MARINE MAMMAL MONITORING AND MITIGATION

90-DAY REPORT

MAY 6 – SEPTEMBER 30, 2012

Apache Alaska Corporation

3D Seismic Program

Cook Inlet, Alaska

Prepared for

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ACRONYMS AND ABBREVIATIONS

3D	three-dimensional
ADAMS	acoustic data acquisition and monitoring system
ADF&G	Alaska Department of Fish and Game
APACHE	Apache Alaska Corporation
AKR	Alaska Region
BA	Biological Assessment
CFR	Code of Federal Regulations
CPA	closest point of approach
cui	cubic inch
dB	decibel
dB re 1 μPa	decibel referenced to one microPascal
DGPS/RTK	differential global positioning system/roving units
DZ	Disturbance Zone
EA	Environmental Assessment
ESA	Endangered Species Act
EZ	Exclusion Zone
FR	Federal Register
ft	feet
GPS	Global Positioning System
Hz	Hertz
IHA	Incidental Harassment Authorization
INS	Integrated Navigation System
JASCO	JASCO Applied Sciences
kg	kilogram
kHz	kilohertz
km	kilometer
km^2	square kilometer
LOA	Letter of Authorization
LOC	Letter of Concurrence
m	meter
mi	mile
mi^2	square miles
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
OBH	ocean bottom hydrophone
OBRL	ocean bottom receiver location
OSK	Offshore Systems Kenai
OTS	Over-the-side
PAM	passive acoustic monitoring
PSAO	protected species acoustic observer
PSO	protected species observer
rms	root mean square
SSV	seismic sound verification
USC	United States Code
USCG	United Stated Coast Guard
USBL	Ultra-Short Baseline

EXECUTIVE SUMMARY

A marine mammal monitoring and mitigation program was conducted for the *Apache Cook Inlet 3D Seismic Program* in central Cook Inlet between May 6 and September 30, 2012. Seismic surveys were conducted in nearshore and offshore waters during slack tides from the *M/V Arctic Wolf* and *M/V Peregrine Falcon* which were supported by several nodal, transport, housing, and mitigation vessels. Marine mammal monitoring was conducted from the seismic vessels, a mitigation vessel, four land platforms, and an aerial platform, either helicopter or small fixed wing aircraft. Protected Species Observers (PSOs) monitored from the seismic vessels, mitigation vessel, and land during all day time seismic operations. Aerial overflights were conducted 1-2 times daily of the project area and surrounding coastline, including the major river mouths to monitor for larger congregations of marine mammals in and around the project vicinity. Passive acoustic monitoring (PAM) took place from the mitigation vessel during all night time seismic operations and most day time seismic operations. There were two acousticians and seven to ten PSOs on the project site at all times: two on each source vessel, two on the mitigation vessel, one to four at the land-based station(s) occasionally with PSOs at two sites, and two acousticians on the mitigation vessel. A total of 6,912.1 hours of observations was completed from May 6 – September 30, 2012 including vessel-based (3,366.8 hours), land-based (915.8 hours), aerial overflights (92.0 hours), and PAM (2.537.5 hours). A total of 1,841.7 hours of seismic activity took place from May 6 – September 30, 2012 including the 10 cubic inch (cui) airgun array (589.1 hours), 440 cui airgun array (32.9 hours), and the 2400 cui airgun array (1,252.6 hours).

Six identified species and three unidentified species of marine mammals were observed from the vessel, land, and aerial platforms during the program. The species observed include Cook Inlet beluga whale (*Delphinapterus leucas*), harbor seal (*Phoca vitulina richardsi*), harbor porpoise (*Phocoena phocoena*), Steller sea lion (*Eumatopias jubatus*), gray whale (*Eschrichtius robustus*), and California sea lion (*Zalophus californianus*). We also observed unidentified species including a large cetacean, pinniped and marine mammal. The gray whale and California sea lion were not included in the IHA, so mitigation measures implemented for these species were implemented at strictest level. There were a total of 882 sightings and an estimated 5,232 individuals. Harbor seals were the most frequently observed marine mammals at 563 sightings (~3,471 estimated individuals), followed by beluga whales with 151 sightings (~1,463 estimated individuals), harbor porpoises with 137 sightings (~190 estimated individuals), and gray whales with 9 sightings (9 estimated individuals). Steller sea lions were observed on three separate occasions (~4 estimated individuals) and California sea lions were observed once (~2 estimated individuals).

A total of 88 safety zone clearing delays, 154 shut downs, 7 power downs, 23 shut downs followed by a power down, and 1 speed and course alteration occurred during the program. Safety zone clearing delays, shut downs, and shut downs followed by a power down occurred most frequently during harbor seal sightings (n=61, n=110, n=14, respectively), followed by harbor porpoise sightings (n=18, n=28, n=6, respectively), and then beluga whale sightings (n=5, n=6, n=3, respectively). Power downs occurred most frequently with harbor seal (n=3) and harbor porpoise (n=3) sightings. One speed and course alteration occurred during a beluga whale sighting. A total of 17 Level B takes occurred from May 6 – September 30, 2012 including harbor porpoises (n=4) and harbor seals (n=13; Table 22). No other marine mammal species were taken by a Level B take. There were no Level A takes for either cetaceans or pinnipeds during the *Cook Inlet 3D Seismic Program*.

1.0 INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) regulations governing the issuance of Incidental Harassment Authorizations (IHAs) and Letters of Authorization (LOAs) permitting the incidental, but not intentional, take of marine mammals under certain circumstances are codified in 50 Code of Federal Regulations (CFR) Part 216, Subpart I (Sections 216.101-216.108). The Marine Mammal Protection Act (MMPA) defines take to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 United States Code [USC] Chapter 31, Section 1362 (13)).

Apache Alaska Corporation (APACHE) plans to acquire three-dimensional (3D) seismic surveys throughout Cook Inlet, Alaska over the course of the next three to five years. APACHE applied for and received an IHA to operate a 3D seismic survey in an area defined as Area 1 between April 30, 2012 and April 30, 2013 (72 Federal Register [FR] 27720). Area 1 encompasses approximately 3,554 square kilometers (km^2, 2,208 square miles [mi^2]) of intertidal and offshore areas (Figure 1).

As required in the IHA, this report summarizes the results of the monitoring and mitigation program for the APACHE 3D seismic program that operated May 6 through September 30, 2012 in Cook Inlet.

1.1 GENERAL TIMELINE OF PERMITS

APACHE has acquired over 800,000 acres of oil and gas leases in Cook Inlet since 2010 with the primary objective to explore for and develop oil fields in Cook Inlet. In the spring of 2011, APACHE conducted a seismic test program to evaluate the feasibility of using new nodal technology seismic recording equipment for operations in the Cook Inlet environment and to test various seismic acquisition parameters in order to finalize the design for a 3D seismic program in the Cook Inlet (hereafter *Cook Inlet 3D Seismic Program*). APACHE applied for and received a Letter of Concurrence (LOC) from NMFS to conduct the test program without an IHA because of the short duration of the program and strict monitoring and mitigation protocols implemented. The test program occurred in late March 2011 and results showed that the nodal technology was feasible for use in the Cook Inlet environment.

In the fall of 2011, APACHE applied for an IHA for 3D seismic activity in Area 1. As part of the IHA application, APACHE assisted NMFS on preparation of an Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA). APACHE also received authorization from the United States Army Corps of Engineers (Corps) to place and retrieve the nodes below the mean high water mark under Section 10 of the Rivers and Harbors Act. Additionally, because Federally-listed species under the Endangered Species Act (ESA) occur in the area of planned activity, NMFS and the Corps were required to consult with NMFS Alaska Region (AKR) under Section 7(a)(2) of the ESA for the Cook Inlet beluga whale and Steller sea lion. APACHE assisted NMFS and the Corps in preparation of a Biological Assessment (BA). The BA covered the three years of planned activity throughout Cook Inlet, not just the IHA Area 1.

In the spring of 2012, NMFS issued the Biological Opinion and Incidental Take Statement under Section 7 of the ESA for three years of seismic activity in Cook Inlet. All of these documents are available for viewing on the NMFS Incidental Take website: (http://www.nmfs.noaa.gov/pr/permits/incidental.htm) and the NMFS AKR website: (http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/regulations.htm). The IHA for Area 1 was received by APACHE on April 30, 2012 and seismic activity commenced on May 6, 2012.

1.2 OBJECTIVES

The objectives of the monitoring and mitigation program were described in detail in the APACHE IHA Application (see website listed above for the entire application) and in the IHA issued by NMFS to Apache (Appendix A). The monitoring plan submitted to and approved by NMFS is included in Appendix B. The primary objectives of the monitoring program were to:

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

2.0 PROJECT DESCRIPTION

APACHE plans to conduct a phased 3D seismic program over the course of the next three to five years. The first year of activity occurred from May 6 through September 30, 2012 in Area 1. Area 1 is located in upper Cook Inlet (Figure 1) and covered approximately 3,554 km^2 (2,208 mi^2), and began along the inlet's west coast from McArthur River, up to the south of Beluga River, moved easterly offshore and then along the eastern coast near the Nikiski/Kenai area. As detailed further below, the program consists of onshore, transition zone, and offshore components (Figure 2).

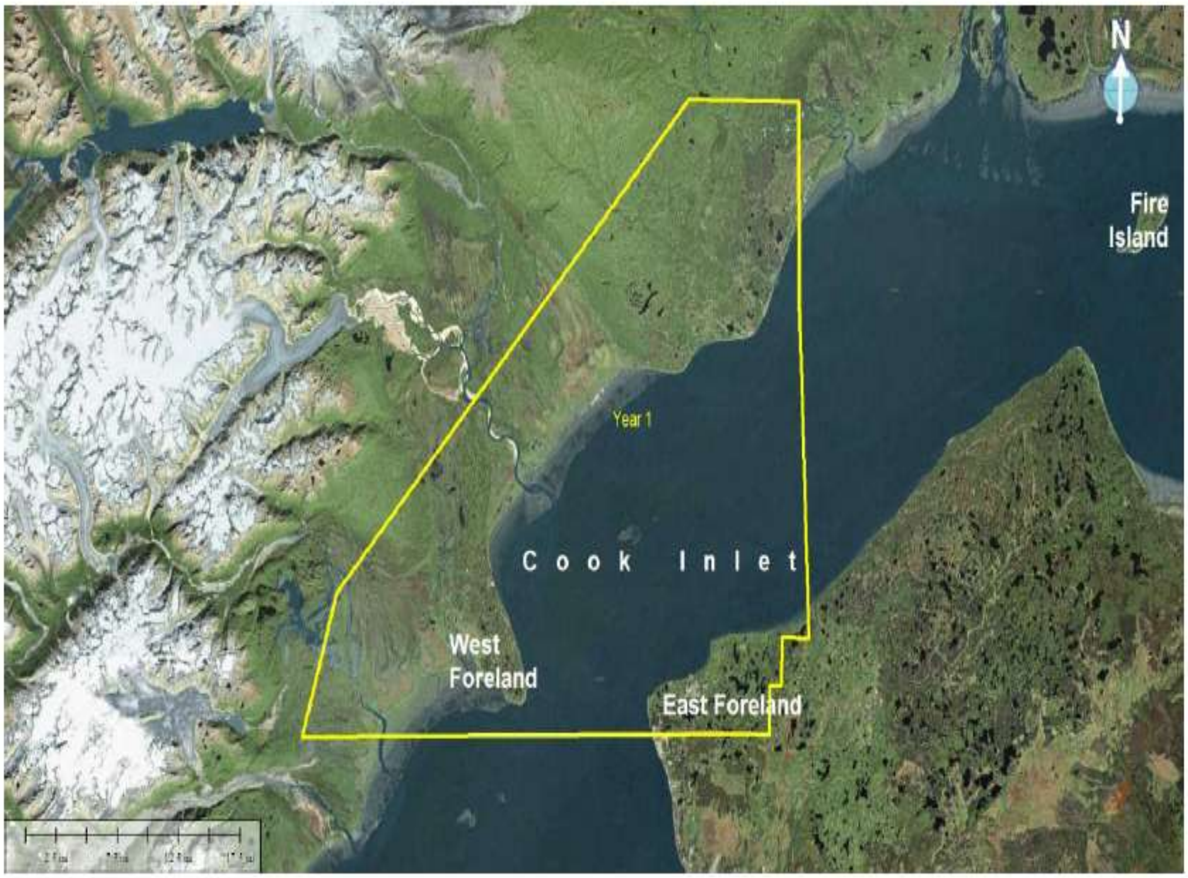

Figure 1. Area 1 (yellow polygon) of the *Cook Inlet 3D Seismic Program*.

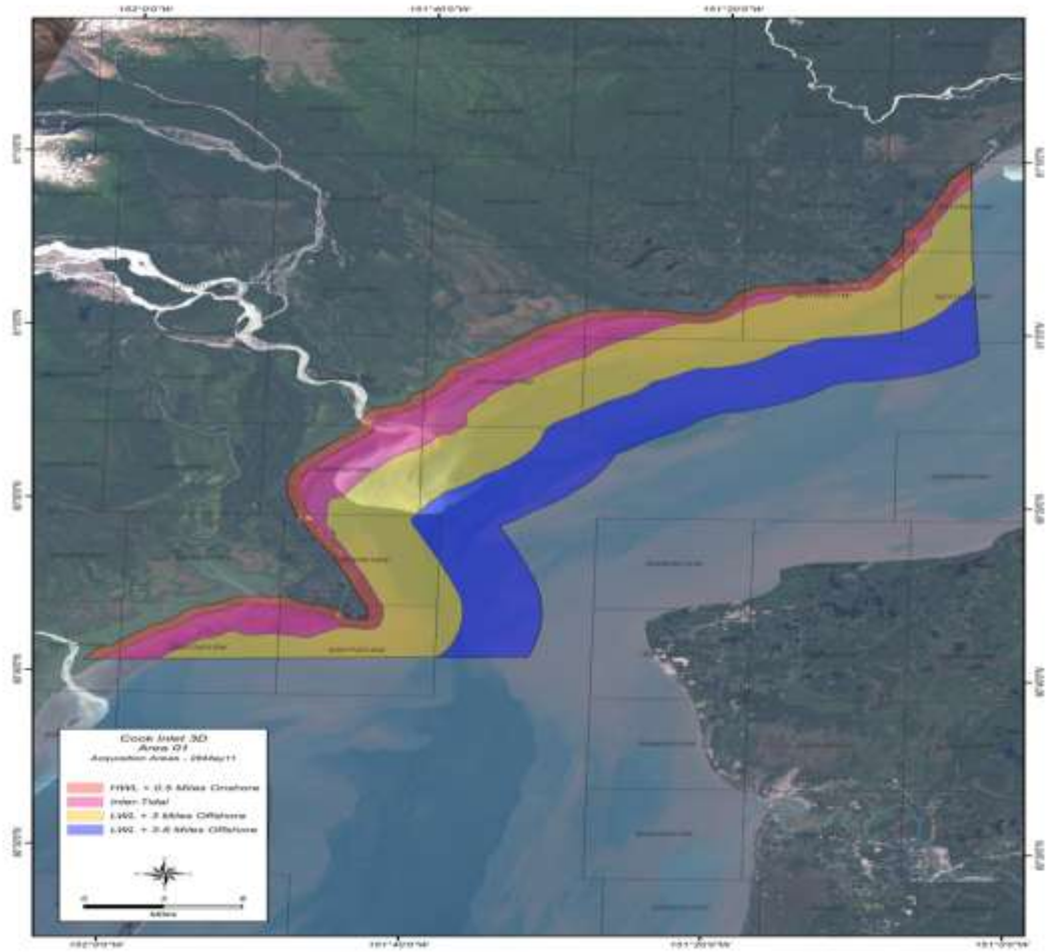

Figure 2. Map of Area 1 showing offshore and transition components.

Each phase of the program within an area includes an onshore component, a transition zone component, and an offshore component. Transition zone and offshore acquisition included areas below the high water mark as depicted in Figure 2. As noted below, the seismic program was comprised of multiple vessels with various missions. The vessels were active 24 hours a day; duties included transferring people and cargo between vessels and to shore, laying and picking of nodes, prepping for the in-water activity, airguns, and monitoring. The extreme tidal currents in Cook Inlet result in very high ambient noise and difficulties in utilizing equipment; therefore, in-water airgun activity only occurs during periods of lower tidal currents, generally slack tide. As a result, in-water airgun activity averaged only 10-12 hours per day, around each high and low slack tide (occurs four times a day).

Vessels laid and retrieved the nodal sensors on the sea floor bottom in periods of low current or, in the case of the intertidal area, during high tide. The offshore and transition zone source effort included the use of input/output sleeve airguns in two different array configurations: 440 and 2400 cubic inches (cui). Two seismic source vessels (*M/V Arctic Wolf* and *M/V Peregrine Falcon*) along with one mitigation vessel and additional support vessels were used during operations (Section 2.1.5). Water depths for the program ranged from 0 to 128 meters (m, 0 to 420 feet [ft]).

2.1 PROGRAM OVERVIEW – GENERAL

The following provides a general overview of the methods employed during the acquisition of the seismic survey.

2.1.1 Recording System

The recording system employed was an autonomous system or "nodal" system (i.e., no cables), which was made up of two types of nodes; one for the land and one for the intertidal and marine environment. For the land environment, this was a single- component sensor land node (Figure 3); for the inter-tidal and marine zone, this was a submersible multi-component system made up of three velocity sensors and a hydrophone (Figure 4). These systems have the ability to record continuous data. Inline receiver intervals for the node systems were 50 m (165 ft).

Figure 3. Onshore nodal recording system.

Figure 4. Offshore nodal recording system.

The geometry method that APACHE employed to gather the data is called *patch shooting*. This type of seismic surveying requires the use of multiple vessels for cable layout/pickup, recording, and sourcing. Operations began by laying nodes off the back of the layout vessels on the seafloor parallel to each other with a node line spacing of 402 m (1,65 ft). APACHE's patch had 6–8 node lines (receivers) laid parallel to each other. The lines generally ran perpendicular to the shoreline. The node lines were separated by either 402 or 503 m (1,320 or 1,650 ft). Inline spacing between nodes was 50 m (165 ft). The node vessels laid the entire patch on the seafloor prior to airgun activity. Individual vessels were capable of carrying up to 400 nodes. With three node vessels operating simultaneously, a patch was laid down in a single 24 hour period, weather permitting. Figure 5 depicts a sample patch shooting.

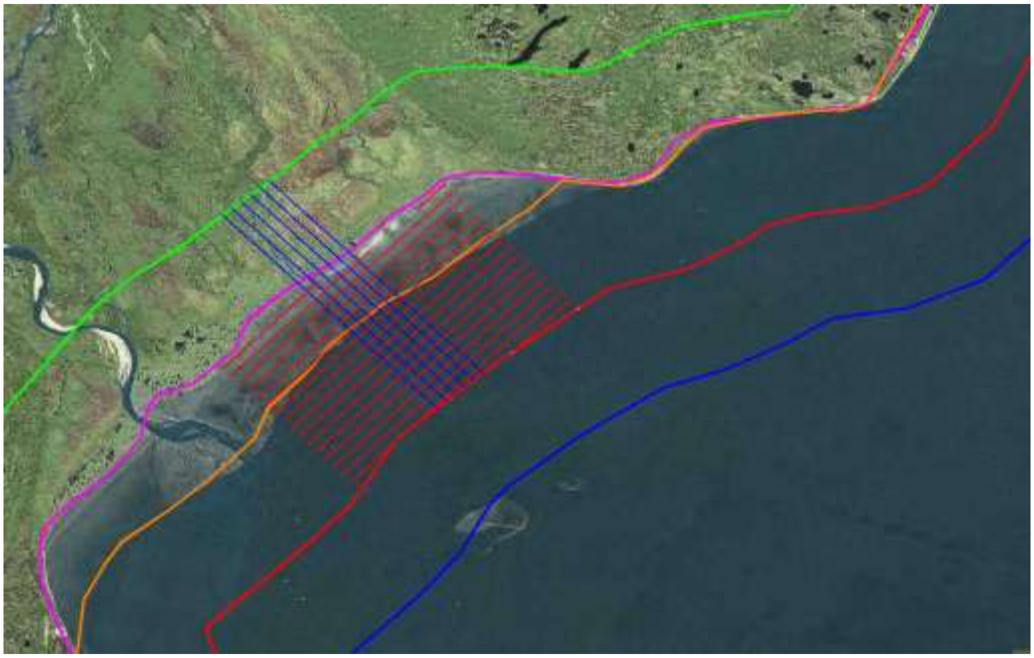

Figure 5. A single intertidal patch, six lines of nodes (blue), 16 source lines (red).

As the patches were acquired, the node lines moved either side to side or inline to the next patch's location. Figure 6 depicts multiple side to side patches that were acquired individually but when seamed together at the processing phase, create continuous coverage along the coastline.

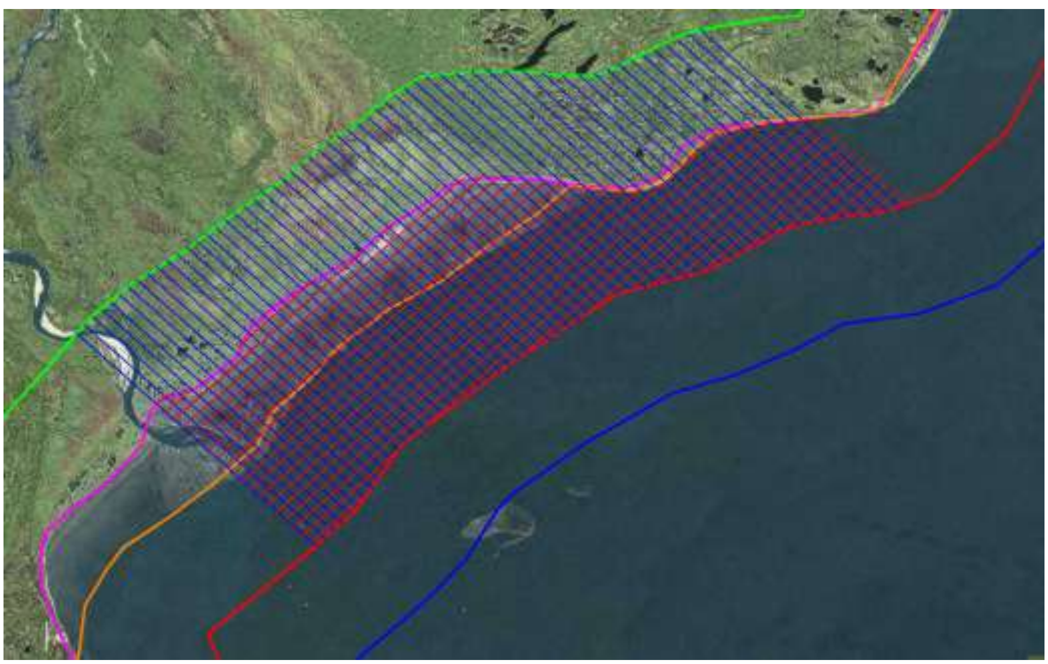

Figure 6. Multiple intertidal patches seamed together at the processing phase creating continuous coverage.

2.1.2 Sensor Positioning

2.1.2.1 Transition Zone/Offshore Components

Once the nodes were in place on the seafloor, the exact position of each node was required for proper data processing. Several techniques were used to locate the nodes on the seafloor, depending on the depth of the water. In very shallow water, the node's position was either surveyed by a land surveyor when the tide was low, or the position was accepted based on the position at which the navigator laid the unit.

