Environmental Assessment

FOR

ISSUANCE OF AN INCIDENTAL HARASSMENT AUTHORIZATION FOR THE ALASKA APACHE CORPORTATION 3D SEIMIC PROGRAM IN COOK INLET, ALASKA

OCTOBER 2011

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Abstract: The National Marine Fisheries Service (NMFS) proposes to issue an Incidental Harassment Authorization (IHA) to the Alaska Apache Corporation for the incidental taking of small numbers of marine mammals in the wild, pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq*.). The IHA would be valid for 1 year from the date of issuance and would authorize the take, by Level B harassment, of marine mammals incidental to a seismic survey program in Cook Inlet, Alaska.

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3D	three dimensional
AASM	Air Array Source Model
ACS	American Community Survey
ADF&G	Alaska Department of Fish and Game
ADCCE	Alaska Department of Commerce, Community, and Economic
ADNR	Alaska Department of Natural Resources
AKRO	Alaska Regional Office
AMAR	Advanced Multichannel Acoustic Recorder
Apache	Apache Alaska Corporation
AQCR	Air Quality Control Regions
BOEM	Bureau of Ocean Energy Management
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CIMMC	Cook Inlet Marine Mammal Council
CIVTS	Cook Inlet Vessel Traffic Study
cm	centimeter
CO	carbon dioxide
cui	cubic inches
dB re 1 µPa	decibel referenced to one microPascal
dBA	A-weighted decibels
DGPS/RTK	differential global positioning system/roving units
DOSITS	Discovery of Sound in the Sea
DPS	Distinct Population Segment
EA	Environmental Assessment
EEZ	Economic Exclusion Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ERF	Eagle River Flats
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
ft	feet
ft^3/sec	cubic feet per second
FR	Federal Register
Hz	Hertz
IHA	Incidental Harassment Authorization
in	inches
INS	Integrated Navigation System
JASCO	JASCO Applied Sciences
JBER	Joint Base Elmendorf-Fort Richardson

KABATA	Knik Arm Bridge and Toll Authority
kg	kilogram
kHz	kilohertz
km	kilometer
km^2	square kilometer
kn	knots
lb	pound
LCI	Lower Cook Inlet Management Area
L_{eq}	equivalent sound level
L_{max}	maximum sound level
L_{min}	minimum sound level
LOA	Letters of Authorization
m	meter
mi	miles
mi^2	square miles
m^3/sec	cubic meters per second
ml/l	milliliters per liter
MLLW	mean low lower water
MMPA	Marine Mammal Protection Act
MOA	Municipality of Anchorage
NAAQS	National Ambient Air Quality Standards
NAO	NOAA Administrative Order
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
OMB	Office of Management and Budget
OPR	Office of Protected Resources
OSP	Optimum Sustainable Population
Pa	Pascals
PAH	Polycyclic aromatic hydrocarbons
PAM	Passive Acoustic Monitoring
PR1	Permits, Conservation and Educational Division
PRD	Protected Resources Division
PSO	Protected Species Observer
PTS	permanent threshold shift
rms	root-mean-squared
SEL	sound energy level
SPL	sound pressure level

SSV	Sound source verification
TS	threshold shift
TTS	temporary threshold shift
UCI	Upper Cook Inlet Management Area
USBL	Ultra-Short BaseLine
USC	United States Code
USCG	United States Coast Guard
USFWS	United State Fish and Wildlife Service

Chapter 1 Purpose and Need for Action

1.1. Description of Action

In response to receipt of request from Apache Alaska Corporation (Apache), NMFS proposes to issue incidental harassment authorizations (IHAs) that authorizes takes[1] by level B harassment of marine mammals in the wild pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1631 *et seq.*), and the regulations governing the taking and importing of marine mammals (50 Code of Federal Regulations [CFR] Part 216).

This Environmental Assessment (EA), titled "Environmental Assessment for the Issuance of Incidental Harassment Authorization to Take Marine Mammals by Harassment Incidental to Conducting Three-Dimensional (3D) Seismic Surveys in Cook Inlet, Alaska," (hereinafter, Apache EA) addresses the impacts on the human environment that would result from the issuance of the IHA.

1.1.1. Background

On June 15, 2011, National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) received an application from Apache requesting an authorization for the harassment of small numbers of marine mammals incidental to conducting a 3D seismic survey program in Cook Inlet, Alaska. After addressing comments from NMFS, Apache modified its application and submitted a revised application on July 19, 2011.

To comply with the MMPA, Apache has submitted an IHA application due to the presence of marine mammal species in the vicinity of the proposed 3D seismic survey area. Marine mammals under the NMFS jurisdiction that could be adversely affected by the proposed 3D seismic survey in Cook Inlet are:

- Cook Inlet beluga whale (*Delphinapterus leucas*)
- Harbor seal (Phoca vitulina richardsi)
- Killer whale (*Orcinus orca*)
- Harbor porpoise (*Phocoena phocoena*)
- Steller sea lion (*Eumatopia jubatus*)

1.1.2. Purpose and Need

The purpose and need of the proposed action is to ensure compliance with the MMPA and its implementing regulations in association with Apache's proposed 3D seismic survey in Cook Inlet, Alaska. The MMPA prohibits takes of all marine mammals with certain exceptions.

In response to the receipt of an IHA application from Apache, NMFS proposes to issue an IHA pursuant to the MMPA §101(a)(5)(D). The primary purpose of the IHA is to provide an exception from the take

[1] Take under the MMPA means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. 16 U.S.C. 1362(13).

prohibitions under the MMPA to authorize takes by level B harassment of marine mammals, including endangered species, incidental to the proposed 3D seismic survey program in Cook Inlet by Apache. The need for the issuance of IHA is related to NMFS' mandates under the MMPA. Specifically, the MMPA prohibits takes of marine mammals, with specific exceptions, including the incidental, but not intentional, taking of marine mammals, for periods of not more than one year, by United States citizens who engage in a specified activity (other than commercial fishing).

IHA issuance criteria require that activities authorized by an IHA will have a negligible impact on the species or stocks(s); and will not have an unmitigable adverse impact on the availability of the species or stocks(s) for subsistence uses. In addition, the IHA must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock or its habitat, and requirements for monitoring and reporting of such takings.

Issuance of an IHA is a federal agency action. For purposes of Section 7 of the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq*.), NMFS must consult with itself to ensure that its action is not likely to jeopardize the continued existence of any federally-listed species or result in the destruction or adverse modification of critical habitat.

In addition, this EA is prepared in accordance with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq*.) for the analysis of the potential environmental impacts as the result of the NMFS proposed issuance of the IHA.

1.2. Scoping Summary

The purpose of scoping is to identify the issues to be addressed and the significant issues related to the proposed action, as well as identify and eliminate from detailed study the issues that are not significant or that have been covered by prior environmental review. An additional purpose of the scoping process is to identify the concerns of the affected public and Federal agencies, states, and Indian tribes.

The MMPA and its implementing regulations governing issuance of an IHA require that upon receipt of a valid and complete application for an IHA, NMFS publish a notice of receipt in the Federal Register (50 CFR 216.104(b)(1)). The notice summarizes the purpose of the requested IHA, includes a statement about whether an EA or an Environmental Impact Statement (EIS) was prepared, and invites interested parties to submit written comments concerning the application.

NOAA Administrative Order (NAO) 216-6, established agency procedures for complying with NEPA and the implementing regulations issued by the President's Council on Environmental Quality (CEQ). NAO 216-6 specifies that the issuance of an IHA under the MMPA is among a category of actions that require further environmental review and the preparation of NEPA documentation.

1.2.1. Comments on Application and EA

NMFS will publish a notice of a proposed IHA for Apache in Cook Inlet in the Federal Register (FR) announcing availability for public comment for 30 days. The public comment period will afford the public the opportunity to provide input on environmental impacts, many of which are highlighted in the EA and IHA application. In addition, NMFS will post the final EA and Finding of No Significant Impact (FONSI), assuming NMFS makes this finding.

1.3. Applicable Laws and Necessary Federal Permits, Licenses, and Entitlements

This section summarizes federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action, as well as who is responsible for obtaining them.

1.3.1. National Environmental Policy Act

Issuance of an IHA is subject to environmental review under NEPA. NMFS may prepare an EA, an EIS, or determine that the action is categorically excluded from further review. While NEPA does not dictate substantive requirements for an IHA, it requires consideration of environmental issues in federal agency planning and decision making. The procedural provisions outlining federal agency responsibilities under NEPA are provided in the CEQ's implementing regulations (40 CFR Parts 1500-1508).

NOAA has, through NAO 216-6, established agency procedures for complying with NEPA and the implementing regulations issued by the CEQ. NAO 216-6 specifies that issuance of an IHA under the MMPA and ESA is among a category of actions that require further environmental review. When a proposed action has uncertain environmental impacts or unknown risks, establishes a precedent or decision in principle about future proposals, may result in cumulatively significant impacts, or may have an adverse effect upon endangered or threatened species or their habitats, preparation of an EA or EIS is required. This Apache EA is prepared in accordance with NEPA, CEQ's implementing regulations and NAO 216-6.

1.3.2. Endangered Species Act

Section 7 of the ESA and implementing regulations at 50 CFR Part 402 require consultation with the appropriate federal agency (either NMFS or the U.S. Fish and Wildlife Service [USFWS]) for federal actions that "may affect" a listed species or critical habitat. NMFS' issuance of an IHA affecting ESA-listed species or designated critical habitat, directly or indirectly, is a federal action subject to these section 7 consultation requirements. Accordingly, NMFS is required to ensure that its action is not likely to jeopardize the continued existence of any threatened or endangered species or result in destruction or adverse modification of critical habitat for such species.

The NMFS Office of Protected Resources (OPR) Permits, Conservation and Education Division (PR1) is required to consult with the NMFS Alaska Regional Office (AKRO) Protected Resources Division (PRD) on the issuance of the IHAs under Section 101(a)(5)(D) of the MMPA. PR1 is required to consult with PRD because the action of issuing an IHA may affect threatened and endangered species under NMFS' jurisdiction.

1.3.3. Marine Mammal Protection Act

Section 101(a)(5)(D) of the MMPA (16 U.S.C. 1371(a)(5)(D)) directs the Secretary of Commerce (Secretary) to authorize, upon request, the incidental, but not intentional, taking by harassment of small numbers of marine mammals of a species or population stock, for periods of not more than one year, by United States citizens who engage in a specified activity (other than commercial fishing) within a specific geographic region if certain findings are made and notice of a proposed authorization is provided to the public for review.

Authorization for incidental taking of small numbers of marine mammals shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The authorization must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock and its habitat, and requirements pertaining to the monitoring and reporting of such takings. NMFS has defined "negligible impact" in 50 CFR 216.103 as "an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Section 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:

any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild ["Level A harassment"]; or (ii) 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 ["Level B harassment"].

Section 101(a)(5)(D) of the MMPA establishes a 45-day time limit for NMFS' review of an application followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of small numbers of marine mammals. Not later than 45 days after the close of the public comment period, if the Secretary makes the findings set forth in Section 101(a)(5)(D)(i) of the MMPA, the Secretary shall issue the authorization with appropriate conditions to meet the requirements of clause 101(a)(5)(D)(ii) of the MMPA.

NMFS has promulgated regulations to implement the permit provisions of the MMPA (50 CFR Part 216) and has produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures (including the form and manner) necessary to apply for permits. All applicants must comply with these regulations and application instructions in addition to the provisions of the MMPA. Applications for an IHA must be submitted according to regulations at 50 CFR §216.104.

1.3.4. Magnuson-Stevens Fishery Conservation and Management Act

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), Federal agencies are required to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency which may adversely affect essential fish habitat (EFH) identified under the MSFCMA.

1.4. Description of Specified Activities

Apache acquired over 300,000 acres of oil and gas leases in Cook Inlet in 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 (no cables) 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 the 3D seismic program in the Cook Inlet. The test program occurred in late March 2011 and results showed that the nodal technology was feasible in the Cook Inlet environment. Therefore, Apache now proposes to conduct a phased 3D seismic survey program throughout Cook Inlet over the course of the next three to five years. The first area (Area 1) proposed to be surveyed over the course of the next year, beginning in fall 2011, is located along the western coast of upper Cook Inlet (Figure 1). The proposed Area 1 program area is approximately 2,719 square kilometers (km^2, 1,050 square miles [mi^2]) and is along the west coast from McArthur River up and to the south of Beluga River. As detailed further below, the program consists of an onshore, transition zone, and offshore component (Figure 2).

Each phase of the program within an area will have an onshore component, a transition zone component, and an offshore component. Transition zone and offshore acquisition will include areas below the high water mark as depicted in Figure 2. The seismic operation will be active 24 hours per day. In-water air gun activity will average 10-12 hours per day and will generally occur around the slack tide or low current periods. Vessels will lay and retrieve 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 will include the use of input/output sleeve air guns in two different configurations of arrays: a 440 and 2,400 cubic inches [cui]). The seismic source vessels currently planned for use are the *M/V Peregrine Falcon* and *M/V Arctic Wolf*, or similar vessel. Cable/Nodal deployment and retrieval operations will be supported by three shallow draft vessels (*M/V Miss Diane I*, *M/V Miss Diane II*, and *M/V Maxime*), or similar vessels. The mitigation/chase vessel, which will also house the Protected Species Observers (PSO) will be the *M/V Dreamcatcher*, or similar vessel. Two smaller jet boats will be used for personnel transport and node support in the extremely shallow water in the intertidal area. Water depths for the program will range 0 to 128 meters (m, 0 to 420 feet [ft]).

1.4.1. General Program Overview

Each phase of the Apache program encounters land, inter-tidal transition zone, and marine environments. The following provides a general overview of the methodology the will be employed during the acquisition of the seismic survey.

1.4.1.1. Recording System

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

The geometry methodology that Apache will employ 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 begin by laying nodes off the back of the layout vessels on the seafloor parallel to each other with a node line spacing of a 402 m (1,320 ft). Apache's patch will have 6–8 node lines (receivers) laid in parallel to each other. The lines are generally run perpendicular to the shoreline. The node lines will be separated by either 402 or 503 m (1,320 or 1,650 ft). Inline spacing between nodes will be 50 m (165 ft). The node vessels will lay the entire patch on the seafloor prior to the air gun activity. Individual vessels

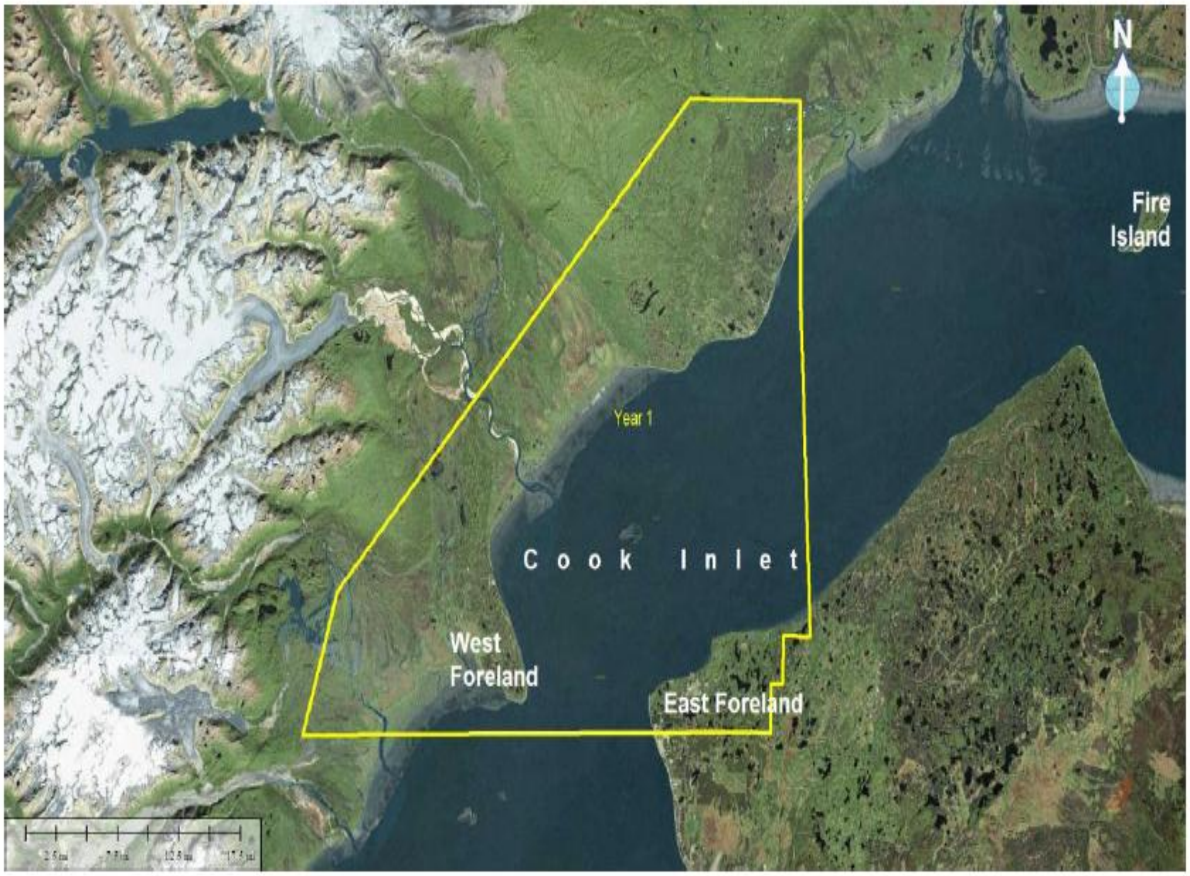

Figure 1. Location of Area 1 Seismic Survey Program.

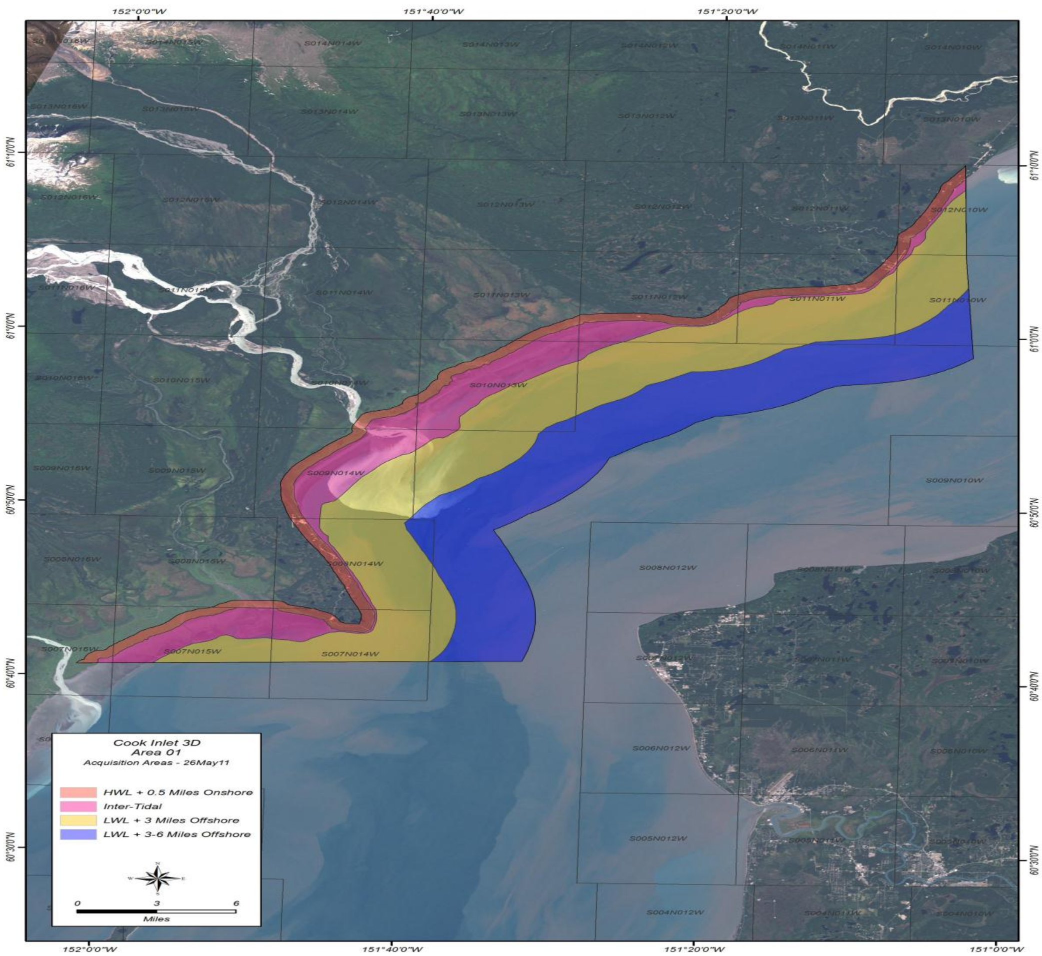

Figure 2: Map of Area 1 Showing Offshore and Transition Components.

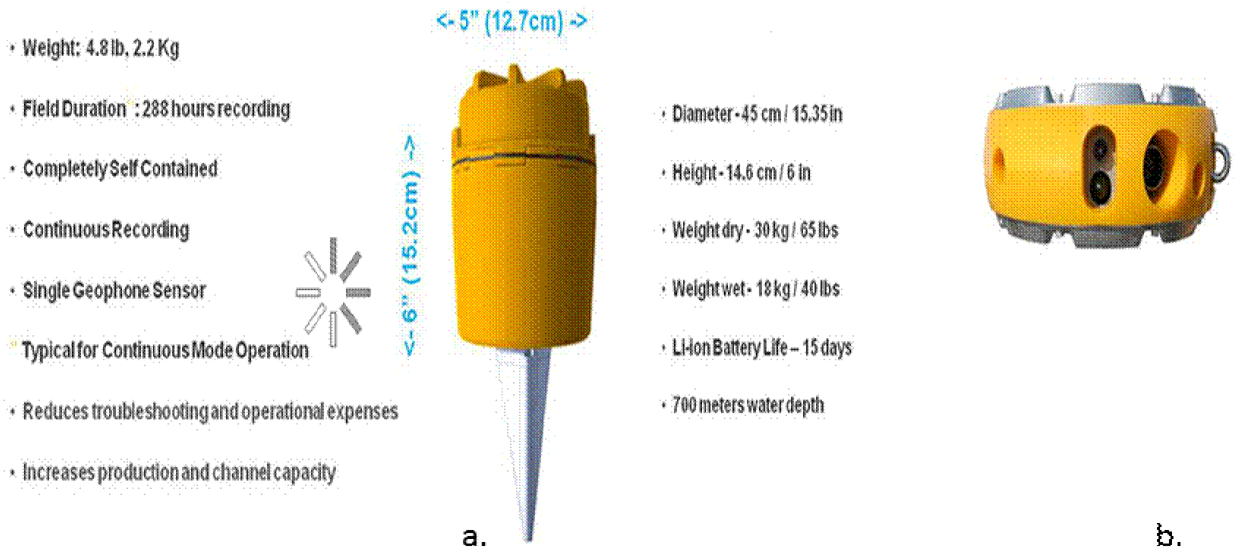

Figure 3. Nodal autonomous recording systems a) a single-component sensor land node and b) a submersible multi-component intertidal and marine zone system.

are capable of carrying up to 400 nodes. With three node vessels operating simultaneously, a patch can be laid down in a single 24 hour period, weather permitting. A sample patch is depicted in Figure 4.

As the patches are acquired, the node lines will be moved either side to side or inline to the next patch's location. Figure 5 depicts multiple side to side patches that are acquired individually but when seamed together at the processing phase, create continues coverage along the coastline.

1.4.1.2. Sensor Positioning

Transition Zone/Offshore Components

Once the nodes are in place on the seafloor, the exact position of each node is required. There are several techniques used to locate the nodes on the seafloor, depending on the depth of the water. In very shallow water, the nodes position is either surveyed by a land surveyor when the tide is low, or the position is accepted based on the position at which the navigator has laid the unit.

In deeper water, there are two recognized techniques. The first is to use a hull or pole mounted pinger to send a signal to transponder which is attached to each node. The transponders are coded and the crew knows which transponder goes with which node prior to the layout. The transponders response (once pinged) is added together with several other responses to create a suite of ranged and bearing between the pinger boat and the node. Those data are then calculated to precisely position the node. In good conditions, the nodes can be interrogated as they are laid out. It is also common for the nodes to be pinged after they have been laid out. The pinger that will be used is a Sonardyne Shallow Water Cable Positioning system. The two instruments used are 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 a LR 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 second technique for the deeper water is called Ocean Bottom Receiver Location (OBRL). This technique uses a small volume (10 cui) air gun firing parallel to the node line. The air gun is fired along each side of the line, the data are then gathered from the node and combined with the known position of the air gun to give a precise location of each node. Figure 6 shows a typical pinger or OBRL geometry that is used to position the nodes. Once the patch of nodes is on the sea floor and positioning information has been gathered, the source activity begins.

Onshore/Intertidal Components

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

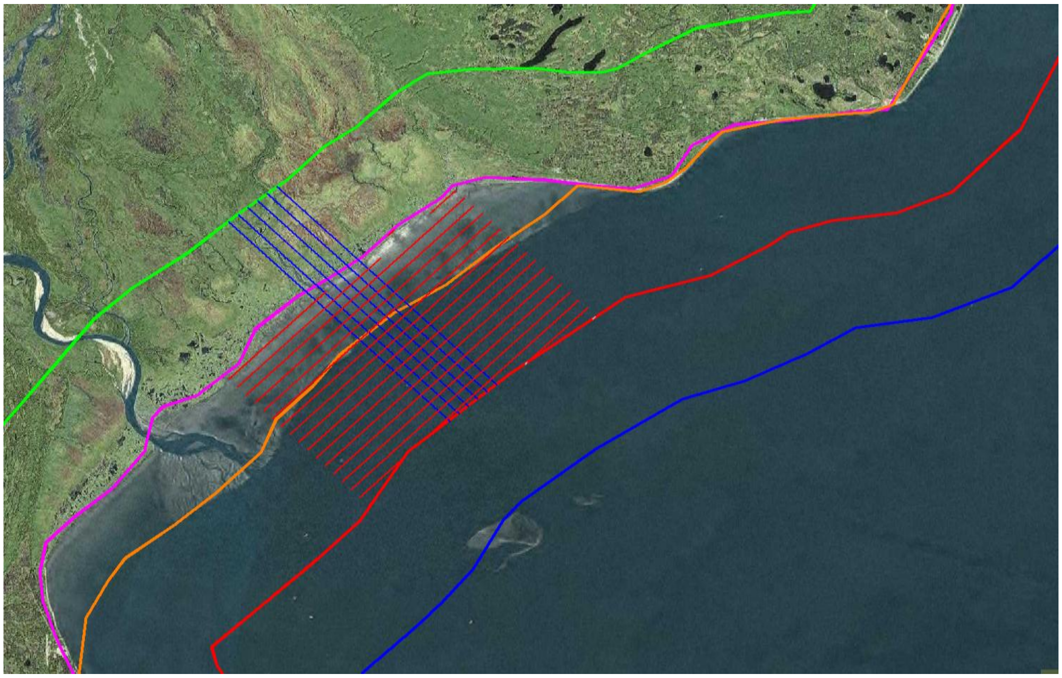

Figure 4. A Single Intertidal Patch, Six Lines of Nodes (Blue), 16 Source Lines (Red).

