FURIE
Operating Alaska LLC

Incidental Harassment Authorization Request for Non-Lethal Harassment of Marine Mammals Incidental to a Seismic Survey in Cook Inlet, Alaska

REVISED

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APPENDIX A FIGURES

ACRONYMS AND ABBREVIATIONS

3-D	three-dimensional
Apache	Apache Alaska Corporation
dB re 1 μPa^2	decibels referenced to a pressure of 1 micropascal
dB re 1 $\mu Pa^2/Hz$	decibels referenced to a pressure of 1 micropascal squared per Hertz
dB re 1 $\mu Pa^2 \cdot s$	decibels referenced to a pressure of 1 micropascal- squared – seconds
dB	decibels
DPS	distinct population segment
ESA	Endangered Species Act
FR	Federal Register
Furie	Furie Operating Alaska, LLC
Hz	hertz
IHA	Incidental Harassment Authorization
in^3	cubic inches
Jacobs	Jacobs Engineering Group Inc.
kHz	kilohertz
KLU	Kitchen Lights Unit
km	kilometers
km^2	square kilometers
mi^2	square miles
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council of the National Academies
OBC	ocean bottom cable
PAM	passive acoustic monitoring
PSO	protected species observer
PTS	permanent threshold shift
rms	root-mean-square
SEL	sound exposure level
SPL	sound pressure level

ACRONYMS AND ABBREVIATIONS (Continued)

TS	threshold shift
TTS	temporary threshold shift
USCG	U.S. Coast Guard
μPa	micropascal

INTRODUCTION

Pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act, Title 16 U.S. Code §1371.101(a)(5), Furie Alaska Operations, LLC requests the National Marine Fisheries Service to issue an Incidental Harassment Authorization for the take of small numbers of marine mammals by Level B harassment incidental to a three-dimensional seismic survey of the Kitchen Lights Unit lease area located in upper Cook Inlet, Alaska.

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1.0 DESCRIPTION OF ACTIVITIES

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

1.1 PROJECT PURPOSE

Furie Operating Alaska, LLC (Furie) is the operator of the Kitchen Lights Unit (KLU) oil and gas lease area located in Cook Inlet, Alaska (Figure A-1). From 2011 through 2013, Furie conducted exploratory drilling in the KLU lease area and encountered oil and gas reserves. Furie now proposes to acquire three-dimensional (3-D) seismic data for the KLU area to characterize the subsurface geological structure, to inform exploration and production drilling operations, and to provide information that may reduce the operational risks of drilling.

1.2 SEISMIC SURVEY METHODOLOGY

KLU encompasses an area of approximately 337 square kilometers (km^2) (130 square miles [mi^2]). In order to acquire data from the entire KLU area, the proposed 3-D seismic survey will be conducted in the Cook Inlet from approximately Tyonek at the northern extent to the Forelands in the south, encompassing approximately 868 km^2 (335 mi^2) of intertidal and offshore areas (Figure A-2). The KLU is composed of four adjacent blocks of lease area: the North, Corsair, Central, and Southwest blocks. Furie plans to survey the Corsair block first, which has been identified as a priority survey area, followed by the North block (secondary priority area), and the Central and Southwest blocks (lesser priority areas). Dates and timing of the survey are discussed in Section 2.0.

A seismic contractor had not been selected at the time of submitting this Incidental Harassment Authorization (IHA) application; therefore, the project description and analyses presented in this application are the most conservative based on the information provided in four different seismic contractor proposals. Activities outlined in the survey proposals fall within the footprints presented in Figure A-2, and are presented as Proposal A and Proposal B (discussed further in Section 6.2).

Furie anticipates that the marine portions of the survey will be completed with two source vessels, each towing an array of airguns that will discharge at a proposed maximum volume of 2,400 cubic inches (in^3), although a lesser volume may be used if practicable. The two source vessels will work in tandem, alternating discharge of the arrays to allow efficient data acquisition, resulting in fewer survey hours. In the event that a second source vessel is not available, the survey will be conducted with a single source vessel. In the shallow waters of the intertidal transition zone (approximately the mean high waterline to mean low waterline), one source vessel will tow an airgun array using a maximum discharge volume of approximately 440 to 1,800 in^3. The sensor, or receiving, system will be deployed to rest on the seafloor.

1.2.1 Seismic Source Arrays

Arrays of sleeve airguns will be used as the seismic source for the proposed survey. Airgun arrays are comprised of multiple airguns and can be described by the combined total volume of air discharged. The discharged air forms a pulse that contains frequencies within the seismic range. The proposed maximum discharge volume for this survey is 2,400 $in^{3.}$ The total volume of the array will be produced by multiple airguns discharging volumes of approximately 70 to 220 in^3 each, with the total number and size of the airguns dependent on the selected contractor for the seismic survey. The maximum discharge volume will be used in marine waters (a lower volume will be used if practicable), while a lesser volume of approximately 440 to 1,800 in^3 will be used in the intertidal zone. The source arrays will be towed at a depth of approximately 2.5 to 5 meters below the water surface and will be discharged at approximately 12-second intervals.

1.2.2 Predicted Sound Levels

As a contractor for the proposed seismic survey is yet to be determined, received sound levels for the specific 2,400 in^3 array to be used in the proposed project have not been modeled at the time of submitting this IHA. In order to evaluate the potential effects and impacts of sound generation from the proposed seismic survey, this IHA considers the levels and attenuation of sound modeled for a 2,400 in^3 airgun array in the same region of the Cook Inlet (Warner et al.

2011). Based on this modeling, the broadband seismic source level is anticipated to be 240 decibels (dB) in reference to a pressure of 1 micropascal (μPa) squared per hertz (dB re 1 $\mu Pa^2/Hz$) at 1 meter or less with dominant frequency components from 1 to 500 Hertz (Hz). Higher frequencies are expected to have increasingly lower decibel levels. For example, the source level at 2,000 Hz is anticipated to be less than 180 dB μPa^2 s at 1 meter. The 440 to 1,800 in^3 airgun array to be used in the intertidal environment will have a lower received sound level. An airgun of approximately 10 in^3 may be employed during power-down operations, as described in Section 1.3.3.4. A pinger, or transceiver, may be used to determine receiver location (discussed below). The pinger is anticipated to operate in the range of 30 to 55 kilohertz (kHz) at a maximum source sound level of 188 decibels (dB) sound pressure level (SPL). Discussion of sound attenuation estimates related to harassment level thresholds is discussed in Section 6.2

1.2.3 Receiver and Recording System

The receiving and recording system to be employed in the proposed seismic survey will depend on the contractor chosen to perform the work. The systems that may be used are a nodal system, an ocean bottom cable (OBC) system, or a combination of the two. Both systems include receiving/recording units connected by a cable.

The nodal system includes autonomous units (nodes), comprised of three velocity sensors, a hydrophone, and built-in recording technology strung together by a cable to facilitate retrieval. The nodes are approximately 15.5 inches in diameter and 6 inches high, with an in-water weight of approximately 40 pounds. The OBC system includes separate recording units and sensors comprised of a coupled geophone and hydrophone.

For both systems, the receiving/recording units are weighted to rest on the seafloor and no additional weights are necessary. For simplicity, the receiving/recording units will generally be referred to as receivers for the remainder of this IHA, except when necessary to identify important differences between the nodal and OBC systems. The cabled receivers are deployed in parallel lines, laid out in units, or patches. The patch size for the proposed survey may range from three to eight lines of approximately 4 to 10 miles in length spaced at 800 to 1,700 feet, depending on the contractor and site-specific design optimization.

Receiver positions may be determined by the drop location or by using acoustic post-lay positioning. For acoustic positioning, transponders will be attached to the receivers and a transceiver will "ping" the transponder to determine its location. The anticipated pinger sound source level is discussed in Section 0.

1.2.4 Vessels and Aircraft

The proposed seismic survey requires the use of multiple vessels for receiver line deployment, retrieval, recording, and source deployment. At least one vessel is also proposed for avoidance and minimization operations. The number and type of vessels that will be used in the proposed survey depends in part on the contractor. The typical vessel use configuration for seismic surveys in the Cook Inlet by the bidding contractors is presented in Table 1-1.

Table 1-1
Anticipated Vessels for Seismic Survey Operations

Vessel Type	Main Activity	Number	Engine Type	Dimensions (feet)
Primary Source Vessel	Seismic source discharge	1	Jet	65 x 21
Mother Ship/Secondary Source Vessel	Seismic source discharge, equipment storage, crew accommodations	1	Propeller or jet	90 to 220 x 20 to 52
Receiver Vessel (Marine)	Receiver deployment and retrieval operations	2-3	Jet	60 to 220 x 15 to 52
Receiver Vessel (Intertidal Zone)	Receiver deployment and retrieval in extremely shallow water and personnel transportation	1	Jet	15 to 50 x 8 to 15
Monitoring/Navigation/Support	Monitoring, navigation operations, and/or other support	2	Jet	70 to 145 x 15 to 30
Shuttle Boat	Crew transportation	1	Jet	40 x 10

The seismic survey crew will be housed onboard the vessels. Transfer and bunkering of fuel will be conducted at the dock, or will comply with U.S. Coast Guard (USCG) bunkering at sea regulations.

The proposed seismic survey may be supported by aircraft (either fixed-wing or helicopter) for marine mammal monitoring. Aircraft used for this purpose is discussed further in Section 1.4.5.

1.2.5 Description of Operations

To begin the seismic survey, receiver vessels deploy the cabled receivers onto the seafloor in parallel lines during a period of low current in the marine environment, and at high tide in the intertidal zone. Patches may be deployed either by laying all lines in the patch prior to airgun activity, or by deploying a line while retrieving a line on the opposing side of the patch, for continuous retrieval and deployment activity. An entire patch unit can be laid down in a single 24 hour period, conditions permitting. The position of the receivers are either recorded as the drop location or located with acoustic positioning (as described in Section 1.2.3). Once the survey has been completed, the cabled receiver lines are retrieved following the same guidelines for low current in the marine environment and at high tide in the intertidal zone.

Once the patch is deployed and the receiver locations are recorded, the seismic source vessels travel in transect lines perpendicular to the receiver lines, discharging the seismic source array at specified intervals. Seismic source activity will only occur during low and high slack tides or when vessels can operate safely and generate quality data. In general, the source activities will occur for 2 to 3 hours at each slack tide (four per 24-hour period) so that airgun operations for survey activities will occur for approximately 8 to 12 hours per 24-hour period. As the two source vessels work in tandem, they will alternately discharge the source array at approximately 10- to 14-second intervals at cruising speeds of 2 to 6 knots. The two source vessels communicate and control cruising speeds in an effort to discharge a seismic source every 50 meters (165 feet). After the source vessels complete one transect line, they turn 180 degrees and travel the next transect line in a parallel route.

As seismic data from the patches are acquired, the receiver lines will be retrieved and generally deployed either alongside or in line with the existing patch to create a continuous field of data collection. If it is necessary to minimize the risk of harassment to marine mammals, the receiver vessels can install the subsequent patch at an alternate location, instead of adjacent to the completed area. Receiver lines are typically in place from several hours to several days (the latter if conditions preclude source activity or retrieval).

1.3 AVOIDANCE AND MINIMIZATION MEASURES TO REDUCE IMPACTS TO MARINE MAMMALS

> *The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.*

This section corresponds to item 11 in the National Marine Fisheries Service (NMFS) guidelines for IHA applications. The avoidance and minimization measures proposed for Furie's seismic survey are summarized below and incorporate some of the most conservative measures as specified by NMFS in IHAs issued for recent seismic surveys. The main source of potential impacts on marine mammals from the proposed seismic survey is introduction of pulsed sound generated by seismic airguns, and is the impetus of this IHA request. The marine mammal species that could potentially be exposed to seismic sounds are Cook Inlet beluga whales, killer whales, harbor porpoises, gray whales, harbor seals, and Steller sea lions.

Implementation of the measures described in the following sections will dramatically reduce the potential impacts to marine mammals. Monitoring and reporting associated with implementation of the avoidance and minimization measures are discussed in Section 1.4.

1.3.1 Measures Incorporated in the Survey Design

Avoidance and minimization measures that have been incorporated in the design of the proposed seismic survey are as follows:

- The total energy source discharge volume and time the survey will take are minimized as much as possible to reduce potential impacts while ensuring adequate results.
- The airgun array has been configured to maximize the proportion of energy that propagates downward and to minimize horizontal propagation. Maximizing the proportion of energy that propagates downward allows for a more efficient operation, which results in a reduction in total field time.
- The proposal includes using two source vessels to increase the efficiency of the operation and reduce field time.
- The widest receiver line spacing practicable will be used. Wider receiver line spacing allows for increased distance between source lines thereby reducing the total number of lines and source points needed to acquire the survey data. Reducing the number of source lines also reduces the total survey time.
- The survey design includes no airgun use within designated Cook Inlet beluga whale Area 1 critical habitat (Figure A-2). Target time periods to conduct the survey have been identified, taking into consideration key factors such as environmental conditions, weather conditions, and proposed equipment. The seasonal distribution of the Cook Inlet beluga whale plays an important role in determining the timing of the proposed seismic survey; the proposed dates to conduct the survey in each priority area is based on the probability of beluga whale presence and minimizes the risk of exposing individuals to acoustic harassment.
- Sound source verification is proposed to determine site-specific sound attenuation and identify the appropriate 180, 190, and 160 dB isopleths for establishing and monitoring exclusion zones and safety radius.
- Airgun arrays shall be discharged at depths greater than 2 meters (approximately 6 feet) to avoid interference or injury to out-migrating juvenile salmonids.
- The airguns will not be active 24-hours per day. Airguns will be active for approximately 3 hours during each of the slack tide periods (approximately four slack tides per 24-hour period), thereby confining noise levels to one location for short and intermittent time periods spaced throughout a 24-hour period, resulting in effects to a very small proportion of the available habitat in Cook Inlet.
- There will be no seismic operations conducted in marine waters of Cook Inlet during regularly scheduled or emergency commercial fishery openings in the areas where fish harvests are occurring. Season openings and fishing days can vary from year to year, usually beginning in late June, and are open for a couple of days per week, ending by late August. Furie will contact the Alaska Department of Fish and Game to obtain the correct opening and closing information for fishery activities.

1.3.2 General Measures for Vessels and Aircraft

The following avoidance and minimization measures apply to all vessels and aircraft involved in the seismic survey

- Vessels will avoid concentrations of marine mammals, and vessel operators will conduct their activities at the maximum distance practicable from such groups.
- Vessels will be operated at speeds necessary to minimize the risk of physical contact with marine mammals. If any vessel approaches within 1.6 kilometers (km) (1 mile) of observed beluga whales or Steller sea lions, except in emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the individuals by taking one or more of the following actions, as appropriate:
  - Reducing vessel speed to less than 5 knots within 275 meters (900 feet) of the individual(s)
  - Steering around the individuals(s) if possible
  - Operating the vessel(s) in such a way as to avoid separation of group members
  - Operating the vessel(s) to avoid causing an individual to make multiple changes in direction
  - Checking the waters immediately adjacent to the vessel(s) to ensure that no individuals will be injured when the propellers are engaged
  - When weather conditions require, vessel(s) will adjust speeds to less than 9 knots to avoid the likelihood of injury to marine mammals.
- Any aircraft used to support the proposed seismic survey, will apply the following minimization measures:
  - Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 feet above sea level within 0.5 km (0.3 miles) of concentrations of marine mammals.
  - Helicopters shall not hover or circle above or within 0.5 km (0.3 miles) of concentrations of marine mammals.

1.3.3 Specific Measures for Seismic Survey Operations, Vessels, and Aircraft

The following operational avoidance and minimization measures apply only to source vessels and the additional monitoring vessel (if employed). All vessels will operate under the general minimization measures described above in Section 1.3.2. Specific operational avoidance and minimization measures include establishing and monitoring a safety radius and exclusion zones; vessel speed or course alterations; and ramp-up, power-down, and shutdown of the airgun array. In addition, there will be special procedures in the event that a marine mammal carcass is encountered.

1.3.3.1 Establishing and Monitoring a Safety Radius and Exclusion Zones

Furie will establish an exclusion zone radius for each sound source based on the 180 dB and 190 dB sound level area and a safety radius based on the 160 dB sound level. The 180 dB and 190 dB sound levels are the safety criteria as used by NMFS to prevent injury to marine mammals and are applicable to cetaceans and pinnipeds, respectively. Furie proposes to shut down operation of all airguns or positioning pingers in the unlikely event that a marine mammal is observed approaching or within an exclusion zone (Section 1.3.3.5). NMFS uses the 160 dB sound level as the harassment threshold. This 160 dB isopleth safety radius will be subject to visual monitoring, power-down, and shutdown procedures as described below.

The preliminary distances for the exclusion zone and safety radii are estimated from a sound source verification study using the same airgun configuration in an overlapping portion of the Cook Inlet (Apache Alaska Corporation [Apache] 2013). Section 6.2 presents further discussion of the safety radius distance determination. Table 1-2 shows the distances at which threshold sound levels are expected to be received from the airgun array. The distance to each sound level will be verified onsite and adjusted based upon actual measurements at the survey startup. Furie will monitor the safety radius before, during, and after operation of the airguns using qualified protected species observers (PSO) by vessel-based visual monitoring. Land-based visual monitoring, and aerial monitoring by fixed-wing aircraft or helicopter may also be used to monitor the safety radius under certain conditions. When a cetacean or pinniped is observed approaching or within a safety zone, PSOs will have the authority to call for immediate power-down (or shutdown) of airgun operations as required by the situation as discussed below. Monitoring details, including qualifications and role of the PSOs are discussed in Section 1.4.

Table 1-2
Estimated Exclusion Zone and Safety Radius Distances

Sound Source	Safety Radius (160 dB)	Exclusion Zone-Cetaceans (180 dB)	Exclusion Zone-Pinnipeds (190 dB)
Pinger (receiver positioning)	25 m	3 m	1 m
10 in^3 airgun	280 m	10 m	10 m
440 in^3 airgun array	2.5 km	310 m	100 m
2,400 in^3 airgun array	9.5 km	1.4 km	380 m

Note:
Estimated distances are from Apache's sound source verification reported to NMFS (Apache 2013).

1.3.3.2 Speed or Course Alterations

If a marine mammal is detected outside the safety zone and is likely to approach or enter the safety zone (based on its relative direction of travel), a vessel's speed and/or direct course may, when practical and safe, be altered to increase the distance between the observed marine mammal and the safety zone. This avoidance and minimization measure is required only when considered operationally practicable. The activities and movements of the marine mammal (relative to the seismic vessel) will continue to be monitored. If the marine mammal appears to be approaching the safety zone, further avoidance and minimization actions will be taken (i.e., power-down procedure and/or shutdown procedures).

1.3.3.3 Ramp-Up of Airgun Array

Airgun operations will follow a ramp-up procedure in which the increase in noise from equipment will occur incrementally in order to allow nearby marine animals the opportunity to move a comfortable distance from the noise. The ramp-up procedure will prevent hazardous noise exposure to any marine mammals or prey species that may be present within the survey area. Ramp-up of an airgun array involves a step-wise increase in the number of operating airguns until the required discharge volume is achieved.

NMFS normally requires, and Furie proposes, that once ramp-up commences, the rate of ramp-up be no more than 6 dB per 5-minute period. A common procedure is to double the number of operating airguns at 5-minute intervals, starting with the smallest gun in the array. Furie intends to begin with the smallest gun in the array and to add airguns in sequence so that the source level of the array shall increase in steps not exceeding 6 dB per 5-minute period. During ramp-up, the safety radius for the full airgun array will be observed (refer to Section 1.4.3 for monitoring details). If, for any reason, electrical power to the airgun array has been discontinued for a period of 10 minutes or more, ramp-up procedures will be implemented. Discontinuation of airgun activity for less than 10 minutes does not require a ramp-up.

The ramp-up procedures will be applied as follows:

- A 30-minute clearance of the safety radius is required prior to commencing ramp-up.
- During a ramp-up, PSOs will monitor the safety zone, and if a marine mammal is sighted approaching or within a safety or exclusion radius, a power-down or shutdown will be implemented as though the full array were operational.
- The airgun array will not be ramped up from a complete shutdown (lasting more than 10 minutes) if the entire safety radius is not visible. A ramp-up, following a cold start (no airguns operational for more than 10 minutes), will be applied only if the entire safety radius has been visible and observed to be free of marine mammals for a consecutive 30-minute period.
- If at least one airgun has operated during a power-down period, ramp-up to full power will be permissible in any visibility conditions, on the assumption that marine mammals will be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away.
- Ramp-up procedures from a cold start, including a shutdown, will be delayed if a marine mammal is sighted within or near the safety radius during the 30-minute period prior to the ramp-up. The delay will last until the marine mammal(s) has been observed to leave the safety zone or until the marine mammal(s) is not sighted for at least 15 minutes (pinnipeds and small odontocetes including the harbor porpoise) or 30 minutes (larger odontocetes and mysticetes, including beluga, killer, and gray whales).
- The seismic operator and PSOs will maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

1.3.3.4 Power-Down of Airgun Array

A power-down is the immediate reduction in the number of operating airguns such that the radii of the 190, 180, and 160 dB areas are decreased to the extent that an observed mammal is not in the applicable radius of the full array. During a power-down, one airgun of at least 10 in^3 discharge volume (or more, but less than the full airgun array) continues operating. In contrast, a shutdown occurs when all airgun activity is completely suspended (see below). The continued operation of one airgun is intended to maintain introduced sound levels (below harassment levels) to allow marine mammals to travel a comfortable distance away from the sound, and to retain the option of initiating a ramp-up to full operations even under poor visibility conditions.

The power-down procedures will be applied as follows:

- The airgun array will be immediately powered down whenever a marine mammal is sighted approaching or within the applicable safety radius of the currently operating array, but is outside the applicable safety radius of fewer airguns or the single 10 in^3 airgun.
- If a marine mammal is already within the safety zone when first detected, the airguns will be powered down immediately.
- If a marine mammal is sighted approaching or within the applicable safety zone of the single 10 in^3 airgun, it will be shut down (see below).
- If concentrations of four or more individuals associating together of any whale species or Steller sea lions, or cow/calf pairs of beluga whales are observed approaching the safety radius and do not appear to be traveling (e.g., they are feeding, socializing, etc.), airgun operations will be shut down, not powered down (see below).
- Following a power-down, ramp-up to the full airgun array will not resume until the marine mammal has cleared the safety radius. The marine mammal(s) will be considered to have cleared the safety radius as described above under ramp-up procedures.

1.3.3.5 Shutdown of Airgun Array

If a marine mammal is observed approaching or within the exclusion zone, the PSO will order operations to be shut down completely to prevent the species' exposure to injurious noise levels. Additionally, shutdown will be initiated by any PSO if concentrations of four or more individuals associating together of any whale species or Steller sea lions, or cow/calf pairs of beluga whales are observed approaching the safety radius.

The PSO will authorize resumption of the activity using ramp-up protocols as required only when the sighted marine mammal(s) are observed to have vacated the safety radius, as appropriate. The marine mammal(s) will be considered to have cleared the safety radius as described for the ramp-up procedures (Section 1.3.3.3).

1.3.3.6 Responding to Marine Mammal Carcasses

If an injured or dead marine mammal is sighted within an area where airguns were operating within the previous 24-hour period, shutdown procedures will be initiated immediately. Activities will only resume after the lead PSO determines that the injury did not result from airgun operations. After the PSO has prepared written certification, including supporting documents (e.g., photographs or other evidence), operations will resume. Within 24 hours after the event, the operator will notify NMFS and provide them with the written documentation.

If the cause of the injury or death cannot be immediately determined by the lead PSO, the incident will be reported immediately to either the NMFS Office of Protected Resources or the NMFS Alaska Regional Office. The seismic airgun array shall not be restarted until NMFS is able to review the circumstances, make determination as to whether modifications to the activities are appropriate and necessary, and has notified the operator that activities may be resumed. In all cases, NMFS will be notified no later than 24 hours after the sighting.

1.4 MONITORING AND REPORTING PROCEDURES

> *The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations if marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordination such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding. Guidelines for developing a site-specific monitoring plan may be obtained by writing to the Director, Office of Protected Resources.*

This section corresponds to item 12 in the NMFS guidelines for IHA applications.

Furie will monitor the safety radius before, during, and after operation of the airguns in order to implement the proposed avoidance and minimization measures (Section 1.3). Furie understands that the monitoring and reporting procedures described in this IHA request is subject to review by NMFS, and that refinements may be required. The monitoring procedures described in this section is proposed as work independent of any other related monitoring projects that may occur simultaneously in the same area. Furie is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable

The monitoring and reporting procedures include use of qualified PSOs, vessel- , land-, and aerial-based visual monitoring. Data recording and reporting are also described.

1.4.1 Monitoring Objectives

The main objectives of the vessel-based visual monitoring program are as follows:

- To implement avoidance and minimization measures during seismic operations (e.g. vessel speed or course alteration, airgun ramp-up, power-down, shutdown, etc.)
- To record all marine mammal data necessary to satisfy all reporting requirements
- To compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity
- To obtain data on the behavior and movement patterns of marine mammals observed and compare those recorded at times with and without seismic activity

The potential to successfully achieve the latter two objectives is subject to the number of marine mammals observed during the survey period.

1.4.2 Qualified Protected Species Observers

Furie will employ qualified trained PSOs to be onboard the source and monitoring vessels as well as to implement any shore-based or aerial-based monitoring. PSOs will be approved in advance by NMFS to conduct the visual monitoring programs and to record the data required under the monitoring program. The PSOs will complete training conducted by a qualified marine mammalogist shortly before the anticipated start of the open-water season. Furie will identify PSO candidates for hiring and will submit candidate information to NMFS for approval before making a final offer and completing the hiring process.

1.4.3 Vessel-Based Visual Monitoring

Furie will employ one or two source vessels operating together and two additional vessels for monitoring and other operational support such as navigation (referred to hereafter as a monitoring vessel). The monitoring vessels will be positioned to have an unobstructed view of the entire 160 dB safety radius and exclusion zones at all times. Each source and monitoring vessel will have at least one PSO on duty and monitoring during PSO Monitoring Periods, defined as those periods of daylight conditions with adequate lighting and environmental conditions to observe the entire safety radius during the following activities:

- When receivers and airgun arrays are deployed or retrieved from the water
- 30 minutes prior to the startup of any airgun operations
- During all airgun operations
- During power-down and shutdown of operations to monitor the movement and behavior of any observed marine mammals that were in (or close to) the 160 dB safety radius.

Should airgun operations that were initiated in daylight conditions with PSO monitoring continue into night or low-light conditions, PSOs will continue monitoring activities for the duration of airgun use. The lead PSO will have the authority to order Furie employees and contractors to temporarily cease operations in accordance with the power-down and shutdown protocols (Sections 1.3.3.4 and 1.3.3.5, respectively). In addition to PSOs, all vessel and aircraft crews will be instructed to assist with the detection of marine mammals and with implementation of avoidance measures such as activity power-down and shutdown, as appropriate. PSOs will be on duty in shifts of a maximum of four consecutive hours with breaks of at least two hours between shifts to avoid observation fatigue. The exact shift schedule will be established by the lead PSO in consultation with the other PSOs. The vessels will provide suitable platforms for PSO observations. Observations will be made from locations where PSOs have the best possible position for observing marine mammals (e.g., outside and as high on the vessel as possible), taking into account weather and other working conditions. During PSO Monitoring Periods, on-duty PSOs will scan the 160 dB isopleth safety radius and exclusion zones systematically with the unaided eye, reticle binoculars, and using other instruments such as night vision devices as practicable.

Acoustic monitoring of the safety radius using passive acoustic monitoring (PAM) was considered by Furie but determined to be not practicable for the proposed survey. The available technology for PAM provides little monitoring value, specifically in the extreme environment of the Cook Inlet. Furie consulted with industry experts with monitoring experience in Cook Inlet who stated that PAM buoys are not functional in the strong currents of the inlet and that resources are better invested in other monitoring efforts. For this reason, Furie does not propose use of PAM to monitor the 160 dB safety radius. As described above, two monitoring vessels (in addition to the source vessels) would focus on monitoring the safety radius.

1.4.4 Land-Based Visual Monitoring

When practicable and necessary, Furie will employ land-based visual monitoring of the safety radius in addition to the vessel-based monitoring. Land-based monitoring will be employed only when the safety radius includes the intertidal area within one mile from shore. The land-based location will have sufficient height to observe marine mammals. Shore-based PSOs will maintain contact with vessel-based PSOs and vessel operators. All of the requirements for vessel-based PSOs outlined in Section 1.4.3 also apply to land-based PSOs.

1.4.5 Aerial-Based Visual Monitoring

When the safety radius of the survey operations will occur within 1.6 km (1 mile) of a river mouth, Furie will conduct aerial surveys (using either one fixed-wing aircraft or helicopter) of the river mouth(s) prior to the commencement of operations. The aircraft may be employed to look for marine mammals during other times, when practicable. The purpose of this monitoring effort is to identify any congregations of beluga whales or other marine mammals, relative to the survey area.

Weather and schedule permitting, aerial monitoring surveys will fly at an altitude of 305 meter (1,000 feet). In the event of a marine mammal sighting, aircraft will attempt to maintain a radial distance of 457 meters (1,500 feet) 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 mammal(s).

1.4.6 Data Reporting

1.4.6.1 Weekly and Monthly Reports

Reports will be submitted to NMFS for each week and month during which seismic survey activities take place. The reports will contain and summarize the following information:

- Dates, times, locations, heading, speed, weather, sea conditions, and associated activities during all seismic operations and marine mammal sightings.
- Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of power-downs and shutdowns), observed throughout all monitoring activities.
- An estimate of the number (by species) of the following:
    - Pinnipeds that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (root-mean-square [rms]) and/or 190 dB re 1 μPa (rms) with a discussion of any specific behaviors those individuals exhibited.
    - Cetaceans that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re 1 μPa (rms) and/or 180 dB re 1 μPa (rms) with a discussion of any specific behaviors those individuals exhibited.
- A description of the implementation and effectiveness of the avoidance and minimization measures as proposed in this IHA.

1.4.6.2 Summary Report

A summary report will be submitted to NMFS within 90 days of the completion of the activity covered by this IHA. This report will summarize all activities and monitoring results conducted during the seismic survey, including the following:

- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals).
- Analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare).
- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover.

- Analyses of the effects of survey operations:
- Sighting rates of marine mammals during periods with and without seismic survey activities (and other variables that could affect detectability), such as:
    - Initial sighting distances versus survey activity state
    - Closest point of approach versus survey activity state
    - Observed behaviors and types of movements versus survey activity state
    - Numbers of sightings/individuals seen versus survey activity state
    - Distribution around the source vessels versus survey activity state
    - Estimates of take by Level B harassment based on presence in the 160 dB safety radius area

2.0 DATES, DURATION, AND REGION OF ACTIVITY

The date(s) and duration of such activity and the specific geographical region where it will occur.

2.1 DATES AND DURATION OF ACTIVITY

Furie proposes to survey the entire project area in approximately 120 days, with starting and ending dates dependent on the timing of permit authorization and actual survey days influenced by other factors such as commercial fishing, other seismic survey operations in overlapping or adjacent areas, and general operational factors (i.e. weather). Details of the daily operations are discussed in Section 1.2.5. In general, survey activities may occur 24 hours per day (e.g. receiver line deployment and retrieval, dependent on weather and permit conditions), however full airgun array seismic source activities will occur for 2 to 3 hours at each slack tide (four per 24-hour period) so that survey airgun operations will occur only for approximately 8 to 12 hours per 24-hour period. A 10 in^3 airgun may be used between these periods of active survey using full airgun array. Furie proposes to survey Priority Area 1 (the Corsair block) first, followed by the North block, and finally the Central and Southwest blocks (Figure A-2). Furie proposes to begin the survey on 1 May 2014 and to complete the entire survey by 30 August 2014. However, should the survey start date be delayed, alternate timing for the survey will depend on the priority of the survey area. Table 2-1 presents Furie's proposed survey dates, along with three alternative date ranges in the event the May 2014 start date is delayed.