In deeper water, two recognized techniques were used. The first includes a hull or pole mounted pinger to send a signal to the transponder attached to each node. The transponders were coded and the crew knew which transponder went with which node prior to the layout. The transponder's response (once pinged or "interrogated") was added together with several other responses to create a suite of ranges and bearings between the pinger boat and the node. Those data were then used to get a precise position of the node. In good conditions, the nodes were interrogated as they were laid out. It was also common for the nodes to be pinged after they had been laid out. The Sonardyne Shallow Water Cable Positioning system was the pinger used for this method. Additional instruments used included a Scout Ultra-Short BaseLine (USBL) Transceiver that operates at a frequency of 33-55 kiloHertz (kHz) at a max source level of 188 decibels referenced to one microPascal (dB re 1 µPa) at 1 m; and an USBL Transponder that operates at a frequency of 35-50 kHz at a source level of 185 dB re 1 µPa at 1 m.

The Ocean Bottom Receiver Location (OBRL) was the second technique used in deeper water. This technique used a small volume (10 cui) airgun firing parallel to the node line. The airgun was fired along each side of the line, the data were gathered from the node and combined with the known position of the airgun to give a precise location of each node during data processing. Figure 7 shows a typical pinger or OBRL geometry used to position the nodes. Once the patch of nodes were on the sea floor and positioning information was gathered, the source activity began.

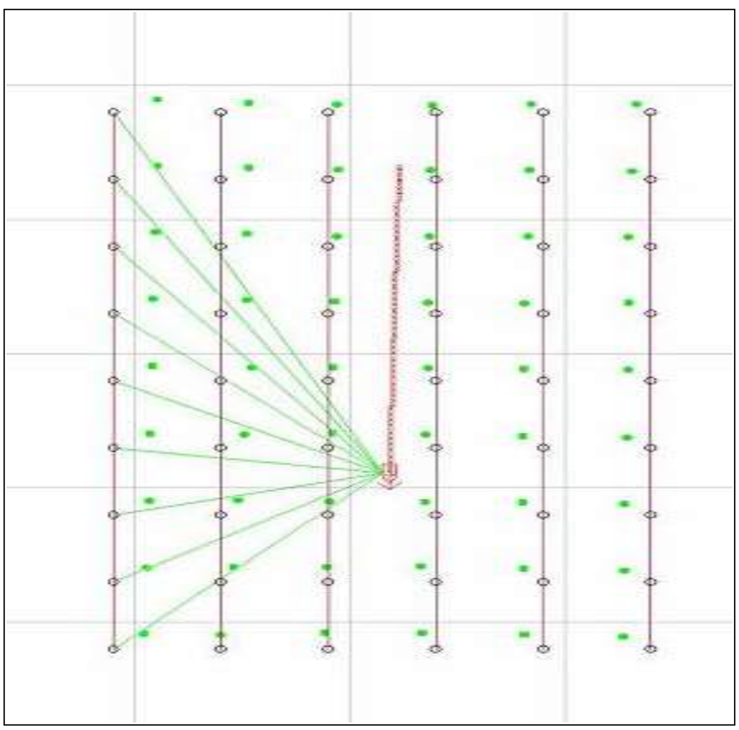

Figure 7. Pinger or OBRL vessel interrogating a patch of 6 lines.

2.1.2.2 Onshore/Intertidal Components

Onshore and intertidal locating of source and receivers was accomplished with Differential Global Positioning System/Roving Units (DGPS/RTK) equipped with telemetry radios linked to a base station established on a source vessel. Survey crews had both helicopter and light tracked vehicle support. Offshore source and receivers were positioned with an integrated navigation system (INS) utilizing DGPS/RTK link to the land located base stations. The integrated navigation system was capable of many features that are critical to efficient safe operations including a hazard display system that can be loaded with known obstructions, or exclusion zones. Typically the vessel displays were also loaded with the day-to-day operational hazards, buoys, etc. This display gave a quick reference when a potential question regarding positioning or tracking arose. In the case of inclement weather, the hazard display was used to vector vessels to safety.

2.1.3 Seismic Source

2.1.3.1 Transition Zone/Offshore Components

APACHE's transition zone and offshore components methods employed the use of two source vessels synchronized in time. The *M/V Arctic Wolf* and *M/V Peregrine Falcon* were equipped with air compressors and 2400 cui airgun arrays. In addition, the *M/V Peregrine Falcon* was equipped with a 440 cui shallow water source which it could deploy at high tide in the intertidal area in less than 1.8 m (6 ft) of water. Source transit lines were orientated perpendicular to the node lines and parallel to the beach (Figure 5). The two source vessels traversed the source lines of the same patch using a shooting technique called *ping/pong*. The ping/pong method had the first source boat commence the source effort. As the first airgun pop initiated, the second airgun boat sent a command and began a countdown to pop its guns 12 seconds after the first vessel. The first source boat would then take its second pop 12 seconds after the second vessel had popped and so on. The vessels tried to manage their speed so that they covered approximately 50 m (165 ft) between pops, which meant the vessel speeds ranged from approximately 2-5 knots. The objective was to generate source positions for each of the two arrays close to a 50 m (165 ft) interval along each of the source lines in a patch. The source effort averaged 10-12 hours per day, as it was only feasible to collect seismic data during periods of low currents (typically high and low slack tides).

Each source line was approximately 12.9 kilometer ([km]; 8 mile [mi]) long. A single vessel was capable of acquiring a source line in approximately 1-2 hours. With two source vessels operating simultaneously, a patch of approximately 3,900 source points were acquired in a single day averaging a 10-12 hour source effort. When the data from the patch of nodes were acquired, the node vessels picked up the patch and rolled it to the next location. The pickup effort took 3/4 of a day.

2.1.3.2 Onshore/Intertidal Components

The onshore source effort used shot holes. The crew drilled holes every 50 m (165 ft) along source lines which were orientated perpendicular to the receiver lines and parallel to the coast. To access the onshore drill sites, APACHE used a combination of helicopter portable and tracked vehicle drills. At each source location, APACHE drilled to the prescribed hole depth of approximately 10 m (35 ft) and loaded it with 4 kilograms (kg) of explosive (Orica OSX Pentolite Explosive). The hole was capped with a "smart cap" that made it impossible to detonate the explosive without the proper blaster.

At the request of NMFS, APACHE conducted a test to determine in-water sound levels from the land-based explosives in the mudflats on Trading Bay on September 17, 2011 to determine if marine mammal monitoring would be required for this activity. The results indicated received in-water sound levels were well below the 160 dB Level B threshold; therefore, no further monitoring was required during this portion of the seismic survey. The final report submitted to NMFS is provided in Appendix C-1.

2.1.4 Aircraft Support

Aircraft support consisted of a Bell 407 helicopter and twin-engine Islander fixed-wing aircraft. The Bell 407 helicopter was used during aerial surveys to monitor for marine mammals when seismic activity took place along the west coast of Cook Inlet. During the aerial surveys, the helicopter stayed within approximately 1.6 km (1 mi) of shore due to safety restrictions for personnel. The helicopter also delivered equipment and personnel along the line or lines on a daily basis. As seismic activity moved easterly, aerial surveys were conducted with *Rediske Air* from a twin-engine Islander fixed-wing aircraft in Nikiski. The Bell 407 helicopter was still used to transport equipment and personnel on a daily basis. Refer to Section 4.6 for details on the aerial surveys.

2.1.5 Vessel Support

Eleven vessels operated for the *Cook Inlet 3D Seismic Program* including the *M/V Arctic Wolf*, *M/V Peregrine Falcon*, *R/V Westward Wind*, *M/V Miss Diane*, *M/V Mark Stevens*, *M/V Maxime*, *M/V Dreamcatcher*, *R/V Norseman I*, *M/V Side Winder*, *M/V Sleeprobber*, and *M/V My Marie* (Table 1). These vessels served as the primary offshore acquisition platforms. The source vessels included the *M/V Arctic Wolf* and *M/V Peregrine Falcon*. The *M/V Dreamcatcher* was the primary mitigation vessel. All other boats acted as support vessels.

2.1.6 Crew Accommodations

The onshore crews were housed in commercial facilities located near the project site. Offshore staff was housed on the vessels, which are certified for housing crew 24 hour per day (Table 1).

2.1.7 Fuel Storage

Any fuel storage required within the program site was positioned away from waterways and lakes and located in modern containment enclosures. The capacity of the containment was 125% of the total volume of the fuel stored in the bermed enclosures. All storage fuel sites were equipped with additional absorbent material and spill clean-up tools. Any transfer or bunkering of fuel for offshore activities occurred either dock side or complied with U.S. Coast Guard (USCG) bunkering at sea regulations.

Table 1. Details on the Vessels Operating for the *Cook Inlet 3D Seismic Program*

Vessel	Vessel Purpose	Size	Documentation No.	Call Sign	Gross Tonnage	Berths
M/V Arctic Wolf	Source vessel	41 m x 9 m (135 ft x 30 ft)	687450	-	251	22
M/V Peregrine Falcon	Source vessel	26 m x 6 m (85 ft x 24 ft)	950245	WCZ6285	131	10
R/V Westward Wind[1]	Node vessel	47 m x 10 m (155 ft x 34 ft)	595289	WCX9055	289	32
M/V Miss Diane	Node vessel	26 m x 6 m (85 ft x 20 ft)	1210779	WAV0779	53	6
M/V Mark Stevens[2]	Node vessel	26 m x 6.7 m (85 ft x 22 ft)	1238385	WCZ7941	81	-
M/V Maxime	Transfer vessel	21 m x 4.9 m (70 ft x 16 ft)	1196716	WAV6716	48	4
M/V Dreamcatcher	Mitigation vessel	26 m x 7.1 m (85 ft x 23 ft)	963070	WBN5411	100	22
R/V Norseman I[3]	Housing Management	33 m x 8.5 m (108 ft x 28 ft)	553713	WDC6817	197	-
M/V Side Winder[4]	Imaging vessel	11 m x 4 m (36.8 ft x 14 ft)	1091516	WCZ6262	16	-
M/V Sleeprobber[5]	Crew/Equipment Transport	-	-	-	-	-
M/V My Marie[6]	Crew/Equipment Transport	-	-	-	-	-

[1] *R/V Westward Wind* operated on the project July 1-21.

[2] *M\V Mark Stevens* arrived at the project area on July 19.

[3] *R/V Norseman I* arrived and began operating on the project July 29.

[4] *M\V Side Winder* left the project area on September 19.

[5] *M\V Sleeprobber* arrived at the project on September 3.

[6] *M\V My Marie* arrived at the project on August 16.

3.0 SPECIES AND ABUNDANCE OF MARINE MAMMALS IN THE AREA

Of the 15 species of marine mammals with documented occurrences in Cook Inlet, only five commonly occur in the upper inlet: Cook Inlet beluga whale, killer whale, harbor porpoise, Steller sea lion, and harbor seal (Shelden et al. 2003). These five were included in the IHA application and specific numbers of Level B takes for each species were authorized by the IHA. Table 1 provides a summary of the abundance and status of the species that could potentially occur in the project area, as well as the authorized takes and actual takes. The Cook Inlet beluga whale, harbor porpoise, and harbor seal were sighted most frequently during the *Cook Inlet 3D Seismic Program*. The killer whale and Steller sea lion were not sighted during the program. Additionally, there were two species that were not included in the IHA application that were sighted, the gray whale and California sea lion. The abundance and status of these species are added to Table 1.

Table 2. Marine Mammal Species in Cook Inlet

Species	Abundance	Comments	Authorized Takes in IHA	Actual Takes During Seismic Work
Beluga whale (*Delphinapterus leucas*)	284 [1]	Occurs in the Area 1. Listed as depleted under the MMPA, endangered under ESA, critical habitat in the project.	30	0
Killer whale *(Orcinus orca)*	1,123 Resident 522 Transient [2]	Occurs rarely in the Area 1. No special status or ESA listing.	10	0
Harbor porpoise *(Phocoena phocoena)*	25,987 [3]	Occurs in the Area 1. No special status or ESA listing.	20	4
Steller sea lion (*Eumatopia jubatus*)	42,286 [4]	Occurs infrequently in the Area 1. Listed as depleted under the MMPA, endangered under ESA.	20	0
Harbor seal *(Phoca vitulina richardsi)*	22,900 [5]	Occurs in the Area 1. No special status or ESA listing.	50	13
Gray whale (*Eschrichtius robustus)*	19,126[6]	Does not typically occur in project area. No special status or ESA listing.	0	0
California sea lion (*Zalophus californianus*)	296,750[6]	Does not typically occur in project area. No special status or ESA listing.	0	0

Notes: MMPA = Marine Mammal Protection Act, ESA = Endangered Species Act
[1]Hobbs et al. 2011
[2]Resident estimate from Alaska resident stock; transient estimate from Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock (Allen and Angliss 2012)
[3]Abundance estimate for the Gulf of Alaska stock (Allen and Angliss 2012)
[4]Abundance estimate for the western stock (Allen and Angliss 2012)
[5]Abundance estimate for the Cook Inlet/Shelikof stock (Allen and Angliss 2012)
[6]Abundance estimate for the Pacific region (Allen and Angliss 2012)

4.0 MONITORING METHODS

4.1 DEFINITION OF MONITORING ZONES

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as "…any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "…any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering."

Since 1997, NMFS has been using generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (70 FR 1871). The current Level A (injury) threshold for impulse noise is 180 dB re 1 µPa root mean square (rms) for cetaceans (whales, dolphins, and porpoises) and 190 dB re 1 µPa rms for pinnipeds (seals, sea lions). The current Level B (disturbance) threshold for impulse noise is 160 dB re 1 µPa rms for cetaceans and pinnipeds.

APACHE's marine mammal monitoring and mitigation program ensured visual and acoustic coverage of the project area. The project area is defined by the 160 dB safety zone for the current patch of seismic activity. Safety zones are further discussed in Section 5.1; however, the 160 dB safety zones will be referred to as the Disturbance Zone (DZ) and the 190 dB and 180 dB safety zones will be referred to as the Exclusion Zone (EZ) hereafter in this report.

4.2 DESCRIPTION OF MONITORING PLATFORMS

APACHE's marine mammal monitoring and mitigation program included vessel, aerial, land, and passive acoustic platforms. Vessel observations took place from two source vessels (*M/V Arctic Wolf* and *M/V Peregrine Falcon*) and one mitigation vessel (*M/V Dreamcatcher*; Section 2.1.5). Two other vessels (*R/V Westward Wind* and *R/V Norseman I*) were used periodically for monitoring when additional monitoring efforts were required or when the *M/V Dreamcatcher* was unavailable due to weather and/or logistics. Aerial overflights were conducted in either a helicopter or fixed-wing aircraft (Section 2.1.4). Land-based observations took place from four different stations: Shirleyville, Tyonek Dock, Bluff Site #1, and Offshore Systems Kenai (OSK) Dock in Nikiski, Alaska (Figure 8). The land-based stations were selected for observations based on proximity and location in relation to project operations. Passive acoustic monitoring took place on the mitigation vessels. All data forms are included in Appendix D.

4.3 PROTECTED SPECIES OBSERVERS

The seismic contractor, SAExploration, employed a large team of trained and experienced Protected Species Observer (PSOs) for this program. All PSOs had experience in marine mammal research and monitoring. All PSOs were approved by NMFS prior to the start of the program or their rotation into the project. PSOs were trained on specific project details and requirements and sighting information for the specific marine mammals found in the project area prior to going to the project site. At any given time, there were seven to ten PSOs on the project site at all times: two on each source vessel *M/V Arctic Wolf* and *M/V Peregrine,* two on the *M/V Dreamcatcher* and one to four at the land-based station(s) occasionally with PSOs at two sites.

All PSOs were equipped with reticle binoculars (Fujinon 7 × 50). Reticle conversions for each vessel bridge or land platform were determined using eye height of the PSO to assist in distance estimations. Eye height from a vessel-based station was calculated as the distance from the surface of the water to the PSO's eye level. Eye heights from a land-based station was calculated as the distance from the water level at high or low tide to the PSO's eye level. The two water levels were used (high and low tide) to provide minimum and maximum distances to sighted marine mammals.

"Big Eyes" binoculars (20 x 100) were also used on both the *M/V Arctic Wolf* and *M/V Dreamcatcher*, but were unsuccessful due to the movement of the vessel, resulting in vibration in the "Big Eyes" through the portable tripod. Mounting "Big Eyes" in a cradle on the deck would improve the success of the instrument on the vessel.

"Big Eyes" binoculars (20 x 100) were used at the land-based stations. These binoculars proved successful from the land-based stations as they were stationary and assisted in the detection, observation and identification of marine mammals at a great distance (upwards of 5 km [3.1 mi]) from land. The land-based stations were typically staffed with two observers; one using the "Big Eyes" and one scanning with the naked eye and Fujinon 7 x 50 binoculars.

4.4 PSO ROLES AND RESPONSIBILITIES

Two PSOs were generally based at each observation station. The PSOs watched for marine mammals prior to and during seismic activity to monitor the DZ. Opportunistic observations took place when applicable from the mitigation vessel and on days when seismic activity did not take place. One PSO was designated as the Lead PSO. The Lead PSO's responsibilities on the source vessels included communication with the Operations Team and daily quality checking and submission of the data. The Lead PSO's responsibilities on the mitigation vessel included communications with the Acoustics Team and management of vessel placement in relation to land observations to ensure that both the upper and lower inlet side of the project area were visually covered during seismic operations.

4.5 VESSEL OBSERVATIONS

PSOs on the vessels rotated observation shifts every 4 - 6 hours in order to better monitor the project area, implement mitigation measures and avoid observer fatigue. Observations occurred during all daylight hours prior to and during seismic operations, unless precluded by weather conditions (e.g., fog, ice, high sea states). Vessel-based observers watched for marine mammals from the bridge, the best available vantage point on the operating source and mitigation vessels. PSOs systematically scanned the area around the vessel in a sweeping pattern, usually alternating scan sweeps between reticle binoculars (Fujinon 7 × 50) and the unaided eye. Observations were focused forward and to the sides of the vessel in an arc of ~180º; however, PSOs regularly checked for the presence of marine mammals astern of the vessel.

4.5.1 2 km Vessel Separation Guideline

When the *M/V Arctic Wolf* and *M/V Peregrine Falcon* were operating the 2400 cui airgun array simultaneously using the ping/pong method (Section 2.1.3), they were required to remain within 2 km (1.24 mi) of each other to act as a single source for monitoring and mitigation purposes. When the *M/V Peregrine Falcon* was operating the 440 cui array, it was not required to remain within 2 km (1.24 mi) of the *M/V Arctic Wolf* because the DZ for the 440 cui array (Section 5.1) could be monitored by the PSOs on the *M/V Peregrine Falcon* without assistance from observers on other platforms. The *M/V Peregrine Falcon* was the only source vessel that operated with the 440 cui airgun array and it only operated the 440 cui array during September with the exception of the *M/V Arctic Wolf* operating the 440 cu in array during the sound source verification (SSV) study in May (Appendix C-2).

4.6 AERIAL OBSERVATIONS

Safety and weather permitting, aerial overflights were implemented daily. Aerial overflights took place on the West side of Cook Inlet from May 8 – July 10 from a helicopter and then shifted to the East side of Cook Inlet from July 18 – September 30 and took place from fixed-wing aircraft (Section 2.1.4). Aerial observers were based at the land camp in either Shirleyville when operating on the West side, or Kenai when operating on the East side of Cook Inlet. Aerial overflights were scheduled based on availability of the helicopter and fixed-wing aircraft, visibility, and weather. They typically took place in the afternoon between the hours of 11:00 and 15:00.

Aerial overflights followed NMFS vessel operation and marine mammal viewing guidelines to minimize potential vessel and aircraft impacts. The aerial PSO was responsible for communicating with the pilot to ensure that proper marine mammal survey protocol was followed. For the duration of the survey, an altitude of 305 m (1,000 ft) or more was maintained. When operating with the helicopter a distance from shore of 1.6 km (1 mi) or less was maintained for safety reasons. In instances of marine mammal sightings, an altitude of at least 305 m (1,000 ft) and a radial distance of 457 m (1,500 ft) were maintained. These stipulations were implemented when permitted due to safety concerns, and in cases such as low cloud ceiling level or high winds, they were altered at the pilot's discretion. Aerial PSOs were in communication with the Lead PSOs on the vessels, especially during flights that took place within the DZ of seismic operations.

In the event that a marine mammal was observed within or near the DZ from the helicopter during seismic activity, the aerial PSO called for a shut down using the helicopter's radio and by stating "shut down" three times. The PSO instructed the pilot to circle the marine mammal while maintaining an altitude of 350 m (1,500 ft) and a radial distance of 457 m (1,500 ft). The Garmin 495 Global Positioning System (GPS) in the helicopter was used to obtain a latitude and longitude. The aerial PSO then relayed the position to the source vessel PSOs in order for them to determine their distance from the marine mammal. Details on marine mammal distance estimations are found in Section 5.9.1.

During aerial overflights from the fixed-winged aircraft, there were no marine mammal observations within or near the DZ; however, protocols were in place and the aerial PSO would communicate with the vessel PSOs via cell phone. A GPS was not available on the fixed-winged aircraft to document the location of observed marine mammal, and therefore, the aerial PSO used geographical features (e.g., mouth of the Susitna River) to identify and estimate the location of the marine mammal.

Aerial observations consistently successfully identified large congregations of beluga whales and haul out sites of harbor seals in the main river mouths. Spatial knowledge of river mouths and areas located near but not within the project area allowed for better planning by the PSOs and assisted in better understanding of the movement of large groups of belugas with respect to the tide. Aerial observations were often not used for real time mitigation, but were occasionally used as an attempt to locate rarely seen mammals (e.g., gray whales) that were difficult to track from the vessels.

4.6.1 Aerial Overflight Route on the West Side of Cook Inlet

Aerial overflights on the West side of Cook Inlet extended from the southern end of the Big Susitna River to the McArthur River and approximately 1.6 km (1 mi) offshore due to safety restrictions (Figure 8)

4.6.2 Aerial Overflight Route on the East Side of Cook Inlet

Aerial overflights on the East side of Cook Inlet typically departed from Nikiski, traveled across the inlet to the Susitna River, south to the McArthur River, transiting within 1.6 km (1 mi) of the shoreline, followed by 2-4 transects spaced approximately 2 km (1.2 mi) apart over the project area and then returned to Nikiski (Figure 8).

4.7 LAND OBSERVATIONS

One to four PSOs were stationed at a land-based observation station throughout the duration of the project. The Lead PSO on land was responsible for coordinating observation hours and set up at one of four observation platforms. The land-based platforms on the West side of Cook Inlet include Shirleyville, Tyonek Dock, Bluff Site #1, and on the East side was restricted to the OSK Dock (Figure 8). Land PSOs scheduled observations to begin at least 30 minutes prior to seismic activity, continue during seismic activity and finish 15 minutes after shooting ceased. Platform use was coordinated with the positioning of the *M/V Dreamcatcher* to ensure that both up- and down-inlet sides of the current patch of the project area were monitored. The Lead PSO through the Seismic Crew Project Manager on land coordinated transportation to and from land platforms. Bear safety protocol was followed at each land-based platform;

PSOs were provided with either a truck or a Bear Guard. When a marine mammal was observed within or near the DZ from the land-based platform during seismic operations, the PSO on land would call a shut down over the radio monitored by all vessels. The PSO noted the time the shut down was requested, and the time that the last airguns were shut off (i.e., the mitigation time requested and mitigation time implemented).