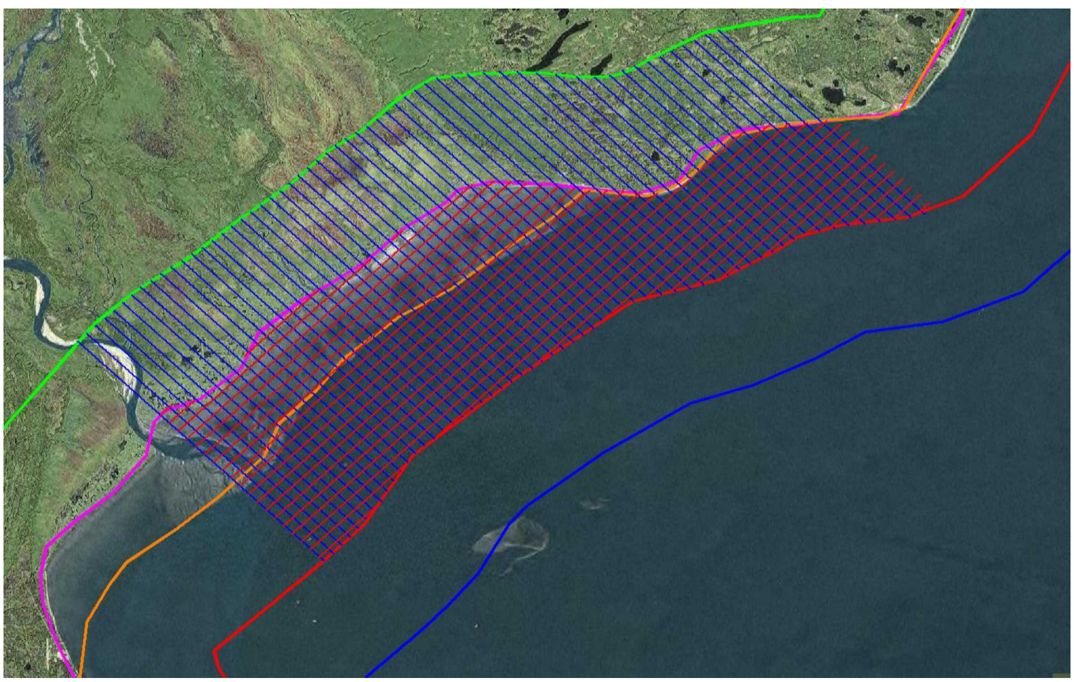

Figure 5. Multiple Intertidal Patches.

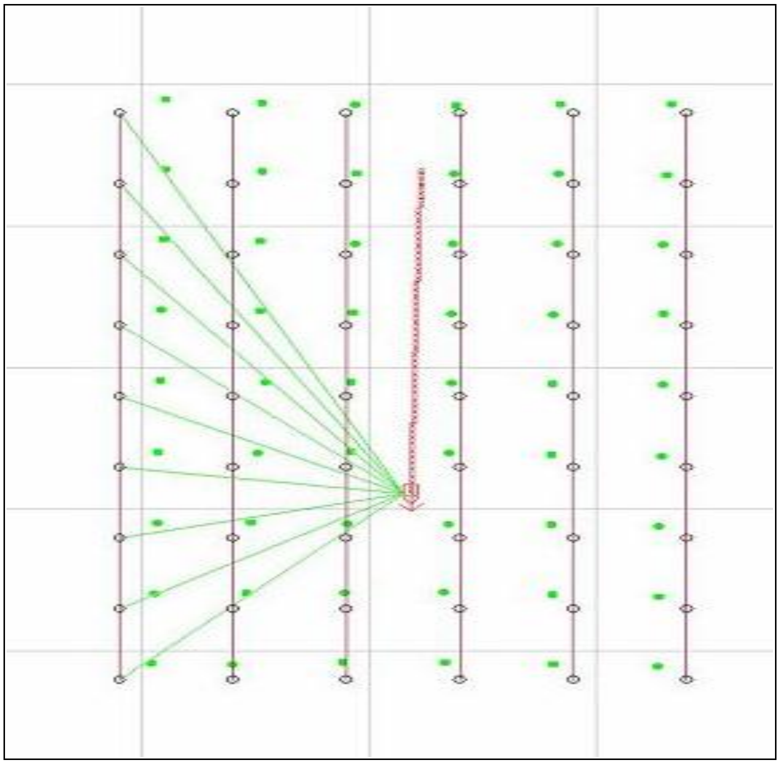

Figure 6. Pinger or OBRL Vessel Interrogating a Patch of 6 Lines.

1.4.1.3. Seismic Source

Transition Zone/Offshore Components

Apache's methodology will employ the use of two source vessels synchronized in time. The source vessels *M/V Peregrine Falcon* and the *M/V Arctic Wolf* (or similar vessels) will be equipped with compressors and 2400 cui air gun arrays. In addition, the *M/V Peregrine Falcon* will be equipped with a 440 cui shallow water source which it can deploy at high tide in the intertidal area in less than 1.8 m (6 ft) of water. Source lines are orientated perpendicular to the node lines and parallel to the beach (see red lines on Figure 4). The two source vessel will traverse source lines of the same patch using a shooting technique called ping/pong. The ping/pong methodology will have the first source boat commence the source effort. As the first air gun pop is initiated, the second gun boat is sent a command and begins a countdown to pop its guns 12 seconds later than the first vessel. The first source boat would then take its second pop 12 seconds after the second vessel has popped and so on. The vessels try to manage their speed so that they cover approximately 50 m (165 ft) between pops. The objective is 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. Vessel speeds will range from 2-4 knots. The source effort will average 10-12 hours per day.

Each source line is approximately 12.9 kilometer (km, 8 miles [mi]) long. A single vessel is capable of acquiring a source line in approximately 1 hour. With two source vessels operating simultaneously, a patch of approximately 3,900 source points can be acquired in a single day assuming a 10-12 hour source effort.

In addition to the marine mammal monitoring radii outlined in this document, there will be 1.6 km (1 mi) setback of source points from the mouths of any anadromous streams to comply with Alaska Department of Fish and Game (ADF&G) restrictions.

When the data from the patch of nodes have been acquired, the node vessels pick up the patch and roll it to the next location. The pickup effort will take 3/4 of a day

Onshore/Intertidal Components

The onshore source effort will be shot holes. These holes are drilled every 50 m (165 ft) along source lines which are orientated perpendicular to the receiver lines and parallel to the coast. To access the onshore drill sites, Apache would use a combination of helicopter portable and tracked vehicle drills. At each source location, Apache will drill to the prescribed hole depth of approximately 10 m (35 ft) and load it with 4 kilograms (kg) of explosive (likely Orica OSX Pentolite Explosive). The hole will be capped with a “smart cap” that will make it impossible to detonate the explosive without the proper blaster.

1.4.2. Vessels

The *M/V Peregrine Falcon*, *M/V Miss Diane I* and *II*, *M/V Arctic Wolf*, *M/V Maxime*, and *M/V Dreamcatc*her will serve as the primary offshore acquisition platforms (or similar vessels). Details of the vessels likely to be used are as follows:

M/V ARCTIC WOLF (SOURCE VESSEL / MOTHER SHIP)

Size: 41 m X 9 m (135 ft X 30 ft)
Documentation: #687450
Gross Tonnage: 251
Berths: 22

M/V PEREGRINE FALCON (SOURCE VESSEL)

Size: 26 m X 6 m (85 ft X 24 ft)
Documentation: #950245
Call sign: WCZ6285
Gross tonnage: 131
Berths: 10

M/V MISS DIANE I (NODE VESSEL)

Size: 26 m X 6 m (85 ft X 20 ft)
Documentation: #1210779
Call sign: WAV0779
Gross tonnage: 53
Berths: 6

M/V MISS DIANE II (NODE VESSEL)

Size: 26 m X 6.7 m (85 ft X 22 ft)
Documentation: Being constructed
Call sign: TBD
Gross tonnage: TBD

Berths: 10

M/V MAXIME (NODE VESSEL)

Size: 21 m X 4.9 m (70 ft X 16 ft)
Documentation: #1196716
Call sign: WAV6716
Gross tonnage: 48
Berths: 4

M/V DREAMCATCHER (MITIGATION /CHASE BOAT)

Size: 26 m X 7.1 m (85 ft X 23 ft)
Documentation: #963070
Call sign: WBN5411
Gross tonnage: 100
Berths: 22

1.4.3. Fuel Storage

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

1.5. Dates, Duration, and Geographical Region of Activities

Apache proposes to conduct offshore/transition zone operations in approximately 8 to 9 months of the first year of the program (during windows of opportunity). Transition zone activities near intertidal areas adjacent to ADF&G refuges are estimated to be acquired during the months October – December 2011 and March 2012. Nearshore areas adjacent to uplands and offshore areas will be acquired in open water periods from April through September 2012. For the proposed Area 1 in the upper Cook Inlet, anticipated windows of opportunity will be defined by regulatory thresholds with respect to agency coordination, subsistence, and appropriate weather conditions.

Apache anticipates completing approximately 829 square km (km^2, 320 square mi [mi^2]) of seismic acquisition in Area 1 in the first year of operations in Cook Inlet. During each 24 hour period, seismic operations will be active throughout the entire period. However, in-water air guns will only be active for approximately 2.5 hours during each of the slack tide periods. There are approximately 4 slack tide periods in a 24-hour period; therefore, air gun operations will be active during approximately 10-12 hours per day, if weather conditions allow. Apache anticipates that a crew can acquire approximately 5.2 km^2 (2 mi^2) per day, assuming an efficient crew can work 10-12 hours per day. Thus, the actual survey duration to acquire the approximately ~829 km^2 (320 mi^2) will take approximately 160 days over the course of the 8-9 months.

Mobilization of operations for Area One will occur in September out of Homer and Anchorage, Alaska, and the survey is proposed to begin in early October depending on weather conditions and permit stipulations.

Chapter 2 Alternatives Including the Proposed Action

The NEPA implementing regulations (40 CFR § 1520.14) and NAO 216-6 provide guidance on the consideration of alternatives to a federal proposed action and require rigorous exploration and objective evaluation of all reasonable alternatives. Alternatives must be consistent with the purpose and need of the action and be feasible. This chapter describes the range of potential actions (alternatives) determined reasonable with respect to achieving the stated objective, as well as alternatives eliminated from detailed study and also summarizes the expected outputs and any related mitigation of each alternative.

In light of NMFS' stated purpose and need, NMFS considered the following two alternatives for the issuance of an IHA to Apache to conduct their 3D seismic survey in 2011/2012 for Cook Inlet.

2.1. Alternative 1 – No Action Alternative

Under the No Action Alternative, NMFS would not issue an IHA to Apache for the harassment of marine mammals incidental to conducting 3D seismic surveys in Cook Inlet. The MMPA prohibits all takings of marine mammals unless authorized by a permit or exemption under the MMPA. The consequences of not authorizing incidental take are 1) the entity conducting the activity may be in violation of the MMPA if take occurs, 2) mitigation and monitoring measures cannot be required by NMFS, and 3) mitigation measures might not be performed voluntarily by the applicant. By undertaking measures to further protect marine mammals from incidental take through the authorization program, the impacts of these activities on the marine environment can potentially be lessened.

While NMFS does not authorize the geophysical activity itself (that authority falls to Bureau of Ocean Energy Management [BOEM]), NMFS does authorize the incidental harassment of marine mammals in connection with these activities and prescribes the methods of taking and other means of effecting the least practicable adverse impact on these species and stocks and their habitats. If IHA is not issued, Apache could decide either to cancel their 3D seismic survey or to continue their activities described in Section 1.4 of this EA. If the latter decision is made, Apache could independently implement (presently identified) mitigation measures; however they would proceeding without authorization from NMFS pursuant to the MMPA. If Apache did not implement mitigation measures during survey activities, takes of marine mammals by harassment (and potentially by injury or mortality) could occur if the activities were conducted when marine mammals were present. Although the No Action Alternative would not meet the purpose and need to allow incidental takings of marine mammals under certain conditions, CEQ regulations require consideration and analysis of a No Action Alternative for the purposes of presenting a comparative analysis to the action alternatives.

2.2. Alternative 2 – Issuance of IHA with Required Mitigation, Monitoring and Reporting Measures (Preferred Alternative)

Under this alternative, NMFS would issue an IHA under section 101(a)(5)(D) of the MMPA to Apache, allowing the take by Level B harassment of small numbers of marine mammal species incidental to conducting 3D seismic survey activities in Cook Inlet during the 2011/2012 season. In order to reduce the incidental harassment of marine mammals to the lowest level practicable, Apache would be required to implement the mitigation, monitoring, and reporting measures described in Chapters 5 and 6 of this EA. For authorizations in Alaska, NMFS must also prescribe measures to ensure no unmitigable adverse impact on the availability of the affected species or stock for taking for subsistence uses. The impacts to marine mammals and subsistence hunters that could be anticipated from implementing this alternative are addressed in Chapter 4 of this EA. Because the MMPA requires holders of IHAs to reduce impacts on marine mammals to the lowest level practicable, implementation of this alternative would meet NMFS' purpose and need as described in this EA.

2.3. Alternatives Considered but Eliminated from Further Consideration

NMFS considered whether other alternatives could meet the purpose and need and support Apache's proposed activities. An alternative that would allow for the issuance of an IHA with no required mitigation or monitoring was considered but eliminated from consideration, as it would not be in compliance with the MMPA and therefore would not meet the purpose and need. For that reason, this alternative is not analyzed further in this document.

Chapter 3 Affected Environment

This chapter describes the affected environment relative to physical, biological, and sociocultural resources found in the proposed 2011-2012 proposed 3D seismic survey project area by Apache. The effects of the alternatives on the environment are discussed in Chapter 4.

3.1. Physical Environment

Cook Inlet extends approximately 370 km (~ 230 mi) from Knik and Turnagain Arms to Kamishak and Kachemak Bays. It is a semi-enclosed tidal estuary, connected to the Gulf of Alaska via Kennedy and Stevenson Entrances and the Shelikof Strait (Muench et al. 1978; Moore et al. 2000).

Cook Inlet is a dynamic shallow body of water. The inlet's deepest areas are found near the mouth of the inlet and range in depths from approximately 183-366 m (600- 1,200 ft; Mulherin et al. 2001). A main channel stretches from the Susitna Delta south, around Kaligan Island, and widens and deepens near Chinita Bay. The areas north of the Forelands mainly consist of shallow river deltas (Moore et al. 2000). The Susitna and Knik Arm rivers contribute substantially to the glacial sediment found in Cook Inlet. In addition to the glacial silt and clay, the substrate of Cook Inlet also consists of cobbles, pebbles and sand (Sharma and Burrell 1970). Salinity and temperature changes seasonally. Decreasing and increasing respectively during the summer due to freshwater input from the contributing tributaries (Muench et al. 1978). The semidiurnal tides and currents are some of the most extreme worldwide. Tides can range as high as10.5 m (34.5 ft) above and 1.9 m (6.4 ft) below the tidal datum of mean lower low water (MLLW, Knik Arm and Bridge Authority [KABATA] 2007). Mean current velocity is approximately 3 knots (kn); however, near the East and West Foreland current speeds can exceed 6 kn increasing to 12 kn near Kaligan Island (Moore et al. 2000). Sea ice generally forms in October-November and remains in Cook Inlet until March-April (Moore et al. 2000).

More detailed information on Cook Inlet physical environment is summarized in the NMFS Cook Inlet Beluga Whale Subsistence Harvest Final Supplemental EIS (NMFS 2008b).

3.2. Water Quality

Cook Inlet is a complex estuary in the Gulf of Alaska with relatively fresh, turbid waters coming from several tributaries. The three primary rivers are the Knik, Matanuska, and Susitna rivers with a combined peak discharge from July through August of 90,000 cubic meters per second (m^3/sec) (295,276 cubic feet per second [ft^3/sec]) (BOEM 1996). The salinity, temperature, and suspended sediment levels vary significantly within the upper inlet as freshwater input decreases in winter.

With some of the highest tides in North America, exceeded only by those in the Bay of Fundy in Nova Scotia and Ungava Bay, Quebec, Cook Inlet's extreme tidal fluctuation is the main force driving surface circulation in the inlet. Mean diurnal range of tides at Anchorage is 8.8 m (29 ft). Mid-inlet currents may reach 2.4 m (8 ft) per second or more. Such strong currents in upper Cook Inlet can make navigation extremely difficult.

During winter months, ice is a dominant physical force within the inlet, forming sea ice, beach ice, and river ice. In the upper inlet, sea ice typically forms in October-November, developing through February from the West Forelands to Cape Douglas. The southern portion of the inlet is generally open in winter. By January, much of the upper inlet may experience 70 to 90 percent ice cover, although rarely freezing solid because of the enormous tidal range. Ice generally leaves upper Cook Inlet by April, but may persist into May.

Surface waters in the region typically carry high silt and sediment loads, particularly during summer. Marine waters are well oxygenated, with concentrations in surface waters from about 7.6 milliliter per liter (ml/l) in the upper inlet to 10 ml/l in the southwest inlet (BOEM 1996). Mean annual freshwater input to Cook Inlet exceeds 70 trillion liters (18.5 trillion gallons). Freshwater sources often are glacially born waters, which carry high-suspended sediment loads, as well as a variety of metals such as zinc, barium, mercury, and cadmium. BOEM (1996) conducted four water quality studies in Cook Inlet and found that hydrocarbon levels in the water column were generally low, often less than the method detection limit. Elevated methane levels were observed in waters from Trading Bay in the upper inlet, an area with oil and natural gas fields. Although saturated hydrocarbons were detected in treated production waters from Trading Bay in 1993, levels from upper Cook Inlet waters were below detection limits. Polycyclic aromatic hydrocarbons (PAHs) were often less than detection or reporting limits, although treated production waters again held elevated levels.

3.2.1. Air Quality

The U.S. Environmental Protection Agency (EPA) defines Air Quality Control Regions (AQCRs) for all areas of the United States and classifies them based on six "criteria pollutants," and has established for each of them a maximum concentration above which adverse effects on human health may occur. These threshold concentrations are called National Ambient Air Quality Standards (NAAQS). When an area meets NAAQS, it is designated as an "attainment area." An area not meeting air quality standards for one of the criteria pollutants is designated as a "nonattainment area."

Areas are designated "unclassified" when insufficient information is available to classify areas as attainment or nonattainment. The Anchorage, Alaska area was designated nonattainment for Carbon Dioxide (CO) and classified as moderate upon enactment of the Clean Air Act Amendments in 1990. EPA approved an attainment plan in 1995. However, two violations of the NAAQS in 1996 resulted in EPA reclassifying Anchorage to serious nonattainment on July 13. The Municipality of Anchorage (MOA) submitted a new plan on in 2002 and EPA proposed approval of the plan (67 FR 38218). On September 18, 2002, EPA approved the Anchorage CO attainment plan (67 FR 58711). The Cook Inlet region has been identified as in attainment for all criteria pollutants.

3.2.2. Acoustic Environment

Sound Characteristics

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. When a source vibrates, it compresses the molecules in the adjacent medium (water or air) and creates a region of high pressure. As the surface of the vibrating object moves back toward its original position, the molecules of the surrounding medium are pulled back and a region of low pressure results. These are called *compressions* and *rarefactions*, respectively. The speed at which these compressions and rarefactions travel away from the source depends on the compressibility and density of the media and is called the *speed of sound*. The layers of compressions and rarefactions result in a *sound wave*. Sound waves travel much faster in water than in air.

Sound is generally described in terms of frequency (or pitch), intensity, and temporal properties (short or long in duration). The following text provides a general description of these terms. For more details, there are several publications and books that provide detailed overviews of acoustics, such as Richardson et al. (1995) and Au and Hastings (2008) for underwater sound, and Harris (1998) for airborne sound.

Frequency is a measure of how many times each second the crest of a sound pressure wave passes a fixed point; it is measured in *Hertz* (Hz). For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. A particular tone that makes the drum skin vibrate 100 times per second generates a sound pressure wave at 100 Hz, and this vibration is perceived as a tonal pitch of 100 Hz. Sound frequencies between 20 Hz and 20,000 Hz are within the range of sensitivity of the best human ear. Some mysticetes (baleen whales) produce and likely hear sounds below 20 Hz, while odontocetes (toothed whales) produce and hear sounds at frequencies much higher than 20,000 Hz (also reported as 20 kHz).

Acoustic *intensity* is defined as the acoustical power per unit area. The intensity, power, and energy of a sound wave are proportional to the average of the squared pressure. Measurement instruments and most receivers (humans, animals) sense changes in pressure which is measured in Pascals (Pa). Pressure changes due to sound waves can be measured in Pa but they are more commonly expressed in *decibels* (dB). The decibel is a logarithmic scale that is based on the ratio of the sound pressure relative to a standard reference pressure p_{ref}. Different standard reference pressures are used for airborne sounds and underwater sounds. The airborne standard pressure reference is p_{ref}(air) = 20 microPascals (µPa), where 1 µPa = 0.000001 Pa. The underwater standard reference pressure is p_{ref}(water) = 1 µPa. The formula used to convert a pressure p measured in µPa to sound pressure level P measured in dB is $P = 20 \log_{10}[p/p_{ref}]$. Because of the logarithmic nature of the decibel, sound levels cannot be added or subtracted directly. If a sound's pressure is doubled, its sound level increases by 6 dB, regardless of the initial sound level.

Sound Metrics

Three metrics are commonly used for the evaluation of underwater sound impacts: peak pressure, root-mean-square (RMS) or sound pressure level, and sound exposure level (SEL). Figure 7 shows a representation of a sinusoidal (single-frequency) pressure wave to help illustrate the various metrics. The amplitude of the pressure is shown on the vertical axis, and time is shown on the horizontal axis. The pressure of the wave is shown to fluctuate around the neutral point. The peak sound pressure is the absolute value of the maximum variation from the neutral position; therefore, it can result from either compression or a rarefaction. The peak-to-peak sound pressure is the difference between the maximum and minimum pressures. The average amplitude is the average of absolute value of pressure over the period of interest. The RMS amplitude is a type of average that is determined by squaring all of the amplitudes over the period of interest, determining the mean of the squared values, and then taking the square root of this mean. The RMS amplitude of an impulsive signal will vary significantly depending on the length of the period of interest (Discovery of Sound in the Sea [DOSITS] 2011). SEL is a metric that is related to the sound energy per area received over time, though it does not have energy units. It is proportional to the square of the sound pressure and the time over which a sound is received.

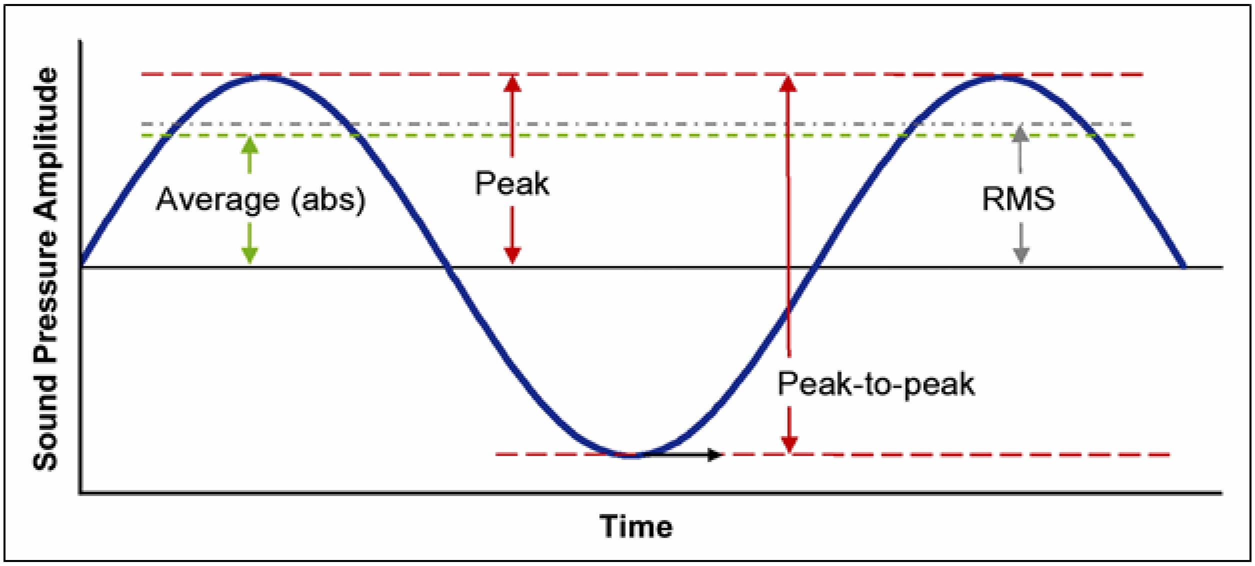

Figure 7. Sound Level Metrics.

In evaluating airborne noise impacts, the method commonly used to quantify environmental sound consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing sensitivity varies with sound frequency. An audiogram shows the lowest level of sounds that an animal or human can hear (hearing threshold) at different frequencies (pitch). The y-axis of the audiogram is sound levels expressed in dB (either in-air or in-water) and the x-axis is the frequency of the sound expressed in Hz. Human hearing is less sensitive at low frequencies and higher frequencies than at mid-range frequencies. The most common frequency weighting to assess human airborne noise impacts is referred to as A-weighting and the decibel level measured is called the A-weighted sound level (dBA). Common metrics used to for airborne noise include the L_{eq} (equivalent sound level) – the energy-mean A-weighted sound level during a measured time interval and the L_{min} and L_{max} – the RMS minimum and maximum noise levels during the monitoring period.

When evaluating acoustic impacts, it is also important to take into account the temporal characteristics of the sound. A sound may be *transient* in nature (a relatively short duration with an obvious start and stop) or *continuous* (no obvious start or stop). NMFS considers transient sound as pulsed and continuous sound as non-pulsed. Examples of transient sounds include explosions, airguns, impact pile drivers, and sonar. Examples of continuous sounds include an operating drillship or ship underway. However, it is important to note that that source-path-receiver model discussed below will influence how a sound is perceived by the receiver. For example, sound from a ship underway is continuous at the source, but will not be a continuous to a stationary receiver once it has passed by. Another example is that transient sound such as airguns are impulsive at the source, but due to the many factors that influence propagation, may be perceived as continuous at a farther distance by a receiver. As described in detail in Southall et al. (2007), pulses are transient sounds with rapid rise-time and high peak pressures and are potentially injurious to mammalian hearing. Non-pulsed sounds may not result in as much damage, but may still cause behavioral changes.

Ambient noise is the background noise, encompassing all noise sources. Noise sources may include natural and anthropogenic sources near and far. Ambient noise varies with season, location, time of day, and frequency. The ambient noise in an environment will influence how well a receiver may detect a sound source of interest.

Propagation of Sound

Transmission loss underwater is the decrease in acoustic intensity as a sound wave propagates out from a source through spreading loss, reflection, or absorption. Simply, spreading loss refers to the decrease in pressure that results from the increasing surface area a sound wave covers as it moves further from the source. The sound energy becomes spread over larger areas, so the energy per area, and consequently pressure, decreases. In a uniform medium, sound spreads out from the source in spherical waves – sound levels in this situation typically diminish by 6 dB due to spreading loss when the distance is doubled. Reflection (sound waves "bouncing" off a surface) and refraction (bending of the propagation path) affect sound propagation and can lead to areas of higher or lower sound level than if they were not present. Absorption is the loss of acoustic energy by internal scattering and conversion of pressure energy into heat within the propagation medium. Transmission loss parameters underwater vary with frequency, temperature, sea conditions, source and receiver depth, water chemistry, and bottom composition and topography. Transmission loss parameters in air vary with frequency, air temperature and humidity, wind, turbulence, cloud cover, type of ground cover between source and receiver, and source and receiver height. It is important to note that when comparing different sound levels, attention must be paid to the reference pressure, distance from the source to the receiver, units, and frequencies. For example, sound levels of airguns are often reported as 230-240 dB re 1 µPa at 1 m – if the 1 m were omitted from the sound level, it could mean that this was a measured level at some unknown distance, which would mean the actual sound level at the source of the sound would be even higher than 230-240 dB.