Table 2-1
Dates and Duration of Activity

Survey Dates	Priority Area 1 Corsair Block	Priority Area 2 North Block	Priority Area 3a Central Block	Priority Area 3b Southwest Block	Approximate Survey Duration
Proposed Dates	May 2014	June 2014	July 2014	August 2014	120 days
Alternate Timing Option 1	June 2014	September 2014	July 2014	August 2014	120 days
Alternate Timing Option 2	July 2014	October 2014	August 2014	September 2014	120 days
Alternate Timing Option 3	August 2014	September 2013	October 2014	November 2014	120 days

Note:
Within each timing option, there is flexibility to rearrange the sequence of work in the priority areas, if necessary, in order to minimize the potential exposure of marine mammals.

2.2 GEOGRAPHIC REGION OF ACTIVITY

The proposed seismic survey will take place in the Cook Inlet between Tyonek at the northern extent to the Forelands in the south (Figure A-2). The approximate boundaries of the seismic survey area are 61°06'N-60°43'N and 151°36'W-150°40'W.

3.0 MARINE MAMMALS OF UPPER COOK INLET

The species and numbers of marine mammals likely to be found within the activity area.

Six species of marine mammals are likely to occur in or near the project area. Table 3-1 summarizes the estimated abundance, Marine Mammal Protection Act (MMPA) status, and Endangered Species Act (ESA) status for each of these species.

Abundance estimates specific to Cook Inlet are available only for the beluga whale and harbor porpoise. For other species, the abundance estimates are for populations with ranges that are broader than Cook Inlet and for which only a small proportion occurs in Cook Inlet; therefore, the Cook Inlet population number of these other species is unknown. The data in Table 3-1 represents the best available scientific data and information. Each of these species is further described in Section 4.0 of this application.

Table 3-1
Species and Numbers of Marine Mammals in Upper Cook Inlet

Common Name	Scientific Name	Abundance	Status
Beluga Whale	*Delphinapterus leucas*	312 [1]	ESA-Endangered MMPA-Depleted
Gray Whale	*Eschrichtius robustus*	19,126 [2]	ESA-delisted MMPA- No Special Status
Harbor Porpoise	*Phocoena phocoena*	31,046 Gulf of Alaska 737 Cook Inlet [3]	ESA-not listed MMPA- No special status
Harbor Seal	*Phoca vitulina richardsi*	22,900 [4]	ESA-not listed MMPA- No special status
Killer Whale (Orca)	*Orcinus orca*	2,347 Resident, 587 Transient [5]	ESA-not listed MMPA- No special status
Steller Sea Lion	*Eumetopias jubatus*	45,659 [6]	ESA- Endangered MMPA-Depleted

Notes:
[1] Estimate for Cook Inlet stock (Shelden et al. 2012)
[2] 2006/07 estimate for the Eastern North Pacific stock (Allen and Angliss 2012)
[3] Estimate for Gulf of Alaska and Cook Inlet populations (Hobbs and Waite 2010, Allen and Angliss 2012)
[4] Cook Inlet/ Shelikof stock (Allen and Angliss 2012)
[5] Resident estimate of Eastern North Pacific Alaska resident stock, transient estimate of Gulf of Alaska, Aleutian Islands and Bering Sea transient stock – draft update (Allen and Angliss 2013)
[6] Estimate for the Western U.S. stock in Alaska – draft update (Allen and Angliss 2013)

Other marine mammals that are present only in the lower Cook Inlet, or that are only rarely observed in Cook Inlet, are not likely to occur in the project area and are therefore not included in this IHA for further analysis. Marine mammal species that were considered but that are not evaluated include the Fin whale, Cuvier's Beaked whale, Minke whale, Humpback whale, Dall's porpoise, Pacific White-sided dolphin, and the northern sea otter (Southwest and Southcentral Alaska stocks).

4.0 DESCRIPTION OF MARINE MAMMALS IN PROJECT AREA

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities.

4.1 BELUGA WHALE

The beluga whale is a small, toothed whale in the family Monodontidae. The beluga whale is a northern hemisphere species, ranging primarily over the Arctic Ocean and some adjoining seas, where they inhabit fjords, estuaries, and shallow water in arctic and subarctic oceans (Gurevich 1980). The total number of beluga whales worldwide is well above 150,000 animals, with many portions of their range unsurveyed (Jefferson et al. 2012). Cook Inlet belugas are one of five distinct beluga whale populations recognized within U.S. waters (Allen and Angliss 2012). The other distinct populations are found in Bristol Bay, eastern Bering Sea, eastern Chukchi Sea, and Beaufort Sea. The Alaska Peninsula may act as a unique genetic barrier between the populations, as Cook Inlet beluga whales are in some respects the most genetically distinct (O'Corry-Crowe et al. 2002). Minimum estimates for all five populations in Alaska total 59,141 beluga whales (Allen and Angliss 2013).

4.1.1 Status

The Cook Inlet beluga whale was listed as endangered under ESA in 2008 and is considered depleted under the MMPA. Designation of critical habitat for the Cook Inlet beluga whale (Figure A-3) became effective in 2011 (Federal Register [FR] Volume 76 page 20180 [76 FR 20180]). Using aerial, video, and manual counts, NMFS has determined that the population of Cook Inlet beluga whales has declined from an estimated 1,300 animals in 1979 to 312 in 2012 (Hobbs et al. 2011; Shelden et al. 2012). Overharvest of Cook Inlet belugas by subsistence users has explained the documented decline of the population during the mid-1990s (NMFS 2008a). In response, cooperative efforts between NMFS and subsistence users have dramatically reduced subsistence harvests; subsistence regulation began in 1999. The annual subsistence harvest between 1993 and 1999 ranged from 30 to over 100 individuals (Mahoney and Shelden 2000). Alaska Natives voluntarily ceased subsistence beluga hunts in 1999 due to the apparent decline in numbers and later that year a federal temporary moratorium on hunting Cook Inlet beluga whales was established (Public Law No. 106-31, Section 3022, 113 Stat. 57, 100) and then made permanent in 2000 (Public Law. No. 106-533). A co-management agreement between NMFS and Alaska Native organizations allowed subsistence take of Cook Inlet beluga whales under certain conditions until 2005. Abundance estimates made after the reduction in the subsistence harvest show a fairly steady maintenance of the population, but with an overall slight decline in abundance. The population trend of Cook Inlet beluga whales for the past 10 years is estimated to be a decline at an annual average rate of 0.6 percent (National Oceanic and Atmospheric Administration [NOAA] 2013) (Figure A-4). The Cook Inlet beluga whale population may be affected by various natural and anthropogenic factors, including subsistence harvest removals, pollution, predation, disease, contamination, fisheries interactions, vessel traffic, small stock size, restricted summer range, strandings, and habitat alterations (73 FR 62919).

4.1.2 Critical Habitat

In its critical habitat designation, NMFS identified two distinct areas (Area 1 and Area 2) that are used by Cook Inlet beluga whales for different purposes at different times of year (Figure A-3). Area 1 habitat is located in the northernmost region of Cook Inlet and consists of shallow tidal flats, river mouths, and estuarine areas. Area 1 habitat lies within the Susitna River Delta, an area where belugas frequently group in early summer to feed on salmon and eulachon (Huntington 2000; Rugh et al. 2000). Belugas also use this area, and further up Cook Inlet into Chickaloon Bay and Turnagain Arm during the summer from May through August for calving (Huntington 2000).

Area 2 habitat was designated for the area’s importance to fall and winter feeding and transit. Area 2 includes the Cook Inlet waters south of Area 1 habitat as well as Kachemak Bay and foraging areas along the western shore of lower Cook Inlet including Kamishak Bay and Douglas Reef at the southern extent (76 FR 20180-20214) (Figure A-3). Area 2 habitat is primarily used by Cook Inlet beluga whales as over-wintering habitat from October through March (Hobbs et al. 2005). Based on dive behavior and analysis of stomach contents from Cook Inlet belugas, it is assumed that Area 2 habitat is an active feeding area during fall and winter months when the spatial dispersal and diversity of winter prey likely influences the wider beluga winter range (NOAA 2008a). There is little current understanding of the habitat characteristics of Area 2.

The remainder of Cook Inlet that is not designated critical habitat may have been used by beluga whales in the past before the population declined. It is believed that the range of belugas consisted of the entire Cook Inlet when the population was in excess of 1,000 members. While the Cook Inlet beluga population was abundant, whales were frequently sighted in the lower Inlet during summer months (NMFS 2008a). The contraction of the species further indicates the value of Type 1 habitat, as the remainder of this species seeks the area with the best feeding, calving, and predator avoidance options (NMFS 2008a).

4.1.3 Distribution

The seasonal distribution pattern of beluga whales in the Cook Inlet is most closely associated with seasonally available prey, and is described in the following sections. To a lesser extent, sea ice, calving, and predator avoidance are also important in the seasonal distribution of belugas in the Cook Inlet.

Spring, Summer, and early Fall

Cook Inlet beluga whales show "obvious and repeated use of certain habitats" and, specifically, concentrate in the upper Cook Inlet during summer months (NMFS 2008a). From approximately April through September, Cook Inlet beluga whales are highly concentrated in the upper Cook Inlet, feeding mainly on gadids (*Gadidae spp.)* and anadromous fish including eulachon, or hooligan (*Thaleichthys pacificus*), and Pacific salmon (*Oncorhynchus spp*.). The hooligan and all five Pacific salmon species (chinook [*O. tshawytscha*], pink [*O. gorbuscha*], coho [*O. kisutch*], sockeye [*O. nerka*], and chum [*O. keta*]) spawn in rivers located throughout the Cook Inlet. Hooligan is the earliest anadromous specie to appear, arriving in upper Cook Inlet in April with major spawning runs in the Susitna River in May and July (NMFS 2008a). The arrival of the hooligan appears to draw Cook Inlet beluga whales. Beluga whales concentrate to feed on the early spring species, sometimes feeding on the hooligan exclusively before salmon arrive in the upper Inlet.

Annual aerial surveys conducted in June from 1998 through 2008 and covering all of Cook Inlet observed beluga whales to be almost entirely absent from mid and lower portions of the Inlet and centrally located between the Little Susitna River and Fire Island in upper Cook Inlet (Figure A-5) (Rugh et al. 2010). From the same aerial survey data and encompassing 1994 through 2008, Goetz et al. (2012a) used the probability of beluga presence, the expected beluga group size given their presence, and the range of predicted habitat to yield a final model to predict the expected number of belugas per km^2 within Cook Inlet in June (Figure A-6). Based on this model, most belugas are likely to be present north of the Forelands, in Knik Arm, the Susitna River Delta, and Chickaloon Bay during June. During recent aerial surveys conducted 29 May to 7 June 2012 (Shelden et al. 2012) a group of seven beluga whales traveling from an area southeast of West Foreland towards Trading Bay was observed; an area in which such large groups of beluga whales have not been observed since 1995. The observation is a rare event since the range of Cook Inlet belugas contracted into the northern portion of Cook Inlet during summer since 1978 (Rugh et al. 2010). Several groups of beluga whales were observed south of the Forelands during June surveys between 1993 and 1997 (Rugh et al. 2010), and previous to the recent sighting, no individuals have been observed south of the Forelands during June surveys since 2001 (Shelden et al. 2012). More recent aerial surveys in August 2012 by Sims et al. (2012) did not observe belugas in the Trading Bay area, or even south of the Beluga River.

Although data concerning the timing and location of calving is limited, Calkins (1983) suggested calving to occur between mid-June and mid-July in larger estuaries within upper Cook Inlet. From traditional knowledge of subsistence hunters, calving is known to occur during the summer from May through August in the upper Cook Inlet into Chickaloon Bay and Turnagain Arm (Huntington 2000). Furthermore, McGuire (2009) observed newborn Cook Inlet beluga whales starting on July 24, and suggested calving to take place in late July. The neonate beluga whales were observed throughout the survey area from the Susitna River Delta to Turnagain Arm and Knik Arm from July 24 through September 30 (McGuire 2009).

Fall and Winter

Beginning in October, Cook Inlet beluga whales become less concentrated, increasing their range and dispersing into deeper waters of the upper and mid-region of Cook Inlet. In late summer and fall (August through October) Cook Inlet belugas use the streams on the west side of Cook Inlet from the Susitna River south to Chinitna Bay, sometimes moving up to 35 miles upstream to follow fish migrations (NMFS 2008a). Direct observation of beluga whales during the winter is less frequent than in summer; however, Hobbs et al. (2005) estimated the Cook Inlet beluga whale distribution during fall and winter months based on known locations of 14 satellite-tagged beluga whales. Estimated Cook Inlet beluga whale distributions for the months of August through March indicate that individuals concentrate their range in the upper region of Cook Inlet through September, but have a much increased range from October to March, utilizing more area of the Inlet (Figure A-7). The predicted winter range has a more southerly focal point than in summer, with the majority of time spent in the mid-region of the Inlet beginning in December. Although historically belugas may have traveled to the extreme south of Cook Inlet, the available data show belugas remaining in the mid to upper Inlet through the winter months.

Most likely the dispersal in late fall and winter results from the need of beluga whales to forage for prey in mid or bottom waters rather than at river mouths after the seasonal salmon runs have ceased (NMFS 2008a). As salmon runs begin to decline, Cook Inlet belugas change to a diet of fish found in nearshore bays and estuaries, and deeper waters, including cod (*Gadus morhua*), Pacific staghorn sculpin (*Leptocottus armatus*), flatfishes such as starry flounder (*Platichthys stellatus*), and yellowfin sole (*Limanda aspera*) (Hobbs et al. 2008).

4.2 HARBOR PORPOISE

The harbor porpoise inhabits coastal waters generally less than 200 meters deep and are most common in bays, estuaries, harbors, and fjords. They are found in northern waters along the coasts of North America, Africa, Europe, and Asia. There are 10 recognized stocks of harbor porpoise recognized by NOAA: Bering Sea, Gulf of Alaska, Gulf of Maine-Bay of Fundy, Inland Washington, Monterey Bay, Morro Bay, Northern California-Southern Oregon, Oregon-Washington Coastal, San Francisco-Russian River, and the Southeast Alaska. Harbor porpoises in Southeast Alaska and the Gulf of Alaska primarily inhabit water less than 100 meters in depth (Hobbs and Waite 2010). The Gulf of Alaska stock has an estimated 31,046 individuals, some of which are regularly seen in Cook Inlet (Hobbs and Waite 2010, Allen and Angliss 2012). A subset of this stock uses the waters of the Cook Inlet, approximated at 737 individuals (Hobbs and Waite 2010). Both the Gulf of Alaska and Cook Inlet abundance estimates are based on survey data over 14 years old, and are not considered reliable enough to establish trends in abundance for the Gulf of Alaska stock of harbor porpoise (Allen and Angliss 2012).

4.2.1 Status

Harbor porpoise are not currently listed as threatened or endangered under the ESA, nor listed as depleted under the MMPA. The Gulf of Alaska stock however is listed as a strategic stock under MMPA, due to the out-of-date abundance estimate and lack of information regarding incidental mortality related to commercial fisheries (Allen and Angliss 2012).

4.2.2 Diet and Distribution

From analysis of stomach contents, harbor porpoises are known to feed primarily on small fish and cephalopods (Sekiguchi 1995). Tides can influence feeding behavior in harbor porpoises, as they move to shallow water with tidal floods, following movement patterns of prey species (Gaskin and Watson 1985). Harbor porpoises are opportunistic feeders, with diet varying by season (Rae 1965; Rae 1973; Sekiguchi 1995). Their presence in any area is dependent on prey abundance and they will feed anywhere within their habitat, with a preference near coastal areas with high numbers of fish (Koschinski 2002). It is thought that mating behaviors occur outside of the immediate coastal zone in calm, shallow coastal waters in June and July with calving in May and June the following year (Sekiguchi 1995).

Historically, observations of harbor porpoises in Cook Inlet have been infrequent and primarily restricted to the lower Inlet. Aerial surveys conducted in Cook Inlet on 1 and 2 August 1991 over 1,873 km resulted in three group sightings of a total of four individuals, at least two sighting of which were in lower Cook Inlet (Dahlheim et al. 2000). Annual surveys conducted by NMFS of the beluga population in Cook Inlet each June and/or July from 1993 to 2004 have resulted in harbor porpoise sightings primarily in the lower Cook Inlet (Rugh et al. 2005). In most years counts were fairly low (approximately 10 to 30 individuals), however in 1994 and 2004, 45 and 59 sightings occurred in locations south of Tuxedni Bay. More recently, a 2012 aerial survey observed eight harbor porpoises within lower Cook Inlet, with one individual spotted between West Foreland and Kenai River (Shelden et al. 2012). While harbor porpoises have been observed within Cook Inlet, they are not known to occur in large numbers.

4.3 HARBOR SEAL

The harbor seal, *Phoca vitulina*, is a member of the Phocidae or “true seal” family. This species lives in temperate coastal habitats from Alaska to Baja California. Haulouts for the harbor seal are found all along the coast and can include rocks, reefs, beaches, and drifting glacial ice. The North American harbor seal population has been separated into seven stocks for management purposes. These stocks include the Bering Sea, California, Gulf of Alaska, Oregon-Washington, Washington Inland, Southeast Alaska, and Western North Atlantic. The Alaskan stocks have recently been combined and broken into twelve smaller stocks for research and management purposes (Allen and Angliss 2012). Encompassing all of Cook Inlet and south to Seal Cape (excluding Kodiak Island) is the Cook Inlet/Shelikof harbor sea stock. The number of seals found in and around this stock is estimated to be around 22,900 with individuals being sighted as far north as Knik Arm in upper Cook Inlet (Allen and Angliss 2012).

4.3.1 Status

Harbor seals are not listed as threatened or endangered under the ESA. Harbor seals also do not have any special status under the MMPA (Allen and Angliss 2012).

4.3.2 Diet and Distribution

A relatively small but unknown proportion of the harbor seal population inhabits the coastal and estuarine waters of Cook Inlet. Harbor seals are opportunistic feeders and will take advantage of various available prey sources, including fish, shellfish, and crustaceans. Accordingly, harbor seals are commonly observed along the Susitna River and other tributaries within upper Cook Inlet during seasonal movements of eulachon (early May) and salmon (June and July) (NMFS 2003). Foraging takes place along coastal regions, close to haulout sites, which consist of any terrestrial or ice platform the seals access.

Harbor seal haulout sites and the adjacent shallow waters are used for birthing, nursing, molting, and resting (Small et al. 2008). Harbor seals spend a considerable amount of time hauled out on shore rather than in the water during summer months, especially in June and August for pupping and molting (Montgomery et al. 2007). Although harbor seals are more common in lower Cook Inlet, aerial surveys in June 2012 (Shelden et al. 2012) observed haulout sites at several upper Cook Inlet locations, with the closest haulout located approximately 6.5 mi (10.5 km) from the proposed survey area (Figure A-8). Harbor seals have been sighted as far north as the Knik River bridge (Rugh et al. 2005).

This species is not known to be migratory, staying within 25 km of land and generally staying within 100 km of where they were tagged in one study (Small et al. 2008). In Alaska, pups are usually born between May and July and are able to swim within minutes of being born. Pups remain with their mothers for about a month, at which point the mothers are ready to mate again. Molting also occurs during summer months, when over half of the seals' time is spent hauled out. In contrast, during winter months these seals spend less time hauled out, living in water around 80 percent of the time.

4.4 KILLER WHALE

The killer whale, or orca, is a widely distributed species whose population status is generally unknown. Killer whale pods can be defined as being 'resident', 'transient', or 'offshore' through various differences in their morphology, ecology, genetics, acoustics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Two recognized killer whale stocks may occur in Cook Inlet. The eastern North Pacific Alaska resident stock, occurring from southeastern Alaska to the Aleutian Islands, is one of eight distinct resident killer whale stocks recognized within the

Pacific U.S. Exclusive Economic Zone. The Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock occurs from Prince William Sound to the Aleutian Islands and Bering Sea (Allen and Angliss 2012).

4.4.1 Status

The Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock and the Eastern North Pacific Alaska resident stock of killer whales are not listed under the ESA, and have no special status under the MMPA (Allen and Angliss 2012).

4.4.2 Distribution

The Eastern North Pacific Alaska resident killer whale stock lives in the largest pods and feeds primarily on fish (salmonids in the case of Alaskan orcas). The Gulf of Alaska, Aleutian Islands, and Bering Sea transient killer whale stock feeds primarily on marine mammals, including the endangered Cook Inlet beluga whales and Steller sea lions. Resident and transient killer whales have different distributions within the Gulf of Alaska. Resident killer whales are more abundant near Umnak and Unalaska in the eastern Aleutians, Seguam Pass in the central Aleutians, and the area surrounding Kodiak (Zerbini et al. 2007). Transient killer whales occur at high densities from Shumagin Island to the eastern Aleutian Islands, with little to no occurrence east of Shumagin Island. In the Pacific Ocean, calving is thought to occur mainly between October and March with mating occurring during summer months of May through August in nearshore areas (Ward et al. 2009). It is believed that members of the different types of killer whales do not interbreed.

An estimated 2,347 resident killer whales belong to the Alaska resident stock (Allen and Angliss 2013). The number of individuals in Cook Inlet fluctuates but it is assumed that there can be an absolute maximum of 2,500 whales in and around the Gulf of Alaska and Cook Inlet, based on the resident and transient stock. The actual number of killer whales in Cook Inlet is believed to be much lower than this number at any given time. The availability of prey species, including beluga whales and anadromous fish in the Cook Inlet likely has the largest influence on their occurrence within the Inlet. From 1993 to 2004, 23 killer whales were observed in the lower Cook Inlet (Rugh et al. 2005). Survey data collected over 20 years (Shelden et al. 2003) indicated only 11 sightings of killer whales between Turnagain Arm, Susitna Flats, and Knik Arm in the upper Cook Inlet. The most recent aerial survey by Shelden et al. (2012) observed several pods of killer whales in the Cook Inlet, none of which were further north than the area between Chinitna and Kachemak Bay. Recent surveys from Funk et al. (2005), Ireland et al. (2005), Brueggeman et al. (2007a, 2007b, 2008), and Prevel Ramos et al. (2006, 2008) have not observed killer whales within the Cook Inlet.

4.5 STELLER SEA LION

The Steller sea lion (*Eumetopias jubatus*) belongs to the family Otariidae which includes fur seals. Steller sea lions are found throughout the North Pacific Rim, ranging from California north through Alaska and west to Japan (NMFS. 2008b). During the 1950s, the population throughout the North Pacific Range was between 240,000 and 300,000 individuals. However, by the early 1990s, this number had declined by approximately 80 percent. NMFS used genetic technology to identify two distinct population segments (DPS) of Steller sea lions within the North Pacific in 1997 (62 FR 24345). The eastern DPS of Steller sea lions ranges from California north to Cape Suckling, Alaska; the western DPS ranges from Cape Suckling west to Japan, including Cook Inlet. The Cook Inlet Steller sea lion population belongs to the western DPS (Allen and Angliss 2012).

4.5.1 Status

In 1997, the western DPS was listed as endangered under the ESA and critical habitat was designated for Steller sea lions in 1993 (62 FR 24345). Steller sea lions (all populations) are also listed as depleted under the MMPA. A minimum of 45,659 Steller sea lions are estimated to make up the Western US stock in Alaska while 52,200 is the extrapolated total population in Alaska using pup counts and survival and fecundity estimates (Allen and Angliss 2013). However, the number of Steller sea lions in Cook Inlet is unknown.

4.5.2 Distribution

Steller sea lions are not known to migrate, preferring to centralize around rookeries. Accordingly, designated critical habitat for this species includes all rookeries and 20 nautical miles seaward from the base of each. During summer months, these rookeries are used for birthing and raising pups in addition to mating activities. No rookeries occur in the mid or upper areas of Cook Inlet, but several have been identified at the extreme southern tip of the Kenai Peninsula (NMFS 2008b). Steller sea lions have an extensive range around the rookeries during the winter months and often travel far out to sea, using deep waters in excess of 1,000 meters as hunting grounds, feeding on fish and cephalopods (NMFS 2008b).

Steller sea lion sightings in the mid and upper areas of Cook Inlet are rare and are not well documented, but do occur. From 6 May to 30 September, marine mammal observers noted one Steller sea lion on 6 May, two on 23 June, and one on 18 August during 2012 monitoring for seismic survey activities in the Cook Inlet (Apache 2013).

Moreover, annual surveys conducted by NMFS each June and/or July since 1993 have resulted in a total of 42 Steller sea lion sightings in Cook Inlet (Rugh et al. 2005). However, the sightings were primarily restricted to the lower Inlet. More recently, Shelden et al. (2012) observed a group of 65 Steller sea lions hauled out near Cape Douglas in lower Cook Inlet (Figure A-8).

4.6 GRAY WHALE

The gray whale is a large baleen whale known to have one of the longest migrations of any mammal. This whale can be found all along the shallow coastal waters of the North Pacific Ocean.

4.6.1 Status

The Eastern North Pacific stock, which includes those whales that travel along the coast of Alaska, was delisted from the ESA in 1994 after distinction between the western and eastern populations was made (59 FR 31094). It is estimated that a minimum of approximately 18,000 individuals exist in the eastern stock (Allen and Angliss 2012).

4.6.2 Distribution

Gray whales are highly migratory, spending summer months feeding in the northern Bering and Chukchi seas before migrating to tropical waters (Rice and Wolman 1971, Berzin 1984, Nerini 1984). Gray whales have also been reported feeding in the summer in waters near Kodiak Island and Southeast Alaska (Rice and Wolman 1971, Darling 1984, Nerini 1984, Rice et al. 1984, Moore et al. 2007). Their migratory route includes the Gulf of Alaska, where gray whales have been sighted on the way to the calving and breeding grounds in the waters of the coast of Mexico (Rice et al. 1984).

Calves are born in shallow lagoons and bays from early January to mid-February. Migration south occurs in fall months while the northward migration occurs with newborn calves from mid-February to May. Gray whales have been observed to cross the mouth of Cook Inlet, apparently on their way northward for summer (Rugh et al. 2005). During both migrations, gray whales feed sporadically, usually traveling with empty stomachs. Due to very limited sightings of the gray whale in the Cook Inlet, it is unknown whether and, if so, where gray whales forage in Cook Inlet. However, in other coastal areas of Alaska gray whales tend to forage in relatively shallow coastal waters (Leatherwood et al. 1988).

Systematic counts of Eastern North Pacific gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967. The most recent abundance estimates are based on counts made during the 1997/98, 2000/01, and 2001/02 southbound migrations, and range from about 18,000 to 30,000 animals. Although observations of this species are rare within Cook Inlet, marine mammal observers noted individual gray whales on nine occasions in the vicinity of this proposed project during 2012 monitoring for seismic survey activities: four times in May, twice in June and three times in July (Apache 2013). Annual surveys conducted by NMFS in Cook Inlet since 1993 have resulted in a total of five gray whale sightings (Rugh et al. 2005). In sum, the Cook Inlet comprises neither essential feeding nor social grounds, and the species is typically not observed within the upper Cook Inlet (Rugh et al. 2005). However, due to these recent sightings, Furie has included the gray whale within the scope of this IHA application.

4.7 FUNCTIONAL HEARING ABILITY AND SOUND PRODUCTION OF MARINE MAMMALS

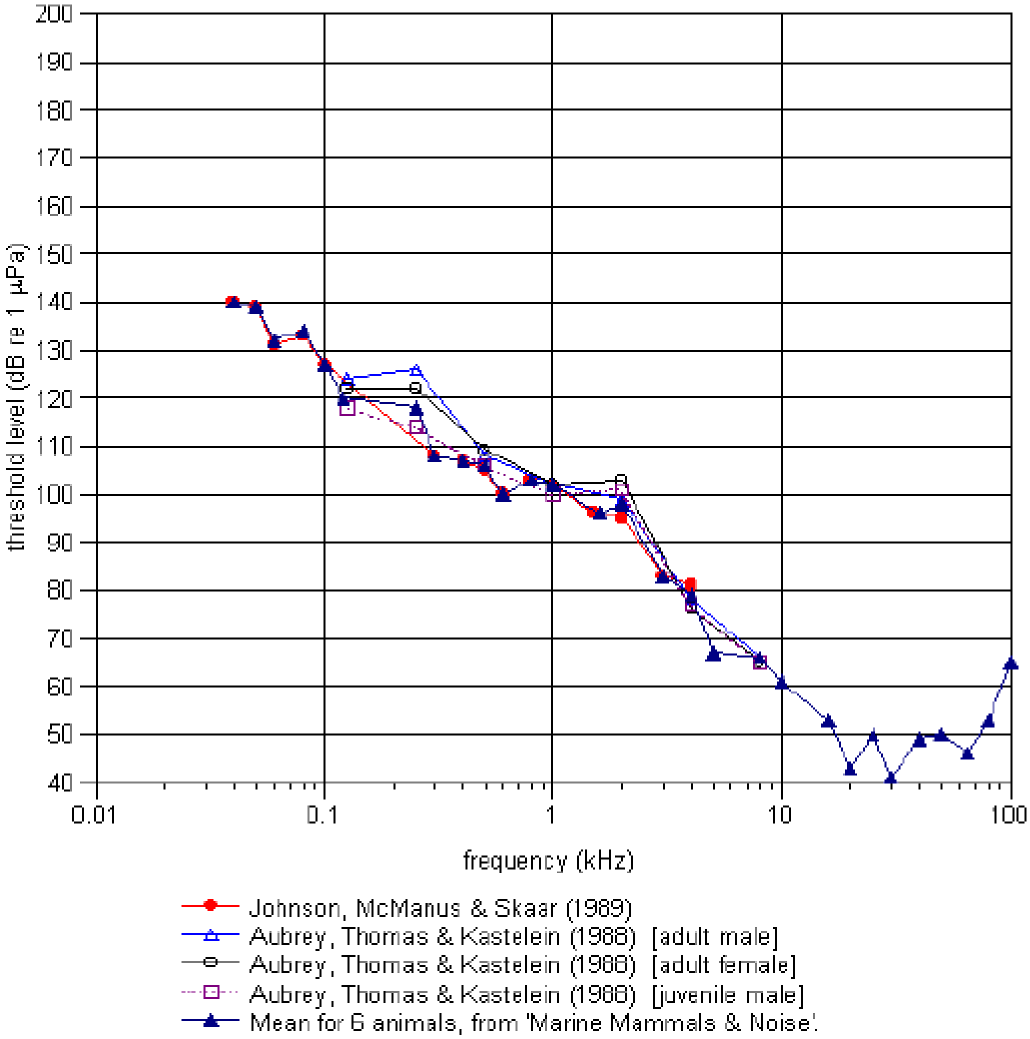
Sound level sensitivities of marine mammals vary by the frequency of the sound source (Richardson et al. 1995). Marine mammals in general have a functional hearing range of 10 Hz to 200 kHz (Wartzok and Ketten 1999; Southall et al. 2007). Table 4-1 presents the underwater hearing and produced sound ranges of the subject species. For reference, the majority of the proposed seismic source energy is anticipated to be at 500 Hz or less with higher frequencies having increasingly lower decibel levels. Underwater audiograms available for the subject marine mammals are shown in Figures 4-1 through 4-4, visually representing the sensitivity of the species to sound (i.e. the lowest sound level at which the species detects a given frequency). In general, odontocetes (toothed whales such as the beluga, killer whale and harbor porpoise), have good functional hearing between 200 Hz and 100 kHz (NRC 2003). Baleen whales (e.g. gray whale) hear and produce sounds at lower frequencies. Most pinnipeds have the best hearing in the range between 1 kHz and 20 kHz. The harbor seal in particular is most sensitive above 10 kHz. Pinnipeds do not have high-frequency ultrasonic or low-frequency infrasonic hearing (Nedwell et al. 2004) and aside from the northern elephant seal, no pinniped has been shown to have even moderate hearing below 1 kHz (NRC 2003). In general, marine mammals have reduced auditory bandwidth and sensitivity to in-air sounds (Kastak and Schusterman 1995; Richardson et al. 1995).