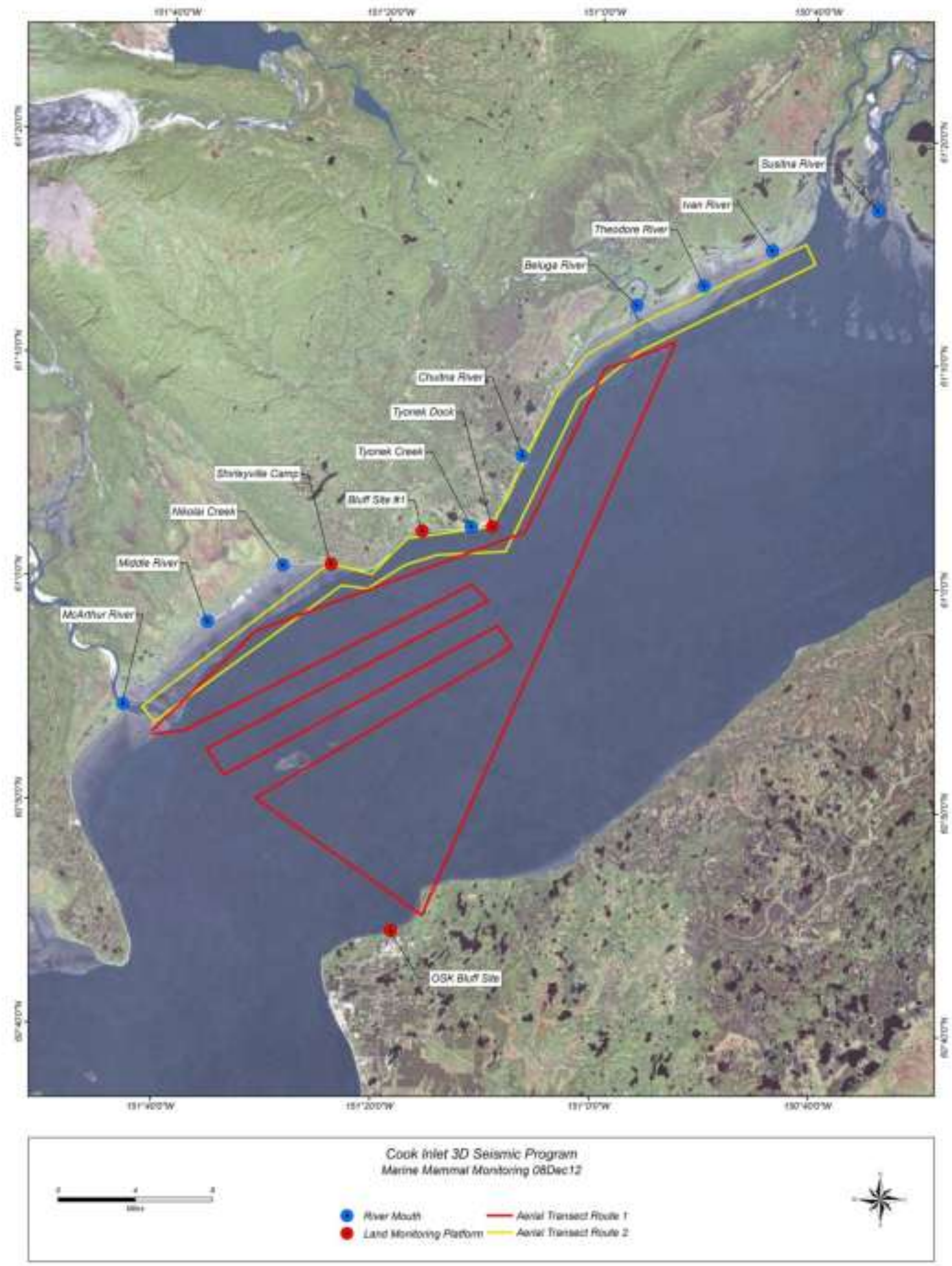

Figure 8. Map of the land-based observations (red dots) and aerial overflight routes; Aerial Transect Route 1 from the East side (red) and Aerial Transect Route 2 from the West side (yellow).

4.8 PASSIVE ACOUSTIC MONITORING

The original passive acoustic monitoring (PAM) plan envisioned the use of a bottom-mounted telemetry buoy to broadcast acoustic measurements using a radio-system link back to a monitoring vessel. Although the buoy was deployed in the first week of the program, it was not successful. Upon deployment, the buoy immediately turned upside down due to the strong current of Cook Inlet. After retrieval, it was not re-deployed as the operations of the seismic program were transient and would have recovered numerous deployments and retrievals in an extremely difficult environment. Therefore, for safety reasons of both the equipment and personnel retrieving/deploying, the buoy was not used. Instead, the study used a single omni-directional hydrophone lowered from the side of the mitigation vessel (*M/V Dreamcatcher*).

4.8.1 Over-the-side Hydrophone

The final report from the acoustic contractor, JASCO Applied Sciences (JASCO), on the PAM program is included in Appendix C-3. A single TC4032 RESON hydrophone was lowered over-the-side (OTS) of the vessel with a 10 m (32 ft) cable that was attached to a monitoring and recording station aboard the *M/V Dreamcatcher*. A hydrodynamically-shaped weight sunk the hydrophone several feet below the surface of the water. Protected Species Acoustic Observers (PSAOs) performed real-time monitoring on the bridge of the vessel using an Acoustic Data Acquisition and Monitoring System (ADAMS) and a laptop computer that displayed and recorded the acoustic data. JASCO's custom software, SpectraPlotter, displayed the signal amplitude and spectrum while continuously processing the data for acoustic event detection. The incoming acoustic signals were recorded as WAV files at a sample rate of 64,000 samples per second to allow for monitoring up to 32 kHz.

The Acoustic Team consisted of two PSAOs monitoring on rotating 6-hour schedules. A PSAO visually monitored a scrolling spectrogram display and listened to the data stream through headphones (Figure 9). The PSAOs immediately communicated all marine mammal detections to the PSO on the vessel and logged the detections in the daily report.

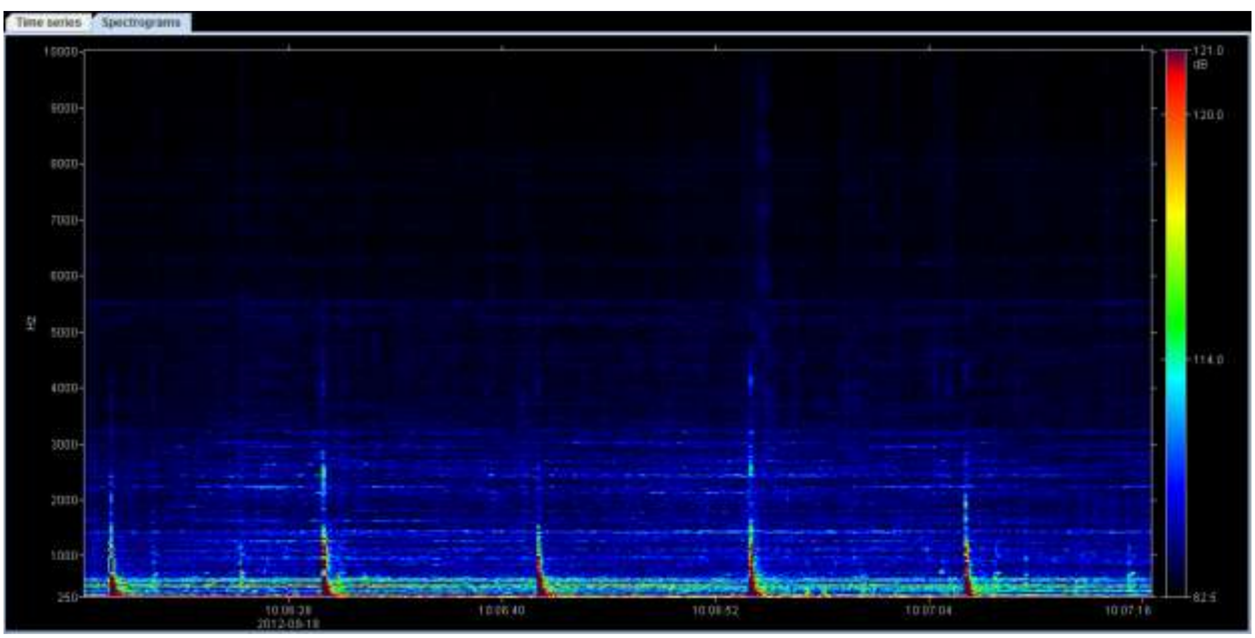

Figure 9. Photo of PAM display during slack tide on August 19, 2012. Airgun pulses are visible as periodic impulses.

4.9 DATA COLLECTION

4.9.1 Environmental Conditions

PSOs recorded environmental conditions every 30 minutes or after any noticeable changes. Conditions recorded included Beaufort Wind Force and Sea State, tides and currents, sunrise and sunset, wind direction, ice coverage (percent), cloud coverage (percent), glare (location and amount), visibility and precipitation. Beaufort Wind Force and Sea State, tides and currents, and sunrise and sunset are further defined below. All other variables are defined in Appendix D-4. Data were entered in *Microsoft Excel™* for storage and subsequent analysis.

4.9.1.1 Beaufort Wind Force and Sea State

The Beaufort Wind Force and Sea State definitions are found in Appendix D-5. In Cook Inlet the Beaufort Sea State is also greatly affected by the massive tidal fluctuations and currents.

4.9.1.2 Tide/Current

Tide tables and currents were determined using predicted tide tables and were generated by month and the location of the seismic activity (Table 3). The location of the seismic activity determined which tidal station data were used when calculating tides.

Table 3. Month and Location Used to Determine Tides

Month	Tidal Station Location
May	North Foreland
June	North Foreland with a combination of currents from Middleground Shoals
July	North Foreland
August	North and East Foreland averaged
September	Nikiski

4.9.1.3 Sunrise/Sunset

Sunrise and sunset times were calculated based on times from Tyonek when operating on the West side and on times from Nikiski when operating on the East side. Sunrise and sunset times were used for determining day and night operations.

4.9.2 Marine Mammal Sightings

Data collected when marine mammals were observed included the date, time, species, behavior, group size and composition, platform, location of initial sighting (latitude and longitude when seen from vessel or helicopter), seismic activity (on or off), airgun volume, estimated distance to the source vessels, mitigation measure implemented, whether or not the animal was considered a “take,” and any additional comments regarding the sighting. Details on the data collected during marine mammal sightings are found in Appendix D-1, D-2, and D-3 for vessel, land, and aerial surveys, respectively. Data were entered in *Microsoft Excel™* for storage and subsequent analysis.

4.10 DATA ANALYSIS

4.10.1 Monitoring Effort, Environmental Conditions and Seismic Activity

The total monitoring effort was summarized per platform per month. The proportion of effort per platform was then calculated. Monitoring effort (hours) affected by environmental conditions was investigated. Environmental variables examined include the daily mean Beaufort Sea State and the daily mean visibility. Cook Inlet was ice-free during the entire 2012 seismic program; therefore, the effects of ice coverage on monitoring effort were not examined. Mean percent cloud coverage and the daily presence and absence of glare are discussed in Section 6.1.2. If environmental data were not documented for a particular day, that day was excluded from the specific environmental analysis.

Monitoring effort with and without seismic activity was examined. The total seismic activity was calculated per airgun array (i.e., 10 cui, 440 cui, and 2400 cui) per month using the gun logs provided by the seismic operators. Aerial overflight monitoring effort was excluded from this analysis because the majority of the overflights and sightings from overflights were outside the project area. PAM was also excluded from this analysis because a separate analysis examining PAM with and without seismic activity is found in Section 6.7. Proportion of time monitored with and without seismic activity was calculated per platform per month by subtracting the monthly monitoring effort with the monthly seismic activity. The *M/V Arctic Wolf* was used to calculate vessel-based monitoring effort with and without seismic activity because the *M/V Arctic Wolf* had the greatest amount of monitoring effort for the vessels, and therefore, best represents the vessel-based effort. All other vessels were excluded due to redundancy. The 10 cui airgun array was excluded from the analyses of the vessel- and land-based monitoring effort with and without seismic activity because it generally took place during night-time operations when visual observations did not take place.

4.10.2 Marine Mammal Observations

Marine mammal sightings from May 6 – September 30, 2012 from vessel, land, and aerial platforms were summarized and include the number of sightings and number of estimated individuals. PAM detections are discussed in Section 6.7. Sightings where then summarized by platform (vessel, land, aerial) by month and include number of sightings, number of estimated individuals, average estimated group size, group size minimum, group size maximum and sighting rate. Sighting rates were determined by dividing the total monthly sightings with the monthly monitoring effort per species.

4.10.3 Sightings With and Without Seismic Activity

Number of sightings with and without seismic activity were compiled and summarized from the vessels and land platforms. The aerial platforms were excluded from these counts due to the extensive distance (typically >15 km [>9.32 mi]) from the project area.

4.10.4 Closet Point of Approach (CPA) With and Without Seismic Activity

Initial observed behavior and Closest Point of Approach (CPA) was analyzed in comparison with or without seismic activity for beluga whale, harbor porpoise, harbor seal, and gray whale. Behavior was specified by those most commonly observed and by species. Beluga whale behavior was divided into the following categories: travel, mill, dive, forage, swim, and unknown. Harbor porpoise behavior was divided into travel, mill, dive, swim, and unknown. Harbor seal behavior was divided into travel, mill, dive, forage, swim, look, look/sink, sink, rest, hauled out, and unknown. Gray whale behavior was divided into swim/mill with fluke down dives, swim/mill with fluke up dives, and travel with fluke down dives as these were the most frequently observed behavior states for the small number of sightings.

CPA was calculated as the closest point of approach to the seismic active source vessel. If both source vessels were in operation then the closest vessel was used. Due to the extensiveness of the monitoring zone and multi-platforms CPA was divided into the following intervals:

- <1000m
- 1000-1999m
- 2000-2999m
- 3000-3999m
- 4000-4999m
- 5000-5999m
- 6000-6999m
- 7000-7999m
- 8000-8999m
- 9000-9999m
- >10,000m

4.10.5 Temporal and Spatial Distribution

Beluga whale, harbor porpoise, and harbor seal (estimated number of individuals) temporal and spatial distribution were summarized by month from all platforms. Beluga whale and harbor seal temporal and spatial distribution were then examined in more detail from aerial overflight observations because the aerial overflights covered an extensive area and large congregations of animals were observed. Beluga whale monthly distribution was mapped using *ArcInfo ArcGIS 10.0* (ESRI, Redlands, CA).

4.10.6 Marine Mammal Takes

Marine mammal takes are summarized by date, time, species, number of individuals, behavior, distance from the source vessel (*M/V Arctic Wolf* or *M/V Peregrine Falcon*), and the airgun volume.

5.0 MITIGATION PROCEDURES

The following mitigation measures were implemented for marine mammal observations during the *Cook Inlet 3D Seismic Program*:

(1) Establishing Safety Zone

(2) Clearing Safety Zone

(3) Ramp-Up

(4) Power Down

(5) Shut Down Followed by Power Down

(6) Shut Down

(7) Mitigation Gun

(8) Communicating Mitigation Measures

(9) Additional Mitigation Protocols

The following text provides details on these measures.

5.1 ESTABLISHING SAFETY ZONES

Safety zones are the areas of monitoring and mitigation that are designated based on safety radii. Safety radii are defined as the distance from the seismic source to a received in-water sound level of 190 dB (pinnipeds) and 180 dB (cetaceans) that could be loud enough to cause injury and 160 dB (all marine mammals) for harassment. Monitoring measures for the first two weeks were based on the estimated safety radii (Table 4) included in the IHA application. A Sound Source Verification (SSV) was conducted on May 6-8, 2012 to determine actual safety radii (Appendix C-2). After completion of review by NMFS of this report, the DZ was increased to 9.5 km (5.9 mi).

Table 4. Modeled and Measured Safety Radii

Source	190 dB Injury Zone (Pinnipeds)	180 dB Injury Zone (Cetaceans)	160 dB Harassment Zone (Groups of >5 beluga whales & female/calf pairs)
Modeled Safety Radii			
Pinger	1 m	3 m	25 m
10 cui airgun (mitigation gun)	10 m	33 m	330 m
2400 cui airgun (nearshore)	510 m	1,420 m	6,410 m
2400 cui airgun (offshore)	1,180 m	980 m	4,890 m
Measured Safety Radii			
10 cui airgun (mitigation gun)	10 m	10 m	280 m
440 cui airgun	100 m	310 m	2,500 m
1200 cui airgun	250 m	910 m	5,300 m
2400 cui airgun	310 m	1,400 m	9,500 m

5.2 CLEARING SAFETY ZONE

The DZ was considered cleared at the beginning of seismic operations if the entire DZ was visible for a minimum of 30 minutes and no marine mammals were observed. Following a shut down or power down, seismic activity would not resume until the marine mammal had cleared the DZ. The animal was considered to have cleared the DZ if it:

- was visually observed to have left the DZ
- had not been seen within the DZ for 15 min in the case of pinnipeds and harbor porpoise
- had not been seen within the DZ for 30 min in the case of cetaceans
- had not been seen or detected in or around the DZ for 60 minutes in the case of marine mammals not covered by the IHA. Upon approval from NMFS on July 11, the clearing safety zone time for gray whales was changed from 60 minutes to 45 minutes.
- If a pinniped or harbor porpoise was sighted and cleared within the initial 30 minute clearing time, ramp up could continue normally at the end of the 30 minute period. For example: if clearing started at 12:00 with expected completion at 12:30 and a harbor seal was sighted at 12:05 and last re-sight is at 12:10. The 15 minute clear post re-sight would be over at 12:25, thus allowing ramp up to start as scheduled at 12:30.

Level A Take Zone visibility for 30 minute clearing

The IHA states: "*No initiation of survey operations involving the use of sound sources is permitted from a shut-down at night or during low-light (heavy rain – dense fog) when the entire relevant EZ cannot be monitored*". This was interpreted as the Level A Take Zone (1,400 m [4,595 ft]) thus observers required that 2 km (1.2 mi) be visible from source vessels for the entire 30 minute clearing prior to ramp up. If fog or rain limited visibility to less than 2 km (1.2 mi), the 30-minute clearing was to start again when visibility reached 2 km (1.2 mi). Once vessels started ramp up, they could continue shooting no matter how limited the visibility, similar to night operations (Section 5.9.4)

5.3 RAMP UP PROCEDURE

Ramp up procedures were implemented at the start of airgun operations after clearing the DZ, or after a power down, shut down, or any time period greater than 10 minutes in duration without airgun operations. The ramp up procedure allowed for a gradual increase in airgun volume at a specified rate. Ramp up began with the smallest airgun in the array used for all airgun array configurations. During the ramp up, the DZ for the full airgun array was continuously observed. The rate of ramp up was no more than 6 dB per 5-minute period, which is approximately doubling the airgun volume (Table 5). The ramp up process generally took 20 - 25 minutes to complete.

If 2 km (1.2 mi) around the source vessels were not visible for a minimum of 30 minutes prior to the start of operations, ramp up would not commence. During night time operations (Section 5.9.4), any cessation of seismic activity at 440 cui airgun array or greater had to be followed within 10 minutes by initiation of the mitigation gun if further night time seismic operations were to occur, such as on the following tide cycle. Ramp up was not permissible from a complete shut down in thick fog or at other times when the outer part of the DZ was not visible.

After the 30 minute clearing period if an animal was observed outside the 180 dB and 190 dB but within the 160 dB (at a distance greater than 1,400 m [4,595 ft] but within 9,500m [5.9 mi]), then a modified ramp up would be implemented to the power level that kept the animal outside the DZ. For example, if an animal was observed between 5,300 m (3.3 mi) and 9,500 m (5.9 mi), then a ramp up to 1200 cui would be permitted as long as PSOs could continue to monitor the animal. If it was not possible to monitor the marine mammal (i.e., a seal that pops up and dives quickly), then PSOs would request that operations wait the full designated time (15 minutes for pinnipeds and 30 minutes for cetaceans) to ramp up to the full volume.

Table 5. Ramp Up Protocol for the 2400 cui Array

Time (minutes)	No. Airguns	Airgun Volume (cui)
00:00	1	150
05:00	2	300
10:00	4	600
15:00	8	1200
20:00	16	2400

5.4 POWER DOWN PROCEDURE

A power down procedure involved reducing the number of airguns in use such that the radius of the 160 dB zone was decreased to the extent that sighted marine mammals were not in the DZ. During a power down, gun of smaller volume or the mitigation airgun was operated. For example, operation of the mitigation gun allowed the DZ to decrease to 10 m, 33 m, and 330 m for the 190 dB, 180 dB, and 160 dB, respectively. If a marine mammal was detected outside the DZ but was likely to enter the DZ, the airguns could power down before the animal was within that DZ, as an alternative to a complete shut down.

Power down procedures when a marine mammal was observed at distances greater than 2.5 km (1.5 mi):

- < 2.5 km (1.5 mi): shut down and wait the full clearing period (30 minutes for cetaceans and 15 minutes for pinnipeds and harbor porpoise)
- 2.5 – 5.3 km (1.5 – 3.3 mi): power down to 300 cui
- 5.3 – 9.5 km (3.3 – 5.9 mi): power down to 1200 cui
- > 9.5 km (5.9 mi): resume full volume

5.5 SHUT DOWN FOLLOWED BY POWER DOWN

Implementation of a shut down followed by a power down occurred when an animal was observed within the DZ, and a smaller airgun volume could be used to maintain operations while observers ensured that the animal remained outside the smaller DZ. Initially a shut down was called on the radio by the PSO who initially observed the marine mammal and both source vessels responded by immediately shutting off their airguns. After the ship's navigator calculated the distance from the gunboat to the marine mammal (Section 5.9.1), the PSO on the source vessel calculated whether or not a power down from the full 2400 cui array was warranted (Table 6). Decreasing the volume of the array allowed airguns to continue operations and avoid freezing in cold waters, and also saved time by avoiding a full ramp up of 20 minutes after the mammal cleared the full DZ. These decreases from full volume to lower volume had to occur within 10 minutes or else a new ramp up procedure had to be initiated.

Additionally, PSOs could work with seismic technicians and navigators to minimize wear on airguns by doing a modified ramp up based on the marine mammal distance (Appendix D-7). This involved allowing full power once the marine mammal cleared the DZ and followed a 5-minute stepping procedure similar to ramp up. The mitigation gun was not employed during these procedures because it took extra effort to deploy and did not save time, as a full ramp up would be required after mammal clearing.

Table 6. Power Down volumes based on SSV results

Seismic Source to Marine Mammal Distance (m)	Allowed Seismic Volume, cui
<2500	0
2501 to 5300	150, 300, 440
5301 to 9500	150, 300, 440, 600, or 1200
>9500	2400 (full volume)

5.6 SHUT DOWN

When a marine mammal was about to enter or was found within the DZ, a shut down procedure was requested and implemented. Shut down procedures were accomplished within several seconds (a "one shot" period) of the PSO shut down request. A shut down was requested any time a marine mammal was observed within or on the cusp of the DZ, such as within 10 km (6.2 mi) of an operating source vessel. A shut down was also requested any time a marine mammal sound was detected by the PAM system during seismic operations, as it was assumed a marine mammal acoustic that was acoustically detected would be within the DZ zone. A shut down for any marine mammal not listed under the IHA was treated more cautiously, with delay times of 45 to 60 minutes instead of the 15 to 30 minutes required for marine mammals listed in the IHA.

5.7 MITIGATION GUN

Prior to the end of daylight hours, PSOs were required to clear the DZ to implement the use of the mitigation gun. The mitigation gun consisted of a 10 cui airgun that allowed for night operations to take place. As long as the mitigation gun was shooting before the end of daylight hours, the night crew could ramp up from the 10 cui airgun to the full 2400 cui array following the approved ramp up protocol.

5.8 COMMUNICATING MITIGATION MEASURES

On the source vessel, the PSOs observed from the bridge, which on both vessels was a small enough area such that radio communication was not necessary between the PSO and Navigation Team. This allowed the PSO to verbally request a shut down on their respective source vessel; however, a shut down call over the radio was still required for the second source vessel. The PSO on watch on each source vessel was in constant communication with the source vessel operators, Navigation Team and PSOs on other vessels and land. On the *M/V Dreamcatcher*, the PSO remained in constant communication with the PSOs on the source vessels via bridge radios. This allowed for the PSO to verbally request a shut down and ensured that the shut down was heard clearly and implemented immediately by both source vessels. Furthermore, radio communication during seismic activity was normally kept to bouts of less than 24 seconds so that any PSO could call for a shut down between calls and the "one-shot" period of seismic activity post-animal detection could be adhered.

