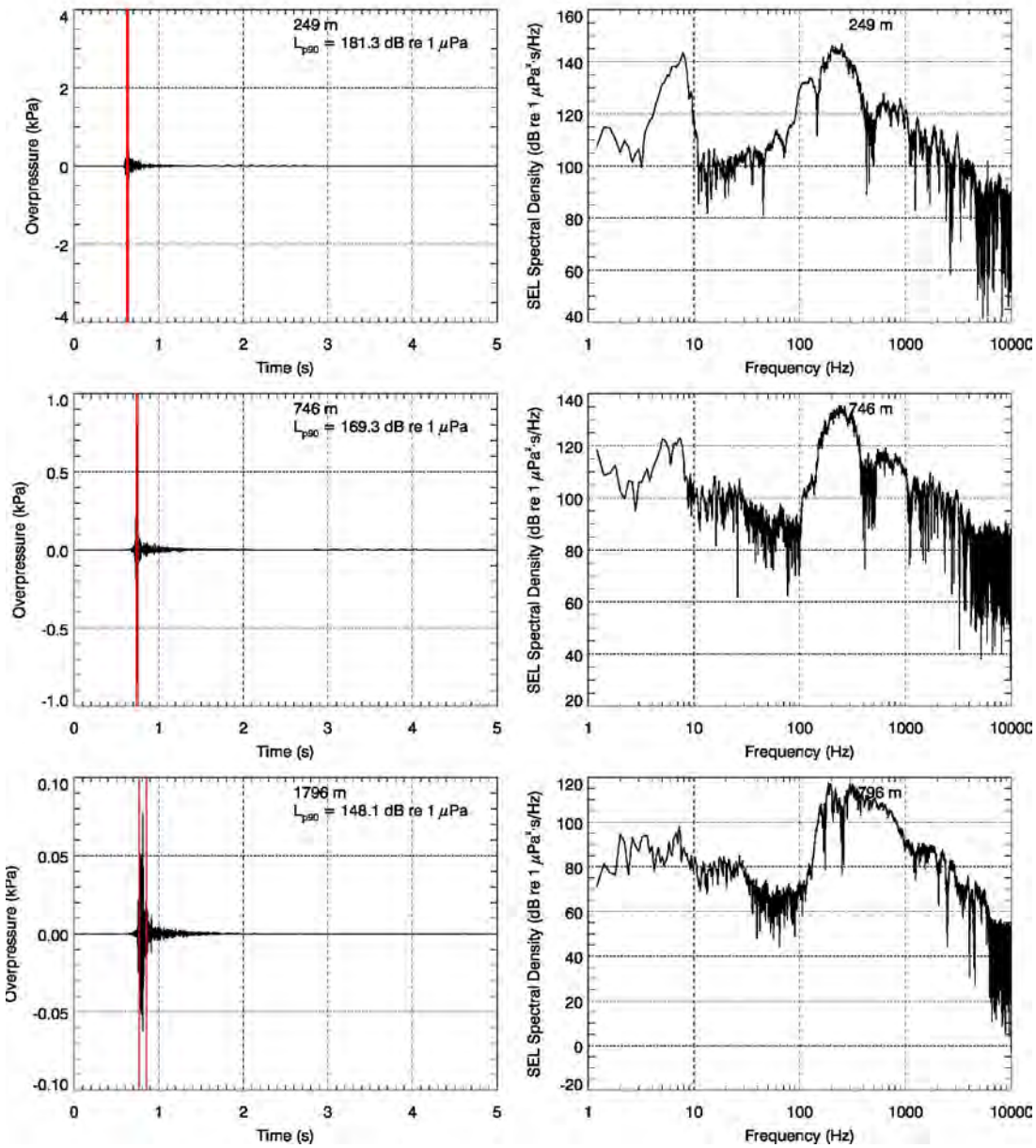

Figure 46. *Broadside*: (left) Waveform and spectra (right) corresponding SEL spectral density of 320 in³ airgun array pulses at the CPA to each OBH, 249 m to A1, 746 m to B2, 1796 m to C2. The red bars on the waveform indicate the 90% energy pulse duration.

3.2.3. 40 in³ Mitigation Airgun

Peak SPL, 90% rms SPL, and SEL for each shot were computed from acoustic data recorded on OBHs A1–C1. Figure 47 shows sound levels from the 40 in³ mitigation airgun versus slant range measured for SSV Track 1. The closest broadside measurements, from OBH A1 were included in the endfire calculations. Table 14 lists ranges to various rms SPL thresholds for each of the fits in Figure 47. The endfire and broadside results presented do not have any connection with source directionality, as the source is omnidirectional, and the different levels at matching distances are only an effect of the propagation environment. Figures 48 and 49 show the spectrograms for the endfire and broadside orientations; Figures 50 and 51 show the waveform and spectra.

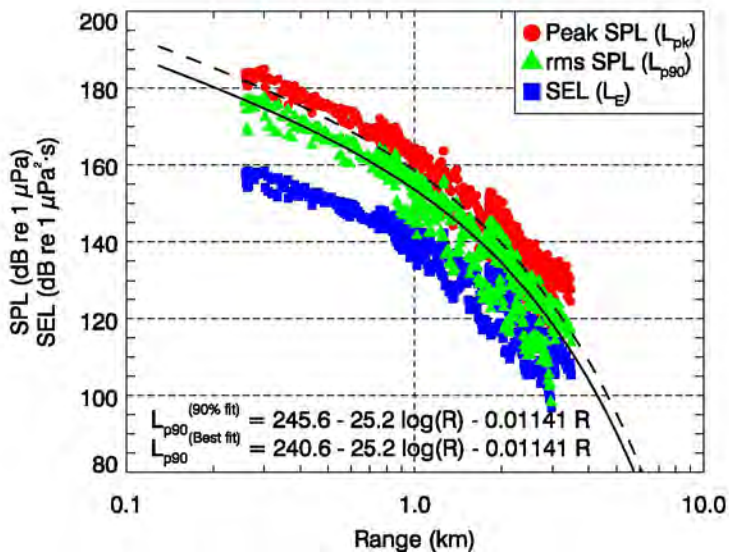

Figure 47. Peak SPL, rms SPL, and sound exposure level (SEL) versus slant range for the 40 in^3 mitigation airgun pulses in the endfire direction, inside the barrier islands. Solid line is the best-fit line to the 90% rms SPL. Dashed line is the best-fit adjusted to exceed 90% of the 90% rms SPL.

Table 14. Threshold radii for the 40 in^3 mitigation airgun, inside barrier islands as determined from best-fit lines to 90% rms SPL versus distance data in Figure 47.

Distance in meters (inside barrier islands)		
Threshold (dB re 1 μPa)	*Best-Fit*	*90th Percentile*
190	92	138
180	203	293
170	409	555
160	729	933
120	2907	3242

The requirement to measure the 320 in^3 airgun with the same OBH deployment inside the barrier islands as the 40 in^3 led to the OBHs being placed at ranges more suitable to measure the 180 and 190 dB thresholds associated with the 320 in^3 airgun. Therefore the closest OBH was A1 in the broadside direction at 258 m (Figure 49), which is 199 m further away than the predicted 180 dB threshold distance, however after analysis it was determined to be close to the 90th percentile measured distance. Figures 48 (endfire 897 m) and 49 (broadside 757 m) show pulse spectrograms from measurements taken at ranges just past the 160 dB modeled threshold radius of 700 m. The broadside range of 757 m is the CPA range for OBH B1, deployed at that lateral offset perpendicular to the array tow path, and the closest point to the 160 dB modeled threshold radius.

These measurements indicate good water propagation at the 180 dB distances, observable through the frequency range of the detected pulse (70 Hz to 8 kHz). The substrate borne low frequency component of the pulse does not propagate well, and is only faintly visible at the 160 dB distance.

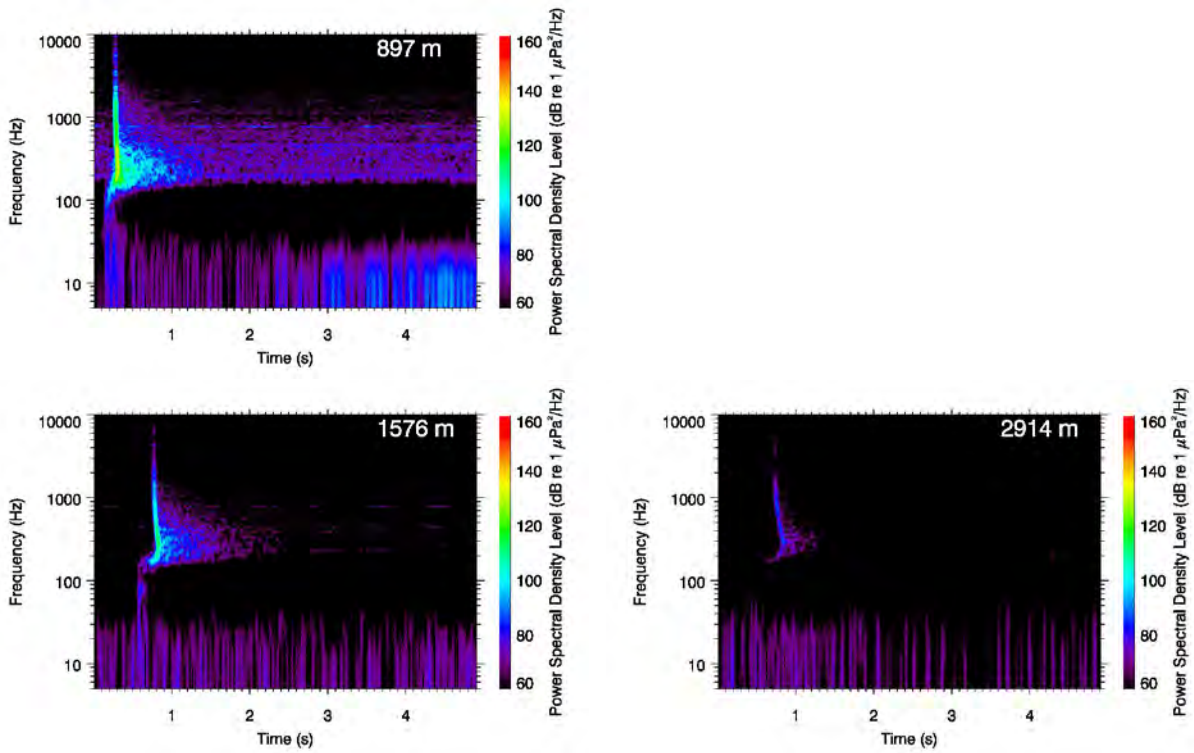

Figure 48. *Endfire*: Spectrograms of airgun pulses from the 40 in^3 mitigation airgun at three distances to OBH A1, 897 m, 1576 m and 2914 m; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap. Endfire only specified to differentiate measurement orientation.

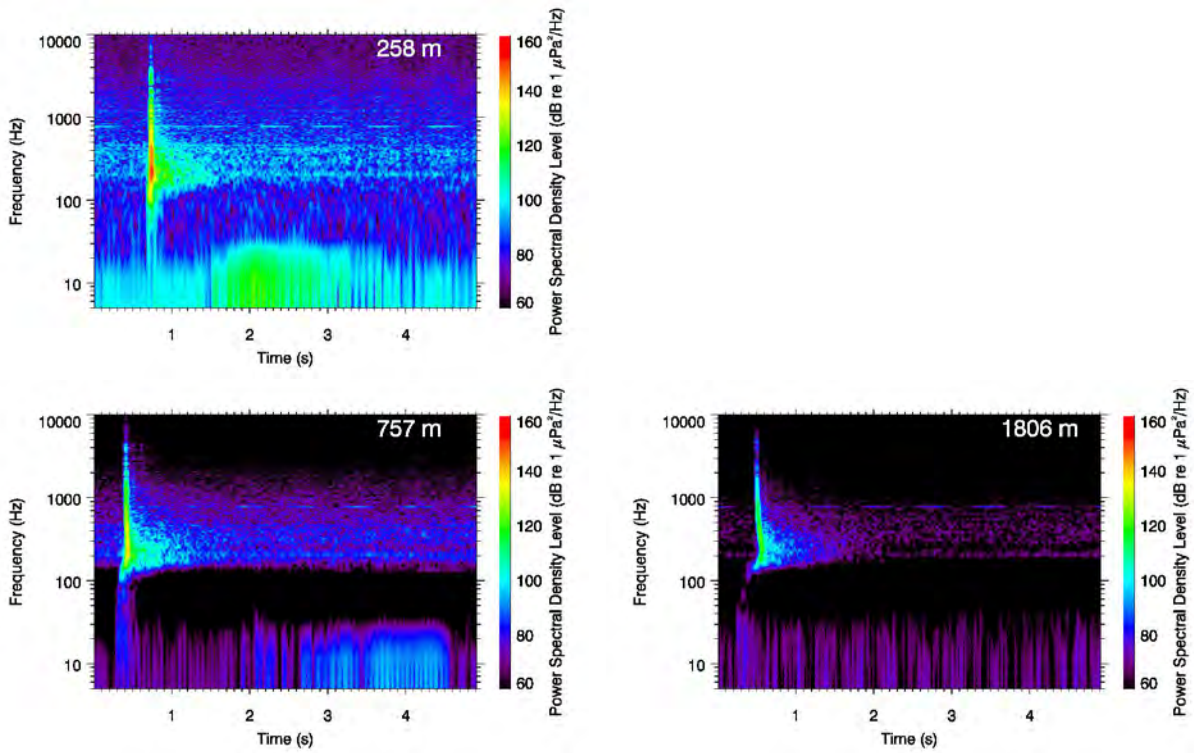

Figure 49. *Broadside*: Spectrograms of airgun pulses from the 40 in^3 mitigation airgun at the CPA to each OBH, 258 m to A1, 757 m to B1, 1806 m to C1; 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap. Broadside only specified to differentiate measurement orientation.

Comparing the endfire and broadband recorded pulse structures at reasonably equivalent ranges (Figure 50, endfire range 1576 m, and Figure 51, broadside range 1806 m) demonstrated the received pulses have similar structures, but are different in received levels by approximately 10 dB. The 40 in^3 mitigation airgun is omnidirectional at the source; therefore, the different received levels are caused by propagation effects, a main contributor would be the sound speed profile combined with the increasing depth in the broadside direction.

The pulse spectrums shown in these figures highlight significant features below 10 Hz. This is most likely due to wind and flow noise in the shallow water environment of the OBH;which varies between locations and times due to wind and current variations. The spectrum also sharply attenuates between 200 and 100 Hz, which is expected for shallow water environments, and only one mode of the pulse propagates.

The measurement location close to the 120 dB modeled threshold (Figure 50, endfire range 2 914 m), shows the pulse as being extremely faint, and close to background noise levels.

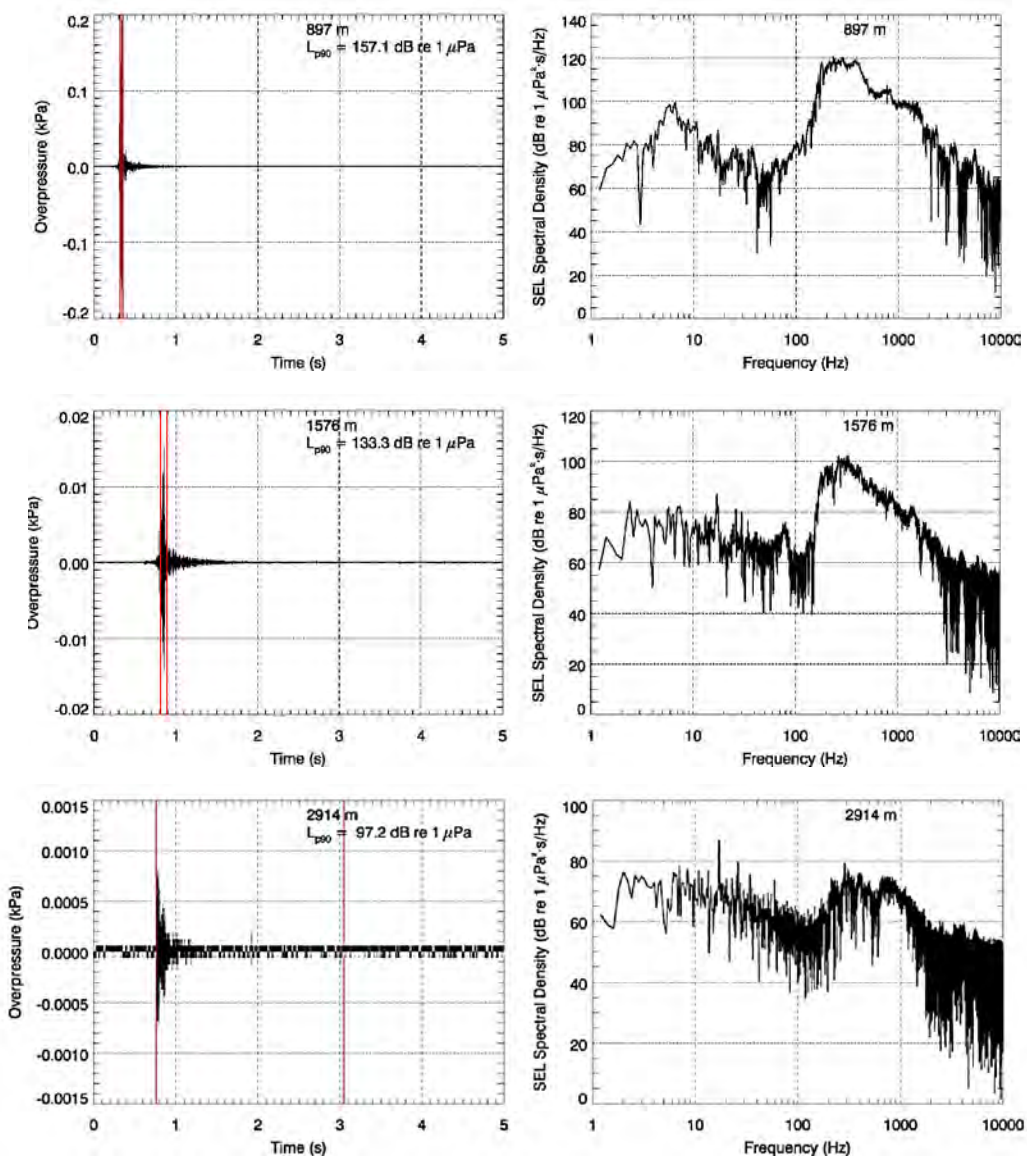

Figure 50. Endfire: (left) Waveform and spectra (right) corresponding SEL spectral density of 40 in³ mitigation airgun pulses at three distances to OBH A1, 897 m, 1576 m and 2914 m. The red bars on the waveform indicate the 90% energy pulse duration. Endfire only specified to differentiate measurement orientation.

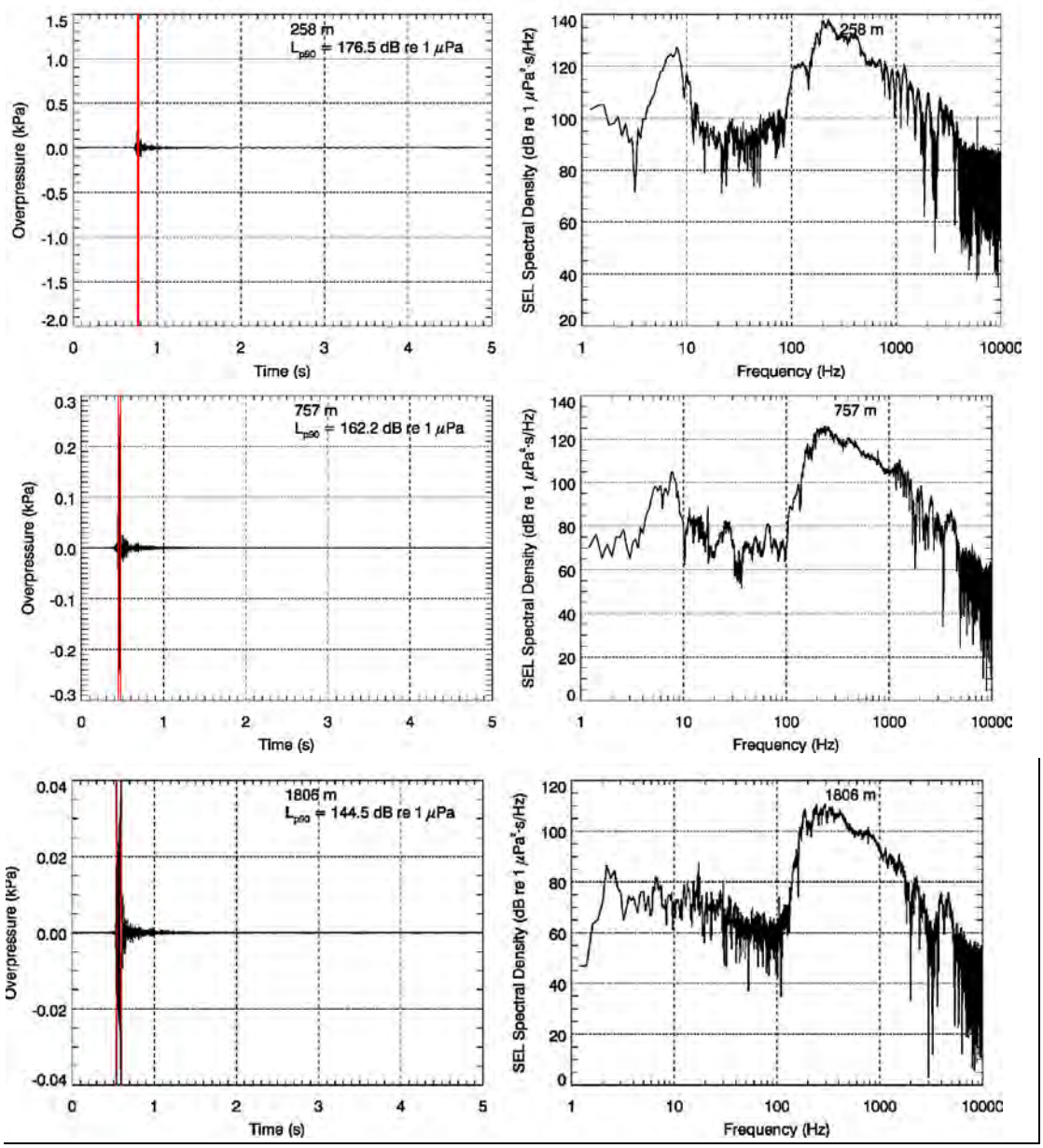

Figure 51. *Broadside*: (left) Waveform and spectra (right) corresponding SEL spectral density of 40 in³ mitigation airgun pulses at the CPA to each OBH, 258 m to A1, 757 m to B1, 1806 m to C1. The red bars on the waveform indicate the 90% energy pulse duration. Broadside only specified to differentiate measurement orientation.

3.2.4. Storm Warning

SPLs were computed for the *Storm Warning*'s vessel noise during its transit along SSC Track 1 from the closest point of approach (CPA) to the end of the track. This section of SSC Track 1 was selected as most representative of the vessel noise characteristics in terms of signal quality and consistency. The water depth along the track (from cartographic records) ranges between 1.8 m and 2.4 m. The continuous noise levels were computed after low-pass filtering at 10 kHz in consecutive 1-second time windows, a standard processing step that eliminates potential contribution from high frequency non-vessel sounds.

Figure 52 shows the rms SPL levels versus time for the *Storm Warning* transiting at 6.3 kts, Figures 53 and 54 presents the sound pressure levels versus range, with the best-fit and 90th percentile trend lines. To remove the surge of non-acoustic noise caused by the propulsion water jet, which occurred for a few meters astern of the hull in the extremely shallow water, we analyzed the acoustic data from the entire approach, but only analyzed acoustic data more than 60 m from the recorder. To achieve the most accurate fits, the approach data were analyzed from 1000 m to the CPA of 3 m, while the departure data were analyzed in two sections: near-range (60 to 300 m), and far-range (300 to 1000 m). Data presented in the Figure 54 plots were recorded from the higher sensitivity TC4032 hydrophone. The ranges to the sound level thresholds of 160 to 120 dB re 1 µPa (rms) for the *Storm Warning* traveling at 6.3 kts are listed in Table 15. The vessel appears as a distributed sound source rather than a point at shorter ranges; therefore, radii smaller than about 20 m should be only considered notional (see Section 3.1.5). Figure 55 shows the spectrograms for the closest two OBHs, and Figure 56 shows the corresponding power spectra at CPA.