Table 4-1
Sound Use by Marine Mammals

Marine Mammal Species	Estimated Underwater Auditory Bandwidth	Produced Sound Range
Gray Whale	7 Hz to 22 kHz (baleen whales in general)	Less than 100 Hz to 2 kHz, most energy at 327 Hz to 825 Hz.
Beluga Whales	150 Hz to 160 kHz, most sensitive between 10 kHz to 100 kHz	0.26 kHz to 20 kHz (calls) 40 kHz to 60 kHz, 100 kHz to 120 kHz (echolocation
Killer Whale	150 Hz to 160 kHz	0.5 kHz to 25 kHz pulsed calls, 12 kHz to 25 kHz echolocation
Harbor Porpoise	200 Hz to 180 kHz	2 kHz (calls), 110 kHz to 150 kHz (echolocation)
Steller Sea Lion	75 Hz to 75 kHz (pinnipeds in general)	0.5 kHz to 8 kHz, most energy less than 4 KHz (California sea lion)
Harbor Seal	75 Hz to 75 kHz (pinnipeds in general); most sensitive above 10 Hz	Less than 0.1 kHz to 150+ kHz

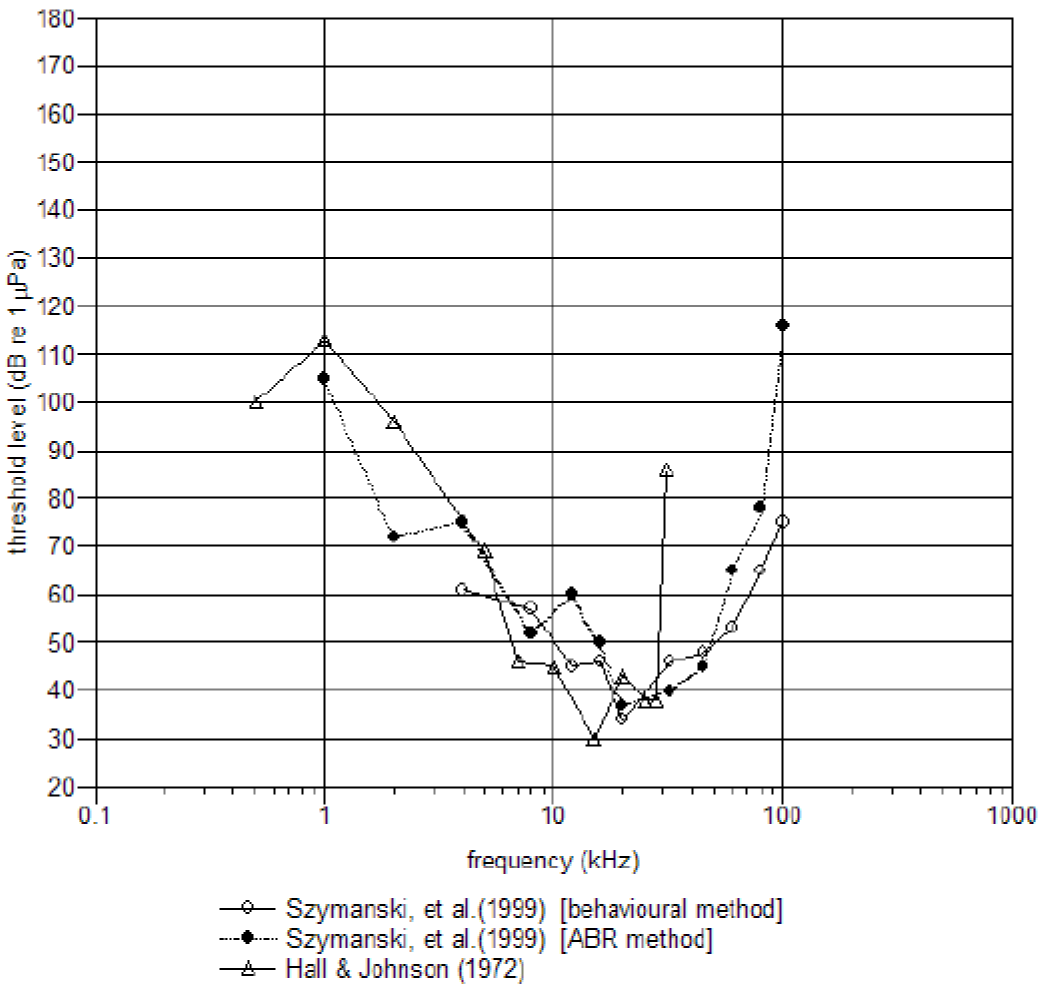
Note:
Adapted from Richardson et al. 1995 and Southall et al. 2007.

Figure 4-1. Beluga Whale In-Water Audiogram



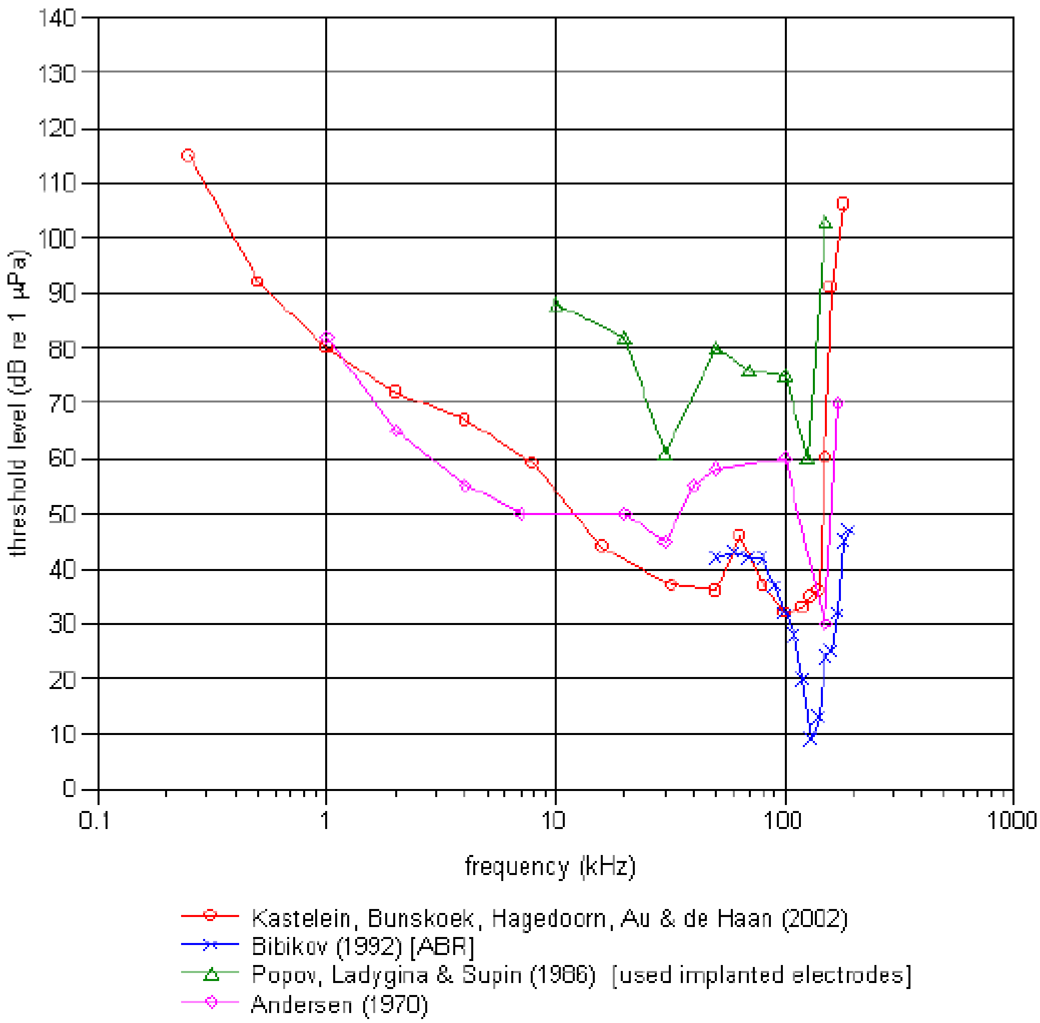
Note: Adapted from Nedwell et al. 2004

Figure 4-2. Killer Whale In-Water Audiogram



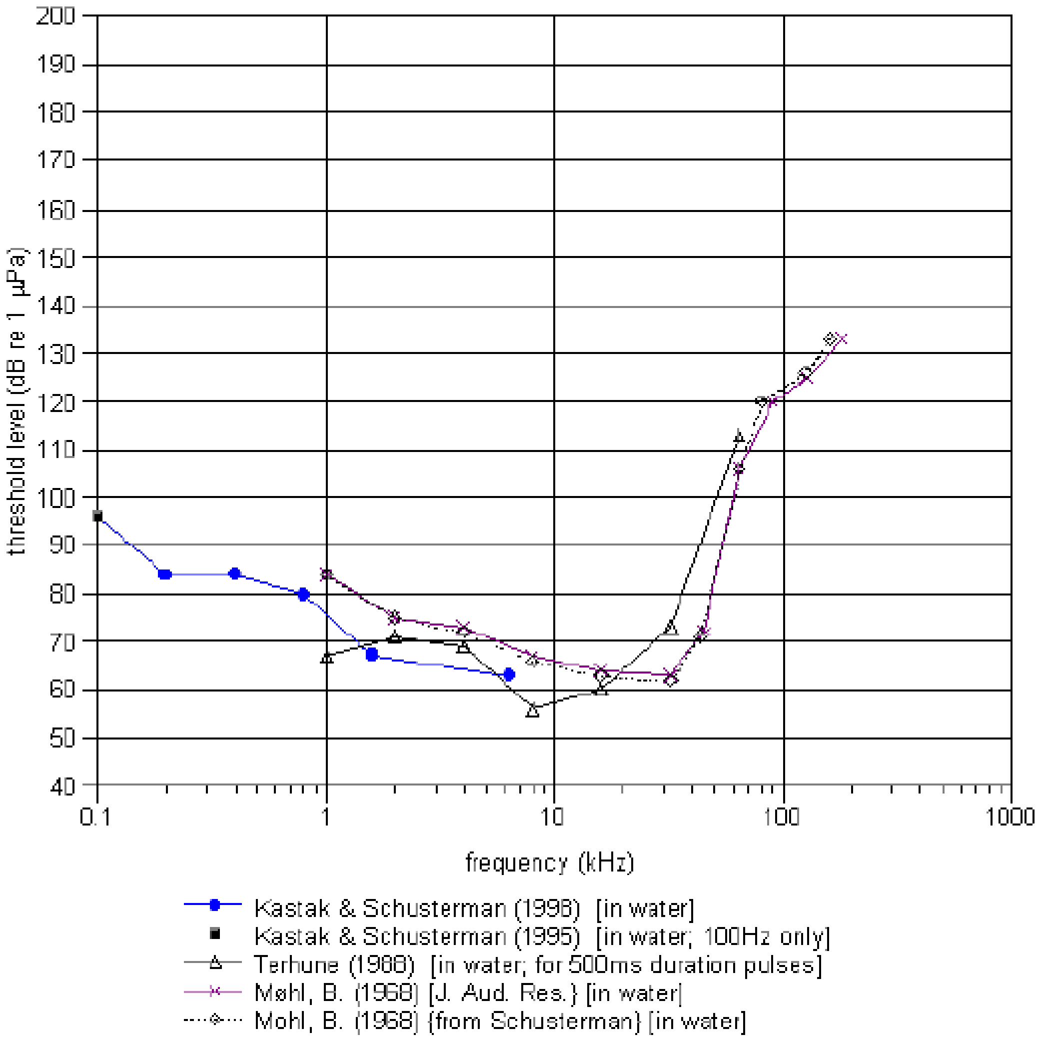
Note: Adapted from Nedwell et al. 2004

Figure 4-3. Harbor Porpoise In-Water Audiogram



Note: Adapted from Nedwell et al. 2004

Figure 4-4. Harbor Seal In-Water Audiogram



Note: Adapted from Nedwell et al. 2004

5.0 REQUESTED TYPE OF INCIDENTAL TAKING AUTHORIZATION

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment injury and/or death) and the method of incidental taking.

Furie seeks authorization for the non-lethal, incidental take of a small number of marine mammals by Level B harassment, pursuant to Section 101(a)(5)(D) of the MMPA during the proposed seismic survey in Cook Inlet, Alaska. Level B harassment is defined as “any act that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption to behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering” (50 CFR 216.3).

The method of incidental take by Level B harassment will result from exposure to pulsed sound at levels at or exceeding 160 dB re 1 μPa rms, which has been designated by NMFS as the threshold for Level B harassment by acoustic disturbance for the species covered in this IHA application. No injury to or mortality of any marine mammal is expected given the nature of the proposed activity and the proposed avoidance and minimization measures (Section 1.3), nor does Furie request authorization for any takes other than incidental take by Level B harassment.

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6.0 INCIDENTAL TAKE ANALYSIS

By age, sex and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in paragraph (a)(5) of this section [Section 7 of the Endangered Species Act and the National Environmental Policy Act(NEPA)], and the number of times such takings by each type are likely to occur.

This section sets forth a series of calculations and assumptions to provide the best estimate of the number of marine mammals that may be incidentally taken by the proposed activity as summarized as follows:

- The expected density of each species in the project area is estimated based on the best available data.
- The total number of marine mammals that could potentially (if no avoidance and minimization measures were implemented) be exposed to pulsed sound levels at or exceeding 160 dB re 1 μPa rms is estimated. The number of marine mammals potentially exposed is calculated by multiplying the density of the marine mammals expected to be present by the area that will be ensonified to 160 dB.
- The estimated numbers of marine mammals, by species, that may be taken are derived by reducing the number of potential exposures based on data and information regarding site-specific observations of marine mammals and the effects of Furie's proposed avoidance and minimization measures (Section 1.3).

Based on the design of Furie's seismic program, along with implementation of Furie's proposed avoidance and minimization measures, Level A harassment of marine mammals is not expected to occur. The proposed avoidance and minimization measures are further expected to substantially avoid and minimize the extent of Level B harassment of marine mammals, if any. Any such Level B harassment will have no more than a negligible impact on the marine mammal species and stocks affected and will be limited to small numbers of marine mammals. The proposed measures include coordinating the timing and location of the proposed seismic survey to avoid areas where marine mammals (particularly Cook Inlet beluga whales) concentrate at certain times of the year, and power-down and shutdown procedures that would suspend airgun operations when marine mammals are observed in or near the area of operations.

6.1 MARINE MAMMAL POPULATION DENSITY ESTIMATES

Population density estimates are based on the best available scientific data. Data specific to Cook Inlet are available for beluga whales and harbor porpoises. For harbor seals, gray whales, killer whales, and Steller sea lions, the data describes larger regional stock assessments and, therefore, supplemental data or observations must be used in order to estimate densities specific to upper Cook Inlet. The density calculations are described for each species in this section. The densities presented here are in most cases higher than those expected in the project area because the population surveys target areas where marine mammals are concentrated (e.g. feeding grounds, haulout areas), which are locations outside of the project area, and thus over-represent the densities that would be found in open water in the upper Cook Inlet.

6.1.1 Density of Beluga Whales

Annual surveys of the Cook Inlet beluga whale provide total population estimates, but because the whales are not typically distributed across the entire survey area, the data do not allow for the direct calculation of density across their entire range. Assumptions are necessary to estimate density for the proposed seismic survey project area.

A population estimate is developed annually for Cook Inlet beluga whales through aerial surveys that cover approximately 30 percent of the Cook Inlet surface area using the methods described by Hobbs et al. (2000) (Rugh et al. 2000, Rugh et al. 2005). During early June, three to seven surveys of upper Cook Inlet and one survey of lower Cook Inlet are conducted. During each aerial survey, the entire coastline to approximately 3 km offshore and all river mouths are surveyed. Transects across the Inlet are flown as well. The daily counts during the annual aerial survey are corrected for perception bias, which is the possibility of not seeing or counting a visible whale, as well as for availability bias, which is the inverse of the probability that a typical beluga is at or will appear at the surface during the survey. The population estimate for the Cook Inlet beluga whales was 312 individuals for 2012 (Shelden et al. 2012). Based on the coefficient of variation, Shelden et al. (2012) reported a minimum Cook Inlet beluga population estimate of 280 and an upper confidence limit of 402 individuals in 2012.

During the target dates for the proposed seismic survey and for most of the summer, beluga whales are concentrated in the upper Cook Inlet near river mouths in Turnagain Arm, Knik Arm, Chickaloon Bay and the Susitna Delta (Rugh et al. 2005, Hobbs et al. 2005). The majority of the total population was observed in these areas from approximately June through September. In most years of the June aerial survey since the mid-1990s, beluga whales were not observed south of the East and West Forelands, with the majority of the population occurring in the Susitna Delta (Rugh et al. 2010). The median daily count of beluga whales in mid Cook Inlet near the proposed Furie project area was nine in 1993, one in 1994, and four in 1995. There were no beluga whales counted in mid Cook Inlet near the proposed Furie project area in any year from 1996 through 2011, until a group of up to 21 beluga whales was observed in Trading Bay in June of 2012 for the first time since 1995 (Rugh et al. 2005, Shelden et al. 2012, NMFS unpublished data). As discussed in Section 4.1.3, more recent aerial surveys in August 2012 by Sims et al. (2012) did not observe belugas in the Trading Bay area, or even south of the Beluga River.

Due to the seasonal concentration of beluga whales in certain areas of Cook Inlet, accurate densities cannot be calculated by assuming the total population is spread evenly throughout the Inlet at all times of the year; doing so would greatly overestimate the density of belugas expected in most areas of the upper Cook Inlet from May through November. Although the actual distribution of the Cook Inlet beluga population during the proposed project period is unknown and inherently varies over time, some studies and additional observations inform the calculation of the best density estimates. Refer to Section 4.1 for a discussion on seasonal distribution of beluga whales in Cook Inlet.

The distribution of beluga whales varies over the course of the summer and into the fall, depending largely on the timing of various fish runs. Movements of 14 satellite-tagged beluga whales studied from 2000 to 2003 indicate that 95 percent of the range where belugas are found from August through November varies from 982 km^2 to 2,945 km^2 (Hobbs et al. 2005; Figure A-7). Hobbs et al. (2005) did not predict distributions for the months of May, June, or

July; however, given that the annual aerial surveys in June typically observe the population in the Susitna Delta and Chickaloon Bay and that the population remains in the Susitna Delta and moves into the Knik Arm around August, the predicted distribution for the month of August is generally expected to represent the distribution of beluga whales during June and July. Prey species, specifically hooligan, arrive in upper Cook Inlet in April with major spawning runs in the Susitna River beginning in May (NMFS 2008a). The arrival of the hooligan appears to draw Cook Inlet beluga whales north around mid-April (NMFS 2008a; Huntington 2000) and thus the distribution of beluga whales in May is assumed to be similar to June, July, and August. Accordingly, the 95 percent probability range area estimated for May, June, and July is assumed to be equal to the area presented for August (982 km^2).

The predicted densities set forth below are based on the reasonable assumption that 95 percent of the total Cook Inlet beluga whale population will be distributed within the 95 percent probability range area for any given month (high concentration area) and that the remaining 5 percent of the population will occur in other areas of the upper Cook Inlet (low concentration area). Figures A-9 through A-24 depict the high concentration areas (shaded red, green and yellow per Hobbs et al. 2005) in relation to the proposed project area. The density for the high and low concentration areas is calculated by dividing 95 percent of the population estimate by the area within the 95 percent range probability kernel of the given month, and 5 percent of the population by the remaining area of upper Cook Inlet (3840 km^2 total), respectively. Table 6-1 presents the population density estimate for the high and low concentration areas of upper Cook Inlet based on the 2012 population estimate (312) and the 95 percent probability range areas published by Hobbs et.al. (2005).

Table 6-1
Predicted Cook Inlet Beluga Whale Densities Within and Outside of the 95% Probability Kernel

Month	Area of 95% Probability (km^2)	High Concentration Area (Number of Animals/km^2)	Low Concentration Area (Number of Animals/km^2)
May/June/July/August	982	0.3018	0.005458
September	1605	0.1847	0.006980
October	2945	0.1006	0.01743
November	2013	0.1472	0.008539

Notes:
Densities in high concentration areas (in 95% kernel area) are calculated using 95% of population estimate divided by the area of 95% probability kernel.
Densities in low concentration areas (Other upper Cook Inlet) are calculated using 5% of population estimate divided by the remaining area in the upper Inlet (3840 km^2 minus the area of 95% probability kernel).

Goetz et al. (2012a) re-analyzed the data reported in Hobbs et al. (2005) and also predicted low numbers of belugas per km^2 in the vicinity of the proposed project area, with the greatest numbers occurring along the coastline along Trading Bay and a shallow area known as Middle Ground Shoal. The density of belugas in the 2012 modeling study was derived as the product of the probability of beluga presence in a specific location and the expected number of individuals when beluga whales are present, using aerial survey data from 1994 to 2008. Of these years, belugas were only observed near the proposed project area in 1994 and 1995.

Additionally, site-specific observations support the findings reported by Hobbs et al. (2005) and Goetz et al. (2012a). Individual observers have reported sighting beluga whales ranging from 1 to 75 individuals (average 16.5) on 24 occasions from 2000 through 2010 in the area south of Threemile Creek connecting to Point Possession and north of East Forelands connecting to West Forelands (observations were made from planes, vessels, shore, and oil platforms; NMFS unpublished data). Only 13 of these sightings occurred in the months of June through September, and no sightings were reported in May, October or November. This average number of beluga whales (16.5) represents 5 percent of the average population abundance estimate (350) from the same time period.

Marine mammal observations are available for the vicinity of the proposed Furie project area as part of monitoring efforts for seismic survey work conducted during May through

September of 2012 (Apache 2013). These observations were made as part of the implementation of mitigation measures to avoid potential harassment and injury to marine mammal species and not for the purpose of estimating population abundance. However, this monitoring data from Apache's 2012 seismic program represents the best available site-specific observational data (Table 6-2). Dividing the number of individuals visually recorded through vessel and land-based observers per month by the number of sightings, the average group size of beluga whales in May, June, July, and September was 6.9. No belugas were observed by vessel and land-based observers in August.

Table 6-2
Beluga Whales Observed During Seismic Survey Activities in 2012

Month	Estimated Number of Individuals Observed	Number of Sightings	Assumed Average Group Size
May	52	20	2.6
June	77	7	11
July	161	23	7
August	0	0	N/A
September	35	5	7
		Average	**6.9**

6.1.2 Density of Harbor Porpoises

A population estimate for the harbor porpoise is available for the Gulf of Alaska stock encompassing the area from Cape Suckling to Unimak Pass, which includes Cook Inlet (Allen and Angliss 2012). The most current estimate of 31,046 individuals is based on a 1998 harbor porpoise aerial survey of the Gulf of Alaska and the 1998 Cook Inlet beluga whale aerial survey and was corrected for availability bias in 2010 (Hobbs and Waite 2010). According to Hobbs and Waite (2010) the survey area for the Gulf of Alaska stock was 158,733 km^2, and the estimated density was 0.196 porpoise per km^2 across the Gulf of Alaska area. Using data specific to Cook Inlet, the Cook Inlet harbor porpoise density estimate can be calculated as 0.0389 porpoises per km^2 (Hobbs and Waite 2010) (Table 6-3). Both of these estimates are greater than the calculated Cook Inlet harbor porpoise density from 1991 aerial surveys (0.0072 porpoises per km^2) (Dahlheim et al. 2000). The 1991 estimate was not corrected for availability bias and application of the same correction factor used in Hobbs and Waite (2010) results in a density estimate of 0.0214 porpoises per km^2. The average density of harbor porpoise in Cook Inlet, combining the results from the two Cook Inlet specific surveys, is 0.0302 porpoise per km^2 (Table 6-3).

Table 6-3
Harbor Porpoise Densities Observed or Calculated From Cook Inlet Surveys

Stock and Survey Year	Population Estimate	Area (km^2)	Density (number of animals/km^2)
Cook Inlet, 1998	737 [1]	18948	0.0389
Cook Inlet, 1991	402 [2]	18787	0.0214

Notes:
[1] Population estimate and area from Hobbs and Waite 2010.
[2] Population estimate reported in Dahlheim et al. 2000 of 136 multiplied by 2.96 correction factor.

Harbor porpoise are documented during the annual aerial surveys for beluga whales, but are generally not observed in the upper Cook Inlet. The number of harbor porpoises observed in lower Cook Inlet in recent surveys are reported in Table 6-4 (Shelden et al. 2009, 2010, 2012). The 2011 survey did not report sightings of marine mammals other than beluga whales and is not included in this table. The observed number of harbor porpoises is multiplied by a 2.96 correction factor and divided by the area of the aerial survey each year to estimate harbor porpoise densities.

Table 6-4
Harbor Porpoises Densities Based on Observations During Annual Aerial Survey

Year	Observed Number of Porpoises	Corrected Numbers	Area (km^2)	Density (Number of Animals/km^2)
2009	86	254.56	5766	0.044
2010	10	29.6	6120	0.0048
2012	11	32.56	6219	0.0052
			Average	**0.018**

The average of the calculated density from three recent aerial surveys (0.018 porpoises per km^2) and the two published harbor porpoise densities for Cook Inlet (0.0389 and 0.0214 porpoises per km^2) is 0.0261 porpoises per km^2. Using this average as an approximation of Cook Inlet harbor porpoise density provides better accounts for variability in the areas of Cook Inlet surveyed in each study by considering the potential for bias due to some of the surveys being for porpoise and some for belugas with incidental porpoise sightings, and for inclusion of the most recent data than could be accounted for by using only one of the calculated densities.

Marine mammal observations gathered by Apache during 2012 seismic survey work reports the number of individuals visually recorded through vessel and land-based observers (Table 6-5). Dividing the number of individuals visually recorded by the number of sightings, the average group size in May through September was 1.37.

Table 6-5
Harbor Porpoises Observed During Seismic Survey Activities in 2012

Month	Estimated Number of Individuals Observed	Number of Sightings	Assumed Average Group Size
May	49	41	1.20
June	81	53	1.52
July	37	26	1.42
August	6	5	1.2
September	15	10	1.5
		Average	**1.37**

6.1.3 Density of Harbor Seals

Harbor seal population estimates are available for the Cook Inlet/Shelikof stock (Allen and Angliss 2012). The most current estimate of 22,900 individuals is based on a multi-year study of seasonal movements and abundance of harbor seals in Cook Inlet conducted between 2004 and 2007 (Montgomery et al. 2007). The surveys were conducted only in the lower Cook Inlet from the Forelands south to Cape Douglas. Actual abundance in the survey area is not reported so presumed density cannot be calculated from this information.

Harbor seals are observed during the annual aerial surveys for beluga whales and are the only marine mammals other than belugas to be routinely reported in the upper Cook Inlet. The number of harbor seals observed in upper Cook Inlet in recent surveys are reported in Table 6-6 (Shelden et al. 2009, 2010, 2012). The 2011 survey did not report sightings of marine mammals other than beluga whales and is not included in this table. The observed number of harbor seals is divided by the area of the upper Cook Inlet surveyed each year to estimate harbor seal densities. Harbor seals tend to concentrate and spend much of their time in haulout areas in June when these surveys are conducted. In contrast, harbor seals are not expected to be present at these densities in open water, as they tend to travel in small groups or as individuals when not hauled out. Accordingly, the densities reported in Table 6-6 overestimate the actual densities that likely occur in the proposed project area.

Table 6-6
Harbor Seal Densities Based on Observations During Annual Aerial Survey

Year	Observed Number of Seals	Area (km^2)	Density (Number of Animals/km^2)
2009	387	2036	0.190
2010	543	2340	0.232
2012	937	1756	0.534
		Average	**0.319**

Marine mammal observations gathered by Apache during 2012 seismic survey work reports the number of individual harbor seals visually recorded through vessel and land-based observers (Table 6-7). Dividing the number of individuals visually recorded by the number of sightings, the average group size in May through September was 1.17. This average group size supports the concept of harbor seals in the open water traveling in small groups or as individuals, thus at a lower density, through the project area.

Table 6-7
Harbor Seals Observed During Seismic Survey Activities in 2012

Month	Estimated Number of Individuals Observed	Number of Sightings	Assumed Average Group Size
May	184	182	1.01
June	174	166	1.05
July	115	104	1.11
August	31	29	1.07
September	64	39	1.64
		Average	**1.17**

6.1.4 Density of Gray Whales

Gray whale population estimates are available for the Eastern North Pacific stock (Allen and Angliss 2012). The most current population estimate is 19,126 individuals, but most of the stock spends the summer in the northern and western Bering and Chukchi seas. During the annual aerial surveys for beluga whales, a total of seven individual gray whales were observed from 1993 to 2004 in the lower Cook Inlet (Rugh et al. 2005). More recently, aerial surveys report only one gray whale in lower Cook Inlet and none in upper Cook Inlet in 2009, 2010, and 2012 (Shelden et al. 2009, 2010, 2012). During 2012 seismic survey work in a similar project area, at least one individual gray whale was observed by PSOs on four occasions in May, two times in June, and three times in July (Apache 2013). In sum, gray whales are rarely observed in Cook Inlet. For purposes of the analysis set forth in this application, and based upon the recent observation by Apache, this analysis assumes that two gray whales will potentially occur in the project area.

6.1.5 Density of Killer Whales

Killer whale population estimates are available for the Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock. The most recent population estimate is 587 individuals for the entire stock with 136 in the Gulf of Alaska (Allen and Angliss 2013). Estimates for the Eastern North Pacific Alaska resident stock are 2347 individuals with 751 of those in the Prince William Sound area (Allen and Angliss 2013).

Most killer whale sightings are recorded in lower Cook Inlet and the observed animals may be from any one of the stocks identified above. The number of killer whales observed in Cook Inlet during recent aerial surveys for beluga whales are reported in Table 6-8 below (Shelden et al. 2009, 2010, 2012). The 2011 survey did not report sightings of marine mammals other than beluga whales and is not included in this table. The observed number of killer whales is divided by the area of the aerial survey each year to estimate density.

Table 6-8
Killer Whale Densities Based on Observations During Annual Aerial Survey

Year	Number of Killer Whales	Area (km^2)	Density (Number of Animals/km^2)
2009	0	5766	0
2010	33	6120	0.0054
2012	3	6219	0.00048
		Average	**0.00196**

No killer whales were observed by PSOs during seismic survey work from May through September 2012 in a similar project area (Apache 2013).

6.1.6 Density of Steller Sea Lions

The population estimate available for the Western DPS of Steller sea lions is 45,659 (Allan and Angliss 2013) but the actual number of sea lions that occur in Cook Inlet is unknown. During the annual aerial surveys for beluga whales, a total of 560 individuals were observed in 42 sightings from 1993 to 2004 (Rugh et al. 2005). The sea lions are considered to be undercounted in these surveys, however, because researchers were mainly scanning the water and not shore areas. The number of Steller sea lions observed in Cook Inlet in recent surveys are reported in Table 6-9 (Shelden et al. 2009, 2010, 2012). All sea lions were observed in lower Cook Inlet. The observed number of sea lions is divided by the area of the aerial survey each year to estimate densities. The 2011 survey did not report sightings of marine mammals other than beluga whales and is not included in this table.