Richardson et al. (1995) describe a useful method for considering the process of sound generation, propagation and perception. This method is referred to as the "source-path-receiver" model:

- ***Source:*** the source of the emitted sound (such as an airgun or drillship). It has particular acoustic characteristics including its pitch and intensity.
- ***Path:*** the route from source to the receiver of the sound wave. The path may alter the nature of the source sound as it travels from the source to the receiver (terms often used are transmission or propagation). The path can include segments through air or water, or both.
- ***Receiver:*** the human or animal that perceives the sound after it has left the source and propagated over the path. Receivers have specific detection abilities, so not all receivers will detect or perceive a sound the same way.

As noted previously, this section provides a very basic introduction to acoustic terminology that will be used in this EA. For more details, there are many textbooks available that provide more details (e.g., Richardson et al. 1995; Au and Hastings 2008; Harris 1998). Furthermore, a website with some basic introductions to sound in the sea is located at: http://www.dosits.org/.

3.2.2.1. Airborne Noise

The existing airborne noise environment in Cook Inlet is influenced by sounds from natural and anthropogenic sources. The primary natural source of airborne noise region is wind, although wildlife can produce considerable sound during specific seasons in certain nearshore and onshore regions. Anthropogenic noise levels in the upper Cook Inlet region are higher due to the presence of Anchorage and surrounding activities. Noise sources consist of regular air traffic from the Anchorage airport and Joint Base Elmendorf-Richardson, vehicular traffic on the roads, and other noises associated with cities.

3.2.2.2. Underwater Noise

Underwater noise is comprised of natural and anthropogenic sources. It varies temporally (daily, seasonally, annually) depending on weather conditions and the presence of anthropogenic and biological sources. Natural sound sources in the Cook Inlet include earthquakes, tidal currents, substrate moving from tides, wind, ice, and sounds from several animal species. Earthquakes and other geologic processes (subduction, spreading, faulting, volcanic, hydrothermal vent activity) typically generate loud, low frequency (<100 Hz) sounds that propagate for long distances. Atmospheric effects, such as wind, lightning, thunder, and rain at the surface have a significant effect on ambient sound levels.

Anthropogenic sounds in Cook Inlet include noise from vessel traffic, air traffic, and oil and gas development.

3.3. Biological Environment

3.3.1. Fish, Fishery Resources, and Essential Fish Habitat

3.3.1.1. Anadromous Fish

Various species of anadromous fish are found in Cook Inlet, including five species of Pacific salmon, trout and eulachon. Salmon species include chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), pink (*O. gorbushka*), chum (*O. keta*), and coho (*O. kisutch*). Trout species include steelhead trout (*O. mykiss*), and Dolly Varden (*Salvelinus malma malma*) (NMFS 2003). Salmon and trout spawn and rear within freshwater drainages of the Inlet, while also utilizing the marine waters of the Inlet to migrate, rear, and feed. Adult salmon return from marine habitats to freshwater rivers and streams to spawn in summer and fall. Eggs are laid and develop in gravel substrates and fry emerge from the gravel in the spring and remain in fresh water until the migration back to marine waters. Fry may to remain in fresh water for durations ranging from a few days to two years, depending on the species and the distance from the spawning area to marine waters. During the migration to brackish and marine habitats they become smolts. Smolts may spend several years in marine habitats before returning to freshwater to spawn as adult salmon. When salmon return to freshwater they undergo physiological changes in body shape and color and die after spawning. Steelhead trout and Dolly Varden may spawn more than once (NMFS 2003, 2007)

Chinook Salmon

Chinook, also called king salmon range to 57 kilogram (kg, 126 pounds [lb]) in weight and 147 centimers (cm, 58 inches [in]) in length, making them the largest of the Pacific salmon species (McPhail and Lindsey, 1970; NMFS 2003). Chinook salmon enter Cook Inlet during early May when spawning and remain present in some spawning streams by the end of the month. Also during May chinook salmon smolt migrate downstream. Spawning for chinook salmon takes place in late June through late July. Egg complements are generally 4,000 to 5,000 but can be as high as 8,000 (NMFS 2003). Eggs are deposited in gravel beds in streams, where they incubate for several months. Chinook salmon rear in freshwater for two winters before their seaward migration and may spend three to four years in the ocean. Chinook salmon prey on other finfish, herring, capelin, eulachon and other small fish species in the ocean environment. Smaller chinook salmon consume a variety of macroscopic fauna found in pelagic waters such as amphipods and euphausids (NMFS 2003).

Sockeye Salmon

Sockeye also called red salmon range to and to about 7 kg (15.5 lb.) in weight and 84 cm (33 in) in length (McPhail and Lindsey 1970; NMFS 2003). Sockeye salmon migrate over much of the North Pacific Ocean and into the eastern Bering Sea and are typically found in large schools. Adult sockeye salmon spawn in Cook Inlet beginning in late June through early August. Sockeye salmon generally spend two or three winters in the North Pacific Ocean before returning to spawn. Sockeye salmon consume a variety of macroscopic fauna from the pelagic zone while in the marine environment (NMFS 2003).

Pink Salmon

Pink salmon average about 1.4 to 2.3 kg (3-5 lb.), and to 76 cm (30 in) in length, making them the smallest of the smallest of the five species of Pacific salmon. Pink salmon begin to enter Cook Inlet in early July to spawn. Eggs hatch in late February and fry remain in stream gravels until early spring, at which time they migrate to the ocean. The out-migration from upper Inlet streams begins in late May and peaks in June (Moulton 1994). Pink salmon rear in the North Pacific Ocean for two winters before returning to Cook Inlet area to spawn. Pink salmon are known to exhibit cyclical population variations within Cook Inlet, with larger numbers occurring during the even-number years (NMFS 2003).

Chum Salmon

Chum salmon range to 100 cm (40 in) in length and 1 to 6 kg (6.6-13.2 lb.) in weight (McPhail and Lindsey 1970). Chum salmon feed on a variety of macroscopic organisms that inhabit the pelagic marine waters where this species migrates. Chum salmon enter the lower Cook Inlet region beginning in early July, and the spawning runs continue through early August. Chum salmon spawn in many streams throughout the region; with the eggs deposited in stream gravels and hatch in early spring. Chum salmon fry then move downstream to the ocean where they remain for three to four winters before returning to their natal streams to spawn (NMFS 2003).

Coho Salmon

Coho, also called silver salmon range to 96 cm (38 in) in length and average about 2.7 to 5.4 kg (6-12 lb) in weight (McPhail and Lindsey 1970). Coho salmon are the latest of the Pacific salmon to return to Cook Inlet to spawn, typically entering the area in late July and running into October and November. The eggs are deposited in stream gravels and the fry remain in the stream for two winters before migrating to the ocean. This migration usually occurs annually from March through June. Coho salmon remain in the North Pacific Ocean for two to three winters before returning to spawn in their natal stream (NMFS 2003).

Rainbow Trout and Steelhead

Steelhead trout is an anadromous sea-run race of the species rainbow trout (*Oncorhynchus)* that is distributed unevenly throughout the lower Cook Inlet region. Information on the steelhead in Alaska is limited to the few areas where larger populations support well-known sport fisheries. These include the Anchor River and Deep Creek on the Kenai Peninsula. Steelhead enter freshwater, generally, from early fall into the winter months. Spawning occurs in the spring and steelhead trout probably enter the ocean after a year in freshwater streams (NMFS 2003).

Eulachon

The eulachon, or hooligan, is a small smelt-like forage fish, reaching lengths of up to 23 cm (9 in). Eulachon is seasonally found throughout much of Cook Inlet. Eulachon are anadromous and move nearshore in early May to spawn, typically in river drainages throughout Cook Inlet. Eggs are deposited on stream gravel and they hatch in about 30 to 40 days (depending on water temperature). The larvae then move downstream to enter marine waters (NMFS 2003).

Forage fish species

Forage fish are primarily schooling fish and considered the nutritional basis for marine mammal and bird populations, and larger fish species. The primary forage fish species in Cook Inlet include Pacific herring (*Clupea pallasi*), walleye pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*), Pacific sand lance (*Ammodytes hexapterus*), eulachon (*Thaleichthys pacificus*), longfin smelt (*Spirinchus thaleichthys*), and saffron cod (*Eleginus gracilis*) (Piatt et al. 1999; LGL 2006). Moulton (1997) found that fish densities in upper Cook Inlet were higher in June than in July. Results found the greatest mean fish densities occurring along the northwest shoreline from the Susitna delta to the North Foreland and the adjacent mid-channel waters with the lowest densities occurring along the southeastern shoreline from Moose Point to Boulder Point. The most abundant forage fish were threespine stickleback (*Gasterosteus aculeatus*) and Pacific herring (Moulton 1997; NMFS 2007).

Groundfish species

Groundfish, also called demersal, benthic or bottom dwelling fish, are fish species that inhabit the seafloor during a portion of their life cycle, most often as adults. During early life stages, many species are pelagic, either free swimming or as planktonic larvae. In Cook Inlet the most common groundfish species include Pacific cod (*Gadus macrocephalus*), rockfish (*Sebastes* spp.), sablefish (*Anoplopama fimbria*), Pacific halibut (*Hippoglossus stenolepis*), flathead sole (*Hippoglossoides elassodon*), and yellowfin sold (*Pleuronectes asper*) (LGL 2006; NMFS 2007).

3.3.1.2. Essential Fish Habitat

Essential Fish Habitat (EFH) means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, “waters” include aquatic areas that are used by fish and their associated physical, chemical, and biological properties and may include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ entire life cycle.

The NMFS and the North Pacific Fishery Management Council identified EFH in upper Cook Inlet for anadromous Pacific salmon. In addition, all streams, lakes, ponds, wetlands, and other water bodies that currently support or historically supported anadromous fish species (e.g., salmon) are considered freshwater EFH. Marine EFH for salmon fisheries in Alaska include all estuarine and marine areas utilized by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusion Economic Zone (EEZ). Details of EFH and the life stage of these species can be found at www.nmfs.noaa.gov/habitat/habitatprotection/efh.

3.4. Marine Birds

Cook Inlet provides an important resting and staging area for migrating birds. More than 100 species of waterfowl, shorebirds, and seabirds are known to occur in Cook Inlet (Alaska Department of Natural Resources [ADNR] 1999). Migratory waterfowl and shorebirds begin arriving in Cook Inlet in early April. Areas such as mudflats, deltas, flood plains and salt marshes provide habitats for the larges variety and number of birds. Bays and exposed inshore waters are habitats for loons (genus *Gavia*), grebes (genus *Podiceps*), cormorants (genus *Phalacrocorax*), sea ducks, and alcids. Geese and dabbling ducks primarily use river flood plains and marshes, while diving ducks spend most of their time on bay waters. Shorebirds are found primarily on mud flats and gravel areas. Gulls are found in a variety of habitats, especially lagoons (BOEM 1996)

The coastal marshes found in upper Cook Inlet provide important staging and resting areas for migrating waterfowl as well as breeding habitats. Common waterfowl found in the salt marshes and wetlands of upper Cook Inlet include pintails, mallards, green-winged teal, lesser Canada geese, cranes, and swans. Common shorebirds include plover, sandpipers, yellowlegs, dowitchers, and phalaropes. The distribution of shorebirds is related to food availability such as clams, gammarid amphipods and algal cover. Vegetated flats and marshes provide important shelter to alkali-grass, insects and algaes that are main food sources for shorebirds and waterfowl. The primary shorebird concentration areas are along the western shores of upper Cook Inlet in Redoubt Bay, Trading Bay, and the marsh flats of the Matanuska, Knik, Susitna, and little Susitna Rivers

A study funded by the U.S. Army at Fort Richardson monitoring the waterfowl mortality in upper Cook Inlet found that ducks are primary users of upper Cook Inlet salt marshes and flats (Susitna flats, Eagle River Flats, Palmer hay Flats, and Goose Bay). Each spring as many as 60,000 to 100,000 of these birds appear in upper Cook Inlet. These ducks are thought to feed on fingernail clams (*Macoma* spp.) or large amphipods (NMFS 2008a).

3.4.1. Threatened and Endangered Marine Birds

The Steller’s eider is a threatened sea duck. The smallest of the eiders, both male and female weigh around 800 grams (1.8 lbs) on average (USFWS 2002). Steller’s eiders nest in arctic and subarctic tundra. They feed by dabbling and diving for mollusks and crustaceans, and move to shallow, nearshore marine waters along the Alaska Peninsula to molt. Wintering Steller's eiders occupy coastal waters in much of southwestern and south coastal Alaska. They are found around islands and along the coast of the Bering Sea and North Pacific Ocean from the Aleutian Islands, along the Alaska Peninsula and Kodiak Archipelago, east to lower Cook Inlet. Steller's eiders usually remain near shore normally in water less than 10 m (30 ft) deep but can also be found well offshore in shallow bays and lagoons or near reefs. In the wintering habitats, Steller's eiders feed on a variety of invertebrate animals that are often associated with aquatic vegetation (Larned 2006). Although Steller’s eiders are known to winter in Cook Inlet, distribution patterns are not well documented (Agler et al. 1995; USFWS 2002; Larned 2006).

In 1997, the Alaska breeding Steller's eider population was listed as threatened under the ESA due to declines in abundance and geographical extent in both breeding areas (USFWS 2002). In 2000, USFWS proposed critical habitat designation that included Kachemak Bay/Ninilchik areas; however final critical habitat designation did not include waters areas in Cook Inlet. Critical habitat was designated in breeding areas on the Yukon-Kuskokwim Delta, staging area in the Kuskokwim Shoals, and molting areas in waters associated with the Seal Islands, Nelson Lagoon, and Izembek Lagoon in Southwestern Alaska. A total of 4,554 km^2 (2,830 mi^2) was designated as critical habitat for Steller's eiders (USFWS 2002).

3.5. Marine Mammals

Of the 15 species of marine mammals with documented occurrences in Cook Inlet, only five species are documented in the upper inlet: Cook Inlet beluga whale (*Delphinapterus leucas*), harbor seal (*Phoca vitulina*), killer whale (*Orcinus orca*), harbor porpoise (*Phocoena phocoena*), and Steller sea lion (*Eumatopia jubatus*) (Shelden et al. 2003). Table 1 provides a summary of the abundance and status of the species likely to occur in the project area. While killer whales and Steller sea lions have been sighted in upper Cook Inlet, their occurrence is considered rare. Cook Inlet beluga whales, harbor porpoises, and harbor seals are the species most likely to be sighted during the seismic program. Recent passive acoustic monitoring research has indicated that harbor porpoises occur more frequently in the project area more than expected based solely on previous visual observations (National Marine Mammal Laboratory [NMML] 2011, personal communication). A more detailed description of these five species is provided in Section 4.

Table 1. Marine Mammal Species in Cook Inlet

Species	Abundance	Comments
Beluga whale (*Delphinapterus leucas*)	355 [2]	Occurs in the project area. Listed as Depleted under the MMPA, endangered under ESA, critical habitat in project area.
Harbor seal *(Phoca vitulina richardsi)*	29,175 [1]	Occurs in the project area. No special status or ESA listing.
Killer whale *(Orcinus orca)*	1,123 Resident 314 Transient [3]	Occurs rarely in the project area. No special status or ESA listing.
Harbor porpoise *(Phocoena phocoena)*	31,046 [4]	Occurs in the project area. No special status or ESA listing.
Steller sea lion (*Eumatopia jubatus*)	41,197 [5]	Occurs infrequently in the project area. Listed as Depleted under the MMPA, endangered under ESA.

Notes: MMPA = Marine Mammal Protection Act, ESA = Endangered Species Act

[1] Abundance estimate for the Gulf of Alaska stock (Allen and Angliss 2010)

[2] Abundance estimate for Cook Inlet stock (Allen and Angliss 2010)

[3] Resident estimate from Alaska resident stock; transient estimate from Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock (Allen and Angliss 2010)

[4] Abundance estimate for the Gulf of Alaska stock (Allen and Angliss 2010)

[5] Abundance estimate for the western stock (Allen and Angliss 2010)

3.5.1. Threatened and Endangered Marine Mammals

3.5.1.1. Beluga Whale

Beluga whales appear seasonally throughout much of Alaska, except in the Southeast region and the Aleutian Islands. Five stocks are recognized in Alaska: Beaufort Sea stock, eastern Chukchi Sea stock, eastern Bering Sea stock, Bristol Bay stock, and Cook Inlet stock (Allen and Angliss 2010). The Cook Inlet stock is the most isolated of the five stocks, as it is separated from the others by the Alaska Peninsula and resides year round in Cook Inlet (Laidre et al. 2000). Only the Cook Inlet stock inhabits the Project area.

Population

Cook Inlet beluga whales may have numbered fewer than several thousand animals but there were no systematic population estimates prior to 1994. Although ADF&G conducted a survey in August 1979, it did not include all of upper Cook Inlet, the area where almost all beluga whales are currently found during summer. However, it is the most complete survey of Cook Inlet prior to 1994 and incorporated a correction factor for beluga whales missed during the survey. Therefore, the ADF&G summary (Calkins 1989) provides the best available estimate for the historical beluga whale abundance in Cook Inlet. For management purposes, NMFS has adopted 1,300 beluga whales as the numerical value for the carrying capacity to be used in Cook Inlet. (65 FR 34590)

NMFS began comprehensive, systematic aerial surveys on beluga whales in Cook Inlet in 1994. Unlike previous efforts, these surveys included the upper, middle, and lower inlet. These surveys documented a decline in abundance of nearly 50 percent between 1994 and 1998, from an estimate of 653 to 347 whales (Rugh et al. 2000). In response to this decline, NMFS initiated a status review on the Cook Inlet beluga whale stock pursuant to the MMPA and the ESA in 1998 (63 FR 64228). The annual abundance surveys conducted each June since 1999 provide the following abundance estimates: 367 beluga whales in 1999, 435 beluga whales in 2000, 386 beluga whales in 2001, 313 beluga whales in 2002, 357 beluga whales in 2003, 366 beluga whales in 2004, 278 beluga whales in 2005, 302 beluga whales in 2006, 375 beluga whales in 2007; 321 beluga whales in 2009; and 340 beluga whales in 2010 (Hobbs et al. 2000; Rugh et al. 2003, 2004a, 2004b, 2005a, 2005b, 2005c, 2006, 2007, 2009; NMFS 2010 [http://www.alaskafisheries.noaa.gov/newsreleases/2010/belugapopulation.htm]).

These results show the population is not growing and is exhibiting a decline (http://www.alaskafisheries.noaa.gov/newsreleases/2010/belugapopulation.htm). The Cook Inlet beluga whale population has been designated as depleted under the MMPA (65 FR 34590). This designation is because the current population estimate (321) places it at about 41 percent of the Optimum Sustainable Population (OSP) of 780 whales (60 percent of the estimated carrying capacity of 1,300 whales). The estimate has remained below half of the OSP, which is the threshold NMFS is required to use to designate the population as depleted under the MMPA (Angliss and Outlaw 2008).

In 1999, NMFS received petitions to list the Cook Inlet beluga whale stock as an endangered species under the ESA (64 FR 17347). However, NMFS determined that the population decline was due to over harvest by Alaska Native subsistence hunters and, because the Native harvest was regulated in 1999, listing this stock under the ESA was not warranted at the time (65 FR 38778). This decision was upheld in court. NMFS announced initiation of another Cook Inlet beluga whale status review under the ESA (71 FR 14836) and received another petition to list the Cook Inlet beluga whale under the ESA (71 FR 44614). In 2006, NMFS issued a decision on the status review on April 20, 2007 concluding that the Cook Inlet beluga whale is a distinct population segment that is in danger of extinction throughout its range; NMFS issued a proposed rule to list the Cook Inlet beluga whale as an endangered species (72 FR 19821). Public hearings were conducted in July 2007, and the comment period extended to August 3, 2007. On April 22, 2008, NMFS announced that it would delay the decision on the proposed rule until after it had assessed the population status in the summer of 2008, moving the deadline for the decision to October 20, 2008 (73 FR 21578). On October 17, 2008, NMFS announced that the population is listed as endangered under ESA (73 FR 62919). On April 11, 2011, NMFS announced the two areas of critical habitat (76 FR 20180) comprising 7,800 km^2 (3,013 mi^2) of marine habitat (Figure 8). NMFS also released the Final Conservation Plan (NMFS 2008b).

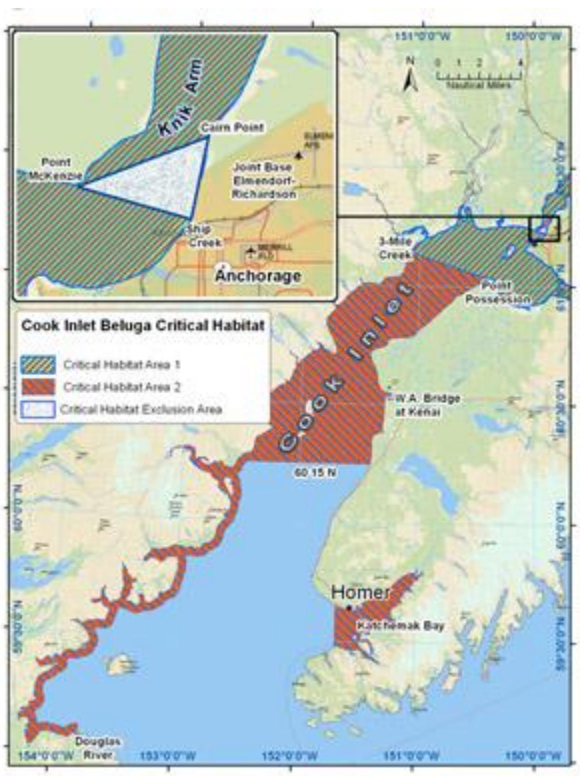

Figure 8. Final critical habitat of Cook Inlet beluga whales (76 FR 20180, April 11, 2011).

Hearing Abilities

In terms of hearing abilities, beluga whales are one of the most studied odontocetes because they are a common marine mammal in public aquariums around the world. Although they are known to hear a wide range of frequencies, their greatest sensitivity is around 10 to 100 kHz (Richardson et al. 1995), well above sounds produced by most industrial activities (<100 Hz or 0.1 kHz) recorded in Cook Inlet. Average hearing thresholds for captive beluga whales have been measured at 65 and 120.6 dB re 1 μPa at frequencies of 8 kHz and 125 Hz, respectively (Awbrey et al. 1988). Masked hearing thresholds were measured at approximately 120 dB re 1 μPa for a captive beluga whale at three frequencies between 1.2 and 2.4 kHz (Finneran et al. 2002). Beluga whales do have some limited hearing ability down to ~35 Hz, where their hearing threshold is about 140 dB re 1 µPa (Richardson et al. 1995). Thresholds for pulsed sounds will be higher, depending on the specific durations and other characteristics of the pulses (Johnson 1991). An audiogram for beluga whales from Nedwell et al. (2004) is provided in Figure 9. An audiogram shows the lowest level of sounds that the animal can hear (hearing threshold) at different frequencies (pitch). The y-axis of the audiogram is sound levels expressed in dB (either in-air or in-water) and the x-axis is the frequency of the sound expressed in kHz.

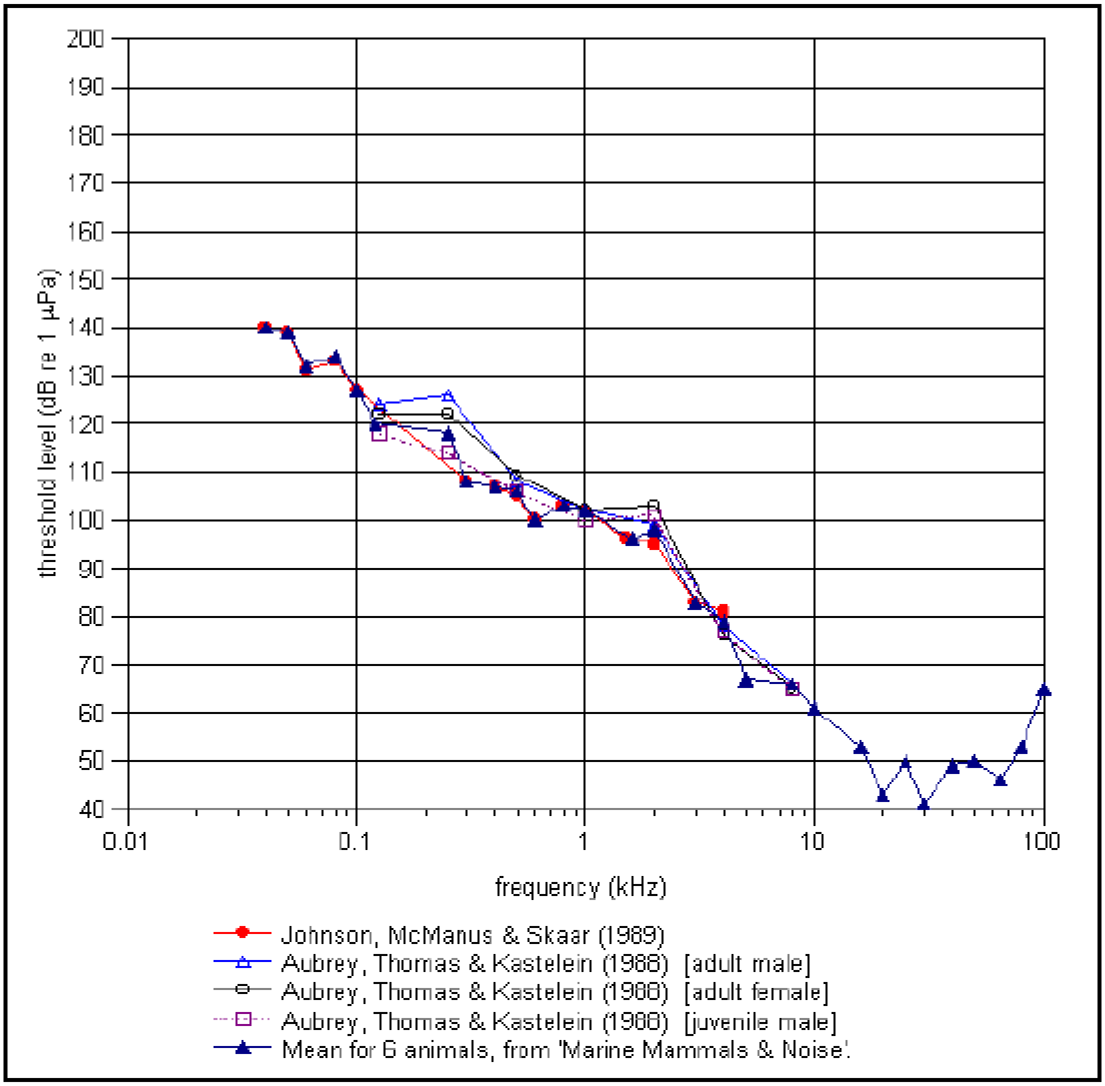

Figure 9: Beluga Whale In-water Audiogram (taken from Nedwell et al. 2004).