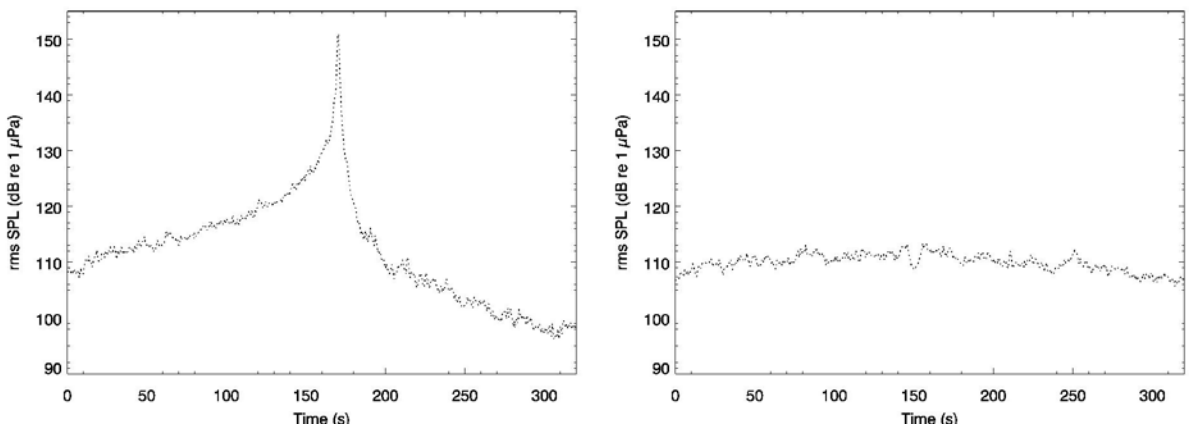

Figure 52. *Storm Warning* rms SPL versus time, in 1 s intervals while transiting at 6.3 kts measured by OBH A1 with a 3 m CPA (left) and OBH B1 with a 501 m CPA (right), inside barrier islands.

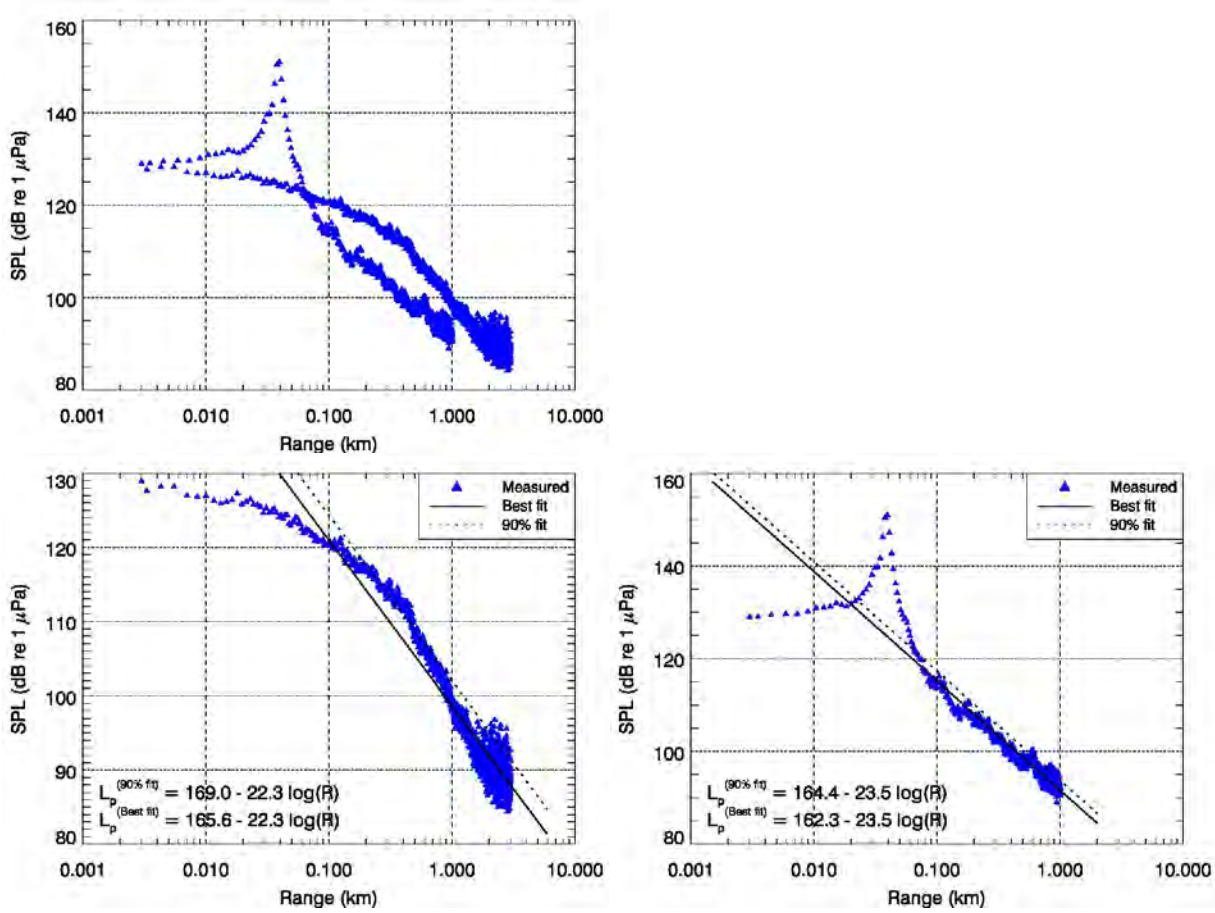

Figure 53. Sound pressure level (rms) versus slant range produced by the *Storm Warning* as it transited past OBH A1 at 6.3 kts inside the barrier islands (top left), showing both approach (bottom left) and departure (bottom right). These plots show the spurious acoustic effects during departure as opposed to approach, but were not used in the analysis.

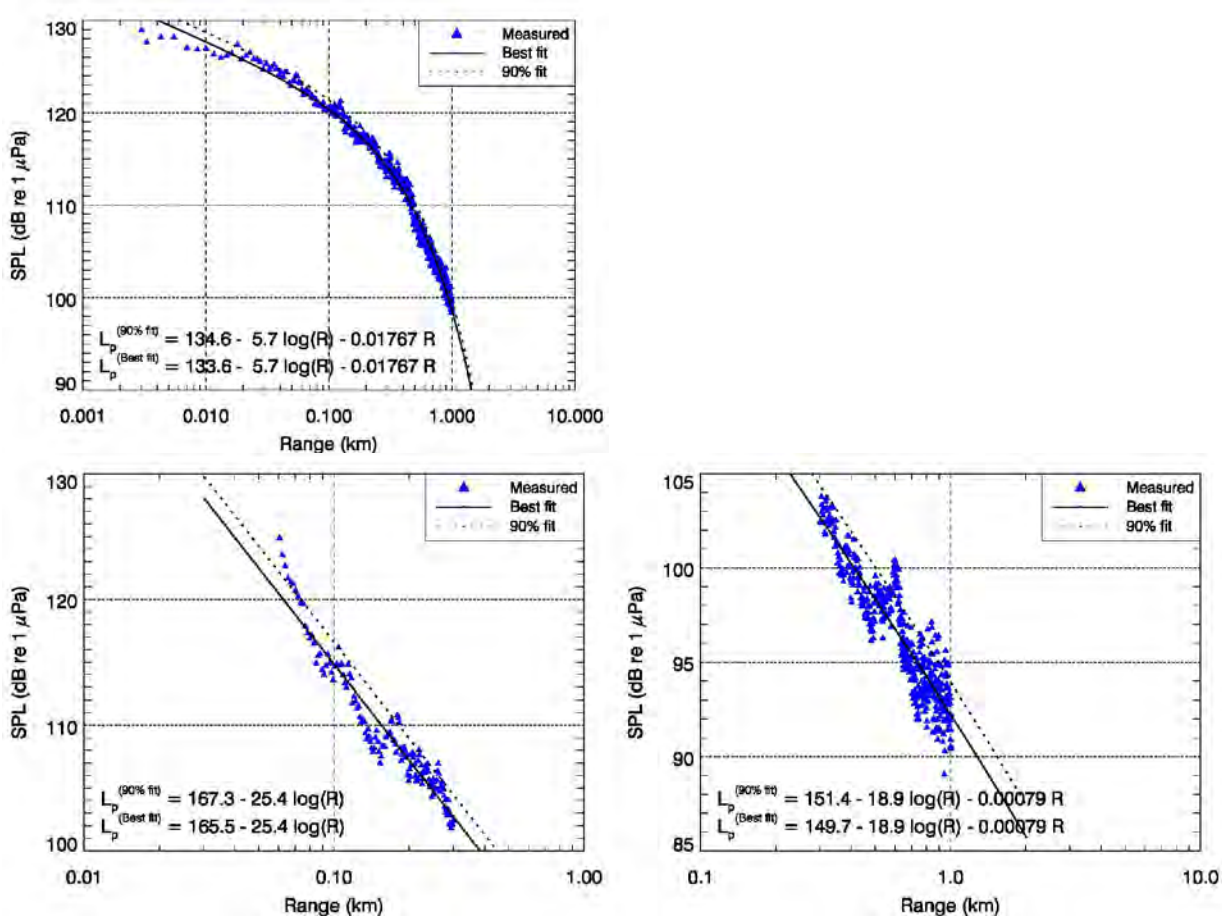

Figure 54. Sound pressure level (rms) versus slant range produced by the *Storm Warning* as it transited past OBH A1 at 6.3 kts inside the barrier islands.(top left) Fit for 130-120 dB re 1 μPa, based only on measurements between 1000 and 3 m range, approach (bottom left) fit for 160–130 dB re 1 μPa, based only on measurements between 60 and 300 m range, departure (right) fit for 120 dB re 1 μPa, based on measurements from 300 to 1000 m, departure. Solid line is the best-fit line to the SPLs. Dashed line is the best-fit adjusted to exceed 90% of the SPLs.

Table 15. Threshold radii for the *Storm Warning* transiting at 6.3 kts at the SSC site, as determined from function fit to SPL versus distance data in Figure 54.

	Approach		Departure	
Threshold (dB re 1 μPa)	*Best-Fit Line Radius (m)*	*90th Percentile Radius*	*Best-Fit Line Radius (m)*	*90th Percentile Radius*
160	-	-	2*	2*
150	-	-	4*	5*
140	-	-	10*	12*
130	4	6	25*	29*
120	106	134	37*	46*

*Extrapolated from a minimum measurement range of 60 m. Distances within 20 m are well inside the near-field of such a distributed source, and should be considered only as notional values.

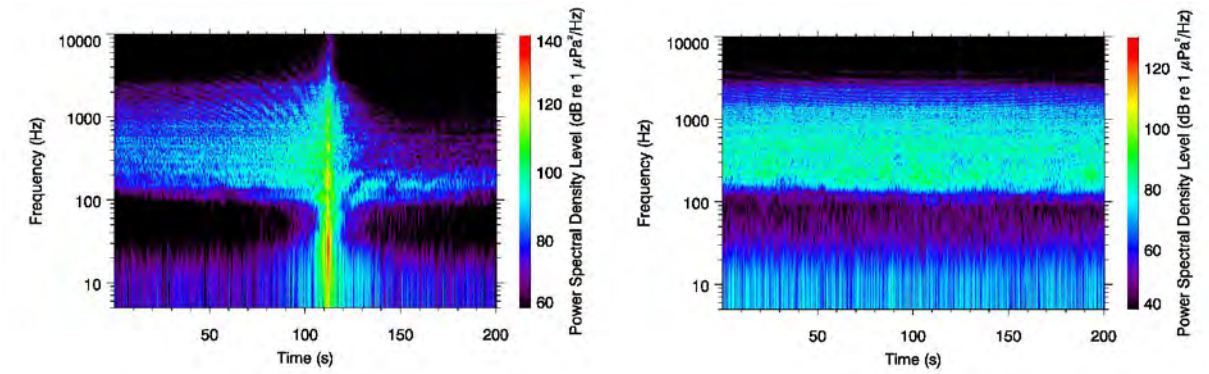

Figure 55. Spectrograms of the *Storm Warning* transiting at 6.3 kts, (left) past A1 with a CPA of 3 m, and (right) past B1 with a CPA of 501 m. 8192-pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

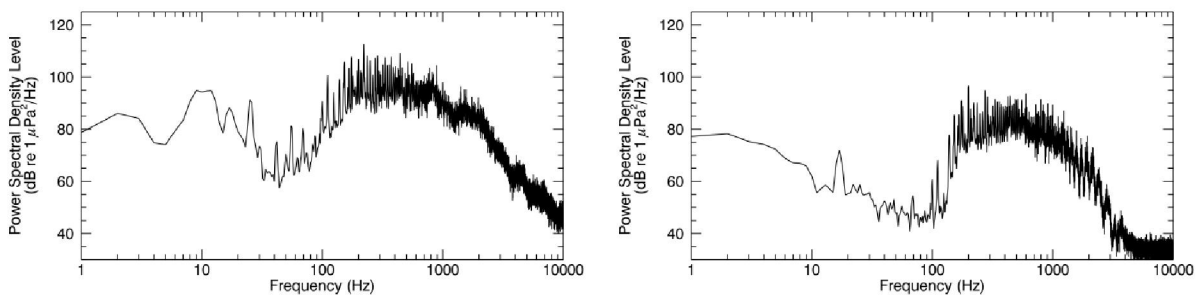

Figure 56. Average power spectral density (PSD) of the *Storm Warning* transiting at 6.3 kts from average of six 1 s Hanning-windowed spectra at centered at 3 m (left) and at 501 m (right) distance.

3.3. Long-Range Measurements: Dipping Hydrophone

The primary goal of the long-range measurements conducted with the dipping hydrophone system was to determine, at discrete times during the seismic survey after 25 August, the airgun pulse levels received outside the barrier islands. The aim was to compare these values to the predicted long-range values from the SSV analysis.

The positional data for the vessels when airguns were active was provided through shot log files (.sps) provided by CGGVeritas. Positional data was only recorded when the main arrays (640 and 320 in^3) were operational, therefore no location data were available for the 40 in^3 mitigation airgun.

No seismic pulses were detected in the dipping hydrophone recordings. Table 16 lists the parameters of each dipping hydrophone recordings and Figures 57–60 show the location of the airgun arrays and dipping hydrophone.

Two examples of the dipping hydrophone recordings are shown in Figures 78 and 81, which show ambient noise and vessel noise respectively. A comparison of the periods measured by the dipping hydrophone and long-term AMARs was conducted (Section 4.4), which verify the levels recorded by the system.

Table 16. Summary of long-range measurements. *Resolution* and *Margarita* were active; *Storm Warning* was inactive. See Table 3 for the recording dates and times, starting locations, and water depths.

Rec No.	Type of signal detected	Distance to source (km)		Source-receiver path blocked by a barrier island	
		Margarita (320 in^3)	*Resolution* (320 in^3)	*Margarita* (320 in^3)	*Resolution* (320 in^3)
1	-*	8.7–9.7	N/A**	No	Yes
2	-	8.1–8.9	9.9-10.3	Yes	Yes
3	-	7.6–8.7	4.9-6.2	Yes	Yes
4	Vessel self-noise	10.3–11.0	4.4-5.6	No	Yes
5	Vessel self-noise	7.4–8.1	7.0-7.9	Yes	Yes
6	-	7.3–8.8	12.1-12.8	Yes	No
7	-	8.7–10.1	7.4-8.4	Yes	Yes
8	-	13.2–14.1	7.6-8.5	Yes	Yes

*The dipping hydrophone system was not functioning properly for this recording.
**Navigation logs indicated the *Resolution's* 40 in^3 mitigation gun was operating during this recording, but the navigation data did not include positional information for this source.

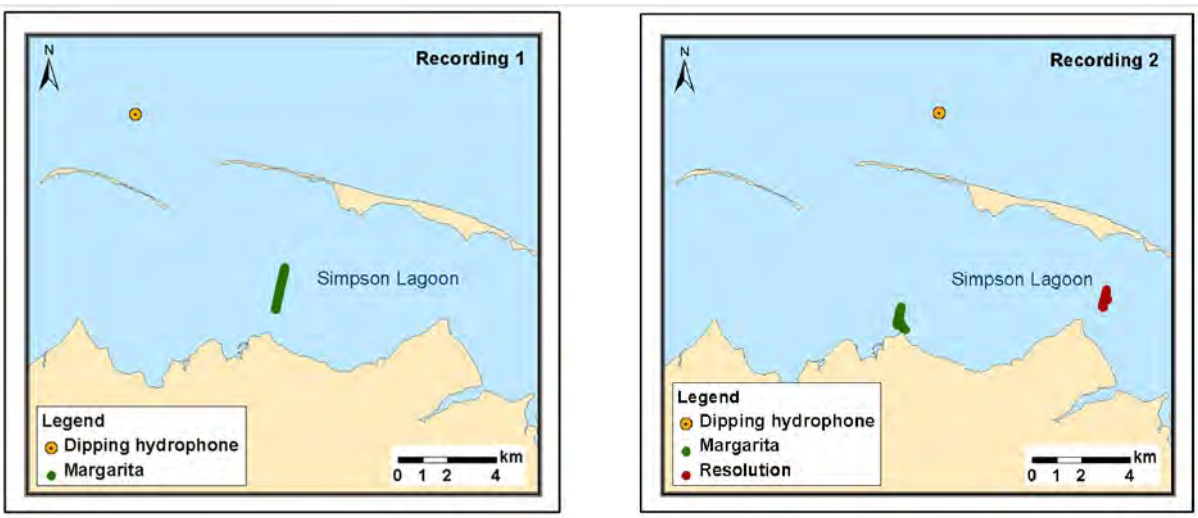

Figure 57. Locations of the *Margarita* and *Resolution* when the 320 in^3 arrays were operating during (left) Recording 1 and (right) Recording 2. The dipping hydrophone system did not function properly during Recording 1. The *Resolution's* 40 in^3 mitigation airgun was operating during Recording 1, but no positional data for that source was provided.

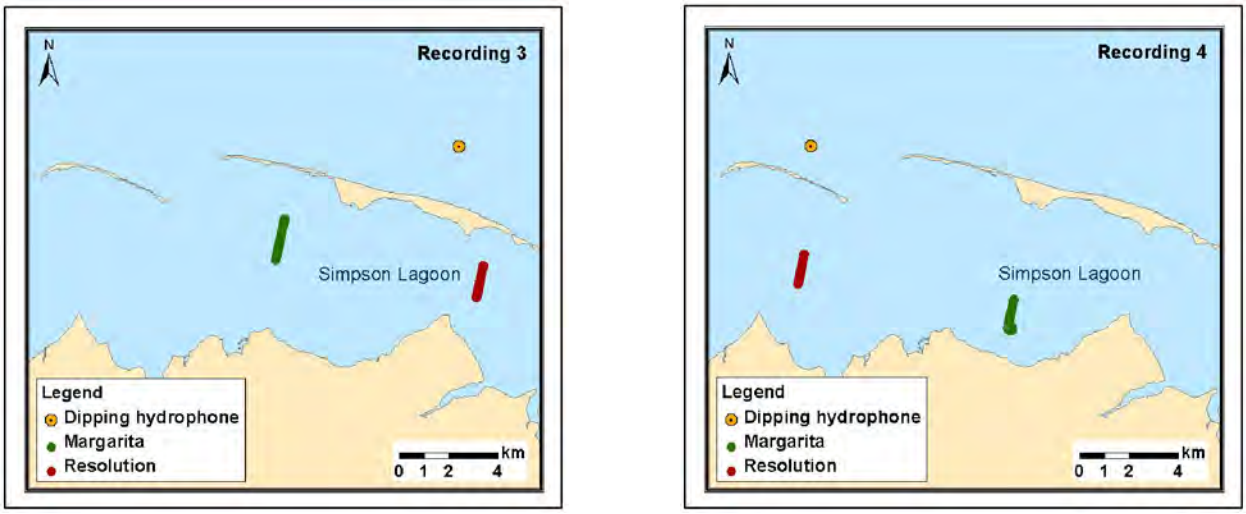

Figure 58. Locations of the *Margarita* and *Resolution* when the 320 in^3 arrays were operating during (left) Recording 3 and (right) Recording 4.

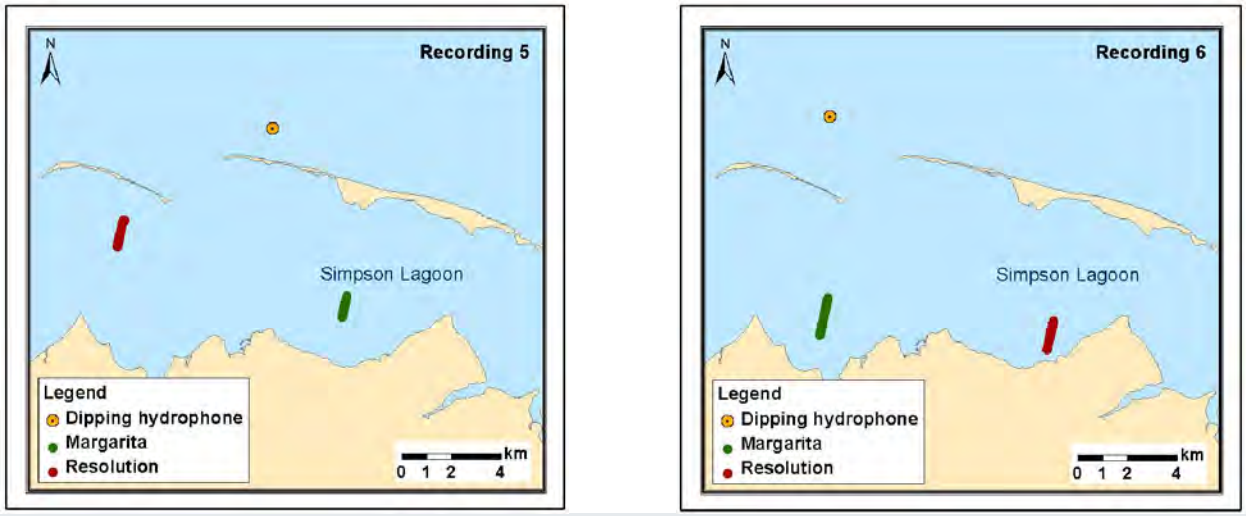

Figure 59. Locations of the *Margarita* and *Resolution* when the 320 in^3 arrays were operating during (left) Recording 5 and (right) Recording 6.

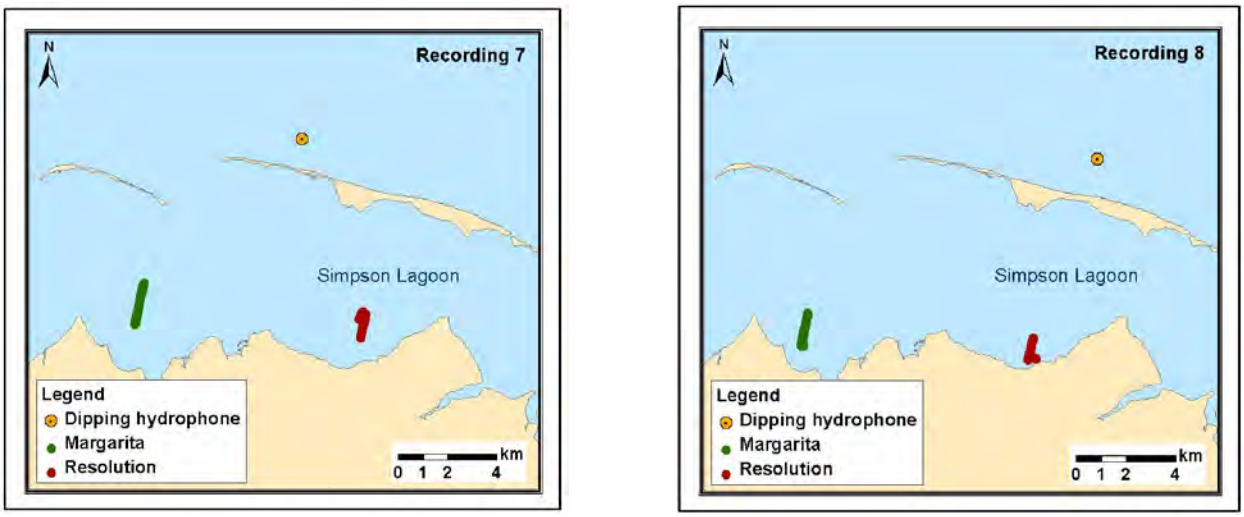

Figure 60. Locations of the *Margarita* and *Resolution* when the 320 in^3 arrays were operating during (left) Recording 7 and (right) Recording 8.