When a marine mammal was sighted by a PSO (land, aerial, mitigation, or source vessel) and the animal was estimated within 10 km (6.2 mi) of either source vessel or approaching the approximate 10 km (6.2 mi) zone the PSO called "SHUT DOWN, SHUT DOWN, SHUT DOWN" over the radio on the operations channel. The operations channel was monitored by all vessels (source, mitigation, support, and node vessels). In the event that the aerial or land-based observers sighted animals sufficiently outside the DZ, no shut down was called.

After a shut down was requested, the airgun or Navigation Teams on both source vessels immediately shut down seismic operations (within a "one–shot" period) and responded over the radio with "*Arctic Wolf shut down*" and "*Peregrine shut down*" to verify that the mitigation measure was implemented adequately. PSOs on the source vessels then had a 10 minute window to calculate whether or not the marine mammal was actually within the DZ.

- If within 10 minutes the animal was determined to be outside the DZ, seismic operations restarted at full volume.
- If within 10 minutes the animal was observed leaving the DZ, seismic operations restarted at full volume; however, a power down procedure was implemented to ensure that the animal remained outside the DZ for the specific airgun volume.
- If within10 minutes the animal was observed leaving the DZ, a ramp up was not required. A ramp up only occurred after a PSO had not observed the animal within the DZ for 15 minutes in the case of harbor porpoise/pinnipeds and 30 minutes for belugas/killer whales AND no seismic activity had occurred for greater than 10 minutes.

5.9 ADDITIONAL MITIGATION PROTOCOLS

5.9.1 Distance Estimation

The distance from the marine mammal(s) to the source vessels was calculated when the animal(s) was observed within or near the DZ during seismic operations. PSOs that initially observed the marine mammal documented the range and bearing of the observed marine mammal using reticle binoculars with compass, a handheld or ship-mounted compass or by referencing geographical features at known bearings and distances. PSOs then relayed the range and bearing to the Navigation Team. The Navigation Team then calculated the distance from the source vessel to the marine mammal using graphical software that included the locations of all platforms.

5.9.1.1 Range & Bearing

After a shut down was implemented, the PSO determined the range and bearing to the marine mammal from the sighting platform. On the vessels, the range and bearing were determined using reticle binoculars and the ship's compass. From the land-based stations, the range was estimated by eye or based on known distances of geographical features such as oil rigs, specific boulders, and land formations (e.g., Granite Point, Middle Ground Shoals) or by using the reticle binoculars.

The bearing was obtained by using a hand held compass, the compass within the Fujinon binoculars, or known bearings to specific geographical formations or objects such as oil platforms. At all land-based stations except for Tyonek Dock, magnetic bearings were converted to true bearings before being reported to vessel PSOs. At Tyonek Dock, the orientation of the dock structure was used as a point of reference in determining sighting bearing. For example, the land-ward portion of the dock "T" was oriented at 152° true, and the perpendicular beam of the inlet-ward portion of the "T" was oriented at 63° true and 243° true, depending on whether the PSO was looking at the up-inlet or down-inlet side of the top of the "T." Once the range and bearing were determined, the Navigation Team would assist the PSO team by determining the estimated distance from the sighted marine mammal to each source vessel. The land PSO continued to monitor the marine mammal and communicate any re-sightings to the vessels, and appropriate delay times were implemented.

Table 7. Data Used to Determine the Location of the Marine Mammal Sighting From Land

Land Station	Latitude	Longitude	Oil Rig Bruce		Oil Rig Anna		Oil Rig Granite Point	
			Range	Bearing	Range	Bearing	Range	Bearing
Shirleyville Camp	61° 00.786 N	151° 24.492 W	4.7 km	107°T	5.5 km	135°T	6.6 km	155°T
Bluff Site #1	61° 02.346 N	151° 16.137 W	NA	NA	NA	NA	NA	NA
Tyonek Dock	61° 2.596 N	151° 9.666 W	5.2 km	198°	7.3 km	196°	9.6 km	202°
OSK Dock	60° 44.464 N	151° 18.354 W	NA	NA	NA	NA	NA	NA

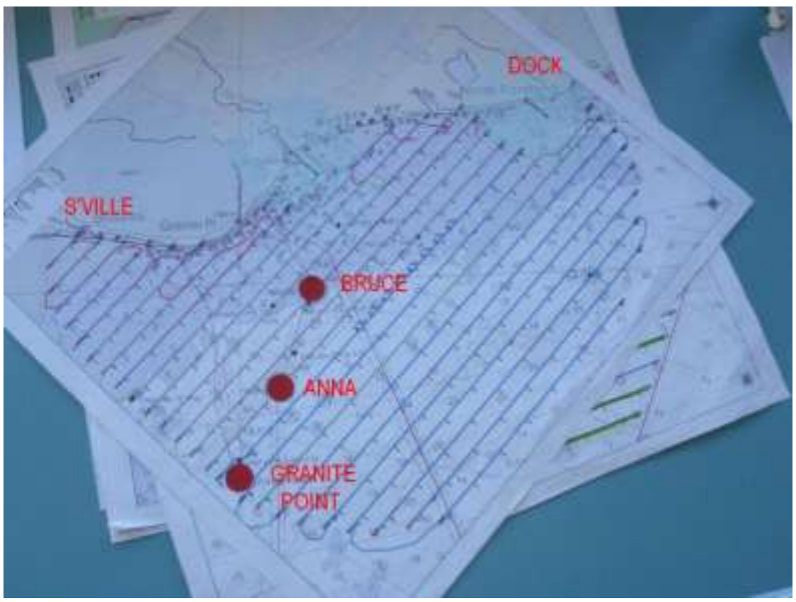

Figure 10. Locations and range/bearing to Oil Rigs Anna, Bruce and Granite Point from land observation platforms.

5.9.2 10 minute rule

Airguns could be off for no longer than 10 minutes without requiring a ramp up starting with the 150 cui airgun. During the day, as long as the PSOs were continuously (> 30 minutes) monitoring, a 30-minute clearing was not required. If airguns were off for longer than 10 minutes at night, no airguns could be activated in-water until a 30-minute PSO clear was completed after sunrise.

5.9.3 45 minute Guideline

Airguns (150-2400 cui) were requested to not operate for longer than 45 minutes when not in production. This was not a stipulation of the IHA; however, it was a guideline to limit the amount of non-productive seismic activity. At times, technical difficulties occurred resulting in airguns operating longer than 45 minutes during non-production times.

5.9.4 Night Operations

Mitigation airguns were required to operate prior to ramp up after dark. The only approved mitigation airgun was the 10 cui airgun. The designated sunset time was used as the start time for the mitigation airgun. No startup of operations at any level (10-2400 cui) after dark was permitted if the airguns were off for a period greater than 10 minutes. If one source vessel maintained their mitigation airgun operations, the other source vessel could move within 280 m (951 ft) of that vessel and begin firing their mitigation airgun. This was possible because the 280 m (951 ft) represented the DZ for the 10 cui airgun and was considered cleared to begin ramp up procedures.

5.9.5 Dead Marine Mammals

In the event of a dead marine mammal, all seismic operations ceased immediately. PSOs gathered as much information as possible including photos/video, environmental conditions, status of source vessels, location, currents, movement, etc. All dead animals were reported to NMFS within 24 hours and a Level-A Stranding Report was submitted to NMFS within 24 hours of the sighting.

- If the cause of death could be determined and was found not associated with the project then operations could re-initiate immediately after the determination.
- If the animal was determined recently dead – less than a moderate state of decomposition and the cause of death was UNKNOWN, this was reported to NMFS immediately. After the determination was made that the cause of death was either unknown or not related to the project, operations could continue once NMFS reviewed the circumstances.
- In the event that there was a Level A take (serious injury or mortality – ship strike, gear interaction, entanglement, seismic effect), all operations were required to cease immediately until further evaluation and consultation with NMFS (see Appendix D-6 for the form). However, this event did not take place during the 2012 Season, but remained a part of the monitoring team protocol.

5.10 DATA ANALYSIS

Mitigation measures were summarized per month and include vessel- and land-based sightings and PAM detections. The totals do not reflect aerial overflight sightings because aerial overflights were generally out of range of the project area.

6.0 RESULTS

6.1 MONITORING EFFORT, ENVIRONMENTAL CONDITIONS, AND SEISMIC ACTIVITY

6.1.1 Monitoring Effort

A total of 6,912.1 hours of observations was completed from May 6 – September 30, 2012 including vessel-based (3,366.8 hours), land-based (915.8 hours), aerial overflights (92.0 hours), and PAM (2.537.5 hours; Table 8). The greatest portion of monitoring effort was through the combined effort of all the vessels during vessel-based visual monitoring (51%). Vessel-based visual monitoring effort was greatest on the *M/V Arctic Wolf* (19%), then on the *M/V Dreamcatcher* (16%), followed by the *M/V Peregrine Falcon* (15%), and other vessels (*R/V Westward Wind* and the *R/V Norseman I*; 1%). PAM also consisted of a large portion of the monitoring effort (34%). Land-based monitoring effort (14%) was similar to that on the *M/V Dreamcatcher*, while aerial overflights consisted of the smallest portion of the monitoring effort (1 %).

Table 8. Total Number of Hours of Monitoring Effort

Month	AW	DC	PF	Vessel-Other	Land	Aerial	PAM	Total Hours
May	237.4	211.5	136.0	7.0	215.5	16.7	375.0	**1,199.1**
June	293.6	275.7	281.8	10.0	281.3	18.1	630.0	**1,790.5**
July	265.9	237.4	243.9	0.0	158.6	18.8	588.5	**1,513.1**
August	252.2	211.9	224.7	22.7	148.8	22.2	607.0	**1,489.5**
September	166.3	144.8	134.5	9.5	111.6	16.2	337.0	**919.9**
Total	**1,215.4**	**1,081.3**	**1,020.9**	**49.2**	**915.8**	**92.0**	**2,537.5**	**6,912.1**

6.1.2 Environmental Conditions

In general, the environmental conditions were conducive to appropriately monitor marine mammals during seismic operations. If weather conditions were poor, seismic activity could not be initiated from a full shut down until conditions improved and were more conducive for monitoring effort. Overall the Beaufort Sea State generally ranged from 1-3 with the occasional 4, 5 or 6 (Section 6.1.3.1). The mean cloud coverage was 65.4%. Glare was present from at least one monitoring platform during 86% of the days monitoring took place. Cook Inlet was ice free during the months seismic activity took place.

6.1.3 Monitoring Effort by Environmental Condition

6.1.3.1 Monitoring Effort by Beaufort Sea State

Overall monitoring effort from vessel-based, land-based, and aerial overflights was conducted 0.9% of the time in a Beaufort 0, 31.1% of the time in a Beaufort 1, 42.9% of the time in a Beaufort 2, 20.9% of the time in a Beaufort 3, 3.5% of the time in a Beaufort 4, and 0.6% of the time in a Beaufort greater than 4 (i.e., 5 or 6; Table 9; Figure 10).

Table 9. Proportion of Effort per Platform by Beaufort Sea States

Beaufort Sea State	Vessel (%)	Land (%)	Aerial (%)	Total (%)
0	1.2	0.0	1.3	0.9
1	32.2	27.8	23.5	31.1
2	41.6	47.8	41.5	42.9
3	20.4	22.3	28.3	20.9
4	3.9	2.1	5.4	3.5
> 4	0.7	0.0	0.0	0.6

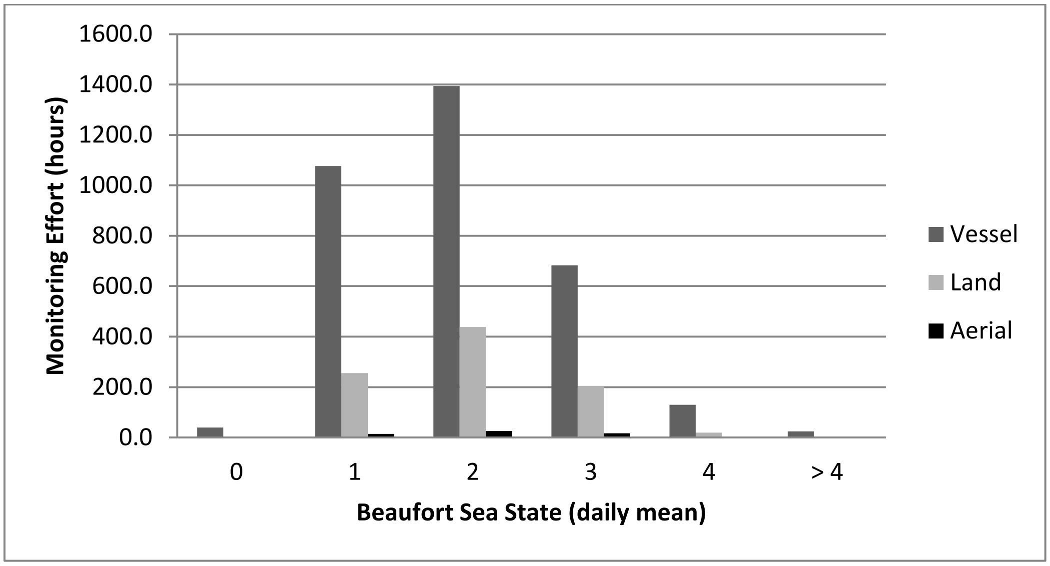

Figure 11. Monitoring Effort (hours) by Beaufort Sea State (daily mean).

6.1.3.2 Monitoring Effort by Visibility

Overall monitoring effort from vessel-based, land-based, and aerial overflights did not generally take place when visibility was < 3 km (1.9 mi). Monitoring effort took place approximately 0.9% of the time when visibility was between 3-3.9 km (1.9-2.4 mi), 4.4% of the time when visibility was between 4-4.9 km (2.5- 3.0 mi), 12.5% of the time when visibility was between 5-5.9 km (3.1-3.7 mi), 25.6% of the time when visibility was between 6-6.9 km (3.7-4.3 mi), 20.9% of the time when visibility was between 7-7.9 km (4.3-4.9 mi), 21.2% of the time when visibility was between 8-8.9 km (5.0-5.5 mi), 9.4% of the time when visibility was between 9-9.9 km (5.6-6.1 mi) and 5.1% of the time when visibility was 10 km (6.2 mi) (Table 10; Figure 12).

Table 10. Proportion of Effort per Platform by Visibility (km)

Distance (km)	Vessel (%)	Land (%)	Aerial (%)[1]	Total (%)
< 1	0.0	0.0	0.0	**0.0**
1-1.9	0.0	0.0	0.0	**0.0**
2-2.9	0.0	0.0	0.0	**0.0**
3-3.9	0.6	2.2	0.0	**0.9**
4-4.9	3.1	9.0	0.0	**4.4**
5-5.9	13.6	8.5	3.7	**12.5**
6-6.9	29.2	13.2	0.0	**25.6**
7-7.9	23.2	13.1	2.5	**20.9**
8-8.9	20.0	26.2	0.0	**21.2**
9-9.9	6.0	21.6	12.8	**9.4**
10	4.2	6.3	81.1	**5.1**

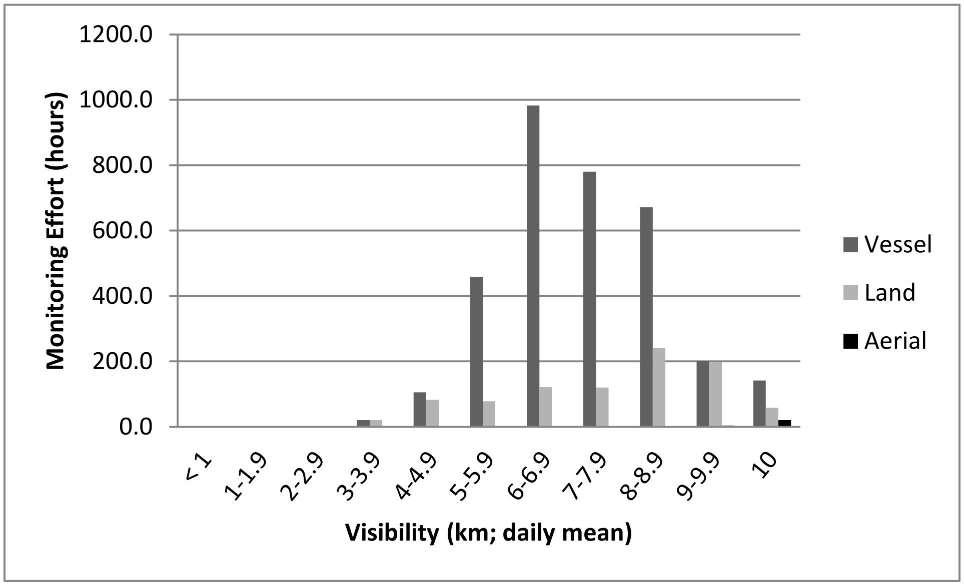

Figure 12. Monitoring effort (hours) by visibility (km; daily mean).

[1] Visibility was often undocumented during aerial overflight because overflights only took place in good weather conditions when visibility was high (> 5 km [3.1 mi]) due to safety reasons.

6.1.4 Seismic Activity

A total of 1,841.7 hours of seismic activity took place from May 6 – September 30, 2012 including the 10 cui airgun array (589.1 hours), 440 cui airgun array (32.9 hours), and the 2400 cui airgun array (1,252.6 hours; Table 11).

Table 11. Total Number of Hours of Seismic Activity

Month	10 cui	440 cui	2400 cui	Total
May	32.4	0.0	168.1	200.5
June	57.9	0.0	278.6	336.5
July	122.1	0.0	264.3	386.4
August	221.8	0.0	346.4	568.2
September	154.9	32.9	162.3	350.1
Total	589.1	32.9	1,252.6	1,841.7

6.1.5 Monitoring Effort With and Without Seismic Activity

Marine mammal monitoring using at least one method of monitoring (i.e., vessel, land, PAM) always took place during seismic activity. Monitoring effort was greater during periods with (1,995.2 hours) than without (136.0 hours) seismic activity (Table 12)[2].

Visual vessel-based monitoring effort took place approximately 93% of the time with and 7% of the time without seismic activity (Table 12; Figure 13)[3]. A total of 123.1 hours of seismic activity took place without visual vessel-based monitoring effort. Reasons why visual vessel-based monitoring did not occur during seismic activity include: 1) vessel-based monitoring did not take place during night-time operations (after sunset) and 2) vessel-based monitoring during the day decreased as daylight decreased during the months of August and September. Land-based monitoring effort took place approximately 94% of the time with and 6% of the time without seismic activity. A total of 386.9 hours of seismic activity took place without land-based monitoring effort. Land-based observations were supplemental and at times the project area was located out of range for adequate land-based monitoring. In addition, PSOs left the land-based station on a daily bases for aerial overflights which took approximately one hour to complete. PAM effort with and without seismic activity is found in Section 6.0.

[2] Total monitoring effort used to calculate periods with and without seismic activity excluded aerial overflights because the majority of aerial overflights were outside the project area. PAM was also excluded from this analysis because a separate analysis is found in Section 6.7. The *M/V Arctic Wolf*'s monitoring effort was the only vessel used in this analysis because it had the greatest number of monitoring hours for all the vessels, and therefore, best represents vessel-based monitoring effort. All other vessels were excluded from the analysis due to redundancy.

[3] Visual-vessel monitoring effort includes the total effort from all monitoring vessels.

Table 12. Total Number of Hours of Monitoring Effort With and Without Seismic Activity by Month and Platform

	Vessel (*M/V Arctic Wolf*)[1]			Land[2]		
Month	**WITH (hours)**	**WITHOUT (hours)**	**Seismic not monitored from vessels**	**WITH (hours)**	**WITHOUT (hours)**	**Seismic not monitor from land**
May	168.1	69.3	0.0	168.1	47.4	0.0
June	278.6	15.0	0.0	278.6	2.7	0.0
July	264.3	1.6	0.0	158.6	0.0	105.7
August	252.2	0.0	94.2	148.8	0.0	197.6
September	166.3	0.0	28.9	111.6	0.0	83.6
Total	**1,129.5**	**85.9**	**123.1**	**865.7**	**50.1**	**386.9**

[1] The *M/V Arctic Wolf*'s monitoring effort was the only vessel used in this analysis because it had the greatest number of monitoring hours for all the vessels, and therefore, best represents vessel-based monitoring effort. All other vessels were excluded from the analysis due to redundancy.The 10 cui airgun array seismic hours were also excluded because it took place during night-time operations because visual vessel-based monitoring effort did not take.

[2]Excludes the 10 cui airgun array seismic hours which took place during night-time operations because land-based monitoring effort did not take place.

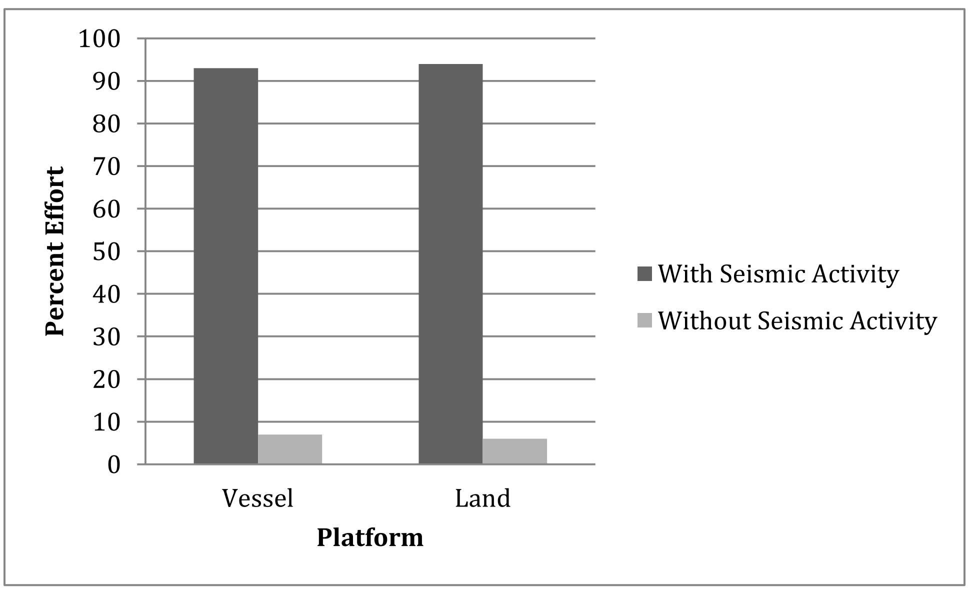

Figure 13. Proportion of total effort by platform during periods with and without seismic activity.

6.2 MARINE MAMMAL OBSERVATIONS

6.2.1 Marine Mammal Abundance and Species Composition

Six identified species and three unidentified species of marine mammals were observed from the vessel, land, and aerial platforms during the marine mammal monitoring and mitigation program (Table 13). The species identified include beluga whale, harbor seal, harbor porpoise, Steller sea lion, gray whale, and California sea lion and the unidentified species included large cetacean, pinniped and marine mammal (Table 13). There were a total of 882 sightings and an estimated 5,232 individuals. Approximately 16.4% (n=145) of the sightings were from the aerial surveys, 44.3% (n=391) from the land-based stations and 39.2% (n=346) from the vessel platforms.

Harbor seals were the most frequently observed marine mammals at 563 sightings (~3,471 estimated individuals) followed by beluga whales with 151 sightings (~1,463 estimated individuals), harbor porpoises with 137 sightings (~190 estimated individuals), and gray whales with 9 sightings (9 estimated individuals). Steller sea lions were observed on 3 separate occasions (~4 estimated individuals) and California sea lions were observed once (~2 estimated individuals). There were 3 unidentified large cetaceans (~3 estimated individuals), 9 unidentified pinnipeds (~85 estimated individuals), 3 unidentified marine mammals (~3 estimated individuals), and 3 false acoustic detections (both visual and acoustic detections that called for mitigation measures but were later found to be non marine mammal or anthropogenic noise).