Table 6-9
Steller Sea Lion Densities Based on Observations During Annual Aerial Survey

Year	Number of Steller Sea Lions	Area (km^2)	Density (Number of Animals/km^2)
2009	39	5766	0.00676
2010	1	6120	0.000163
2012	65	6219	0.0105
Average			**0.00579**

Steller sea lions observed by PSOs during seismic survey work from May through September 2012 in a similar project area included one individual in May, two in June, and one in August (Apache 2013).

6.2 DURATION AND INTENSITY OF ACTIVITIES

The proposed 3-D seismic survey will be conducted in the Cook Inlet from approximately Tyonek at the northern extent to the Forelands in the south, encompassing approximately 868 km^2 (335 mi^2) of intertidal and offshore areas. As described in Section 2.0, Furie proposes to survey the entire project area in four months with start and end dates dependent on permit authorization and actual survey days influenced by other factors such as commercial fishing activities, other seismic survey operations in overlapping or adjacent areas, and general operational factors (i.e. weather). The target date to begin the survey is 1 May 2014. With this proposed start date, the entire survey is anticipated to be completed by 30 August 2014. Should the survey start date be delayed, alternate timing for the survey will depend on the priority of the survey area and may extend into November 2014. Priority areas for surveying and alternate timing are described in Section 2.0. Each priority area will require approximately 30 days to survey. The overall duration estimate includes a 10 to 15 percent increase for weather and other delays. The timing of the survey of each priority area can be adjusted based on the achievable start date after the issuance of the IHA. The survey location can be adjusted to avoid anticipated locations of higher concentrations of beluga whales during each month. This prioritization and flexibility is incorporated into the exposure calculations presented herein.

During each 24-hour period of survey activity, in-water airguns for survey activities will be active for approximately 2 to 3 hours around each of the four slack tide periods. Therefore, survey airgun operations will be active during approximately 8 to 12 hours per day, if weather conditions allow. A 10 in^3 airgun may be used between these periods of active survey using full airgun array.

The proposed airgun array will ensonify the Inlet surrounding the survey area to levels at and exceeding 160 dB re 1 μPa rms, the NMFS threshold for Level B acoustic harassment (refer to Sections 1.3.3.1, 3.0, and 7.1.2 for discussion regarding this threshold). The area that will be ensonified to at least 160 dB re 1 μPa rms during seismic operations is identified as a buffer surrounding the survey area, called the safety radius. The safety radius for the proposed seismic survey is estimated by the maximum distance sound at the 160 dB re 1 μPa rms level was predicted to travel from a 2,400 in^3 airgun array during a seismic survey in an overlapping area of Cook Inlet (Warner et al. 2011 [JASCO]). Furie may use a smaller airgun array during the proposed seismic work but the 2,400 in^3 array was used to model the largest predicted safety radius. Considering the levels and attenuation of sound modeled at various depths for the 2,400 in^3 airgun array, the maximum safety radius is calculated to be 6 km (4 miles). However, the analysis presented in this application uses a safety radius increased from 6 km to 9.5 km based on sound source verification within the project area (Apache 2013). For evaluation purposes, this IHA considers a 9.5-km safety radius around the proposed survey area (the actual safety radius will be determined prior to the survey start with a sound source verification study, as described below). Figure A-25 presents the total ensonified area over the course of the project resulting from survey areas proposed by two different potential survey contractors. The maximum total area is calculated to be 1925 km^2. A third potential contractor proposed a footprint identical to Contractor A. On a daily basis, work will overlap within this area, but individuals exposed to sound from the project would be in the area for a few days to weeks at a time and exposed to some area within the total project area so the ensonified area is calculated with no overlap.

Figures A-9 through A-24 present the safety radius around each priority survey area (Priority Areas 1, 2, 3a, and 3b) for one seismic survey proposal. Each area will require approximately 1 month to complete, so the priority areas also represent the project effects area for each month. The area predicted to be ensonified to 160 dB is presented in Table 6-10 for each proposal.

Table 6-10
Monthly Area Predicted to Be Ensonified to 160 dB

Priority Area	Area Ensonified to 160 dB (km^2)	
	Proposal A	Proposal B
Priority Area 1	890	905
Priority Area 2	880	885
Priority Area 3a	775	865
Priority Area 3b	1050	1000

The actual ensonified area will vary depending on the airgun array used, which may be smaller than the 2,400 in^3 array used in the model, and on the survey footprint used by the selected contractor. The 9.5-km safety radius is based on the proposed survey areas and is used here as a very conservative estimate of the maximum potentially ensonified area. A sound source verification study for this project will be used to modify the actual safety radius prior to the start of the seismic survey.

6.3 NUMBER OF MARINE MAMMALS POTENTIALLY EXPOSED TO SOUND AT OR EXCEEDING THE LEVEL B HARASSMENT THRESHOLD

Tables 6-11, 6-12, and 6-13 present the calculated number of Cook Inlet beluga whales and other marine mammals potentially exposed to sound levels at or exceeding the Level B harassment threshold each month, or for the entire season, as applicable. The number of animals potentially exposed to sound exceeding Level B harassment thresholds is calculated for belugas based on their expected monthly distribution and for other marine mammals across the entire project area over all time periods.

In order to calculate the number of beluga whales potentially exposed to sound at or exceeding 160 dB, this analysis considered the following factors:

- **The size of the ensonified area**

  The size of the ensonified area varies for each priority area surveyed and varies with the layout proposed by the surveying contractor. For illustration purposes, the layout proposed by Contractor A was used to divide the work into the four priority areas depicted in Figures A-9 to A-24. This layout is identical to the one proposed by Contractor C. Contractor B proposed a slightly different layout and the resultant calculations are provided, but are not shown on the figures.

- **The month during which work will take place in that area**

  The month during which each priority area will be surveyed depends on the available start date for work and the desire to avoid working in areas where beluga whales will be present in higher concentrations, to the extent possible. Figures A-9 to A-24 depict work in each priority area over four different months, August through November. The distribution of beluga whales is presumed to be similar in May, June, and July to that observed in August based on the best available data.

- **The size of the ensonified area that overlaps predicted high and low beluga concentration areas**

  The degree to which each ensonified area overlaps high concentration areas for beluga whales varies from month to month. As shown on Figure A-9, the entire ensonified area for Priority Area 1 (890 km^2) in August is within the predicted low concentration area for belugas. However, in October the ensonified area for Priority Area 1 overlaps the high concentration area by 240 km^2. Therefore, the predicted number of beluga whales potentially exposed to sound at or exceeding 160 dB was calculated for each priority area for each month by multiplying the ensonified area by the density of beluga whales in that area, accounting for the degree of overlap with low and high beluga concentration areas. (Table 6-11 for Proposal A and Table 6-12 for Proposal B).

Using Priority Area 1 in August as an example, the predicted number of beluga whales potentially exposed to sound at or exceeding 160 dB is calculated by multiplying the ensonified area (890 km^2) by the density of belugas in low concentration areas in August (0.005458 belugas per km^2) to equal 4.8 beluga whales (rounded to 5). For Priority Area 1 in October, the number of belugas was calculated by first multiplying the ensonified area overlapping the red "high concentration" area (240 km^2) by the density of beluga whales in that area (0.1006 belugas per km^2) resulting in 24.1 belugas (rounded up to 25) and then by adding this number to the number calculated for the remaining low concentration area ([890 km^2 - 240 km^2] x 0.01743 belugas per km^2 = 11.3 rounded up to 12). The total for Priority Area 1 in October is 37 beluga whales (Table 6-11). This method is carried through for each priority area in each month.

Table 6-11
Predicted Number of Belugas Potentially Exposed to 160 dB (Proposal A)

Month	Priority Area 1 (890 km^2)	Priority Area 2 (880 km^2)	Priority Area 3a (775 km^2)	Priority Area 3b (1,050 km^2)
May	5	42	5	6
June	5	42	5	6
July	5	42	5	6
August	5	42	5	6
September	7	28	6	8
October	37	37	36	76
November	8	27	7	23

The same calculations were applied to the Proposal B survey area using the methods described (Table 6-12).

Table 6-12
Predicted Number of Belugas Potentially Exposed to 160 dB (Proposal B)

Month	Priority Area 1 (905 km^2)	Priority Area 2 (885 km^2)	Priority Area 3a (865 km^2)	Priority Area 3b (1,000 km^2)
May	6	51	5	6
June	6	51	5	6
July	6	51	5	6
August	6	51	5	6
September	7	33	7	7
October	35	39	43	74
November	10	30	8	20

The timing of survey activities in various tracts can be adjusted, to some extent, to avoid areas where beluga whales may be expected in greater densities. The modeling data is fairly coarse and can be expected to vary annually, but the best available anecdotal and scientific knowledge shows that belugas will be concentrated in the Susitna River delta, Turnagain Arm, and Knik Arm following the timing of various fish runs. The number of potential exposures that could occur depends upon the time frames in which Furie could accomplish the proposed work and the priority of the area (see Table 2-1 for proposed dates and the alternate timing options). The proposed project dates result in an exposure estimate at the lower end of the range; 58 beluga whales would potentially be exposed to 160 dB or greater in the survey area by sequencing the work in Priority Areas 1, 2, 3a, and then 3b in May through August (Proposal A). This estimate is 68 for the same priority sequence with Proposal B. Alternate timing option 1 (June through September) results in the lowest potential exposure estimate of 44 beluga whales by sequencing the work in Priority Area 1, 3a, 3b, and then 2 (Proposal A). At the higher end of the estimate range, the number of beluga whales potentially exposed would be 92 by assuming work does not start until August (alternate timing option 3, in order of Priority Areas 1, 2, 3a, and 3b, Proposal A). The higher range estimate is 107 for Proposal B.

For other marine mammals, the densities reported are not as seasonally dependent as for belugas, so the predicted density of animals is multiplied across the entire project area and is not reported on a monthly basis (Table 6-13). We used the largest, and thus the most conservative, exposure area of 1,925 km^2, calculated from Proposal A.

Table 6-13
Estimated Number of Other Marine Mammals Potentially Exposed to 160 dB

Species	Average Density (Number of Animals/km^2)	Ensonified Area (km^2)	Number of Individuals
Harbor Porpoise	0.0261	1925	51
Harbor Seal	0.319	1925	614
Gray Whales	unknown	1925	assumed at 2
Killer Whales	0.00196	1925	4
Steller Sea Lions	0.00579	1925	12

Note:
Total number of individual marine mammals potentially exposed to sound at or exceeding 160 dB over the course of the four month survey.

This section provides the initial analysis of the number of beluga whales that might potentially be exposed to Level B harassment in the absence of any avoidance and minimization measures, using the most conservative assumptions possible. Importantly, the potential exposure estimates described in this section are not the estimates of the actual number of incidental takes that are anticipated as a result of Furie's program. The actual number of marine mammals that may be incidentally taken will be much less than the number potentially exposed due to the implementation of a suite of avoidance and minimization measures (Section 1.3). Apache used similar measures in its 2012 seismic program and reported 13 takes of harbor seals, four takes of harbor porpoises and no takes of any other marine mammals, including belugas, during May through September 2012 (Apache 2013). Section 6.4 of this application provides the next step of the incidental take analysis by applying the proposed avoidance and minimization measures to the estimates of potential exposures to predict the actual anticipated incidental takes that may result from Furie's program. The final estimate of the number of marine mammals that may be incidentally taken as a result of the proposed project, after avoidance and minimization measures and other information are taken into account, are presented in Table 6-14.

6.4 INCIDENTAL TAKE SUMMARY

Due to the implementation of avoidance and minimization measures (Section 1.3) and protected species monitoring (Section 1.4), the number of animals actually exposed to sound levels 160 dB or greater is expected to be much lower than the number of animals potentially exposed as set forth above. Additionally, it is uncertain whether the seismic sounds will necessarily disrupt the behavior of every mammal that may occur within the ensonified area (discussed further in Section 7.0). The estimated number of marine mammals that may be incidentally taken reflects the balance of the implementation of measures to avoid harassment of marine mammals with the project needs to complete the work in a reasonable, yet cautious manner. For example, if seismic project work continues beyond September and increased numbers of belugas are encountered later in the season, the avoidance and minimization measures are designed to reduce or prevent harassment and, based on a substantial record (including the record of implementing similar measures in arctic operations and in Apache's Cook Inlet operations last year), these measures are reasonably expected to be effective both when higher and lower densities of marine mammals are present. For example, power-down and shutdown operations may occur more often when higher densities are present, but are reasonably expected, based on the available information, to be effective in avoiding take.

Similar measures to those proposed by Furie, including vessel and land-based monitoring and ramp-up and power-down procedures were employed by Apache in the project area in May through September 2012. Total marine mammal takes during that time were far below the potential number of animals predicted to be exposed and were also well below the number of takes applied for by Apache in 2012 (Apache 2012 IHA). As noted, avoidance and minimization measures used by Apache in this area resulted in 13 takes of harbor seals, four takes of harbor porpoises, and no takes of any other marine mammals, including belugas, during May through September 2012 (Apache 2013).

Taking into account the potential exposure calculations, the effects of implementing avoidance and minimization measures, and actual observer data from similar operations (i.e., Apache's 2012 survey), Furie estimates the number of marine mammals that may be taken by harassment as set forth in Table 6-14. The proposed avoidance and minimization measures are proven to be effective in reducing or eliminating marine mammal harassment (based on many years of implementation in the arctic and based on experience in Cook Inlet) and are described in detail in Section 1.3, above. Additional analyses in Section 7.1 presents information showing how belugas' hearing sensitivities, range of sound use, vocalization flexibility, and directional hearing allowing localization of sound sources will minimize the potential for the proposed activities to affect the behavior of the belugas. The ramp-up and power-down of airguns will significantly minimize the potential for belugas to be exposed to Level B harassment. In addition, qualified PSOs will monitor the 160 dB isopleth safety radius around seismic activities prior to and during all airgun operations. This monitoring will be used to detect marine mammals approaching the 160 dB isopleth safety zone. If a marine mammal is detected outside the safety zone and is likely to approach or enter the safety zone (based on its relative direction of travel), a vessel's speed and/or direct course may, when practical and safe, be altered to increase the distance between the observed marine mammal and the safety zone. Airgun operations will be shut down, not powered down, if concentrations of four or more individual belugas or any whale species or cow/calf pairs of beluga whales are noted by the PSO and if they are approaching the safety radius and do not appear to be traveling (e.g., they are feeding, socializing, etc.). Although beluga whales may potentially occur in the project area, these measures, which are proven to be effective, are designed to avoid and minimize the extent, if any, of Level B harassment.

The best available data regarding beluga harassment as a result of seismic operations in Cook Inlet (i.e., the results of Apache's 2012 seismic program) suggest that the proposed avoidance and minimization measures will eliminate all beluga incidental take because Apache observers reported zero beluga incidental takes associated with implementation of Apache's seismic program, which involved similar avoidance and minimization measures to those proposed by Furie. Despite this recent information, Furie has conservatively estimated the anticipated incidental take as greater than zero based on the conservative assumption that the avoidance and minimization measures may not completely eliminate the potential for incidental harassment. Taking into account the data from Apache's program, the conservative estimates of potential exposures provided in Section 6.3 above, the application of the proposed avoidance and minimization measures (as described in detail in Section 1.3), and all available information about beluga distribution and abundance, and using the most conservative estimates and assumptions, we estimate that up to two groups of nine beluga whales may be incidentally harassed as a result of implementation of Furie's program (Table 6-14). This group size is based on the group sizes observed from vessel- and land-based platforms by Apache in 2012, which represents the best available information. In conservatively estimating potential beluga group size, Furie considered all group size data reported by Apache and based its group size estimate on data reported in June, July, and August. Group sizes observed by Apache in May were significantly and substantially smaller than those observed in June through August and may not be reflective of average beluga group size in Cook Inlet.

The number of harbor porpoises potentially exposed is substantially greater than the potential number of takes that may occur due to the following:

- Furie's avoidance and minimization measures are expected to be effective.
- Harbor porpoises are known to avoid sound (Section 7.1.2.1).
- The four takes reported by Apache in 2012 was much lower than the 188 animals observed.

Accordingly, Furie conservatively estimates that the actual number of takes by harassment that may occur is 25.

Similarly, for harbor seals, the actual numbers observed by Apache in 2012 (568) and the actual number of reported takes (13) was substantially less than the number of potential exposures predicted in this analysis (614). Furie conservatively estimates that 160 harbor seals may be taken by harassment.

Gray whales and killer whales are generally not expected to occur in the project area. However, Apache encountered at least one gray whale in the project area during 2012. To be conservative, the requested takes remain equal to the numbers predicted in the area for these species.

Steller sea lions are also not expected in the project area and generally spend more time on shore than in the water during the study period. Apache encountered individuals in low numbers in the project area during 2012. The requested take remains equal to the numbers predicted in the area for these species to be conservative.

Table 6-14
Estimated Maximum Number of Animals That May Be Incidentally Taken by Harassment

Species	Takes (Number of Individuals)
Beluga Whale	18
Harbor Porpoise	25
Harbor Seal	160
Gray Whale	2
Killer Whale	4
Steller Sea Lion	12

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7.0 ANTICIPATED IMPACT ON SPECIES OR STOCKS OF MARINE MAMMALS

The anticipated impact of the activity upon the species or stock.

This section summarizes the potential impacts from the proposed seismic survey program on marine mammals in the project area during seismic exploration activities. In instances where information is not available for the subject species, the analysis relies upon analogous information for other marine mammal species to allow for the most informed evaluation based on the best available scientific data.

7.1 POTENTIAL EFFECTS OF AIRGUN SOUNDS

Use of sound is the predominant long-range sensory modality for marine mammals (National Research Council of the National Academies [NRC] 2005). Hearing, vocalization, and echolocation play prominent roles in primary functions of marine mammals, including providing information about their environment (i.e. orientation, navigation, prey capture, predator avoidance) and communication (individual recognition, mate selection, mother-offspring bonding) (Wartzok and Ketten 1999). Depending on the frequency, intensity, and duration, anthropogenic sound may affect marine mammal behavior, mask important natural sounds on which they depend, and alter their physiological function and physical well-being (Marine Mammal Commission [MMC] 2007). Hearing capabilities of and sound use by the species included in this IHA are discussed in Section 4.7.

A description of the seismic source is included in Section 1.2. The effects of sound described here, including from airguns, on marine mammals might include one or more of the following: masking of natural sounds, tolerance, behavioral disturbance, stranding and mortality, physiological effects such as temporary or permanent hearing impairment, and non-auditory physical effects (Richardson et al. 1995).

Potential effects resulting from airguns are expected to be the same for all marine mammals under each of the presented project schedule options. The effects described in the following section are relevant to all the schedule options.

7.1.1 Masking of Mammal Vocalizations

Masking occurs when introduced sound interferes with the detection of other sounds, including communication calls, prey sounds, or other environmental sounds (Richardson et al. 1995). A marine mammal's behavior may be affected because it is unable to detect, interpret, and respond to these biologically relevant sounds. Masking may also cause a sound to be inaudible, even if it is above the hearing threshold of a particular species (Richardson et al. 1995).

A pure tone is masked mainly by noise at frequencies near the frequency of the tone. Noise at frequencies outside this "masking band" has little influence on detection of the signal unless the noise level is very high (Spieth 1956; Kryter 1985 in Richardson et al. 1995). If little or no overlap occurs between the introduced sound and the frequencies used by the species, communication or other functions of the species are not expected to be disrupted. Masking can occur when the frequency of the introduced sound source is present for a significant fraction of the time (Southall et al. 2007; Richardson et al. 1995).

7.1.1.1 Odontocetes (Cook Inlet Beluga Whale, Killer Whale, and Harbor Porpoise)

The majority of the proposed seismic source energy is anticipated to be at 500 Hz or less with higher frequencies having increasingly lower decibel levels. For example, the source level at 2,000 Hz is anticipated to be less than 180 dB μPa^2 s at 1 m. Beluga whales, killer whales, and harbor porpoises generally call (0.26 to 20 kHz, beluga whale; 0.5 to 25 kHz , killer whale; 2 kHz, harbor porpoise) and echolocate (40 to 60 kHz and 100 to 120 kHz, beluga whale; 12 to 25 kHz, killer whale; 110 to 150 kHz, harbor porpoise) at frequencies much higher than 500 Hz (Au et al. 1985, 1987; Au 1993 in Richardson et al. 1995; Blackwell and Greene 2002). Therefore, the potential for auditory masking for the Cook Inlet beluga whale, killer whale, and harbor porpoise is diminished by the absence or small amount of overlap between frequencies produced by the seismic source and the vocalizations of the odontocetes. This prediction is supported by acoustic monitoring of the Cook Inlet beluga whale in the vicinity of construction noise from the Port of Anchorage. Beluga whale echolocation clicks with most acoustic energy at frequencies higher than 15 kHz were commonly recorded in the vicinity of the port construction site, even within an area with received sound levels of 160 dB

(Integrated Concepts & Research Corporation 2008, Kendall 2010; Sirovic and Kendall 2009). Other types of beluga whale vocalizations (e.g. whistles) were rare. The paucity of beluga whale vocalizations in the lower frequency band (less than 10 kHz) may indicate that beluga whales were not producing lower frequency sounds (whistles, pulse tones, or noisy vocalizations) while transiting through the monitored area, or that these sounds may be masked by other noises at lower frequencies and may only be detectable by nearby conspecifics or observers (Kendall 2010; Sirovic and Kendall 2009). Studies show that odontocetes can detect different sources of the same low-frequency tone (approximately 3,000 Hz or less) even when there is less than 20 dB difference between the sources (Richardson et al. 1995). At higher frequencies, the decibel difference of the high-frequency tone would need to be greater to allow detection. Source levels of sound generated by odontocetes is commonly 160 to 200 dB re 1µPa-m, and even greater (Richardson et al. 1995). As odontocetes will be present only outside of the 160 dB safety radius during the seismic survey (due to avoidance and minimization measures outlined in Section 1.3), it is likely that sound produced by odontocetes would be received by conspecifics at levels detectable above the introduced seismic survey noise. The intermittent property of the seismic sound source (a short pulse approximately every 12 seconds, each pulse lasting a few hundred milliseconds) also increases the detectability of sounds produced by odontocetes.

The potential for masking from the proposed seismic source energy is anticipated to be minimal, based on the following:

- Source levels of sound generated by odontocetes are generally at decibel levels likely to be heard above the introduced seismic noise.
- Much higher frequencies make up the sounds predominantly important to odontocetes unlike the low-frequency energy of airgun sounds.

Ondontocetes are able to localize sound sources. Directional hearing may significantly reduce the masking effect of noises (Richardson et al. 1995). For high-frequency sounds and hearing, studies have shown that masking depends strongly on the relative direction of the sound signal and the masking noise (Richardson et al. 1995). Therefore seismic source sound, which is generated at a specific location, should have limited potential of masking. Additionally, beluga whales have been known to change their vocalizations in the presence of high background noise possibly to avoid masking calls (Au et al. 1985; Lesage et al. 1999; Scheifele et al. 2005). If cetaceans exposed to airgun sounds sometimes respond by changing their vocal behavior, this adaptation, along with directional hearing and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995), would reduce the risk of masking by seismic pulses. Change of vocalization is discussed further in Section 7.1.2.1. Given this information, effects of masking are not expected to substantially affect individuals, nor affect rates of survival or recruitment of the species.

While the effects of masking are expected to be negligible in general, the proposed dates for the activity to occur are during the months of May through August with the purpose to avoid Cook Inlet belugas whales in particular. During these months, the beluga whales are concentrated in the upper reaches of the Cook Inlet, greatly reducing the opportunity for any potential masking effects. Groups of beluga whales do travel through the project area but generally travel quickly during the June to November period, with the exception of Trading Bay where the transit rate is slower (Goetz et al. 2012b). This study included May in the winter/spring analysis and found similar travel rates through the project area during the December to May time period.

The population-level effects of masking resulting from airgun seismic pulses are therefore expected to be negligible, if any, in the case of the Cook Inlet beluga whale, killer whale, and harbor porpoise. This determination is based on several different factors, including odontocete hearing sensitivities, range of sound use and directional hearing, vocalization flexibility, timing of the activity, and the intermittent nature of the seismic sound source.

7.1.1.2 Gray Whale

Gray whales are relatively silent when dispersed in small groups on summer feeding grounds, slightly more vocal when migrating, and most vocal when concentrated on their winter breeding/calving grounds (Dahlheim 1987 in Richardson et al. 1995). Gray whales are rarely observed in the upper Cook Inlet, and may be present only during summer months since gray whales winter in the waters surrounding Baja California (Rice et al. 1984). The most common sounds recorded for feeding gray whales during summer are at frequencies from less than 100

Hz to 2 kHz, with most of the energy at 327 Hz to 825 Hz. For this species, there is potential for some acoustic masking of communications based on overlapping frequencies with the seismic source. Baleen whales appear to have sound localization abilities (Richardson et al. 1995) which may reduce potential masking effects. The effects of masking are not expected to affect rates of survival or recruitment of the species. Due to localization abilities and the intermittent nature of the seismic source, masking is not expected to substantially affect any individuals present in the area, and as very few individuals are expected to be present in the project area, no impact at the population level is anticipated.

7.1.1.3 Pinnipeds

Both the harbor seal and sea lion use and hear sounds at a wide range of frequencies, but their functional hearing range is shifted slightly lower than odontocetes (Section 4.7) and appear to have less sensitivity within their functional hearing range than odontocetes (Richardson et al. 1995). Results of testing masking thresholds in a harbor seal and California sea lion are similar to most mammals in that there is a lack of specialization for enhanced detection of specific frequency sounds (Southall et al. 2000), which may facilitate sound detection in naturally noisy marine environments. Although there are few studies conducted, available data indicates that pinnipeds can hear specific sound signals relatively well despite background noise (Southall et al. 2000). Pinnipeds are able to localize sounds, but with less precision than odontocetes. However, this ability to differentiate sound locations reduces the potential for masking effects.

Pinniped vocalizations are generally low-frequency (less than 10 kHz) and are usually associated with mating displays, territoriality, or mother-pup interactions (Richardson et al. 1995). Harbor seals generally produce low-frequency (less than 4 kHz) displays under water for courtship and pups make calls with frequencies of around 350 Hz. For harbor seals, there is potential for some acoustic masking of communications based on overlapping frequencies with the seismic source. Steller sea lions also produce low-frequency sounds, but usually above water in relation to social interactions, aggression, territoriality, and mother-pup interactions (see Richardson et al. 1995). As these interactions generally take place above water, there is little opportunity for masking for this species.

Steller sea lions are expected to be present only on rare occasions and any potential masking impacts are anticipated to have no effect on individuals or the regional population. Harbor seals are expected to be present in higher numbers, however given the results of limited biological studies and the intermittent nature of the seismic source, masking is not expected to substantially affect any individuals present in the area and any effects are not expected to affect rates of survival or recruitment of the species. Population-level effects resulting from masking are not anticipated for any pinniped species.

7.1.2 Tolerance and Potential Disturbance Reactions

Marine mammals have adapted to varying levels of natural sound which may allow them to function normally in the presence of many anthropogenic sounds (MMC 2007). Level B harassment occurs when there is an observable disruption to behavioral patterns. According to NMFS a change in a marine mammal's actions does not always translate to disruption of behavioral patterns. Short-term and minor behavioral changes that fall within the animal's normal range of behavior is not considered by NMFS to be a disruption of behavioral patterns (66 FR 9293). For this reason, this IHA considers tolerance of sound to be represented by an individual showing either no observable response when exposed to audible noise (as expected from known or modeled hearing sensitivity) or subtle/ minor changes that do not amount to changes in behavioral patterns.

Behavioral responses of marine mammals to sound is dependent upon a multitude of factors (Richardson et al. 1995; Wartzok et. al. 2004; Southall et al. 2007) including:

- Species affected
- Acoustic characteristics of the noise source frequency
- Duration and temporal pattern of the sound
- Physical and behavioral state of the individual(s) at time of exposure
- Ambient acoustic and ecological characteristics of the environment
- any previous exposure to the sound

Behavioral responses by marine mammals (Finley et al. 1990; Cosens and Dueck 1993; Richardson et al. 1995, Kraus et al. 1997, Würsig et al. 1998; Olesiuk et al. 2002, NRC 2003) include:

- Subtle changes in diving, surfacing, and breathing patterns
- Minor changes in direction of movement or habitat use to avoid an area of high sound levels
- Cessation or other changes to vocalization intensity, frequency, repetition, and duration
- Active avoidance or escape

Temporary behavioral effects are simply evidence that an animal has heard a sound and may not indicate lasting consequence for exposed individuals (Southall et al. 2007). For example, if a marine mammal reacts briefly to an introduced sound by moving a short distance away or slightly changing its dive sequence, the impacts of the reaction are unlikely to be significant to the individual. These temporal effects are not likely to affect survival or recruitment rates of the stock or the species. Minor and temporary changes in response to audible sound that do not constitute change to behavioral patterns may be considered tolerant behavior. Alternatively, if introduced sound displaces marine mammals from an important feeding or breeding area for a prolonged period, which is not anticipated for the proposed seismic program, the impacts could potentially, but not necessarily have important implications for the individuals and stock (Richardson et al. 1995).

The sound threshold at which a marine mammal's behavior may be altered is used by NMFS to estimate marine mammal takes by Level B harassment. The Level B threshold for impulse noise, as specified by NMFS, is 160 dB (Section 5.0). Recent reviews of marine mammal responses to noise have indicated that reactions are influenced by behavioral and contextual co-variates in addition to the received level of sound (Southall et al 2007, Clark et al. 2012 letter to NMFS Office of Protected Resources in Moray Offshore Renewables Ltd. Environmental Statement). Some available data indicates highly variable responses of apparent tolerance and reaction behaviors across marine mammal groups, species, and on an individual and contextual basis (Gordon et al. 2004). Further discussion of the threshold issue is provided by Southall et al. (2007). Their review of acoustic studies and reports on marine mammals states that "current data do not support a more sophisticated approach" than using a direct-sound level threshold for marine mammal noise exposure criteria, as is NMFS's practice (Southall et al 2007). Accordingly, NMFS's current and established approach for identifying the sound threshold at which Level B harassment may occur represents the best available scientific methodology for predicting potential effects on marine mammals resulting from noise.

7.1.2.1 Odontocetes (Beluga Whale, Killer Whale, and Harbor Porpoise)

There is little systematic information available regarding reactions of the beluga whale, killer whale, and harbor porpoise to sound pulses. Available information is limited and indicates a wide range of potential responses, leaving the biological significance of any responses to speculation. Monitoring activities associated with seismic operations near the U.K. provide some data on the behavior of various toothed whales exposed to seismic pulses (Stone 2003; Gordon et al. 2004; Stone and Tasker 2006). For small odontocetes as a whole, significantly fewer individuals traveled towards and/or more traveled away from the source vessel during seismic operation and body orientation during large airgun array operations (most arrays with discharge volumes of 3,000 in^3) differed from silent periods. For most types of small odontocetes, the median closest observed approach distance during airgun operations was greater than periods of no operations by at least 0.5 km (Stone and Tasker 2006). It should be noted the airgun arrays associated with these observed responses were generally of greater discharge volume (3,000 in^3) than the 2,400 in^3 array proposed for Furie's seismic survey.

In some monitoring of seismic operations and controlled at-sea studies of seismic sound, odontocetes were observed either to have no change in behavior during seismic operations or behave in a manner similar to that when the airguns were silent even when large airgun arrays were employed (3,959 in^3 array, Arnold 1996; during both ramp-up of a 20- or 31-gun array at 7 to 13 km [4 to 8 miles] and a full array at 1 to 13 km [0.6 to 8 miles], LGL Ltd., Environmental Research Associates 2011). However, other controlled exposure experiments indicate that foraging behavior differed during exposure to airgun sound (Jochens et al. 2008; Miller et al. 2009; Tyack 2009). Sperm whales exposed to airgun sounds exhibit considerable tolerance of seismic pulses (Stone 2003; Moulton et al. 2005, 2006; Stone and Tasker 2006; Weir 2008).