3.4. Long-Term Measurements

The results of the analysis of the AMAR data to determine the degree to which the barrier islands block seismic survey sound propagation are presented in Section 3.4.1. The automated ambient data analysis results for percentiles (Section 3.4.2), spectrograms, and 1/3-octave band level plots (Section 3.4.3) are also presented.

3.4.1. Propagation Effects

Seismic pulse levels from each of the three AMARs were computed for two periods when a single seismic vessel was operating near AMAR 2 to see how sound propagates through gaps in the barrier islands and how it is attenuated through the barrier islands. Sound levels from the *Margarita's* 320 in^3 array were computed during the period 17:14–17:40 on 4 August 2012; for the *Resolution's* 320 in^3 array, the period was 13:52–13:55 on 7 August 2012. Figure 61 shows the location of the *Margarita* and *Resolution* relative to the AMARs and barrier islands during the analyzed periods.

Figure 62 shows sound levels versus range for pulses from the 320 in^3 airgun arrays on the *Margarita* and *Resolution*. Pulses measured on AMAR 1 were low-pass filtered at 150 Hz. Pulses measured on AMAR 3 were low-pass filtered at 50 Hz. Figures 63 and 64 show pulse waveforms and spectra from the *Resolution's* 320 in^3 airgun array that were recorded on AMARs inside and outside the barrier islands.

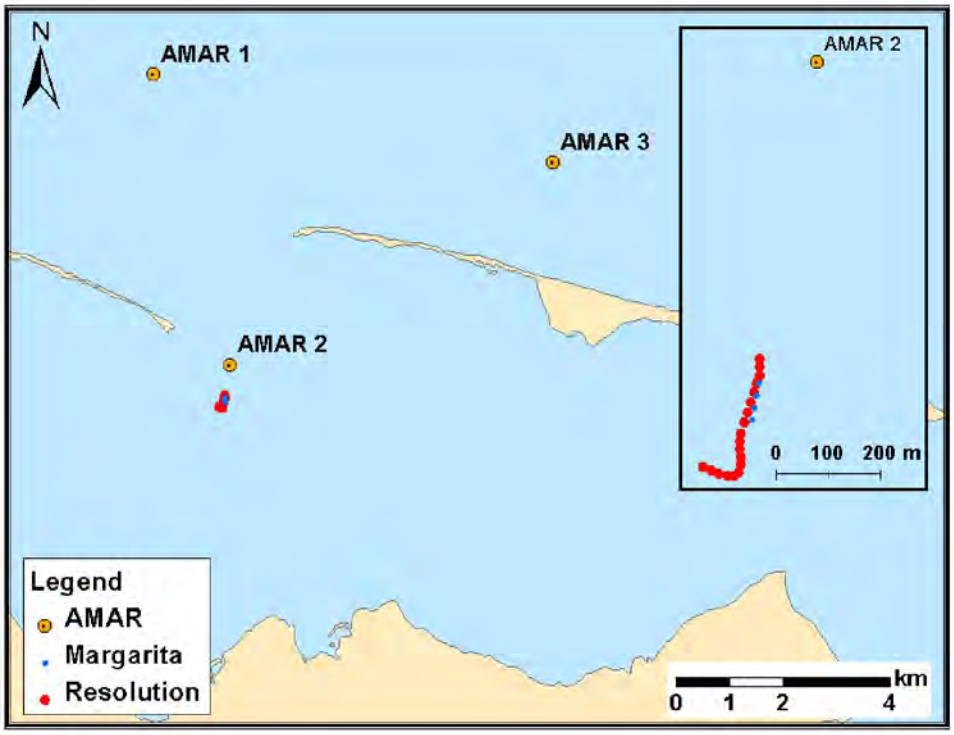

Figure 61. Track of the *Margarita* during 17:14-17:40 4 Aug 2012 AKDT and the *Resolution* during 13:52-13:55 7 Aug 2012 AKDT. For each period, the seismic vessel was operating its respective 320 in^3 airgun arrays.

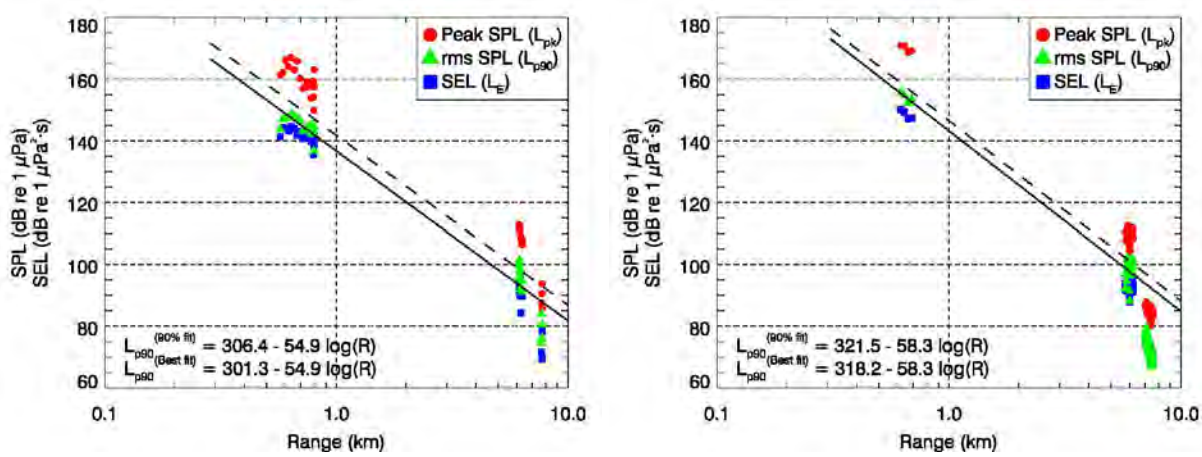

Figure 62. Peak SPL, rms SPL, and sound exposure level (SEL) versus range for the *Resolution's* 320 in^3 airgun array (left) and the *Margarita's* 320 in^3 airgun array (right) operating inside the barrier islands (Figure 61).Pulses at ranges less than 1 km were recorded inside the barrier islands on AMAR 2. Pulses at 6 km were recorded outside the barrier islands on AMAR 1 after propagating between two barrier islands. Pulses at 7-8 km were recorded outside the barrier islands on AMAR 3 after propagating through a barrier island. Best fit and 90% fit lines were made to pulse levels on AMARs 1 and 2.

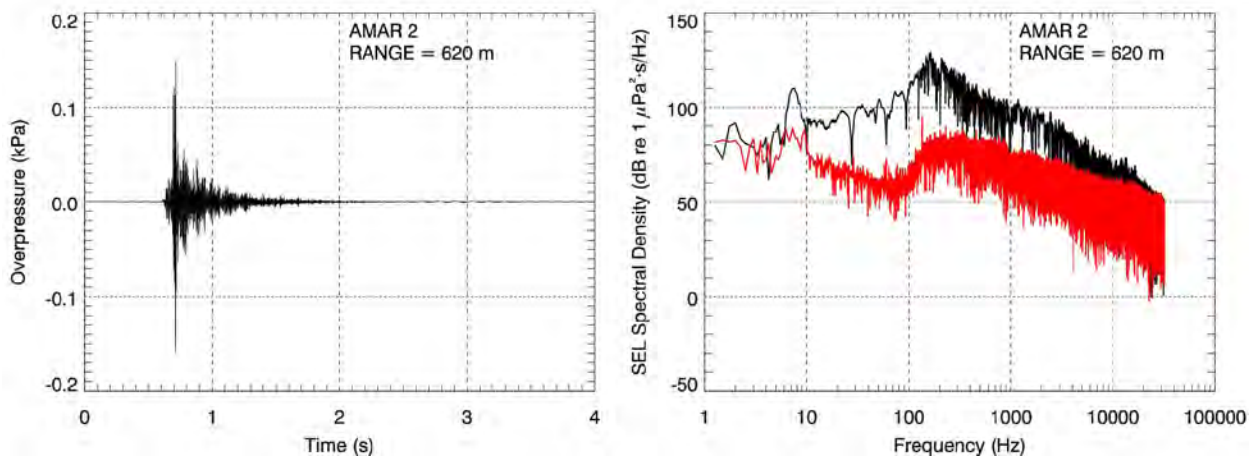

Figure 63. Waveform (left) and SEL spectral density (right) of a pulse from the *Resolution*'s 320 in^3 airgun array measured on AMAR 2 at 620 m range. The red line on the spectral density plot shows the background noise from a time window preceding the pulse.

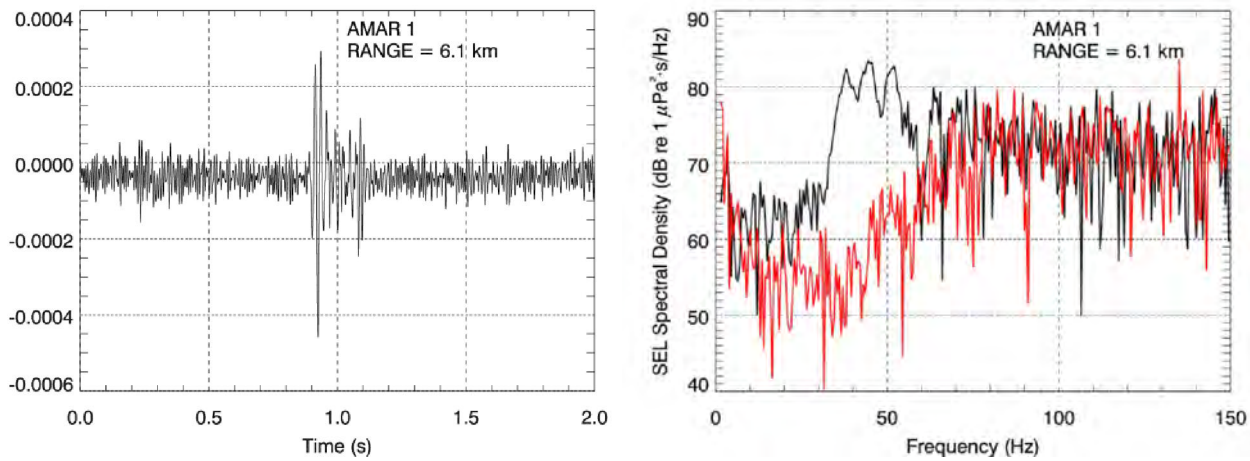

Figure 64. Waveform (left) and SEL spectral density (right) of a pulse from the *Resolution's* 320 in^3 airgun array measured on AMAR 1 at 6.1 km range. A low-pass filter with a cutoff frequency of 150 Hz was applied to the waveform to remove high frequency ambient noise. The red line on the spectral density plot shows the background noise from a time window preceding the pulse.

3.4.2. Percentiles

The frequency domain ambient analysis of the data recorded on each AMAR for the entire deployment determined 1 Hz resolution spectral density values for each minute recorded. Figures 65–67 show these percentiles for each AMAR.

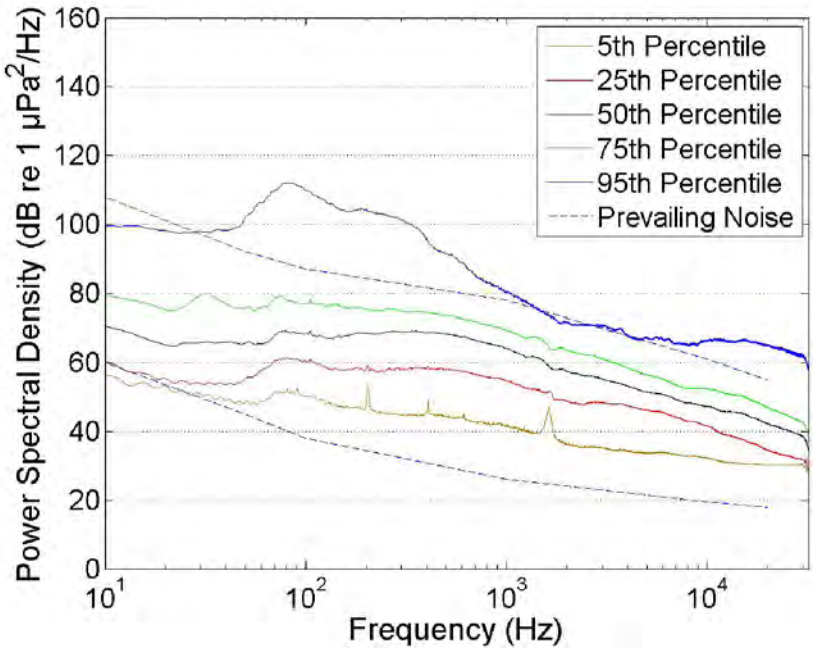

Figure 65. Ambient noise percentiles for AMAR 1 outside barrier islands, 27 Jul to 9 Sep 2012. The dashed lines are the "Limits of Prevailing Noise" from the Wenz curves, Figure 9.

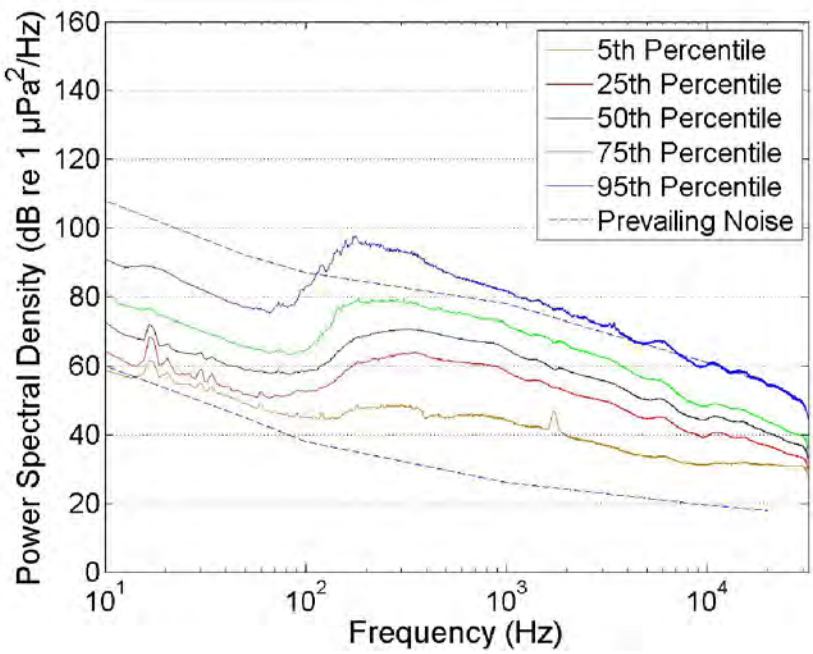

Figure 66. Ambient noise percentiles for AMAR 2 inside barrier islands, 27 Jul to 7 Sep 2012. The dashed lines are the "Limits of Prevailing Noise" from the Wenz curves, Figure 9.

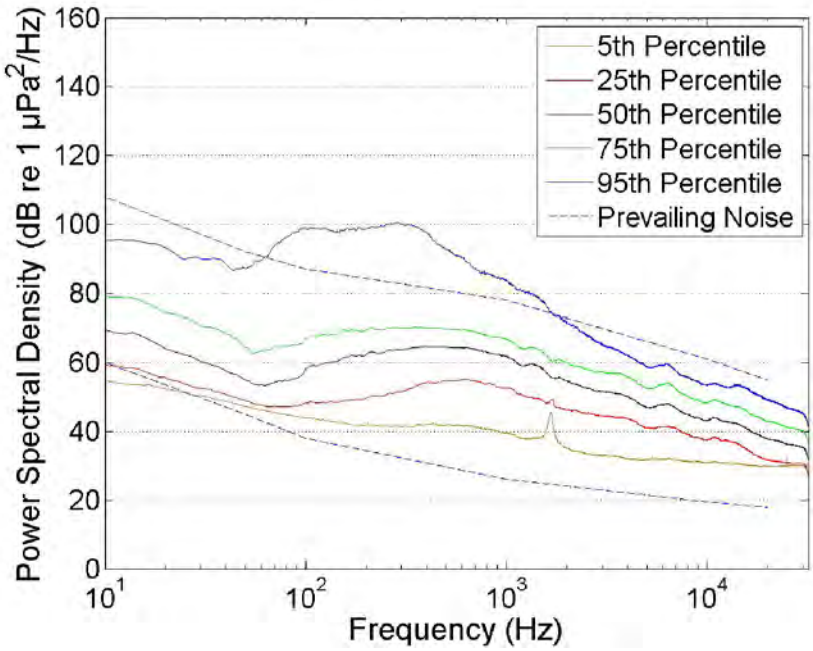

Figure 67. Ambient noise percentiles for AMAR 3 outside barrier islands, 27 Jul to 9 Sep 2012. The dashed lines are the "Limits of Prevailing Noise" from the Wenz curves, Figure 9.

3.4.3. Spectrograms and 1/3–Octave Band Levels

The frequency domain ambient analysis of the data recorded on each AMAR for the entire deployment also generated spectrograms (Figures 68, 70, and 72) and 1/3-octave band level plots (Figures 69, 71, and 73). The 1/3-octave band level plots consist of box/whisker plots that show the 25th and 75th percentiles through the position of the top and bottom of the box, and the 50th percentile through the band inside the box. The ends of the whiskers represent the maximum and minimum levels in that band. The brown line represents the mean value, which is strongly influenced by high intensity outliers, such as seismic.

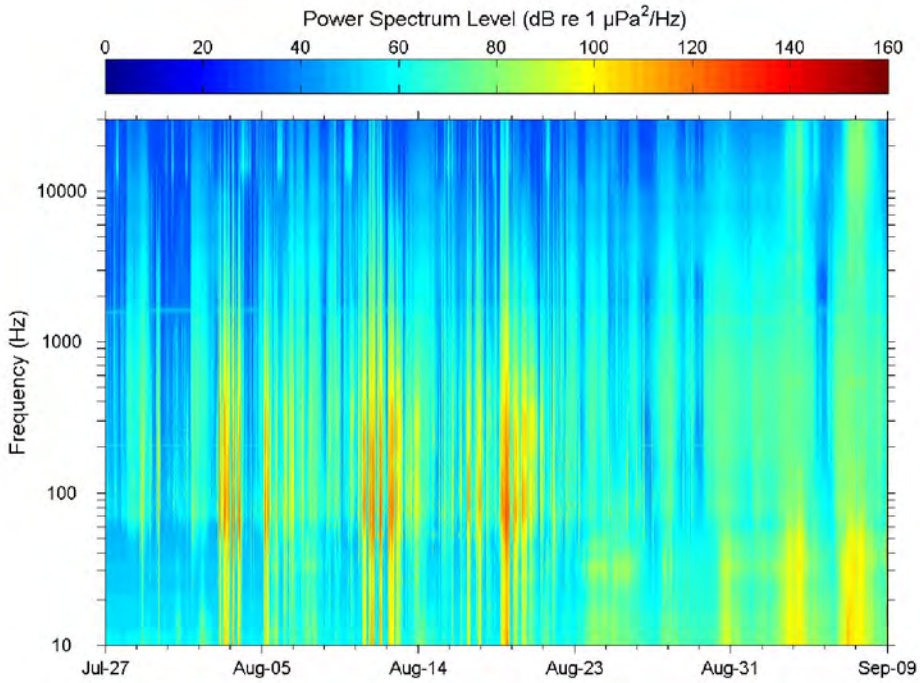

Figure 68. Spectrogram of underwater sound at AMAR 1, outside barrier islands, 27 Jul 2012 to 9 Sep 2012. 1 Hz resolution, Hamming window, 50% window overlap.

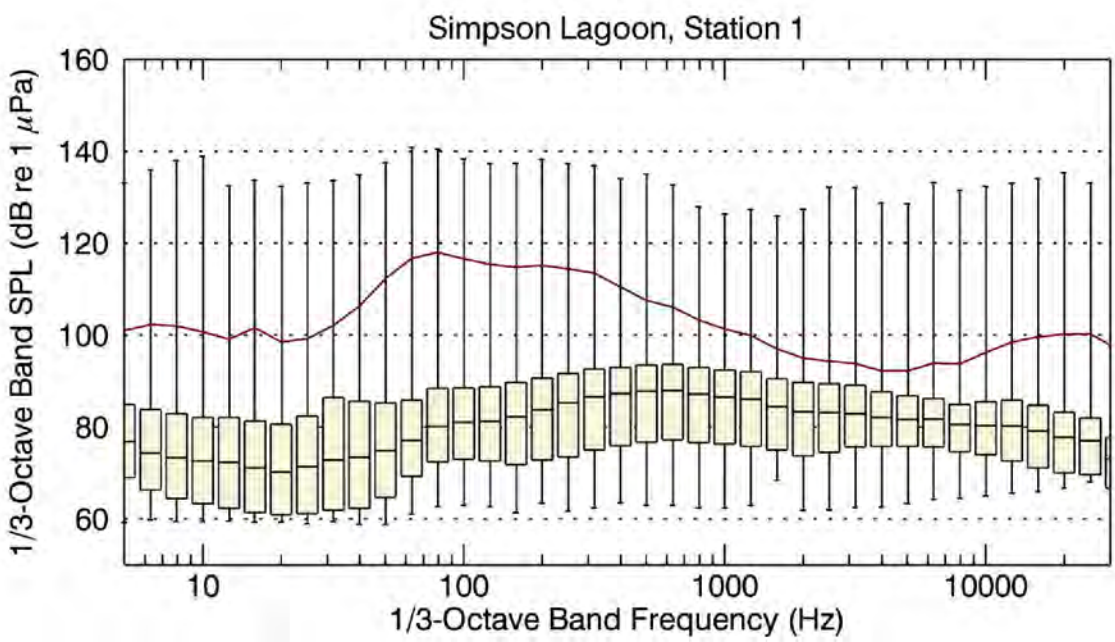

Figure 69. 1/3-octave band SPL box/whisker plot for AMAR 1, outside barrier islands, 27 Jul 2012 to 9 Sep 2012. The plots show the 50th percentile (the line in the middle of each box), 25th and 75th percentiles (top and bottom of each box), and the minimum and maximum (top and bottom of whiskers), while the curve above the boxes shows the mean value, which is strongly influenced by high intensity outliers, including seismic pulses

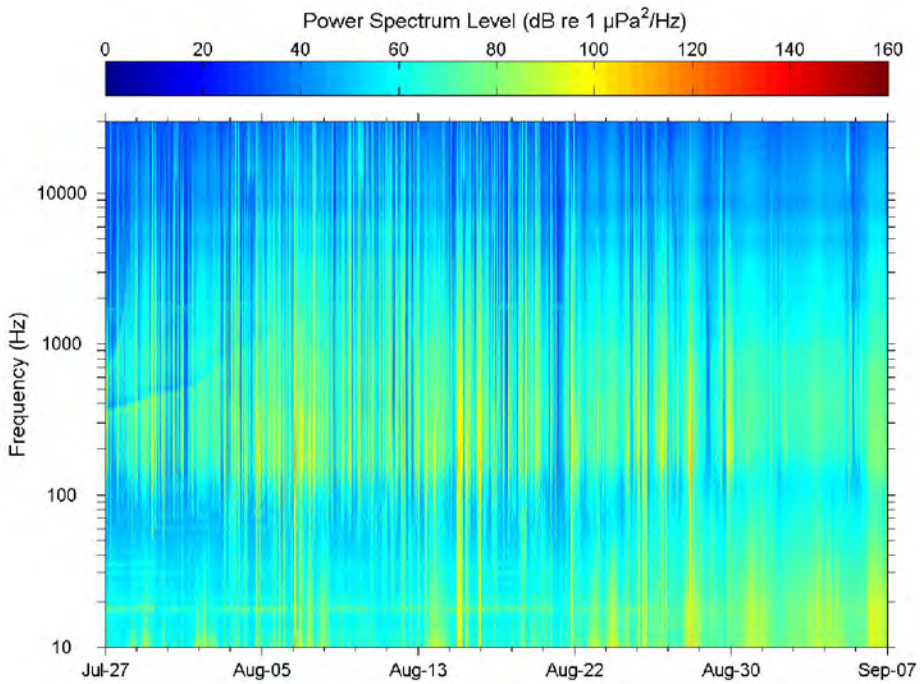

Figure 70. Spectrogram of underwater sound at AMAR 2, inside barrier islands, 27 Jul to 7 Sep 2012. 1 Hz resolution, Hamming window, 50% window overlap.