Table 13. Sighting Summary of Species and Estimated Numbers by Month From Combined Vessel, Land and Aerial Platforms During Monitoring Program May 6 – September 30, 2012

Species	Number of Sightings	Number of Estimated Individuals
Vessel, Land & Aerial Totals	882	5232
Beluga Whale	151	1,463
Harbor Porpoise	137	190
Harbor Seal	563	3,471
Gray Whale	9	9
Steller Sea Lion	3	4
California Sea Lion	1	2
Unidentified Large Cetacean	3	3
Unidentified Pinniped	9	85
Unidentified Marine Mammal	3	3
False Detection	3	3
May	273	686

Beluga Whale	30	88
Harbor Porpoise	42	50
Harbor Seal	192	540
Gray Whale	4	4
Steller Sea Lion	1	1
Unidentified Marine Mammal	1	1
False Detection	3	2
June	**303**	**3506**
Beluga Whale	44	664
Harbor Porpoise	54	82
Harbor Seal	193	2670
Gray Whale	2	2
Steller Sea Lion	1	2
California Sea Lion	1	2
Unidentified Large Cetacean	3	3
Unidentified Pinniped	5	81
July	**179**	**502**
Beluga Whale	41	341
Harbor Porpoise	26	37
Harbor Seal	107	119
Gray Whale	3	3
Unidentified Large Cetacean	1	1
Unidentified Pinniped	1	1
August	**57**	**297**
Beluga Whale	16	209

Harbor Porpoise	5	6
Harbor Seal	31	77
Steller Sea Lion	1	1
Unidentified Pinniped	3	3
Unidentified Marine Mammal	1	1
September	**70**	**241**
Beluga Whale	20	161
Harbor Porpoise	10	15
Harbor Seal	40	65

6.2.2 Vessel-based Sightings

A total of 346 groups of marine mammals (~ 550 estimated individuals) were observed from the vessel-based platforms (Table 14). Harbor seals were the most frequently observed marine mammals at 247 sightings (~285 estimated individuals), followed by harbor porpoises with 55 sightings (~81 estimated individuals), beluga whales with 26 sightings (~165 estimated individuals), and gray whales with 7 sightings (7 estimated individuals). All sightings of Steller and California sea lions were made from vessels. Estimated group sizes of beluga whale sightings from the vessel observations ranged from 1 to 30 individuals and averaged ~6.0 animals. Harbor porpoises ranged from 1 to 3 individuals and averaged 1.5 animals. Harbor seal sightings ranged from 1 to 10 estimated individuals with an average of 1.2 animals

Table 14. Sighting Summary of Species and Estimated Numbers By Month From Vessel-Based Platforms During Monitoring Program May 6 – September 30, 2012

Species	Number of Sightings	Number of Estimated Individuals	Average Estimated Group Size	Group Size Minimum	Group Size Maximum	Sighting Rate
Vessel Totals	**346**	**550**				
Beluga Whale	26	165	6.0	1	30	0.0077
Harbor Porpoise	55	81	1.5	1	3	0.0163
Harbor Seal	247	285	1.2	1	10	0.0734
Gray Whale	7	7	1.0	1	1	0.0021
Steller Sea Lion	3	4	1.0	1	1	0.0009
California Sea Lion	1	2	1.0	1	1	0.0003
Unidentified Large	3	3	1.0	1	1	0.0009

Cetacean						
Unidentified Marine Mammal	1	1	1.0	1	1	0.0003
False	3	2	1.0	1	1	0.0009
May	**97**	**113**				
Beluga Whale	6	19	3.2	2	5	0.0101
Harbor Porpoise	16	20	1.3	1	2	0.0270
Harbor Seal	67	67	1.0	1	1	0.1132
Gray Whale	4	4	1.0	1	1	0.0068
Steller Sea Lion	1	1	1.0	1	1	0.0017
False	3	2	1.0	1	1	0.0051
June	**126**	**206**				
Beluga Whale	6	68	11.3	5	30	0.0070
Harbor Porpoise	25	38	1.6	1	3	0.0290
Harbor Seal	90	93	1.0	1	2	0.1045
Gray Whale	1	1	1.0	1	1	0.0012
Steller Sea Lion	1	2	2.0	2	2	0.0012
California Sea Lion	1	2	2.0	2	2	0.0012
Unidentified Large Cetacean	2	2	1.0	1	1	0.0023
July	**72**	**122**				
Beluga Whale	9	43	8.6	1	30	0.0120
Harbor Porpoise	9	15	1.7	1	3	0.0120
Harbor Seal	51	61	1.2	1	7	0.0683
Gray Whale	2	2	1.0	1	1	0.0027
Unidentified Large Cetacean	1	1	1.0	1	1	0.0013
August	**13**	**14**				
Harbor Porpoise	2	3	1.5	1	2	0.0028

Harbor Seal	9	9	1.0	1	1	0.0126
Steller Sea Lion	1	1	1.0	1	1	0.0014
Unidentified Marine Mammal	1	1	1.0	1	1	0.0014
September	38	95				
Beluga Whale	5	35	7.0	2	20	0.0110
Harbor Porpoise	3	5	1.7	1	2	0.0066
Harbor Seal	30	55	1.8	1	10	0.0659

6.2.3 Land-based Sightings

A total of 391 groups of marine mammals (~ 561 estimated individuals) were observed from the land-based stations (Table 15). Harbor seals were the most frequently observed marine mammals at 273 sightings (~283 estimated individuals), followed by harbor porpoises with 80 sightings (~107 estimated individuals), and beluga whales with 29 sightings (~160 estimated individuals). Gray whales were observed on 2 separate occasions (~2 estimated individuals). Estimated group sizes of beluga whale sightings from the land-based observations ranged from 1 to 45 individuals and averaged ~4.0 animals. Harbor porpoises ranged from 1 to 3 individuals and averaged 1.0 animal. Harbor seal sightings ranged from 1 to 4 estimated individuals with an average of 1.0 animals.

Table 15. Sighting Summary of Species and Estimated Numbers By Month From Land-Based Platforms During Monitoring Program May 6 – September 30, 2012

Species	Number of Sightings	Number of Estimated Individuals	Average Estimated Group Size	Group Size Minimum	Group Size Maximum	Sighting Rate
Land Totals	391	561				
Beluga Whale	29	160	4.0	1	45	0.0317
Harbor Porpoise	80	107	1.3	1	4	0.0874
Harbor Seal	273	283	1.0	1	3	0.2981
Gray Whale	2	2	1.0	1	1	0.0022
Unidentified Pinniped	5	7	1.0	1	2	0.0055
Unidentified Marine Mammal	2	2	1.0	1	1	0.0022
May	155	180				
Beluga Whale	14	33	2.5	1	6	0.0650
Harbor Porpoise	25	29	1.2	1	2	0.1160

Harbor Seal	115	117	1.0	1	2	0.5336
Unidentified Marine Mammal	1	1	1.0	1	1	0.0046
June	**110**	**140**				
Beluga Whale	1	9	9.0	9	9	0.0036
Harbor Porpoise	28	43	1.5	1	4	0.0995
Harbor Seal	76	81	1.1	1	2	0.2702
Gray Whale	1	1	1.0	1	1	0.0036
Unidentified Pinniped	3	5	1.7	1	2	0.0107
Unidentified Marine Mammal	1	1	1.0	1	1	0.0036
July	**85**	**195**				
Beluga Whale	14	118	8.4	2	45	0.0883
Harbor Porpoise	17	22	1.3	1	2	0.1072
Harbor Seal	53	54	1.0	1	2	0.3342
Gray Whale	1	1	1.0	1	1	0.0063
August	**25**	**27**				
Harbor Porpoise	3	3	1.0	1	1	0.0202
Harbor Seal	20	22	1.1	1	3	0.1344
Unidentified Pinniped	2	2	1.0	1	1	0.0134
September	**16**	**19**				
Harbor Porpoise	7	10	1.4	1	3	0.0627
Harbor Seal	9	9	1.0	1	1	0.0806

6.2.4 Aerial Sightings

A total of 145 groups of marine mammals (~ 4,121 estimated individuals) were observed during aerial overflights (Table 16). Many of these individuals were likely resighted on several occasions during aerial overflights. Beluga whales were the most frequently observed marine mammals at 96 sightings (~1,138 estimated individuals), followed by harbor seals with 43 sightings (~2,903 estimated individuals). Harbor porpoises were observed on two different occasions (2 individuals). There were four unidentified pinniped sightings. One sighting of an unidentified pinniped congregation was of ~75 individuals hauled out on the banks of the Beluga River mouth in late June. This sighting was recorded as *unidentified pinniped* due to the inability to clearly identify them from the aerial platform. These animals could have potentially been a congregation of Steller sea lions because they were larger and lighter in color than the harbor seals observed in the area at the same time. Estimated beluga whale group size from the aerial overflights ranged from 1 to 90 individuals and averaged ~10.5 animals. Harbor seal sightings ranged from 1 to 250 estimated individuals with an average of 30.7 animals.

Table 16. Sighting Summary of Species and Estimated Number Individuals By Month From Aerial Platforms During Monitoring Program May 6 – September 30, 2012

Species	Number of Sightings	Number of Estimated Individuals	Average Estimated Group Size	Group Size Minimum	Group Size Maximum	Sighting Rate
Aerial Totals	**145**	**4,121**				
Beluga Whale	96	1,138	10.5	1	90	1.0435
Harbor Porpoise	2	2	1	1	1	0.0217
Harbor Seal	43	2,903	30.7	1	250	0.4674
Unidentified Pinniped	3	3	1	1	1	0.0326
Unidentified Pinniped (possible Steller sea lions)	1	75	75	1	75	0.0552
May						
Beluga Whale	10	36	3.6	1	6	0.5988
Harbor Porpoise	1	1	1	1	1	0.0599
Harbor Seal	10	356	35.6	1	100	0.5988
May Total	**21**	**393**	**18.71**	**1**	**100**	**1.2575**
June						
Beluga Whale	37	587	17.26	2	90	2.0442
Harbor Porpoise	1	1	1	1	1	0.0552
Harbor Seal	27	2496	92.44	1	250	1.4917
Unidentified Pinniped	1	1	1	1	1	0.0552
Unidentified Pinniped (possible Steller sea lions)	1	75	75	75	75	0.0552
June Total	**67**	**3,160**	**49.38**	**1**	**250**	**3.7017**
July						
Beluga Whale	18	180	10	1	75	0.9574
Harbor Seal	3	4	1.33	1	2	0.1596
Unidentified Pinniped	1	1	1	1	1	0.0532
July Total	**22**	**185**	**8.41**	**1**	**75**	**1.1702**

August						
Beluga Whale	16	209	13.06	1	50	0.7207
Harbor Seal	2	46	23	1	45	0.0901
Unidentified Pinniped	1	1	1	1	1	0.045
August Total	**19**	**256**	**13.47**	**1**	**50**	**0.8559**
September						
Beluga Whale	15	126	8.4	1	25	0.9259
Harbor Seal	1	1	1	1	1	0.0617
September Total	**16**	**127**	**7.94**	**1**	**25**	**0.9877**

6.3 ANOMOLOUS MARINE MAMMALS

6.3.1 Gray whale

Gray whales were observed on nine ocasions with eight observations taking place from the vessels and one observation from land. Gray whales were not observed from the aerial platforms.

6.3.2 California sea lion

On June 23, a pair (n=2) of California sea lions were observed from the *M/V Dreamcatcher*. There was no seismic activity taking place during the observation. The sea lions were observed approximately 500 m (1,640 ft) from the mitigation vessel. Their observed behavior was fast travel against the current towards the lower inlet. The sea lion pair was sighted 4 times.

6.4 SIGHTING RATES

Sighting rates (number of species/effort hour) for beluga whales were highest first during aerial overflights (1.0435), then from the land-based stations (0.0317), followed by vessel-based platforms (0.0077; Table 14-16; Figure 13). Harbor porpoise sighting rates were highest from the land-based stations (0.0874), then aerial overflights (0.0217), followed by vessel-based platforms (0.0163; Table 14-16; Figure 13. Harbor seal sighting rates were highest during aerial overflights (0.4674), then the land-based stations (0.281), followed by vessel-based platforms (0.0734; Table 14-16; Figure 14). Gray whale sighting rates were low, but similar from the vessel- (0.0021) and land-based (0.0022) platforms (Table 14-16; Figure 13). There were no gray whale sightings during aerial overflights. Steller sea lion, California sea lion, and unidentified large cetacean had low sighting rates (0.0009, 0.0003, 0.0009, respectively) and were only observed from the vessel-based platforms (Table 15; Figure 13). Unidentified pinniped sighting rates were highest during aerial overflights (0.0435) and then from land-based stations (0.0022; Table 14; Figure 13). There were no observations of unidentified pinnipeds from the vessel-based platforms. Sighting rates from unidentified marine mammals were highest from the land-based stations (0.0022) and then from the vessel-based platforms (0.0003; Table 14-15; Figure 14). There were no sightings of unidentified marine mammals during aerial overflights.

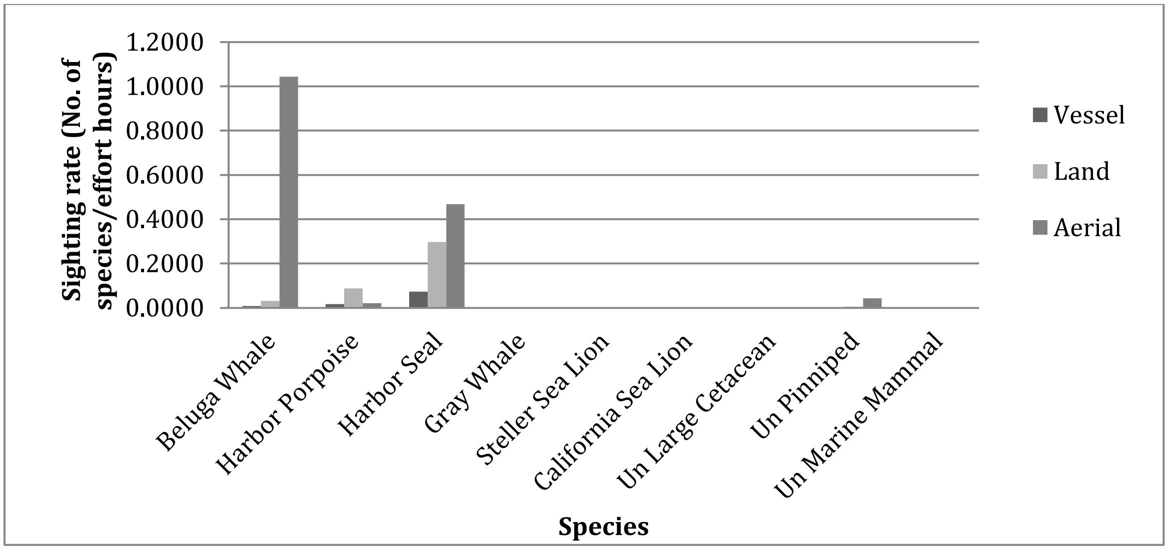

Figure 14. Sighting rates by species from vessel, land and aerial platforms.

6.5 SIGHTINGS WITH AND WITHOUT SEISMIC ACTIVITY

A total of 737 sightings (1,111 estimated individuals) were observed from the vessel and land platforms (Table 17).[4] Of the combined vessel and land sightings, 303 sightings (~ 458 estimated individuals) were observed with and 434 sightings (~653 estimated individuals) were observed without seismic activity. Of the 55 belugas whale sightings (~325 estimated individuals), 17 sightings (~136 estimated individuals) were observed with and 38 sightings (~189 estimated individuals) were observed without seismic activity. Of the 135 harbor porpoise sightings (~188 estimated individuals), 61 sightings (~82 estimated individuals) were observed with and 74 sightings (~106 estimated individuals) were observed without seismic activity. Of the 520 harbor seal sightings (~568 estimated individuals), 212 sightings (~225 estimated individuals) were observed with seismic activity and 308 sightings (~343 estimated individuals) were observed without seismic activity (Table 17 and Figure 15).

[4] Aerial platforms were excluded from these counts due to the extensive distance (typically >15 km) from the project area.

Table 17. Species Summary of Sightings and Estimated Number Of Individuals (Vessel And Land Observation Platforms) With and Without Seismic Activity During Monitoring Program May 6 – September 30, 2012

Species	Number of Sightings WITH seismic	Number of Estimated Individuals WITH seismic	Number of Sightings WITHOUT seismic	Number of Estimated Individuals WITHOUT seismic	Total Number of Sightings	Total Number of Estimated Individuals
Beluga Whale	17	136	38	189	55	325
Harbor Porpoise	61	82	74	106	135	188
Harbor Seal	212	225	308	343	520	568
Gray Whale	5	5	4	4	9	9
Steller Sea Lion	0	0	3	4	3	4
California Sea Lion	0	0	1	2	1	2
Unidentified Large Cetacean	0	0	4	4	4	4
Unidentified Pinniped	4	6	1	1	5	7
Unidentified Marine Mammal	2	2	0	0	2	2
False	2	2	1	0	3	2
Grand Total	303	458	434	653	737	1111

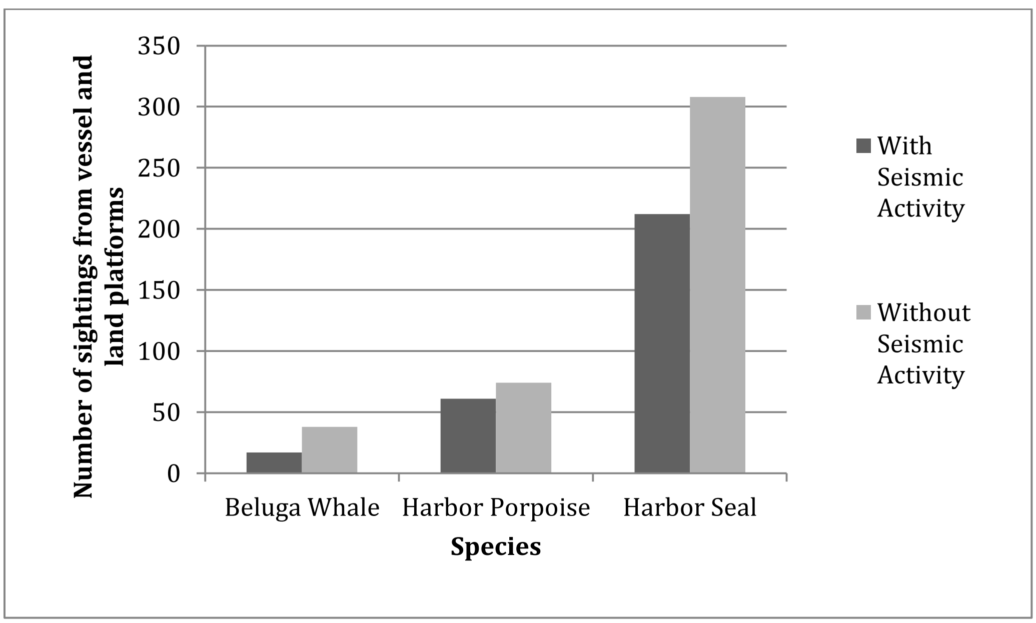

Figure 15. Number of sightings with seismic and without seismic activity from vessel and land platforms for beluga whales, harbor porpoises, and harbor seals.

6.5.1 Behavior and CPA With and Without Seismic Activity

6.5.1.1 Beluga Whale

Behavior

Beluga whales were most frequently observed traveling (n=27), followed by mill (n=11), unknown (n=8), and swim (n=5). With seismic activity, beluga whales were most frequently observed traveling (n=7) followed by milling (n=5), swimming (n=3), foraging (n=1), and diving (n=1). Without seismic activity beluga whales were most frequently observed traveling (n=20) followed by an unknown (n=8) or unidentifiable behavior state (mostly attributed to the distance from the observation platform), milling (n=6), swimming (n=2), foraging (n=1), and diving (n=1; Figure 16)

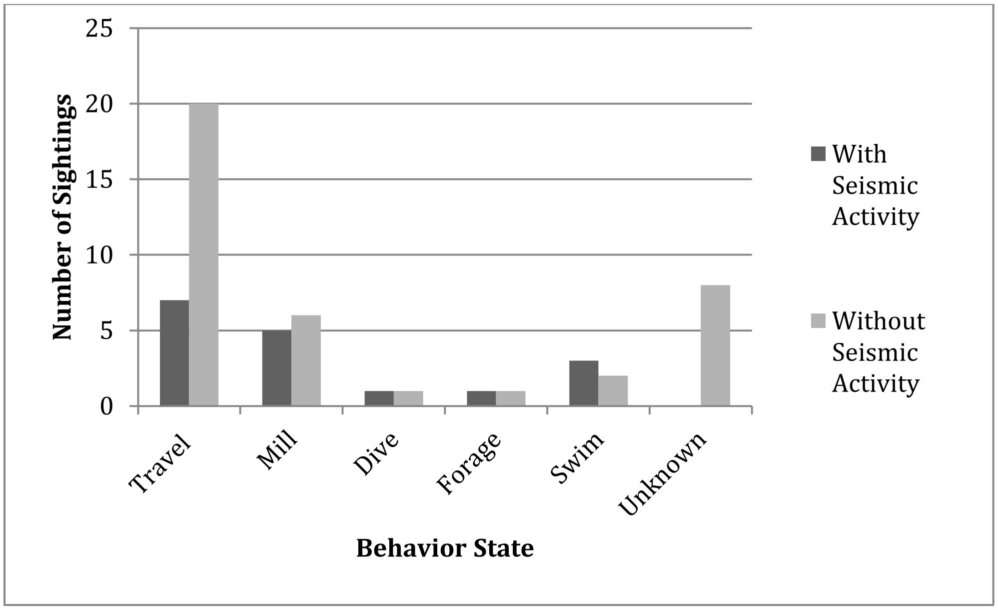

Figure 16. Beluga whales initially observed behavior with and without seismic activity.

CPA

There were a higher number of sightings of beluga whales closer to the vessels without seismic activity. Within <1000 m, there were nine sightings of beluga whales without and one sighting with seismic activity. In the zones 1000-1999 m and 2000-2999 m, there were three sightings without and one with seismic activity. In zone 4000-4999 m, there were six sightings without and two with seismic activity. In >10,000 m zone, there were eight sightings without and three with seismic activity. The one zone which had a higher frequency of sightings with (n=4) than without (n=2), seismic activity was 7000-7999 m (Figure 17).

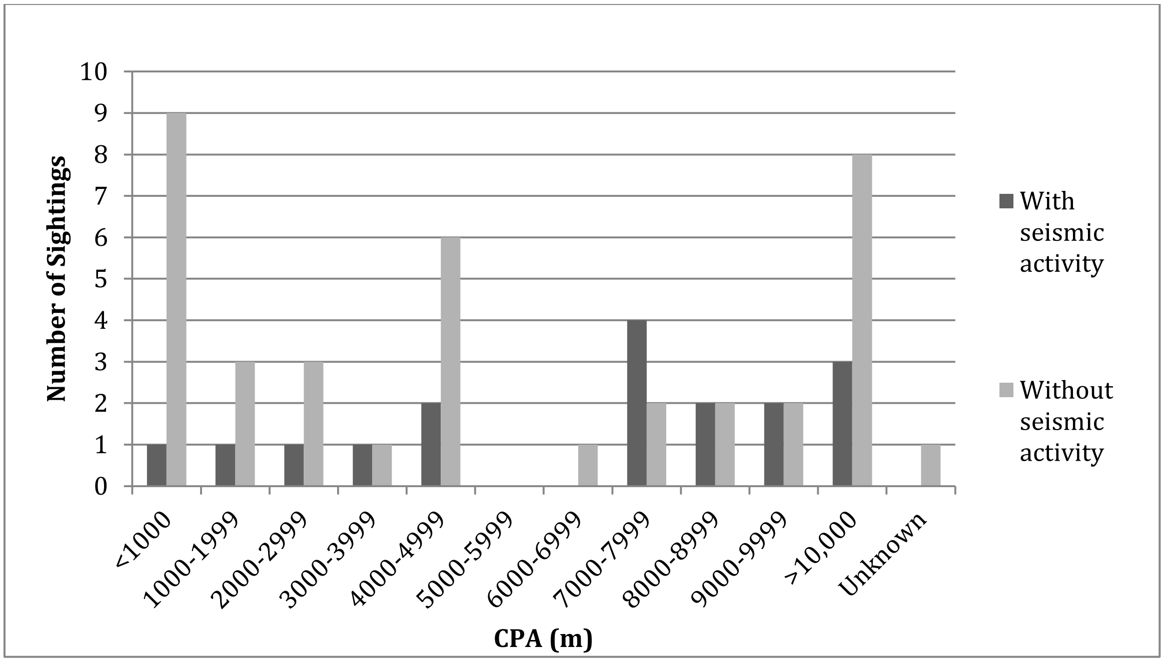

Figure 17. Beluga whales CPA (m) to source vessel(s) with and without seismic activity.