Studies show that some cetaceans continue communication- and foraging-related vocalizations during seismic surveys (common dolphins, Goold and Fish 1998; sperm whales, Madsen et al. 2002; Tyack et al. 2003; Smultea et al. 2004; Holst et al. 2006; Jochens et al. 2008; Miller et al. 2009). However, some may increase the source levels of their calls, shift their peak frequencies, or otherwise modify their vocal behavior in response to the introduced noise (Dahlheim 1987; Au 1993; reviewed in Richardson et al. 1995:233*ff*, 364*ff*; Lesage et al. 1999; Terhune 1999; Nieukirk et al. 2005; Scheifele et al. 2005; Parks et al. 2007, 2009; Hanser et al. 2009; Di Iorio and Clark 2010). In certain conditions, multiple pulses at relatively low sound levels (approximately 80 to 90 dB re: 1 μPa) is associated with temporary cessation of sperm whale vocalizations (Southall et al. 2007). Yet in other instances, responses were not observed at much higher sound levels, up to 180 dB re: 1 μPa (for a significant percentage of individuals either in the field or in the laboratory).

Studies and observations specific to the subject species are presented below; anticipated tolerance and disturbance of behavior for each subject species is also discussed.

Beluga Whale

Highly variable responses of belugas have been observed for individuals exposed to similar sounds but in different locations and different contexts (Wartzok et al. 2004 in Southall et al. 2007). It appears that the context in which the sound is received (recent experience of the individual with the sound, the activity engaged in at the time of exposure, and the individual's motivation to remain or leave) is much more significant in governing the behavioral responses of belugas than is the exposure level of the sound. During monitoring of marine mammals (including beluga whales) in the southeastern Beaufort Sea in association with seismic operations using a 2,250 in^3 airgun array, Miller et al (2005) suggested that some beluga whales may have avoided the area of seismic operations by approximately 10-20 km (6-12 mi). Despite this observation, the study found that beluga whales remained widely distributed across the study area, even during active seismic operations. Beluga whales were observed as close as 2,000 m during active seismic periods. During that two-year seismic program, no belugas were observed within the 1,000 m safety radius (Miller et al. 2005).

Although studies outside of the Cook Inlet show beluga whale avoidance of active seismic operations (Bain and Williams 2006, LGL Ltd., Environmental Research Associates 2011), observations within the Cook Inlet indicate less aversive behavior to anthropogenic noise.

A study of Cook Inlet beluga whale behavior in the presence of impact pile driving (impulse sound source similar to seismic exploration noise) investigated whether beluga whales show displacement or modified behavior in the presence of construction noise introduced to their environment. The monthly sightings of beluga whales in the affected area did not significantly correlate with monthly rates of pile-driving activity (Kendall 2010). Continued use of the area was documented, despite a quadruple increase in the number of hours of pile-driving activity throughout the course of the study. The study found that the primary behavior of traveling observed in the area pre-pile driving, remained the primary behavior during pile driving, although the number of groups traveling during pile-driving increased. Observations of diving and suspected feeding decreased during pile driving, milling behavior was observed only during pile-driving activity, and actual observed feeding was only documented on two occasions during pre-pile-driving periods. Significance in the change of individual behaviors is not discussed but the study states that the overall variation in the combined observed behavior was statistically significant. No acute behavioral responses (aggressive or aversive) were documented. Although the sighting rate of beluga whales was the same before and during pile driving, the duration of observations decreased during pile driving at a statistically significant level. Group size of observed beluga whales decreased during pile-driving activity, however not at a statistically significant level. The slight decrease in group size could account for the decrease in sighting duration, as smaller groups are not as easily detected as larger groups. However, the increased travel through the area could also explain shorter duration of observations.

Although change in behavior was observed at a statistically significant level, the biological implication of the behavior is unknown. Continued use of habitat by Cook Inlet beluga whales despite introduced construction noise, as observed by Kendall (2010), indicates that the beluga whales are not entirely displaced from an area due to introduced impulse noise, and that they continue to exhibit the same behaviors as without noise, albeit at different rates. However, the location of this study area is adjacent to Area 1-designated critical habitat, and beluga whales may be more tolerant of noise in the location in order to continue use of important habitat. This also indicates that beluga whales would not be displaced from important habitat by introduced impulse noise. The location of Furie's proposed project is not within Area 1 critical habitat (Figure A-2), but within Area 2 habitat that is considered primarily a fall and winter migratory corridor and feeding habitat (76 FR 20180). Given the limited feeding observations in the study, conclusions regarding potential feeding behavior impacts cannot be formulated. However, given the study results, and taking into account the proposed avoidance and minimization measures, traveling beluga whales are not likely to be deterred from using the proposed project area.

Similarly, a study of Cook Inlet beluga whale vocalization in the presence of construction noise (Kendall 2010) reports that there was a decline, but not a statistically significant change, in vocalization frequency during construction activities.

Most significantly, monitoring reports for similar seismic activities conducted during May through September 30 of 2012 in the same region of the Cook Inlet (using a larger seismic source of up to 2,400 in^3) document no observed behavioral disruption, or takes, of Cook Inlet beluga whales (Apache 2013).

The project area is not known as important breeding or calving grounds (NMFS 2008a). Cook Inlet beluga whale critical habitat Area 2, which includes the project area, is primarily used as over-wintering habitat (fall and winter migratory corridor and feeding habitat) from October through March (Hobbs et al. 2005). Additionally, the proposed dates for the activity are for the period of time that Cook Inlet beluga whales tends to concentrate in coastal mudflats and river mouths (Rugh et al. 2000, Goetz et al. 2012a, Goetz et al. 2012b) for reasons such as prey availability, breeding, and/or calving (Huntington 2000, NMFS 2008a). As discussed in Section 6.1.1, these areas of concentration (i.e., mudflats and river mouths including Chickaloon Bay, Knik Arm, and Turnagain Arm) are largely outside of the proposed project area (Figures A-6 and A-9 through A-24). The low number of individuals expected to be present in the project area are likely to be traveling or foraging. Based on tracking data from 14 beluga whales, Goetz et al. (2012b) found that from June through November, beluga whales spent the greatest amount of time in Knik Arm and Chickaloon Bay. Beluga whales are expected to use the proposed project area primarily from December through May (Figure A-7). The study by Goetz et al. (2012) indicates that from June through November, beluga whales move quickly through the proposed project area to feeding grounds in Trading Bay or else the majority of the population is expected to be outside of the project area in Susitna Delta and Chickaloon Bay, a more substantial feeding and breeding area during this time period. Based on the continued use of habitat during construction noise with no aversive behaviors observed (Kendall 2010) and the likelihood of belugas to be outside of the project area (Rugh et al. 2000, Goetz et al. 2012a, Goetz et al. 2012b), effects during all the potential project schedules would be the same: no aversive or acute behavioral changes are expected as a result of the proposed project, especially when avoidance and minimization measures are considered (Section 1.3). Measures such as vessel-, aerial-, and land-based visual monitoring for approaching Cook Inlet beluga whales and powering down and/or shutting down the airgun arrays will reduce the risk of exposure of any beluga whales to sound at or above harassment thresholds, as specified by NMFS. For the previously stated reasons, population-level effects of any behavioral disturbance resulting from the airgun seismic pulses are expected to be negligible, if any, in the case of the Cook Inlet beluga whale.

Killer Whale

Observations in other areas of the world report that killer whales that are present during seismic operations may be displaced by around 0.5 km (0.3 miles) or more, typically less than other odontocetes species (Stone 2003; Gordon et al. 2004). Killer whales are known to increase vocalization duration and amplitude as a function of variable background noise levels (Foote et al. 2004 in Southall et al. 2007, Holt et al. 2009 in Wood et al. 2012).

Killer whales are uncommon in the upper Cook Inlet. Monitoring reports for similar seismic activities conducted during May through 30 September of 2012 in the same region of the Cook Inlet did not document any sightings of killer whales (Apache 2013). However, given the odontocete behavioral responses to seismic surveys and noise described above, particularly the negligible reactions by sperm whales and continued use of the habitat by Cook Inlet beluga whales, should a killer whale be present in the project area, no aversive or acute behavioral changes are expected as a result of the proposed project, especially when avoidance and minimization measures are considered (Section 1.3). Measures such as vessel-, aerial-, and land-based visual monitoring for approaching killer whales and powering down and/or shutting down the airgun arrays will reduce the risk of exposure of any killer whales to sound at or above harassment thresholds, as specified by NMFS. For the previously stated reasons, population-level effects of any behavioral disturbance resulting from the airgun seismic pulses are therefore not expected in the case of the killer whale.

Harbor Porpoise

Although porpoises are commonly heard calling while airguns are operating (LGL Ltd., Environmental Research Associates 2011), harbor porpoises have been observed engaging in strong avoidance responses to seismic source sounds and are apparently more responsive to lower received levels of sound than other odontocetes (Richardson et al. 1995; Bain and Williams 2006; Wood et al. 2012). Although the lack of data does not allow determination of appropriate sound thresholds for this apparently distinct odontocetes species, from the little data available, it could be assumed that harbor porpoises may be more responsive to the proposed activity than other marine mammals likely to be present in the project area. However, the lack of available data precludes surmising the biological significance of potential responses.

Harbor porpoises are routinely sighted in lower Cook Inlet, but are less common in upper Cook Inlet (Rugh et al. 2005, Prevel Ramos et al. 2006). Monitoring reports for similar seismic activities conducted during May through 30 September of 2012 in the same region of the Cook Inlet documented observation of approximately 188 individual harbor porpoises (Apache 2013). Based on the relatively small portion of the overall population expected to be present in the project area, the proposed survey is anticipated to have negligible, if any, impact on survivability and recruitment of the species and therefore the population-level impact of any behavioral disruptions resulting from the proposed project is expected to be negligible.

7.1.2.2 Gray Whale

Varied behavioral responses of gray whales have been observed associated with seismic operations. Reports of abandoned habitat in some circumstances (Clark and Gagnon 2006) are countered by other reports of no significant change in gray whale presence during seismic activity (Gailey et al. 2007).

Gray whales within the vicinity of seismic activities may alter their behavior. Change in blow interval, dive time, and travel speed are among some behavioral traits that were found to be associated with seismic activity in a study of gray whales, that remained in the general area and continued to feed during the seismic survey operations (Gailey et al. 2007). Migrating gray whales were found to alter their course at sound levels below the NMFS harassment level threshold (Malme et al. 1984 in Wood et al. 2012), yet the observed course alteration was not determined to be outside of the normal range of gray whale behavior and not necessarily a disruption to a behavioral pattern (66 FR 9293). Vocalization changes associated with seismic noise vary by baleen whale species and are not available for gray whales. Bowheads may decrease their call rates, while blue whales may increase theirs. While studies outside of the Cook Inlet show beluga whale avoidance of active seismic operations (Bain and Williams 2006; LGL Ltd., Environmental Research Associates 2011), observations within the Cook Inlet indicate less aversive behavior to anthropogenic noise.

Gray whales are uncommon in both the upper and lower Cook Inlet with few documented sightings (Rugh et al. 2005). Monitoring reports for similar seismic activities conducted during May through 30 September of 2012 in the same region of Cook Inlet documented observation of an individual gray whale on nine occasions (Apache 2013). Based on the relatively few individuals expected to be present in the project area, the proposed survey is anticipated to have negligible, if any, impact on survivability and recruitment of the species and therefore population-level impact of any behavioral disruptions resulting from the proposed project is expected to be negligible.

7.1.2.3 Pinnipeds

Although there is little data regarding pinniped exposure to seismic pulses, what is available indicates limited reactions or short-term localized avoidance (Harris et al. 2001; Woods et al. 2012). Observations, primarily anecdotal and not suitable to estimate tolerance thresholds, indicate that sea lions and other pinnipeds generally tolerate strong noise pulses (Richardson et al. 1995; Southall et al. 2007). Some of these observations indicate only temporary displacement. Pinnipeds frequently do not avoid the area within a few hundred meters of operating airgun arrays and are seen at nearly identical rates during seismic operations as periods with no seismic activity (Harris et al. 2001).

Harbor seals are expected to be present in the project area, but at levels that represent a relatively low proportion of the overall population. Steller sea lions are rarely sighted in the upper Cook Inlet. Monitoring reports for similar seismic activities conducted during May through 30 September of 2012 in the same region of the Cook Inlet documented observation of four individual Steller sea lions and 568 harbor seals (Apache 2013). Based on the relatively few individuals of each species expected to be present in the project area, the proposed survey is anticipated to have negligible, if any, impact on survivability and recruitment of the pinniped species/stock and therefore population-level impact of any behavioral disruptions resulting from the airgun seismic pulses is expected to be negligible.

7.1.3 Stranding and Mortality

There is no specific evidence that airgun pulses can cause serious injury, death, or stranding even in the case of large airgun arrays (LGL Ltd., Environmental Research Associates 2011) Strandings have been associated with military mid-frequency sonar pulses, but information regarding such reactions is extremely limited (Southall et al. 2007). Seismic pulses and mid-frequency sonar signals are very different. Sounds produced by airgun arrays are impulsed and broadband, with most of the energy below 1 kHz. Typical military mid-frequency sonars emit non-impulse sounds at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time. Furie will not use a mid-frequency sonar system during the proposed seismic activities.

7.1.4 Physiological Effects Including Noise-Induced Threshold Shifts

Exposure to sound energy can cause a range of physiological effects in marine mammals. Primarily, sound exposure may affect the auditory system. Sound exposure can also cause non-auditory physiological impacts such as stress, tissue injury, and bubble formation. There is very little known about the potential for sound from seismic surveys to cause non-auditory physical effects to mammals.

7.1.4.1 Auditory Effects

A few common terms need to be defined before discussing ways in which mammals could experience effects to the auditory system from the proposed seismic survey program.

Threshold shift (TS) occurs when animals are exposed to intense sound and experience reduced hearing sensitivity for some period of time following exposure. This increased hearing threshold is known as noise-induced TS. The amount of TS incurred in the animal is influenced by a number of noise exposure characteristics, including amplitude, duration, frequency content, temporal pattern, and energy distribution (Kryter 1985; Richardson et al. 1995; Southall et al. 2007).

Temporary threshold shift (TTS) is a temporary loss in hearing and is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). The magnitude of TS generally decreases over time after noise exposure and if it eventually returns to zero, it is known as TTS. TTS is not considered to cause auditory injury (Southall et al. 2007) and therefore does not constitute Level A Harassment as defined by the MMPA (Marine Mammal Protection Act of 1972 as Amended 2007). While experiencing TTS, the hearing threshold rises and a sound must be louder in order to be heard. The effects of TTS can be reversed, and effects can last from minutes to days. Exposure of marine mammals to high intensity sound may cause TTS, or a temporary loss of hearing sensitivity (Finneran et al. 2005).

Permanent threshold shift (PTS) occurs when there is physical damage to the sound receptors in the ear. If TS does not eventually return to zero (i.e. within weeks), it is known as PTS. In severe cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter 1985).

Sound exposure level (SEL) 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 µPa2s (Kastak et al. 2005; Southall et al. 2007). SEL is used to assess the cumulative level of exposure to multiple sounds, and allows sounds with different durations and involving multiple exposures to be compared in terms of total energy.

SPL is a logarithmic measure of the effective sound pressure of a sound relative to a reference value and is measured in decibels above the standard reference level. The current NMFS policy regarding exposure of marine mammals to impulsive sound uses this measure of sound. NMFS states that to avoid injury, cetaceans should not be exposed to impulsive sounds at or greater than 180 dB re 1 µPa rms and pinnipeds should not be exposed to impulsive sounds at or greater than 190 dB re 1µPa rms (65 FR 34014-34032). A description of the seismic source for this the proposed seismic program is included in Section 1.2.

The following subsections summarize the available data on noise-induced hearing impairment in marine mammals.

Temporary Threshold Shift

TTS is the mildest form of hearing impairment that can occur during exposure to loud sound (Kryter 1985).

<u>TTS in Odontocetes (Beluga Whale, Killer Whale, and Harbor Porpoise)</u>

The majority of research conducted regarding TTS in odontocetes is focused on non-impulse sound, and has 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 the key results, with details provided in the following paragraphs:

- TTS magnitude appears to be best correlated with cumulative exposure to sound (SEL) rather than with received levels (SPL) and SPL values that cause TTS onset tend to decrease with increasing exposure duration.

- Continuous (non-pulse) noise exposure may (but not always) result in TTS in odontocetes beginning at 195 dB SEL
- For a single brief pulse to induce TTS, greater SPLs (e.g. 226 SPL (peak-to-peak) are required than for continuous noise

Finneran et al. (2005) measured TTS in bottlenose dolphins exposed to 3 kHz tones with various durations and SPLs in a quiet pool. The data gathered from this study in addition to Schlundt et al. (2000) and Nachtigall et al. (2004) support the use of 195 dB re 1μPa2s (SEL, or cumulative exposure) as a threshold for TTS onset in mid-frequency cetaceans (including dolphins and belugas) exposed to pure tones or octave band noise (greatest frequency is twice the lowest frequency) at or above 3 kHz. However, not all exposures at this threshold will cause TTS. For example, only 18 percent of exposures to an SEL of 195 dB re 1μPa2s resulted in measurable TTS. It was also found that each additional dB of SEL produced an additional 0.4 dB of TTS and that for TTS of 3 to 4 dB, recovery was nearly complete within 10 minutes post-exposure. For greater TTS, longer recovery times were required. All of these TTS measurements are based on exposure to pure tones or octave band noise, at or greater than 3 kHz, for durations from 1 second to 50 minutes; TTS onset from broadband noise, especially those with greater energy at lower frequencies (such as that introduced by an airgun) may differ.

Exposure to a single impulse noise from a watergun (more energy at higher frequencies than airguns in general) appears to result in a lower TTS than exposure to non-impulse sound (Finneran et al. 2002). A beluga whale exposed to a single watergun pulse (226 SPL peak-to-peak) showed TTS onset at 186 dB SEL at 0.4 kHz and 30 kHz, and returned within 2 dB of normal hearing within four minutes of exposure. The dolphin did not show indication of TTS at the highest sound level the experiment produced (228 SPL peak-to-peak, 188 SEL). TTS threshold measured for a single harbor porpoise was lower than that measured for the beluga whale and bottlenose dolphin (Lucke et al. 2009). Exposure to one airgun pulse with a received level of approximately 200 SPL peak-to-peak or an SEL of 164.3 dB SEL caused TTS in the harbor porpoise at 4 kHz. This is considerably lower than the 186 dB SEL reported by Finneran et al. (2002) for belugas. It should be noted that the data described above is limited to one individual of each species in each study and based on different sound sources and conditions than the proposed project.

TTS in odontocetes, as indicated in the studies described above, is realized at much higher frequencies than the predominant frequencies of the proposed airgun array (most energy will be below 500 Hz). Therefore, the broadband sound characteristic of the airgun array is expected to have less effect on odontocetes. TTS, in the extremely unlikely event it were induced, is inherently temporary and is not expected to reduce any species' ability to feed, move, or reproduce. However, the proposed avoidance and minimization measures (Section 1.3) including power-down and shutdown of airgun operations if an individual marine mammal approaches the 160 dB sound level area of the proposed project, makes the potential exposure of odontocetes to sound levels that may induce TTS highly unlikely. No population-level effects are expected due to TTS for beluga whales, killer whales, or harbor porpoises.

TTS in Baleen Whales (Gray Whale)

There are no data for baleen whales on levels or properties of sound that are required to induce TTS from either direct or indirect sources. The frequencies to which baleen whales are most sensitive are assumed to be lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher (Richardson et al. 1995). As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales (Southall et al. 2007). No marine mammals are expected to be exposed to sound levels at or greater than 160 dB. The proposed avoidance and minimization measures (Section 1.3) including power-down and shutdown of airgun operations if an individual marine mammal approaches the 160 dB sound level area of the proposed project, precludes exposure of gray whales, or any marine mammals to sound levels that may induce TTS. TTS, in the extremely unlikely event it were induced, is inherently temporary and is not expected to reduce any species' ability to feed, move or reproduce. No population-level effects are expected due to TTS for gray whales.

TTS in Pinnipeds (Steller Sea Lion and Harbor Seal)

TTS has been measured for only three pinniped species: harbor seals, California sea lions, and northern elephant seals. Most of the available research has been conducted on non-impulse sound. Only one study has examined pinniped TTS in response to exposure to underwater pulses (Finneran et al. 2003). In this study, two captive California sea lions were exposed to single underwater pulses produced by an arc-gap transducer, or pulsed power device. No measurable TTS was observed following exposures up to a maximum level of 183 dB SPL peak-to-peak (163 dB SEL). TTS onset in a harbor seal from single pulsed noise is estimated at 171 dB SEL (Southall et al.2007). Finneran et al. (2003), Kastak et al. (2005) and Mooney et al. (2009a, 2009b) all emphasize the need for taking both SPL and duration (therefore SEL) into account when evaluating the effect of sound exposure on marine mammal auditory systems. The proposed avoidance and minimization measures (see Section 1.3) including power-down and shutdown of airgun operations if an individual marine mammal approaches the 160 dB sound level area of the proposed project, precludes exposure of pinnipeds, or any marine mammals to sound levels that may induce TTS. TTS, in the extremely unlikely event it were induced, is inherently temporary and is not expected to reduce any species' ability to feed, move or reproduce. No population-level effects are expected due to TTS for harbor seals or Steller sea lions.

Permanent Threshold Shift

PTS occurs when there is physical damage to the sound receptors in the ear. There is currently no evidence that exposure to airgun 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).

PTS in Cetaceans (Beluga Whale, Killer Whale, and Harbor Porpoise and Gray Whale)

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. 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. Therefore Southall et al. (2007) recommends a peak pressure of 230 dB re 1 μPa and 198 SEL for PTS onset, based on 15 dB added to the TTS onset of 183 SEL (described above). This measurement is the same for both pulsed and non-pulsed noises.

PTS in Pinnipeds (Steller Sea Lion and Harbor Seal)

There are no data on the sound level of multiple pulses that would cause TTS onset in pinnipeds, therefore Southall et al. (2007) made assumptions based on pinniped biology, TTS onset in the harbor seal from a single pulse, and TTS onset in cetaceans to predict PTS onset in pinnipeds. TTS onset in the harbor seal exposed to a single underwater pulse was estimated to occur at 171 dB SEL. Using the same methodology as described above, the addition of 15 dB results in an estimated PTS onset of 186 dB SEL, or peak pressure of 218 dB re 1 μPa for pinnipeds exposed to single or multiple pulses. This is likely to be a precautionary estimate, especially for Steller sea lions, as the estimate is largely based on studies with a single harbor seal which is the most sensitive pinniped species studied to date (Kastak et al. 1999, 2005).

PTS Conclusions

Due to the proposed avoidance and minimization measures for the proposed seismic activity (Section 1.3), it is extremely unlikely that a marine mammal would come within or remain close enough to an airgun array long enough to incur PTS. No marine mammals are expected to be exposed to sound levels at or greater than 160 dB. The proposed avoidance and minimization measures, including power-down and shutdown of airgun operations if an individual marine mammal approaches the 160 dB sound level area of the proposed project, makes the potential exposure of any marine mammals to sound levels that may induce PTS highly unlikely. Population-level effects resulting from PTS are not expected for any marine mammal species.

7.1.4.2 Non-Auditory Physiological Effects

Non-auditory physiological effects or injuries in marine mammals exposed to strong underwater sound may include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall et al. 2007).

Noise also has the potential to cause stress and immune responses in marine mammals (Romano et al. 2004; Wright et al. 2007, Rolland et al. 2012). However, these are difficult to measure in nature and are generally associated with behavioral responses (e.g., startle response, avoidance, etc.).

Another potential impact of sound on marine mammals is the formation of gas bubbles in the animal's tissues. This is based on evidence of lesions in the tissues of beaked whales that stranded after naval sonar exercises (Fernandez et al. 2005). Seismic pulses and mid-frequency sonar signals are very different. Sounds produced by airgun arrays are impulsed and broadband, with most of the energy below 1 kHz. Typical military mid-frequency sonars emit non-impulse sounds at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time. Furie will not use a mid-frequency sonar system during the proposed seismic activities. The acoustic pressure itself, a rapid change in depth, or a combination of the two may possibly lead to the formation of bubbles (reviewed in Southall et al. 2007). There is no evidence linking seismic surveys to stranding events or bubble formation in cetaceans.

At extremely close distances, loud sounds could cause physical damage to gas filled chambers (e.g., lungs) in animals. This is caused by the rapid and extreme pressure differentials that make up the sound wave (Gotz et al. 2009).

Non-auditory physiological effects may result from extreme behavioral responses or exposure to sound at high levels and/or close range. As discussed in the previous sections, acute avoidance behavior, indeed extreme responses of any kind, and exposure to sound at or greater than 160 dB is not anticipated for any marine species during the proposed project. The proposed avoidance and minimization measures (Section 1.3), including power-down and shutdown of airgun operations if an individual marine mammal approaches the 160 dB sound level area of the proposed project, precludes exposure of any marine mammals to sound levels that may induce non-auditory physiological effects. Population-level effects resulting from non-auditory physiological effects on individuals is not anticipated.

7.2 POTENTIAL EFFECTS OF VESSELS AND AIRCRAFT

A total of seven or eight vessels are expected to be used during the course of the proposed seismic exploration project (Section 1.2.4). Additionally, a fixed-wing aircraft or helicopter may be used for marine mammal monitoring purposes (Section 1.3). The potential impact of vessels and aircraft on marine mammals associated with the proposed seismic survey is expected to be negligible at the population level for all the subject species.

The proposed activity will introduce few additional vessels or aircraft in relation to the number typically present in the region. The industrialized nature of the region, including a relatively long history of vessel traffic and aircraft use, suggests that the addition of a relatively small number of vessels to the highly trafficked area will have a negligible impact. Additionally, vessel use will occur in a localized area, in a manner that is expected to pose little threat to marine mammals (stationary use and slow travel speeds). Although beluga whales are observed to avoid fast watercraft such as small recreational vessels, they do not typically react adversely to slow-moving commercial vessels that maintain direct travel paths (NMFS 2008a). Vessel strike with a marine mammal is considered highly unlikely given the proposed vessel use and avoidance and minimization measures including monitoring by trained PSOs (Section 1.4.2). Aircraft may be used for marine mammal monitoring and would adhere to guidelines for aerial observation specified by NMFS to reduce potential harassment of marine mammals (Section 1.3). In general, marine mammals reacting to aircraft overflights show minimal negative responses and are more likely to react when the aircraft is at low altitudes (Richardson et al. 1995). Marine mammal responses to aircraft overflights occur most commonly when aircraft altitudes are 150 - 180 meters (492 - 591 feet) and at a lateral distance of approximately 250 meters (820 feet) (Patenaude et al. 2002). Beluga whales in the arctic have been observed to respond to helicopter and fixed-wing aircraft at low rates: approximately 38 percent of studied groups responded to helicopters and only about 3 percent to fixed-wing aircraft (Patenaude et al. 2002). Of those observed responses, individuals primarily reacted to helicopters at altitudes less than 150 meters and fixed wing aircraft at less than 182 meters. All reactions (e.g. abrupt diving, vigorous swimming, and looking up at the aircraft) were short-term and the biological significance of the short term reactions have not been investigated. Furie's proposed minimum aircraft altitude (305 meters or 1,000 feet) and minimum lateral distance (457 meters or 1,500 feet) are much greater than the distances that have been shown to elicit responses from marine mammals.

The potential impact from unintentional spills or leaks of fuel or lubricant is considered negligible given the low volume of such substances expected to be onboard the vessels and strict adherence to USCG bunkering at sea requirements, should fuel be transferred offshore. The potential for vessel collision is considered negligible as vessels maintain a high-level of communication to conduct the highly organized and methodical seismic survey. As vessels used in the survey will adhere to USCG regulations regarding visibility, and will maintain stationary positions and slow travel speeds, collision with vessels other than those involved in the proposed activity are also highly unlikely.

There would be potential masking of mammal vocalizations from vessels only outside of periods when the airgun arrays are in use. Low vessel speeds should limit potential masking as engine frequencies are lower at slower speeds and marine mammals tend to use sounds at higher frequencies. Anecdotal information from the Port of Anchorage authorities indicates that groups of highly vocal beluga whales have traveled near vessels and their vocalizations even resonate through the vessel (NMFS 2008c). Based on this information, including habituation of Cook Inlet marine mammals to high levels of vessel and air traffic, the various adaptations of the species that may reduce masking impacts (discussed previously in Section 7.1.1), and the fact that few individuals relative to the overall population are expected to be present during operations, potential masking of vital acoustics used by the subject marine mammals resulting from vessel use is anticipated to have negligible, if any, impacts on individuals and no effect at the population level of any of the subject marine mammals.

7.3 SUMMARY OF ANTICIPATED IMPACTS

Based on the best available scientific data and information, the proposed project is not reasonably likely to adversely affect the subject marine mammal species or stocks through effects on annual rates of recruitment or survival. We expect that any effects that occur will be limited to short-term, minor behavioral changes, and primarily temporary displacement from areas not known to be important for breeding and/or feeding. Any incidental take of a marine mammal will be limited to harassment by disturbance and will not affect reproduction or survival.

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8.0 POTENTIAL IMPACT ON SUBSISTENCE USE

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

Cook Inlet provides important subsistence resources upon which many residents depend for their cultural and nutritional well-being. Alaska Native communities have been vitally connected to Cook Inlet and its resources for thousands of years. Of the six species described in Section 4.0, harbor porpoises, and killer whales are not traditionally hunted by Alaska Natives for subsistence purposes (Allen and Angliss 2012). The remaining four species are described in detail in this section. Avoidance and minimization measures (as outlined in Section 1.3 and as stipulated by NMFS) will be implemented to minimize potential impacts to marine mammals; therefore, Furie does not expect that the proposed seismic survey will adversely affect the availability of subsistence resources.

8.1 COOK INLET BELUGA WHALE

Although the Cook Inlet beluga whale has traditionally been hunted by Alaska Natives, the subsistence hunt of the stock is currently regulated and has not been hunted since 2005. Traditional hunting would generally occur between April and October in the upper reaches of the Cook Inlet, mainly at the Susitna, Chickaloon, and Beluga Rivers, although also in the Knik Arm, and near Anchorage and Fire Island (Mahoney and Shelden 2000).

The annual subsistence harvest between 1993 and 1999 ranged from 30 to over 100 individuals (Mahoney and Shelden 2000). Alaska Natives voluntarily ceased subsistence beluga hunts in 1999 due to the apparent decline in numbers and later that year a federal temporary moratorium on hunting Cook Inlet beluga whales was established (Public Law No. 106-31, Section 3022, 113 Stat. 57, 100) and then made permanent in 2000 (Public Law No. 106-533). A co-management agreement between NMFS and Alaska Native organizations allowed subsistence take of Cook Inlet beluga whales under certain conditions until 2005. Four beluga whales were taken between 2000 and 2005; no takes have been documented since 2005. Allowable harvest numbers are now determined in part by the previous 5-year's average abundance, and harvest is not permitted if the average is below 350 individuals. For this reason, the allowable harvest during 2008 through 2012 was set at zero. Re-evaluation of allowable harvest numbers for 2013 through 2017 is unlikely to result in a harvest allowance, given a 5-year average of less than 350 individuals from 2008 through 2012. Therefore, subsistence hunting is highly unlikely to occur during the proposed activity.