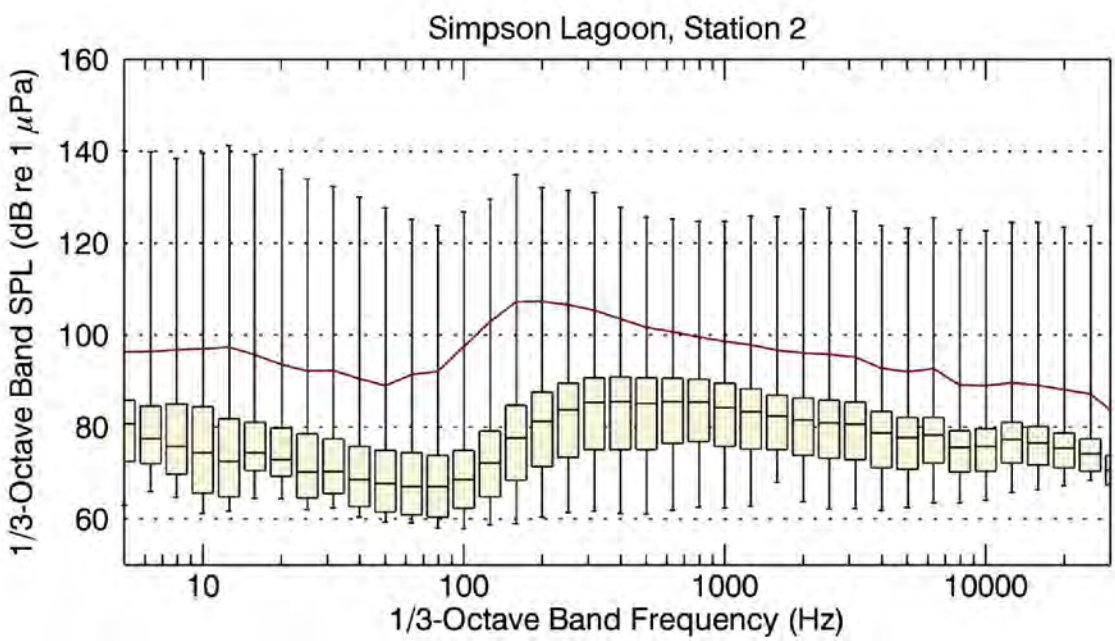

Figure 71. 1/3-octave band SPL box/whisker plot for AMAR 2, inside barrier islands, 27 Jul to 7 Sep 2012. The plots show the 50th percentile (the line in the middle of each box), 25th and 75th percentiles (top and bottom of each box), and the minimum and maximum (top and bottom of whiskers), while the curve above the boxes shows the mean value, which is strongly influenced by high intensity outliers, including seismic pulses

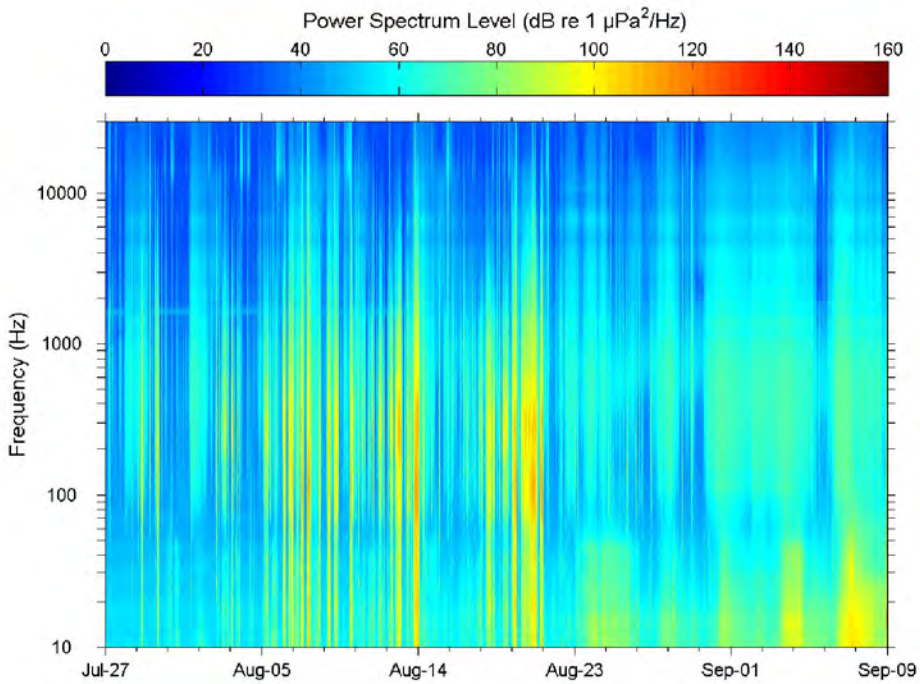

Figure 72. Spectrogram of underwater sound at AMAR 3, outside barrier islands, 27 Jul to 9 Sep 2012. 1 Hz resolution, Hamming window, 50% window overlap.

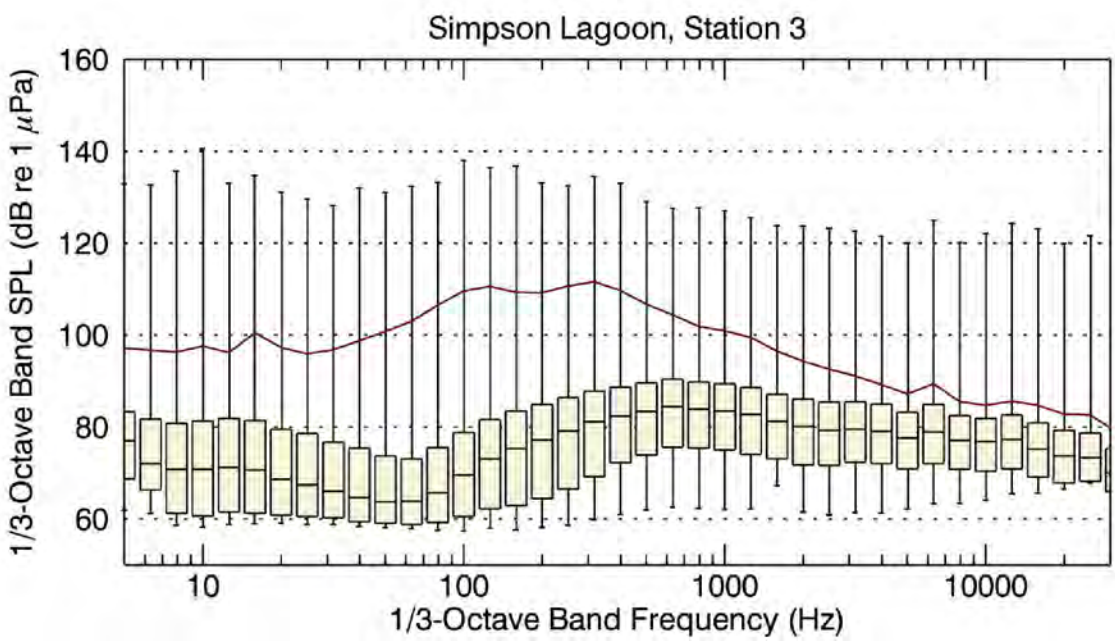

Figure 73. 1/3-octave band SPL box/whisker plot for AMAR 3,outside barrier islands, 27 Jul to 9 Sep 2012. The plots show the 50th percentile (the line in the middle of each box), 25th and 75th percentiles (top and bottom of each box), and the minimum and maximum (top and bottom of whiskers), while the curve above the boxes shows the mean value, which is strongly influenced by high intensity outliers, including seismic pulses

4. Discussion

4.1. SSV/SSC Outside Barrier Islands

4.1.1. SSV

The 640 in^3 airgun array and 40 in^3 mitigation airgun outside the barrier islands were both modeled pre-season, which allowed us to compare their measured results to model-based estimates. The 320 in^3 airgun array outside the barrier islands was not modeled pre-season; the measured results, therefore, cannot be compared to model-based estimates.

The sound speed profile (SSP) measured outside the barrier islands on three different days was consistently downward refracting (Section 3.1), which means the sound energy was directed into the absorptive substrate across the area. These profiles were measured in shallow water (less than 15 m) across the survey region outside the barrier islands; the water column in such conditions can be unstable as weather events (storms/currents) can rapidly redistribute its layers.

The SSP strongly affects the propagation of sounds in shallow water. The downward-refracting profile caused the sound energy to be directed to the ocean floor, which caused higher levels at close range, but increased the attenuation at longer distances.

The pre-season modeling used a weakly refracting SSP (almost uniform), which, along with other propagation parameters, was drawn from a nearby region for a different survey. The difference between the modeled and measured sound speed profiles was the dominant influential factor in the difference between the measured and modeled levels outside the barrier islands, and indicated a strong site sensitivity of the propagation.

The SSP caused the low frequency pulse component to propagate extremely well at close range, which is a significant contributor to the higher than expected received levels within 1000 m of the source.

For the 640 in^3 airgun array, the pre-season modeled radii, which represent broadside levels, underestimated the measured distances for the 190 and 180 dB thresholds, but overestimated the 160 and 120 dB radii (Table 17). Similarly, for the 40 in^3 mitigation airgun, the pre-season modeled radii underestimated the measured distances for the 180 and 160 dB thresholds (close range), but overestimated the 120 dB threshold distance (Table 17). Note that for these latter measurements, the pre-season 190 dB had only been given as an upper limit.

The underestimation of close range levels required an increase of the close range initial mitigation radii used by the Marine Mammal Observers (MMOs), but a reduction of the distant radii.

Another difference between the measured and modeled results was the sound exposure level (SEL) to rms SPL conversion offset the model used. For sound propagation outside the barrier islands, the model used a constant +9 dB conversion factor, which measurements have shown was too simplistic (Figure 14). To exemplify this, a conversion of +12 to 15 dB is required close to the source (180 and 190 dB thresholds) in the endfire direction for the 640 in^3 airgun array, , but beyond the 160 dB threshold point, a conversion offset is not required. In the broadside

direction, a similar conversion is required at close ranges, but only a slight conversion offset (+2 dB) at the 160 dB threshold point, which is still much smaller than the estimated conversion.

Further examination of the effect of the SSP on the SEL showed that it caused the measured sound exposure level (SEL) to differ from the modeled SEL through discrepancies in the estimated pulse length. Longer pulse lengths give smaller differences between rms SPL and SEL. This, coupled with the differences between the modeled and observed SEL to rms SPL conversion offset, resulted in the observed levels being higher than expected at closer ranges to the source (180 and 190 dB thresholds), but lower than predicted farther from the source (beyond the 160 dB threshold) (Table 17).

Sound from the 320 in^3 airgun array propagated similarly to the 640 in^3 airgun array operating in the same environment, with good substrate and water propagation within 1000 m of the source, and predominantly substrate propagation beyond 5000 meters. Therefore, we believe that had the 320 in^3 airgun array been included in pre-season modeling, similar differences would have been observed in the measurements.

Table 17. Outside barrier islands: Comparing measurements with pre-season estimated marine mammal safety radii. Distances are maximized over direction and are based on the 90th percentile fits.

	Safety radii in meters			
Airgun Type	*Threshold (dB re 1 µPa)*	*Pre-Season Estimated*	*90th Percentile Measured*	*Ratio (%)*
640 in³ airgun array	190	120	516	430
	180	950	1386	146
	160	5 500	4616	84
	120	44 000*	14 163	32
320 in³ airgun array	190		360	
	180		1134	
	160		4265	
	120		13 313	
40 in³ mitigation array	190	< 50	24	48
	180	< 50	158†	316
	160	810	1602	198
	120	16 000	9 221	57

*Computed based on 2 dB SPL-SEL conversion factor. See Section 3.1.2 for more detail.
†Actual maximum range from measurements.

4.1.2. SSC

The *Resolution* and *Margarita* transited the same track line outside the barrier islands ranges, an area in which the water ranged in depth between approximately 12.8 m and 13.4 m. The *Resolution* transited at close to the expected operating speed of 5.5 kts, Figures 29 and 30. The *Margarita* moved faster than the typical survey operating speed, at 7.7 kts, Figures 33 and 34. The SPL fits of both vessels were calculated in two sections because the difference in levels between the peak period and the remainder of the track due to differing transit times and periods of peak levels. For the *Resolution*, the spectrograms (Figure 31) and the power spectrum density (PSD) plots (Figure 32) show the nature of the vessel noise has defined tonal components, with the primary two centered at 70 Hz and 125 Hz, and are the only components distinguishable at

664 m. The Lloyd mirror pattern is weak, and present only in the recording from OBH A2 (above 100 Hz), but are not present at OBH B2. The spectrograms show the *Margarita* has a different signature (Figure 35) and power spectrum density (PSD) (Figure 36). The *Margarita* has defined tonal components centered at 70 Hz and 200 Hz, and Lloyd mirror pattern above 100 Hz, which are still distinguishable at OBH B2, 660 m distant.

Because the *Resolution* is a jetboat and the *Margarita* is propeller driven, they have different signatures, with the *Resolution* being significantly quieter (Table 18).

Table 18. Threshold radii for the vessels at the SSC site outside the barrier islands, as determined from function fit to SPL versus distance data in Figures 30 and 34.

	Resolution (5.5 kts)		Margarita (7.7kts)	
Threshold (dB re 1 μPa)	*Best-Fit Line Radius (m)*	*90th Percentile Radius (m)*	*Best-Fit Line Radius (m)*	*90th Percentile Radius (m)*
160	<1*	1*	6†	8†
150	1*	2*	17	24
140	5*	7*	53	73
130	17	28	162	222
120	47	61	889	1151

*Extrapolated from minimum measurement range of 14.3 m.
†Extrapolated from minimum measurement range of 15.5 m.
These distances are well inside the near-field of such a distributed source, and should be considered only as notional values.

4.2. SSV/SSC Inside Barrier Islands

4.2.1. SSV

The 320 in^3 airgun array and 40 in^3 mitigation airgun inside the barrier islands were both modeled pre-season, which allowed us to compare their measured results with model-based estimates.

The sound speed profile (SSP) was measured inside the barrier islands on only one occasion and was found to be downward refracting, similar to outside the barrier islands. This means that sound energy was directed into the absorptive substrate across the area. The instability of the SSP inside the barrier islands in the extremely shallow water can be very high. The limited depths also restricted the sounds to a narrow region, leading to many attenuating boundary interactions.

Inside the barrier islands both the depth and the SSP influenced the propagation of sounds in shallow water. The downward-refracting profile caused the sound energy to be directed to the ocean floor, resulting in higher levels at close range, but increasing the attenuation at longer distances.

The pre-season modeling used a weakly refracting SSP (almost uniform), which, along with other propagation parameters, was drawn from a nearby region for a different survey. The modeling depths were also slightly greater than the actual depths encountered inside the islands

due to changing bathymetry. The different SSP and very shallow depth are the dominant factors that influenced the difference in the measured and modeled levels.

The recorders were intentionally placed, based on the available cartography, along the axis of a slight depression in the otherwise almost flat seafloor, oriented in the direction of the gap between the barrier islands. This placed them along a somewhat deeper channel (about 30 cm) compared to the track line along which the SSV would be run. Because the water was very shallow (1.8 m), this represented an appreciable difference, likely enhancing sound propagation in the broadside direction compared to the endfire.

For the 320 in^3 airgun array, the pre-season modeled radii underestimated the measured distance for the 190 dB threshold, but were comparable to the 180 to 160 dB thresholds. For the 120 dB threshold, the comparison is mixed because of issues with extrapolating a broadside estimate from the measurements as described in a Section 3.2.2. Table 19 shows the measured endfire radius and the extrapolated broadside radii, the latter only for completeness rather than as a realistic estimate.

The 40 in^3 mitigation airgun differed slightly from the 320 in^3 airgun array, as the pre-season modeled radii underestimated the measured distances for the 180 and 160 dB thresholds (the pre-season 190 dB had only been given as an upper limit), but overestimated the 120 dB threshold (Table 19). Another difference between the measured and modeled results was the SEL to rms SPL conversion offset the model used. Inside the barrier islands, the conversion factor for the array is range-dependent, between +15 and +3 dB. Upon examining the 320 in^3 airgun array measurements, this relationship is overly complex (Figure 39). In the endfire direction, the conversion is +20 dB within 500 m, but this quickly goes to zero as the SEL and rms SPL results align. In the broadside direction, the offset is a constant +20 dB within 1 km however after this distance the SEL and rms SPL results come close to aligning.

The effect of the SSP on the SEL inside the barrier islands was the same as outside the islands, with discrepancies in the estimated pulse length. This, coupled with the differences between the modeled and observed SEL to rms SPL conversion offset, resulted in the observed levels being higher than expected at closer ranges to the source (190 dB threshold) but lower than predicted at greater distances from the source (near the 120 dB threshold).

The difference between the original modeled estimate of 5700 m for the 320 in^3 airgun array 120 dB mitigation radius, and the measured value of 2528 m in the endfire direction, is significant in terms of long-range mitigation both inside and outside the barrier islands. Despite the significant difference in ranges, to be conservative, we adopted the modeled estimate of 5700 m. This was validated when we analyzed the AMAR long-term measurements (Section 3.4), which showed that at approximately 6 km in range the received levels outside the barrier islands from the 320 in^3 airgun array operating inside the barrier islands were a maximum of 100 dB (90% rms SPL) (Figure 62). Therefore, the 120 dB threshold would have been well within the selected threshold, and the AMAR measurements show that with the barrier islands between the source and receiver, the threshold distance would have been approximately only 2000 m.

Table 19. Inside barrier islands: Measurement comparison with pre-season estimated marine mammal safety radii. Distances are maximized over direction and are based on the 90th percentile fit lines.

	Safety radii in meters			
Airgun Type	*Threshold (dB re 1 μPa)*	*Pre-Season Estimated*	*90th Percentile Measured*	*Ratio (%)*
320 in³ airgun array	190	160	260	163
	180	480	472	98
	160	1 500	1545	103
	120	5 700	2528*	44
			16 598†	291
40 in³ mitigation array	190	16	138	863
	180	59	293	497
	160	700	933	133
	120	3 700	3242	87

* Measured endfire.
† Extrapolated broadside.

4.2.2. SSC

The *Storm Warning* transited the track line in water 2 m deep at an average speed of 6.3 kts, which was faster than the specified operating speed of the vessel during the survey. The peak levels recorded from the vessel occurred over a brief period, approximately 25 seconds, and 200 m (Figures 74, 53, and 54). The difference in received levels required the SPL fit be calculated in two sections. The effect of the vessel's jet complicated analysis, with all departure results within 60 m, after an invalid 3 m closest point of approach (CPA), which was due the direct flow from the jet nozzle causing spurious pressure effects (non-acoustic noise spike) on the recorder.

The spectrograms (Figures 75 and 55) and the power spectrum density (PSD) plots (Figure 56) showed the nature of the vessel noise lacks defined tonal components, but instead had a band-limited broadband noise structure from 100 to 3000 Hz with Lloyd mirror pattern. The structure of the vessel noise reflects the jetboat's properties: it doesn't have a true propeller but does have a flat-bottomed hull. These features make the vessel relatively quiet; it has no true vessel sound components under 100 Hz, but has a 90th percentile radius of 134 m at a threshold of 120 dB.

The noise characteristics of this jet propelled boat in extremely shallow water are complex, with the vessel hull effectively shielding sound from reaching the recorder at extremely close approach, and the direct flow from the jet nozzle causing spurious pressure effects (non-acoustic noise spike) on the recorder on the departure track (Figure 53). These anomalies are discussed in this section, but were excluded from the analysis because we appropriately selected unaffected data segments.

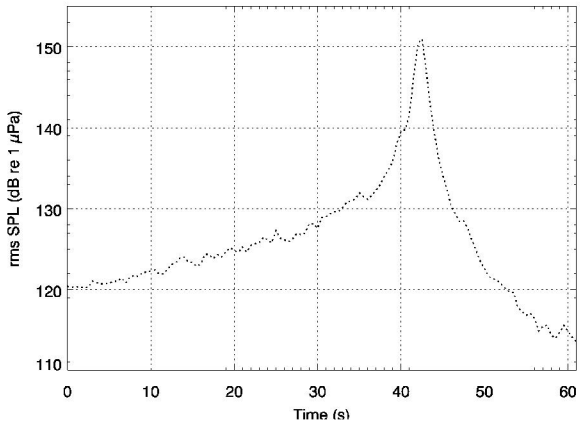

Figure 74. *Storm Warning* rms SPL versus time, in 1 s intervals as it transited past OBH A1 at 6.3 kts with a 3 m CPA, from 100 m before to 97 m after.

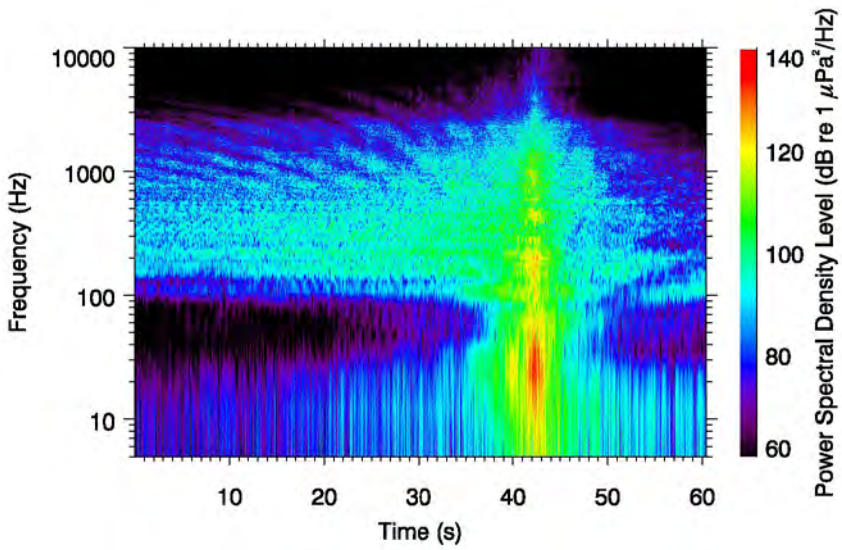

Figure 75. Spectrogram of the *Storm Warning* transiting at 6.3 kts, CPA of 3 m, from 100 m before to 97 m after; 8192 pt FFT, 96 kHz sample rate, Hanning window, 87.5% overlap.

4.3. Long-Range Measurements

The dipping hydrophone recordings did not detect seismic pulses from the active 320 in^3 arrays. To verify the sound levels on the dipping hydrophone, we analyzed matching periods from the long-term AMAR recordings. Figure 76 shows the locations of both. Maps of the recording geometry and spectrograms from the dipping hydrophones and AMARs are shown in Figures 76–82. For Recording 2, pulses were detected inside the barrier islands on AMAR 2 but not outside the barrier islands on AMAR 3. For Recording 4, the *Kimberlin Kat*'s engines were not turned off so the dipping hydrophone detected only vessel noise. Seismic pulses were detected inside the barrier islands on AMAR 2 but not outside the barrier islands on AMAR 1. These results are consistent with the shallow water environment inside the barrier islands severely

attenuating pulses as they propagated through the sub-bottom and outside the barrier islands. This effect is discussed in more detail in Section 4.4.1.