Distribution

The following discussion of the distribution of beluga whales in upper Cook Inlet is based upon NMML data including NMFS aerial surveys (Figure 10); NMFS data from satellite-tagged belugas, and opportunistic sightings (NMML 2004); baseline studies of beluga whale occurrence in Knik Arm conducted for KABATA (Funk et al. 2005); baseline studies of beluga whale occurrence in Turnagain Arm conducted in preparation for Seward Highway improvements (Markowitz et al. 2007); marine mammal surveys conducted at Ladd Landing to assess a coal shipping project (Prevel Ramos et al. 2008);

and marine mammal surveys off Granite Point, the Beluga River, and further down the inlet at North Ninilchik (Brueggeman et al. 2007a, 2007b, 2008).

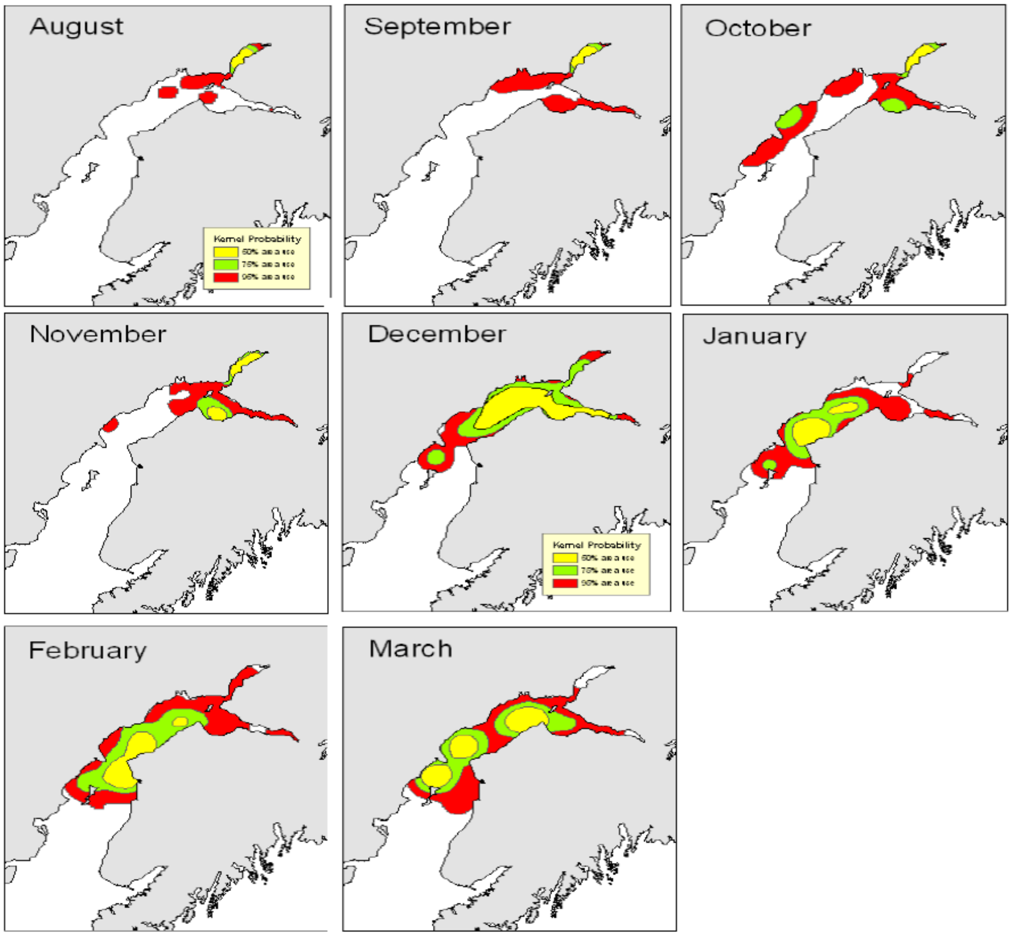

Figure 10. Predicted beluga distribution by month based upon known locations of 14 satellite tagged belugas (predictions derived via kernel probability estimates; Hobbs et al. 2005). Note the large increase in total area use and offshore locations beginning in December and continuing through March. The red area (95 percent probability) encompasses the green (75 percent) and yellow (50 percent) regions. From NMFS 2008b.

NMFS Aerial Surveys

Since 1993, NMFS has conducted annual aerial surveys in June or July to document the distribution and abundance of beluga whales in Cook Inlet. In addition, to help establish beluga whale distribution in Cook Inlet throughout the year, aerial surveys were conducted every one to two months between June 2001 and June 2002 (Rugh et al. 2004a). These annual aerial surveys for beluga whales in Cook Inlet have provided systematic coverage of 13 to 33 percent of the entire inlet each June or July since 1994 including a 3 to km (1.9 mi) wide strip along the shore and approximately 1,000 km (621 mi) of offshore transects (Rugh et al. 2000, 2005a, 2005b, 2006, 2007). Surveys designed to coincide with known seasonal feeding aggregations (Table 1.3 in Rugh et al. 2000) were generally conducted on two to four days per year in June or July at or near low tide in order to reduce the search area (Rugh et al. 2000).

However from June 2001 to June 2002, surveys were conducted during most months in an effort to assess seasonal variability in beluga whale distribution in Cook Inlet (Rugh et al. 2005a).

The collective survey results show that beluga whales have been consistently found near or in river mouths along the northern shores of upper Cook Inlet (i.e., north of East and West Foreland). In particular, beluga whale groups are seen in the Susitna River Delta, Knik Arm, and along the shores of Chickaloon Bay. Small groups had also been recorded seen farther south in Kachemak Bay, Redoubt Bay (Big River), and Trading Bay (McArthur River) prior to 1996, but very rarely thereafter. Since the mid-1990s, most (96 to 100 percent) beluga whales in upper Cook Inlet have been concentrated in shallow areas near river mouths, no longer occurring in the central or southern portions of Cook Inlet (Hobbs et al. 2008). Based on these aerial surveys, the concentration of beluga whales in the northernmost portion of Cook Inlet appears to be fairly consistent from June to October (Rugh et al. 2000, 2004a, 2005a, 2006, 2007; Shelden et al. 2008, 2009, 2010).

NMFS Satellite Tag Data

In 1999, one beluga whale was tagged with a satellite transmitter, and its movements were recorded from June through September of that year. Since 1999, 18 beluga whales in upper Cook Inlet have been captured and fitted with satellite tags to provide information on their movements during late summer, fall, winter, and spring. Hobbs et al. (2005) described: 1) the recorded movements of two beluga whales (tagged in 2000) from September 2000 through January 2001; 2) the recorded movements of seven beluga whales (tagged in 2001) from August 2001 through March 2002; and 3) the recorded movements of eight beluga whales (tagged in 2002) from August 2002 through May 2003.

The concentration of beluga whales in the upper Cook Inlet appears to be fairly consistent from June to October based on aerial surveys (Rugh et al. 2000, 2004a, 2005a). Studies for KABATA in 2004 and 2005 confirmed the use of Knik Arm by beluga whales from July to October (Funk et al. 2005). Data from tagged whales (14 tags between July and March 2000 through 2003) show beluga whales use upper Cook Inlet intensively between summer and late autumn (Hobbs et al. 2005). As late as October, beluga whales tagged with satellite transmitters continued to use Knik Arm and Turnagain Arm and Chickaloon Bay, but some ranged into lower Cook Inlet south to Chinitna Bay, Tuxedni Bay, and Trading Bay (McArthur River) in the fall (Hobbs et al. 2005). In November, beluga whales moved between Knik Arm, Turnagain Arm, and Chickaloon Bay, similar to patterns observed in September (Hobbs et al. 2005). By December, beluga whales were distributed throughout the upper to mid-inlet. From January into March, they moved as far south as Kalgin Island and slightly beyond in central offshore waters. Beluga whales also made occasional excursions into Knik Arm and Turnagain Arm in February and March in spite of ice cover greater than 90 percent (Hobbs et al. 2005). While they moved widely around Cook Inlet there was no indication from the tagged whales (Hobbs et al. 2005) that beluga whales had a seasonal migration in and out of Cook Inlet.

Opportunistic Sightings

Opportunistic sightings of beluga whales in Cook Inlet have been reported to the NMFS since 1977. Beluga whale sighting reports are maintained in a database by NMML. Their high visibility and distinctive nature make them well-suited for opportunistic sightings along public access areas (e.g., the Seward Highway along Turnagain Arm, the public boat ramp at Ship Creek). Opportunistic sighting reports come from a variety of sources including: NMFS personnel conducting research in Cook Inlet, ADF&G, commercial fishermen, pilots, and the general public. Location data range from precise locations (e.g., GPS-determined latitude and longitude) to approximate distances from major landmarks. In addition to location data, most reports include date, time, approximate number of whales, and notable whale behavior (Rugh et al. 2000, 2004a, 2005a). Since opportunistic data are collected any time, and often multiple times a week, these data often provide an approximation of beluga whale locations and movements in those areas frequented by natural resource agency personnel, fishermen, and others.

Depending upon the season, beluga whales can occur in both offshore and coastal waters. Although they remain in the general Cook Inlet area during the winter, they disperse throughout the upper and mid-inlet areas. Data from NMFS aerial surveys, opportunistic sighting reports, and satellite-tagged beluga whales confirm they are more widely dispersed throughout Cook Inlet during the winter months (November-April), with animals found between Kalgin Island and Point. Based upon monthly surveys (e.g., Rugh et al. 2000), opportunistic sightings, and satellite-tag data, there are generally fewer observations of these whales in the Anchorage and Knik Arm area from November through April (NMML 2004; Rugh et al. 2004a).

During the spring and summer, beluga whales are generally concentrated near the warmer waters of river mouths where prey availability is high and predator occurrence is low (Moore et al. 2000). Most beluga whale calving in Cook Inlet occurs from mid-May to mid-July in the vicinity of the river mouths, although Native hunters have described calving as early as April and as late as August (Huntington 2000).

Beluga whale concentrations in upper Cook Inlet during April and May correspond with eulachon migrations to rivers and streams in the northern portion of upper Cook Inlet (NMFS 2003; Angliss and Outlaw 2005). Data from NMFS aerial surveys, opportunistic sightings, and satellite-tagged beluga whales confirm that they are concentrated along the rivers and nearshore areas of upper Cook Inlet (Susitna River Delta, Knik Arm, and Turnagain Arm) from May through October (NMML 2004; Rugh et al. 2004a). Beluga whales are commonly seen from early July to early October at the mouth of Ship Creek where they feed on salmon and other fish, and also in the vicinity of the Port (e.g., alongside docked ships and within 300 ft of the docks) (Blackwell and Greene 2002; NMML 2004). Beluga whales have also been observed feeding immediately offshore of the tidelands north of the Port and south of Cairn Point (NMFS 2004).

KABATA 2004-2005 Baseline Study

To assist in the evaluation of the potential impact of a proposed bridge crossing of Knik Arm north of Cairn Point, KABATA initiated a study to collect baseline environmental data on beluga whale activity and the ecology of Knik Arm. Boat and land-based observations were conducted in Knik Arm from July 2004 through July 2005. Land-based observations were conducted from nine stations along the shore of Knik Arm. The three primary stations were located at Cairn Point, Point Woronzof, and Birchwood. The majority of the beluga whales were observed north of Cairn Point. Temporal use of Knik Arm by beluga whales was related to tide height. During the study period, most beluga whales using Knik Arm stayed in the upper portion of Knik Arm north of Cairn Point. Approximately 90 percent of observations occurred during the months of August through November, and only during this time were whales consistently sighted in Knik Arm. The relatively low number of sightings in Knik Arm throughout the rest of the year suggested the whales were using other portions of Cook Inlet. In addition, relatively few beluga whales were sighted in the spring and early to mid-summer months. Beluga whales predominantly frequented

Eagle Bay (mouth of Eagle River), Eklutna, and the stretch of coastline in between, particularly when they were present in greater numbers (Funk et al. 2005).

Seward Highway Study along Turnagain Arm

Markowitz et al. (2007) documented habitat use and behavior of beluga whales along the Seward Highway in Turnagain Arm from May through November 2006. This study was focused around the high tides when whales regularly traverse the near-shore channels to the mouths of rivers and streams, where they feed on fish. Most of the observations of whales occurred between the end of August and the end of October. No beluga whales were sighted in the study area in May, June, or July. The age composition of all whales observed was 58 percent adults, 17 percent subadults, 8 percent calves, and 17 percent unknown. Most beluga whale observations were in the upper Turnagain Arm, east of Bird Creek. The observation station closest to the Port was at Potter Creek but few beluga whales were sighted in the lower Turnagain Arm section of the Project area. About 80 percent of all beluga whale sightings were within 1,100 m off shore. About a third of all sightings in September were less than 50 m from shore while two-thirds of all sightings in October were within 50 m off shore. Most beluga whale movements were with the tide: eastward into the upper Turnagain Arm on the rising tide and westward out of Turnagain Arm on the falling tide. The few observations of beluga whales in the lower Turnagain Arm were close to the mid-tide, indicating that beluga whales may use these areas closer to the low tide rather than the high tide pattern observed in the upper Turnagain Arm.

Marine Mammal Surveys at Ladd Landing

Prevel Ramos et al. (2008) conducted surveys near Ladd Landing on the north side of upper Cook Inlet between Tyonek and the Beluga River from April through October in 2006 and July through October 2007. The results from 2006 indicated that July through October had the least amount of beluga whale activity in the Project area. Relatively few beluga whales were observed during the 2007 surveys near Ladd Landing, with three groups of one or two whales observed in July, two groups of three whales in September, and two groups averaging seven whales in October. Two groups of 20 whales were observed near the Susitna Flats in August. Some of these whales may have been recorded more than once. Most of the whales sighted were close to shore. Of the whales seen in 2006 and 2007, 60 to 75 percent were white, 16 to 18 percent were gray, and the color of 10 to 22 percent was unknown.

Marine Mammal Surveys at Granite Point, Beluga River, and North Ninilchik

Brueggeman et al. (2007a, 2007b, 2008) conducted vessel and aerial surveys in 2007 near the Beluga River between April 1 and May 15, Granite Point between September 29 and October 21, and North Ninilchik between October 25 and November 7. They recorded 148 to 162 belugas near the Beluga River with most observed during early May, 35 belugas near Granite Point with most observed in early to mid-October, and no belugas recorded off North Ninilchik. Most of the whales were observed near the shore. In addition, the movements indicated they were transiting through the areas to the head of the upper inlet. Small percentages of calves and yearlings were recorded with adults during the spring and early fall surveys. No belugas were observed at North Ninilchik which is considered marginal habitat because of a lack of habitat structure (bays, inlets, etc.) combined with easy public access, typical of the eastern shore of the inlet.

Feeding

Hobbs et al. (2008) presents the most current analysis of stomach contents derived from stranded or harvested belugas in Cook Inlet. This analysis is continuing and provides information on prey availability and prey preferences of Cook Inlet belugas which is summarized below.

Cook Inlet belugas feed on a wide variety of prey species particularly those that are seasonally abundant. In spring, the preferred prey species are eulachon and cod. Other fish species found in the stomachs of belugas may be from secondary ingestion by cods that feed on polychaetes, shrimp, amphipods, mysids, as well as other fish (e.g., walleye pollock and flatfish), and invertebrates.

From late spring and throughout summer most beluga stomachs sampled contained Pacific salmon corresponding to the timing of fish runs in the area. Anadromous smolt and adult fish concentrate at river mouths and adjacent intertidal mudflats (Calkins 1989). Five Pacific salmon species: Chinook, pink, coho, sockeye, and chum spawn in rivers throughout Cook Inlet (Moulton 1997; Moore et al. 2000). Calkins (1989) recovered 13 salmon tags in the stomach of an adult beluga found dead in Turnagain Arm. Beluga hunters in Cook Inlet reported one whale having 19 adult Chinook salmon in its stomach (Huntington 2000). Salmon, overall, represent the highest percent frequency of occurrence of the prey species in Cook Inlet beluga stomachs. This suggests that their spring feeding in upper Cook Inlet, principally on fat-rich fish such as salmon and eulachon, is very important to the energetics of these animals.

In the fall, as anadromous fish runs begin to decline, belugas return to consume fish species (cod and bottom fish) found in nearshore bays and estuaries. Bottom fish include Pacific staghorn sculpin, starry flounder, and yellowfin sole. Stomach samples from Cook Inlet belugas are not available for winter months (December through March), although dive data from belugas tagged with satellite transmitters suggest whales feed in deeper waters during winter (Hobbs et al. 2005), possibly on such prey species as flatfish, cod, sculpin, and pollock.

3.5.1.2. Steller Sea Lion

Steller sea lions’ habitat extends around the North Pacific Ocean rim from northern Japan, the Kuril Islands and Okhotsk Sea, through the Aleutian Islands and Bering Sea, along Alaska's southern coast, and south to California (NMFS 2008c). NMFS reclassified Steller sea lions as two distinct population segments (DPS) under the ESA based on genetic studies and phylogeographical analyses from across the sea lion’s range (62 FR 24345). The eastern DPS includes sea lions born on rookeries from California north through Southeast Alaska; the western DPS includes those animals born on rookeries from Prince William Sound westward (NMFS 2008c). Steller sea lions occur in Cook Inlet but 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). Portions of the southern reaches of the lower inlet are designated as critical habitat, including a 20-nautical mile buffer around all major haul out sites and rookeries. Rookeries and haulout sites in lower Cook Inlet include those near the mouth of the inlet, which are far south of the project area. It is unlikely that any Steller sea lion would be in the project area during operations.

Hearing Abilities

Steller sea lions have similar hearing thresholds in-air and underwater to other otariids. In-air hearing range from 0.250–30 kHz, with a region of best hearing sensitivity from 5–14.1 kHz (Muslow and Reichmuth 2010). The underwater audiogram shows the typical mammalian U-shape. The range of best hearing was from 1 to 16 kHz. Higher hearing thresholds, indicating poorer sensitivity, were observed for signals below 16 kHz and above 25 kHz (Kastelein et al. 2005).

3.5.2. Non-ESA Listed Marine Mammals

3.5.2.1. Harbor Seal

Harbor seals range from Baja California north along the west coasts of the Washington, Oregon, and California, British Columbia, and Southeast Alaska; west through the Gulf of Alaska, Prince William Sound, and the Aleutian Islands; and north in the Bering Sea to Cape Newenham and the Pribilof Islands. There are three stocks in Alaska: Southeast Alaska stock, Gulf of Alaska stock (including Cook Inlet), and Bering Sea stock. The Gulf of Alaska stock is estimated to have 29,175 individuals (Allen and Angliss 2010). Harbor seals are taken incidentally during commercial fishery operations at an estimated annual mortality of 24 individuals (Allen and Angliss 2010).

Harbor seals inhabit the coastal and estuarine waters of Cook Inlet. A relatively small but unknown proportion of the population occurs in Cook Inlet. Harbor seals are more abundant in lower Cook Inlet than in upper Cook Inlet, but they occur in the upper inlet throughout most of the year (Rugh et al. 2005a,b). Harbor seals haul out on rocks, reefs, beaches, and drifting glacial ice, and feed on capelin, eulachon, cod, pollock, flatfish, shrimp, octopus, and squid in marine, estuarine, and occasionally fresh waters. Harbor seals are non-migratory; their local movements are associated with tides, weather, season, food availability, and reproduction.

The major haulout sites for harbor seals are located in lower Cook Inlet. The presence of harbor seals in upper Cook Inlet is seasonal. Harbor seals are commonly observed along the Susitna River and other tributaries within upper Cook Inlet during eulachon and salmon migrations (NMFS 2003). During aerial surveys of upper Cook Inlet in 2001, 2002, and 2003, harbor seals were observed 24 to 96 km (15 to 60 mi) south-southwest of Anchorage at the Chickaloon, Little Susitna, 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.

Harbor seals respond to underwater sounds from approximately 1 to 80 kHz with the functional high frequency limit around 60 kHz and peak sensitivity at about 32 kHz (Kastak and Schusterman 1995). Hearing ability in the air is greatly reduced (by 25 to 30 dB); harbor seals respond to sounds from 1 to 22.5 kHz, with a peak sensitivity of 12 kHz (Kastak and Schusterman 1995). Figure 11 is an in-air audiogram and Figure 12 is an in-water audiogram for the harbor seal (taken from Nedwell et al. 2004).

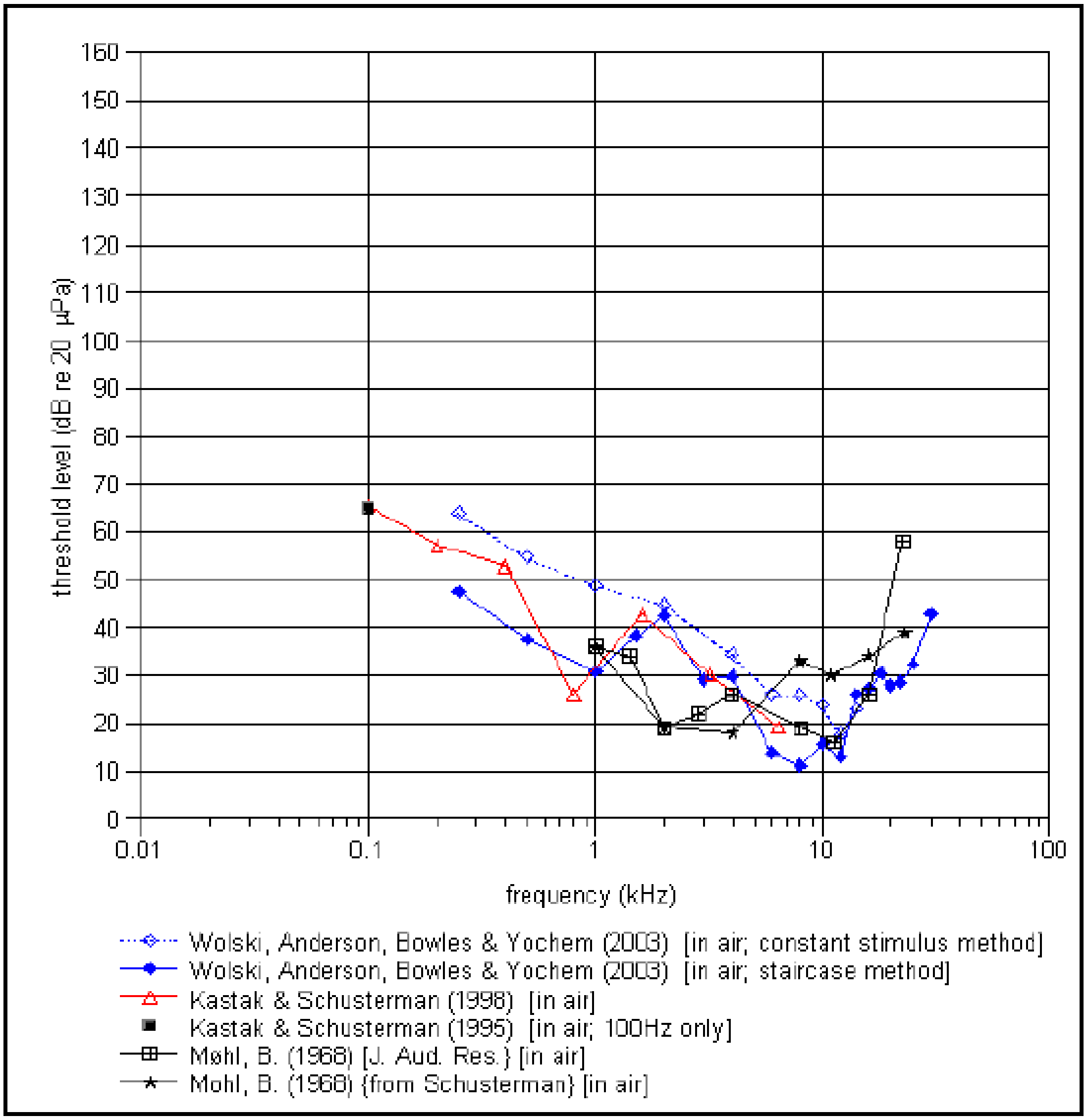

Figure 11. Harbor Seal In-air Audiogram (taken from Nedwell et al. 2004).

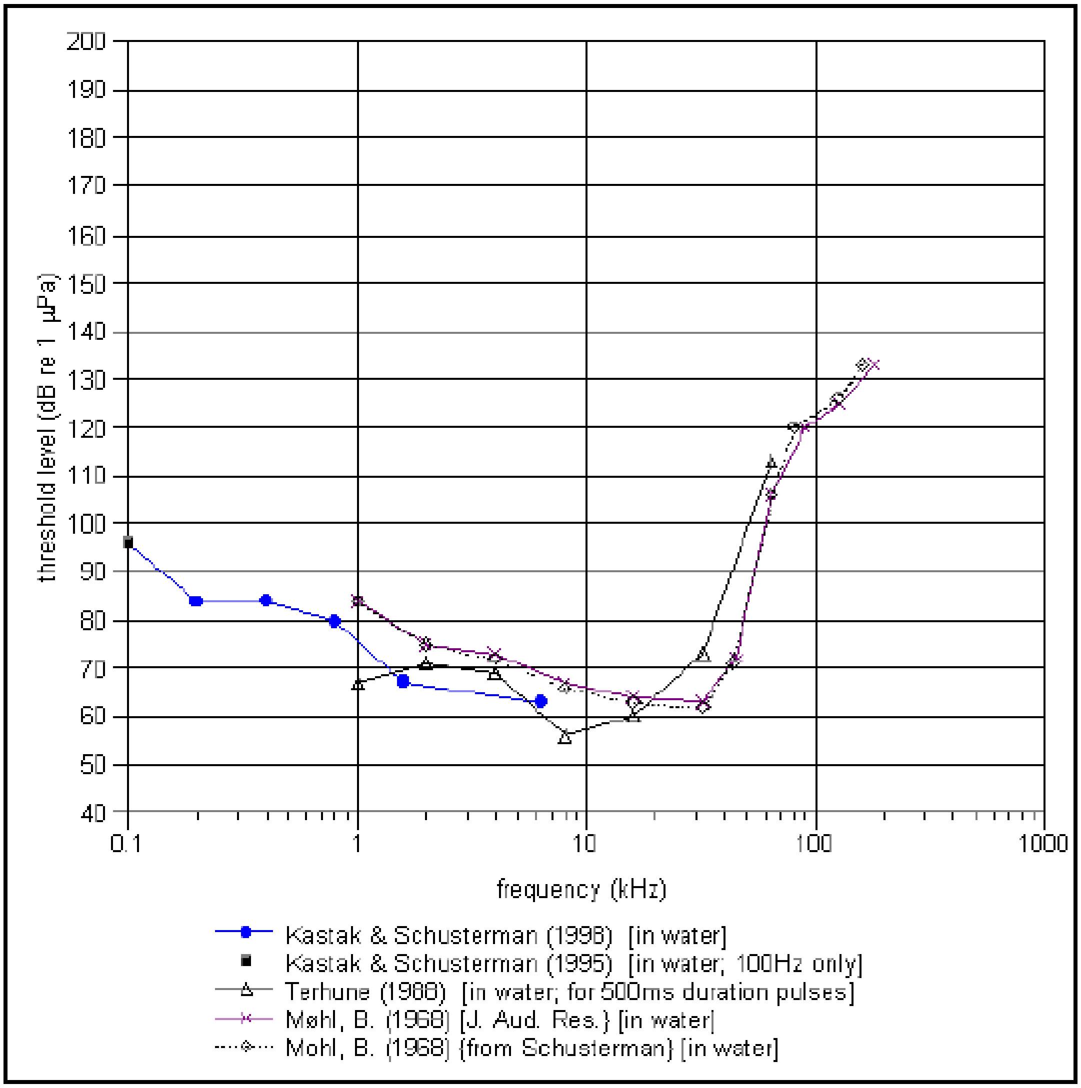

Figure 12: Harbor Seal In-water Audiogram (taken from Nedwell et al. 2004).