No impact to the recruitment or survival of the Cook Inlet beluga whale stock is expected as a result from the proposed activity, as effects will be limited to short-term, minor behavioral changes. The anticipated effects would not alter beluga whale distribution nor remove any individuals from the population; therefore, no impact on the availability of the stock for subsistence use is anticipated.

8.2 GRAY WHALE

While Alaska Natives traditionally hunted gray whales, no documented takes by Alaska Natives have occurred since 1995 (Allen and Angliss 2012). Current regulations of the International Whaling Commission permit subsistence hunting of the gray whale in U.S. waters only by the Makah Indian Tribe in the state of Washington. As no impact to the recruitment or survival of the Eastern North Pacific stock of gray whale is expected as a result from the proposed activity, and the activity is not expected to displace gray whales from hunting areas used by the Makah Indian Tribe, no impact on the availability of the stock for subsistence use is anticipated.

8.3 HARBOR SEAL

There is a low level and declining rate of subsistence hunting for harbor seals by Cook Inlet and upper Kenai communities with the total take around 37 individuals in 2008. This is the latest reported take number of harbor seals in Cook Inlet. No take number surveys were conducted in 1999, 2009, or 2010. In 2011, harvest numbers were reported from Kodiak Island only, due to limited funding (Wolfe 2012). This estimate includes takes for the entire Upper Kenai-Cook Inlet reporting region, consisting of the communities of Anchorage, Homer Kenai, and Tyonek (Alaska Department of Fish and Game 2009). Reported takes for the previous 15 years ranged widely from 0 to 110 individuals. It is not clear from the data where harvests actually occur, however it is assumed that the reporting communities take individuals in the Cook Inlet. Harbor seals are taken year round; however, the seasonal patterning of harbor seal takes statewide (1992 through 2008 data) shows two distinct hunting peaks, the first in spring and the second in fall/early winter, with a low point in activity in June (Wolf et al. 2009). The 2008 harvest of harbor seals by Cook Inlet communities took place from March through November, ranging from approximately 0 to 8 takes per month. The months with the highest take numbers were April, June, and July. As the Cook Inlet harbor seal population is considered healthy and abundant, the proposed seismic survey is anticipated to have no impact on the recruitment or survival of the stock, and any displacement of individuals would be short-term and localized. No impact on the availability of the stock for subsistence use is anticipated.

8.4 STELLER SEA LION

Subsistence hunting of Steller sea lions by Alaska Natives statewide decreased precipitously in the early 1990s and has remained at a steady low rate in recent years (Wolf et al. 2009). However, hunting of Steller sea lions by communities of the Cook Inlet and upper Kenai (consisting of the reporting communities of Anchorage, Homer Kenai, and Tyonek) was not documented from 2002 through 2008, and only one individual was known to be harvested in the preceding 5 years. More recent information on Steller sea lion harvests in the Cook Inlet was not publicly available at the time of writing this IHA application. Steller sea lions are not expected in large numbers in the project area. Important haulout areas are located in lower Cook Inlet, removed from the project area. No impact of the overall subsistence use is anticipated. No impact to the recruitment or survival of Steller sea lions is expected as a result from the proposed activity, as any effects will be limited short-term, minor behavioral changes, primarily temporary displacement. The anticipated effects would not alter Steller sea lion distribution nor remove any individuals from the population; therefore, no impact on the availability of the stock for subsistence use is anticipated.

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9.0 ANTICIPATED IMPACT ON MARINE MAMMAL HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

No long-term or permanent impacts are anticipated as a result of the proposed seismic exploration activity. The proposed seismic survey will be limited spatially and temporarily to small patches of habitat and any effects are expected to be localized and short-term. The primary potential impact from the proposed project is the minor, temporary displacement of individual marine mammals from habitat as a result of seismic noise, rather than impacts to habitat characteristics. Other potential, but highly unlikely, impacts to habitat characteristics are discussed here and include impacts to the availability of prey, and physical disturbance of the seafloor. Potential impacts to water quality resulting from vessel use are also considered highly unlikely and are discussed in Section 7.2 Potential Effects of Vessels and Aircraft.

9.1 PREY SPECIES OF COOK INLET MARINE MAMMALS

Fish, namely salmon, eulachon, cod, mackerel, pollock, capelin, herring, whiting, shrimp, squid, and octopus, are the primary prey species of the beluga whale, harbor porpoise, harbor seal, resident killer whale, and Steller sea lion. The killer whales found in Cook Inlet are usually transient, meaning their main prey is other marine mammals, including beluga whales, sea lions, sea otters, and various species of seal. There are few studies of Cook Inlet regarding the use of seismic activities and its impact on the environment; however, studies conducted elsewhere indicate the results of airguns on fish behavior and health.

A study conducted on squids using an array of airguns firing at a minimum of 174 dB concluded that squid show startle responses and avoidance behavior when exposed to sound (McCauley et al. 2000). Although the startle responses were not defined by the study, avoidance behavior was characterized in this species by movement to the farthest location from the sound source and a tendency to reside near the surface where sound levels are up to 12 dB lower. Once the airguns ceased firing, behavior returned to normal and no hearing losses or mortalities were reported for the squid in the long term.

Fish are able to perceive underwater sounds between the frequencies of 50 and 2,000 Hz but are most sensitive to frequencies under 800 Hz (Popper and Carlson 1998). Fish can be sensitive to impulsive sounds, such as the sound produced by airguns or pile driving, because the pressure levels created by the sound waves cause the swim bladder, which is full of pressured gasses, to squeeze and expand. This can cause damage to internal organs. Sensory hair damage has also been recorded after exposure to airguns. Based on research by Hastings and Popper (2005), NMFS has set the single strike peak pressure threshold at 208 dB and the multiples strike peak pressure threshold at 187 dB.

Several species of fish have also been reported showing startle and avoidance behavior when subjected to seismic activity of varying intensities. These behaviors include leaving the direct area, increased tail beating, swimming faster, diving, gathering into tight schools (only in schooling fish), attempting to escape the cage, shudders, tremors, body flexions, increased glucose, cortisol, and lactate levels, and Mauthner cell reflex (Hassel et al. 2004; Pearson et al. 1992; Slotte et al. 2004; Santulli et al. 1999; Boeger et al. 2006). Some species (rockfish, whiting, salmonids) became habituated to the noise, returning to normal behavior while the airguns were still in use (Pearson et al. 1992; Chapman and Hawkins 1969; Boeger et al. 2006). Other fish returned to normal behavior within two hours, indicating that effects from seismic exploration are temporary (Santulli et al. 1999). No mortalities were recorded in any of the studies using adult fish.

Weinhold and Weaver (1972) conducted an experiment on caged coho salmon smolts, to test if seismic airguns affected the younger, potentially more vulnerable fish. The smolts were exposed to a single airgun or an array of airguns at varying distances from 1 to 10 meters. No lethal effects were observed and none of the damage found during autopsy was attributed to the exposure. Furthermore, in the 72 hours following exposure, the smolts were observed and behavior was compared to a control group. Feeding in the experimental group remained normal as did other behavior.

Additionally, although the seismic testing proposed by Furie will not be near salmon spawning streams, studies conducted on fish eggs and embryos have shown no difference between control and experimental groups with the exception of a report by Cox et al. (2012). However, the test resulted in higher mortality rates in the experimental group was where the airguns were placed within 0.1 meter of the eggs. Active airguns during Furie's proposed seismic survey will be at least 2,000 feet from productive salmon streams; therefore, there is no possibility that the airgun activities proposed by Furie will adversely affect eggs laid in salmon streams.

After a careful review of many studies, and based upon the best available science, Furie's proposed seismic program will have insignificant effects on prey species in Cook Inlet. Should prey species be impacted by this project, it is unlikely that these changes will affect marine mammal populations. The project site is not located in an area that constitutes critical hunting ground for these species. Higher concentrations of prey species are not expected to be within the proposed survey area than are found in other areas. Additionally, the project area that is actively ensonified at any given time constitutes a small portion of habitat area for the marine mammal species and any temporary displacement or impact to foraging in the area is not expected to affect marine mammals individually, and therefore have negligible, if any population-level effect.

9.2 POTENTIAL IMPACTS TO THE SEAFLOOR

Seafloor disturbances resulting from the proposed project include the placement of cabled receivers deployed in parallel lines, laid out in units, or patches. As stated in Section 1.2, the patch size for the proposed survey may range from three to eight lines of approximately 4 to 10 miles in length spaced at 800 to 1,700 feet, depending on the contractor and site-specific design optimization. Individual receivers are small: approximately 15.5 inches in diameter, 6 inches high, and weigh 40 pounds in water.

Cook Inlet is comprised mainly of cobbles, pebbles, sand, silt, and clay (Karlstrom 1964) and exhibits high tidal flows, turbulence, and low sediment deposition. These characteristics contribute to the ever-changing and dynamic system of the Cook Inlet. As such, the small and temporary footprints of the receivers are not likely to disturb or permanently alter the seafloor.

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10.0 ANTICIPATED IMPACT ON MAMMALS FROM LOSS OR MODIFICATION TO HABITAT

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed seismic survey will not result in any permanent impact on the physical habitats used by marine mammals, or to the food sources they utilize. Direct impacts are physical destruction or alteration of habitat, which will not occur from the seismic program. Indirect impacts are primarily caused by ensonification of habitat from noise, which will be very localized and short term, because the proposed seismic survey will be of short duration and confined to one area. As described in Section 7.1, ensonification from seismic operations should have no more than a negligible effect on marine mammal habitat.

Disturbance to prey species would be short-term and prey would return to their pre-disturbance behavior once the seismic activity ceases. Thus, the proposed survey would have little, if any, impact on marine mammals to feed in the area where seismic work is planned.

The seismic area covers a small percentage of the potentially available habitat used by marine mammals in Cook Inlet allowing beluga and other marine mammal to move away from any seismic program sounds to feed, rest, migrate or conduct other elements of their life history.

The proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, since operations will be limited in duration, location, timing, and intensity.

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11.0 MEASURES TO MINIMIZE IMPACTS ON THE AVAILABILITY OF MARINE MAMMALS FOR SUBSISTENCE USE

Where the proposed activity would take place in or near a Traditional Arctic Subsistence Hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a "plan of cooperation" or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

Adverse effects on the availability of marine mammals for subsistence use is not expected. No impact to any species recruitment or survival is anticipated. No long-term or permanent impact to the distribution of marine mammals is expected, and any short-term displacement would be localized and would affect subsistence hunts negligibly, if at all. The proposed seismic survey will follow the avoidance and minimization procedures outlined in Section 1.3 to minimize potential harassment of marine mammals and, therefore, maintain opportunities for subsistence harvest by Alaska Native communities.

Furie is committed to minimizing impacts to marine mammals and their subsistence users. Should subsistence users voice concern regarding the proposed seismic survey, or should beluga whale subsistence hunts be reinstated, Furie will coordinate with Alaska Native organizations to minimize any effects to subsistence users resulting from the proposed seismic survey. Additionally, Furie will welcome representatives of regional subsistence organizations to provide staff support to assist in the monitoring and recording of marine mammals observations, in addition to the PSOs, as part of the proposed monitoring program.

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12.0 RESEARCH COORDINATION

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

Currently there is very little scientific and public information regarding the impact of noise on marine mammals in Cook Inlet. Based on the available information, Furie does not expect the proposed activity to adversely affect any marine mammals in Cook Inlet. The monitoring program proposed by Furie will provide much needed site-specific information regarding marine mammal presence and behavior in mid-Cook Inlet. Should feasible alternative methods of seismic surveys become available that may further minimize risk of harassment to marine mammals, Furie will further evaluate the practicability of such methods. One theoretical alternative to airgun use is marine vibroseis. However, although first developed in the 1980s, there is at present little commercial use and no widely used marine vibroseis equipment available (LGL and MAI 2011). As such, the environmental impacts of the marine vibroseis method are largely untested. The vibroseis method is not considered feasible or practicable for this project due to the unavailability of the technology. Another theoretical alternative to airgun use, gravity gradiometry, which introduces no sound energy to the marine environment, does not provide the same level of detail as seismic data (Wielgart 2010). The gravity gradiometry method relies on geologic structures to exhibit density contrast in order to enable modeling and structural interpretation. Based on previous data acquired and modeled within the Kitchen Lights Unit state oil and gas lease area of the Cook Inlet, density contrasts sufficiently resolute to enable gravity modeling have not been observed, nor are they expected to be present in the geologic structures to be examined as part of the proposed project. Additionally, the gravity method would not provide reservoir characterization information that can be valuable for predicting porosity and potential gas contents. Given what is known of the geologic formations within the Kitchen Lights Unit, a gravity gradient data set would not provide sufficient information of the lease area and 3-D seismic methods would ultimately have to be employed to characterize the area's subsurface geological structure. Gravity gradiometry is therefore not practicable and would not accomplish the purpose of Furie's program. Furie is committed to collaborate with and support research by the NMFS, Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, other appropriate state and federal agencies, local Alaska Native and research groups, and other monitoring programs to further the information available about Cook Inlet and the marine mammals that occupy this area.

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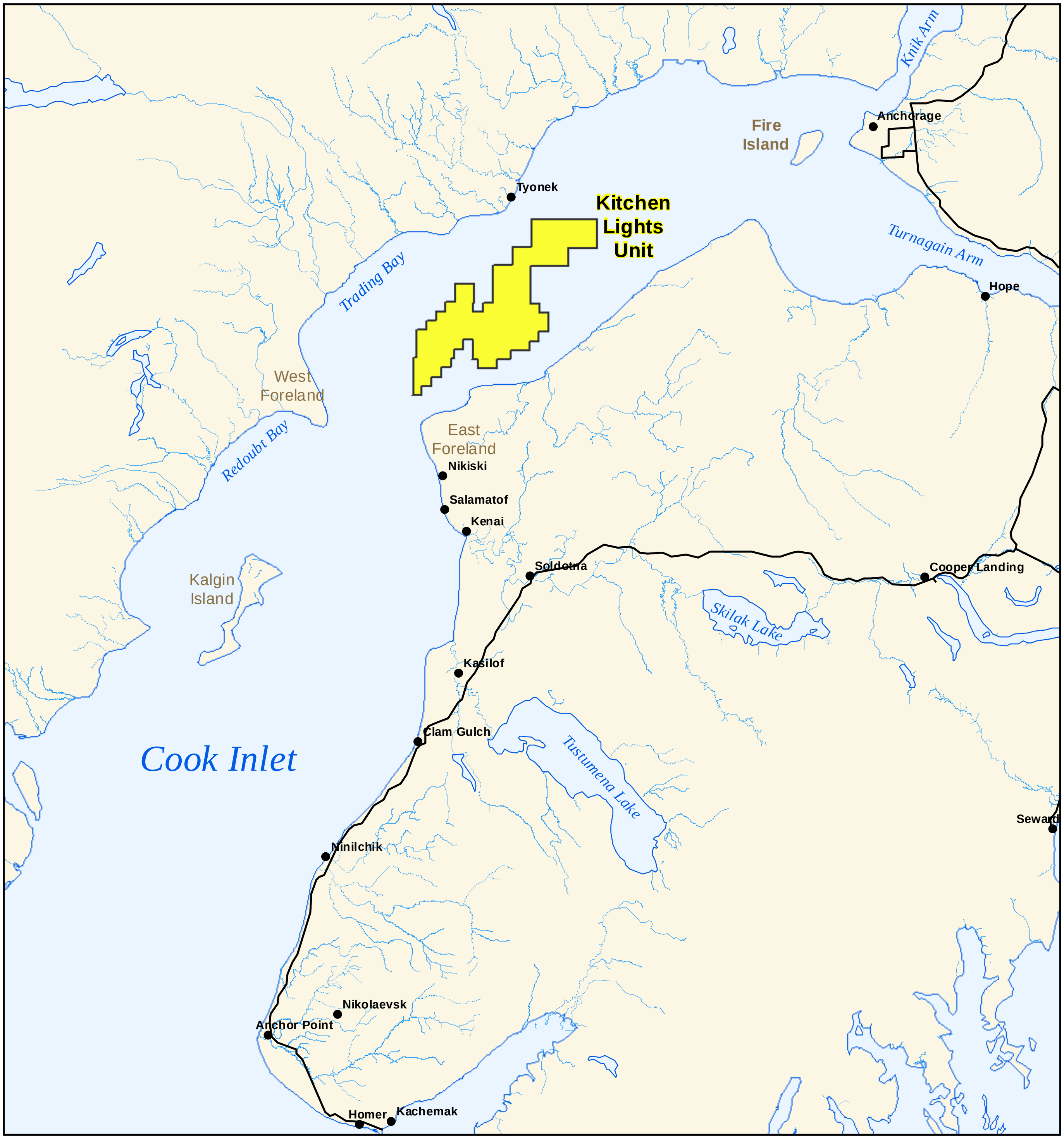
APPENDIX A

Figures



Kitchen Lights Unit

0 10 20 30 40
Kilometers

0 5 10 15 20
Miles

NAD 1983 StatePlane Alaska 4, Feet

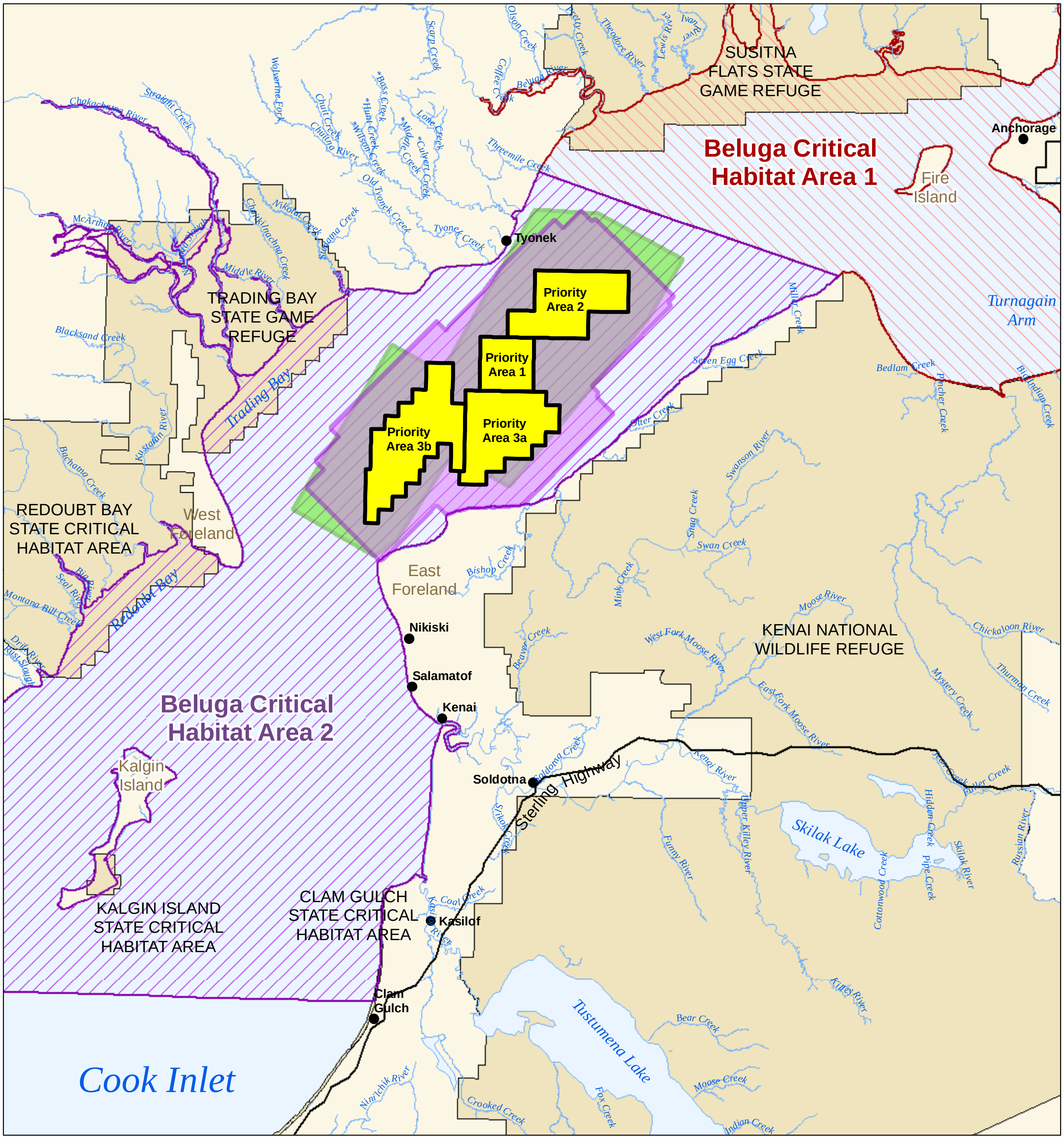
N

FURIE OPERATING ALASKA
LOCATION AND VICINITY

COOK INLET, ALASKA

JACOBS	DATE: 07 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-1

P:\Furie\BiologicalAssessment\FigA-1_LocationVicinity.mxd taylorta



- KLU Priority Area
- Proposal A Seismic Survey Area
- Proposal B Seismic Survey Area
- Beluga Critical Habitat Area 1
- Beluga Critical Habitat Area 2
- Refuge/State Critical Habitat

All Locations Are Approximate

Miles: 0 2 4 6 8 10

Kilometers: 0 5 10 15 20 25

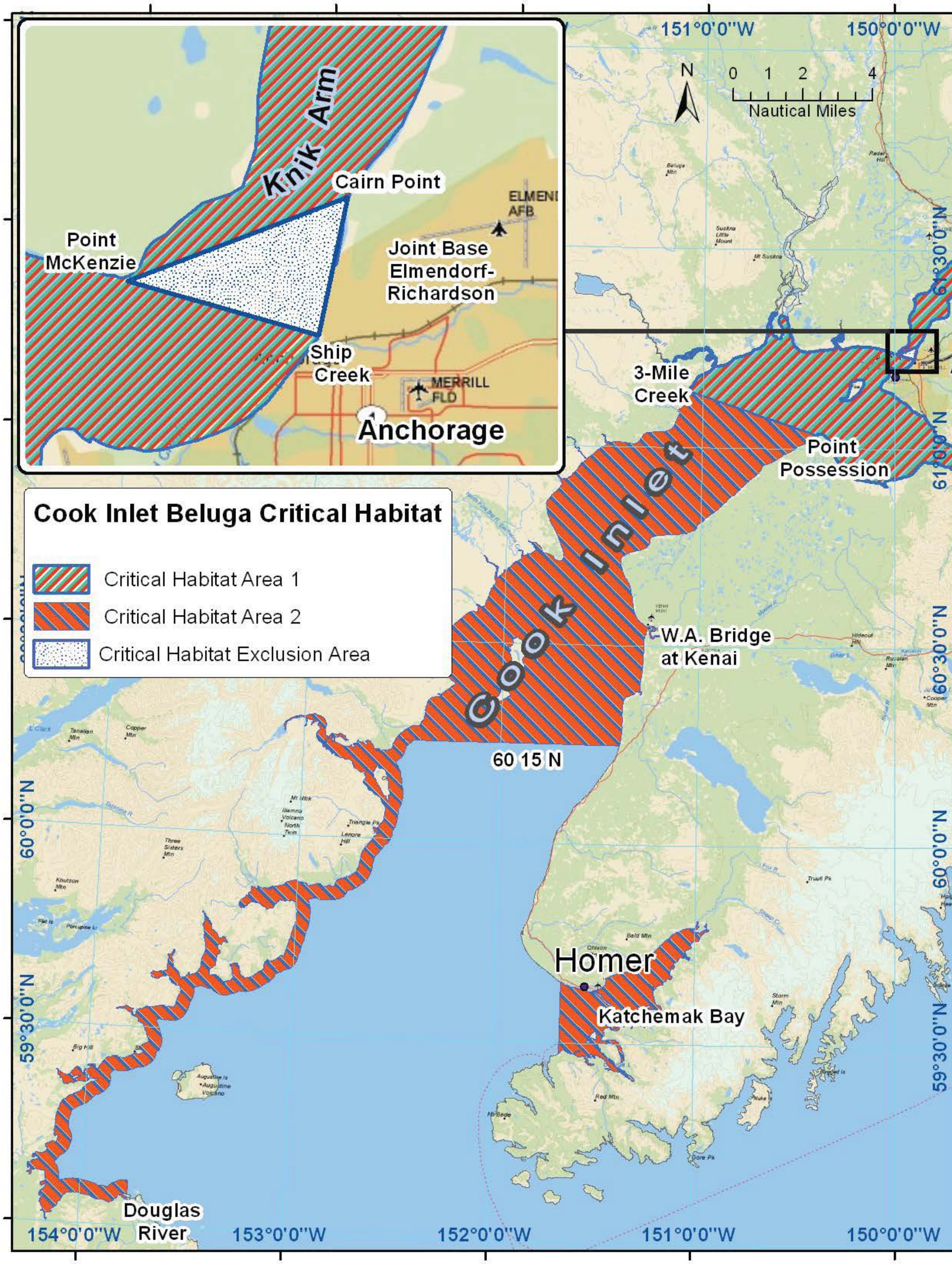
NAD 1983 StatePlane Alaska 4, Feet

N

FURIE OPERATING ALASKA, LLC
PROPOSED SEISMIC SURVEY AREA
COOK INLET, ALASKA

JACOBS	DATE: 17 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-2

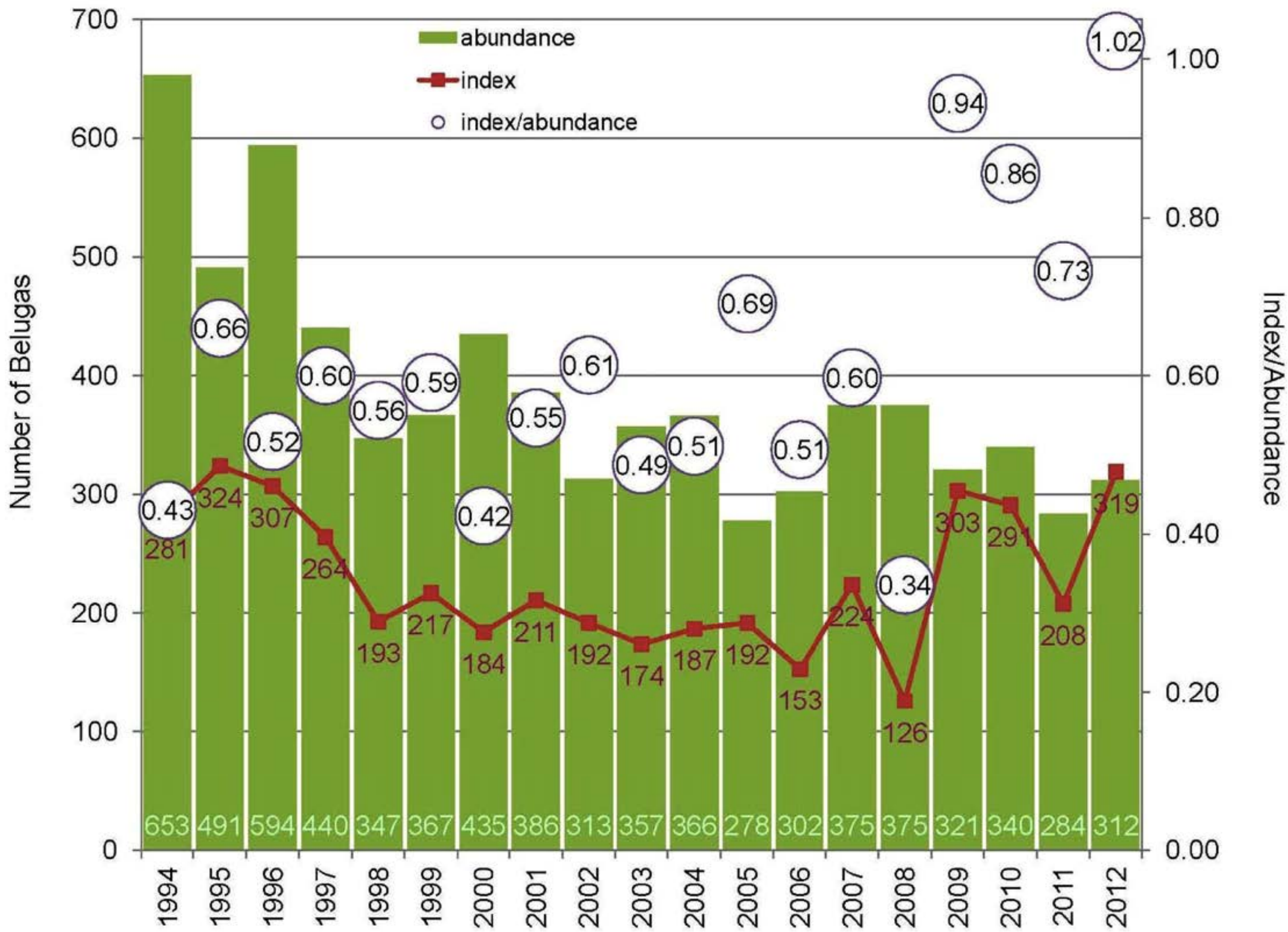
P:\Furie\Seismic Survey BE\MXD\ProposedSeismicSurveyArea.mxd beatycj



Notes:
Area 2, where the proposed project is located, encompasses dispersed fall and winter feeding habitat and transit areas in waters where whales typically occur in smaller densities or deeper waters. It includes both near and offshore areas of the mid and upper Inlet, and nearshore areas of the lower Inlet.

Source: NOAA 2011

DESIGNATED COOK INLET BELUGA WHALE CRITICAL HABITAT COOK INLET, ALASKA			
JACOBS	11 OCT 2012	T. HEIKKILA	A-3



Notes:
Green bars indicate the annual abundance estimates for Cook Inlet beluga whale aerial surveys from 1994 to 2012. The red trend line indicates the median index counts and the white circles indicate counts divided by abundance.