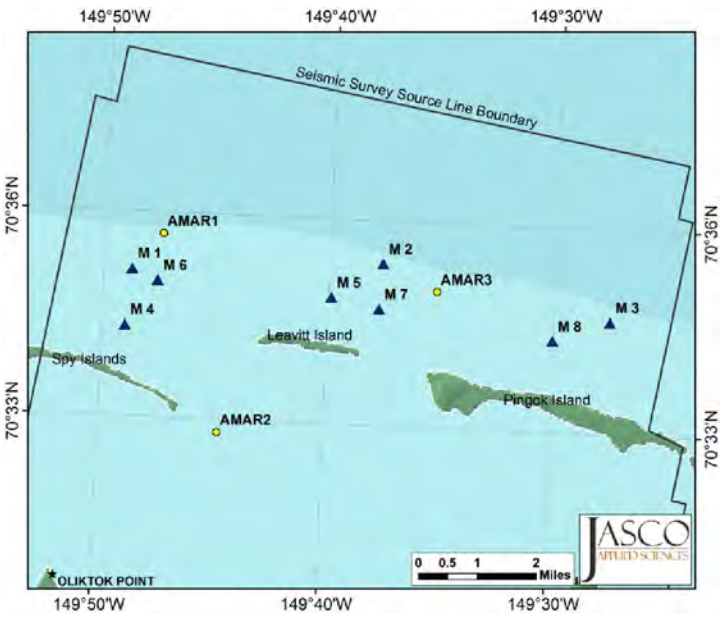

Figure 76. Locations where AMARs recorded and dipping hydrophone measurements were taken.

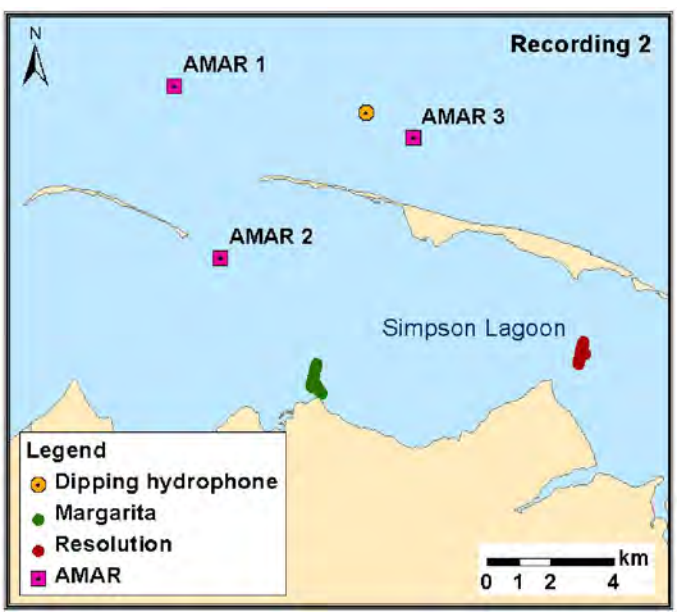

Figure 77. Locations of the *Margarita* and the *Resolution* during Recording 2 at 13:03 AKDT on 29 Aug 2012.

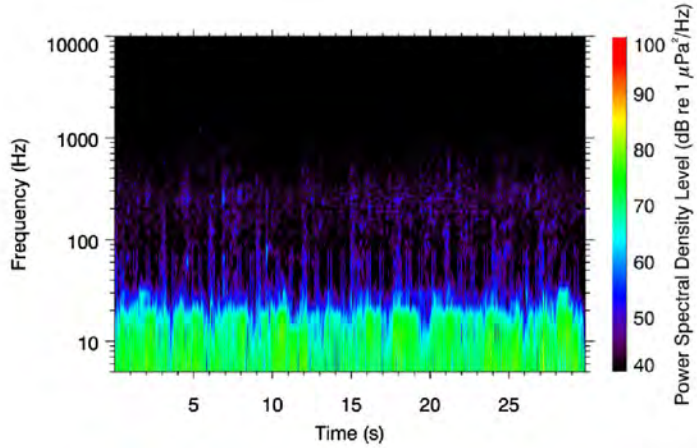

Figure 78. Spectrogram from the dipping hydrophone (Recording 2) starting at 13:03 AKDT on 29 Aug 2012; FFT length 16 384 pts; Hanning window, 87.5% overlap.

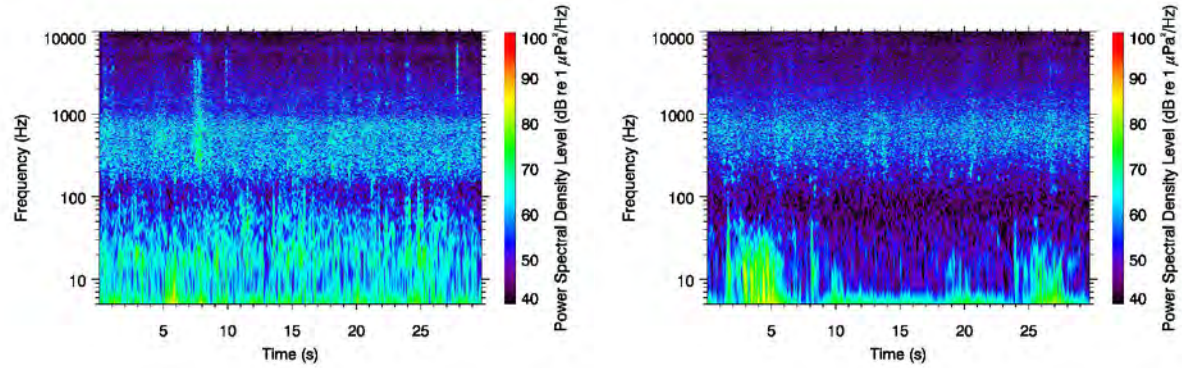

Figure 79. Left: Spectrogram from AMAR 2 starting at 13:03 AKDT on 29 Aug 2012; FFT length 16 384 pts; Hanning window, 87.5% overlap. Airgun pulses from the *Margarita*'s 320 in^3 airgun array are visible above 1000 Hz at 1, 10, 19, and 28 seconds into the spectrogram. Wave noise is visible at 7-8 seconds between 200 and 4000 Hz. Right: Spectrogram from AMAR 3 starting at 13:03 on 29 Aug 2012 AKDT. FFT length 16384 pts. Hanning window, 87.5% overlap. No airgun pulses were detected during this time.

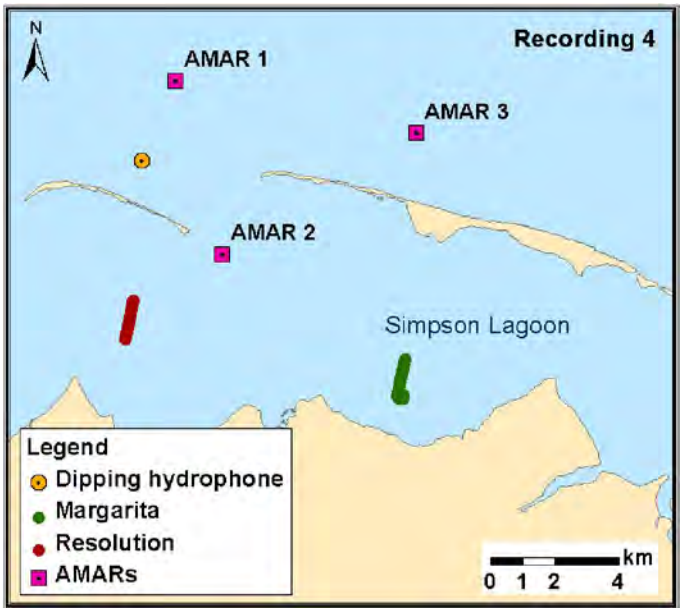

Figure 80. Locations of the *Margarita* and the *Resolution* during Recording 4 at 12:41 AKDT on 1 Sept 2012.

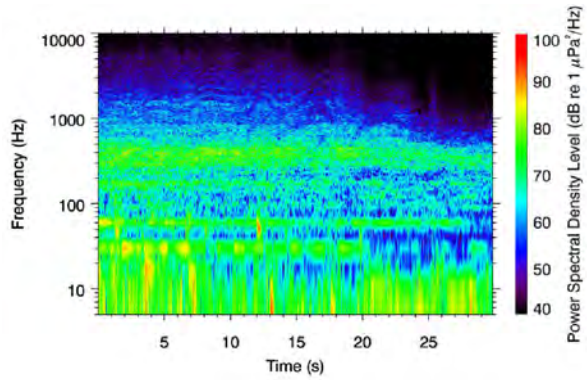

Figure 81. Spectrogram from dipping hydrophone Recording 4 starting at 12:41 AKDT on 1 Sept 2012; FFT length 16 384 pts, Hanning window, 87.5% overlap.

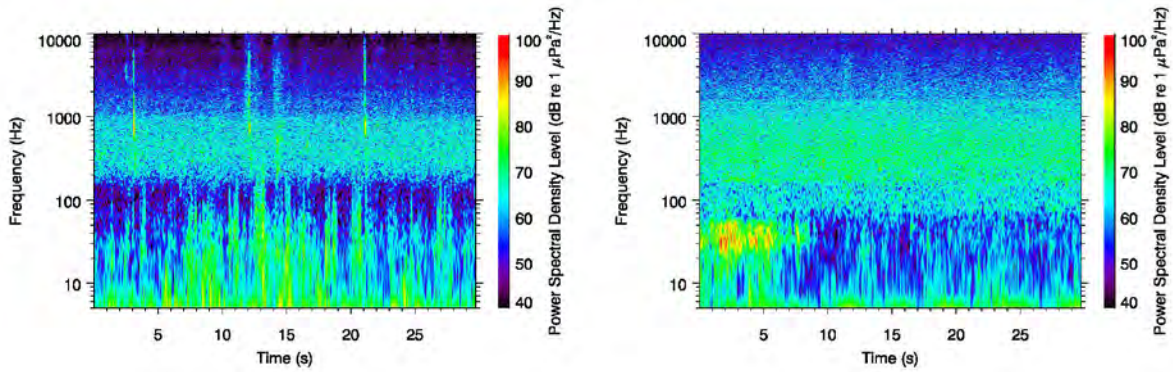

Figure 82. Left: Spectrogram from AMAR 2 starting at 12:41 on 1 Sep 2012 AKDT: FFT length 16384 pts, Hanning window, 87.5% overlap. Airgun pulses from the *Resolution's* 320 in^3 airgun array are visible at 3, 12, and 21 seconds into the spectrogram. The pulse energy is above 100 Hz. A pulse-like sound from an unknown source was observed at 14-15 seconds into the spectrogram. Right: Spectrogram from AMAR 1 starting at 12:41 on 1 Sep 2012 AKDT: FFT length 16 384 pts, Hanning window, 87.5% overlap. No airgun pulses were detected during this time. The signal between 20 and 50 Hz and 1 and 9 seconds is too long to have been generated by the seismic sources used in this survey.

4.4. Long-Term Measurements

4.4.1. Propagation Effects

Sound levels for pulses propagating from inside to outside the barrier islands were computed to determine the transmission loss between the two regions and the degree to which the barrier islands block sound transmission (see Section 3.4.1). Several pulses were analyzed from the *Margarita's* and *Resolution's* 320 in^3 arrays when they operated inside the barrier island. Pulses received inside the barrier islands were recorded on AMAR 2. Pulses that propagated offshore through a navigable channel between the barrier islands were recorded on AMAR 1. Pulses that propagated offshore through one of the islands were recorded on AMAR 3. The differences in spectral density show the effect of the barrier islands on sound propagation.

Pulse spectral density inside the barrier islands exceeded background levels at frequencies above 10 Hz and peaked between 100 and 200 Hz. Most of the pulse energy propagated through the water directly to the recorder.

Pulse spectral density for the same pulses after they propagated between and outside the barrier islands exceeded background levels at frequencies between 10 and 80 Hz. Even though the path from the array to the recorder was not blocked by an island, the shallow water inside the barrier islands prevented long-range sound propagation at frequencies over 80 Hz. The detected low frequency energy propagated through the sub-bottom and radiated energy back into the water column.

Pulse spectral density for the same pulses after they propagated through a barrier island exceeded background levels at frequencies between 10 and 30 Hz. The path from the array to the recorder was blocked by an island and the pulse propagated through the sub-bottom, reradiating energy back into the water column. Transmission loss was larger for this path compared to the unobstructed path to AMAR 1 indicating that sound was attenuated significantly as it travelled through the sub-bottom.

4.4.2. Percentiles, Spectrograms, and Band Levels

Power spectral density levels (see Section 3.4.2) are highest in the frequency range 60–1 000 Hz, which is consistent with the Wenz curves (Figure 9) for sea-state and vessel noise in shallow water. The raised portion of the 95th percentile above the upper Wenz curve for each AMAR is due to the contribution of the seismic survey. This level is higher for the outside barrier islands AMARs (Figures 65 and 67), most likely due to the use of the 640 in^3 airgun arrays in this area and the better propagation conditions. The inside barrier island AMAR, AMAR 2 (Figure 66), recorded a lower 95th percentile level, most likely due to the comparatively poor propagation conditions and the maximum array size of 320 in^3.

As the outside barrier islands AMARs only received low level pulses when then survey was inside the islands, their 75th percentiles are lower when compared to AMAR 2, which was inside the barrier islands. This means that those outside received lower levels 75% of the time, which reflects the amount of time the survey was operational outside the barrier islands, compared to the length of the deployment.

The spectrograms and 1/3-octave band level plots for each long-term AMAR (see Section 3.4.3) show that most seismic survey activity outside the barrier islands occurred in the first part of the survey, prior to 22 August. After that time, the recorded sounds, and therefore the 1/3-octave band levels, were mainly attributed to vessel noise. Levels inside the barrier islands were lower because of the shallower water, but were relatively higher after 22 August as seismic surveying continued later in the survey. AMAR 3 (Figures 72 and 73) most clearly demonstrates this difference because it is the furthest geographically removed from the inside lagoon area.

5. Summary and Conclusions

5.1. Airgun Array Sound Source Verification (SSV) and Vessel Sound Source Characterization (SSC)

JASCO performed acoustic measurements of a seismic trial as part of the Sound Source Verification (SSV) and Sound Source Characterization (SSC) components of the acoustic measurements study. Tables 20 and 21 present the maximum distances to 190, 180, 160, and 120 dB re 1 µPa threshold levels for each of the airgun source configurations. The distances obtained from measurements are based on the 90th percentile fits as described in Sections 3.1 and 3.2, and are the maxima over direction (broadside and endfire). The radius to the 190 dB re 1 µPa threshold for the 640 in^3 array was much larger than expected and exceeds the pre-season estimate by as much as 430%. In contrast, the 120 dB re 1 µPa threshold for the 640 in^3 array was the largest, but only 32% of the pre-season estimate.

Measured sound levels at close range tended to be higher than predicted by pre-survey modeling; the attenuation at longer ranges, however, was stronger than forecast and thus led to distant levels being lower than expected, particularly inside the barrier islands.

Table 22 presents the maximum distances to 160, 140, and 120 dB re 1 µPa threshold levels for each of the three vessels BP used to tow arrays. Pre-season modeling did not account for these

vessels. The distances to threshold levels are relatively short, influenced primarily by the propagation conditions, with the 120 dB re 1 µPa threshold for the *Margarita*, the only propeller driven vessel, being the largest at 1151 m.

Table 20. *Outside barrier islands:* Maximum threshold distances for the mitigation airgun and two airgun arrays. Distances are maximized over direction and environment and are based on the 90th percentile fits.

90% rms SPL Threshold (dB re 1 µPa)	Outside Barrier Islands, 90th Percentile Distance (m)		
	640 in^3	320 in^3	40 in^3
190	516	360	24
180	1386	1134	158*
160	4616	4265	1602
120	14 163	13 313	9 221

*Actual maximum range from measurements.

Table 21. *Inside barrier islands:* Maximum threshold distances for the mitigation airgun and 320 in^3 airgun array. Distances are maximized over direction and environment and are based on the 90th percentile fits except as noted.

90% rms SPL Threshold (dB re 1 µPa)	Inside Barrier Islands, 90th Percentile Distance (m)	
	320 in^3	40 in^3
190	260	138
180	472	293
160	1545	933
120	5 700*	3 242

*Based on pre-season model estimate (actual range from measurements was 2528 m).

Table 22. Maximum threshold distances for the three vessels. Distances are maximized over direction and environment and are based on the 90th percentile fits.

90% rms SPL Threshold (dB re 1 µPa)	90th Percentile Distance (m)		
	Resolution, Outside Islands	*Margarita*, Outside Islands	*Storm Warning*, Inside Islands
160	1*	8**	2†
140	7*	73	12†
120	61	1151	134

*Extrapolated from minimum measurement range of 14.3 m.
**Extrapolated from minimum measurement range of 15.5 m.
†Extrapolated from a minimum measurement range of 60 m on departure.

5.2. Monitoring (Dipping Hydrophone)

JASCO provided BP with a dipping hydrophone system, which was deployed by BP's marine mammal observer (MMO) contractor HDR Inc. No seismic pulses were detected in the recordings made by the system, and the levels were verified by the long-term AMAR recordings, which did not record pulses at matching times. These results show the shallow water environment inside the barrier islands severely attenuated pulses as they propagated through the sub-bottom and outside the barrier islands.

5.3. Monitoring (Long-Term)

JASCO used three Autonomous Multichannel Acoustic Recorders (AMARs) for long-term acoustic measurements over the entire seismic survey to determine the degree that the islands block seismic survey sound propagation.

By comparing the pulses between the single AMAR inside the islands with the two AMARs outside the islands, we found different results for sounds passing through the channel between the barrier islands and sounds passing directly through an island.

When the pulses travelled through the channel between islands, the pulse spectral density exceeded background levels at frequencies between 10 and 80 Hz, which demonstrated the islands prevented long-range high frequency sound propagation. The detected low frequency energy propagated through the sub-bottom and reradiated energy back into the water column.

When the pulses travelled through an island, the pulse spectral density exceeded background levels at frequencies between 10 and 30 Hz. The detected low frequency energy propagated through the sub-bottom and reradiated energy back into the water column. The transmission loss was significantly greater for this path than for pulses travelling through the channel between islands.

The seismic survey contributed to the acoustic environment, which raised the 95th percentile levels above the expected prevailing noise levels, bringing the 75th percentile level close to the expected prevailing noise levels. The point at which the survey moved from outside the islands to inside is noticeable in the spectrograms and 1/3-octave band level plots. It isn't possible to compare these results to normal ambient conditions in the region due to the recording period only encompassing the survey time.

5.4. Transmission Through Barrier Islands

A comprehensive program that included pre-season modeling, a comprehensive SSV—both inside and outside the barrier islands—long-range opportunistic recordings, and long-term distributed recorders, resulted in a detailed understanding of the sound propagation from the OBC survey sound sources.

One of the primary questions this study aimed to answer was the way in which sound from survey activities inside the barrier islands was transmitted through the islands and into Harrison Bay. The 320 in^3 airgun array was the loudest source within the barrier islands (Table 21). The pre-season modeling estimated that the 120 dB mitigation radius for this source was 5700 m. The SSV measured this threshold as 2528 m in the endfire direction, whereas the broadside results based on sound level measurements at a maximum distance of 1800 m suggested an extrapolated range of over 16 km, which is well outside the perimeter of the barrier islands. Such an extrapolation, however, would have been inconsistent with the propagation conditions beyond the localized deeper region where the receivers had been deployed; this led to us disregarding the broadside results when assessing the 120 dB threshold distance.

This early interpretation, based on the SSV results alone, was later validated by analyzing the long-range and long-term measurements. Analysis of the long-range measurements did not detect pulses, whereas the long-term measurement data from the AMARs showed that at approximately

6 km from the 320 in^3 airgun array, which was operating inside the barrier islands, the received levels outside the islands only reached a maximum of 100 dB (90% rms SPL). This corroborated the decision made at the time of the SSV analysis to recommend adopting the pre-season modeled threshold distance of 5700 m as a conservative estimate of the 120 dB threshold radius for a sound source inside the islands.

The outcome of this study confirmed the validity of using three complementary measurement techniques to investigate the estimates provided by pre-season modeling. Although not all results fully agreed with the nature of acoustic propagation in Simpson Lagoon, they did contribute to the knowledge obtained through diverse approaches of investigating sound sources by providing more information on the significant sound attenuation properties of the shallow bathymetry and the barrier islands for seismic survey pulses emitted within the lagoon.

Acknowledgements

The authors would like to thank Roberto Racca, Zizheng Li, Katherine Williams, and Holly Sneddon for contributing to the data analysis and editing of this report. Bill Streever from BP was a key contributor of insightful comments at various stages of the preparation of this report and his input is gratefully acknowledged.

Glossary

peak SPL

Maximum instantaneous sound pressure level, in a stated frequency band, within a stated time interval. Also referred to as zero-to-peak SPL. Unit, decibel (dB); symbol, L_{pk}.

peak-to-peak SPL

Difference between the maximum and minimum instantaneous sound pressure levels. Unit, decibel (dB); symbol, $L_{pk\text{-}pk}$.

rms

root mean square.

sound pressure level

See SPL.

SPL

sound pressure level. Ten times the logarithm to the base ten of the ratio of the time-mean-square pressure of a sound, in a stated frequency band, to the square of the reference pressure (ANSI S1.1-1994 R1999). Unit, decibel (dB); symbol, L_P. For sound in water, the reference sound pressure is one micropascal (1 μPa) and the unit for SPL is therefore written as "dB re 1 μPa".

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

where p^2 is the time-mean-square sound pressure and p_o = 1 μPa is the reference sound pressure.

zero-to-peak SPL

See peak SPL.

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Appendix A. Analysis

A.1. Ambient noise processing

Ambient sound levels at all recording stations were examined to document baseline underwater sound conditions. Ambient noise at each of these stations was analyzed by Hamming-windowed fast Fourier transforms (FFTs) with 1 Hz resolution and 50% window overlap. 120 FFTs performed this way were averaged to yield 1-min average spectra. These spectral density values (dB re 1 μPa^2·s) are output for each minute to the analysis XML file.

Ambient sound levels at each analyzed recording station are extracted for the entire deployment period from the XML files and are presented as follows:

- Spectrograms of the 1-min average spectra computed as described above.
- Spectral level percentiles:
    5. Histograms of each frequency bin for all 1-min data from each recorder were computed.
    6. The 5th, 25th, 50th, 75th, and 95th percentiles were plotted. The 95th percentile curve describes the frequency dependent levels exceeded by 5% of the 1-min averages. Equivalently, 95% of the 1-min spectral levels are below the 95th percentile curve.

The 50th percentile (median of 1-min spectral averages) can be compared to the well-known Wenz ambient noise curves shown in Figure 9. The Wenz curves show ranges of variability of ambient spectral levels as a function of frequency based on measurements worldwide over a range of weather, vessel traffic, and seismic conditions. The Wenz curve data are general and are used for approximate comparisons only.

The one minute averaged, 1 Hz spectral density levels are also summed over the 1/3-octave and decade bands to obtain one-minute broadband levels as dB re 1 μPa. These values are output to the XML files and then collapsed over the entire deployment to create a single CSV file for each recorder. These values are available to stakeholders on request. The third octave center frequencies are shown in Table 23

Table 23. Third octave bands.