6.5.1.2 Harbor Porpoise

Behavior

The most frequently observed behaviors for harbor porpoises with seismic activity were traveling (n=29) followed by swimming (n=16) and milling (n=7). Other behaviors observed included unknown (n=8) and diving (n=1). The most common behaviors observed for harbor porpoises without seismic activity were traveling (n=27) and swim (n=26). Other behaviors observed included unknown (n=8), diving (n=7), and milling (n=6; Figure 18).

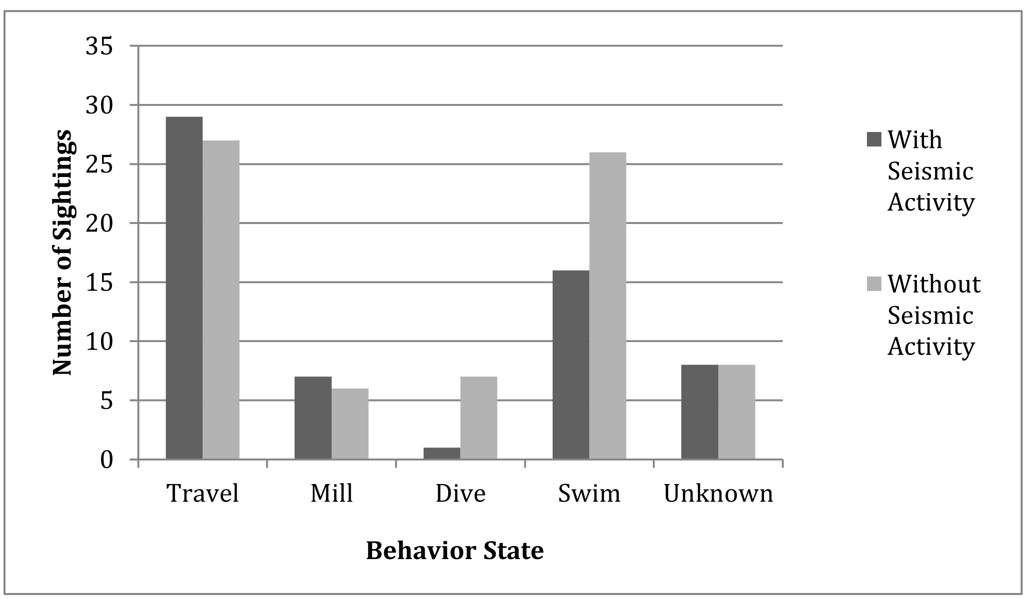

Figure 18. Harbor porpoises initially observed behavior with and without seismic activity.

CPA

There were a higher number of sightings of harbor porpoises closer to the vessels without seismic activity. Within <1000 m, there were 25 sightings of harbor porpoise without and only four sightings with seismic activity. There were not many noticeable differences in CPA for zones 1000 m – 9999 m, but for the zone >10,000 m, there were higher number of sightings with (n=17) than without (n=11) seismic activity (Figure 19).

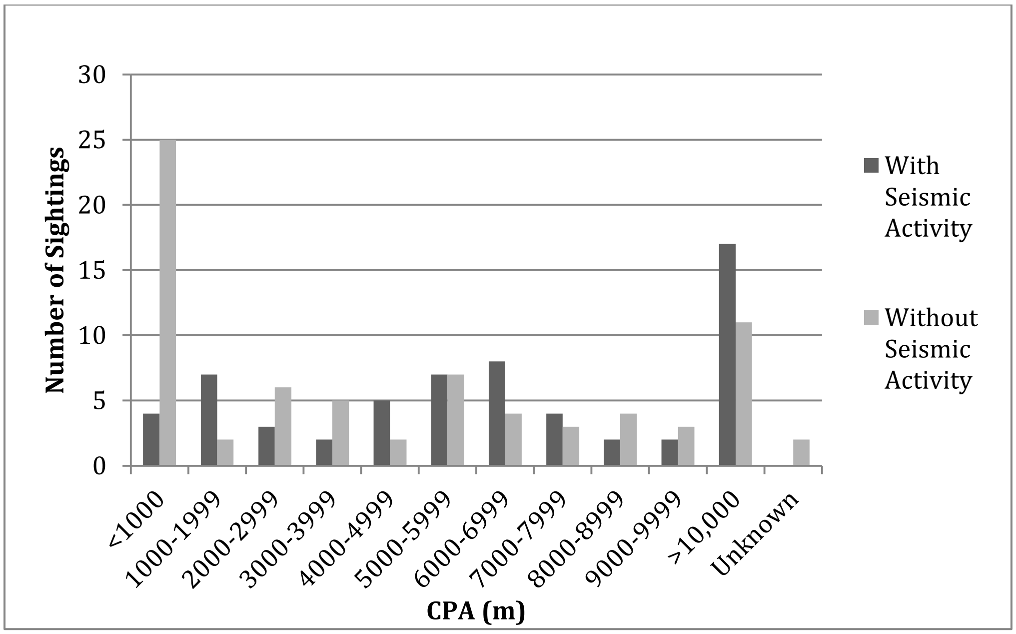

Figure 19. Harbor porpoises CPA (m) to source vessel(s) with and without seismic activity.

6.5.1.3 Harbor seals

Behavior

The most frequent observed behaviors with seismic activity for harbor seals were swimming (n=40), looking (n=37), and looking followed by sinking (n=39). Other behaviors included sinking (n=20), resting (n=13), traveling (n=10), diving (n=15), milling (n=4), foraging (n=4), hauled out (n=2), and unknown (n=28). The most common behaviors observed without seismic activity for harbor seals were swimming (n=83), looking followed by sinking (n=57), and looking (n=44). Swimming, looking, looking followed by sinking, sinking, resting, traveling, and diving were observed more frequently without than with seismic activity (Figure 19).

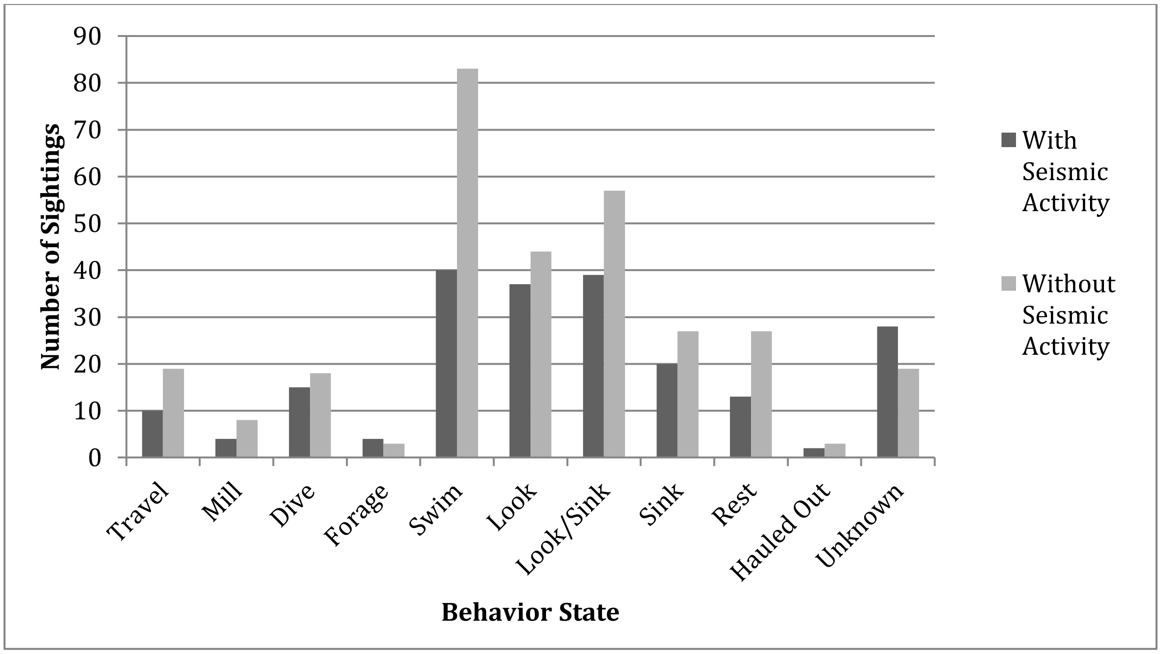

Figure 20. Harbor seals observed initial behavior with and without seismic activity.

CPA

There were a higher number of sightings closer to the vessels without seismic activity. Within <1000 m, there were ~100 sightings of harbor seals without and only 24 sightings with seismic activity. There were not many noticeable differences in CPA for zones 1000 m – 9999 m; however, for the >10,000 m zone, there were a higher number of sightings with than without seismic activity (Figure 21).

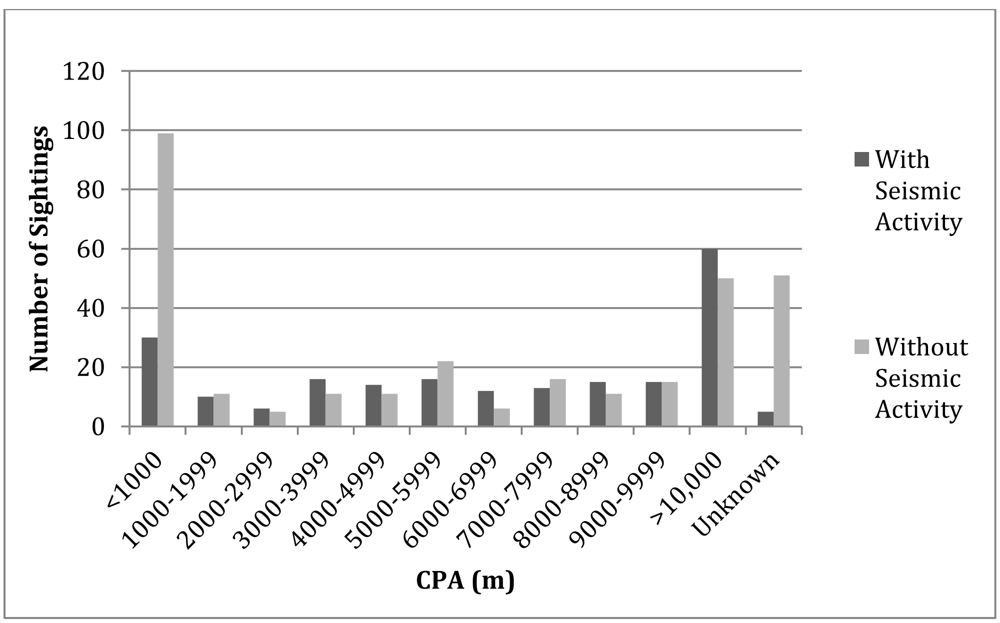

Figure 21. Harbor seal CPA (m) to source vessel(s) with and without seismic activity.

6.5.1.4 Gray Whale

Behavior

The most frequently observed gray whale behavior states included swim/mill with fluke down dives (n=5) and swim/mill with fluke up dives (n= 3) and unknown (n= 1). With seismic activity, gray whales were typically observed raising their flukes out of the water prior to a terminal dive; however, similar swim/mill behavior was observed without seismic activity but with fluke down dives (Figure 22).

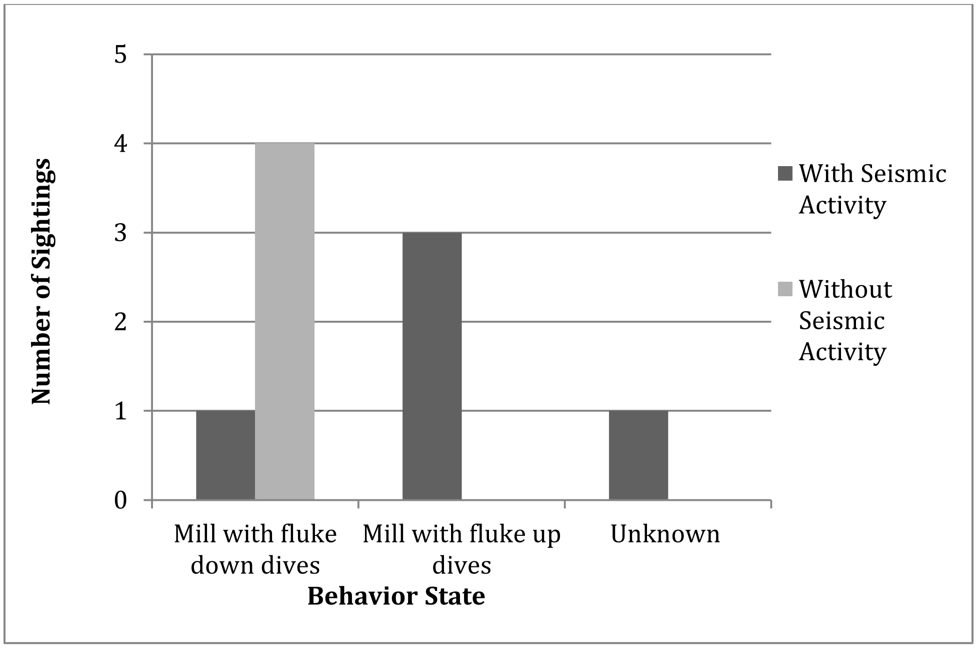

Figure 22. Gray whales observed behavior with and without seismic activity.

CPA

There were three sightings of gray whales in the <1000 m zone with and two sightings without seismic activity. There was one sighting between 1000-1999 m and one sighting between 2000-2999 m without seismic activity, while there was one sighting of a gray whale between 4000-4999 m and one unknown with seismic activity (Figure 23). The unknown was due to an acoustic detection that was later found to be a false detection.

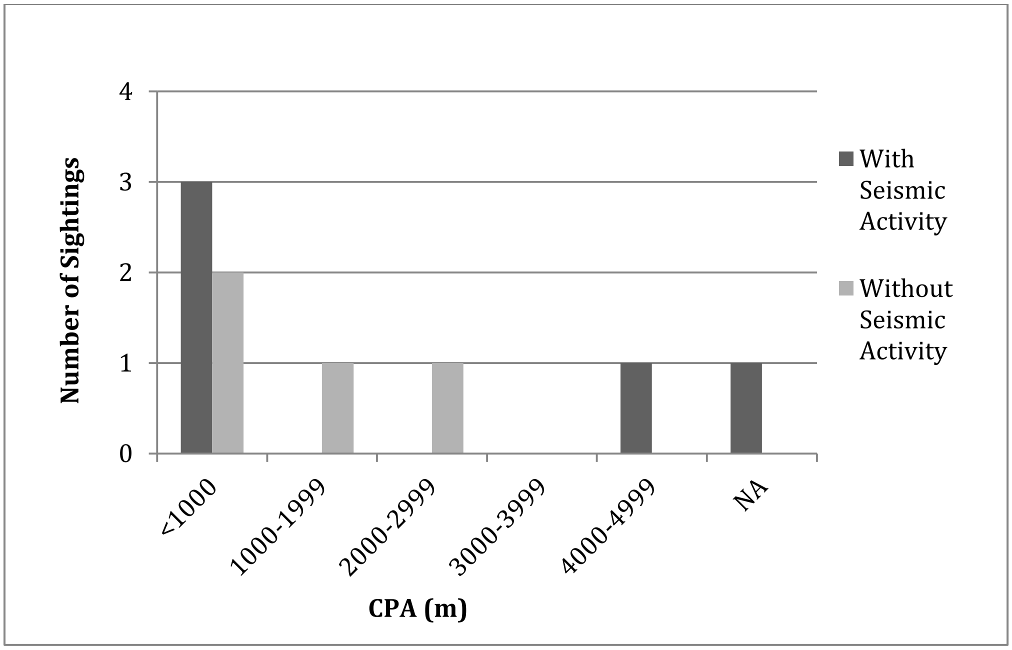

Figure 23. Gray Whales CPA (m) to source vessel(s) with and without seismic activity.

6.6 TEMPORAL AND SPATIAL DISTRIBUTION

6.6.1 Beluga Whale Observations from All Platforms

Beluga whales were observed in the project area from early May until the end of the seismic operations in late September. Many of these individuals were likely resighted on several occasions, and ***therefore, estimated individual numbers cannot be used for abundance estimates***. For all platforms (vessel, land, and aerial) the number of estimated individuals was highest during the month of June (~664 estimated individuals) followed by July (~341 estimated individuals). In August there were ~209 estimated individuals observed from the aerial platform and 0 individuals observed form the vessel/land platforms. In September there were a total of 161 estimated individuals observed with ~126 from the aerial platform and ~35 from vessel/land. The least number of belugas were observed during the month of May with ~88 total, ~36 from aerial, and ~52 from vessel/land. Higher numbers of beluga whales were observed from the aerial platform than from the vessels during June, July, August, and September (Figure 24).

Table 18. Beluga sightings by month from Vessel/Land and Aerial platforms

Platform	May	June	July	August	September
Aerial	36	587	180	209	126
Vessel/Land	52	77	161	0	35
Total	**88**	**664**	**341**	**209**	**161**

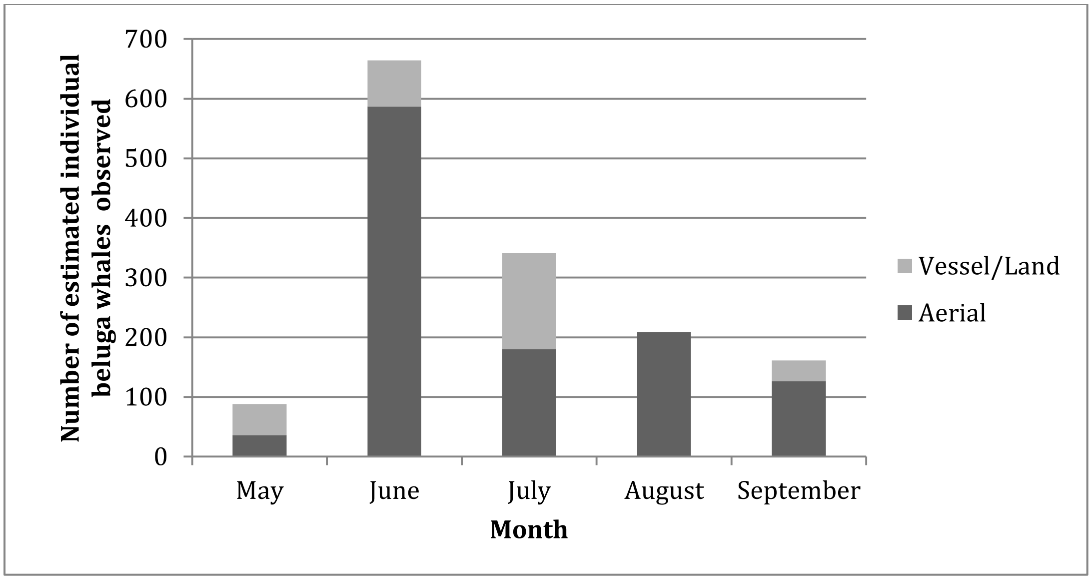

Figure 24. Beluga whales estimated number of individuals observed over time from vessel-based, land-based, and aerial platforms.

6.6.2 Beluga Whale Observations during Aerial Overflights

Beluga whales were most often observed in coastal waters (<1 km [0.62 mi] offshore) and in river mouths along the western side of Cook Inlet in Trading Bay. Beluga whales were most frequently observed in the upper river mouths including the Beluga (~315 estimated individuals), Susitna (~215 estimated individuals), Theodore (~190 estimated individuals), Lewis (~64 estimated individuals), and Ivan Rivers (~56 estimated individuals). In the lower river mouths, ~115 estimated individuals were observed which included ~66 estimated individuals in the McArthur River and ~49 estimated individuals in Middle River and Nikolai Creek. In central river mouths, beluga whales were observed in the Tyonek Creek near Granite Point (~55 estimated individuals) and Chuitna River (~5 estimated individuals). In the coastal (<1000 m from shore) non-river areas, ~21 estimated individuals were observed and ~102 estimated individuals were observed in offshore waters (>1000 m from shore; Figure 25 and 26).

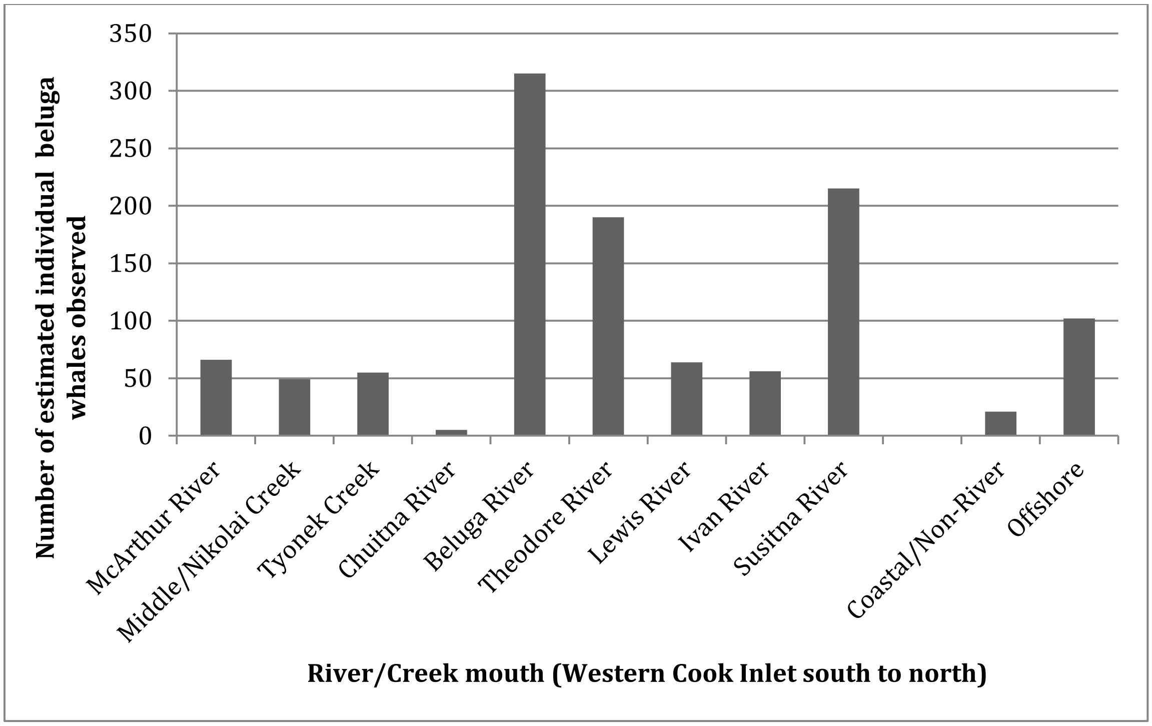

Figure 25. Beluga whale habitat distribution by estimated number of individuals observed from aerial platforms.