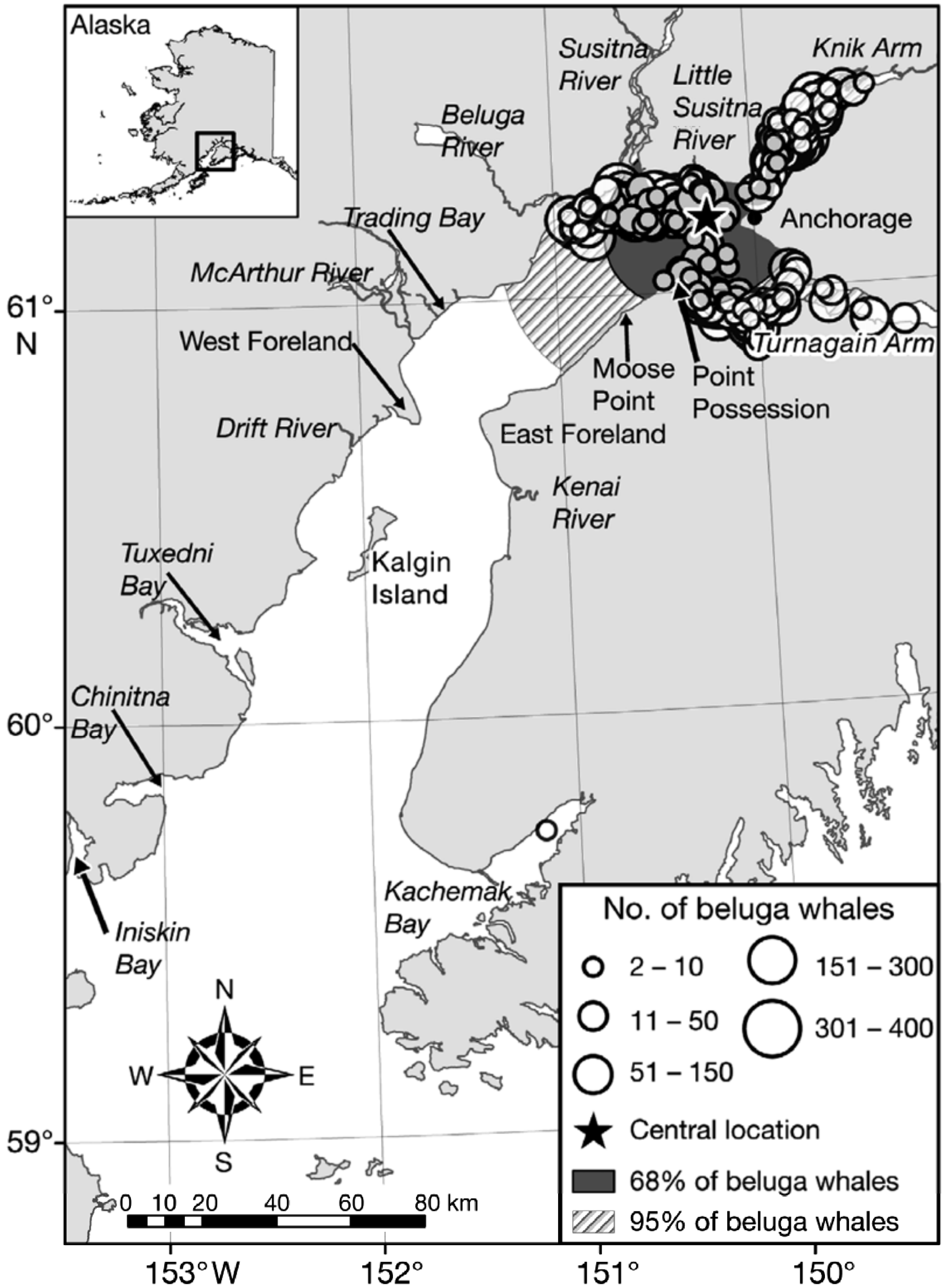
Source: Shelden et. al. 2012

ESTIMATED COOK INLET BELUGA WHALE POPULATION ABUNDANCE AND TREND 1994-2012

COOK INLET, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	09 JAN 2013	T. HEIKKILA	A-4

P:\Furie\Seismic Survey BE\MXD\Figure A-4 EstimatedCookInletBelugaWhalePopulationChart.mxd beatycj



Notes:
The hatching represents statistical distributions of beluga whales around the central location, caculated at 1 standard deviation (capturing ca. 68% of the observations) or 2 standard deviations (95% of observations). Note that actual observations are highly concentrated in the far northwest of Cook Inlet, and that the statistical distribution shown for 95% of observations is pulled south by only several observations in Katchemak Bay.

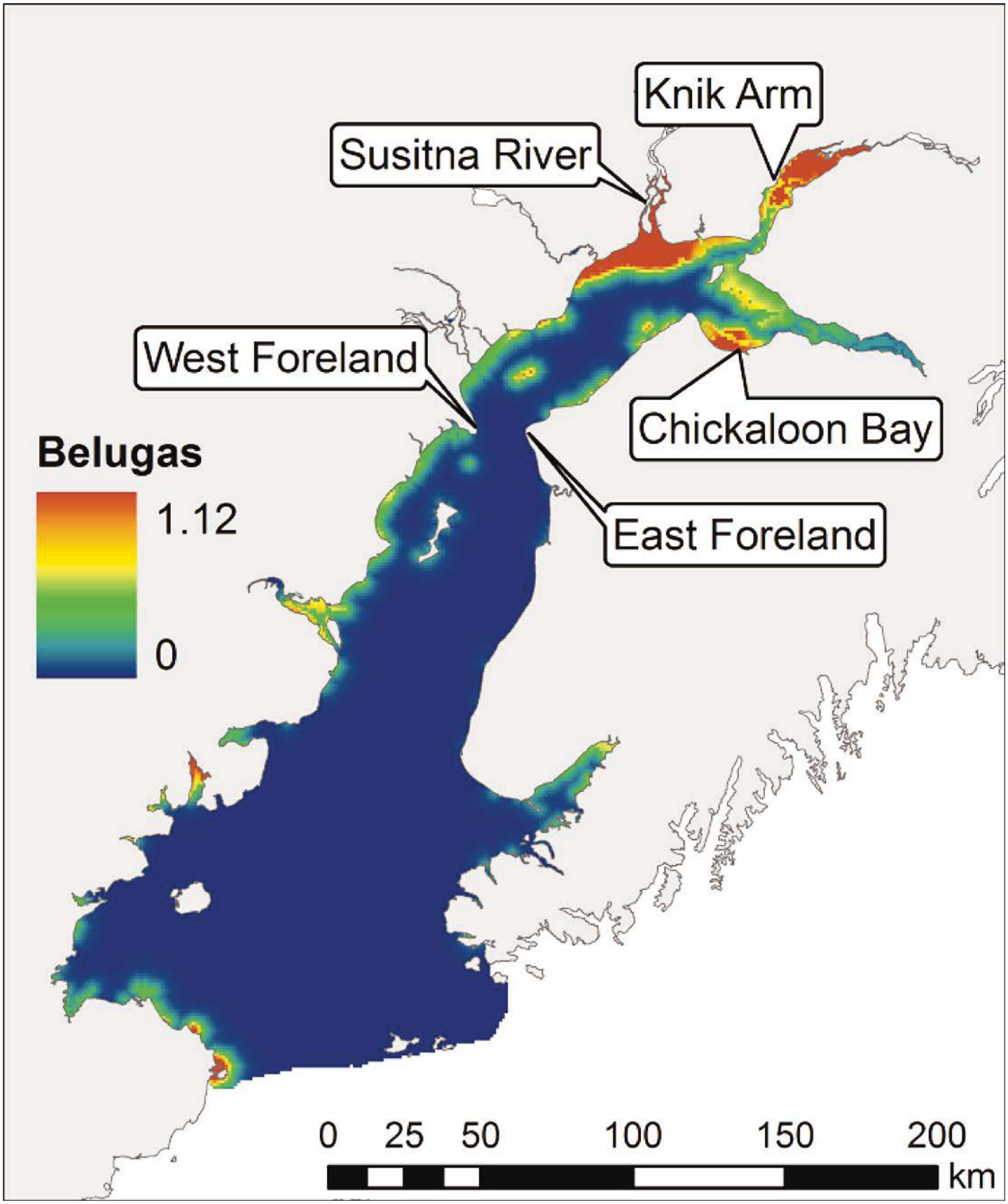
Source: Rugh et. al. 2010

AREAS OCCUPIED BY BELUGA WHALES IN COOK INLET, ALASKA
JUNE 1998-2008

COOK INLET, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	09 JAN 2013	T. HEIKKILA	A-5

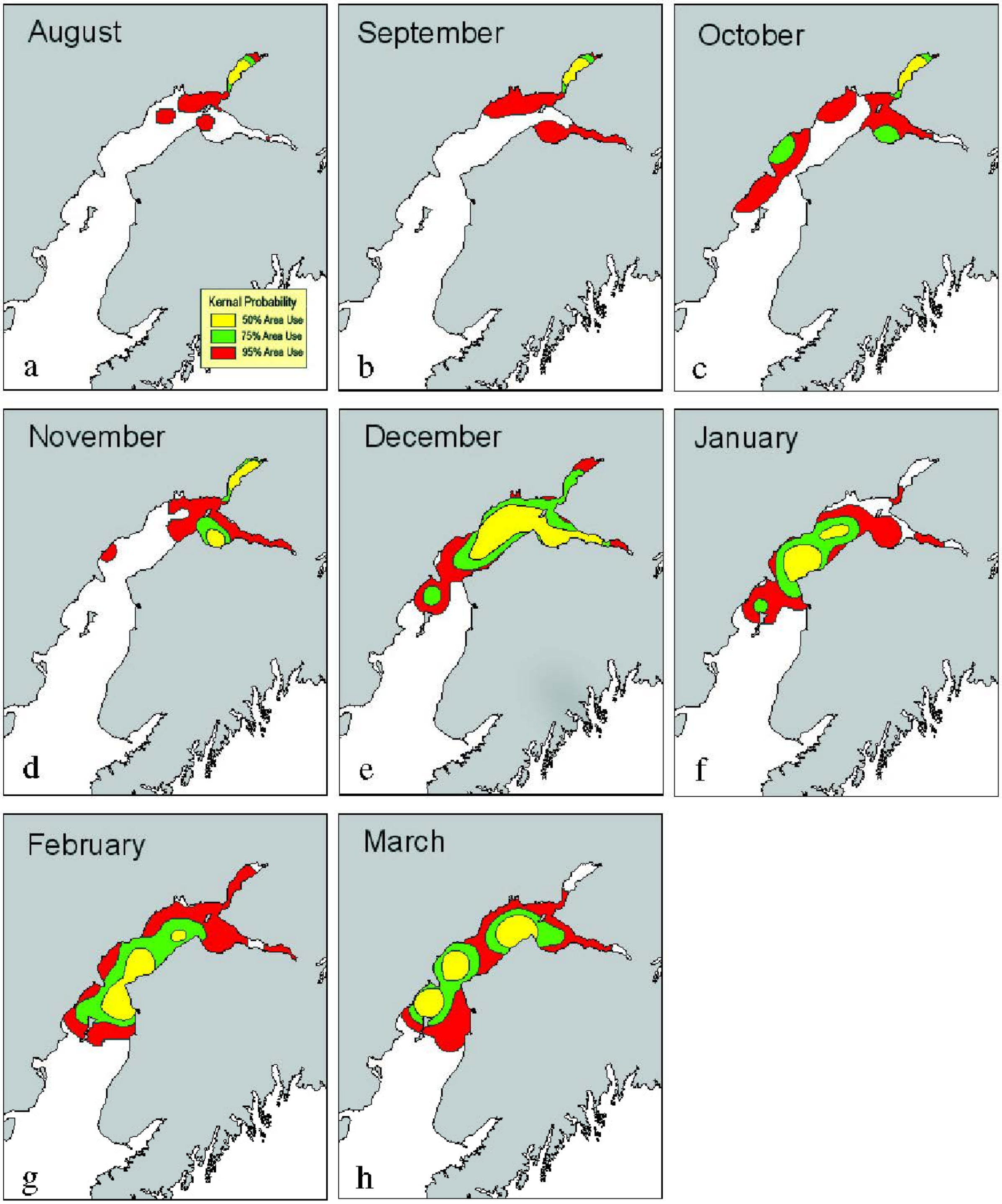
P:\Furie\Seismic Survey BE\MXD\Figure A-5 AreasOccupiedByBelugaWhalesInCookInlet.mxd beatycj



Notes: Expected number of Cook Inlet beluga whales within each 1 km^2 habitat unit. Most belugas are likely to be present north of the Forelands, in Knik Arm, the Susitna River Delta, and Chickaloon Bay

Source: Goetz et al. 2012

EXPECTED NUMBER OF BELUGAS COOK INLET, ALASKA			
JACOBS	18 JAN 2013	T. HEIKKILA	A-6



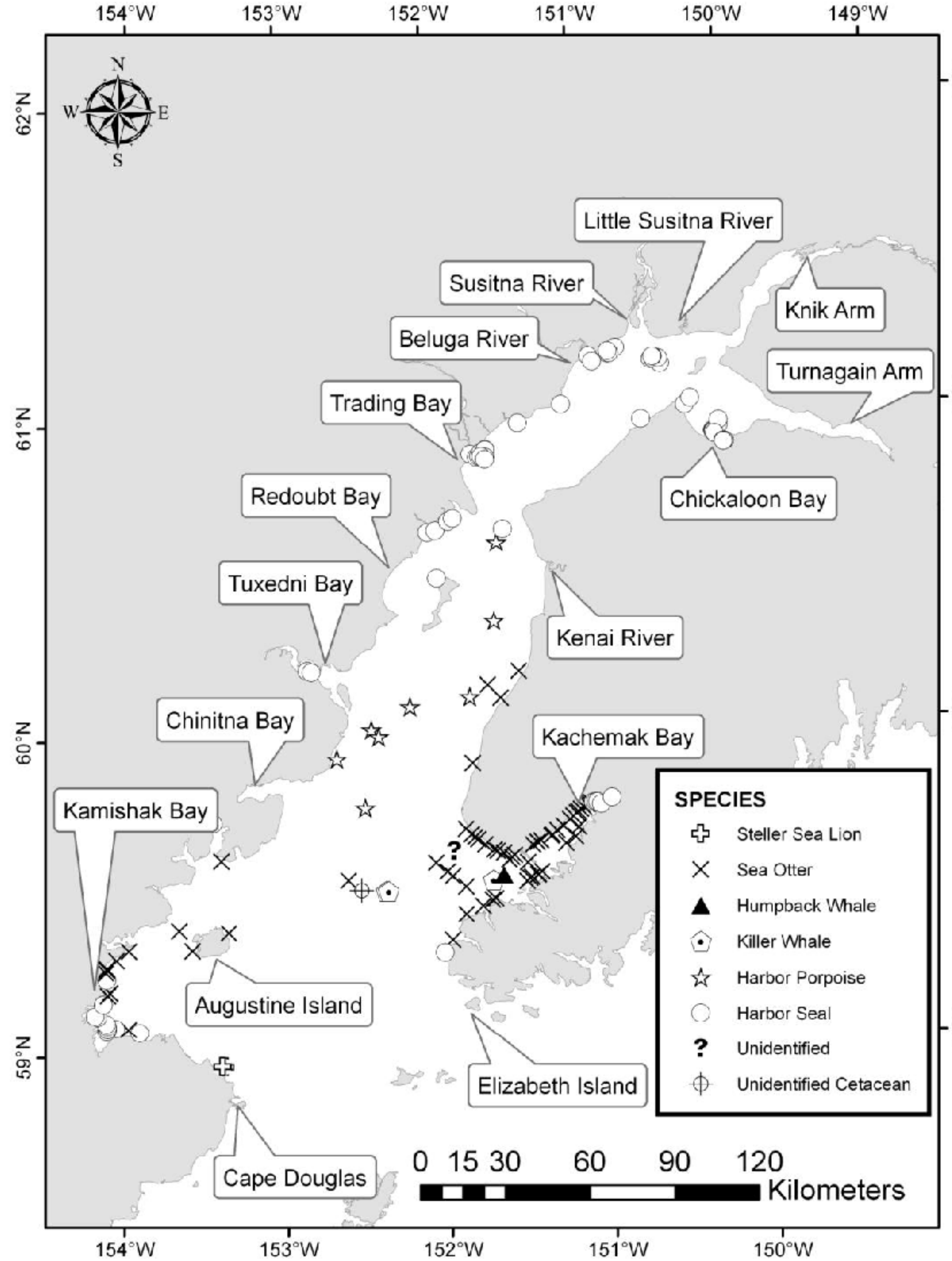
Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.

Source: Hobbs et. al. 2005

PREDICTED BELUGA WHALE FALL AND WINTER DISTRIBUTION BY MONTH

COOK INLET, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	09 JAN 2013	T. HEIKKILA	A-7



Notes:
Beluga whales are not represented in this figure. Harbor seals were observed hauled out at Chickaloon River (47), Susitna River (183), McArthur River in Trading Bay (125), and the Theodore and Lewis Rivers (100 at each river, both located between the Beluga and Susitna Rivers) (numbers in parentheses are the maximum number of individuals observed during a survey). Two groups of Steller sea lions totaling 65 animals were observed hauled out near Cape Douglas.

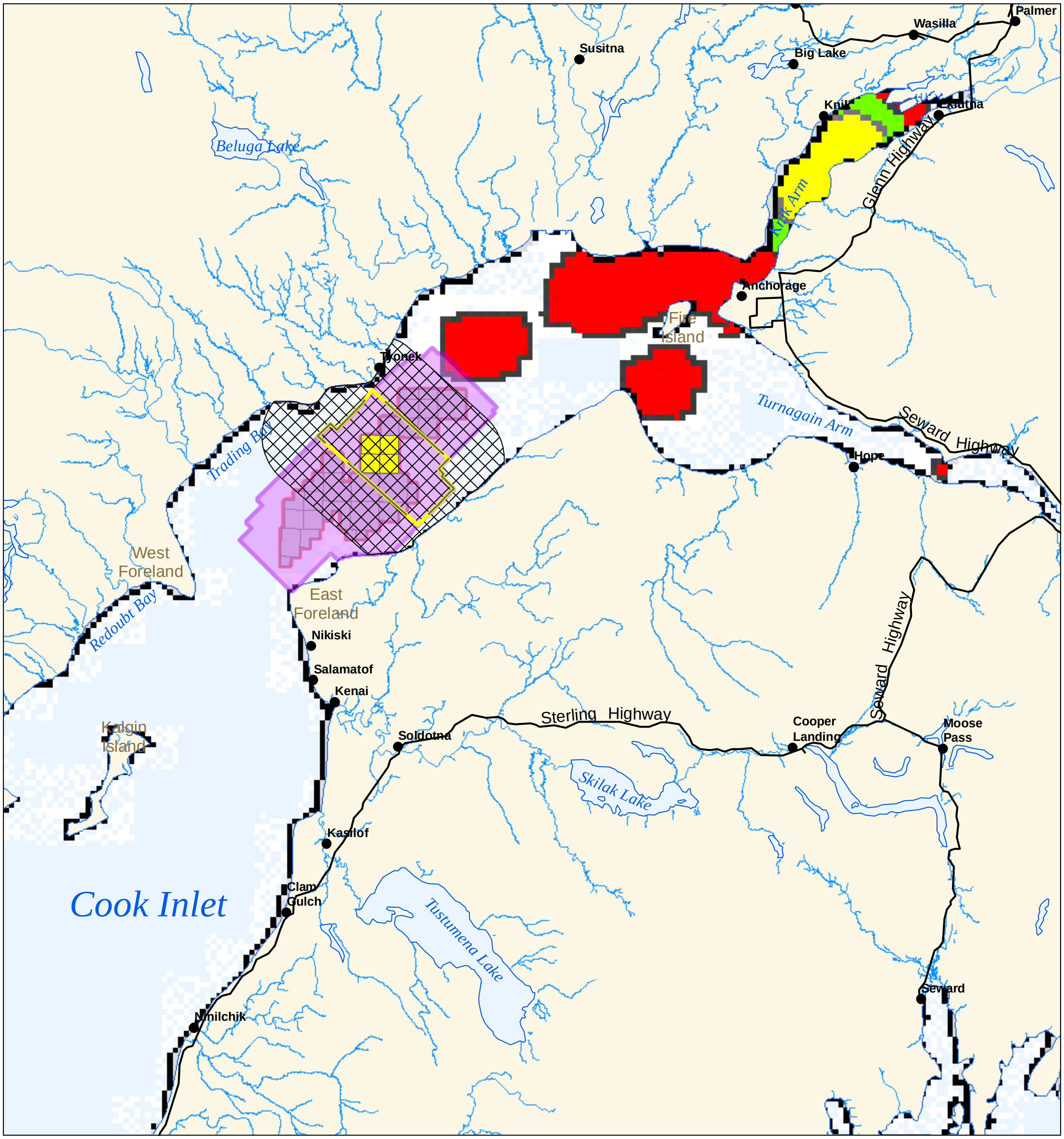
Source: Shelden et al. 2012

MARINE MAMMAL SIGHTINGS AND HAUL-OUT SITES
JUNE 2012

COOK INLET, ALASKA

JACOBS	DATE: 01 MAR 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-8

P:\Furie\Seismic Survey BE\MXD\Figure A-8 (new) Marine Mammal Observations and haulouts.mxd smithnj



- Priority 1 Survey Area (250 Sq Km)
- Priority 1 Ensonified Area (890 Sq Km)
- Priority 1 Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

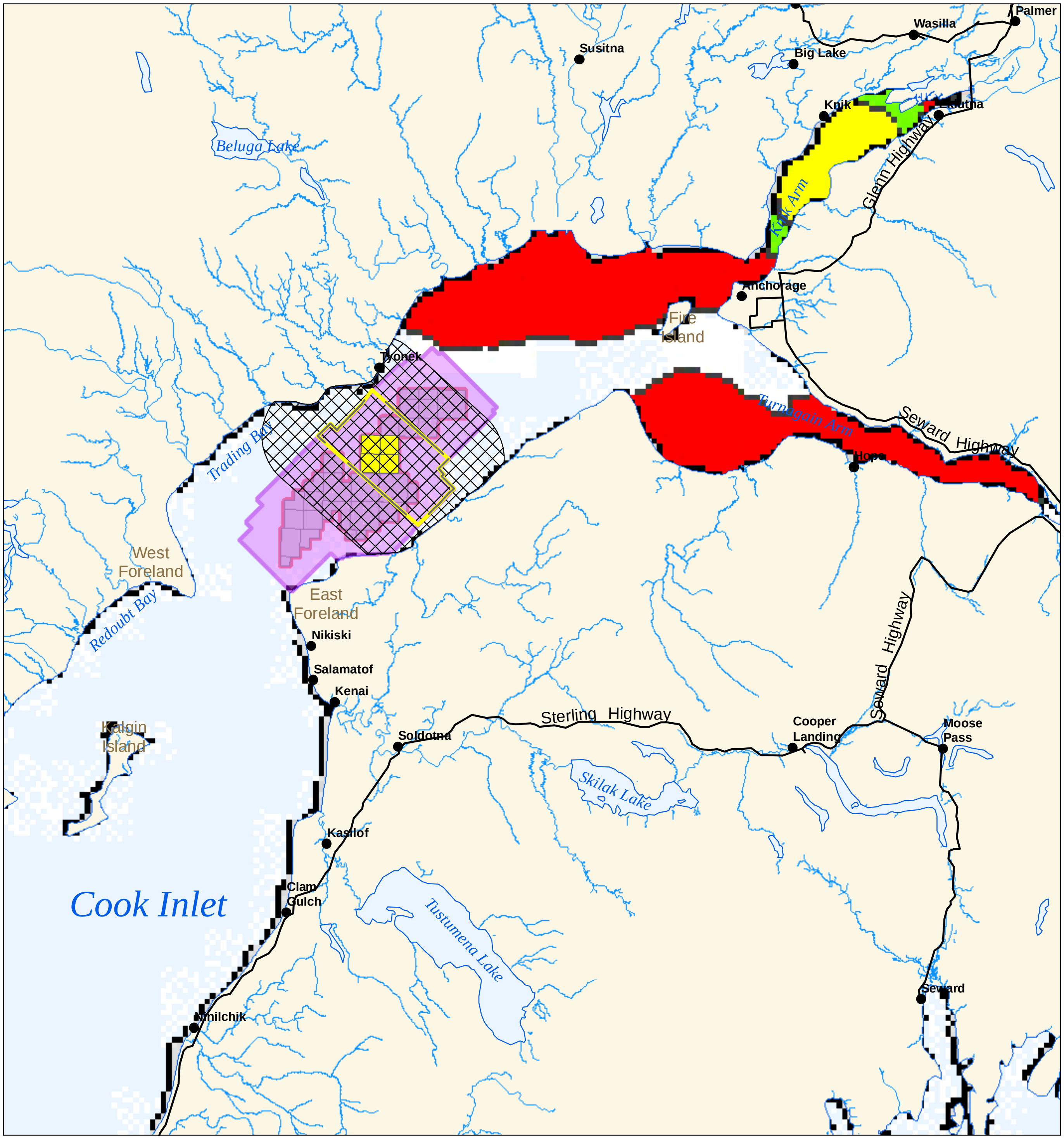
N

AUGUST PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 1

COOK INLET, ALASKA

JACOBS	DATE: 14 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-9

P:\Furie\Seismic Survey BE\MXD\PriorityArea1_August.mxd beatycj



- Priority 1 Survey Area (250 Sq Km)
- Priority 1 Ensonified Area (890 Sq Km)
- Priority 1 Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

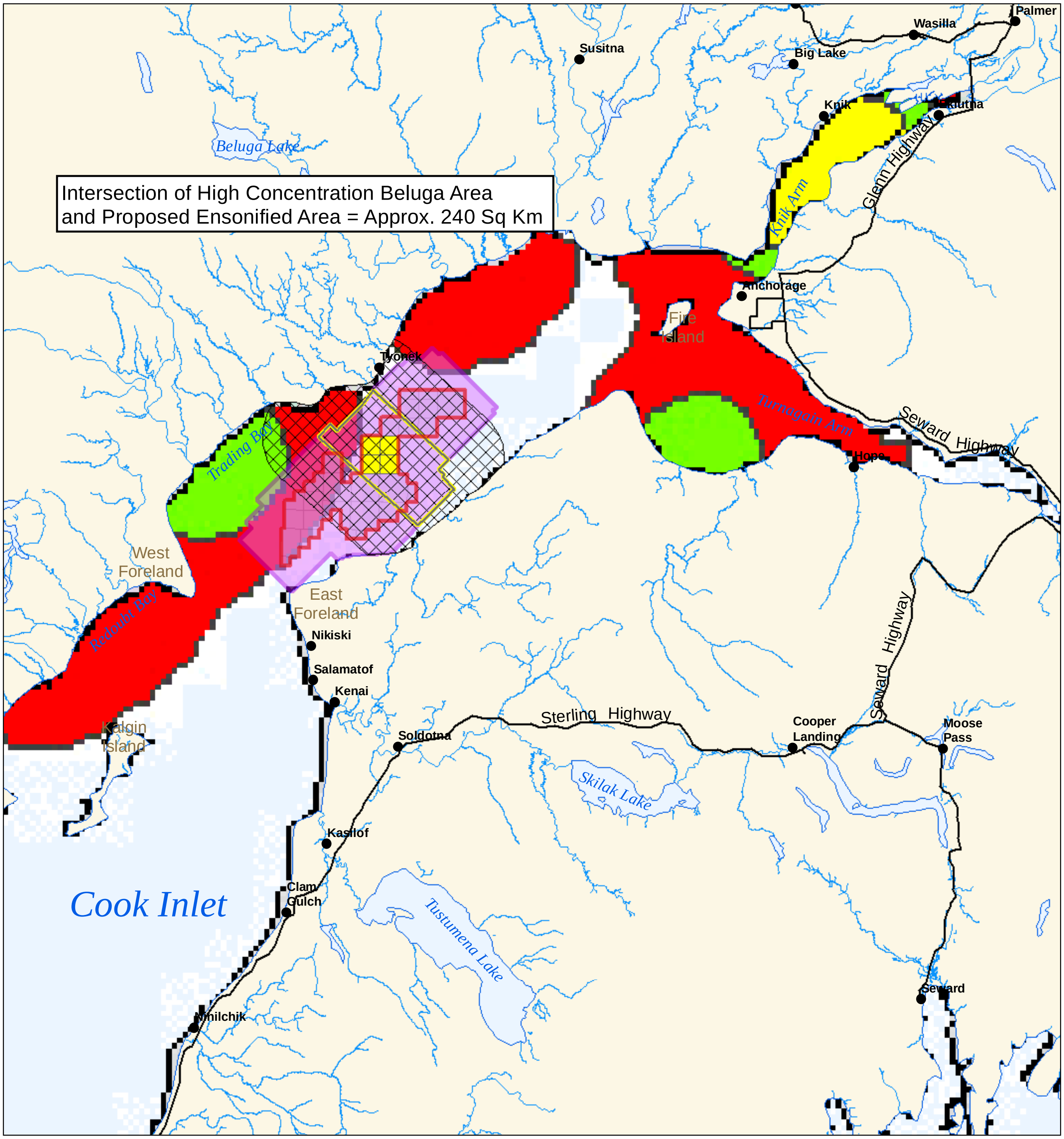
N

SEPTEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 1

COOK INLET, ALASKA

JACOBS	DATE: 14 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-10

P:\Furie\Seismic Survey BE\MXD\PriorityArea1_September.mxd beatycj



- Priority 1 Survey Area (250 Sq Km)
- Priority 1 Ensonified Area (890 Sq Km)
- Priority 1 Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

Miles: 0 3 6 9 12 15

Kilometers: 0 5 10 15 20 25

NAD 1983 StatePlane Alaska 4, Feet

N

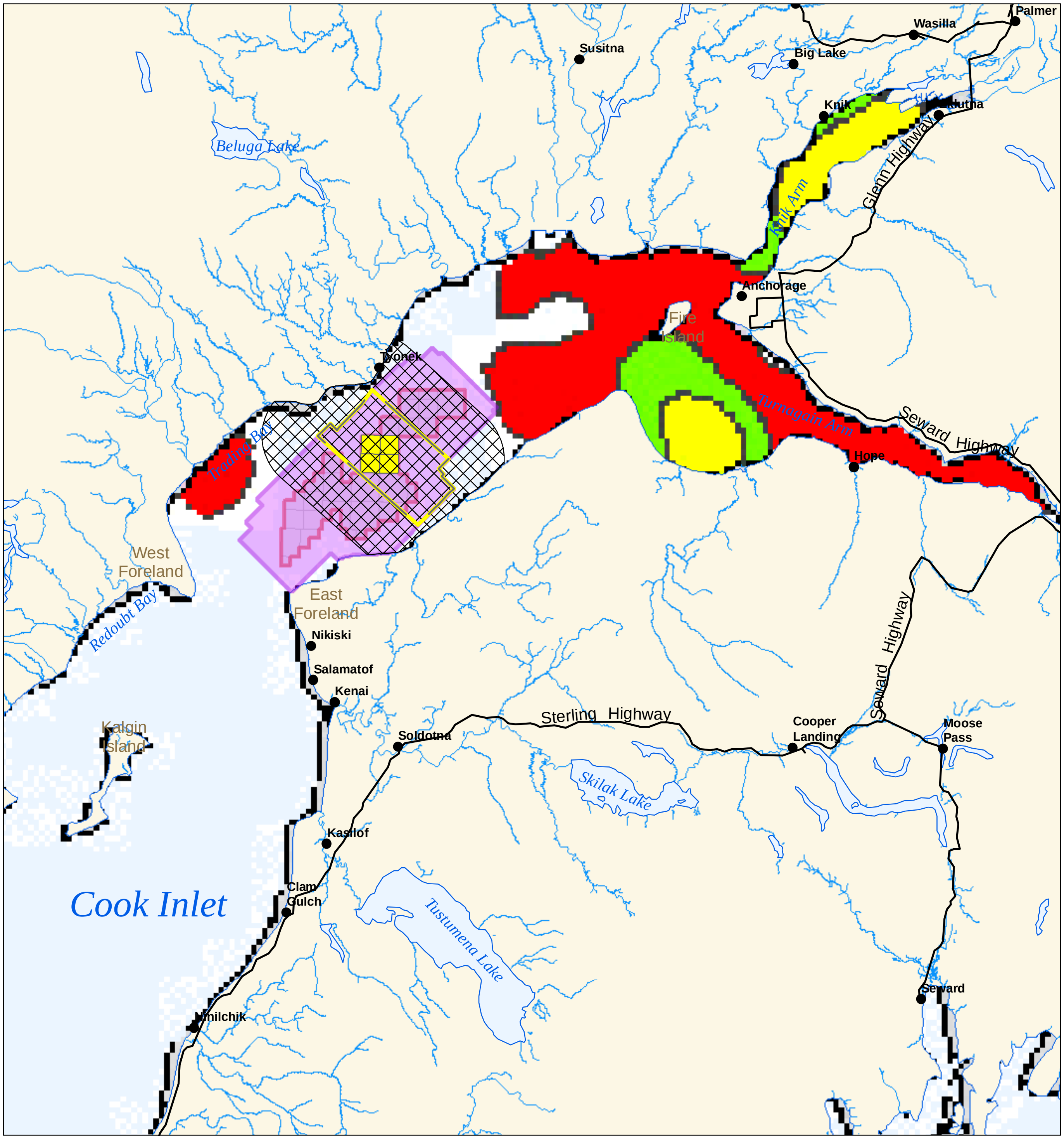
OCTOBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 1