Band	Nominal Center Freq.	Lower Frequency	Upper Frequency
1	10	8.9	11.2
2	13	11.6	14.6
3	16	14.3	17.9
4	20	17.8	22.4
5	25	22.3	28.0
6	32	28.5	35.9
7	40	35.6	44.9
8	51	45.0	57.2
9	64	57.0	71.8
10	81	72.0	90.9
11	102	90.9	114.4
12	128	114.1	143.7
13	161	143.4	180.7
14	203	180.8	227.9
15	256	228.0	287.4
16	323	287.7	362.6
17	406	362.7	455.7
18	512	456.1	574.7
19	645	574.6	723.9
20	813	724.2	912.6
21	1024	912.3	1149
22	1290	1150	1447
23	1625	1448	1824
24	2048	1824	2297
25	2580	2298	2896
26	3251	2896	3649
27	4096	3649	4597
28	5161	4598	5793
29	6502	5793	7298
30	8192	7298	9195
31	10321	9195	11585
32	13004	11585	14597

Appendix B

NMFS IHA

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

Incidental Harassment Authorization

BP Exploration (Alaska), Inc. (BP), P.O.Box 196612, 900 E. Benson Boulevard, Anchorage, Alaska 99519-6612, is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107 to take, by Level B harassment only, small numbers of marine mammals incidental to conducting an open-water ocean bottom cable (OBC) seismic survey in the Simpson Lagoon of the Alaskan Beaufort Sea, contingent upon the following conditions:

1. This Authorization is valid from July 1, 2012, through October 15, 2012.

2. This Authorization is valid only for activities associated with open-water OBC seismic surveys and related activities in the Beaufort Sea. The specific areas where BP's surveys will be conducted are within the Simpson Lagoon Area, Beaufort Sea, Alaska, as shown in Figure 1.2 of BP's 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*); minke whales (*Balaenoptera acutorostrata*); bearded seals (*Erignathus barbatus*); spotted seals (*Phoca largha*); ringed seals (*P. hispida*); and ribbon seals (*P. fasciata*).

(b) The authorization for taking by harassment is limited to the following acoustic sources and from the following activities:

(i) 640 in^3 airgun arrays for each of the two main source vessels;

(ii) 320 in^3 airgun array for one mini source vessels; and

(ii) Vessel activities related with the OBC seismic surveys.

(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).

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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. Prohibitions

(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) Seismic Operation Mitigation:

(i) Whenever a marine mammal is detected outside the exclusion zone radius and based on its position and motion relative to the ship track is likely to enter the exclusion radius, calculate and implement an alternative ship speed or track or de-energize the airgun array, as described in condition 6(a)(iv) below.

(ii) Exclusion Zones:

(A) Establish and monitor with trained PSOs a preliminary exclusion zone for cetaceans surrounding the airgun array on the source vessel where the received level would be 180 dB re 1 μPa rms. For purposes of the field verification test, described in condition 7(b), this radius is estimated to be 750 m (2,460 ft) from the seismic source for the 640 in^3 airgun arrays, 480 m (1,574 ft) for the 320 in^3 airgun array, and 59 m (194 ft) for a single 40 in^3 airgun for surveys conducted inside barrier islandss; and 950 m (3,116 ft) for 640 in^3 airgun arrays and less than 50 m (164 ft) for a single 40 in^3 airgun for surveys conducted outside barrier islandss.

(B) Establish and monitor with trained PSOs a preliminary exclusion zone for pinnipeds surrounding the airgun array on the source vessel where the received level would be 190 dB re 1 μPa rms. For purposes of the field verification test described in condition 7(b), this radius is estimated to be 310 m (1,017 ft) from the seismic source for the 640 in^3 airgun arrays, 160 m (525 ft) for the 320 in^3 airgun array, and 16 m (53 ft) for the single 40 in^3 airgun for surveys conducted inside barrier islandss; and 120 m (394 ft)

for 640 in^3 airgun arrays and less than 50 m (164 ft) for a single 40 in^3 airgun for surveys conducted outside barrier islands.

(C) A 120-dB vessel monitoring zone for four or more bowhead cow/calf pairs will be established and monitored after August 25, 2012, from monitoring vessel outside the barrier islands during all daytime seismic surveys, as described in 7(a)(iv) below. For purposes of the field verification test described in condition 7(b), this radius is estimated to be 6,400 m (20,992 ft) from the seismic source for the 640 in^3 airgun arrays, 5,700 m (18,700 ft) for the 320 in^3 airgun array, and 3,700 m (12,140 ft) for the single 40 in^3 airgun for surveys conducted inside barrier islands.

(D) Immediately upon completion of data analysis of the field verification measurements required under condition 7(b) below, the new 180-dB and 190-dB marine mammal exclusion zones shall be established based on the sound source verification.

(iii) Ramp-up:

(A) A ramp up, following a cold start, 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) Ramp up procedures from a cold start shall be delayed if a marine mammal is sighted within the exclusion zone during the 30-minute period prior to the ramp up. The delay shall last until the marine mammal(s) has been observed to leave the exclusion zone or until the animal(s) is not sighted for at least 15 or 30 minutes. The 15 minutes applies to small toothed whales and pinnipeds, while a 30 minute observation period applies to baleen whales and large toothed whales.

(C) A ramp up, following a shutdown, can be applied if the marine mammal(s) for which the shutdown occurred has been observed to leave the exclusion zone or until the animal(s) is not sighted for at least 15 minutes (small toothed whales and pinnipeds) or 30 minutes (baleen whales and large toothed whales).

(D) 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. 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.

(E) The seismic operator and PSOs shall maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

(iv) Power-down/Shutdown:

(A) The airgun array shall be immediately powered down (reduction in the number of operating airguns such that the radii of exclusion zones are decreased) 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, ramp up to 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) Whenever more than four or more bowhead cow/calf pairs are observed within or entering the 120 dB disturbance zone the lead PSO on monitoring vessel will immediately contact the lead PSO on the source vessel, who will ensure prompt implementation of airgun power downs or shut-downs.

(F) Airgun activity shall not resume until the marine mammal has cleared the exclusion zone of the full array. The animal will be considered to have cleared the exclusion zone as described above under ramp up procedures.

(iv) Poor Visibility Conditions:

(A) If during foggy conditions, heavy snow or rain, or darkness, the full 180 dB exclusion zone is not visible without using vessel lights, night vision devices, and/or forward looking infrared, 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, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.

(C) Airguns shall not be fired during long transits when exploration activities are not occurring, including the common firing of one airgun (also referred to as the "mitigation gun" in past IHAs). This does not apply to turns when starting a new track line.

(b) Vessel and Helicopter Movement Mitigation:

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

(ii) Transit and cable laying vessels shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any barge or transit 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.

(F) Reducing vessel speed to less than 9 knots when weather conditions reduce visibility.

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

(iv) In the event that any aircraft (such as helicopters) are used to support the planned survey, the mitigation measures below would apply:

(A) Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 feet above sea level (ASL) when within 0.3 mile (0.5 km) of groups of whales.

(B) Helicopters shall not hover or circle above or within 0.3 mile (0.5 km) of groups of whales.

(c) Mitigation Measures for Subsistence Activities:

(i) No seismic surveys with airgun operations shall be conducted within the barrier islands before July 25, 2012; and no airgun operations shall be conducted in the area north of the barrier islands after 25 August, 2012;

(ii) Fully implement the following measures, consistent with the 2012 Conflict Avoidance Agreement (CAA) and Plan of Cooperation (COP), in order to avoid having an unmitigable adverse impact on the availability of marine mammal species or stocks for taking for subsistence uses:

(A) For the purposes of reducing or eliminating conflicts between subsistence whaling activities and BP's survey program, the holder of this Authorization will participate with other operators in the Communication and Call Centers (Com-Center) Program. The Com-Centers will be operated 24 hours/day during the 2012 fall subsistence bowhead whale hunt.

(B) BP shall routinely call the Com-Center according to the established protocol in the CAA while in the Beaufort Sea.

(C) 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.

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

(E) Post-season Review: Following the end of the fall 2012 bowhead whale subsistence hunt and prior to the 2013 pre-season introduction meetings, BP shall offer to the Alaska Eskimo Whaling Commission (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 stations on BP's 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 2012 Beaufort Sea open-water season, unless it is agreed by

all designated individuals or their representatives that such a meeting is not necessary.

7. Monitoring:

(a) Vessel Monitoring:

(i) The holder of this Authorization must designate biologically-trained, on-site individuals (PSOs) to be onboard the source vessel and monitoring vessels outside the barrier islands, who are approved in advance by NMFS, to conduct the visual monitoring programs required under this Authorization and to record the effects of seismic surveys and the resulting noise on marine mammals.

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

(B) Crew leaders and most other biologists serving as observers in 2012 will 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.

(C) PSOs shall complete a two or three-day training session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2012 open-water season. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs. A marine mammal observers' handbook, adapted for the specifics of the planned survey program will be reviewed as part of the training.

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

(E) Crew members should 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 rampdown or shutdown if a marine mammal enters the safety zone (or exclusion zone).

(F) If crew members 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.

(G) 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.

(H) BP shall train its PSOs to follow a scanning schedule that consistently distributes scanning effort according to the purpose and need for observations. For example, the schedule might call for 60% of scanning effort to be directed toward the near field and 40% at the far field. All PSOs should follow the same schedule to ensure consistency in their scanning efforts.

(I) 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.

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

(iii) Monitoring is to be conducted by the PSOs onboard the active seismic vessel, to (A) ensure that no marine mammals enter the appropriate exclusion zone whenever the seismic acoustic sources are on, and (B) to record marine mammal activity as described in condition 7(a)(vii) below. Two PSOs will be present on each seismic source vessel. At least one PSO shall monitor for marine mammals at any time during daylight hours.

(iv) Monitoring vessel based surveys outside the barrier islands will be conducted up to 3 days per week, weather depending, after August 25, 2012, and continue until the end of the data acquisition period. One PSO will be present on the monitoring vessel. The monitoring effort will be aided by the skipper of the monitoring vessel.

(v) At all times, the crew must be instructed to keep watch for marine mammals. If any are sighted, the bridge watch-stander must immediately notify the PSO(s) on-watch. If a marine mammal is within or closely approaching its designated exclusion zone, the seismic acoustic sources must be immediately powered down or shutdown (in accordance with condition 6(a)(iv) above).

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

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

(viii) Monitoring shall consist of recording: (A) the species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals seen near the seismic vessel and/or its airgun array (e.g., none, avoidance, approach, paralleling, etc); (B) the time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at (I) any time a marine mammal is sighted (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, bearing, distance, heading, speed and activity of the other vessel(s); (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.

(ix) BP shall work with its observers to develop a means for recording data that does not reduce observation time significantly.

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

(xi) 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 ("Generation 3") when needed.

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

(xiii) Night-vision equipment (Generation 3 binocular image intensifiers, or equivalent units) shall be available for use during low light hours.

(xiv) 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.

(xv) Additional details about unidentified marine mammal sightings, such as "blow only", mysticete with (or without) a dorsal fin, "seal splash", etc., shall be recorded.

(xvi) PSOs on monitoring vessel outside barrier islands shall also monitor for the presence and behavior of marine mammals in the offshore area projected to be exposed to seismic sounds.

(b) Sound Source Verification: Using a hydrophone system, the holder of this Authorization is required to conduct sound source verification tests for seismic airgun array(s) and vessels that are involved in the OBC seismic surveys.

(i) Sound source verification shall consist of distances where broadside and endfire directions at which broadband received levels reach 190, 180, 170, 160, and 120 dB re 1 μPa (rms) 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.

(ii) The test results shall be reported to NMFS within 5 days of completing the test.

(c) Acoustic Monitoring:

(i) BP shall use the offshore monitoring vessel to monitor (periodically) the propagation of airgun sounds from within the lagoon into offshore areas during its marine mammal survey using a dipping hydrophone.

(ii) BP shall use additional acoustic monitoring with bottom mounted recorders to verify noise propagation model results. Recorders shall be deployed throughout the entire duration of the seismic survey.

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) Water depth should be continuously recorded by the vessel and for each marine mammal sighting. Water depth should be accounted for in the analysis of take estimates.

(c) BP shall be very clear in their report about what periods are considered "non-seismic" for analyses.

(d) BP shall examine data from Bowhead Whale Aerial Survey Program and other such programs to assess possible impacts from their seismic survey.

(e) 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 and comprehensive reports 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.

(f) To help evaluate the effectiveness of PSOs and more effectively estimate take, if appropriate data are available, BP shall perform analysis of sightability curves (detection functions) for distance-based analyses.

(g) To better understand the potential effects of oil and gas activities on marine mammals and to facilitate integration among companies and other researchers, the following data should be obtained and provided electronically in the 90-day report:

(i) the location and time of each aerial or 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, drilling ship, support ship, 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's ability to detect marine mammals); and

(v) adjustments made to operating procedures.

(h) BP should improve take estimates and statistical inference into effects of the activities by incorporating the following measures:

(i) Reported results from all hypothesis tests should include estimates of the associated statistical power when practicable.

(ii) Estimate and report uncertainty in all 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.

9. Reporting:

(a) Sound Source Verification Report: A report on the preliminary results of the sound source verification measurements, including the measured 190, 180, 160, and 120 dB (rms) radii of the airgun sources, 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) 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 BP's 2012 open water OBC seismic surveys in the Beaufort Seas. 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) to better assess impacts to marine mammals, data analysis should be separated into periods when a seismic 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 should include estimates of the associated statistical power when practicable.

(vii) estimate and report uncertainty in all 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 level of actual estimated takes.

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

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), BP shall immediately cease survey operations and immediately report the incident to the Supervisor of 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 BP to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. BP may not resume their activities until notified by NMFS via letter, email, or telephone.

(b) In the event that BP 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), BP 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 BP to determine whether modifications in the activities are appropriate.

(c). In the event that BP 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), BP 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. BP shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. BP 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 Conflict Avoidance Agreement and 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. BP is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion.

Helen Golde, Acting Director
Office of Protected Resources
National Marine Fisheries Service

JUN 29 2012
Date

Table 1. Species/stocks and numbers of marine mammals allowed to be taken incidental to under this IHA.

Species / Stocks	Take Allowed
Beluga whale / Eastern Chukchi Sea	50
Killer whale / Aleutian Islands & Bering Sea transient	3
Harbor porpoise / Bering Sea	3
Bowhead whale / Bering-Chukchi-Beaufort Sea	37
Gray whale / Eastern North Pacific	3
Minke whale / Alaska	2
Bearded seal / Alaska	17
Ribbon seal / Alaska	3
Ringed seal / Alaska	111
Spotted seal / Alaska	20

Appendix C

USFWS LOA

United States Department of the Interior

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

IN REPLY REFER TO:

AFES/MMM

JUL 16 2012

Ms. Allison Erickson
Wildlife Compliance Authority
BP Exploration (Alaska), Inc.
900 East Benson Boulevard
Anchorage, Alaska 99519-6612

Dear Ms. Erickson:

We have received your February 21, 2012, request for Letters of Authorizations (LOAs) for the incidental take of polar bears and Pacific walrus and the intentional take of polar bears in regards to the BP Exploration (Alaska), Inc. (BPXA) 2012 Simpson Lagoon Seismic Survey in the Beaufort Sea.

In response, enclosed is LOA 12-16 that will allow BPXA to take small numbers of polar bears and Pacific walrus incidental to oil and gas industry activities at the location identified in your LOA request. The proposed start date for this project is mid July 2012, with operations completed by mid-October 2012. All provisions contained within BPXA's "*Request for Letters of Authorization Pursuant to 50 CFR 18, Subpart J and Section 101(A)(5) and Sections 101(a)(4)(A), 109(h), and 112(c) of the Marine Mammal Protection Act (MMPA) for Incidental Take and Take by Harassment (Deterrent Activities) of Polar Bears and the Pacific Walrus during 2012 Simpson Lagoon Seismic Survey*" are incorporated by reference into this LOA.

An additional requirement of this LOA is for BPXA to provide observational data of polar bears and Pacific walruses throughout the project and a complete report of all observations at the conclusion of the project to document take. This final report must be provided to the Marine Mammals Management Office (MMM) within 90 days after completion of the project.

Furthermore, this letter includes a harassment authorization (12-INT-13), where BPXA and its representatives are granted authorization to take polar bears by harassment (deterrent activities) for the protection of both human life and polar bears while conducting activities in polar bear habitat outside BPXA oilfield operating units. Within BPXA operating units, deterrence activities will be conducted under the existing BPXA LOA 12-INT-01. This LOA is issued specifically to BPXA employees who are responsible for ensuring that trained and qualified personnel are assigned the task to harass (deter) polar bears. It is the responsibility of BPXA personnel to report all polar bear harassment events to the MMM within 24 hours. This LOA is effective from the date of issuance to October 31, 2012. Intentional take is authorized under Sections 101 (a)(4)(A), 109(h), and 112(c) of the Marine Mammal Protection Act.

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Polar bear conservation has benefited from monitoring programs associated with the Incidental Take program since 1993. Monitoring serves to assess the effect of industrial activities on polar bears by evaluating bear encounter rates, take frequency, as well as the location and timing of encounters. If questions or concerns arise during the project period, U.S. Fish and Wildlife Service (Service) biologists are available for consultation at the phone numbers listed below and noted in your Interaction Plan (*Polar Bear Interaction Plan for the Operating Units – Revision Date: September 26, 2011*).

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 appropriate LOA(s).

The Service has completed intra-Service consultation under the Endangered Species Act of 1973, as amended (ESA), on the issuance of this LOA and has determined that the issuance this LOA to BPXA is not likely to jeopardize the continuing existence of the polar bear or the Pacific walrus and is not likely to destroy or adversely modify polar bear critical habitat. 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: Mr. Richard Shideler, Alaska Department of Fish and Game
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 Service

LETTER OF AUTHORIZATION
(12-16)

ISSUED: July 16, 2012
EXPIRES: October 31, 2012

BP Exploration (Alaska), Inc. (BPXA) is hereby authorized to take small numbers of polar bears and Pacific walruses (walruses) incidental to activities occurring during BPXA's 2012 Simpson Lagoon Seismic Survey in the Beaufort Sea. BPXA proposes to conduct a three-dimensional ocean bottom cable seismic survey with a transition zone component in the Simpson Lagoon area, Beaufort Sea, during the open water period. Anticipated duration of seismic data acquisition is approximately 50 days, depending on weather and other circumstances. The project area encompasses approximately 110 mi^2 (~285 km^2) in Simpson Lagoon, Beaufort Sea, Alaska. About 46 mi^2 (~120 km^2) (41.8%) of the survey area is located inside the barrier islands in water depths of 0 to 9 ft ~1 to 3 m), and 36 mi^2 (~93 km^2) (32.7%) outside the barrier islands in water depths of 3 to 45 ft (~1 to 16 m). The remaining 28 mi^2 (~73) (25.5%) of the survey area is located on land (onshore and barrier island), which is solely being used for deployment of the receivers.

This U.S. Fish & Wildlife Service (Service) authorization and the required conditions below apply to all employees, contractors, and personnel performing BPXA approved work under the scope of operations to be conducted. This authorization stipulates the following conditions:

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

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

3. The following BPXA documents are hereby approved, and all provisions unless specifically noted are incorporated into this authorization by reference all provisions must be complied with unless specifically noted otherwise in this LOA:

   (a) The Polar Bear Interaction Plan "*Polar Bear Interaction Plan for the Operating Units – Revision Date: September 26, 2011*" and "*Appendix A; Polar Bear Interaction*

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Plan for Helicopter and Vessel supported Island and Onshore Activities during the Simpson Lagoon Seismic Survey;"

(b) The Marine Mammal Monitoring and Mitigation Plan (Section 2, Mitigation and Monitoring Plans for Offshore Vessel-based Activities in "*Request for Letters of Authorization Pursuant to 50 CFR 18, Subpart J and Section 101(A)(5) and Sections 101(a)(4)(A), 109(h), and 112(c) of the Marine Mammal Protection Act (MMPA) for Incidental Take and Take by Harassment (Deterrent Activities) of Polar Bears and the Pacific Walrus during 2012 Simpson Lagoon Seismic Survey*").

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

5. This authorization is valid only for those activities and locations identified in the request for a Letter of Authorization dated February 21, 2012, for the Beaufort Sea and described in the "*Request for Letters of Authorization Pursuant to 50 CFR 18, Subpart J and Section 101(A)(5) and Sections 101(a)(4)(A), 109(h), and 112(c) of the Marine Mammal Protection Act (MMPA) for Incidental Take and Take by Harassment (Deterrent Activities) of Polar Bears and the Pacific Walrus during 2012 Simpson Lagoon Seismic Survey*"

6. Polar bear and walrus monitoring, reporting, and survey activities must be conducted in accordance with 50 CFR Section 18.128 and must comply with the following monitoring, mitigation, and reporting requirements:

   a. BPXA must cooperate with the Service, and other designated Federal, State, or local agencies to monitor the impacts of oil and gas exploration activities on polar bears and walruses.

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

   c. Avoid concentrations or groups of walruses and individuals or groups of polar bears hauled out onto land or ice by all vessels under the management of BPXA. Operators of vessels should, at all times, conduct their activities at the maximum distance possible from known or observed concentrations of marine mammals. Under no circumstances, other than an emergency, should vessels operate within 800 meters (0.5 mile) of walruses or polar bears observed on land or ice.

   d. Take every precaution to avoid encroachment upon or harassment of walruses or polar bears in water when a vessel is operated near these animals. Maintain an 800 meter (0.5 mile) distance, when practicable. Vessels must reduce speed and steer around walruses or polar bears observed in water when able to do so. Vessels may not be operated in such a way as to separate members of a group of

walruses or polar bears from other members of the group. Vessels will avoid multiple changes in direction and speed when walruses or polar bears are present.

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

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

g. BPXA must designate a qualified individual or individuals as Marine Mammal Observers (MMO) to observe, record, and report the effects of project activities on polar bears and walruses to the Service, MMM within 24 hours of visual observation. All evidence of polar bears and walruses, such as tracks, carcasses, or haul out sites, if applicable, will also be reported.

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

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

- ice condition, provide: 1) estimated % ice cover in vicinity of sighting (10% increments), 2) estimated distance to pack ice (km, mi, or nm);

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

xvi. MMO comments or notes.

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

8. At the discretion of the Service, BPXA must allow the Service to place an observer on site, including any facilities, vessels, aircraft or vehicles, to monitor the impacts of the activity on marine mammals, when requested.

9. BPXA must submit an annual monitoring report to the Service, MMM as required under 50 CFR 18.128(f), a draft of which will be received by MMM no later than 90 days after completion of the project. The report will describe in detail:

   a. The operations that were conducted;
   b. The methods, results, and interpretation pertaining to all monitoring tasks;
   c. The results of the 2012 shipboard marine mammal monitoring;
   d. Marine mammal sightings (species, numbers, dates, times and locations, age/size/gender, environmental correlates, activities, associated survey activities);
   e. Estimates of the amount and type of potential take (exposure) of walruses and polar bears (by species) to project activities;
   f. An analysis of the effects of operations (e.g., on sighting rates, sighting distances, behaviors, movement patterns of walruses and polar bears);
   g. An analysis of factors influencing detectability of walruses and polar bears during project operations;
   h. Summaries of communications with hunters and potential effects on subsistence uses.

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

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

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

13. The Service has completed intra-Service consultation under the Endangered Species Act of 1973, as amended (ESA), on the issuance of this LOA and has determined that the issuance this LOA to BPXA is not likely to jeopardize the continuing existence of the polar bear or the Pacific walrus and is not likely to destroy or adversely modify polar bear critical habitat. Issuance of this LOA also completes ESA requirements for authorization of incidental take of the polar bear. Compliance with the terms and conditions of this LOA ensures that the LOA holder is also in compliance with the ESA. No additional authorization under the ESA is required.

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

Acting Chief, Marine Mammals Management

JUL 16 2012

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

U.S. Fish and Wildlife Service

AUTHORIZATION TO TAKE, BY HARASSMENT, POLAR BEARS 12-INT-13

ISSUED: July 16, 2012
EXPIRES: October 31, 2012

Under Sections 101 (a)(4)(A), 109(h), and 112(c) of the Marine Mammal Protection Act of 1972, as amended (MMPA), BP Exploration (Alaska) Inc. (BPXA) is authorized to take, by harassment, polar bears during slope-wide activities the during BPXA's 2012 Simpson Lagoon Seismic Survey in the Beaufort Sea.

The purpose of authorizing taking by harassment, or deterrence, is to maintain human and bear safety and welfare in the North Slope oilfields. Authorizing Level B harassment take reduces the likelihood of death or injury of polar bears. This is accomplished by the following objectives:

- Prevent bears from associating food with humans and facilities.
- "Condition" bears to avoid people (avoidance conditioning).
- Allow bears to use travel routes (natural and man-made) to move along the coast.
- Prevent bears from extended use of areas around facilities.
- Prevent bears from entering the developed parts of the oilfield.