May

During the month of May there were few numbers of beluga whales observed (<100 estimated individuals). The majority of those sightings were found in central and lower rivers and coastal waters from Granite Point south to the McArthur River, and one sighting in the Theodore River (Figure 27).

June

The highest number of beluga whale congregations took place during the month of June (>600 estimated individuals) and they were concentrated in the upper river mouths, which included the Susitna, Ivan, Lewis, Theodore, and Beluga Rivers. During June a small number of belugas were found in the lower river mouths, which included the McArthur River, Middle River, and Nikolai Creek (Figure 28).

July

During the month of July, there were ~180 estimated individuals observed and they were found more often in coastal, non-river, and offshore areas than any other month. The majority of the sightings were concentrated in the upper and central river mouths. There were no beluga sightings south near the McArthur River during the month of July (Figure 29).

August

During the month of August, nearly all of the sightings were in the upper river mouths in the Susitna, Ivan, Lewis, Theodore, and Beluga Rivers. There were a small number (~20 estimated individuals) observed in the McArthur River (Figure 30).

September

During the month of September nearly all of the sightings were in the upper river mouths in the Susitna, Ivan, Lewis, Theodore, and Beluga Rivers. There was a small number (~20 estimated individuals) observed in the McArthur River (Figure 31).

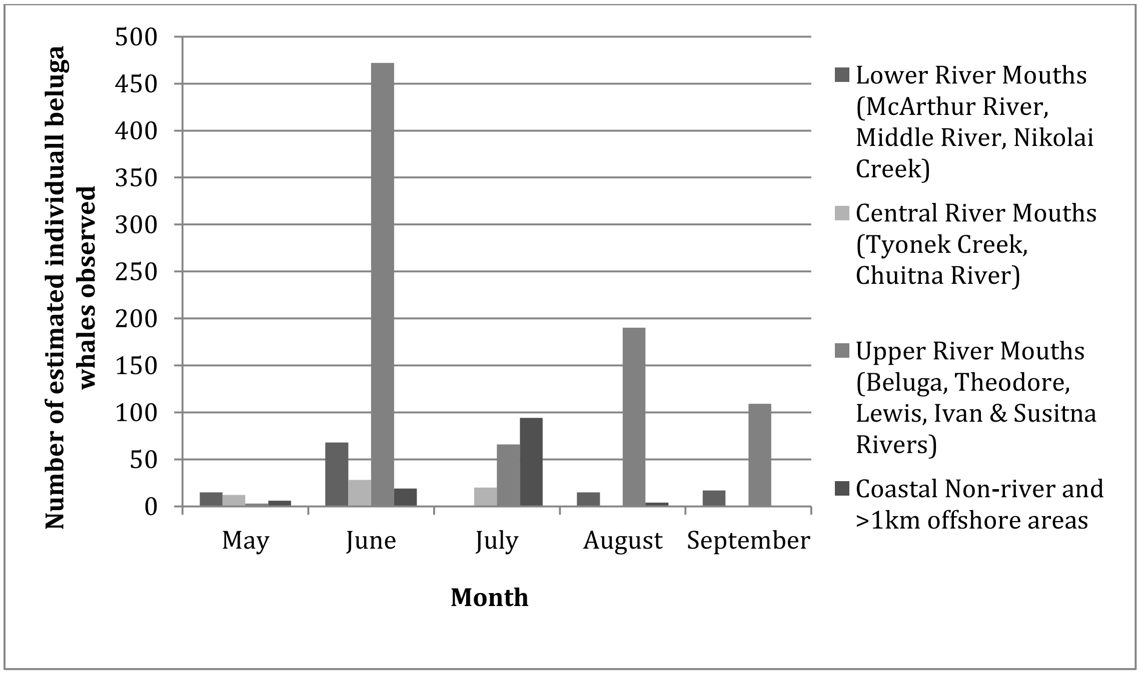

Figure 26. Beluga whale seasonal habitat use in Central Cook Inlet observed from aerial overflights.

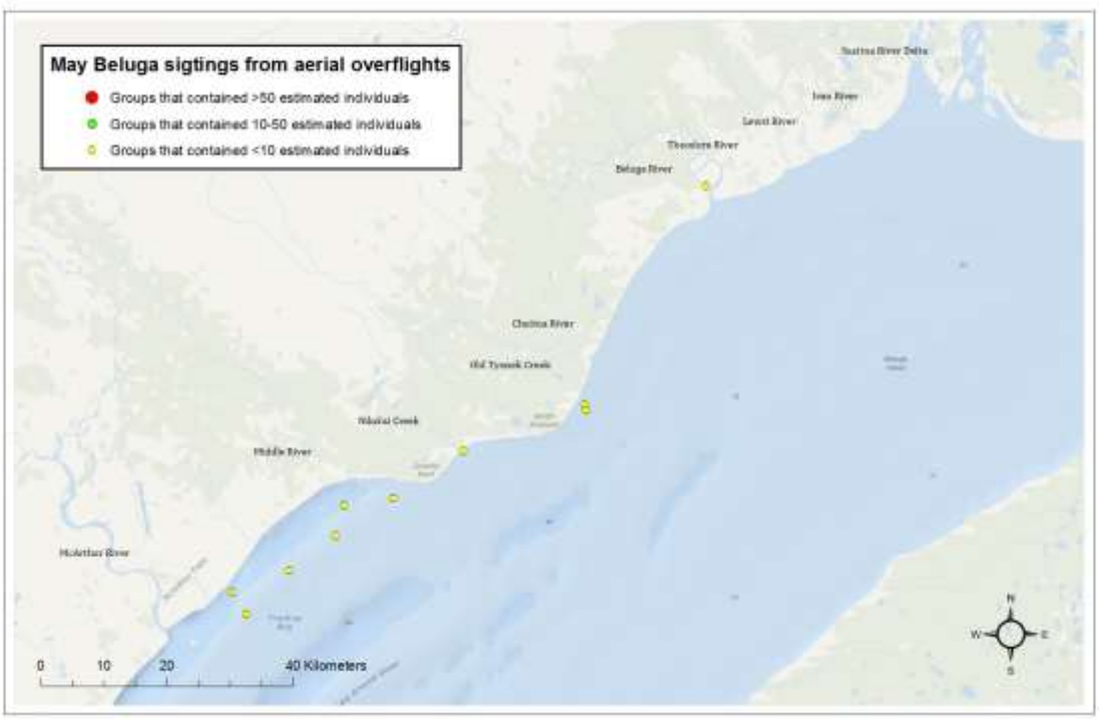

Figure 27. Beluga whale sightings by estimated group size from aerial overflights during the month of May.

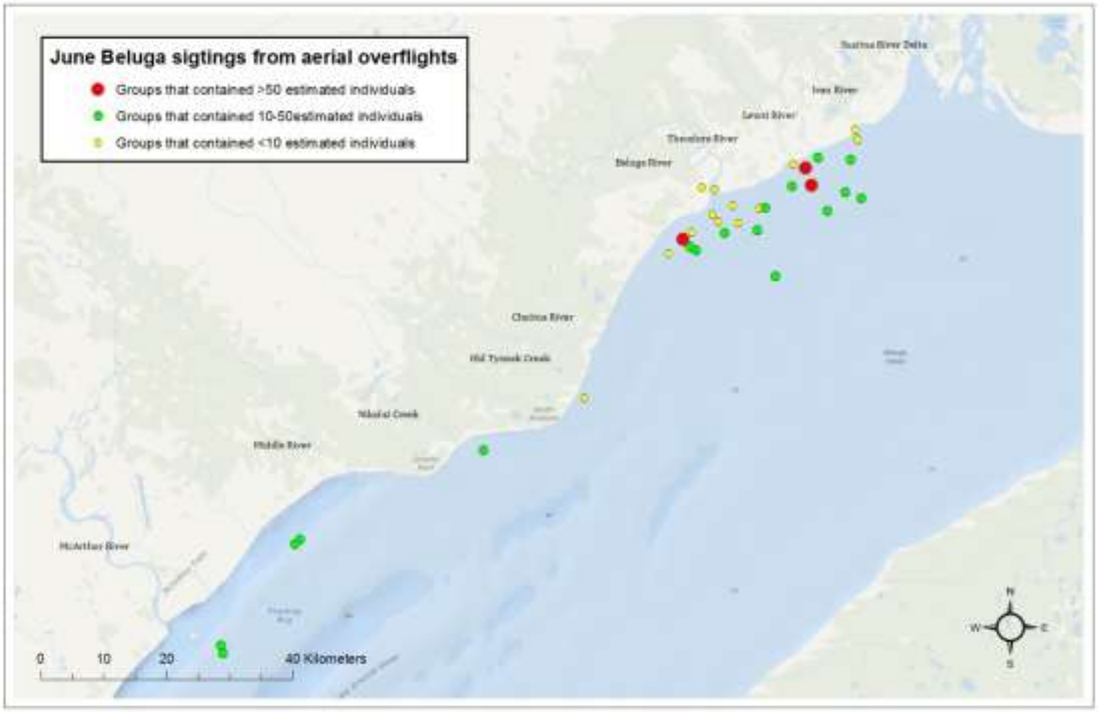

Figure 28. Beluga whale sightings by estimated group size from aerial overflights during the month of June.

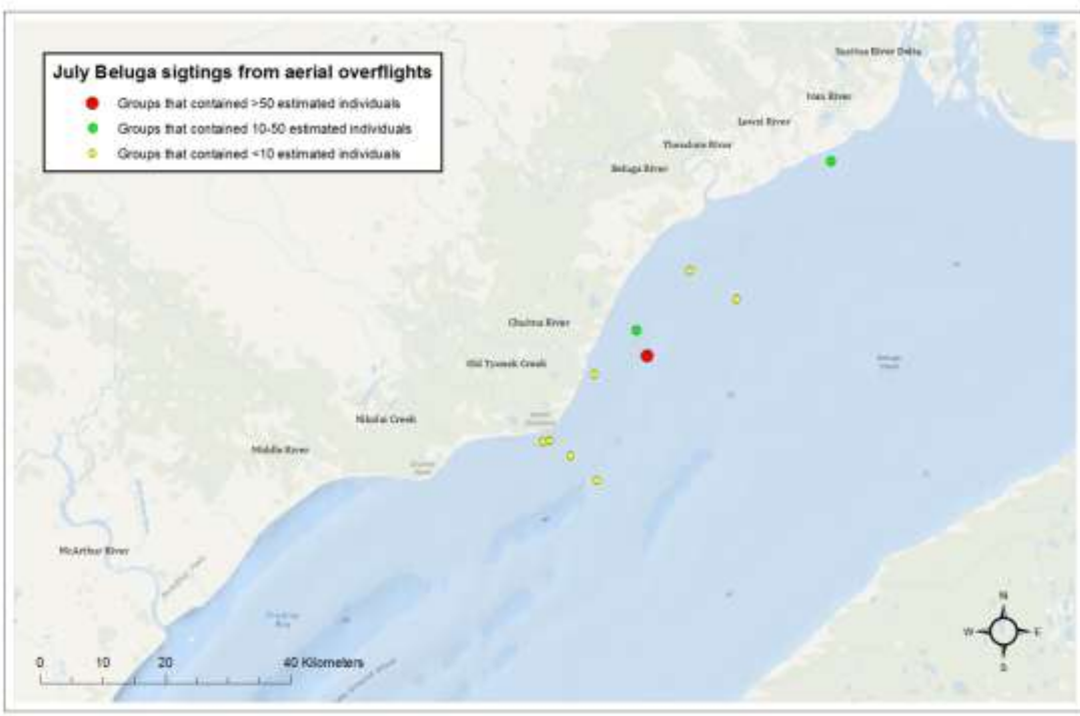

Figure 29. Beluga whale sightings by estimated group size from aerial overflights during the month of July.

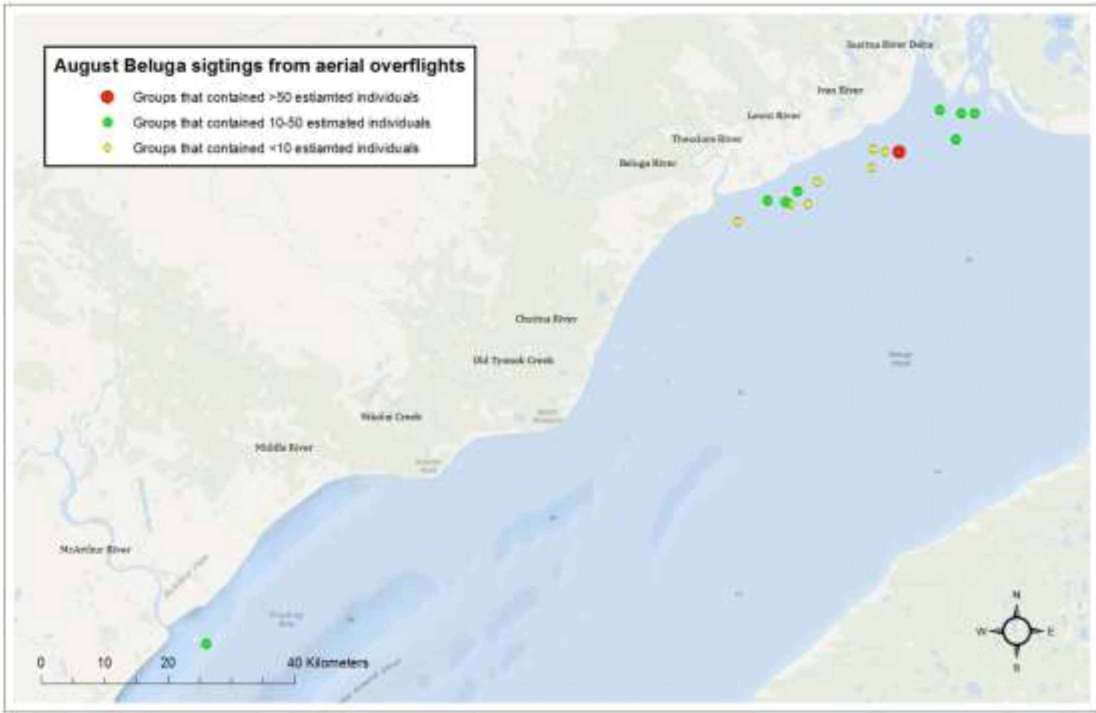

Figure 30. Beluga whale sightings by estimated group size from aerial overflights during the month of August.

Figure 31. Beluga whale sightings by estimated group size from aerial overflights during the month of September.

6.6.3 Harbor Porpoises Observed from All Platforms

Harbor porpoises were observed in the project area from early May until the end of the seismic operations in late September. The number of estimated individuals was highest during the month of June (~82 estimated individuals) followed by May (~50 estimated individuals) and July (~37 estimated individuals). Higher numbers of harbor porpoises were observed from the vessels during all months and only a very small percentage was observed from the aerial overflights (Figure 32).

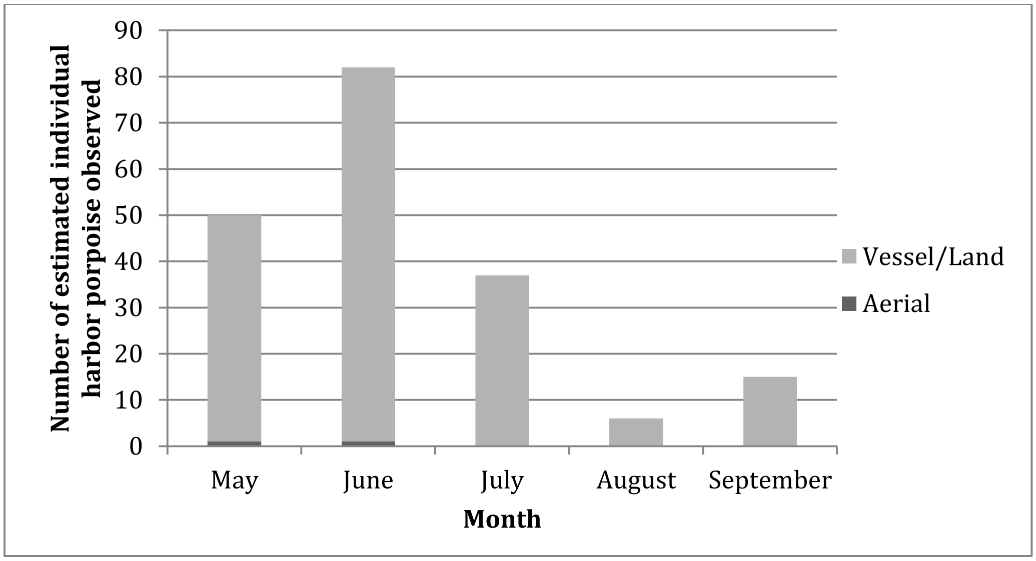

Figure 32. Harbor Porpoise estimated individuals observed over time from vessel/land and aerial platforms.

6.6.4 Harbor Seal from All Platforms

Harbor seals were observed in the project area from early May until the end of the seismic operations in late September. Number of estimated individuals was highest during the month of June (~2670 estimated individuals) followed by May (~538 estimated individuals) and July (~119 estimated individuals). Higher numbers of harbor seals were observed from the aerial platform during May, June, and August (Figure 33).

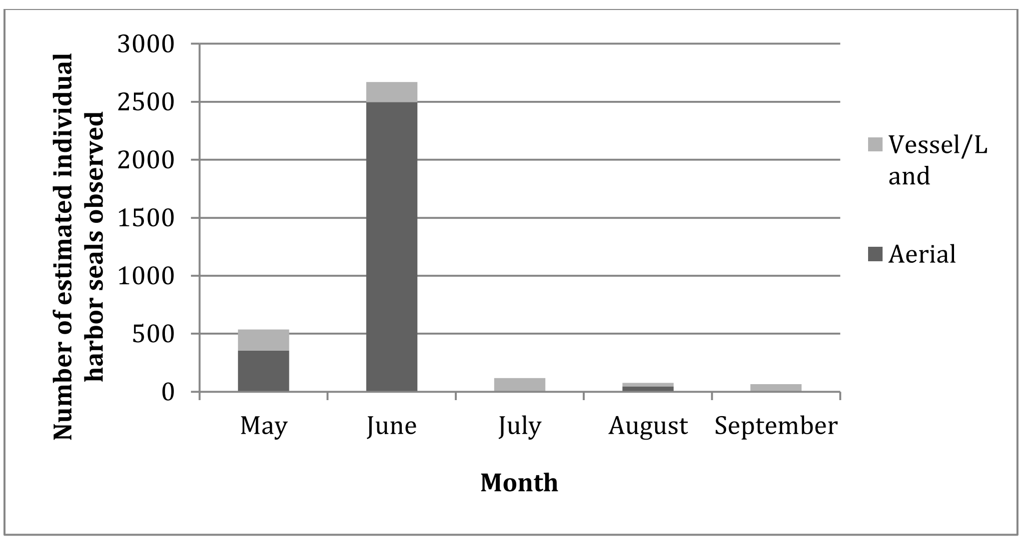

Figure 33. Harbor Seal estimated individuals observed over time from vessel/land and aerial platforms.

From the aerial platform, harbor seals were observed in the highest numbers in the Theodore River (~1,200 estimated individuals), followed by the Lewis River (~788 estimated individuals), McArthur River (~613 estimated individuals), and Beluga River (~251 estimated individuals). Highest numbers were observed in June. Few or no harbor seals were observed in the river mouths during July, August, and September (Figure 34 and 35).

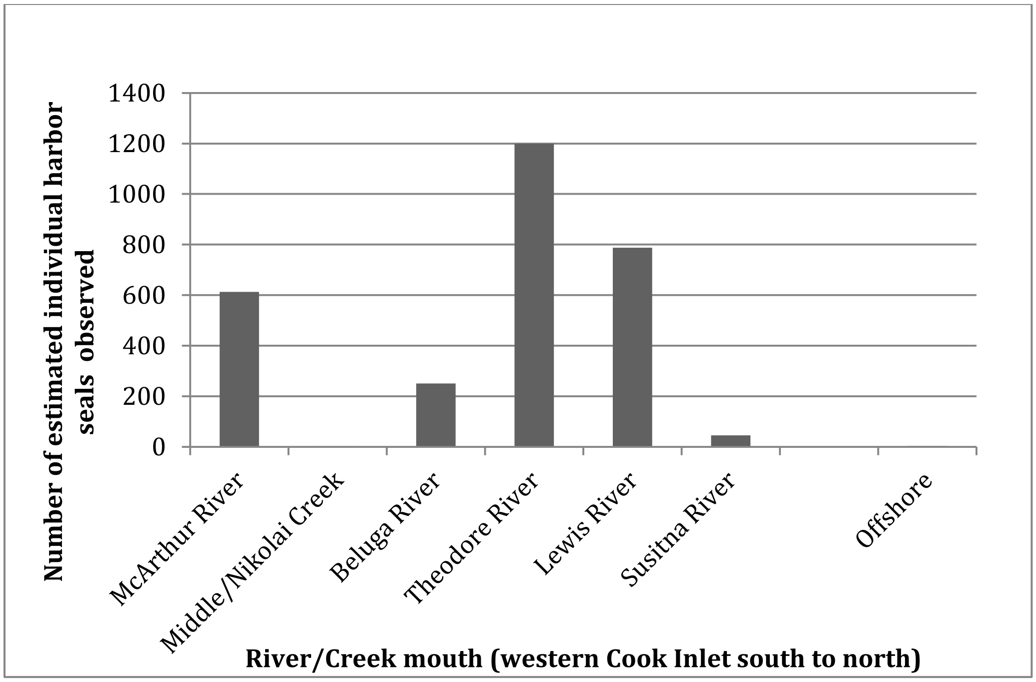

Figure 34. Harbor seal habitat distribution by estimated number of individuals observed from aerial platforms.

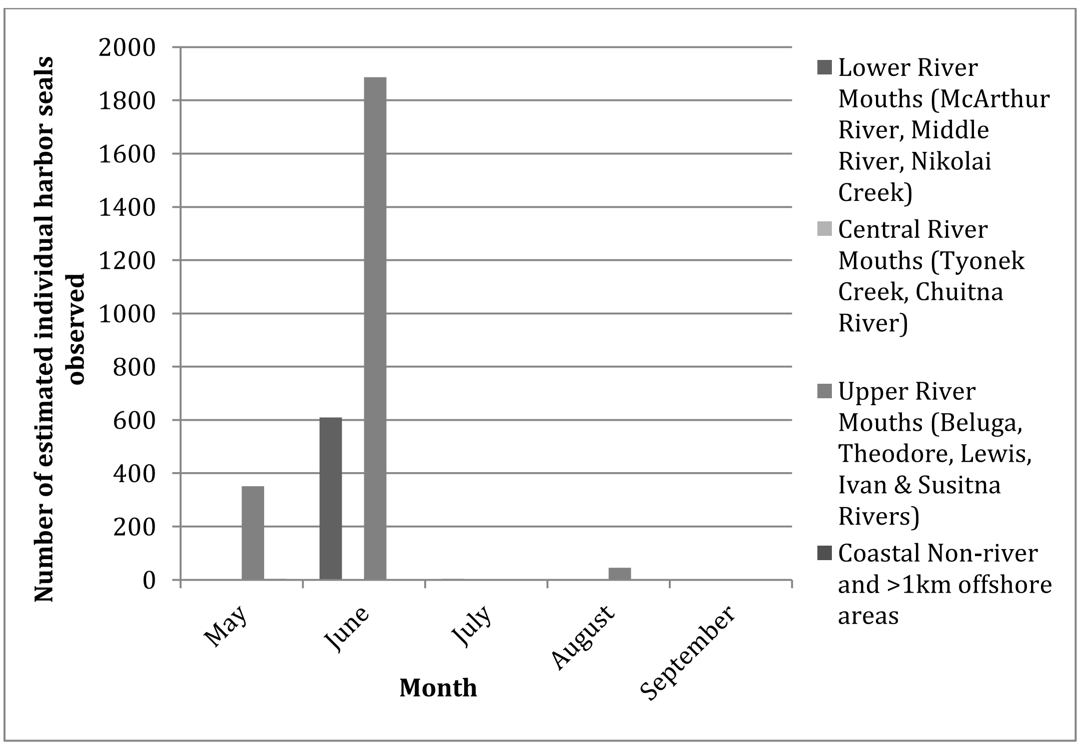

Figure 35. Harbor seal seasonal habitat use in Central Cook Inlet observed from aerial platforms.