3.5.2.2. Killer Whale

The population of the North Pacific stock of killer whales contains an estimated 1,123 animals in the resident group and 314 animals in the transient group (Allen and Angliss 2010). Numbers of killer whales in Cook Inlet are small compared to the overall population and most are recorded in the lower Cook Inlet. Killer whales are rare in upper Cook Inlet, where transient killer whales are known to feed on beluga whales, and resident killer whales are known to feed on anadromous fish (Shelden et al. 2003). The availability of these prey species largely determines the likeliest times for killer whales to be in the area. Twenty-three sightings of killer whales were reported in the lower Cook Inlet between 1993 and 2004 in aerial surveys by Rugh et al. (2005a). Surveys over 20 years by Shelden et al. (2003) reported 11 sightings in upper Cook Inlet between Turnagain Arm, Susitna Flats, and Knik Arm. No killer whales were spotted during surveys by Funk et al. (2005), Ireland et al. (2005), Brueggeman et al. (2007a, 2007b, 2008), or Prevel Ramos et al. (2006, 2008). Eleven killer whale strandings have been reported in Turnagain Arm, six in May 1991, and five in August 1993. Very few killer whales, if any, are expected to approach or be in the vicinity of the Project area.

The hearing of killer whales is well developed. Szymanski et al. (1999) found that they responded to tones between 1 and 120 kHz, with the most sensitive range between 18 and 42 kHz. Their greatest sensitivity was at 20 kHz, which is lower than many other odontocetes, but it matches peak spectral energy reported for killer whale echolocation clicks. Figure 13 is an audiogram for the killer whale (taken from Nedwell et al. 2004).

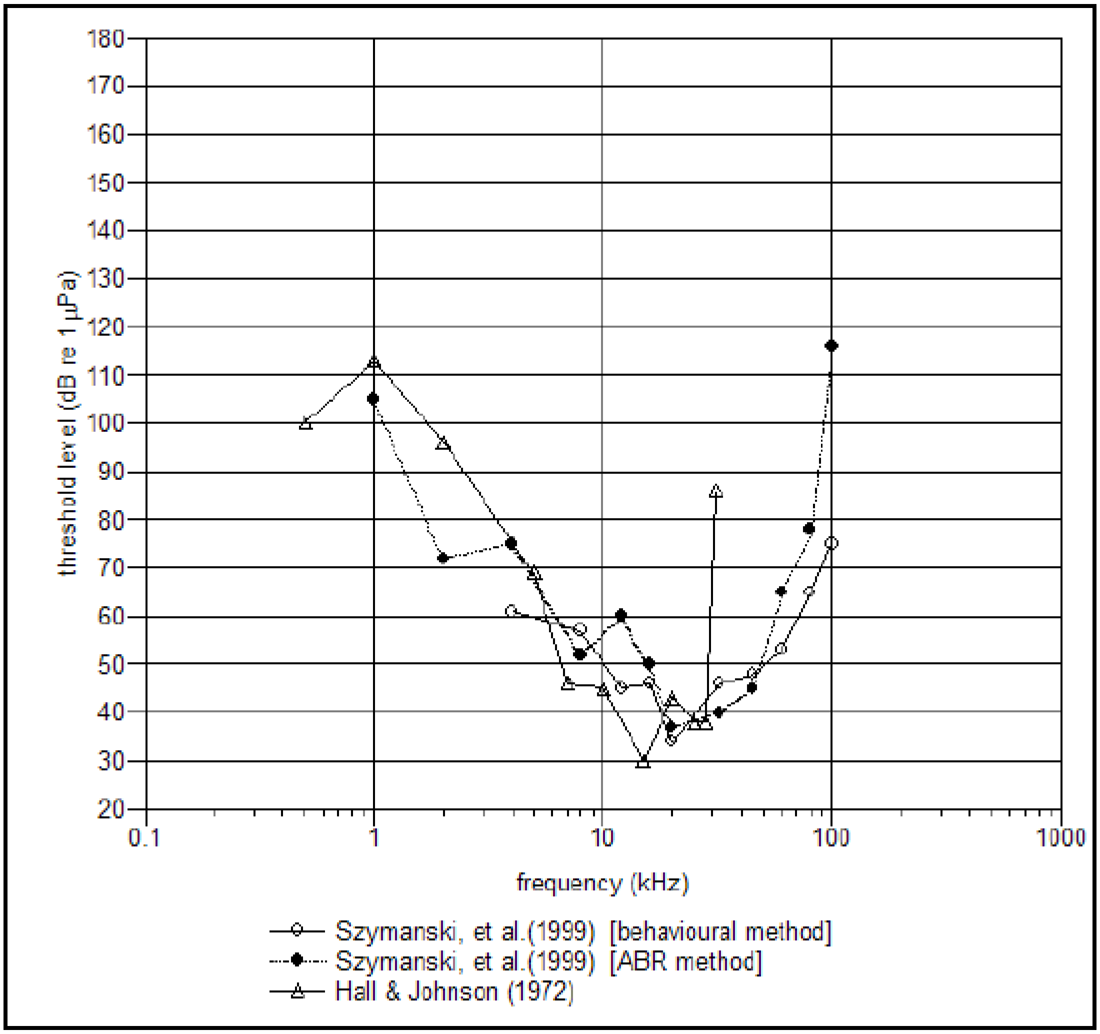

Figure 12. Killer Whale In-water Audiogram (taken from Nedwell et al. 2004).

3.5.2.3. Harbor Porpoise

Harbor porpoise stocks in Alaska are divided into three stocks: the Bering Sea stock, the Southeast Alaska stock, and the Gulf of Alaska stock. The Gulf of Alaska stock is currently estimated at 41,854 individuals (Allen and Angliss 2010). The most recent estimated density of animals in Cook Inlet is 7.2 per 1,000 km^2 (386 mi^2) (Dahlheim et al. 2000) indicating that only a small number use Cook Inlet. Harbor porpoise have been reported in lower Cook Inlet from Cape Douglas to the West Foreland, Kachemak Bay, and offshore (Rugh et al. 2005a). Small numbers of harbor porpoises have been consistently reported in the upper Cook Inlet between April and October, except for a recent survey that recorded higher numbers than typical. Highest monthly counts include 17 harbor porpoises reported for spring through fall 2006 by

Prevel Ramos et al. (2008), 14 for spring of 2007 by Brueggeman et al. (2007a), 12 for fall of 2007 by Brueggeman et al. (2008), and 129 for spring through fall in 2007 by Prevel Ramos et al. (2008) between Granite Point and the Susitna River during 2006 and 2007; the reason for the recent spike in numbers (129) of harbor porpoises in the upper Cook Inlet is unclear and quite disparate with results of past surveys, suggesting it may be an anomaly. The spike occurred in July, which was followed by sightings of 79 harbor porpoise in August, 78 in September, and 59 in October in 2007. The number of porpoises counted more than once was unknown indicating that the actual numbers are likely smaller than reported.

Recent passive acoustic research in Cook Inlet by ADF&G and NMML have indicated that harbor porpoises occur more frequently than expected, particularly in the West Foreland area in the spring (NMFS 2011, personal communication), although overall numbers are still unknown at this time.

The harbor porpoise has the highest upper-frequency limit of all odontocetes investigated. Kastelein et al. (2002) found that the range of best hearing was from 16 to 140 kHz, with a reduced sensitivity around 64 kHz. Maximum sensitivity (about 33 dB re 1 µPa) occurred between 100 and 140 kHz. This maximum sensitivity range corresponds with the peak frequency of echolocation pulses produced by harbor porpoises (120–130 kHz). Figure 14 is an audiogram for the harbor porpoise (taken from Nedwell et al. 2004).

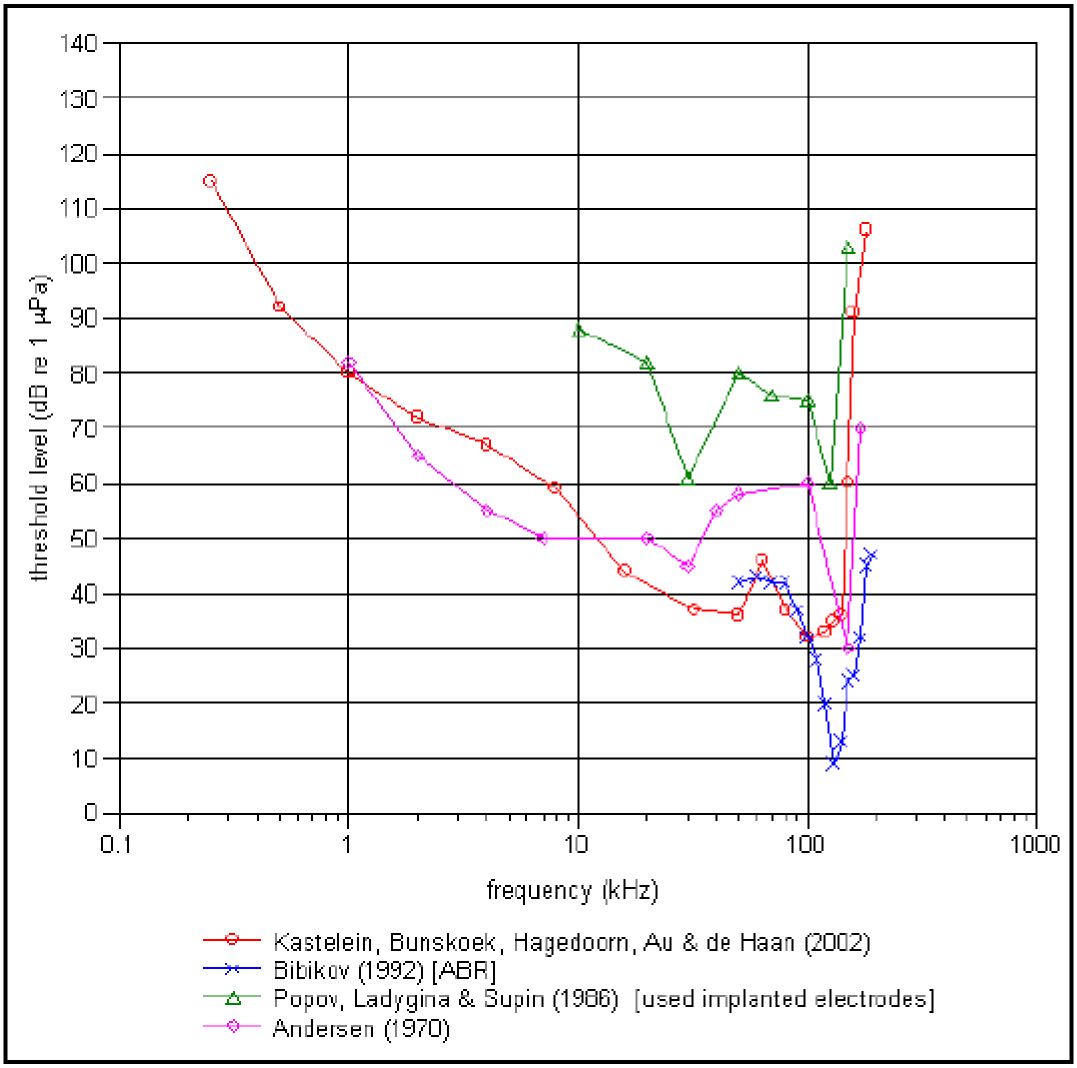

Figure 14: Harbor Porpoise In-water Audiogram (taken from Nedwell et al. 2004).

3.6. Socioeconomic Environment

The Kenai Peninsula Borough is comprised of the Kenai Peninsula, Cook Inlet, and a large unpopulated area northeast of the Alaska Peninsula. The Borough includes portions of the Chugach National Forest, Kenai National Wildlife Refuge, Kenai Fjords National Park, and portions of the Lake Clark and Katmai National Park. The twin cities of Kenai and Soldotna are the population centers of the Borough, approximately 65 air miles south of Anchorage Historically; the Dena'ina (Kenaitze Indians) occupied the peninsula. The City of Kenai was founded in 1791 as a Russian fur trading post. In the early 1900s, cannery operations and construction of the railroad spurred development. It was the site of the first major Alaska oil strike in 1957 and has been a center for exploration and production since that time. The borough was incorporated as a second-class borough in 1964.

The Borough economy is diverse, even more diverse than other parts of the State. Offshore oil and gas production in Cook Inlet and downstream production primarily take place north of Kenai. Important economic sectors include commercial fishing and fish processing. In 2010, 1,427 borough residents held commercial fishing permits, which allow fishing for salmon, cod, halibut, and other species.

The 2005-2009 American Community Survey (ACS) estimated 23,887 residents as employed. The ACS surveys established that average median household income was $55,966. The per capita income was $26,940. About 9.7% of all residents had incomes below the poverty level (ADCCE 2010).

According to Census 2010, there were 30,578 housing units in the community and 22,161 were occupied. Its population was 7.4 percent American Indian or Alaska Native; 84.6 percent white; 0.5 percent black; 1.1 percent Asian; 0.2 percent Pacific Islander; 5.6 percent of the local residents had multi-racial backgrounds. Additionally, 3 percent of the population was of Hispanic descent (ADCCE 2010).

3.6.1. Subsistence

The principal wild foods harvested and consumed by Dena'ina communities are fish, land mammals (moose), and marine mammals. Salmon consistently provides the major portion of the region's subsistence food, and sockeye is the most harvested. Shellfish, plants, and birds and eggs each make up approximately 2% of the total annual harvest (BOEM 2003)

Native hunters historically have hunted beluga whales for food. The subsistence harvest of beluga transcends nutritional and economic value of the whale as the harvest is an integral part of the cultural identity of the region's Alaska Native communities. Inedible parts of the whale provide Native artisans with materials for cultural handicrafts, and the hunting perpetuates Native traditions by transmitting traditional skills and knowledge to younger generations. Due to dramatic decreases in Cook Inlet beluga whale populations, a moratorium on hunting beluga whales is currently in place.

Near the proposed activities, Tyonek is a Dena'ina Athabascan village practicing a subsistence lifestyle. The Village of Tyonek lies on a bluff on the northwest shore of Cook Inlet and has no interconnected road access. According to Census 2010, there were 144 housing units in the community and 70 were occupied. Its population was 88.3 percent American Indian or Alaska Native; 5.3 percent white; 6.4 percent of the local residents had multi-racial backgrounds (ADCCE 2010).

3.6.2. Coastal and Marine

3.6.2.1. Fishing

Subsistence, personal use, recreational and commercial fishing occur throughout Cook Inlet. Subsistence and personal use are only allowed for Alaskan residents and personal use requires a valid Resident Sport Fishing License where subsistence does not (ADF&G 2011b). Popular recreational salmon fish streams within the action area include anadromous streams along the west coast of Cook Inlet (NMFS 2008b; ADF&G 2011b). Eulachon harvest locations within the action area include areas from the Chuitna to the Big and Little Susitna Rivers (NMFS 2008b; ADF&G 2011a). Groundfish (e.g., halibut, lingcod and rockfish) may also be harvested within the action area. Additionally, littleneck, butter and razor clams are harvested along the intertidal areas (NMFS 2008b).

Commercial fisheries in Cook Inlet waters include salmon, herring, groundfish (halibut, lingcod, rockfish, sablefish, Pollock and Pacific cod); and shellfish (crab, shrimp, scallops, and clams). The largest being the salmon fishery. Second only to Alaska's groundfish fishery, Alaska's salmon fishery is one of the largest fisheries in volume and value (ADF&G 2011a). Salmon fisheries in Shelikof Strait and near Kodiak

Island are closely equivalent to those in Cook Inlet, with slightly different fishing seasons and periods. Cook Inlet and Kodiak salmon fisheries use purse seines, drift gillnets, set gillnets and, in small numbers, beach seines. The regional salmon fisheries commence in early May and continue well into September each year (ADF&G 2011a).

The Upper Cook Inlet Management (UCI) Area, north of the latitude of Anchor Point, recently had a commercial harvest of 3.5 million salmon with a commercial exvessel value of approximately $32.4 million (ADF&G 2010a). While all five species of Pacific salmon are present in UCI, sockeye salmon are the most valuable, accounting for approximately 77% of the exvessel value in the commercial fishery since 1960 and more than 92% of the total value during the past 20 years (ADF&G 2010a). The estimated exvessel value of the 2010 UCI commercial fishery of $33.2 million was approximately 105% more than the average annual exvessel value of $16.1 million from the previous 10 years (2000–2009), and approximately 34% more than the 1966–2009 average annual exvessel value of $24.8 million (Shields 2010).

The Lower Cook Inlet (LCI) Management Area is comprised of all waters west of the longitude of Cape Fairfield, north of the latitude of Cape Douglas, and south of the latitude of Anchor Point. Area marine waters vary from the numerous fjord-like bays along the north Gulf of Alaska coast to the moderately protected waters of Kachemak Bay and the high-energy shoreline of Kamishak Bay (ADF&G 2010b). The preliminary 2010 Lower Cook Inlet (LCI) all-species commercial salmon harvest of 468,000 fish fell short of both the recent 10- and 20-year averages, representing the lowest cumulative total in the management area since 1976. The overall harvest was less than half of the revised preseason forecast of 1.02 million fish. A third consecutive season of strong prices for all species allowed the estimated exvessel value to reach $1.78 million, which was the sixth highest in the past decade but well below the recent 10- and 20-year averages (ADF&G 2010b).

3.6.2.2. Vessel Traffic

Cook Inlet supports a wide variety of vessel traffic ranging from the small fishing vessels to crude oil tankers (Cook Inlet Vessel Traffic Study [CIVTS] 2006). Vessels frequently trading in Cook Inlet include Alaska Marine Highway ferries, commercial cruise ships, cargo and container ships, and tanker and gas ships. Both Homer and Seward have developed deepwater docks. The Alaska Marine Highway System serves Homer and provides service to Seldovia.

The Port of Anchorage maintains five docks that accommodate barges and ships with domestic supply bound for Cook Inlet and western Alaska. The port receives on average four (4) tank ship calls to off-load refined product for local fuel consumption, including military facilities. Passenger vessels are infrequent. In addition there are four (4) private industrial docking facilities located roughly midway between Homer and Anchorage. The Nikiski terminals are located on the east side of Cook Inlet and 2.3 miles south of the geographically prominent East Forelands (CIVTS 2006). Three moorages are a mile north/northwest of Nikiski: the Agrium wharf, the ConocoPhillips pier and the Kenai Pipeline pier.

Vessel traffic in Cook Inlet (2005-2006) totaled over 480 commercial vessels (CIVTS 2006). Roll On-Roll Off vessels (tractor –trailer loaded) make continuous round trips between the ports of Tacoma, Washington and Anchorage, covering the 1450 nautical miles between ports in about 66 hours, one way. Container cargo vessels (crane loaded) operating from Tacoma, Washington services not only Anchorage but Kodiak and Dutch Harbor. The transit time for these cargo vessels from Tacoma to Anchorage takes about 80 hours (CIVTS 2006).

ADF&G 2005 landing data shows 479 vessels landed salmon in UCI. For the LCI, 187 vessels landed groundfish and 37 vessels landed salmon in the seine fishery.

3.6.2.3. Oil and Gas

Oil and gas has been a part of the history of the Kenai Peninsula Borough for nearly 150 years. The discovery of oil in the Swanson River oil field in 1957 was a catalyst for Alaska statehood. Today, there are 16 oil and gas production platforms located offshore in Cook Inlet. Operations at three of the platforms have been temporarily suspended due to market conditions and low production volumes.

Oil production on the Peninsula peaked in 1970 at 226,000 barrels of oil per day compared to 29,000 today. Oil and gas is still the single largest source of high paying jobs. In 2003, the oil and gas industry directly generated approximately 1,000 wage and salary jobs on the Peninsula, or nearly six percent of all wage and salary employment. Because of the higher wages it represents almost 12 percent of all wage and salary payroll. Not only does this industry play an important employment role, but nine of the Peninsula's top ten taxpayers are attached to the oil industry (KPB 2004). Seismic surveys use high energy, low frequency sound in short pulse durations to determine substrates below the seafloor, such as gas and oil deposits (Richardson et al. 1995). These short pulses of sound increase noise levels near the seismic activity. Airguns have been previously used in Cook Inlet for seismic exploration (JASCO 2007) and will be used for the proposed Cook Inlet 3D Seismic Program. Vessel and air traffic are required for support during oil and gas development. Oil produced on the westside of Cook Inlet is transported by tankers to the refineries on the east side. Refined petroleum products are then shipped to other parts of Alaska. Liquid gas is also transported via tankers once it is processed (ADNR 2009). Offshore drilling is generally conducted from man-made islands, drilling vessels or platforms (Richardson et al. 1995). In Cook Inlet, oil and gas drilling occurs from platforms.

3.6.2.4. Military

Anchorage is home to Joint Base Elmendorf-Fort Richardson (JBER), a joint Air Force and Army base. Fort Richardson Army Base encompasses over 61, 000 acres in south-central Alaska with Knik Arm of the Cook Inlet bordering on the north side of the post. Cargo is routinely transported between the Port of Anchorage and this base, including the off-loading of jet fuel.

The Eagle River Flats (ERF) Impact Area is a 2,483-acre made up of tidal salt marsh at the mouth of the Eagle River and discharges into Eagle Bay of the Knik Arm. The base maintains and operates a runway near and airspace directly over Knik Arm. Aircraft noise can be loud within the proposed project area. The area has been used for weapons training since the 1940s. Recent acoustic research has found noise from detonations on the ERF can exceed 160 dB within Cook Inlet, including high-use areas in Eagle Bay. Currently, live-fire weapons training within ERF is restricted to winter months only, when specified ice conditions are met.

Chapter 4 Environmental Consequences

This chapter outlines the effects or impacts to the aforementioned resources in the Cook Inlet from the proposed action and alternative. Significance of these effects is determined by considering the context in which the action will occur and the intensity of the action. The context in which the action will occur includes the specific resources, ecosystem, and the human environment affected. The intensity of the action includes the type of impact (beneficial versus adverse), duration of impact (short versus long term), magnitude of impact (minor versus major), and degree of risk (high versus low level of probability of an impact occurring).

The terms “effects” and “impacts” are used interchangeably in preparing these analyses. The CEQ’s regulations for implementing the procedural provisions of NEPA, also state, “Effects and impacts as used in these regulations are synonymous” (40 CFR §1508.8). The terms “positive” and “beneficial”, or “negative” and “adverse” are likewise used interchangeably in this analysis to indicate direction of intensity in significance determination.

4.1. Effects of Alternative 1 – No Action Alternative

Under the No Action Alternative, NMFS would not issue an IHA to Apache for the proposed seismic survey in Cook Inlet. In this case, Apache would decide whether or not they would want to continue with their seismic survey activities. If Apache choose not to conduct the survey, then there would be no effects to marine mammals. Conducting these activities without an MMPA authorization (i.e., an IHA) could result in a violation of Federal law. If Apache decide to conduct some or all of the activities without implementing any mitigation measures, and if activities occur when marine mammals are present in the action areas, there is the potential for unauthorized harassment of marine mammals. The sounds produced by the airgun arrays are likely to cause behavioral harassment of marine mammals in the action area, while some marine mammals may avoid the area of ensonification or with survey activities altogether. Additionally, masking of natural sounds may occur. Auditory impacts (i.e., temporary and permanent threshold shifts) could also occur if no mitigation or monitoring measures are implemented. As explained later in this document, monitoring of safety zones for the presence of marine mammals allows for the implementation of mitigation measures, such as power-downs and shutdowns of the airguns when marine mammals occur within these zones. These measures are required to avoid the onset of shifts in hearing thresholds. However, if a marine mammal occurs within these high energy ensonified zones, it is possible that hearing impairments to marine mammals could occur. Additionally, although unlikely, based on its proximity to the airgun array, permanent threshold shift (PTS) could also occur, but this possibility is thought to be unlikely if the exposure is of a few pulses. If Apache were to decide to implement mitigation measures similar to those described in Chapter 5 of this EA, then the impacts would most likely be similar to those described for Alternative 2 below.

4.2. Effects of Alternative 2 – Preferred Alternative

Under this alternative, NMFS would issue an IHA to Apache for their proposed seismic survey in Cook with required mitigation, monitoring, and reporting requirements as discussed in Chapters 5 and 6 of this EA. As part of NMFS’ action, the mitigation and monitoring described later in this EA would be undertaken as required by the MMPA, and, as a result, no serious injury or mortality of marine mammals is expected and correspondingly no impact on the reproductive or survival ability of affected species would occur. Potentially affected marine mammal species under NMFS’ jurisdiction would be: beluga whale, killer whale, harbor porpoise, harbor seal, and Steller sea lion. Two of these species (beluga whale and Steller sea lion) are listed as endangered under the ESA.

4.2.1. Effects on Physical Environment

4.2.1.1. Effects of Geology and Oceanography

The proposed seismic survey in Cook will have no effects on the geology and geomorphology and the physical oceanography of the project area. The seismic survey activities will not affect the stratigraphy, seafloor sediments and geology, or sub-seafloor geology in any way. The proposed surveys will not affect the Cook Inlet circulation patterns, topography, bathymetry, or incoming watermasses; atmospheric pressure systems; surface-water runoff; density differences between watermasses; or seasonal sea ice.

The proposed seismic survey will not have an effect on the sea ice of the project area. Apache has designed their offshore project to be during the open water season. Apache will not be using ice-breakers or other ice-related support vessels for this project. However, the presence of sea ice in the project area could affect the surveys by reducing the geographical extent of the survey area.

4.2.1.2. Effects on Water Quality

Increased vessel activity in the action area from the proposed Cook Inlet 3D Seismic Program will temporarily increase the risk of accidental oil spills. Accidental oil spills may occur from a vessel leak or if the vessel runs aground. Impacts from an oil spill on water quality in the action area will remain relatively small and will be minimized by maintaining safe operational and navigational conditions and best management practices for spill prevention, response, and clean up.

4.2.1.3. Effects on Air Quality

The proposed Apache seismic survey will have a minimal, temporary, and localized effect on air quality in the project area and no measurable effect on air quality on Cook Inlet's coastline. The short duration of the proposed survey in one area at a time and relative lack of residential communities along the western will ensure that the potential effects from the vessels' emissions will not represent any threat to the project are or Cook Inlet's coastline air quality.

4.2.1.4. Effects of Acoustic Environment

Potential effects on the marine acoustic environment within the project area include sound generated by the seismic airguns, active acoustic sources for surveys (i.e., pingers), and vessel transit. The most intense sources from the proposed survey would be impulse sound generated from the airgun arrays. However, these effects are expected to be localized to the project area and temporary, occurring only during seismic data acquisition.

Acoustic Sources

The Apache would tow two identical 2400 cui airgun arrays from two source vessels using ping/pong methodology (described in Section XXX). The array consists of 16 individual guns with individual volumes of 150 cui arranged in clustered pairs. The overall layout is comprised of two sub-arrays of 8 guns each. The array is expected to be operated at a constant depth of 3 m (9.8 ft) during the course of the survey. The acoustic source level of the 2400 cui airgun array was predicted using JASCO Applied Science (JASCOs) air array source model (AASM). Two general survey environment scenarios were considered for the modeling study: a nearshore (from shore out to 18 km [11 mi] offshore) and a channel survey scenario (more than 18 km [11 mi] from shore). The nearshore scenario was further divided into three distance intervals of 6 km (3.7 mi) from each shore, this interval is defined by the zone that can be surveyed in a 24 hour period. Details on the modeling can be found in Appendix A, JASCO modeling report.