This harassment authorization is subject to the following conditions:

1. The Polar Bear Interaction Plan "*Polar Bear Interaction Plan for the Operating Units – Revision Date: September 26, 2011*" and "*Appendix A; Polar Bear Interaction Plan for Helicopter and Vessel supported Island and Onshore Activities during the Simpson Lagoon Seismic Survey*," is approved and all provisions, unless noted specifically, are incorporated into this Letter of Authorization (LOA) by reference. A copy of the Polar Bear Interaction Plan must be available on site for all personnel.

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

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3. This LOA is restricted to harassment activities and is valid only for those activities identified in the request for an LOA dated February 21, 2012, for the 2012 Simpson Lagoon Seismic Survey.

4. Authorized individuals are responsible for documenting and reporting to the U.S. Fish and Wildlife Service, Marine Mammals Management Office (Service-MMM), at (907) 786-3800, all instances involving harassment activities as soon as possible and not later than 24 hours after the occurrence.

5. BPXA is responsible for ensuring that trained and qualified personnel are assigned the task of deterring polar bears.

   - Shotguns may not be used as a deterrent tool until further notice. Hazing tools other than shotguns, such as vehicles and auditory tools (horns and sirens), may be used until such time as use of shotguns for intentional take is approved.

   - If necessary, shotguns may be used as a mechanism for lethal take under Section 101(c) of the MMPA. Without specific authorization, the lethal take of a polar bear is warranted if such taking is imminently necessary for self-defense or to save the life of a person in immediate danger, and such taking is reported to the Service-MMM within 24 hours.

6. BPXA will not conduct activities that operate nor pass within one mile (approximately 1600 meters) of known polar bear dens, and all observed dens will be reported to the Service-MMM immediately. Should occupied dens be identified within one mile of activities, work in the immediate area will cease and BPXA will contact the Service-MMM for guidance. The Service-MMM will evaluate these instances on a case-by-case basis to determine the appropriate action. Potential responses may range from cessation or modification of work to conducting additional monitoring. BPXA must comply with any additional measures specified. Polar bear den detection surveys may be required prior to BPXA beginning operations.

7. A final report of all encounters and hazing events must be submitted to the Service-MMM within 60 days from the expiration date of this authorization.

8. Hazing techniques must not cause the injury or death of a bear. Types of hazing techniques may include, but are not limited to:

   - Bear Monitors.
   - Air horns.
   - Electric fences.
   - Chemical repellents.
   - Acoustic recordings.
   - Vehicles.

9. Prior to conducting a harassment activity, operators must:

- Make a reasonable effort to reduce or eliminate attractants.
- Secure site; notify supervisor; move personnel to safety.
- Ensure bear has escape route(s).
- Ensure communication with all personnel.

10. When conducting a harassment activity, operators must:

- Chose the method that will have the least effect on the bear and increase the intensity of the method or use additional methods only if necessary.
- Shout at the bear before using a repellent.
- Move bear in proper direction; continuing with minimally necessary deterrents to receive desired result.

11. After a harassment event has occurred, operators must:

- Monitor bear's movement (to ensure no return).
- Notify supervisor and personnel when it is safe to resume work.
- Fill out report to be sent to the Service as required under condition number four, above, (within 24 hours).

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

Acting Chief, Marine Mammals Management

JUL 16 2012
Date

Appendix D

Conflict Avoidance Agreement

2012 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.
SHELL OFFSHORE, INC

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

FINAL FOR SIGNATURE
MARCH 1, 2012

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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.

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, 2012.

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 2012 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.

(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.

(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 2012 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 2012 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 2012 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 2012 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 2012 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 2012 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 2012 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 2012 Chukchi Sea Open Water Season and prior to the 2013 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 2012 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 2012 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 2012 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 2012 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, 2012, 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 2012 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 2012 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 2012 fall bowhead subsistence whale hunting season shall be completed no later than August 15, 2012. 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 2012 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, 2012, 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, Jim Croak, will be stationed at Northstar Island and will be available by telephone at the above number.

(3) ENI's Local Representative

Hans Neidig (907) 865-3314

(4) Exxon Mobil's Local Representative

TBD

(5) GX Technology's Local Representative

Ed Nelson (832) 344-6852

(6) 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.

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

JOHN MAKETA 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.

(8) STATOIL's Local Representative

TBD

(9) 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).

(10) 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).

(11) 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.

(12) 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).

(13) 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).

(14) 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.

(15) The Village of Kivilina

For the purposes of this Agreement, the individuals to contact for the Village of Kivilina will be: _____.

(16) The Village of Little Diomede

For the purposes of this Agreement, the individuals to contact for the Village of Little Diomede will be: _____.

(17) The Village of Wales

For the purposes of this Agreement, the individuals to contact for the Village of Wales will be: _____.

(18) The Village of Savoonga

For the purposes of this Agreement, the individuals to contact for the Village of Savoonga will be: _____.

(19) The Village of Gambell

For the purposes of this Agreement, the individuals to contact for the Village of Gambell will be: _____.

(20) 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 (12) twelve boats for subsistence whale hunting during the late summer and fall of 2012.

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

The subsistence whaling crews of the Village of Kaktovik plan to use (8) eight boats for subsistence whale hunting during the late summer and fall of 2012.

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

The subsistence whaling crews of the Village of Barrow plan to use (40) forty boats for subsistence whale hunting during the late summer and fall of 2012.

(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 2012.

(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 (10) ten boats for subsistence whale hunting during the late fall of 2012.

(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 2012.

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, TRANSIT, AND CABLE LAYING VESSEL OPERATIONS

SECTION 301. IN GENERAL.

A Participant may employ barges, transit, or cable laying vessels to transport materials or lay cable 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, Transit or Cable Laying 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, transit, or cable laying 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, Transit, and Cable Laying Vessels.

(1) All barge, transit, and cable laying 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.

(d) Vessel Speeds.

Barge. transit, and cable laying 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, 2012.

(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 identify, 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 2012 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 2012 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 2012/2013. The results of this workshop will be presented at the 2013 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.

(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.[1] 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[2]

(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.

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.

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[1] 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.

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

(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,[3] 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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[3] 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.

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 2012, 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, 2012. 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, 2012 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.

(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: _____

_____
Joseph Kaleak
AEWC Commissioner for Kaktovik
Dated: _____

_____
Raymond Hawley
AEWC Commissioner for Kivalina
Dated: _____

_____
Ronald Ozenna, Jr.
AEWC Commissioner for Little Diomede
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: _____

_____
George Noongwook
AEWC Commissioner for Savoonga
Dated: _____

_____
John Hopson, Jr.
AEWC Commissioner for Wainwright
Dated: _____

_____
Luther Komonaseak
AEWC Commissioner for Wales
Dated: _____

Name:
BP Exploration (Alaska) Inc.
Dated: 3/27/2012

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: _____

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 E

Comm-Log

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/4/2012	0:07	Rex Okakok	Margarita	70 32.72	149 51.76	1	Midnight call in, no one answered. Shooting lines
8/4/2012	12:03	Willow Leedy	Margarita	70 30.65	149 39.19	0	At anchor, Margarita and Storm Warning are at the dock at F-Pad
8/4/2012	17:08	Willow Leedy	Margarita	70 32.58	149 44.95	4.6	Call in for Seismic line shooting
8/5/2012	1:03	Rex Okakok	Margarita	70 32.66	149 47.01	0	Midnight call in, no one answered.
8/5/2012	11:57	Willow Leedy	Margarita	70 30.68	149 39.34	0	At anchor making repairs. Will update when seismic begins
8/5/2012	12:12	Willow Leedy	Margarita	70 31.21	149 40.75	5	Started seismic activity inside the islands
8/6/2012	0:03	Rex Okakok	Margarita	70 35.25	149 40.03	3.4	Midnight call in, no answer. Outside barrier islands, line shooting
8/6/2012	12:06	Willow Leedy	Margarita	70 30.58	149 39.44	0	Repairs starting seismic shooting soon
8/6/2012	16:13	Willow Leedy	Margarita	70 34.40	149 45.00	3.7	Begin seismic survey
8/7/2012	9:16	Willow Leedy	Margarita	70 34.77	149 42.71	3.3	Starting seismic surveying
8/7/2012	12:00	Willow Leedy	Margarita	70 34.21	149 30.41	0.8	Continuing seismic surveying
8/7/2012	15:35	Willow Leedy	Margarita	70 34.30	149 35.96	2	Finished seismic survey
8/8/2012	12:03	Willow Leedy	Margarita	70 30.53	149 38.90	0	At anchor, will start seismic surveying in an hour
8/8/2012	14:44	Willow Leedy	Margarita	70 33.34	149 36.74	3.7	Began seismic surveying
8/9/2012	0:10	JoAnn Ahootchook	Margarita	70 33.49	149 47.16	3.7	Midnight call in, no answer.
8/9/2012	1:04	Rex Okakok	Margarita	70 34.03	149 34.71	3.4	Midnight call, no answer. Shooting outside barrier island
8/9/2012	12:20	Rob Swanson	Margarita	70 34.69	149 32.41	3.7	Seismic shooting underway for next six hours
8/9/2012	18:00	Rob Swanson	Margarita	70 34.37	149 44.76	7.4	stopped seismic, returning to F-Pad
8/10/2012	10:05	Matrona Fortner	Margarita	70 34.87	149 34.9	3.9	Conducting seismic activity
8/10/2012	15:05	Matrona Fortner	Margarita	70 33.97	149 28.39	1	Headed back to F-Pad
8/11/2012	9:44	Rob Swanson	Margarita	70 36.15	149 48.00	4.1	Seismic shooting underway unitl end of shift.
8/11/2012	18:43	Matrona Fortner	Margarita	70 30.59	149 39.50	2.1	Heading to dock
8/12/2012	6:01	Matrona Fortner	Margarita	70 30.61	149 39.35	0	At anchore, under repair
8/12/2012	12:15	Rob Swanson	Margarita	70 30.61	149 39.35	0	At anchore, under repair

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/13/2012	6:10	JoAnn Ahootchook	Margarita	70 30.56	149 39.50	0	6AM call in. Information relayed to com center
8/13/2012	12:08	Matrona Fortner	Margarita	70 36.11	149 39.30	1.2	Waiting fror recorder to tell us which line.
8/13/2012	14:00	Matrona Fortner	Margarita	70 36.42	149 35.58	2.4	Start seismic activity
8/13/2012	18:03	Matrona Fortner	Margarita	70 31.02	149 40.35	0	Completed operations at F-Pad
8/14/2012	6:06	JoAnn Ahootchook	Margarita	70 32.10	149 44.10	6.7	6AM call in. Information relayed to com center
8/14/2012	12:00	Matrona Fortner	Margarita	70 34.52	149 32.79	3.3	Line shooting
8/14/2012	18:23	Matrona Fortner	Margarita	70 31.68	149 41.13	6.1	Headed to F-Pad
8/15/2012	11:58	Matrona Fortner	Margarita	70 33.25	149 50.87	3.6	Seismic activity
8/15/2012	18:03	Matrona Fortner	Margarita	70 31.78	149 46.92	7.4	Headed back to F-Pad
8/16/2012	13:31	Matrona Fortner	Margarita	70 34.53	149 49.15	3.4	Headed back to F-Pad due to repair issues
8/17/2012	12:42	Matrona Fortner	Margarita	70 33.59	149 47.09	4.8	Seismic activity
8/17/2012	18:21	Matrona Fortner	Margarita	70 31.91	149 42.44	6.9	Headed back to F-Pad for crew change
8/18/2012	12:28	Matrona Fortner	Margarita	70 32.27	149 26.09	4.9	Seismic activity inside island
8/18/2012	17:57	Matrona Fortner	Margarita	70 30.61	149 39.41	0	Headed to F-Pad
8/19/2012	0:21	JoAnn Ahootchook	Margarita	70 34.51	149 49.27	3.6	12AM call in exchanged information
8/19/2012	12:00	Sigmond Patterson	Margarita	70 34.43	149 37.45	3.4	Seismic activity outside islands
8/19/2012	18:00	Sigmond Patterson	Margarita	70 33.10	149 45.43	5.7	On transit back to the dock for crew change
8/20/2012	12:00	Sigmond Patterson	Margarita	70 36.45	149 33.73	3.4	Production
8/20/2012	18:06	Sigmond Patterson	Margarita	70 34.30	149 37.45	7.4	Back to the dock
8/21/2012	0:04	JoAnn Ahootchook	Margarita	70 36.39	149 33.53	2.2	12AM call in. Gave them our information
8/21/2012	5:59	JoAnn Ahootchook	Margarita	70 31.60	149 49.01	8	6AM call in. Gave them our information
8/21/2012	12:00	Sigmond Patterson	Margarita	70 30.55	149 39.49	0	Anchored at dock
8/21/2012	18:15	Sigmond Patterson	Margarita	70 31.11	149 40.87	6.6	To dock for crew change
8/22/2012	0:36	JoAnn Ahootchook	Margarita	70 31.11	149 40.81	4	12AM call in. No answer
8/23/2012	0:06	JoAnn Ahootchook	Margarita	70 32.66	149 48.19	2.4	12AM call in. Gave them our information
8/23/2012	6:04	JoAnn Ahootchook	Margarita	70 30.69	149 41.83	0.4	6AM call in. Gave them our information
8/23/2012	12:00	Sigmond Patterson	Margarita	70 31.89	149 48.54	1.5	Line shootinh

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/23/2012	17:53	Sigmond Patterson	Margarita	70 30.55	149 39.49	0	Inactive
8/24/2012	12:00	Sigmond Patterson	Margarita	70 31.63	149 48.03	3.1	Line shooting
8/24/2012	18:00	Sigmond Patterson	Margarita	70 32.12	149 43.31	7	On transit to dock
8/25/2012	0:11	JoAnn Ahootchook	Margarita	70 32.90	149 33.03	3.7	12AM call in. Gave them our information
8/25/2012	6:09	JoAnn Ahootchook	Margarita	70 30.50	149 37.69	1.2	6AM call in. Gave them our information
8/25/2012	12:00	Sigmond Patterson	Margarita	70 31.96	149 32.11	2.9	Line shooting
8/26/2012	0:06	JoAnn Ahootchook	Margarita	70 32.04	149 28.14	4.3	12AM call in. Gave them our information
8/26/2012	12:00	Sigmond Patterson	Margarita	70 32.43	149 30.97	2.5	Continue with production
8/26/2012	17:55	Sigmond Patterson	Margarita	70 30.55	149 39.49	0	Anchored at dock
8/26/2012	20:19	Chad Johnson	Margarita	70 31.03	149 41.53	1.5	Line shooting
8/27/2012	2:50	Chad Johnson	Margarita	70 30.64	149 38.98	0.7	Line shooting
8/27/2012	12:00	Sigmond Patterson	Margarita	70 31.08	149 37.18	3.3	No Response from Com Center.
8/27/2012	13:30	Sigmond Patterson	Margarita	70 32.85	149 33.69	1.1	Line shooting
8/27/2012	18:00	Sigmond Patterson	Margarita	70 30.55	149 39.89	0	Inactive
8/28/2012	6:14	Chad Johnson	Margarita	70 31.78	149 39.24	6	Line shooting
8/28/2012	12:00	Sigmond Patterson	Margarita	70 30.63	149 39.28	0	Anchored until weather calms
8/28/2012	18:07	Sigmond Patterson	Margarita	70 30.56	149 39.48	0	At dock, crew change
8/29/2012	12:25	Sigmond Patterson	Margarita	70 31.65	149 38.84	3.3	Line Shooting
8/29/2012	18:00	Sigmond Patterson	Margarita	70 30.70	149 39.98	3.7	Transit to dock, crew change
8/30/2012	12:00	Sigmond Patterson	Margarita	70 30.55	149 39.49	0	Anchored at dock
8/31/2012	12:08	Sigmond Patterson	Margarita	70 30.87	149 39.53	0	Anchored
8/31/2012	17:56	Sigmond Patterson	Margarita	70 30.55	149 39.49	0	At dock
9/1/2012	13:00	Sigmond Patterson	Margarita	70 30.95	149 35.26	3	Line Shooting
9/1/2012	18:00	Sigmond Patterson	Margarita	70 30.55	149 39.47	0	At dock
9/2/2012	12:01	Sigmond Patterson	Margarita	70 30.69	149 39.53	0	Anchored
9/2/2012	18:00	Sigmond Patterson	Margarita	70 30.69	149 39.51	0	Anchored
9/3/2012	13:00	Sigmond Patterson	Margarita	70 30.69	149 39.52	0	Anchored
9/3/2012	18:00	Sigmond Patterson	Margarita	70 30.71	149 39.66	0	Anchored

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
9/4/2012	12:00	Sigmond Patterson	Margarita	70 30.71	149 39.67	0	Anchored
9/4/2012	18:00	Sigmond Patterson	Margarita	70 30.72	149 39.67	0	Anchored
9/5/2012	12:00	Sigmond Patterson	Margarita	70 30.79	149 45.85	3.4	Line Shooting
9/5/2012	18:00	Sigmond Patterson	Margarita	70 30.55	149 39.86	0	Anchored
9/6/2012	12:00	Sigmond Patterson	Margarita	70 30.73	149 40.73	2.7	Line shooting
8/3/2012	21:57	Sigmond Patterson	Resolution	70 30.67	149 39.55	0	Com Center will be off until 06:00. They just announced
8/4/2012	5:59	Sigmond Patterson	Resolution	70 34.92	149 45.382	0	Inactive
8/4/2012	21:10	Sigmond Patterson	Resolution	70 34.92	149 45.382	0	Com Center will be off until 06:00.
8/5/2012	6:02	Sigmond Patterson	Resolution	70 31.590	149 43.744	3.3	Inactive
8/5/2012	12:00	Jens Hopson	Resolution	70 34.061	149 46.636	3.3	Line shooting
8/5/2012	18:18	Jens Hopson	Resolution	70 34.863	149 43.741	3.3	Line shooting
8/6/2012	0:00	Sigmond Patterson	Resolution	70 30.645	149 39.420	0	Com Center will be off until 06:00.
8/6/2012	6:07	Sigmond Patterson	Resolution	70 35.392	149 42.286	2.7	Line shooting
8/6/2012	12:15	Jens Hopson	Resolution	70 30.544	149 39.491	0	Inactive
8/7/2012	6:10	Sigmond Patterson	Resolution	70 32.717	149 41.638	3.7	Line shooting
8/7/2012	12:15	Jens Hopson	Resolution	70 32.407	149 44.564	2.1	Line shooting
8/7/2012	16:09	Jens Hopson	Resolution	70 32.660	149 46.935	5.7	Line shooting
8/8/2012	7:00	Patrick Easterday	Resolution	70 30.921	149 40.310	0	Inactive
8/8/2012	12:02	Price Ungarook	Resolution	70 30.634	149 38.661	0	Inactive
8/8/2012	18:03	Price Ungarook	Resolution	70 35.00	149 31.303	1	Line shooting
8/9/2012	6:42	Patrick Easterday	Resolution	70 32.224	149 31.625	4.6	Line shooting
8/9/2012	12:00	Price Ungarook	Resolution	70 31.407	149 31.617	6.6	Line shooting
8/9/2012	18:00	Price Ungarook	Resolution	70 31.556	149 28.748	3.9	Line shooting
8/10/2012	12:00	Price Ungarook	Resolution	70 31.81	149 25.963	3.8	Line shooting
8/10/2012	0:00	Price Ungarook	Resolution	70 30.10	149 31.842	3.8	Line shooting
8/11/2012	6:30	Patrick Easterday	Resolution	70 33.682	149 48.604	5.2	Line shooting
8/11/2012	9:50	Price Ungarook	Resolution	70 30.787	149 32.573	7.6	Line shooting

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/11/2012	12:00	Price Ungarook	Resolution	70 32.731	149 28.130	4.2	Line shooting
8/11/2012	18:00	Price Ungarook	Resolution	70 32.989	149 38.534	3.5	Line shooting
8/12/2012	12:08	Price Ungarook	Resolution	70 36.304	149 44.780	3.9	Line Shooting outside the island
8/12/2012	18:00	Price Ungarook	Resolution	70 35.553	149 43.168	3	Line Shooting outside the island
8/12/2012	18:13	Patrick Easterday	Resolution	70 34.406	149 28.581	3.4	Line shooting
8/13/2012	9:40	Price Ungarook	Resolution	70 32.733	149 44.973	2.6	Line shooting inside the island north to south.
8/13/2012	12:00	Price Ungarook	Resolution	70 32.905	149 46.059	0	Idle inside the islands
8/13/2012	13:53	Price Ungarook	Resolution	70 34.571	149 43.804	3.5	Will be shooting outside the islands, north to south.
8/13/2012	18:00	Price Ungarook	Resolution	70 36.778	149 45.055	2.1	Line shooting
8/13/2012	18:12	Patrick Easterday	Resolution	70 35.145	149 32.141	0	Inactive
8/14/2012	6:21	Patrick Easterday	Resolution	70 33.91	149 33.09	3.7	Line shooting
8/14/2012	11:30	Price Ungarook	Resolution	70 30.926	149 39.551	6.9	Will be shooting inside the islands.
8/14/2012	18:00	Price Ungarook	Resolution	70 31.026	149 39.291	3.3	Ramping up to shoot line inside the island, north to south.
8/15/2012	6:00	Patrick Easterday	Resolution	70 30.62	149 39.38	0	On anchor at dock
8/15/2012	10:20	Price Ungarook	Resolution	70 31.476	149 43.152	2.1	Will be shooting inside the island 18-1220
8/15/2012	12:00	Price Ungarook	Resolution	70 34.032	149 44.430	1.7	Line shooting inside the island north to south.
8/15/2012	18:00	Price Ungarook	Resolution	70 31.733	149 43.431	4.3	Line shooting inside the island
8/16/2012	6:00	Patrick Easterday	Resolution	70 31.32	149 41.10	6	Line shooting
8/16/2012	9:00	Price Ungarook	Resolution	70 30.673	149 39.716	3.3	Will be shooting inside the island.
8/16/2012	12:03	Price Ungarook	Resolution	70 31.367	149 41.612	1.7	Line shooting inside the island
8/16/2012	18:00	Price Ungarook	Resolution	70 32.933	149 39.537	3.8	Line shooting
8/17/2012	6:05	Patrick Easterday	Resolution	70 32.42	149 36.83	3.9	Line shooting
8/17/2012	9:34	Price Ungarook	Resolution	70 30.721	149 39.673	4.5	Will be shooting inside the island north to south.
8/17/2012	12:41	Price Ungarook	Resolution	70 33.084	149 35.627	2	Line shooting
8/17/2012	18:00	Price Ungarook	Resolution	70 32.304	149 33.714	4.1	Line shooting inside the island

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/18/2012	6:13	Patrick Easterday	Resolution	70 34.08	149 32.33	3.3	Line shooting
8/18/2012	10:27	Price Ungarook	Resolution	70 31.014	149 30.535	1.4	Line shooting inside the island
8/18/2012	12:05	Price Ungarook	Resolution	70 30.987	149 28.987	3.3	Line shooting inside the island
8/18/2012	18:00	Price Ungarook	Resolution	70 36.806	149 19.617	2.4	Line Shooting outside the island
8/19/2012	6:39	Patrick Easterday	Resolution	70 36.62	149 44.12	0	Repair equipment boat.
8/19/2012	12:00	Price Ungarook	Resolution	70 36.312	149 46.094	3.9	Shooting outside the islands
8/19/2012	12:25	Patrick Easterday	Resolution	70 36.19	149 45.28	3.7	Line shooting
8/19/2012	18:00	Price Ungarook	Resolution	70 37.423	149 46.321	0	Shut down for repairs likely to resume to shoot tonight in few hours
8/20/2012	6:25	Patrick Easterday	Resolution	70 36.33	149 31.86	2.9	Line shooting
8/20/2012	12:00	Price Ungarook	Resolution	70 36.153	149 31.837	2.5	Will be line shooting outside the islands
8/20/2012	18:00	Price Ungarook	Resolution	70 35.337	149 29.552	3.9	Shooting outside the islands
8/21/2012	6:01	Patrick Easterday	Resolution	70 32.44	150 00.64	5.5	Line shooting
8/21/2012	12:00	Price Ungarook	Resolution	70 30.724	149 39.506	0	Anchored off the dock about 1/4 mile
8/21/2012	12:45	Patrick Easterday	Resolution	70 34.65	149 28.13	3.3	Line shooting
8/21/2012	18:00	Price Ungarook	Resolution	70 33.941	149 48.921	3.4	Shooting outside the islands
8/22/2012	7:02	Patrick Easterday	Resolution	70 31.00	149 40.34	3.6	Line shooting
8/22/2012	12:00	Price Ungarook	Resolution	70 30.966	149 42.122	1.4	Will be shooting inside the islands.
8/22/2012	12:48	Patrick Easterday	Resolution	70 31.96	149 46.56	2.7	Line shooting
8/22/2012	18:00	Price Ungarook	Resolution	70 31.971	149 37.371	1.4	Shooting inside the islands
8/23/2012	6:39	Patrick E	Resolution	70 31.64	149 47.88	1.8	Line shooting
8/23/2012	12:00	Price Ungarook	Resolution	70 30.822	149 39.237	2.7	Line shooting inside the island north to south.
8/23/2012	18:00	Price Ungarook	Resolution	70 30.734	149 39.521	0	Anchored off dock
8/23/2012	22:28	Patrick E	Resolution	70 30.55	149 39.49	0	On dock
8/24/2012	0:00	Pete Hopson	Resolution	70 33.283	149 40.001	3	Line shooting
8/24/2012	13:00	Price Ungarook	Resolution	70 31.93	149 40.99	2.5	Line shooting
8/24/2012	18:00	Charlie Hopson	Resolution	70 30.27	149 36.00	3.3	Line shooting inside
8/25/2012	6:00	Pete Hopson	Resolution	70 33.441	149 43.331	4	Line shooting