6.7 PASSIVE ACOUSTIC MONITORING

6.7.1 Passive Acoustic Monitoring With and Without Seismic Activity

PAM continued as much as was feasibly practical throughout the survey, which included times when the seismic sources were not operating. Table 19 shows the PAM effort hours with and without seismic activity. Occasional shutdowns of the PAM equipment were necessary due to required movement of the monitoring vessel—to obtain fuel or water, for example—or due to harsh sea conditions, which could damage the PAM equipment.

Table 19. PAM Effort With and Without Seismic Activity

Effort (hours)	WITH (hours)	WITHOUT (hours)	Total
Active PAM effort	1772.4	765.1	2537.5
PAM suspended	69.25	779.25	848.5

6.7.2 Acoustic Detections

Confirmed marine mammal vocalizations were detected on six separate occasions throughout the survey. Detected species were identified as harbor seal, beluga whale, and an unspecified pinniped. Four of the acoustic detections corresponded to sightings by the onboard visual PSO, confirming the assumed species. A suspected detection of harbor porpoise from June 15 was later identified as vessel equipment noise in post-season review. With the exception of the pinniped detection, all the detected signals extended above 1 kHz in frequency, which is above the frequency range where background noise would more likely mask calls. Spectrograms of the acoustic detections are found in Appendix C-3 –PAM Report.

Table 20. Acoustic Detections During the Seismic Survey

Date	Time (UTC)	Visual sighting	Seismic activity	Types of sounds heard	Assumed species	Hydrophone position when heard	Shutdown initiated
Jun 16	06:39:00	Yes	No	Clicks	Harbor seal	60°56.343'N 151°33.092'W	No
Jun 17	15:25:00	Yes	No	Clicks	Harbor seal	60 56.392'N 151 33.064'W	No
Jun 18	06:36:19	No	No	Clicks	Harbor seal	60 56.371'N 151 33.143'W	No
Jun 19	23:16:00	Yes	Yes	Clicks	Harbor seal	60 56.403'N 151 33.070'W	Yes
Jul 2	19:28:25	Yes	Yes	Whistle	Beluga whale	60°56.842'N 51° 31.408'W	No
Aug 31	00:21:38	No	No	Bark	Pinniped	60°45.396'N 51° 17.884' W	No

6.8 SUMMARY OF MITIGATION MEASURES

A total of 88 safety zone clearing delays, 154 shut downs, 7 power downs, 23 shut downs followed by a power down, and 1 speed and course alteration occurred during the marine mammal monitoring and mitigation program (Table 21). Safety zone clearing delays, shut downs, and shut downs followed by a power down occurred most frequently during harbor seal sightings (n=61, n=110, n=14, respectively), followed by harbor porpoise sightings (n=18, n=28, n=6, respectively), and then beluga whale sightings (n=5, n=6, n=3, respectively). Power downs occurred most frequently with harbor seal (n=3) and harbor porpoise (n=3) sightings. One speed and course alteration occurred during a beluga whale sighting.

Table 21. Summary of Mitigation Measures Per Species and Month.

Species	Safety Zone Clearing Delay	Shut Down	Power Down	Shut Down/Power Down	Speed & Course Alteration	No Mitigation Measure Required	Total
Overall Total[1]	88	154	7	23	1	464	737
Beluga Whale	5	6	1	3	1	39	55
Harbor Porpoise	18	28	3	6	0	80	135
Harbor Seal	61	110	3	14	0	332	520
Gray Whale	0	6	0	0	0	3	9
Steller Sea Lion	0	0	0	0	0	3	3
California Sea Lion	0	0	0	0	0	1	1
Unidentified Large Cetacean	3		0	0	0	1	4
Unidentified Pinniped	0	1	0	0	0	4	5
Unidentified Marine Mammal	0	1	0	0	0	1	2
False	1	2	0	0	0	0	3
May							

Beluga Whale	3	2	0	0	0	15	20
Harbor Porpoise	2	9	0	0	0	30	41
Harbor Seal	30	38	0	0	0	114	182
Gray Whale	0	2	0	0	0	2	4
Steller Sea Lion	0	0	0	0	0	1	1
Unidentified Marine Mammal	0	0	0	0	0	1	1
FALSE	1	2	0	0	0		3
June							
Beluga Whale	0	1	0	0	0	6	7
Harbor Porpoise	13	9	3	1	0	27	53
Harbor Seal	22	40	3	5	0	96	166
Gray Whale	0	2	0	0	0	0	2
Steller Sea Lion	0	0	0	0	0	1	1
California Sea Lion	0	0	0	0	0	1	1
Unidentified Large Cetacean	2	0	0	0	0	1	3
Unidentified Pinniped	0	1	0	0	0	2	3
July							
Beluga Whale	2	3	0	3	1	14	23
Harbor Porpoise	2	8	0	5	0	11	26
Harbor Seal	7	29	0	9	0	59	104
Gray Whale	0	2	0	0	0	1	3
Unidentified Large Cetacean	1	0	0	0	0	0	1
August							
Harbor Porpoise	0	1	0	0	0	4	5
Harbor Seal	0	3	0	0	0	26	29
Steller Sea Lion	0	0	0	0	0	1	1
Unidentified Marine Mammal	0	1	0	0	0	0	1
Unidentified Pinniped	0	0	0	0	0	2	2
September							
Beluga Whale	0	0	1	0	0	4	5
Harbor Porpoise	1	1	0	0	0	8	10
Harbor Seal	2	0	0	0	0	37	39

[1]Summary of mitigation measures excludes aerial overflights because aerial overflights generally took place outside the project area; however, the summary does include PAM detections.

6.9 MARINE MAMMAL TAKES

NMFS authorized APACHE the incidental taking of marine mammals during seismic activity by Level B harassment only and limited the takes to several species found in Cook Inlet (Table 1). If any other marine mammal species not listed in the IHA were encountered during seismic activity and potentially exposed to 160 dB, then a shut down immediately followed to avoid a take (Section 5.0). A Level A take (injury, serious injury, or death) of any marine mammal species during seismic activity was prohibited.

Table 22. Authorized Number of Takes During the *Cook Inlet 3D Seismic Program*

Species	Authorized No. of Takes
Odontocetes	
Beluga whale	30
Killer whale	10
Harbor porpoise	20
Pinnipeds	
Steller sea lion	20
Harbor seal	50

6.9.1 Summary of Takes

A total of 17 marine mammal Level B takes occurred from May 6 – September 30, 2012 including harbor porpoises (n=4) and harbor seals (n=13; Table 22). No other marine mammal species were taken by a Level B take during the *Cook Inlet 3D Seismic Program*. No Level A takes occurred for either cetaceans or pinnipeds. Details on the Level B takes are described in Table 23 including the time, species, number and behavior of species, distance from the source vessels (*M/V Arctic Wolf* and *M/V Peregrine Falcon*), and the seismic activity at the time of the take (airgun volume).

Table 23. Summary of Number of Marine Mammal Level B Takes By Species Per Month

Species	May	June	July	August	September	Total
Beluga	0	0	0	0	0	**0**
Killer whale	0	0	0	0	0	**0**
Harbor porpoise	0	0	0	1	3	**4**
Steller sea lion	0	0	0	0	0	**0**
Harbor seal	5	1	1	1	5	**13**
Total	**5**	**1**	**1**	**2**	**8**	**17**

Table 24. Details on the Level B Takes

Date	Time	Species	No.	Behavior	Distance from Source Vessel (AW/PF)	Airgun Volume (AW/PF)
8-May	17:40	Harbor seal	1	Looked toward vessel and then dove	4.3km/NA	2400cui/NA
11-May	10:36	Harbor seal	1	Swimming and then sank without diving	6.0 km/NA	2400 cui/NA
11-May	11:16	Harbor seal	1	Bottlenosed and then sank	6.0 km/NA	2400 cui/NA
15-May	11:04	Harbor seal	1	Swimming, looked toward vessel, then sank	4.8 km/NA	2400 cui/NA
31-May	17:52	Harbor seal	1	Bottlenosing	7.2 km/6.7 km	2400 cui/2400 cui
9-Jun	4:35	Harbor seal	1	Swimming	8.3 km/8.5 km	2400 cui/2400 cui
19-Jul	8:32	Harbor seal	1	Surfacing and traveling	9.4 km/8.9 km	2400 cui/2100 cui
20-Aug	14:45	Harbor porpoise	1	Traveling	8.0 km/8.0 km	1200 cui/1200 cui
25-Aug	12:45	Harbor seal	1	Looked toward vessel	3.0 km/1.0 km	300 cui/300 cui
1-Sep	8:09	Harbor porpoise	1	Swim	2.6 km/3.2 km	2400 cui/240 cui
13-Sep	11:54	Harbor porpoise	1	Swim, travel, dive	8 km/1.4 km	2400 cui/0
13-Sep	16:14	Harbor porpoise	1	Porpoise	3.5 km/2.6 km	150cui/440 cui
14-Sep	16:49	Harbor seal	1	Surface, travel, sink	1.2 km/NA	1200 cui/NA
14-Sep	19:04	Harbor seal	1	Swim	5.7 km/NA	1950 cui/NA
18-Sep	18:44	Harbor seal	1	Swim, look, dive	6.4 km/1.2 km	150 cui/70cui
20-Sep	14:25	Harbor seal	1	Look, swim, travel, sink	3.91 km/600 m	300 cui/140 cui
20-Sep	14:48	Harbor seal	1	Swim, look, sink	5.9 km/7.1 km	2400 cui/440 cui

6.10 INJURED/DEAD MARINE MAMMALS

During the month of August, there were two dead harbor seal sightings (Figure 36). Sightings occurred on August 7 and 13. Details on the sightings are described below. Level A stranding reports were submitted to NMFS within 24 hours of both dead seal incidents (Appendix E).

6.10.1 Dead Harbor Seal August 7, 2012

On August 7th, 2012 at 17:35 a harbor seal carcass was observed by crew on the *M/V Mark Stevens* in central inlet waters between Nikiski and Tyonek (60° 53.582 N, 151° 15.256 W; Figure 36; Appendix E). The vessel had completed picking up seismic gear and was in transit to another portion of the line when the seal was observed. The crew was instructed to monitor the carcass from a distance and later instructed to move closer to take photos. When initially observed, the seal was moving northwards with current. After obtaining photos, and closer investigation of the carcass, it was determined that the cause of death was likely not associated with the project activity. The *M/V Mark Stevens* left the harbor seal carcass location at 18:15. There were no other marine mammals or birds sighted with the harbor seal carcass. The carcass appeared bloated with very little decomposition and potential bullet holes along the left side of the head below the ear orifice. The dead seal was resighted at 15:00 from the aerial overflight at 60° 52.54N 151° 20.107 W.

6.10.2 Dead Harbor Seal August 13, 2012

On August 13th, 2012 at 22:00, a harbor seal carcass was observed by PSOs on vessels *M/V Maxime* and *M/V Dreamcatcher*. The carcass was observed north of Boulder Point on the East side of Cook Inlet, north of the East Foreland in the Nikiski area (60° 48.651 N 151° 12.244 W) (Figure 36; Appendix E). The carcass was described as "bloated and advanced decomposition with significant loss of fur.” The carcass was observed while the vessels were in transit thus no photo/video was taken. The *M/V Sidewinder* was sent back in attempt to take photos but the carcass was not resighted as the lighting was limited.

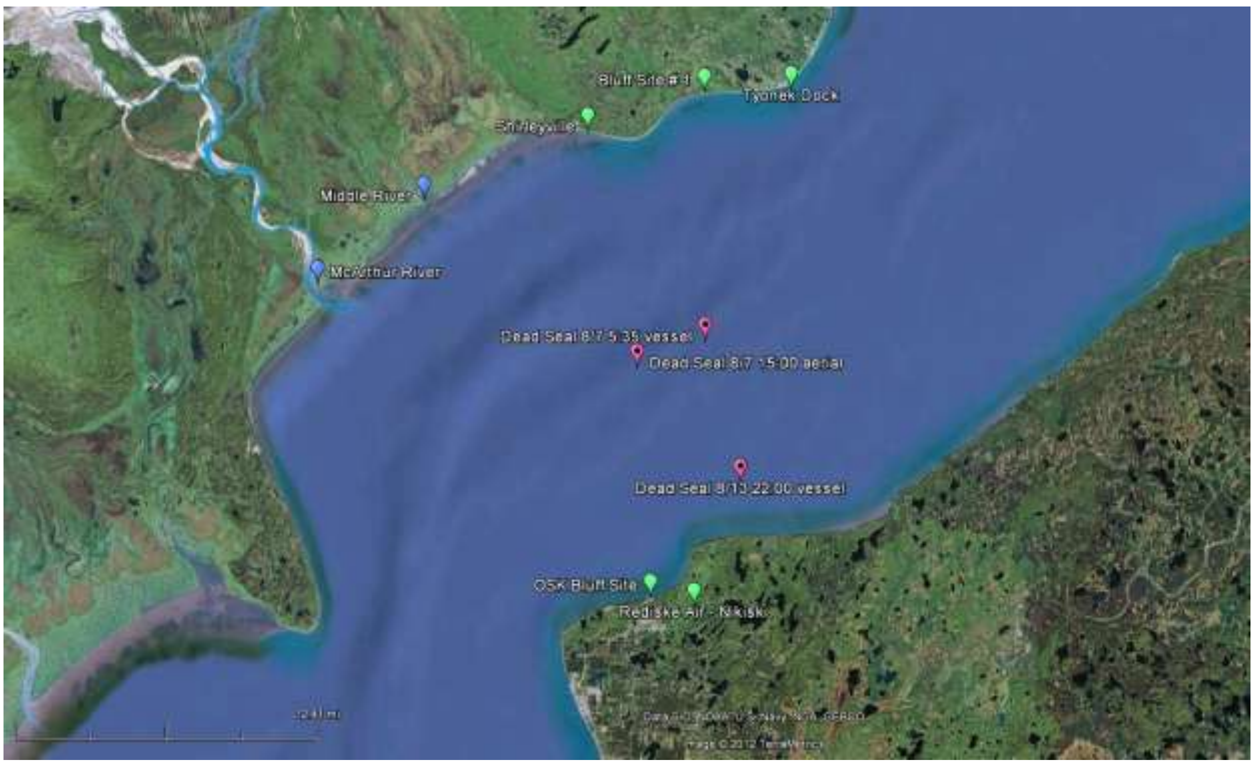

Figure 36. Location of the harbor seal carcasses observed on August 7 and 13 (pink dot with black star).

7.0 DISCUSSION

7.1 BELUGA WHALES

Response to Seismic Activity

Seismic activity may have affected the presence of beluga whales in the area because the number of beluga whale sightings was greatest without seismic activity and beluga whale sightings were generally closer to the vessels (< 5 km [3.1 mi]) without seismic activity. Beluga whales were most commonly observed traveling through the area both with and without seismic activity. In addition to traveling, during seismic activity belugas were most frequently observed milling and swimming. Without seismic activity, belugas were commonly observed in an unknown or unidentifiable behavior state and milling. No acute behavioral responses were observed during seismic activity; however, this could be due to distance from the platform at which the belugas were initially observed.

Temporal and Spatial Distribution

Beluga whales were most frequently observed during the month of June along the West side of Cook Inlet, as far south as McArthur River to as far north as the Ivan River. Beluga whales were also commonly observed adjacent to the shoreline near river mouths, which is consistent with other studies conducted in the area (Rugh et al. 2000, Nemeth et al. 2007). All major rivers belugas were observed near are anadromous fish streams (ADFG 2012a). The increased presence of beluga whales in the area during June could correspond to the Chinook salmon (*Oncorhynchus tshawytscha*) runs which generally take place in Cook Inlet from mid-May through June (Alaska Department of Fish & Game [ADF&G] 2012b); however, additional studies correlating salmon runs with the presence of beluga whales need to take place. Beluga whale abundance decreased and moved north (Beluga River to Susitna River) July through September, when beluga whales are more commonly observed in the upper reaches of Cook Inlet (e.g., Knik and Turnagain Arms; Hobbs et al. 2005). It is possible that the decreased number of beluga whale sightings during the month of July and increased number during August and September could correspond to the beluga whale seasonal movement up inlet into Turnagain Arm and Knik Arm and return during later months corresponding to late summer early fall salmon runs.

The high number of beluga whale sightings within 1 km (0.62 mi) of the coastline, typically in or near river mouths and in the northern shores of upper Cook Inlet to the collective NMFS aerial survey results (Rugh et al. 2000, 2004a, 2005a, 2006, 2007; Shelden et al. 2008, 2009, 2010; Hobbs et al 2008). Additionally, the higher number of beluga whales observed during the month of June and consistent numbers during July – September correspond to the NMFS aerial survey data that shows concentrations of beluga whales in the northernmost portion of Cook Inlet fairly consistent from June to October (Rugh et al. 2000, 2004a, 2005a, 2006, 2007; Shelden et al. 2008, 2009, 2010).

Small groups have been recorded in the lower river mouths of Trading Bay (McArthur River) prior to 1996 but not consistently thereafter. The results from this monitoring program suggest the lower Trading Bay river mouths (McArthur River, Middle River and Nikolai Creek) are used more frequently that previously understood. The habitat use of lower Trading Bay possibly corresponds to the anadromous fish runs in the McArthur River (ADFG 2012a).

7.2 HARBOR PORPOISES

Harbor porpoises were most frequently observed from the vessels without seismic activity within a distance of 1 km (0.62 mi), while harbor porpoises were not commonly observed from aerial overflights. Harbor porpoises were likely observed within close proximity of vessels because they are generally difficult to observe because they are typically solitary and do not stay at the surface for long periods of time. Harbor porpoises were most commonly observed traveling and swimming both with and without seismic activity. No acute responses were observed during seismic activity, but as with beluga whales, this could be due to distance from the platform at which the harbor porpoises were initially observed or due their size, coloration, and typical behavior. Additionally, harbor porpoises were most commonly observed during May and June.

7.3 HARBOR SEALS

Harbor seals were most frequently observed during aerial overflights during the month of June. The majority of these sighting represent the large congregations of hauled-out harbor seals in the major rivers in the area (e.g., Theodore, Lewis Beluga, and McArthur Rivers). A greater number of harbor seals were observed closer to the vessels (<1 km [0.62 mi]) without than with seismic activity. Harbor seals were most commonly observed swimming, looking, and looking forward followed by sinking both with and without seismic activity; however, these behaviors were observed more frequently without than with seismic activity. No acute responses were observed during seismic activity.

Harbor seals were observed frequently hauled out in the Susitna, Ivan, Lewis, Theodore, and Beluga Rivers as well as small numbers hauled out in the McArthur River. These sightings correspond to the NMFS aerial surveys of upper Cook Inlet in 2001, 2002, and 2003, harbor seals were observed in the Susitna, Ivan, McArthur, and Beluga Rivers (Rugh et al. 2005a). The closest traditional haulout side to the project area is located on Kalgin Island, which is about 22 km (14 mi) away from the McArther River. The presence of harbor seals in upper Cook Inlet is known to be seasonal and most likely associated with eulachon and salmon migrations (NMFS 2003).

7.4 OTHER MARINE MAMMALS

7.4.1 Gray Whales

Gray whale observations were not expected to take place within the project area or within Cook Inlet. Gray whales have not previously been documented in central Cook Inlet and were not recorded during the NMFS aerial surveys (Rugh et al. 2000, 2004a, 2005a, 2006, 2007; Shelden et al. 2008, 2009, 2010). Gray whales were observed during May – July with two individuals observed on July 28th. The gray whales observed in May and June were thought to be juveniles and possibly the same animal although no valid identification for resight purposes was possible. Gray whales were observed within close proximity to the source vessels during seismic operations. Five of the nine sightings were <1 km (0.62 mi) of the source vessels both with and without seismic operations. With seismic activity, three of the five sightings were observed milling with fluke up dives, one was observed milling with fluke down dives, and one was unknown. All four of the gray whale sightings without seismic activity were observed milling with fluke down dives.

7.4.2 Steller Sea Lions

Steller sea lions were observed during the project on three different occasions (4 estimated individuals). The small number of sightings of Steller sea lions in the project area corresponds with what has previously been documented for this species in Cook Inlet. In Cook Inlet, Steller sea lions are known to occur in the southern areas, typically south of Anchor Point around the offshore islands and along the west coast of the upper inlet in the bays (Chinitna Bay, Iniskin Bay, etc.) (Rugh et al. 2005a). A small number (n = <5) of sightings have been recorded from the Port of Anchorage monitoring program; and the NMFS aerial surveys found no Steller sea lions in upper Cook Inlet (Prevel-Ramos, et al. 2006, 2008). Rookeries and haulout sites in lower Cook Inlet include those near the mouth of the inlet, which are far south of the project area so it was not expected to have large number of sightings of Steller sea lions in the project area (Rugh et al. 2000, 2001, 2002, 2003, 2004b, 2005b, 2006, 2007; Shelden et al. 2008, 2009, 2010).

On June 27th, during an aerial overflight there was an observation of a congregation of ~75 unidentified pinnipeds. The congregation was observed hauled out on the banks of the Beluga River mouth. This sighting was recorded as *unidentified pinniped* due to the inability to clearly identify them from the aerial platform. These animals were a possible a congregation of Steller sea lions as they were recorded to be larger and lighter in color than the harbor seals observed in the area at the same time.

7.5 MONITORING PLATFORMS

Despite the difficulties in effectively monitoring the DZ because of its size (9.5 km), the combination of multiple platforms (vessel, land, and aerial) allowed for adequate monitoring of the DZ. Without one of these platforms, the monitoring effort would not have been as successful. Vessel platforms allowed for sufficient monitoring of the immediate area, while land and aerial platforms allowed for monitoring the outer parameters and extending the monitoring zone beyond the 9.5 km.

Aerial overflights were highly valuable because they covered an extensive area, allowing the marine mammal monitoring program to extend beyond the DZ. The extended monitoring zone offered insight on where large congregations of beluga whales and harbor seals were located and whether or not the groups of animals were moving in the direction of the project area. When large congregations of marine mammals, specifically beluga whales, were observed from the aerial platform and their movement was observed as a clear direction of travel towards the project location, the aerial team could alert the vessel PSOs along with the operations team and utilize the aerial sighting information to plan the location of operations. These alerts also allowed for better ability for the vessel PSOs to detect marine mammals when moving towards the project area as they were then aware of the potential location speed of the animals travel.

Aerial overflights allowed for a better understanding of the spatial distribution of marine mammals in the general area, such as the large congregations of beluga whales observed in June near the Beluga, Theodore, Lewis, and Ivan Rivers or the extensive haul-outs of harbor seals during June in the Beluga, Theodore, Lewis, Ivan, and Susitna Rivers (to the north) and the McArthur River (to the south). Understanding the location of these large congregations assisted in the decision of where and when seismic activity could take place.

PAM proved challenging in Cook Inlet. First, there were many difficulties encountered when deploying the telemetry buoy, and therefore, an OTS hydrophone was used during the monitoring program. Secondly, background acoustic conditions including flow noise from currents and weather along with additional noise from the project (e.g., vessel noise, noise from other project equipment) made it difficult to detect marine mammals in the area. Marine mammal vocalizations that were detected extended above 1 kHz in frequency, generally above the frequency of background noise. For a more detailed discussion on the PAM program, its limitations and recommendations refer to Appendix C-3.

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