Nearshore Survey Results

The distances to the 160, 180, and 190 dB re 1 µPa rms sound level thresholds for the nearshore survey locations are given in Table 2. Distances correspond to the three transects modeled at each site in the onshore, offshore, and parallel to shore directions. The 160 dB re 1 µPa footprints for one day of nearshore surveying in shallow, mid-depth, and deep water are shown in Figure 15; the corresponding areas of the footprints are listed in Table 3.

Table 2: Distances to Sound Level Thresholds for the Nearshore Surveys

Sound Level Threshold (dB re 1 µPa)	Water Depth at Source Location (m)	Distance in the Onshore Direction (km)	Distance in the Offshore Direction (km)	Distance in the Parallel to Shore Direction (km)
160	5	0.85	3.91	1.48
	25	4.70	6.41	6.34
	45	5.57	4.91	6.10
180	5	0.46	0.60	0.54
	25	1.06	1.07	1.42
	45	0.70	0.83	0.89
190	5	0.28	0.33	0.33
	25	0.35	0.36	0.44
	45	0.10	0.10	0.51

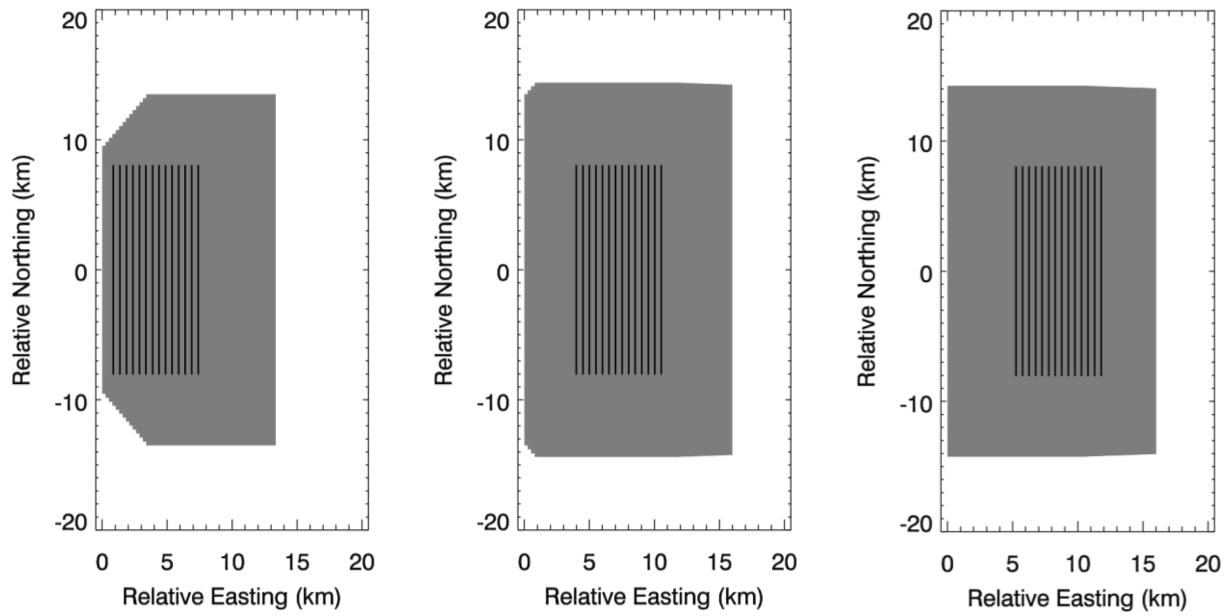

Figure 15: Daily footprints for (a) shallow, (b) mid-depth, and (c) deep water nearshore surveys. The ensonified areas are shown in gray and survey lines are shown in black.

Table 3: Areas Ensonified to 160 dB re 1 μPa for Nearshore Surveys in 24 Hours

Nearshore Survey Depth Classification	Depth Range (m)	Area Ensonified to 160 dB re 1 μPa (km^2)
Shallow	5-21	346
Mid-depth	21-38	458
Deep	38-54	455

Channel Survey Results

The distances to the 160, 180, and 190 dB re 1 μPa rms sound level thresholds for the channel surveys are shown below in Table 4. Distances correspond to the broadside and endfire directions. The 160 dB re 1 μPa rms footprint for 24 hours of seismic survey in the inlet channel is shown in Figure 16; the corresponding area of the footprint is 389 km^2.

Table 4: Distances To Sound Level Thresholds For The Channel Surveys

Sound Level Threshold (dB re 1 μPa)	Water Depth at Source Location (m)	Distance in the Broadside Direction (km)	Distance in the Endfire Direction (km)
160	80	4.24	4.89
180	80	0.91	0.98
190	80	0.15	0.18

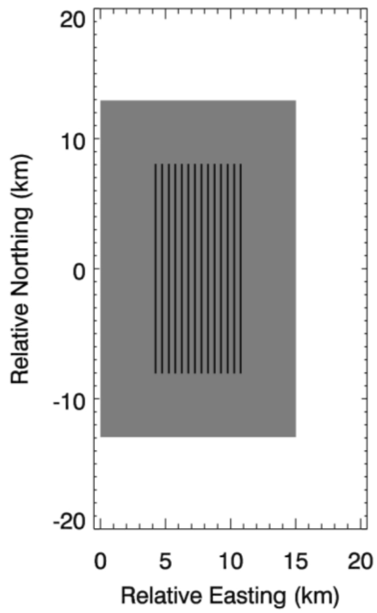

Figure 16: Daily footprint for channel surveys. The ensonified area is shown in gray and the survey lines are shown in black. Its area is 389 km^2.

Positioning pinger

As described in Section 1.2.5, the maximum source level of the pinger is 188 dB re µPa at 1 m rms (at 33-55 kHz). Assuming a simple spreading loss of 20 log R (where R is radius) with a source level of 188 dB, the distance to the 190, 180, and 160 dB isopleths would be 1, 3, and 25 m (3.28, 9.8, and 82 ft). This spreading loss is appropriate for high-frequency pulsed systems. The reason is that the multipaths (direct path, surface reflection, bottom reflection, etc.) of short duration pulses arrive at the receivers spaced in time. The rms level therefore should be computed for the strength of the strongest multipath, which will be the direct path. The use of 20 log R is fully appropriate because this path does not interact with surface or bottom (otherwise it would have an even higher coefficient than 20).

4.2.2. Effects of Biological Environment

4.2.2.1. Effects on Fish

While there may be few definitive studies on the use of the nearshore shallow coastal areas in the upper inlet, use of this type of habitat elsewhere by salmon and other species in Cook Inlet is not well supported in literature (NMFS 2008a). In general, fish perceive underwater sounds in the frequency range of 50 to 2,000 Hz, with peak sensitivities below 800 Hz (Popper and Carlson 1998; Department of the Navy 2001). However, fish are sensitive to underwater impulsive sounds due to swimbladder resonance. As the pressure wave passes through a fish, the swimbladder is rapidly squeezed as the high pressure wave, and then under pressure component of the wave, passes through the fish. The swimbladder may repeatedly expand and contract at the high SPL, creating pressure on the internal organs surrounding the swimbladder.

Permanent injury to fish from acoustic emissions has been shown for high-intensity sounds of several hours long. In a review on the effects of low-frequency noise to fish, a threshold of 180 dB peak sound level was used to define the potential injury to fish. Sound pressure levels greater than an average of 150 dB rms are expected to cause temporary behavioral changes such as a startle response or behaviors associated with stress. Although these SPLs are not expected to cause direct injury to a fish, they may decrease the ability of a fish to avoid predators.

Carlson (1994), in a review of 40 years of studies concerning the use of underwater sound to deter salmonids from hazardous areas at hydroelectric dams and other facilities, concluded that salmonids were able to respond to low-frequency sound and to react to sound sources within a few feet of the source. He speculated that the reason that underwater sound had no effect on salmonids at distances greater than a few feet is because they react to water particle motion/acceleration, not sound pressures. Detectable particle motion is produced within very short distances of a sound source, although sound pressure waves travel farther.

Hastings and Popper (2005) reviewed all pertinent peer-reviewed and unpublished papers on noise exposure of fish through early 2005. They proposed the use of SEL to replace peak SPL in pile driving criteria. This report identified interim thresholds based on SEL or sound energy. The interim thresholds for injury were based on exposure to a single pile driving pulse. The report also indicates that there was insufficient evidence to make any findings regarding behavioral effects associated with these types of sounds. Interim thresholds were identified for pile driving consisting of a single-strike peak sound pressure and a single strike SEL for onset of physical injury. A peak pressure criterion was retained to function in concert with the SEL value for protecting fishes from potentially damaging aspects of acoustic impact stimuli. The available scientific evidence suggested that a single-strike peak pressure of 208 dB and a single strike SEL of 187 dB were appropriate thresholds for the onset of physical injury to fishes.

Following the Hasting and Popper (2005) paper, NMFS developed their version of the dual criteria that included the single strike peak pressure threshold of 208 dB, but addressed the accumulation of multiple strikes through accumulation of sound energy by setting a criterion of 187 dB SEL. The accumulated SEL is calculated using an equal energy hypothesis that combines the SEL of a single strike to 10 times the 10-based logarithm of the number of pile strikes.

4.2.2.2. Effects on Marine Birds

Although NMFS does not anticipate direct effects on marine birds from the proposed action (issuing IHA to Apache for seismic survey in Cook Inlet), they could be indirectly affected by the seismic survey. Therefore, as part of the environmental analysis, the effects on marine birds are analyzed as part of the environment consequence analysis.

Potential adverse effects of the proposed open water marine and seismic survey activities on coastal and marine birds can be summarized in categories of:

- Disturbance from the presence and noise of seismic surveys; and
- Collision with vessels.

Disturbance from the Physical Presence of Vessels

Waterfowl and marine birds respond to disturbances in a wide variety of ways, depending on the species, time of year, disturbance source, habituation, and other factors (Fox and Madsen 1997). Some studies have indicated larger flocks react at greater distances than smaller flocks (Madsen 1985). Some sea-duck species (e.g., Steller's eider, long-tailed duck, and harlequin duck [*Histrionicus histrionicus*]) exhibit different responses to different size vessels near developed harbors on the Alaska Peninsula and eastern Aleutian Islands during the winter (U.S. Army Corps of Engineers 2000). These species appear to tolerate large, slow-moving commercial vessels passing through narrow channels but typically fly away when in visual distance of a fast-moving skiff. Skiffs running small outboard engines at high speed make a distinctive high-pitched sound, whereas large commercial vessels produce a lower rumble. As these sea ducks appear more tolerant of slow-moving skiffs, their reaction may be interpreted as incorporating aspects of vessel size, speed, and engine noise. It also could be that these species associate the small skiffs with hunters they encounter elsewhere in their range.

Very few studies have assessed the effects of seismic surveys on marine birds and waterfowl. Stemp (1985) observed responses of northern fulmars, black-legged kittiwakes, and thick-billed murres to seismic activities in Davis Strait offshore of Baffin Island and observed no disturbance from airguns. The study concluded that adverse effects of seismic survey are not expected as long as activities are conducted away from colonies, feeding concentrations, and flightless murres.

It is possible that some birds could be near enough to an airgun to be injured by a pulse, if they are in the water feeding. The threshold for physiological damage for marine birds is unknown. Although NMFS has no information about the circumstances where this might occur, the reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all. A mitigation measure to "ramp-up," which is a gradual increase in decibel level as the seismic activities begin, can allow diving birds to hear the start up of the seismic survey and help disperse them before harm occurs. During ongoing surveys, diving birds also are likely to hear the advance of the slow-moving survey vessel and associated airgun operations and move away. Mitigation measures to ramp up airguns for use and to document bird reactions to marine and seismic survey activities may help further evaluate the potential for marine birds to be harmed by airgun noises.

Collision with Vessels

The collision of migrating birds into manmade structures has been well documented in the literature. Weather conditions such as storms associated with rain, snow, icing, and fog or low clouds at the time of the occurrences often are attributed as causal factors (Weir 1976; Brown 1993). Lighting of structures, which can be intensified by fog or rain, also has been identified as a factor (Avery et al. 1980; Brown 1993; Jehl 1993). Birds are attracted to the lights, become disoriented, and may collide with the light support structure (e.g., pole, tower, or vessel).

Lights on fishing vessels at sea have been known to attract large numbers of seabirds during storms (Dick and Donaldson 1978). Waterfowl and shorebirds also have been documented as colliding with lighted structures and boats at sea (Day et al. 2003).

Marine birds are at risk of collisions with seismic-survey vessels at night due to attraction and subsequent disorientation from high-intensity lights on ships. Sea ducks are vulnerable to collisions with seismic-survey vessels, primarily because they tend to fly low over the water.

Identification and avoidance of marine mammals is an important mitigation measure to prevent harmful impacts to marine mammals from seismic surveys. High-intensity lights are needed during the seismic surveys to help spot marine mammals during nighttime operations or when visibility is hampered by rain or fog. A mitigation measure to not use high-intensity lights when not needed can reduce the potential that marine birds would be attracted to and strike the seismic survey vessel (BOEM 2006).

4.2.2.3. Effects on Marine Mammals

General Effects of Noise on Marine Mammals

Marine mammals use hearing and sound transmission to perform vital life functions. Introducing sound into their environment could be disrupting to those behaviors. Sound (hearing and vocalization/ echolocation) serves four primary functions for marine mammals, including: 1) providing information about their environment, 2) communication, 3) prey detection, and 4) predator detection. The distances to which air gun noise associated with the test program are audible depend upon source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and sensitivity of the receptor (Richardson et al. 1995).

The effects of sounds from air guns on marine mammals might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al. 1995). In assessing potential effects of noise, Richardson et al. (1995) has suggested four criteria for defining zones of influence. These zones are described below from greatest influence to least:

***Zone of hearing loss, discomfort, or injury* –** the area within which the received sound level is potentially high enough to cause discomfort or tissue damage to auditory or other systems. This includes temporary threshold shifts (TTS, temporary loss in hearing) or permanent threshold shifts (PTS, loss in hearing at specific frequencies or deafness). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage.

***Zone of masking* –** the area within which the noise may interfere with detection of other sounds, including communication calls, prey sounds, or other environmental sounds.

***Zone of responsiveness* –** the area within which the animal reacts behaviorally or physiologically. The behavioral responses of marine mammals to sound is dependent upon a number of factors, including: 1) acoustic characteristics the noise source of interest; 2) physical and behavioral state of animals at time of exposure; 3) ambient acoustic and ecological characteristics of the environment; and 4) context of the sound (e.g., whether it sounds similar to a predator) (Richardson et al. 1995; Southall et al. 2007). However, temporary behavioral effects are often simply evidence that an animal has heard a sound and may not indicate lasting consequence for exposed individuals (Southall et al. 2007).

***Zone of audibility* –** the area within which the marine mammal might hear the noise. Marine mammals as a group have functional hearing ranges of 10 Hz to 180 kHz, with best thresholds near 40 dB (Ketten 1998; Kastak et al. 2005; Southall et al. 2007). These data show reasonably consistent patterns of hearing sensitivity within each of three groups: small odontocetes (such as the harbor porpoise), medium-sized odontocetes (such as the beluga and killer whales), and pinnipeds (such as the harbor seal). Hearing capabilities of the species included in this Application are discussed in Section 3. There are no applicable criteria for the zone of audibility due to difficulties in human ability to determine the audibility of a particular noise for a particular species.

Potential Effects of Air Gun Sounds

The following text describes the potential impacts on marine mammals due to seimsic activities. Due to the mitigation measures and monitoring discussed in Sections 5 and 6, it is unlikely there would be any temporary or especially permanent hearing impairment, or non-auditory physical effects on marine mammals. In addition, most of nearshore area of Cook Inlet is a poor acoustic environment because of its shallow depth, soft bottom, and high background noise from currents and glacial silt which greatly reduces the distance sound travels (Blackwell and Greene 2002).

Tolerance

Studies have shown that pulsed sounds from air guns are often readily detectable in the water at distances of many kilometers, but they don't necessarily cause behavioral disturbances. Numerous studies have shown that marine mammals at distances over a few kilometers from operating seismic vessels often show no apparent response. That is often true even when pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to temporarily react behaviorally to air gun pulses under some conditions, at other times they have shown no overt reactions. In general, pinnipeds and small odontocetes are more tolerant of exposure to air gun pulses than baleen whales.

Masking

Masking of marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data of relevance. Some whales are known to continue calling in the presence of seismic pulses. Their calls can be heard between seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999; Nieukirk et al. 2004). Masking effects of seismic pulses are expected to be negligible in the case of the odontocete cetaceans, given the intermittent nature of seismic pulses. Also, the sounds important to small odontocetes are predominantly at much higher frequencies than are air gun sounds. Therefore, the potential problem of auditory masking for beluga whales is diminished by the small amount of overlap between frequencies produced by seismic and other industrial noise (<1 kHz) and frequencies which beluga whales call (0.26-20 kHz) and echolocate (40-60 kHz and 100-120 kHz) (Blackwell and Greene 2002).

Disturbance Reactions

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, environmental conditions, and many other factors (Richardson et al. 1995). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a short distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, which is not anticipated in the proposed seismic program, impacts on the animals could be significant. Given the many uncertainties in predicting the quantity and types of impacts of sound on marine mammals, it is common practice to estimate how many mammals were present within a particular distance of industrial activities, or exposed to a particular level of industrial sound to assess behavioral disturbance. However, this procedure likely overestimates the numbers of marine mammals that are affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important but unknown degree by a seismic program are based on behavioral observations during studies of several species. However, information is largely lacking for many species including those species likely to occur in the project areas. Detailed studies have been done on other species found elsewhere in Alaska waters including gray whales, bowhead whales, and ringed seals. The criteria established for these marine mammals, which are applied to others are conservative and have not been demonstrated to significantly affect individuals or populations of marine mammals in Alaska waters. Therefore, the effect of the test seismic program on the behavior of marine mammals should be no more than negligible for reasons stated earlier, and since the immediate project area is not an important feeding or breeding area, and it appears to be primarily a transition area during the fall that marine mammals pass through while going between the mid or upper inlet to the lower inlet and Gulf of Alaska to winter.

Toothed Whales. Little systematic information is available about reactions of beluga whales, killer whales, and harbor porpoise to noise pulses. Beluga whales exhibit changes in behavior when exposed to strong, pulsed sounds similar in duration to those typically used in seismic surveys (Finneran et al. 2000, 2002). However, the animals tolerated high received levels of sound (peak–peak level >200 dB re 1 µPa) before exhibiting aversive behaviors (Richardson et al. 1995). Some belugas summering in the Eastern Beaufort Sea may have avoided the specific area of seismic operations (2 arrays with 24 air guns per array), which used a much larger array than the proposed program (2 arrays of 3 air guns per array), by 10 to 20 km, although belugas occurred as close as 1,540 m to the line of seismic operations (Miller et al 2005). Observers stationed on seismic vessels operating off the United Kingdom from 1997–2000 have provided data on the occurrence and behavior of various toothed whales exposed to seismic pulses (Stone 2003; Gordon et al. 2004). Killer whales were found to be significantly farther from large air gun arrays during periods of shooting compared with periods of no shooting. The displacement of the median distance from the array was ~0.5 km (0.3 miles) or more. Killer whales also appear to be more tolerant of seismic shooting in deeper water. Killer whales are rare to uncommon in the inlet, therefore, the planned seismic program should have no more than a negligible impact on killer whales and no effect on the population. Harbor porpoises are rarely sighted, but have been detected acoustically throughout the inlet. However, based on the relatively few animals observered, the planned should have no more than a negligble impact and no effect on the population.

Pinnipeds. While there are no published data on seismic effect on sea lions or harbor seals, anecdotal data and data on arctic seals indicate that sea lions and other pinnipeds generally tolerate strong noise pulses (Richardson et al 1995). Monitoring studies in the Alaskan and Canadian Beaufort Sea during 1996–2002 provided considerable information regarding behavior of arctic seals exposed to seismic pulses (Miller et al. 2005; Harris et al. 2001; Moulton and Lawson 2002). These seismic projects usually involved arrays of 6 to 16 with as many as 24 air guns with total volumes 560 to 1500 cui. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the air guns were operating than when they were not (Moulton and Lawson 2002). However, these avoidance movements were relatively small, on the order of 100 m (328 ft) to (at most) a few hundred meters, and many seals remained within 100 to 200 m (328 to 656 ft) of the trackline as the operating air gun array passed by them. Seal sighting rates at the water surface were lower during air gun array operations than during no-air gun periods in each survey year except 1997. Miller et al. (2005) also reported higher sighting rates during non-seismic than during line seismic operations, but there was no difference for mean sighting distances during the two conditions nor was there evidence ringed or bearded seals were displaced from the area by the operations. The operation of the air gun array had minor and variable effects on the behavior of seals visible at the surface within a few hundred meters of the array. The behavioral data from these studies indicated that some seals were more likely to swim away from the source vessel during periods of air gun operations and more likely to swim towards or parallel to the vessel during non-seismic periods. No consistent relationship was observed between exposure to air gun noise and proportions of seals engaged in other recognizable behaviors, e.g. "looked" and "dove". Such a relationship might have occurred if seals seek to reduce exposure to strong seismic pulses, given the reduced air gun noise levels close to the surface where "looking" occurs (Miller et al. 2005; Moulton and Lawson 2002).

Consequently, by using the responses of bearded, ringed, and spotted seals (least amount of data on reaction to seismic operations) to seismic operations as surrogates for harbor seals and sea lions, it is reasonable to conclude that the relatively small numbers relative to the population size (see Table 8) of harbor seals and the even smaller numbers of Steller sea lions possibly occurring in the project area during seismic operations are not likely to show a strong avoidance reaction to the proposed air gun sources. Pinnipeds frequently do not avoid the area within a few hundred meters of operating air gun arrays, even for air gun arrays much larger than that planned for the proposed project (e.g., Harris et al. 2001). Reactions are expected to be very localized and confined to relatively small distances and durations, with no long-term effects on individuals or populations.

Strandings and Mortality

There is no evidence in the literature that air gun pulses can cause serious injury, death, or stranding of marine mammals even in the case of much larger air gun arrays than planned for the proposed program. While strandings have been associated with military mid-frequency sonar pulses, Apache does not plan to use such sonar systems during the seismic test program. Seismic pulses and military mid-frequency sonar pulses are quite different. Sounds produced by air gun arrays are broadband with most of the energy below 1 kHz.

Noise Induced Threshold Shift

Animals exposed to intense sound may experience reduced hearing sensitivity for some period of time following exposure. This increased hearing threshold is known as noise induced threshold shift (TS). The amount of TS incurred in the animal is influenced a number of noise exposure characteristics, such as amplitude, duration, frequency content, temporal pattern, and energy distribution (Kryter 1985; Richardson et al. 1995; Southall et al. 2007). It is also influenced by characteristics of the animal, such as behavior, age, history of noise exposure and health. The magnitude of TS generally decreases over time after noise exposure and if it eventually returns to zero, it is known as TTS. If TS does not return to zero after some time (generally on the order of weeks), it is known as PTS. Temporary threshold shift is not considered to be auditory injury and does not constitute 'Level A Harassment' as defined by the MMPA. Sound levels associated with TTS onset are generally considered to be below the levels that will cause PTS, which is considered to be auditory injury.

Temporary threshold shift has been studied in captive odontocetes and pinnipeds (reviewed in Southall et al. 2007). Data are available for three cetacean species (bottlenose dolphin, *Tursiops truncatus*; beluga whale, and harbor porpoise) and three pinniped species (harbor seal, California sea lion, *Zalophus californianus*; Northern elephant seal, *Mirounga angustirostris*). However, these data have all been collected from captive animals and no documentation exists of TTS or PTS in free ranging marine mammals exposed to air gun pulses.

The current NMFS policy regarding exposure of marine mammals to impulsive sound is that cetaceans should not be exposed to impulsive sounds >180 dB re 1 µPa rms and that pinnipeds should not be exposed to impulsive sounds >190 dB re 1µPa rms (NMFS 2000). These criteria were established before information was available about minimum received levels of sound that would cause auditory injury in marine mammals. They are likely lower than necessary and are intended to be precautionary estimates below which no physical injury will occur (Southall et al. 2007). Many marine mammal species avoid ships and/or seismic operations. This behavior in and of itself should be sufficient to avoid TTS onset. In addition, monitoring and mitigation measures often implemented during seismic surveys are designed to detect marine mammals near the air gun array and avoid exposing them to sound pulses that may cause hearing impairment. For example, it is standard protocol for many seismic operators to ramp up air gun arrays, which should allow animals near the air guns at startup time to move away from the source and thus avoid TTS. If animals do incur TTS, it is a temporary and reversible phenomenon unless exposure exceeds the TTS-onset threshold by an amount sufficient to cause PTS. The following subsections summarize the available data on noise-induced hearing impairment in marine mammals.

Sound Exposure Level (SEL)

Sound exposure level is a measure of sound energy, calculated as 10 times the logarithm of the integral (with respect to duration) of the mean-square sound pressure, referenced to 1 μPa^2s (Kastak et al. 2005, Southall et al. 2007). It is useful for assessing the cumulative level of exposure to multiple sounds because it allows sounds with different durations and involving multiple exposures to be compared in terms of total energy. This type of comparison assumes that sounds with equivalent total energy will have similar effects on exposed subjects, even if the sounds differ in SPL, duration and/or temporal exposure patterns. Sound exposure level likely over estimates TTS and PTS arising from complex noise exposures because it does not take varying levels and temporal patterns of exposure and recovery into account (Southall et al. 2007). Some support for the use of SEL to evaluate TTS and PTS has been shown for marine mammals (e.g., Finneran et al. 2002, 2005), and this measure will be referred to in the following sections of this document.

Temporary Threshold Shift (TTS)

Temporary threshold shift is the mildest form of hearing impairment that can occur during exposure to loud sound (Kryter 1985). It is not considered to represent physical injury, as hearing sensitivity recovers relatively quickly after the sound ends. It is, however, an indicator that physical injury is possible if the animal is exposed to higher levels of sound. The onset of TTS is defined as a temporary elevation of the hearing threshold by at least 6 dB (Schlundt et al. 2000). Several physiological mechanisms are thought to be involved with inducing TTS. These include reduced sensitivity of sensory hair cells in the inner ear, changes in the chemical environment in the sensory cells, residual middle-ear muscular activity, displacement of inner ear membranes, increased blood flow, and post-stimulatory reduction in efferent and sensory neural output (Kryter 1994; Ward 1997).

Very few data are available regarding the sound levels and durations that are necessary to cause TTS in marine mammals. Data are available for only three species of cetaceans and three species of pinnipeds. No data are available for mysticete species. No data are available for any free ranging marine mammals or for exposure to multiple pulses of sound during seismic surveys.

TTS in Odontocetes

Most studies of TTS in odontocetes have focused on non-impulsive sound, and all have been carried out on captive animals. A detailed review of all TTS data available for marine mammals can be found in Southall et al. (2007). The following is a summary of key results.

Finneran et al. (2005) measured TTS in bottlenose dolphins exposed to 3 kHz tones with various durations and SPL levels in a quiet pool. The amount of TTS was positively correlated with the SEL, and statistically significant amounts of TTS were observed for SELs > 195 dB re 1µPa^{2}s. These data agree with those reported by Schlundt et al. (2000) and Nachtigall et al. (2004) and support the use of 195 dB re 1µPa^{2}s as a threshold for TTS onset in dolphins and belugas exposed to mid-frequency sounds. Finneran et al. (2005) also found that each additional dB of SEL produced an additional 0.4 dB of TTS and that for TTS of 3-4 dB, recovery was nearly complete within 10 minutes post-exposure. For larger TTS, longer recovery times were required. The authors caution, however, that interpretation of TTS growth and recovery curves is hampered by the very small amounts of TTS measured relative to the variability of the measurements. They also note that not all exposures above a certain TTS threshold will cause TTS. For example, only 18% of exposures to an SEL of 195 dB re 1µPa2s resulted in measurable TTS.