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/25/2012	12:00	Charlie Hopson	Resolution	70 33.8	149 44.97	2.8	Line shooting inside the island north to south.
8/25/2012	18:00	Charlie Hopson	Resolution	70 32.17	149 39.93	2.6	No Response from Com Center.
8/26/2012	0:00	Pete Hopson	Resolution	70 30.993	149 27.051	3	Line shooting
8/26/2012	6:00	Pete Hopson	Resolution	70 31.125	149 41.781	0	Inactive
8/26/2012	12:00	Charlie Hopson	Resolution	70 32.59	149 41.965	2.6	Line shooting inside the island north to south.
8/26/2012	18:00	Charlie Hopson	Resolution	70 30.62	149 44.6	2.9	Line shooting
8/27/2012	0:00	Pete Hopson	Resolution	70 30.850	149.36.625	2.4	Line shooting
8/27/2012	0:00	Pete Hopson	Resolution	70 31.548	149 48.461	4.7	Line shooting
8/27/2012	6:00	Pete Hopson	Resolution	70 30.686	149 39.144	0	Docked for repairs
8/27/2012	6:45	Pete Hopson	Resolution	70 31.382	149 35.067	4.2	Line shooting
8/27/2012	13:31	Ningeok	Resolution	70 30.15	149 47.32	4.4	Off line shooting
8/28/2012	0:00	Pete Hopson	Resolution	70 30.947	149 33.660	4	Line shooting
8/28/2012	6:00	Pete Hopson	Resolution	70 31.498	149 32.072	1.2	Line shooting
8/28/2012	12:03	Johnny Ningeok	Resolution	70 30.55	149 39.49	0	Gun array repair at this time.
8/28/2012	18:30	Johnny Ningeok	Resolution	70 32.76	149 27.37	2.5	Line shooting
8/29/2012	0:00	Pete Hopson	Resolution	70 32.286	149 44.299	1.4	Line shooting
8/29/2012	6:00	Pete Hopson	Resolution	70 31.290	149 44.091	2.3	Line shooting
8/29/2012	12:01	Johnny Ningeok	Resolution	70 30.56	149 31.53	2.5	Our activities is ling shooting at this time.
8/29/2012	18:05	Johnny Ningeok	Resolution	70 32.39	149 33.89	2.3	Line shooting at 1500 swath
8/30/2012	12:03	Johnny Ningeok	Resolution	70 30.59	149 39.34	0	Anchored due to maintenance repair on the arrays
8/31/2012	0:00	Pete Hopson	Resolution	70 30.633	149 39.107	0	Operations sease until better weather.
8/31/2012	6:00	Pete Hopson	Resolution	70 30.633	149 39.111	0	Inactive
8/31/2012	12:05	Johnny Ningeok	Resolution	70 30.63	149 39.12	0	No activities at this time. Maintenance work on the arrays
8/31/2012	18:05	Johnny Ningeok	Resolution	70 30.63	149 39.12	0	No activities. Arrays in working order, now waiting for weather to die down. White caps with spray, rolling waves.

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
9/1/2012	0:00	Pete Hopson	Resolution	70 30.641	149 39.114	0	Anchored off F-Pad dock
9/1/2012	6:00	Pete Hopson	Resolution	70 32.035	149 38.722	3.4	Line shooting
9/1/2012	12:03	Johnny Ningeok	Resolution	70 32.03	149 48.83	3	We are line shooting at swath 1140.
9/1/2012	18:04	Johnny Ningeok	Resolution	70 30.81	149 27.02	1.9	Line shooting, next swath number heading to swath 1692 from swath 1684.
9/2/2012	0:00	Pete Hopson	Resolution	70 31.852	149 45.988	4	Line shooting
9/2/2012	6:00	Pete Hopson	Resolution	70 30.871	149 40.278	0	Anchored off of F-Pad dock. Nukapiagek Crew from Nutqsut near Cross Island
9/2/2012	12:02	Johnny Ningeok	Resolution	70 30.86	149 40.27	0	Waiting for a go from the recorder at this time.
9/3/2012	0:00	Pete Hopson	Resolution	70 30.870	149 40.300	0	Anchored off of F-Pad due to weather.
9/3/2012	6:00	Pete Hopson	Resolution	70 30.870	149 40.300	0	Inactive
9/3/2012	12:00	Johnny Ningeok	Resolution	70 30.87	149 40.30	0	No answer at com center
9/4/2012	0:00	Pete Hopson	Resolution	70 30.870	149 40.310	0	Still anchored due to weather (22 to 23 knot winds).
9/4/2012	6:00	Pete Hopson	Resolution	70 30.870	149 40.310	0	Inactive
9/4/2012	12:00	Johnny Ningeok	Resolution	70 30.87	149 40.30	0	Com center answered call. We are currently anchored at this time due to foul weather.
9/4/2012	18:34	Johnny Ningeok	Resolution	70 30.87	149 40.30	0	Weather is the same. Anchored at this time.
9/5/2012	0:00	Pete Hopson	Resolution	70 31.315	149 39.803	0	Still anchored.
9/5/2012	6:00	Pete Hopson	Resolution	70 30.315	149 39.803	0	Inactive
9/5/2012	12:01	Johnny Ningeok	Resolution	70 30.79	149 30.74	2.6	We are ponging at this time. Nice day.
9/6/2012	0:00	Pete Hopson	Resolution	70 31.086	149 50.977	3.1	Line shooting
9/6/2012	6:00	Pete Hopson	Resolution	70 30.087	149 48.620	3.6	
8/5/2012	0:18	Chad Johnson	Storm Warning	70 30.543	149 39.470	0	Inactive
8/5/2012	7:12	Chad Johnson	Storm Warning	70 30.543	149 39.470	0	Inactive
8/6/2012	0:00	Chad Johnson	Storm Warning	70 30.551	149 39.465	0	Inactive
8/6/2012	6:00	Chad Johnson	Storm Warning	70 30.551	149 39.465	0	Inactive
8/7/2012	0:04	Chad Johnson	Storm Warning	70 30.544	149 39.470	0	Inactive

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/7/2012	6:13	Chad Johnson	Storm Warning	70 30.544	149 39.470	0	Inactive
8/8/2012	5:59	Chad Johnson	Storm Warning	70 30.544	149 39.470	0	Inactive
8/9/2012	6:21	Chad Johnson	Storm Warning	70 30.546	149 39.464	0	Inactive
8/10/2012	0:26	Chad Johnson	Storm Warning	70 30.550	149 39.465	0	Inactive
8/10/2012	6:03	Chad Johnson	Storm Warning	70 30.550	149 39.465	0	Inactive
8/11/2012	6:02	Chad Johnson	Storm Warning	70 30.548	149 39.472	0	Inactive
8/11/2012	7:27	Chad Johnson	Storm Warning	70 30.548	149 39.472	0	Attempted to call at 06:00, no answer. Called again to inform our stationed position with inactive activity
8/11/2012	12:05	Johnny Ningeok	Storm Warning	70 30.55	149 39.46	0	Thanks to Marty Wise for calling in. I had too soft of a voice
8/12/2012	6:12	Chad Johnson	Storm Warning	70 33.156	149 40.050	0	Inactive
8/12/2012	12:20	Martin Wise	Storm Warning	70 37.73	149 39.18	3.1	Commencing seismic opperations. Speaking for Johnny Ningeok
8/12/2012	18:13	Johnny Ningeok	Storm Warning	70 30.55	149 39.45	0	Called in to Deadhorse com center on our update, waiting for instructions on deployment
8/13/2012	6:19	Chad Johnson	Storm Warning	70 33.049	149 42.361	1.7	Line shooting
8/13/2012	14:23	Johnny Ningeok	Storm Warning	70 30.55	149 39.49	0	Called in at 14:23
8/13/2012	17:04	Johnny Ningeok	Storm Warning	70 30.90	149 40.99	4.3	Preparing to ramp up.
8/14/2012	6:17	Chad Johnson	Storm Warning	70 33.10	149 45.43	0	Inactive
8/15/2012	0:47	Chad Johnson	Storm Warning	70 30.572	149 40.278	0	Anchored at buoy. Inactive.
8/15/2012	6:06	Chad Johnson	Storm Warning	70 31.628	149 45.463	4.3	Line shooting
8/15/2012	18:11	Johnny Ningeok	Storm Warning	70 30.59	149 40.20	0	Anchored, waiting for instructions at this time
8/16/2012	0:52	Chad Johnson	Storm Warning	70 30.603	149 40.321	0	Inactive
8/16/2012	6:01	Chad Johnson	Storm Warning	70 30.603	149 40.321	0	Inactive
8/16/2012	14:28	Johnny Ningeok	Storm Warning	70 30.80	149 39.78	1.8	Tried calling com center, but no answer
8/16/2012	18:07	Johnny Ningeok	Storm Warning	70 31.46	149 46.18	2.9	Shooting off line, doing mitigation shots at this time.
8/17/2012	0:08	Chad Johnson	Storm Warning	70 30.620	149 39.380	0.9	Refueling vessel and generators

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
8/17/2012	7:13	Chad Johnson	Storm Warning	70 30.540	149 40.300	0	Inactive
8/17/2012	13:08	Johnny Ningeok	Storm Warning	70 30.56	149 39.47	0	We are docked at F-Pad for maintenance repairs on the 2 gun arrays
8/17/2012	18:17	Johnny Ningeok	Storm Warning	70 30.60	149 40.21	0	Waiting for instrucitons from recorder, Alaganic. We are inactive at this time
8/18/2012	1:16	Chad Johnson	Storm Warning	70 30.540	149 39.450	0	Inactive
8/18/2012	6:10	Chad Johnson	Storm Warning	70 31.220	149 30.200	1.3	Line shooting
8/18/2012	12:05	Sigmond Patterson	Storm Warning	70 30.635	149 39.716	2	In transit to anchor.
8/18/2012	18:00	Sigmond Patterson	Storm Warning	70 30.58	149 40.31	0	Inactive
8/19/2012	1:22	Chad Johnson	Storm Warning	70 30.600	149 40.280	0	Inactive
8/19/2012	6:02	Chad Johnson	Storm Warning	70 30.600	149 40.320	0	Inactive
8/19/2012	12:32	Matrona Fortner	Storm Warning	70 30.59	149 40.33	0	Out on anchor right off F-Pad for maintenance.
8/19/2012	18:05	Matrona Fortner	Storm Warning	70 30.59	149 40.33	0	Still at anchor
8/20/2012	0:26	Chad Johnson	Storm Warning	70 30.550	149 39.460	0	Inactive
8/20/2012	6:57	Chad Johnson	Storm Warning	70 30.600	149 40.300	0	Inactive
8/20/2012	13:15	Matrona Fortner	Storm Warning	70 30.60	149 40.25	0	Still at anchor, just south of F-Pad
8/20/2012	18:05	Matrona Fortner	Storm Warning	70 30.60	149 40.23	0	At anchor for repairs.
8/21/2012	0:02	Chad Johnson	Storm Warning	70 30.550	149 39.470	0	Inactive
8/21/2012	6:01	Chad Johnson	Storm Warning	70 30.600	149 40.300	0	Inactive
8/22/2012	2:29	Chad Johnson	Storm Warning	70 30.550	149 39.480	0	Inactive
8/22/2012	7:00	Chad Johnson	Storm Warning	70 30.580	149 40.380	0	Inactive
8/23/2012	23:55	Chad Johnson	Storm Warning	70 30.580	149 40.340	0	Inactive
8/24/2012	0:00	Chad Johnson	Storm Warning	70 30.59	149 40.33	0	Inactive
8/24/2012	7:15	Chad Johnson	Storm Warning	70 30.59	149 40.33	0	Inactive
8/25/2012	0:00	Chad Johnson	Storm Warning	70 30.60	149 40.31	0	Inactive
8/25/2012	6:00	Chad Johnson	Storm Warning	70 30.60	149 30.28	0	Inactive
8/26/2012	0:03	Chad Johnson	Storm Warning	70 30.55	149 39.48	0	Inactive
8/26/2012	12:00	Chad Johnson	Storm Warning	70 31.21	149 47.87	3.5	Line shooting

Date	Time	Caller's Name	Vessel	Latitude	Longitude	Vessel Speed (kts)	Planned Destination or Activities & Comments
9/1/2012	12:40	Solomon Okpeaha	Storm Warning	70 30.55	149 39.48	0	NW side of the dock
9/1/2012	18:00	Solomon Okpeaha	Storm Warning	70 30.72	149 32.72	3	Line shooting
9/2/2012	6:32	Rex Okakok	Storm Warning	70 30.61	149 39.89	0	Called in, no anwer
9/2/2012	12:34	Solomon Okpeaha	Storm Warning	70 30.60	149 39.88	0	Inactive, anchored off of F dock
9/2/2012	18:03	Solomon Okpeaha	Storm Warning	70 30.60	149 39.88	0	Inactive
9/3/2012	6:02	Rex Okakok	Storm Warning	70 30.61	149 39.90	0	Called in, we are inactive
9/3/2012	12:09	Solomon Okpeaha	Storm Warning	70 30.61	149 39.89	0	Called 3 times 12:09, 12:30, and 13:00 no contact with Com Center in Deadhorse. Called Barrow Com Center and checked in.
9/3/2012	19:53	Solomon Okpeaha	Storm Warning	70 30.61	149 39.89	0	Inactive
9/4/2012	12:33	Solomon Okpeaha	Storm Warning	70 31.18	149 40.11	0	Inactive
9/4/2012	18:34	Solomon Okpeaha	Storm Warning	70 31.18	149 40.11	0	Inactive
9/5/2012	0:03	Rex Okakok	Storm Warning	70 30.18	149 40.11	0	Midnight call in
9/5/2012	12:38	Solomon Okpeaha	Storm Warning	70 31.19	149 40.09	0	Inactive
9/5/2012	18:01	Solomon Okpeaha	Storm Warning	70 30.77	149 40.79	0	Inactive
9/6/2012	12:08	Solomon Okpeaha	Storm Warning	70 30.66	149 39.61	0	Inactive
9/6/2012	17:43	Solomon Okpeaha	Storm Warning	70 30.66	149 39.61	0	30 kt winds, awaiting to move and call it a day.

Appendix F

Detailed Marine Mammal Sightings

Date	Hour	Min	Sec	Species	Number of animals	Heading	Distance (m)	Behavior	Reaction	Lat_Deg	Lat_Min	Long_Deg	Long_Min	Depth (m)	Vessel Speed	Beaufort sea state	Visibility	Vessel	Mitigation Type	Siesmic Activity
07/27/2012	08	44	00	Ringed seal	1	Unknown	30	Look	Look	70	23.75	148	31.7	1.5	6.6	2	5	Resolution	None	Non-seismico
07/27/2012	14	13	43	Ringed/Spotted seal	1	Unknown	20	Look	Look	70	29.25	148	57.517	5.3	8.7	2	5	Resolution	None	Non-seismico
07/30/2012	11	45	22	Ringed/Spotted seal	1	90	300	Look	Look	70	36.588	149	41.75	14	4	1	5	Resolution	None	Seismic
07/30/2012	14	48	50	Ringed/Spotted seal	1	200	250	Swim	Look	70	35.717	149	30.665	13.8	4	1	5	Resolution	None	Seismic
07/31/2012	08	56	28	Ringed/Spotted seal	1	Unknown	100	Look	X	70	30.608	149	39.204	1.1	0	2	3.5	Resolution	None	Non-seismic
07/31/2012	11	19	25	Unidentified pinniped	1	Unknown	40	Sink	X	70	31.634	149	46.555	2.4	0	2	3.5	Resolution	None	Non-seismic
8/3/2012	11	30	35	Ringed/Spotted seal	1	300	70	Look	Look	70	35.64	149	48.088	10.5	6.7	0	5	Resolution	Power down	Seismic
08/03/2012	21	54	20	Unidentified seal	1	Unknown	600	Swim	X	70	32.861	149	51.803	1.9	3.7	0	10	Margarita	Delayed ramp up	Non-seismic
08/03/2012	21	31	45	Unidentified seal	1	Unknown	200	Swim	X	70	31.94	149	46.111	1.9	6	1	5	Margarita	None	Non-seismic
08/03/2012	21	41	32	Ringed/Spotted seal	1	Unknown	300	Swim	X	70	32.466	149	48.943	1.8	6	1	5	Margarita	None	Non-seismic
08/04/2012	12	15	00	Unidentified seal	2	Unknown	2000	Sink	X	70	30.55	149	39.46	1.5	0	1	8	Storm Warning	None	Non-seismic
08/04/2012	07	35	00	Ringed/Spotted seal	1	Unknown	80	Swim	X	70	31.264	149	41.471	1.4	0	1	5	Resolution	None	Non-seismic
08/04/2012	19	43	50	Spotted seal	1	60	40	Look	Look	70	30.678	149	39.385	2.1	3.4	1	10	Margarita	None	Non-seismic
08/05/2012	16	40	00	Spotted seal	1	Unknown	40	Feeding	X	70	30.55	149	39.47	2	0	2	10	Storm Warning	None	Non-seismic
08/05/2012	19	18	05	Unidentified pinniped	1	Unknown	50	Dive	X	70	34.455	149	41.167	5.5	2.3	1	5	Resolution	None	Non-seismic
08/06/2012	16	10	15	Unidentified pinniped	1	Unknown	120	Swim	X	70	34.566	149	41.391	8.5	0	3	5	Resolution	Power down	Seismic
08/06/2012	18	00	48	Unidentified pinniped	2	Unknown	40	Look	X	70	32.945	149	44.759	3	0	3	5	Resolution	None	Non-seismic
08/06/2012	18	26	00	Unidentified seal	1	Unknown	150	Swim	X	70	35.3	149	39.2	12	2.9	3	10	Margarita	None	Non-seismic
08/11/2012	17	29	00	Ringed/Spotted seal	1	Unknown	76	Swim	X	70	35.69	149	46.39	11.9	3	2	10	Margarita	Shut down	Seismic
08/11/2012	20	06	36	Ringed/Spotted seal	1	Unknown	800	Swim	X	70	33.91	149	47.06	4	3	2	10	Margarita	None	Non-seismic
08/11/2012	21	40	49	Spotted seal	1	180	100	Look	Look	70	35.83	149	47.11	11.9	3	2	10	Margarita	None	Non-seismic
08/11/2012	08	30	00	Ringed/Spotted seal	1	270	100	Look	Look	70	34.56	149	46.45	7.1	3	2	10	Margarita	Delayed ramp up	Seismic
08/11/2012	08	22	44	Unidentified seal	1	Unknown	80	Look	Look	70	34	149	34.281	5.1	1.9	0	5	Resolution	None	Non-seismic
08/11/2012	13	10	0	Spotted seal	1	Unknown	20	Swim	X	70	30.55	149	39.47	1.5	0	1	10	Storm Warning	None	Non-seismic
08/12/2012	08	16	45	Unidentified seal	1	90	130	Look	Look	70	34.575	149	43.617	6.5	4.6	0	4	Resolution	None	Non-seismic
08/12/2012	10	30	0	Bearded seal	1	Unknown	100	Look	X	70	34.433	149	45.759	7.8	4.6	0	4	Resolution	Delayed ramp up	Seismic
08/12/2012	01	01	08	Bearded seal	1	Unknown	800	Swim	X	70	34.1	149	34.56	6.6	0.2	1	8	Margarita	Shut down	Seismic
08/13/2012	06	13	00	Unidentified seal	1	200	500	Look	Look	70	35.191	149	32.124	13	4.2	2	5	Resolution	Shut down	Seismic
08/13/2012	06	34	29	Unidentified pinniped	1	Unknown	300	Swim	X	70	32.884	149	42.695	3	0	1	10	Storm Warning	None	Non-seismic
08/13/2012	07	25	00	Unidentified seal	1	Unknown	400	Swim	X	70	34.487	149	45.48	11.8	4.2	2	5	Resolution	Delayed ramp up	Seismic
08/13/2012	20	04	00	Bearded seal	1	Unknown	40	Swim	X	70	34.56	149	43.68	6.4	3.5	4	10	Margarita	None	Non-seismic
08/16/2012	10	46	31	Unidentified seal	1	Unknown	140	Look	X	70	34.86	149	50.19	9.7	3.4	2	8	Margarita	None	Non-seismic
08/17/2012	12	07	00	Ringed seal	1	Unknown	50	Look	X	70	33.601	149	37.306	2.4	2.8	0	8	Resolution	Shut down	Seismic
08/18/2012	17	12	30	Ringed seal	1	Unknown	450	Swim	X	70	36.6	149	51.05	13.2	6.6	0	5	Resolution	Delayed ramp up	Seismic
08/20/2012	19	23	40	Unidentified pinniped	1	Unknown	50	Swim	Look	70	35.4	149	39.72	14.2	3	0	8	Resolution	Shut down	Seismic
8/24/2012	20	1	21	Unidentified seal	1	Unknown	250	Look	X	70	30.72	149	37.05	2.4	2	1	10	Margarita	None	Non-seismic
8/25/2012	19	23	30	Unidentified seal	1	Unknown	200	Look	X	70	33.53	149	45	2	0	1	10	Resolution	None	Non-seismic
08/26/2012	06	19	50	Unidentified seal	1	Unknown	225	Look	X	70	31.15	149	47.43	3.3	2.6	1	10	Storm Warning	Power down	Seismic
08/26/2012	16	30	15	Bearded seal	1	Unknown	160	Swim	X	70	30.31	149	49.93	2.2	0	1	10	Storm Warning	None	Non-seismic
08/27/2012	21	35	41	Unidentified seal	1	Unknown	300	Swim	X	70	30.65	149	39.51	1.9	0	3	9	Storm Warning	None	Non-seismic
8/28/2012	21	54	31	Unidentified seal	1	Unknown	600	Swim	X	70	30.59	149	34.01	2.4	2.9	1	10	Margarita	None	Seismic
8/29/2012	17	20	25	Spotted seal	1	Unknown	150	Swim	X	70	30.88	149	34.59	1.8	1.8	2	10	Resolution	Shut down	Seismic
8/30/2012	19	19	0	Spotted seal	1	Unknown	80	Swim	X	70	32.55	149	46.42	2.4	0	4	10	Resolution	None	Non-seismic
8/31/2012	11	33	0	Spotted seal	1	30	30	Swim	Look	70	30.87	149	39.52	1.5	0	5	5	Margarita	None	Non-seismic
9/5/2012	13	25	30	Spotted seal	1	Unknown	95	Swim	X	70	31.18	149	40.12	1.3	0	1	10	Storm Warning	None	Non-seismic
9/6/2012	14	26	0	Ringed/Spotted seal	1	Unknown	15	Swim	X	70	30.94	149	43.62	2.5	0	5	4	Margarita	None	Non-seismic