Mooney et al. (2009a) measured TTS in a bottlenose dolphin exposed to octave-band non-impulse noise ranging from 4 to 8 kHz at SPLs of 130-178 dB re 1µPa for 1.88 to 30 min. The results of this study showed a strong positive relationship between SEL and the amount of TTS, however the relationship was not a simple equal energy relationship. When SEL was kept constant and exposure duration decreased, TTS did not stay constant, as expected by the equal energy rule. The amount and occurrence of TTS decreased as the duration of sound exposure decreased, so relative to longer duration exposures, shorter duration exposures required greater SELs to induce TTS. Recovery time also varied with both SPL and duration of sound exposure and followed a logarithmic function according to the amount of TTS. Similar results were reported by Mooney et al (2009b). The results of this work illustrate the importance of reporting both SPL and duration of sound exposure when evaluating TTS in odontocetes.

The TTS threshold for odontocetes exposed to a single impulse from a watergun appears to be lower than that for exposure to non-impulse sound (Finneran et al. 2000). An exposure SEL of 186 dB re 1µPa^{2}s resulted in mild TTS in a beluga whale. However, these measurements were made in the presence of band-limited white noise (masking noise), which may have resulted in a lower TTS than would have been observed in the absence of masking noise. Data from terrestrial mammals also show that broadband pulsed sounds with rapid rise times have a greater auditory effect than do non-impulse sounds (Southall et al. 2007). The rms level of an airgun pulse is typically 10-15 dB higher than the SEL for the same pulse when received within a few km of the airguns. A single airgun pulse might therefore need to have a received level of approx 196-201 dB re 1 µPa rms to produce brief, mild TTS. Exposure to several strong seismic pulses, each with a flat-weighted received level near 190 dB rms (175-180 dB SEL) could result in cumulative exposure of approximately 186 dB SEL and thus slight TTS in a small odontocete.

While the majority of TTS research has been conducted on bottlenose dolphins and beluga whales, one study involved another odontocete species, the harbor porpoise (Lucke et al. 2009). The TTS threshold for this harbor porpoise was lower than that measured for the larger odontocetes. TTS occurred in the harbor porpoise upon exposure to one airgun pulse with a received level of approximately 200 dB re 1 µPa pk-pk or an SEL of 164.3 dB re 1µPa^{2}s.

When estimating the amount of sound energy required for the onset of TTS, it is generally assumed that the effect of a given cumulative SEL from a series of pulses is the same as if that amount of sound energy were received as a single strong sound (Southall et al. 2007). However, some recovery may occur between pulses and it is not currently known how this may affect TTS threshold. In addition, more data are needed in order to determine the received levels at which odontocetes would start to incur TTS upon exposure to repeated, low-frequency pulses of air gun sound with variable received levels. For example, the total energy received by an animal will be a function of received levels of ai rgun pulses as an air gun array approaches, passes at various distances and moves away (e.g., Erbe and King 2009). Finally, as TTS threshold was lower for the harbor porpoise than for bottlenose dolphins or beluga whales, more data are needed regarding TTS thresholds in other odontocete species.

TTS in Pinnipeds

Temporary threshold shift has been measured for only three pinniped species: harbor seals, California sea lions, and northern elephant seals, and only one study has examined TTS in response to exposure to underwater pulses (Finneran et al. 2003). Of the three species for which data are available, the harbor seal exhibits TTS onset at the lowest exposure levels to non-pulsed sounds. A 25 minute exposure to a 2.5 kHz sound elicited TTS in a harbor seal at an SPL of 152 dB re 1 µPa (SEL 183 dB re 1µPa^{2}s), as compared to 174 dB re 1 µPa (SEL 206 dB re 1µPa^{2}s) for the California sea lion and 172 dB re 1 µPa (SEL 204 dB re 1µPa^{2}s) for the elephant seal (Kastak et al 2005).

The auditory response of pinnipeds to underwater pulsed sounds has been examined in only one study. Finneran et al. (2003) measured TTS onset in two captive California sea lions exposed to single underwater pulses produced by an arc-gap transducer. No measurable TTS was observed following exposures up to a maximum level of 183 dB re 1 µPapeak-to-peak (SEL 163 dB re 1µPa^{2}s). Finneran et al. (2003) suggest that the equal energy rule may apply to pinnipeds, however Kastak et al. (2005) found that for harbor seals, California sea lions and elephant seals exposed to prolonged non-impulse noise, higher SELs were required to elicit a given TTS if exposure duration was short than if it was longer. For example, for a non-impulse sound, doubling the exposure duration from 25 to 50 min (a 3 dB increase in SEL) had a greater effect on TTS than an increase of 15 dB (95 vs 80 dB) in exposure level. These results are similar to those reported by Mooney et al (2009a, b) for bottlenose dolphins and emphasize the need for taking both SPL and duration into account when evaluating the effect of sound exposure on marine mammal auditory systems.

Permanent Threshold Shift (PTS)

Permanent threshold shift is defined as 'irreversible elevation of the hearing threshold at a specific frequency (Yost 2000). It involves physical damage to the sound receptors in the ear and can be either total or partial deafness or impaired ability to hear sounds in specific frequency ranges (Kryter 1985). Some causes of PTS are severe extensions of effects underlying TTS (e.g. irreparable damage to sensory hair cells). Others involve different mechanisms, for example exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of inner ear fluids (Ward 1997; Yost 2000). The onset of PTS is determined by pulse duration, peak amplitude, rise time, number of pulses, inter-pulse interval, location, species and health of the receivers ear (Ketten 1994).

The relationships between TTS and PTS thresholds have not been studied in marine mammals and there is currently no evidence that exposure to air gun pulses can cause PTS in any marine mammal, however there has been speculation about that possibility (e.g. Richardson et al. 1995; Gedamke et al. 2008). In terrestrial mammals, prolonged exposure to sounds loud enough to elicit TTS can cause PTS. Similarly, shorter term exposure to sound levels well above the TTS threshold can also cause PTS (Kryter 1985). Terrestrial mammal PTS thresholds for impulse sounds are thought to be at least 6 dB higher than TTS thresholds on a peak-pressure basis (Southall et al. 2007). Also, pulses with rapid rise times can result in PTS even when peak levels are only a few dB higher than the level causing slight TTS.

Southall et al. (2007) used available marine mammal TTS data and precautionary extrapolation procedures based on terrestrial mammal data to estimate exposures that may be associated with PTS onset. For terrestrial mammals, TTS exceeding 40 dB generally requires a longer recovery time than smaller TTS, which suggests a higher probability of irreversible damage (Ward 1970) and possibly different underlying mechanisms (Kryter 1994; Nordman et al. 2000). Based on this, and the similarities in morphology and functional dynamics among mammalian cochleae, Southall et al. (2007) assumed that PTS would be likely if the hearing threshold was increased by more than 40 dB and assumed an increase of 2.3 dB in TTS with each additional dB of sound exposure. This translates to an injury criterion for pulses that is 15 dB above the SEL of exposures causing TTS onset. Finneran et al. (2002) found TTS onset in belugas exposed to a single pulse of sound at an SEL of 183 dB re 1µPa^{2}s. Therefore, according to the assumptions above, the PTS threshold would be approximately 198 dB re 1µPa^{2}s for a single pulse.

There are no data on the sound level of pulses that would cause TTS onset in pinnipeds. Southall et al. (2007) therefore assumed that known pinniped-to-cetacean differences in TTS-onset for non-pulsed sounds also apply to pulse sounds. Harbor seals experience TTS onset at received levels that are 12 dB lower than those required to elicit TTS in beluga whales (Kastak et al. 2005, Finneran 2002). Therefore, TTS onset in pinnipeds exposed to a single underwater pulse was estimated to occur at an SEL of 171 dB re 1µPa^{2}s. Adding 15 dB results in a PTS onset of 186 dB re 1µPa^{2}s for pinnipeds exposed to a single pulse. This is likely to be a precautionary estimate as the harbor seal is the most sensitive pinniped species studied to date and these results are based on measurements taken from a single individual (Kastak et al. 1999, 2005).

It is unlikely that a marine mammal would remain close enough to a large airgun array long enough to incur PTS. Some concern arises for bowriding dolphins, however the auditory effects of seismic pulses are reduced by Llyod's mirror and surface release effects. In addition, the presence of the ship between the bowriding animals and the airgun array may also reduce received levels (e.g. Gabriele and Kipple 2009). As discussed in the TTS section, the levels of successive pulses received by a marine mammal will increase and then decrease gradually as the seismic vessel approaches, passes and moves away, with periodic decreases also caused when the animal goes to the surface to breath, reducing the probability of the animal being exposed to sound levels large enough to elicit PTS.

General Effects of Oil Spill on Marine Mammals

Toxic substances, such as oil, can impact animals in the following ways: 1) acute toxicity caused by an event such as an oil spill can result in acute mortality or injured animals with neurological, digestive and reproductive problems and/or 2) can cause detrimental effects to the population through complex biochemical pathways that suppress the immune system or disrupt the endocrine system of the body causing poor growth, development, reproduction and reduced fitness (NMFS 2008b).

Evidence shows that cetaceans can see oil at the surface and some can detect it, often resulting in avoidance; however, some cetaceans have been observed swimming and foraging in the presence of oil. Therefore, cetacean's immediate reactions to oil spills vary depending on the behavioral state of the animal (Geraci 1990). The effects of an oil spill on beluga whales are largely unknown; however, based on evidence from other species, generalization can be made. Related affects from an oil spill on beluga whales could include death or injure from swimming through oil (skin contact, ingestion of oil, respiratory distress from hydrocarbon vapors), contaminated food sources or displacement from foraging areas (NMFS 2008a). Impacts from an oil spill on beluga whales depend on the extent and duration the animals are in contact with the oil and the characteristics of the oil (type and age; NMFS 2008b).

Oil has been implicated in the deaths of pinnipeds (St. Aubin 1990). Pinnipeds exposed to oil at sea through incidental ingestion, inhalation or limited surface contact do not appear greatly harmed by the oil; however, pinnipeds found close to the source or must emerge directly in oil appear substantially more affected. Fur seals pelts exposed to oil appear to lose thermal characteristics causing energetic stress. Additionally, individuals or groups of species that are compromised by preexisting disease or stress are more vulnerable when exposed to oil (St. Aubin 1990).

Toxic substances, such as oil, may be a contributing factor in the decline of Steller sea lion population (NMFS 2008b). Sea lions exposed to oil through inhalation, dermal contact and absorption, direct ingestion or through the ingestion of prey may become heavily contaminated with PAH's. The Exxon oil spill occurred after the decline began in Steller sea lion population; however, there were substantial mortalities from toxic contamination following the event. Twelve carcasses were discovered in Prince William Sound and 16 were found near Prince William Sound, Kenai coast and the Barren Island. The highest levels of PAHs were in the animals found dead after the spill (NMFS 2008b).

Increased vessel activity in the action area from the proposed Cook Inlet 3D Seismic Program will temporarily increase the risk of accidental oil spills. Accidental oil spills may occur from a vessel leak or if the vessel runs aground. Impacts from an oil spill on beluga whales or Steller sea lions in the action area will remain relatively small and will be minimized by maintaining safe operational and navigational conditions.

4.2.3. Effects on Socioeconomic Environment

4.2.3.1. Effects on Community and Economy

Under the Proposed Alternative, marine seismic activities in the Cook Inlet would be authorized to harass marine mammals' incidental to project activities. The proposed project is expected to have negligible, if any, effect to resident population, infrastructure, commercial fishing, shipping and boating, or oil and gas operations. Direct effects on social and economics of the region are likely to be temporary and localized. The most pronounced disturbance might be the slight increase of vessel and air traffic that will occur to support seismic survey activities.

The reasonable foreseeable effects on communities within the region include: increased temporary employment opportunities, increased revenue from food and lodging income, and profession contract work supporting seismic/exploration activities of the oil and gas industry.

4.2.3.2. Effects on Subsistence

Under the Proposed Alternative, marine seismic activities in the Cook Inlet is expected to have minor and temporary effects on subsistence wildlife and marine mammals in the area. Noise from seismic activities and array guns might temporarily displace wildlife from the area and increase hunting effort.

Residents of the Native Village of Tyonek are the primary subsistence users in Knik Arm area. The project should have any effect because no beluga harvest will take place in 2011 or 2012 and the area is not an important native subsistence site for other subsistence species of marine mammals.

Data on the harvest of other marine mammals in Cook Inlet are lacking. The only data available for subsistence harvest of harbor seals, harbor porpoises, and killer whales in Alaska are in the marine mammal stock assessments. However, these numbers are for the Gulf of Alaska including Cook Inlet, and they are not indicative of the harvest in Cook Inlet. Because the relatively small proportion of marine mammals utilizing Cook Inlet, the number harvested is expected to be extremely low. Therefore, because the proposed program would result in only temporary disturbances, the seismic program would not impact the availability of these other species for subsistence uses.

4.2.4. Estimation of Takes

4.2.4.1. Estimates of Marine Mammal Density

Estimated densities of marine mammals in the proposed project area were estimated from the annual aerial surveys conducted by NMFS for Cook Inlet beluga whale between 2000 and 2010 in June (Rugh et al. 2000, 2001, 2002, 2003, 2004b, 2005b, 2006, 2007; Shelden et al. 2008, 2009, 2010). These surveys are flown in June to collect abundance data of beluga whales, but sightings of other marine mammals are also reported. Although these data are only collected in one month each year, these surveys provide the best available relatively long term data set for sighting information in the proposed Project Area. The general trend in marine mammal sighting is that beglua whales and harbor seals are seen most frequently in upper Cook Inlet, with higher concentrations of harbor seals near haul out sites on Kalgin Island and of beluga whales near river mouths, particularly the Susitna River. The other marine mammals of interest for this IHA (killer whales, harbor porpoises, Steller sea lions) are observed infrequently in upper Cook Inlet and more commonly in lower Cook Inlet. In addition, these densities are calculated based on a relatively large area that was surveyed, much larger than Area 1, the proposed semisic area in the first year. Furthermore, these annual surveys are conducted only in June (numbers from August surveys were not used because the area surveyed was not provided), so it does not account for seasonal variations in distribution or habitat use of each species. Therefore, the use of these data to estimate density is extremely conservative and provides a worst-case estimate of the probability of observing these animals in the Project Area, which is located in upper Cook Inlet.

Table 5 provides a summary of the results of each annual survey conducted from between 2000 and 2010 in June. The total number of individuals sighted for each survey by year is reported, as well as total hours for the entire survey and total area surveyed. To estimate density of marine mammals, the total number of animals observed for the entire survey by year (surveys usually last several days) was divided by the total number of hours for each aerial survey by the approximate total area surveyed for each year (density = individuals/hr/km^2). As noted previously, the total number of animals observed for the entire survey includes both lower and upper Cook Inlet, so the total number reported and used to calculate density is higher than the number of marine mammals anticipated to be observed in Area 1. In particular, the total number of harbor seals observed on several surveys is very high due to several large haul outs in lower and middle Cook Inlet.

As discussed previously and shown in Table 5, beluga whales are observed in higher concentrations in river mouths, particularly Susitna River, due to feeding. Therefore, to account for the higher concentration near river mouths, the highest number of beluga whales observed for each year (which was always in the Susitna River delta) was used to provide a density for river mouths. To account for the lower concentration away from river mouths, the average number of beluga whales observed for each year was used to provide density away from river mouths. The maximum and average of the total years (2000-2010) is provied in Table 6. A maximum and average density are provided to account for the inherent level of uncertainty in using aerial surveys conducted a few days once a year to estimate density for the entire year. These densities will be used to estimate the number of Level B takes in the following section.

Table 5. Density of Marine Mammals from NMFS Annual Aerial Surveys

Location	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Beluga whales											
Turnagain Arm (north and east of Chickaloon Bay)	0	34	0	0	50	21	0	76	0	0	4
Chickaloon Bay to Pt. Possession	28	0	11	64.5	65	66	60	50	33	40	131
Mid-Inlet east of Trading Bay	0	0	0	0	0	0	15	0	0	0	9
East Foreland to Homer	0	0	0	0	0	0	0	0	0	0	0
Susitna Delta (N. Foreland to Pt. Mackenzie)	114	175	93	109.8	41	155	126	152	103	290	160
Knik Arm	42	0	88	0	0	43	9	23	0	0	0
Fire Island	0	0	0	0	0	16	0	2	0	0	9
Harbor seals (total observed)	1800	672	1481	974	975	633	887	393	1219	387	543
Harbor porpoise (total observed)	29	0	0	0	100	2	0	4	6	32	9
Killer whales(total observed)	0	15	0	0	0	0	0	0	0	0	33
Steller sea lions (total observed)	10	0	54	76	1	104	3	0	75	39	1
Number of hours surveyed (hrs)	43	55	45	61	45	54	58.4	47.2	47.7	39.4	48.4
Total area surveyed (km^2)	6500	5200	5244	5100	6000	5500	6723	5255	7172	5766	6120
Density (number of animals / number of hrs / area surveyed)											
Belugas (avg number observed)	0.00006	0.00007	0.00007	0.00005	0.00005	0.00009	0.00005	0.00011	0.00004	0.00015	0.00010
Belugas (max number observed - rivers)	0.00041	0.00061	0.00039	0.00035	0.00024	0.00052	0.00032	0.00061	0.00030	0.00128	0.00054
Harbor seals (total number observed)	0.00644	0.00235	0.00628	0.00313	0.00361	0.00213	0.00226	0.00158	0.00356	0.00170	0.00183
Harbor porpoise (total number observed)	0.00010	0.00000	0.00000	0.00000	0.00037	0.00001	0.00000	0.00002	0.00002	0.00014	0.00003
Killer whales (total number observed)	0.00000	0.00005	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00011
Steller sea lions (total number observed)	0.00004	0.00000	0.00023	0.00024	0.00000	0.00035	0.00001	0.00000	0.00022	0.00017	0.00000

Table 6. Summary of Density of Marine Mammals

	Density (number/km²)	
Species	**max**	**avg**
Beluga whale (avg number observed)	0.00103	0.00026
Beluga whale (max number observed - rivers)	0.00770	0.00154
Harbor seal (total number observed)	0.00644	0.00317
Harbor porpoise (total number observed)	0.00037	0.00006
Killer whale (total number observed)	0.00011	0.00001
Steller sea lion (total number observed)	0.00035	0.00011

4.2.4.2. Calculation of Takes

The estimated number of marine mammals that may be potentially harassed during the seismic surveys was calculated by multiplying the expection densities discussed in the previous section (in individuals/hr/km^2) by the anticipated area ensonified by levels ≥160 dB re µPa rms by the number of expected days that will be surveyed seismically in Area 1. As discussed in Section 2, Apache anticipates that a crew will collect seismic data 10-12 hours per day over approximately 160 days over the course of 8 to 9 months. It was assumed that over the course of this 160 days, 100 days would be working in the offshore region and 60 days in the shallow, intermediate, and deep nearshore region. Of those 60 days in the nearshore region, 20 days would be in each depth. Because operations would occur over 12 hours per day, the total number of days for each region was divided by two (or half a day) for purposes of calculating takes. It is important to note that environmental conditions (such as ice, wind, fog) will play a significant role in the actual operating days; therefore, these estimates are conservative in order to provide a basis for probability of encountering these marine mammal species in the project area. The number of estimated takes by harassment was calculated using the following assumptions:

- The number of nearshore and shallow water survey days is 10 (20 days/12 hours) and daily acoustic footprint is 356 km^2.
- The number of nearshore and intermediate water depth survey days is 10 (20 days/12 hours) and daily acoustic footprint is 468 km^2.
- The number of nearshore and deep water depth survey days is 10 (20 days/12 hours) and daily acoustic footprint is 455 km^2.
- The number of offshore survey days is 50 (100 days/12 hours) and daily footprint is 389 km^2.

Table 7 shows the estimated maximum and average takes by species for the first year of the program in Area 1 with the methods and assumptions outlined above. As noted previously, the use of the NMML aerial survey data has inherent weaknesses that need to be discussed further. The estimated number of takes by harassment of harbor seals is higher than what is anticipated in the first year of the proposed program, as there are no reported large haul out sites in the Area 1. Seals in some numbers are expected to be observed in the Susitna River delta, but not in the large numbers that are observed in the lower Cook Inlet. These density estimates are skewed by the numbers observed in large haul outs on the aerial surveys; seals on land would not be exposed to in-water sounds during that time. Seals in the water usually travel in small groups or as singles. Therefore, although Table 7 indicates an average of 102 and maximum of 207 seals to be harassed, it is highly unlikely that those numbers of seals would be taken by harassment during seismic operations.

For many of the same reasons discussed above for harbor seals, the number of actual takes by harassment of Steller sea lions are expected to be much lower than the average of 4 and maximum of 11. In all of the NMML aerial surveys, no Steller sea lions were observed in upper Cook Inlet. Less than five Steller sea lions have been observed by the Port of Anchorage monitoring program, and those observed have been single, juvenile animals (likely male). Apache anticipates less than five Steller sea lions in the project area in the first year.

The average and maximum take estimates for the harbor porpoise and killer whales shown in Table 7 appear to be reasonable based on the NMFS aerial surveys, although the actual number of animals observed is expected to be low.

The average and maximum estimated number of takes by harassment for beluga whales away from river mouths in the first year of the program is 2 and 5, respectively. Given that belugas are usually transiting from one feeding area to another in lower concentrations, these estimates appear to be reasonable in assessing probability of beluga whales potentially observed. However, it is important to note that a combination of visual and acoustic monitoring will be used extensively throughout this project, particularly for sighting beluga whales approaching the operations, so the actual number of takes is expected to be lower than these estimates for beluga whales away from river mouths.

The average and maximum estimated number of takes by harassment for beluga whales near river mouths is at 16 and 41 whales, respectively. It is very important to note that Apache will implement a rigorous monitoring program when conducting seismic operations near river mouths during periods of high potential for encountering beluga whales, consisting of both vessel and aerial visual and acoustic monitoring. Apache commits to shutting down air guns when beluga whales are observed to be approaching the 160 dB threshold to minimize and avoid takes of beluga whales to the greatest extent possible. Furthermore, the total number of days actually surveying near river mouths is much lower than the 160 days used to estimate takes in these different water depths, so this take estimate is extremely conservative. Therefore, due to actual number of days and hours likely to be operating air guns near river mouths and the strict monitoring and mitigation measures to be used when operating near rivers, the actual number of takes by harassment estimated for beluga whales is expected to be extremely low, much lower than the numbers in Table 7.

Table 7. Estimated Takes per Species for First Year

Species	shallow		mid-depth		deep		offshore		Total	
	max	avg	max	avg	max	avg	max	avg	max	avg
Beluga whales – away from river mouths	0.5	0.3	0.7	0.3	0.7	0.3	2.8	1.5	4.7	2.4
Beluga whales – near river mouths	4.5	1.8	5.8	2.3	5.8	2.3	24.8	9.9	41.0	16.3
Harbor seals	22.9	11.3	29.5	14.5	29.3	14.4	125.3	61.7	207.0	101.9
Harbor porpoises	1.3	0.2	1.7	0.3	1.7	0.3	7.2	1.2	11.9	2.0
Killer whales	0.4	0.1	0.5	0.1	0.5	0.1	2.2	0.3	3.6	0.5
Steller sea lions	1.2	0.4	1.6	0.5	1.6	0.5	6.8	2.2	11.3	3.7

Notes:
Shallow water (5-21 m): area ≥ 160 dB re 1 µPa rms = 356 km^2, number of days = 10
Intermediate water (21-38 m): area ≥ 160 dB re 1 µPa rms = 458 km^2, number of days = 10
Deep water (38-54 m): area ≥ 160 dB re 1 µPa rms = 455 km^2, number of days = 10
Offshore: area ≥ 160 dB re 1 µPa rms = 389 km^2, number of days = 50

Takes estimated by multiplying density (# animals/hour/km^2) from NMFS June surveys 2000-2010 by area ensonified ≥ 160 dB re 1 µPa rms from JASCO by number of days estimated to be seismically surveyed.

4.2.4.3. Summary of Requested Takes

Based on the discussion and estimates above, Apache requests the following number of takes by harassment by species for the first year of the program in Area 1 (Table 8). The abundance of the population, as summarized in Section 3, is also provided with the calculated percent of the population that will be temporarily behaviorally disturbed during seismic operations. As shown in the table, the percent of all species requested to be taken by harassment is less than 10% of the population. Therefore, NMFS anticipates there will be no more than a negligible impact on small numbers of marine mammals during the seismic operations.

Table 8. Requested Number of Takes

Species	Number of Requested Takes	Population Abundance	Percent of Population
Beluga whales	30	355	8.45%
Harbor seals	50	29,175	0.17%
Harbor porpoises	20	31,406	0.06%
Killer whales	10	1,123	0.89%
Steller sea lions	20	41,197	0.12%

Note: population abundance summarized in Section 3

4.2.5. Cumulative Effects

Cumulative effect is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably forseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7).

4.2.5.1. Pollution

As the population in urban areas continue to grow, an increase in amount of pollutants that enter Cook Inlet is likely to occur. Sources of pollutants in urban areas include runoff from streets and discharge from wastewater treatment facilities. Gas, oil, and coastal zone development projects (e.g., the Chuitna Coal Mine) also contribute to pollutants that enter Cook Inlet through discharge. Gas, oil, and coastal zone development will continue to take place in Cook Inlet; therefore, it would be expected that pollutants could increase in Cook Inlet. However, the EPA and the ADEC will continue to regulate the amount of pollutants that enter Cook Inlet from point and non-point sources through NPDES permits. As a result, permitees will be required to renew their permits, verify they meet permit standards and potentially upgrade facilities. Additionally, the extreme tides and strong currents in Cook Inlet may contribute in reducing the amount of pollutants found in the Inlet.

4.2.5.2. Fisheries Interaction

Fishing is a major industry in Alaska. As long as fish stocks are sustainable, subsistence, personal use, recreational and commercial fishing will continue to take place in Cook Inlet. As a result there will be continued prey competition, risk of ship strikes, potential harassment, potential for entanglement in fishing gear and potential displacement from important foraging habitat for the Cook Inlet beluga whales. NMFS and the ADF&G will continue to manage fish stocks and monitor and regulate fishing in Cook Inlet to maintain sustainable stocks.

4.2.5.3. Gas and Oil Development

Most of the existing gas and oil development occurs in the action area and it is likely that future gas and oil development will continue to take place in the action area. Impacts from gas and oil development include increased noise from seismic activity, vessel and air traffic and well drilling; discharge of wastewater; habitat loss from the construction of oil and gas facilities; and contaminated food sources and/or injury from a natural gas blowout or oil spill. The risk of these impacts may increase as oil and gas development increases; however, new development will undergo consultation prior to exploration and development.

Support vessels are required for gas and oil development to transport supplies and products to and from the facilities. Not only will the support vessels from increased gas and oil development likely increase noise in the action area, there is a potential for increased ship strikes with beluga whales.

4.2.5.4. Coastal Zone Development

Coastal zone development may result in the loss of habitat, increased vessel traffic, increased pollutants and increased noise associated with construction and noise associated with the activities of the projects after construction. In the action area, two main projects are being considered, the Chuitna Coal Mine and the ORPC Tidal Energy Project. The POA is currently expanding their facilities and Port MacKenzie is scheduled to expand their facilities. Both port facilities may have an effect on beluga whales in the action area due to increased vessel traffic passing through the area on their way to both facilities.

Port of Anchorage and Port MacKenzie Expansions

The POA and Port MacKenzie in upper Cook Inlet are either currently expanding or scheduled to expand their facilities. These ports will contribute to increased vessel traffic throughout Cook Inlet. The POA is expanding its facilities to accommodate increased growth in Alaska and to support military services at

JBER. In the next five years at Port MacKenzie a fuel tank farm, the Rail Extension, and a deep draft dock are scheduled for construction. The Rail Extension would connect Port MacKenzie to the Alaska Railroad Corporation's existing mainline between Wasilla and Willow, providing freight service between Port MacKenzie and Interior Alaska. Port MacKenzie will be exporting coal from Healy, Alaska with the construction of the Rail Extension. The fuel tank farm is scheduled to be completed by fall 2012 and the Rail Extension should be completed by 2014. Additionally, Port MacKenzie is currently preparing permits to construct a deep draft dock. As a result, number of ships calling to port at Port MacKenzie is expected to increase over the next five years. Increased vessel traffic may result in increased in water noise and potential ship strikes with beluga whales.

Chuitna Coal Project

The Chuitna Coal Project is located within the action area of the proposed Cook Inlet 3D Seismic Program. PanRim Coal, LP is proposing to develop, construct and operate a coal mine and export facility 19 km (12 mi) northwest of the Village of Tyonek. Potential impacts on the Cook Inlet beluga whale from the Chuitna Coal Project would include the construction of the coal export facility and surface water discharge. The coal export facility that includes an overland coal conveyer and ship loading berth would extend from shore into Cook Inlet. The conveyer and ship berth would incorporate tower sites approximately 335 m (1,100 ft) apart to allow for uninhibited movement of marine life (PamRim Coal, LP 2011). No chemical or water-based processing of the coal would take place; therefore, the expected sources of discharge from the project would include rainfall, snowmelt and groundwater (PamRim Coal, LP 2011). Prior to discharging water into Cook Inlet, the water would be directed to sediment control structures and meet the water quality criteria described by the Alaska Pollutant Discharge Elimination Systems permit (PamRim Coal, LP 2011).

ORPC Alaska Tidal Energy Projects

ORPC is proposing two tidal energy projects in Cook Inlet. The first tidal energy project would be located on the Westside of Fire Island near Anchorage and the second project would be located adjacent to the East Foreland in the vicinity of Nikiski on the Kenai Peninsula (ORPC 2011). The tidal energy projects would require the installation of an array of turbine generator units and transmission cables on the seafloor to harness the tidal energy. The tidal energy will be converted to electrical energy at stations on land. These projects are still in preliminary testing and environmental monitoring phases (ORPC 2010, ORPC 2011).

4.2.5.5. Research

Research is important for understanding the ecology and biology of the Cook Inlet beluga whale. Although, research activities could potentially kill, injure, harass or change behavior of beluga whales, impacts from many individual and multiple threats are unknown, therefore, it is important for research to continue in order to fill gaps in the data.

4.2.5.6. Conclusion

Based on the analyses provided in this section, NMFS believes that the proposed Apache seismic survey in Cook Inlet would not be expected to add significant impacts to overall cumulative effects on marine mammals from past, present, and future activities. The potential impacts to marine mammals and their habitats are expected to be minimal based on the limited noise footprint and mitigation and monitoring.

Chapter 5 Mitigation Measures

5.1. Standard Mitigation Measures

The primary marine mammal species potentially exposed to seismic sounds during the seismic program will be beluga whales, harbor seals, and harbor porpoises. There are no known rookeries, mating grounds, or areas of similar significance in the project area. The following text describes the proposed measures to minimize takes by harassment. The monitoring plan is discussed in more detail in Section 6.

5.1.1. Vessel-Based Monitoring

Vessel-based PSOs will monitor marine mammals at the seismic program during all daytime air gun operations. These observations will provide the real-time data needed to implement some of the key mitigation measures. When marine mammals are observed within, or about to enter, designated shut-down safety zones (see below) where there is a possibility of significant effects on hearing or other physical effects, air gun operations will be powered down (or shut down if necessary) immediately. Mitigation measures will be communicated by the PSO on the source vessel to the air gun operators and vessel captain/crew.

During daytime operations, vessel-based PSOs will watch for marine mammals at the project location during all periods of seismic operations and for a minimum of 30 minutes prior to the planned start of air gun operations after an extended shut down. PSOs will also observe opportunistically during daylight hours when no seismic activity is taking place.

Apache proposes to conduct both daytime and nighttime operations. Nighttime operations can be initiated only if a mitigation gun has been continuously operational from the time that the PSO monitoring ended. Seismic activity will not ramp up from an extended shutdown during nighttime operations. PSOs will not monitor during seismic operations at night. Vessel captain and crew will watch for marine mammals (insofar as practical at night) and will call for the air gun(s) to be shut down if marine mammals are observed in or about to enter the safety radii. After a shut down during night operations, seismic activity will be suspended until the followint day and the full safety zone is visible.

5.1.2. Proposed Safety Radii

In order to avoid any takes by injury (Level A), Apache proposes to shut down air guns or positioning pingers in the event a marine mammal approaches the 180 or 190 dB injury sound level zone and monitor the 160 dB harassment sound level zone to shut down if large groups of animals approach. Apache proposes to shut down if a group of more than five beluga whales is sighted within the 160 dB harassment sound level zone. Apache also proposes to shut down if a beluga whale calf is sighted approaching or within the 160 dB harassment zone.

As discussed in detail in Appendix A, received sound levels for determining safety zones were obtained for the 2010 APACHE test program. Distances to the 190, 180, and 160 dB with the 440 and 2400 cui air gun configurations and pinger were estimated These estimates are provided in Table 9.

Table 9. Summary of Distance to NMFS Sound Level Thresholds

Source	190 dB	180 dB	160 dB
Pinger	1 m	3 m	25 m
10 cui air gun	10 m	33 m	330 m
2400 cui air gun (nearshore)	0.51 km	1.42 km	6.41 m
2400 cui air gun (offshore)	1.18 km	0.98 km	4.89 km

Apache proposes to monitor these zones for marine mammals before, during, and after the operation of the offshore air guns and pingers. Monitoring will be conducted using qualified PSOs on three vessels and a boat-based and fixed real-time passive acoustic monitoring (PAM), as discussed in Section 6.

5.1.3. Power Down Procedure

A power down procedure involves reducing the number of air guns in use such that the radius of the 180 dB (or 190 dB) zone is decreased to the extent that marine mammals are not in the safety zone. In contrast, a shut down procedure occurs when all air gun activity is suspended. During a power down, a mitigation air gun, typically the 10 cui, is operated. Operation of the mitigation gun allows the safety radii to decrease to 10 m, 33 m, and 330 m for the 190 dB, 180 dB, and 160 dB zones, respectively. If a marine mammal is detected outside the safety radius (either injury or harassment) but is likely to enter that zone, the air guns may be powered down before the animal is within the safety radius, as an alternative to a complete shut down. Likewise, if a marine mammal is already within the harassment safety zone when first detected, the air guns will be powered down immediately if this is a reasonable alternative to a complete shut down. If a marine mammal is already detected within the injury safety zone when first detected, the air guns will be shut down immediately.

Following a power down, air gun activity will not resume until the marine mammal has cleared the safety zone. The animal will be considered to have cleared the safety zone if it:

- Is visually observed to have left the safety zone, or
- Has not been seen within the zone for 15 min in the case of pinnipeds and harbor porpoise, or
- Has not been seen within the zone for 30 min in the case of cetaceans.

5.1.4. Shut-down Procedure

As noted previously, a shut-down occurs when all air gun activity is suspended. The operating air gun (s) and/or pinger will be shut down completely if a marine mammal approaches the applicable injury safety zone. The shutdown procedure will be accomplished within several seconds (of a “one shot” period) of the determination that a marine mammal is either in or about to enter the safety zone.

Air gun activity will not resume until the marine mammal has cleared the safety radius. Following a shut-down, air gun activity will not resume until the marine mammal has cleared the safety zone. The animal will be considered to have cleared the safety zone if it:

- Is visually observed to have left the safety zone;
- Has not been seen within the zone for 15 min in the case of pinnipeds or harbor porpoise;
- Has not been seen within the zone for 30 min in the case of cetaceans.

5.1.5. Ramp-up Procedure

A "ramp up" procedure gradually increases air gun volume at a specified rate. Ramp up is used at the start of air gun operations, including a power down, shut down, and after any period greater than 10 minutes in duration without air gun operations. the air gun array begins operating after a specified-duration period without air gun operations. NMFS normally requires that the rate of ramp up be no more than 6 dB per 5 minute period. Ramp up will begin with the smallest gun in the array that is being used for all air gun array configurations. During the ramp up, the safety zone for the full air gun array will be maintained.

If the complete safety radius has not been visible for at least 30 minutes prior to the start of operations, ramp up will not commence unless the mitigation gun has been operating during the interruption of seismic survey operations. This means that it will not be permissible to ramp up the 24-gun source from a complete shut-down in thick fog or at other times when the outer part of the safety zone is not visible. Ramp up of the air guns will not be initiated if a marine mammal is sighted within or near the applicable safety radii at any time.

5.1.6. Speed or Course Alteration

If a marine mammal is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or direct course may, when practical and safe, be changed that also minimizes the effect on the seismic program. This can be used in coordination with a power down procedure. The marine mammal activities and movements relative to the seismic and support vessels will be closely monitored to ensure that the marine mammal does not approach within the safety radius. If the mammal appears likely to enter the safety radius, further mitigative actions will be taken, i.e., either further course alterations, power down, or shut down of the air gun(s).

5.2. Subsistence Mitigation Measures

Apache met with the Cook Inlet Marine Mammal Council (CIMMC) to describe the Project activities and discuss subsistence concerns on March 29, 2011. The meeting provided information on the time, location, and features of the proposed 3D program, opportunities for involvement by local people, potential impacts to marine mammals, and mitigation measures to avoid impacts.

In addition, Apache met with the Tyonek Native Corporation on November 9, 2010 and the Salamatof Native Corporation on November 22, 2010. No concerns were raised regarding potential conflict with subsistence harvest.

The features of the test should prevent any adverse effects on the availability of marine mammals for subsistence.

- In-water seismic activities will follow mitigation procedures to minimize effects on the behavior of marine mammals and; therefore, opportunities for harvest by Alaska Native communities.

- Regional subsistence representatives may support recording marine mammal observations along with marine mammal biologists during the monitoring program and be provided annual reports.
- The size of the affected area, mitigation measures, and input from the CIMMC should result in the test program having no effect on the availability of marine mammals for subsistence uses.

Chapter 6 Monitoring and Reporting Requirements

6.1. Visual Monitoring

6.1.1. Visual Boat-Based Monitoring

Three vessels will employ PSOs to identify marine mammals during all daytime hours of air gun operations: the two source vessels (*M/V Peregrine Falcon* and *M/V Arctic Wolf*) and one support vessel (*M/V Dreamcatcher*). Two PSOs will be on the source vessels and two PSOs on the support vessel in order to better observe the safety, power down, and shut down areas. When marine mammals are about to enter or are sighted within designated safety zones, air gun or pinger operations will be powered down (when applicable) or shut down immediately. The vessel-based observers will watch for marine mammals at the seismic operation during all periods of source effort and for a minimum of 30 minutes prior to the planned start of air gun or pinger operations after an extended shut down. Apache personnel will also watch for marine mammals (insofar as practical) and alert the observers in the event of a sighting. Apache personnel will be responsible for the implementation of mitigation measures only when a PSO is not on duty (e.g., nighttime operations).

Seismic operations will not be initiated or continue when adequate observation of the designated safety zone is not possible due to environmental conditions such as high sea state, fog, ice and low light. Termination of seismic operations will be at the discretion of the lead PSO based on continual observation of environmental conditions and communication with other PSOs.

With NMFS consultation, PSOs will be hired by Apache. Apache will provide the curriculum vitae and references for all PSOs. PSOs will follow a schedule so observers will monitor marine mammals near the seismic vessel during all ongoing operations and air-gun ramp ups. PSOs will normally be on duty in shifts no longer than 4 hours with 2 hour minimum breaks to avoid observation fatigue. The vessel crew will also be instructed to assist in detecting marine mammals and implementing mitigation requirements (if practical). Before the start of the seismic survey the crew will be given additional instruction on how to do so.

The source and support vessels are suitable platform for marine mammal observations. When stationed on the flying bridge, the observer will have an unobstructed view around the entire vessel. If surveying from the bridge, the observer's eye level will be about 6 m (20 ft) above sea level. During operations, the PSO(s) will scan the area around the vessel systematically with reticle binoculars (e.g., 7 × 50 or equivalent) and with the naked eye. Laser range finders (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. They are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly.

All observations mitigation measures will be recorded in a standardized format. Data will be entered into a custom database using a notebook computer. The accuracy of the data entry will be verified by computerized validity data checks as the data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to statistical, graphical, or other programs for further processing and archiving.

Results from the vessel-based visual observations will provide:

- The basis for real-time mitigation (air gun shut down, power down, and ramp up).
- Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted.
- Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity.
- Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

6.1.2. Visual Shore-Based Monitoring

In addition to the vessel-based PSOs, Apache proposes to utilize a shore-based station when possible. The shore-based station will follow all safety procedures, including bear safety. The shore-based location will need to have sufficient height to observe marine mammals; the PSO would be outfitted on scaffolding with big-eye binoculars. The PSO would scan the area prior to, during, and after the air gun operations. The PSO would be in contact with the other PSOs on the vessels, as well as the source vessel operator via radio to be able to communicate the sighting of a marine mammal approaching or sighted within the project area.

6.1.3. Aerial-Based Monitoring

When practicable, Apache proposes to utilize the crew helicopter to conduct aerial surveys near river mouths prior to the commencement of operations in order to identify locations of congregations of beluga whales. ***The helicopter will not be used every day, but will be used when operating near a river mouth***. The types of helicopters currently planned to be used by Apache include a Bell 407, Bell UH1B, and ASB3. Aerial surveys will fly at an altitude of 305 m (1,000 ft) when practical and weather conditions permit. In the event of a marine mammal sighting, aircraft will attempt to maintain a radial distance of 457 m (1,500 ft) from the marine mammal(s). Aircraft will avoid approaching marine mammals from head-on, flying over or passing the shadow of the aircraft over the marine mammals. Using these operational requirements, sound levels underwater are not expected to reach NMFS harassment thresholds (Richardson et al. 1995; Blackwell et al. 2002).

Results from the aerial and shore-based observations will provide:

- The basis for real-time mitigation (air gun power down, shut down, and ramp up).
- Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted.
- Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity.
- Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity. When practicable, Apache proposes to utilize the crew helicopter to conduct aerial surveys of areas near river mouths prior to the commencement of operations. These surveys will assist in the identification of congregations of beluga whales.

6.2. Acoustic Monitoring

In order to further enhance detection of cetaceans, Apache proposes to utilize passive acoustic monitoring (PAM). The actual PAM system has not yet been identified, but Apache anticipates utilizing similar real-time systems as used in the 2D test program in March, 2011 in Cook Inlet.

6.2.1. Fixed PAM Stations

During the March 2011 2D test, Apache planned to deploy two JASCO Advanced Multichannel Acoustic Recorders (AMAR) systems in surface buoys on anchored moorings. The AMARs send real-time acoustic data via digital UHF radio-broadcast systems to the PAM operators aboard the *M/V Dreamcatcher*. However, it was determined that the buoys were not able to deployed when ice was present. Therefore, deploying the buoy to be moored on the M/V Dreamcatcher with a PAM operator on board was successful in obtaining real-time acoustic data.

If there is no ice present, the real-time system will be deployed to be monitored by the PAM operator on the Dreamcatcher far enough away from the source vessels to allow for detection of marine mammals, but close enough so that the PSOs can observe the distance in between the source vessels and the Dreamcatcher.

The PAM operators will use specialized real-time detection software and audio playback to detect marine mammal sounds. If the PAM operators detect marine mammals, Apache will initiate a temporary shut-down of air gun systems to avoid takes. Restarting of the air gun systems would occur as defined in Section 5.

Proposed Locations

Based on results of the test program, these buoys are not deployable when there is ice present. However, the buoys were operational when anchored on the crew boat (M/V Dreamcatcher) and signals of beluga whales were detectable up to 8 km. Therefore, if ice conditions allow, the PAM systems will be located inside the exclusion zone boundary in both the up-inlet and down-inlet directions. The boundaries are predicted to occur at between 4400 m and 5700 m from the sources, depending on air gun array configuration. Detection ranges for beluga whales are nominally a maximum of 2 km for whistles and 500 m for clicks, although much greater ranges for whistle detections have been achieved with AMARs (>8 km in the Cook Inlet in the spring test program). We propose to locate the PAM moorings in the middle of the inlet at 1 km inside the exclusion zone boundaries both east and west of the survey sites. This approach will be able to detect whistles from animals just entering the exclusion zone and well into the zone. It has the added benefit of providing coverage closer to the air gun sources to identify animals that may have eluded visual observers near the boundary. Prior to the start of the test program, Apache will work to identify the best location for the fixed PAMs to allow for monitoring of the safety zone.

If there is ice present, the PAM system will be deployed from the M/V Dreamcatcher.

Acoustic Systems and Frequencies

If selected, we will use JASCO's AMAR-G2 digital acoustic recording/streaming systems (Figure 17). The AMARs will be set to digitally sample at 100 kHz (depending on quality of radio link at the site) with 24-bit samples, in order to capture both whistles and clicks. These sample rates capture acoustic frequencies up to 16 and 32 kHz respectively. Killer whale calls occur primarily between 400 Hz and 15 kHz. Beluga whistles occur primarily between 3 kHz and 11 kHz. Clicks for both species occur primarily in the 10 kHz to 50 kHz band. Both sample rates will effectively capture the full range of call and whistle frequencies but the higher 64 kHz sample rate is required to capture the significant bandwidth of clicks. Calls and whistles are detectable to larger ranges so are the more important signal of interest here. However, only clicks may be present while the animals are feeding. Belugas may not vocalize when killer whales are present to avoid detection.

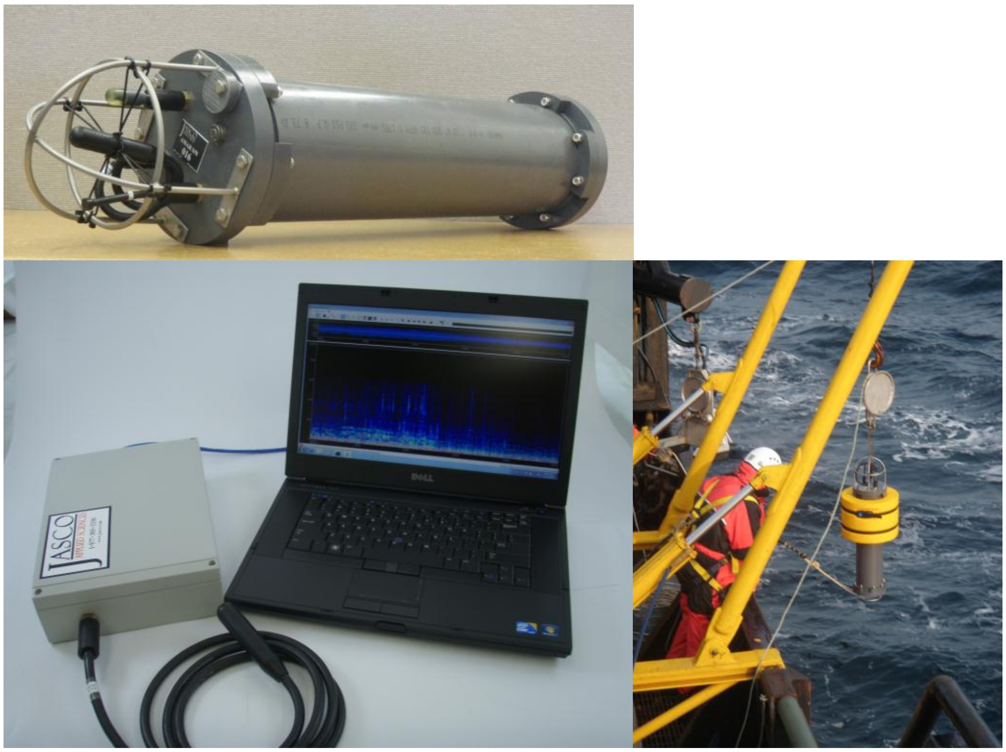

Figure 17: AMAR Recorders. In pressure case (top and right) and in deck box (left-bottom)

Radio Telemetry Acoustic Buoys

The AMAR deck box units (Figure 17, bottom left) with batteries will be mounted in surface-buoys that also support the radio telemetry systems. The buoys gave 12-ft masts on which the telemetry antennas are mounted. These buoys are highly visible so will reduce the risk of collision by support vessels working nearby.

The radio telemetry system provides high-bandwidth TCP-IP connectivity direct to the AMAR recorder from a base station located on nearby vessels. The AMAR has built in ability to stream data through the radio's TCP-IP channels. The buoy's radio system will be a 5 GHz 1000 mW 802.11b/g/N extended range outdoor TCP/IP link. The radio telemetry system includes LS5 transmitting radios (Figure 18, left) with whip-style antennas on the buoys. AirMax base stations (Figure 18, right) will be mounted on the work boats where the PAM operators will work. The LS5 radio is designed for multi-kilometer marine telemetry links. The present application will use shorter distances so very good performance is expected even in poor weather conditions.

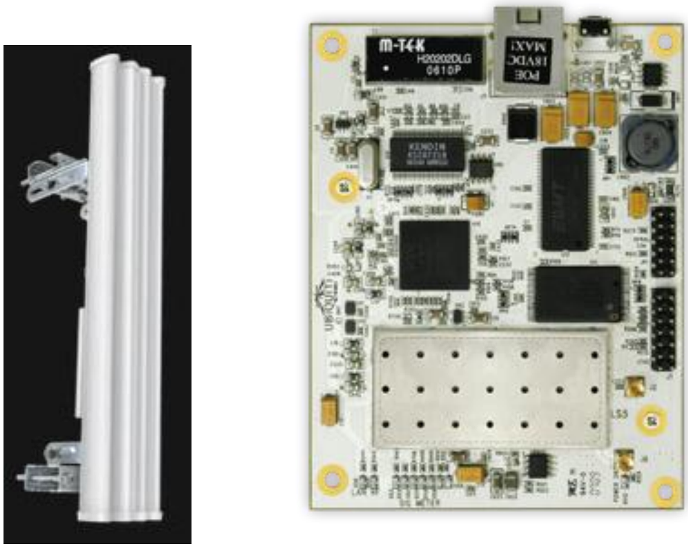

Figure 18: Radio system base station (built into antenna at left) and buoy radio transmitter at right. A co-linear array whip antenna will be mounted on a standard seismic streamer tail-buoy and connected to the transmitter which will be housed in a small pressure case at the buoy.

Real-Time Data Display and Logging

Acoustic data received at the buoys will be streamed back to the work boats over the radio links. These data will be directly displayed in a scrolling spectrogram format and audio played out to a speaker and headphone system using JASCO's standard SpectroPlotter software (Figure 19). The software also logs data to acoustic files in PCM WAV format. We will log all recorded data for possible post-processing (not included in this application).

SpectroPlotter will run on ruggedized field laptop computers connected directly to the radio-link system. The PAM operators will utilize the displays to assist in detections of beluga and killer whale sounds.

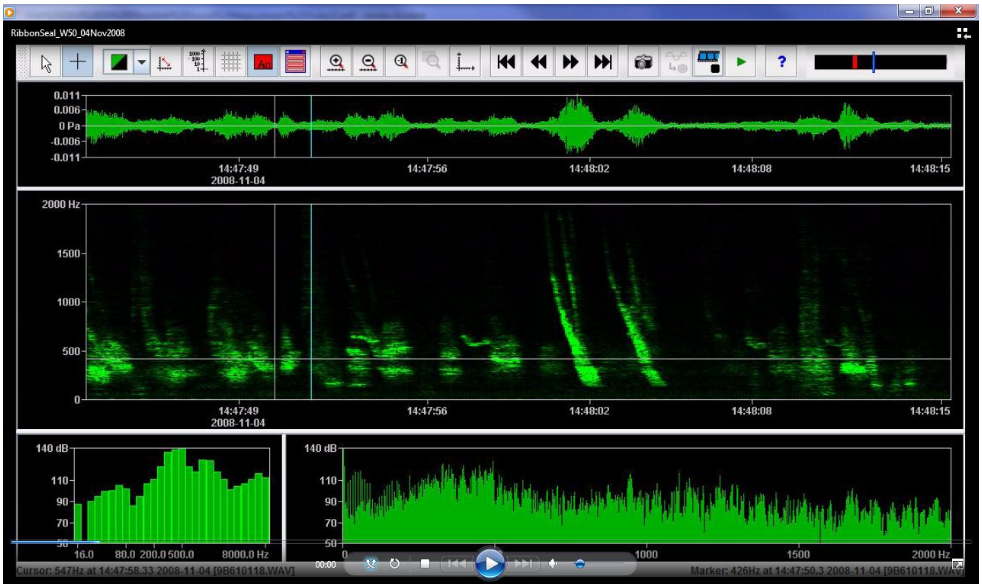

Figure 19: SpectroPlotter display window. Spectrogram scrolls as sound is received and played back through audio system. This software also logs data to files for possible post-processing.

Data Analysis

Only real-time analysis is proposed here, but all data will be recorded for possible post-processing. Post processing is not included in this proposal but can be discussed as an add-on. The real-time analysis will consist of:

a. Audio playback of real-time acoustic data on the work boats.

b. Real-time display of spectrogram and current sound levels.

c. PAM operator to log anthropogenic (man-made) noise events other than seismic survey sounds.

d. PAM operator to log start and stop times for air gun activity (only start and stop times for shot sequences).

e. PAM operator to log all marine mammal sound detections. All detections occurring during seismic shooting will be red-flagged and immediate notifications sent to the survey operators to initiate shut-downs.

f. Logging acoustic data to files containing 30 minutes of data.

Limitations

Acoustic monitoring for detecting marine mammals has limitations. First, it requires that the animals produce sounds, and second it requires those sounds to be of sufficient amplitude to be detected at the monitoring location. Sounds produced by marine mammals will decrease in amplitude with distance from the animal. Detection of sounds at the monitoring stations requires that the received levels of the biological sounds exceed background noise and other measurement noise. Background noise originates from waves, rain and from other vessels operating in the inlet. Measurement noise will include water flow noise at the hydrophone and low level electronic noise. Flow noise could be significant for this study due to high tidal currents in Cook Inlet. Flow noise is a significant issue for masking low frequency sounds from mysticetes. It will be less of a problem for detecting beluga and killer whale calls that occur at higher frequencies (most above 1 kHz). We also understand that seismic survey activity will be limited to times close to tide changes, when currents are small. Still flow noise likely will be the dominant measurement noise source. We estimate that the maximum detection range for belugas and killer whales will be 2-3 km for this study.

6.3. Reporting

A report will be submitted to NMFS within 90 days after the end of the project. The report will describe the operations that were conducted and the marine mammals that were observed. The report will be submitted to NMFS, providing full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report will summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities, marine mammal behavior and any observed behavioral changes).

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