COOK INLET, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
14 JAN 2013	T. HEIKKILA	A-11

P:\Furie\Seismic Survey BE\MXD\PriorityArea1_October.mxd beatyq



Priority 1 Survey Area (250 Sq Km)
Priority 1 Ensonified Area (890 Sq Km)
Priority 1 Leases
Proposal A Seismic Survey Area
Kitchen Lights Unit Leases
Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

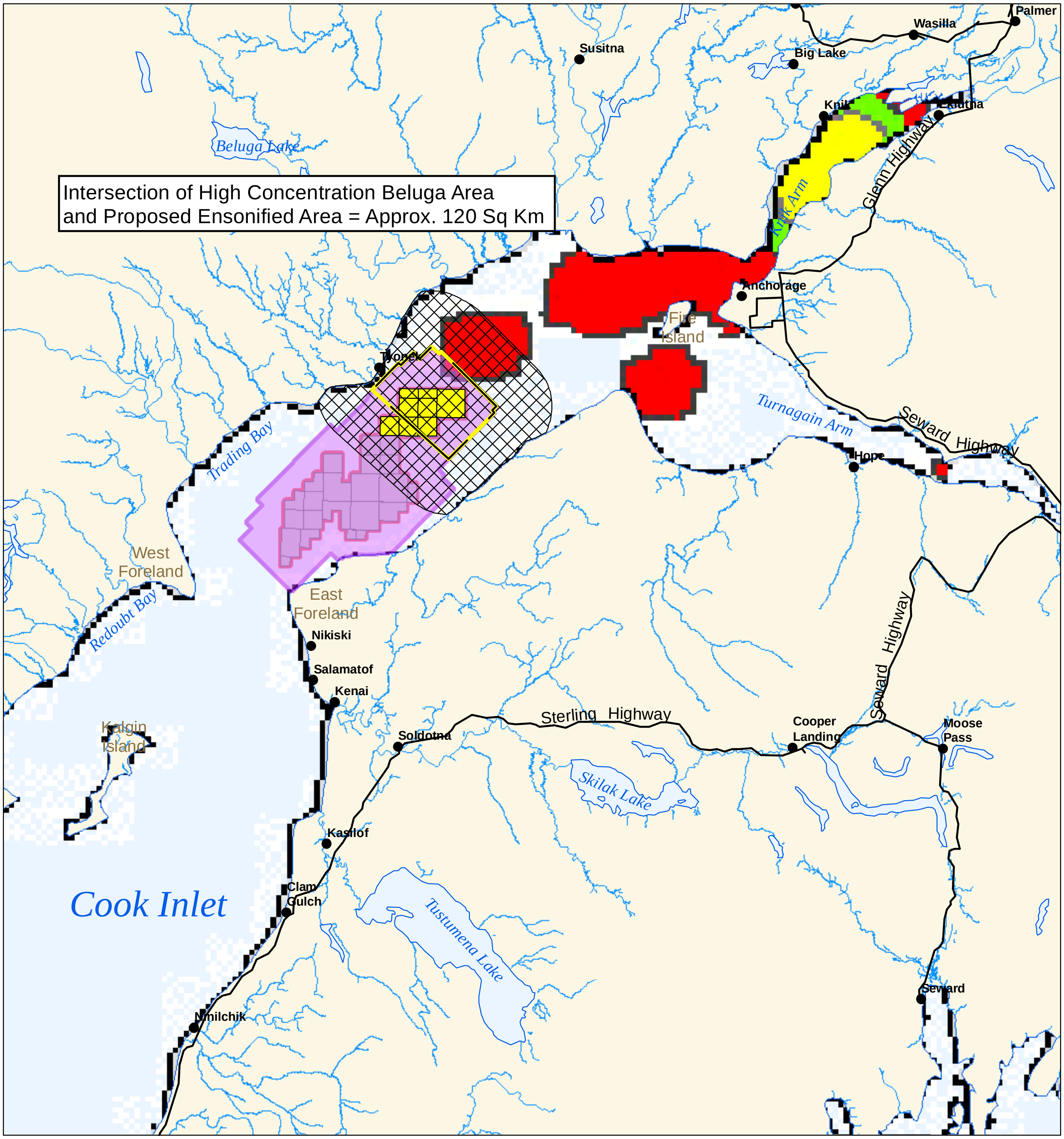
N

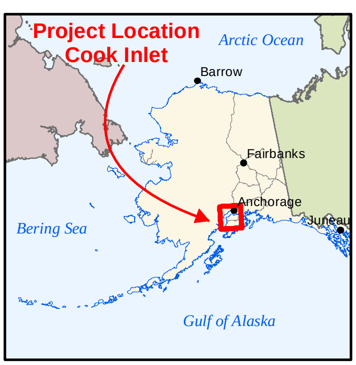
NOVEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 1

COOK INLET, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	14 JAN 2013	T. HEIKKILA	A-12

P:\Furie\Seismic Survey BE\MXD\PriorityArea1_November.mxd beatycj





- Priority 2 Survey Area (210 Sq Km)
- Priority 2 Ensonified Area (880 Sq Km)
- Priority Area 2 Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

Miles: 0 3 6 9 12 15

Kilometers: 0 5 10 15 20 25

NAD 1983 StatePlane Alaska 4, Feet

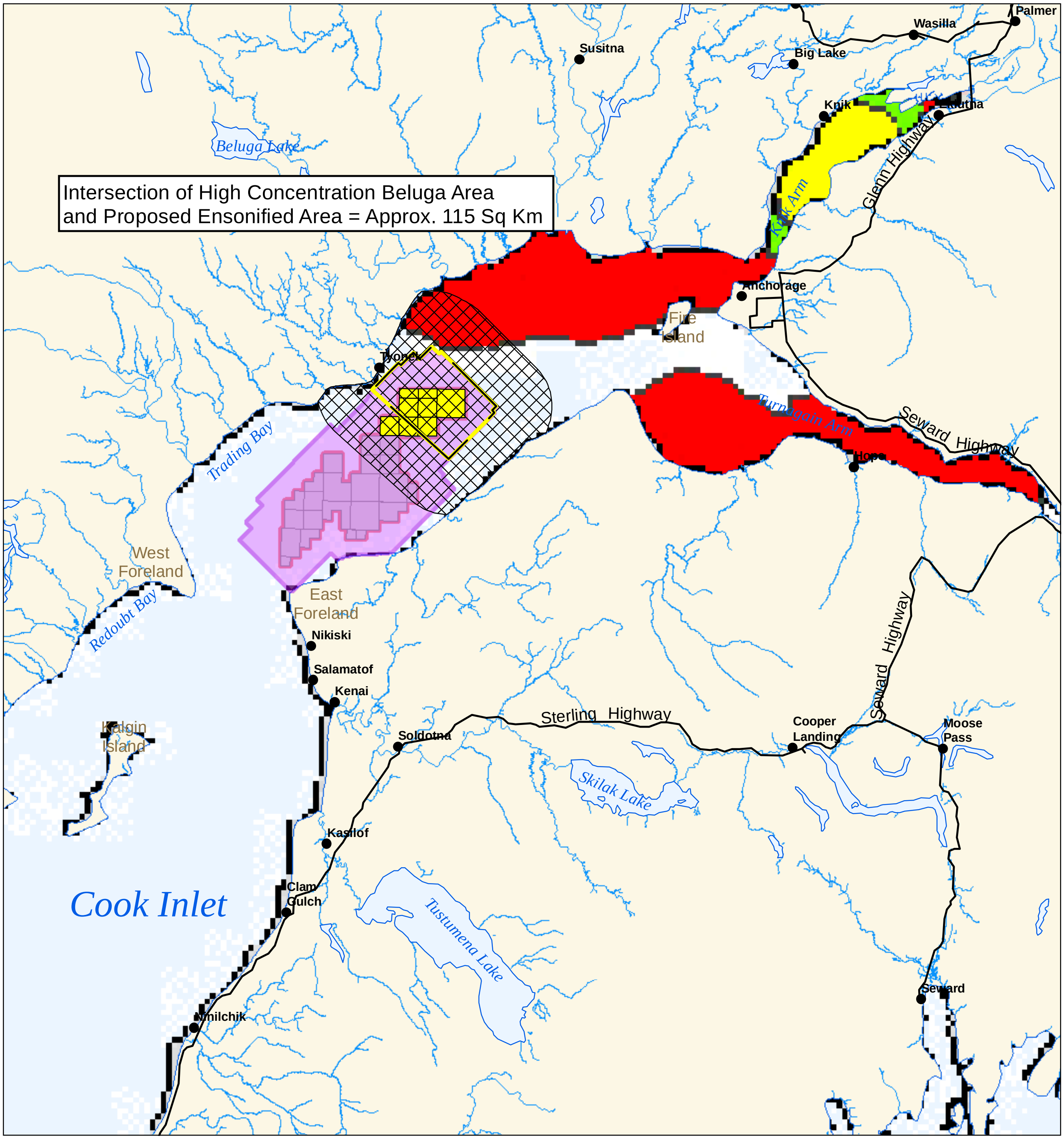
N

AUGUST PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 2

COOK INLET, ALASKA

JACOBS	DATE: 14 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-13

P:\Furie\Seismic Survey BE\MXD\PriorityArea2_August.mxd beatycj



- Priority 2 Survey Area (210 Sq Km)
- Priority 2 Ensonified Area (880 Sq Km)
- Priority Area 2 Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

Miles: 0 3 6 9 12 15

Kilometers: 0 5 10 15 20 25

NAD 1983 StatePlane Alaska 4, Feet

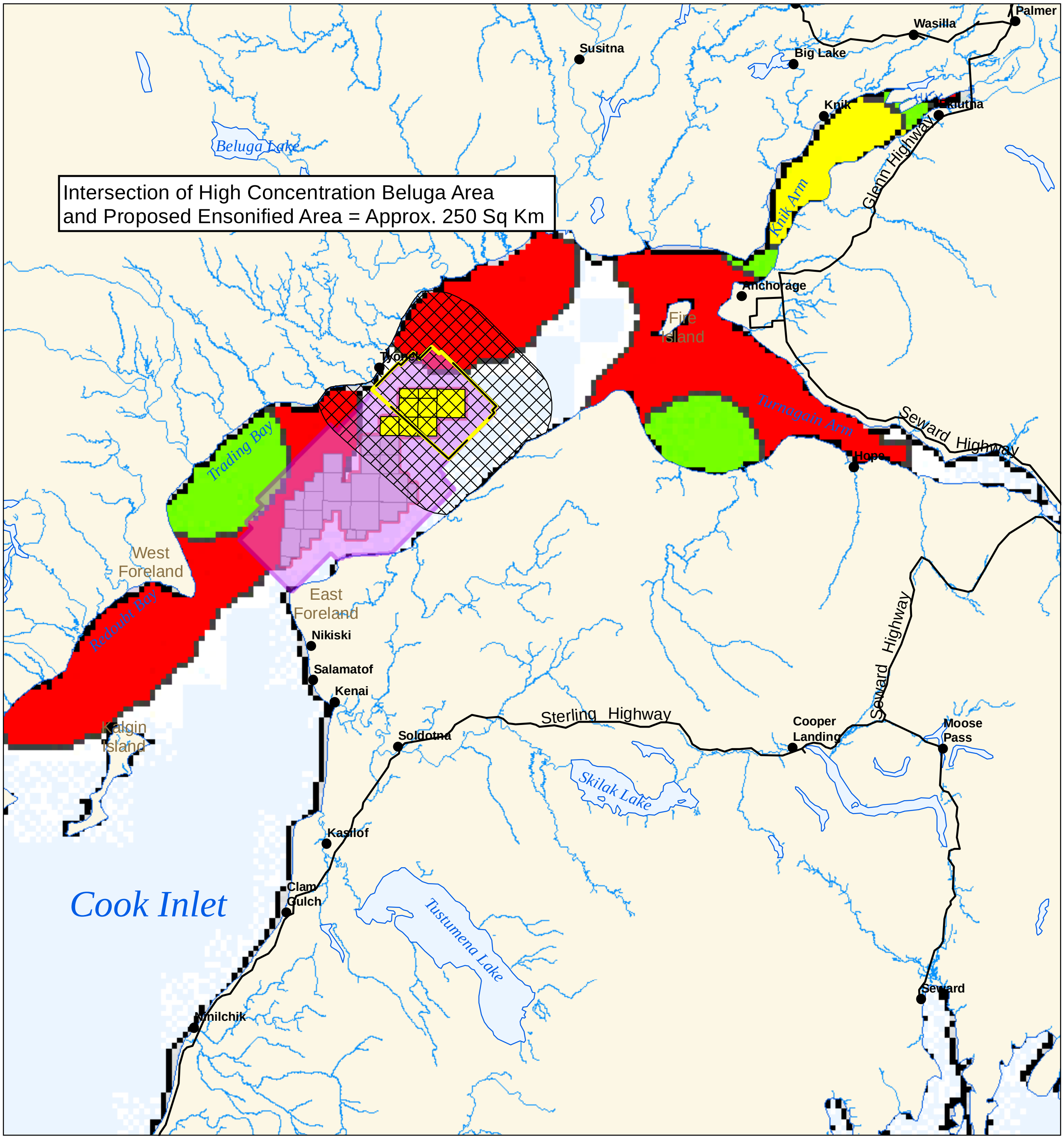
N

SEPTEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 2

COOK INLET, ALASKA

JACOBS	DATE: 14 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-14

P:\Furie\Seismic Survey BE\MXD\PriorityArea2_September.mxd beatycj



- Priority 2 Survey Area (210 Sq Km)
- Priority 2 Ensonified Area (880 Sq Km)
- Priority Area 2 Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

Miles: 0 3 6 9 12 15

Kilometers: 0 5 10 15 20 25

NAD 1983 StatePlane Alaska 4, Feet

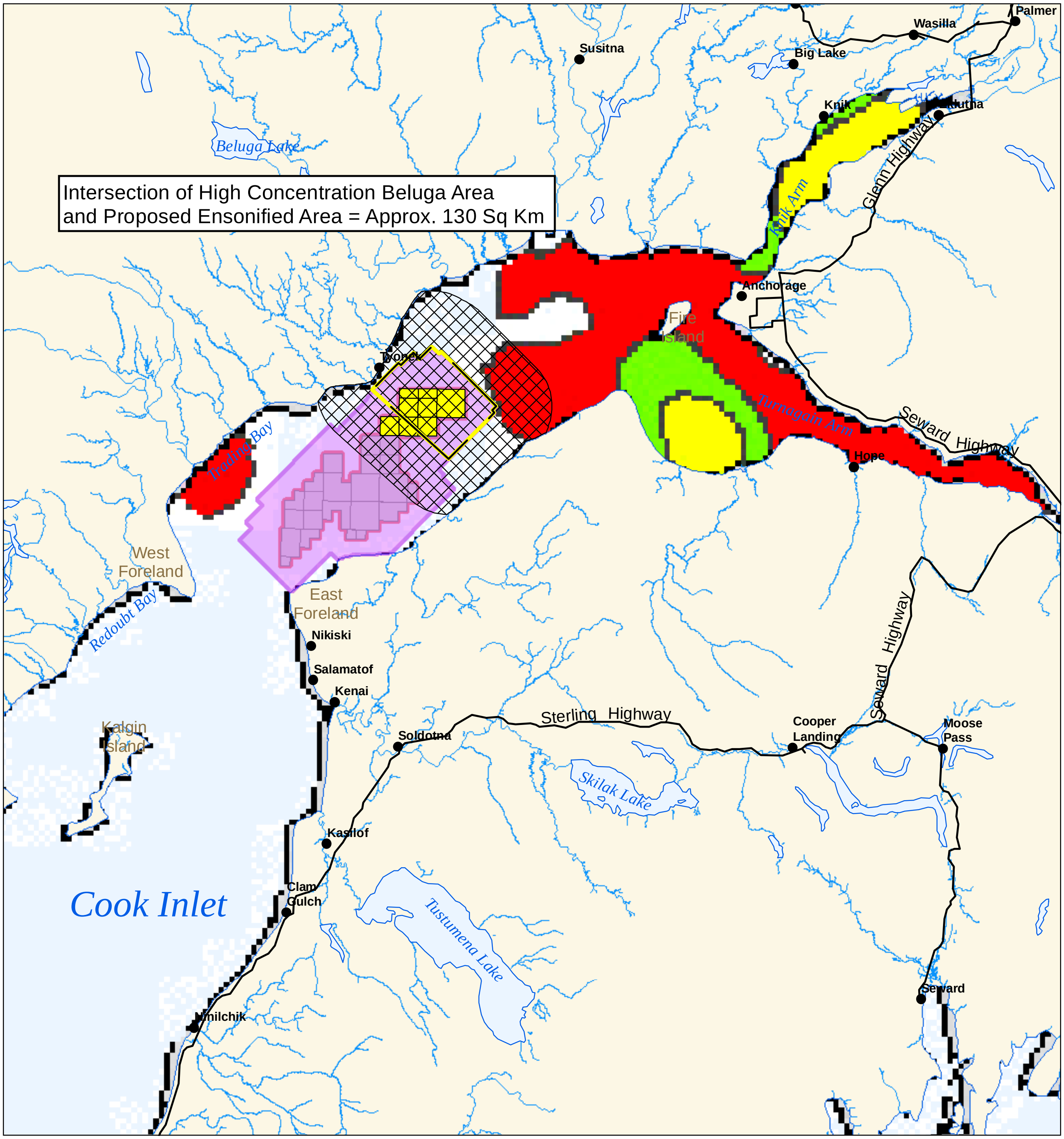
N

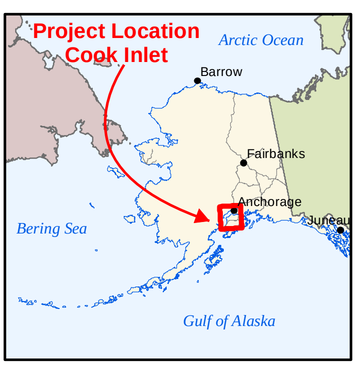
OCTOBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 2

COOK INLET, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	14 JAN 2013	T. HEIKKILA	A-15

P:\Furie\Seismic Survey BE\MXD\PriorityArea2_October.mxd beatyqj





- Priority 2 Survey Area (210 Sq Km)
- Priority 2 Ensonified Area (880 Sq Km)
- Priority Area 2 Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

N

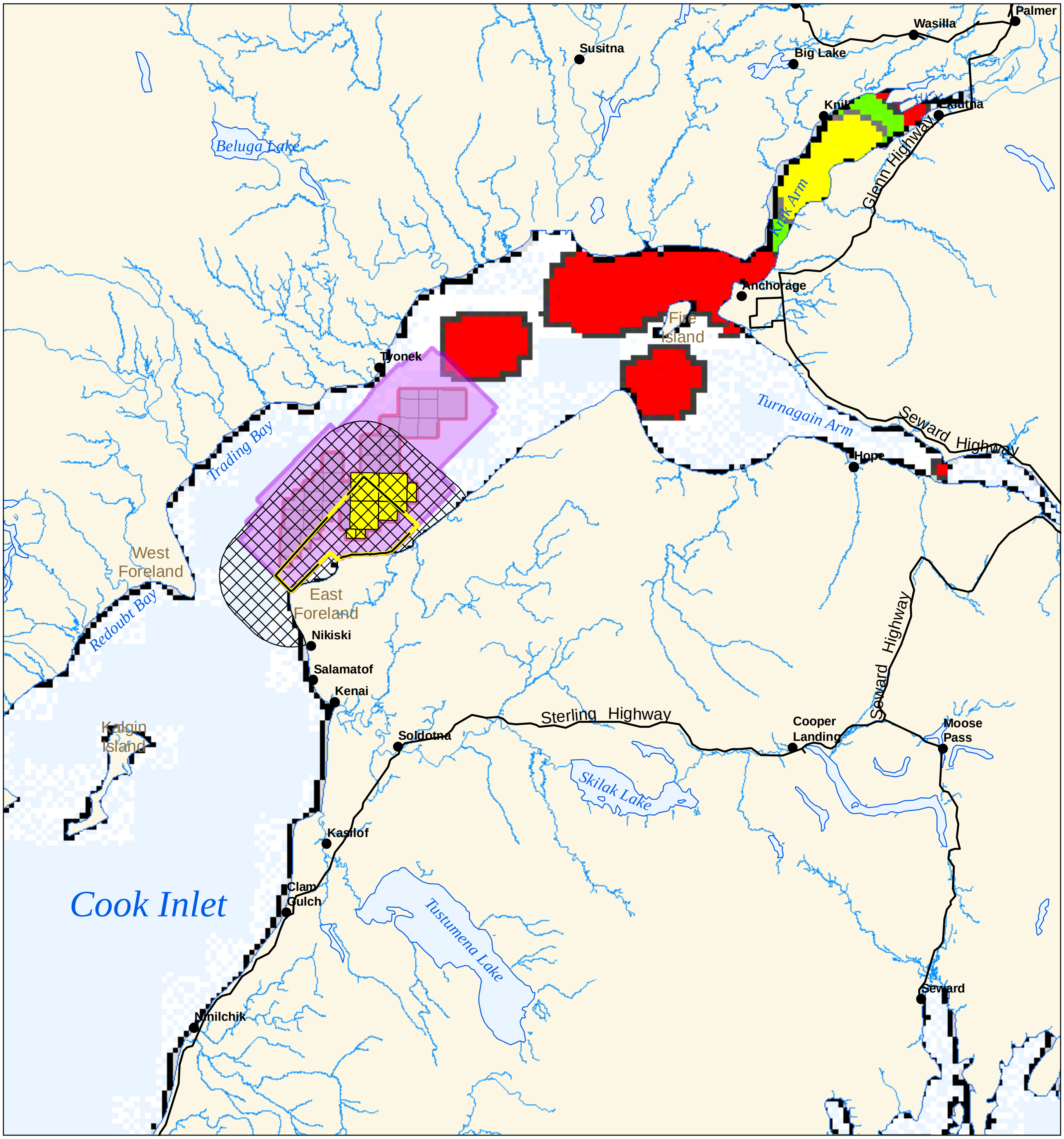
NOVEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 2

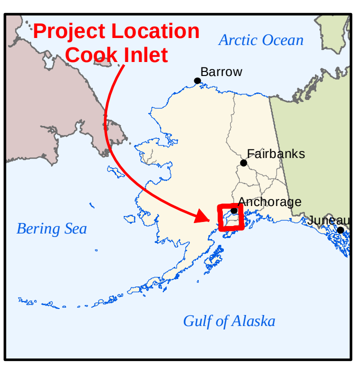
COOK INLET, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
14 JAN 2013	T. HEIKKILA	A-16

P:\Furie\Seismic Survey BE\MXD\PriorityArea2_November.mxd beatycj





- Priority 3a Survey Area (180 Sq Km)
- Priority 3a Ensonified Area (775 Sq Km)
- Priority Area 3a Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

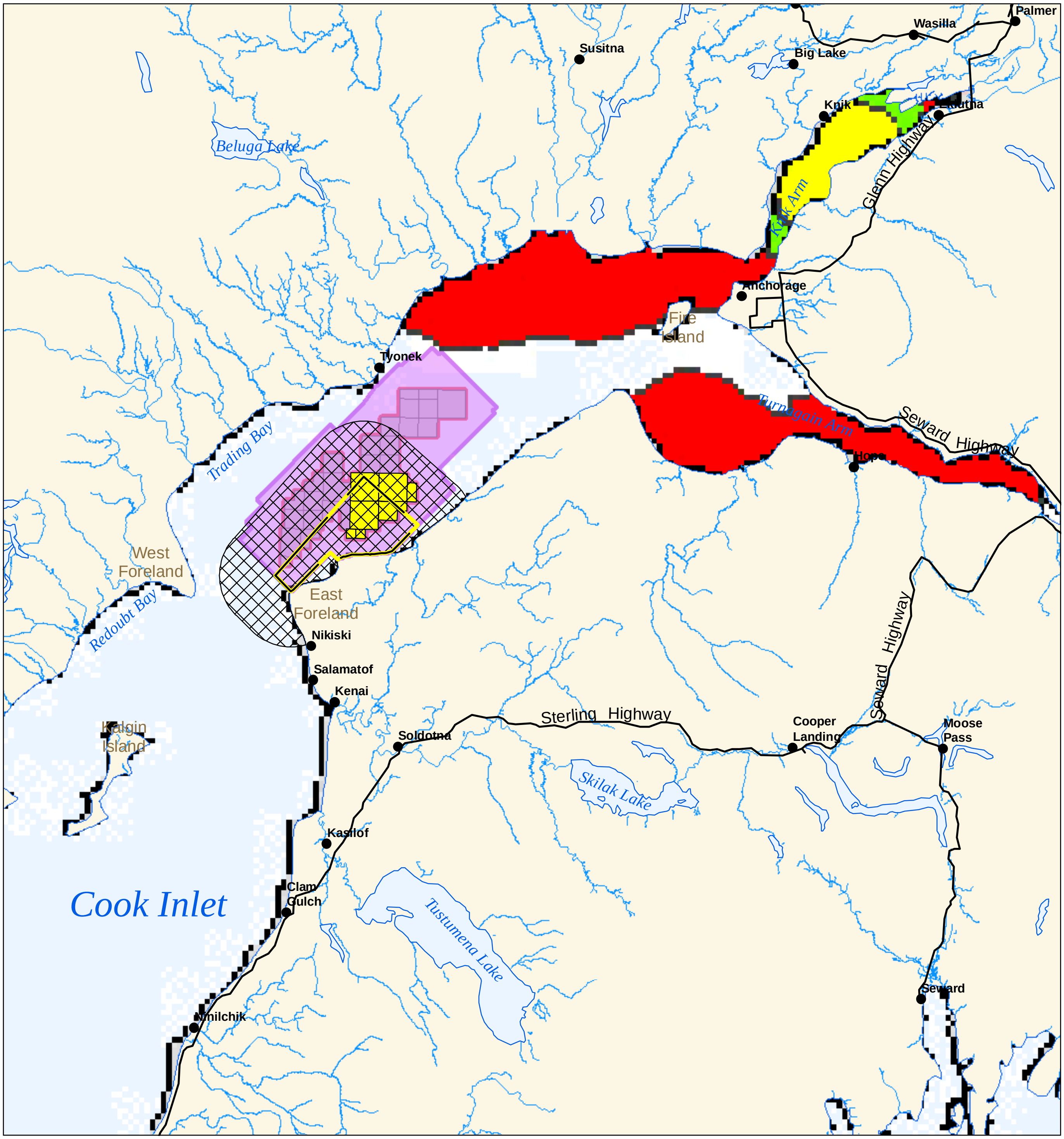
N

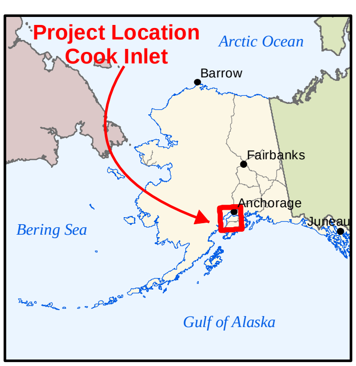
AUGUST PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3a

COOK INLET, ALASKA

	DATE:	PROJECT MANAGER:	FIGURE NO:
JACOBS	14 JAN 2013	T. HEIKKILA	A-17

P:\Furie\Seismic Survey BE\MXD\PriorityArea3_August.mxd beatycj





- Priority 3a Survey Area (180 Sq Km)
- Priority 3a Ensonified Area (775 Sq Km)
- Priority Area 3a Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

Miles: 0 3 6 9 12 15

Kilometers: 0 5 10 15 20 25

NAD 1983 StatePlane Alaska 4, Feet

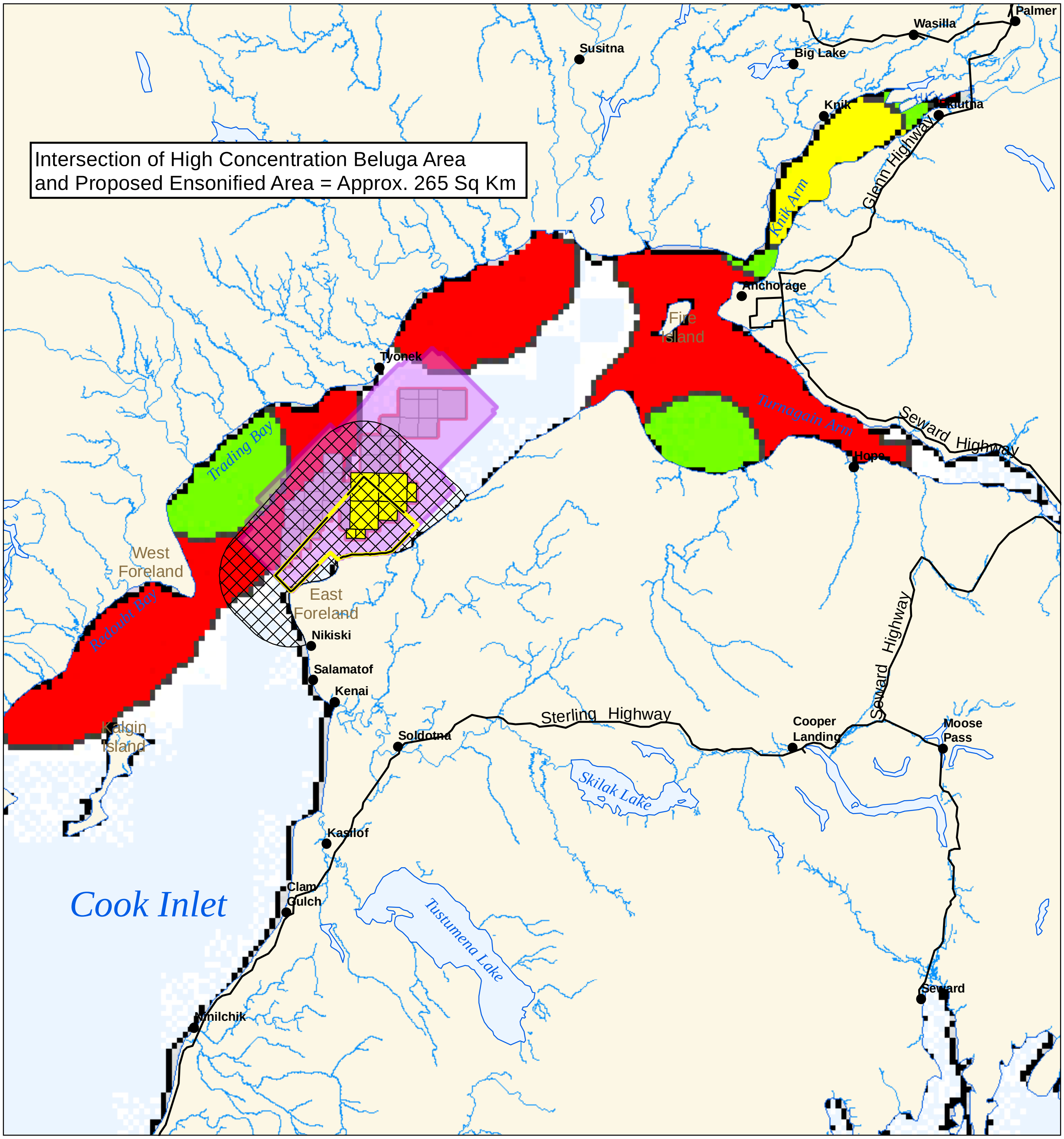
N

SEPTEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3a

COOK INLET, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	14 JAN 2011	T. HEIKKILA	A-18

P:\Furie\Seismic Survey BE\MXD\PriorityArea3_September.mxd beatycj



- Priority 3a Survey Area (180 Sq Km)
- Priority 3a Ensonified Area (775 Sq Km)
- Priority Area 3a Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

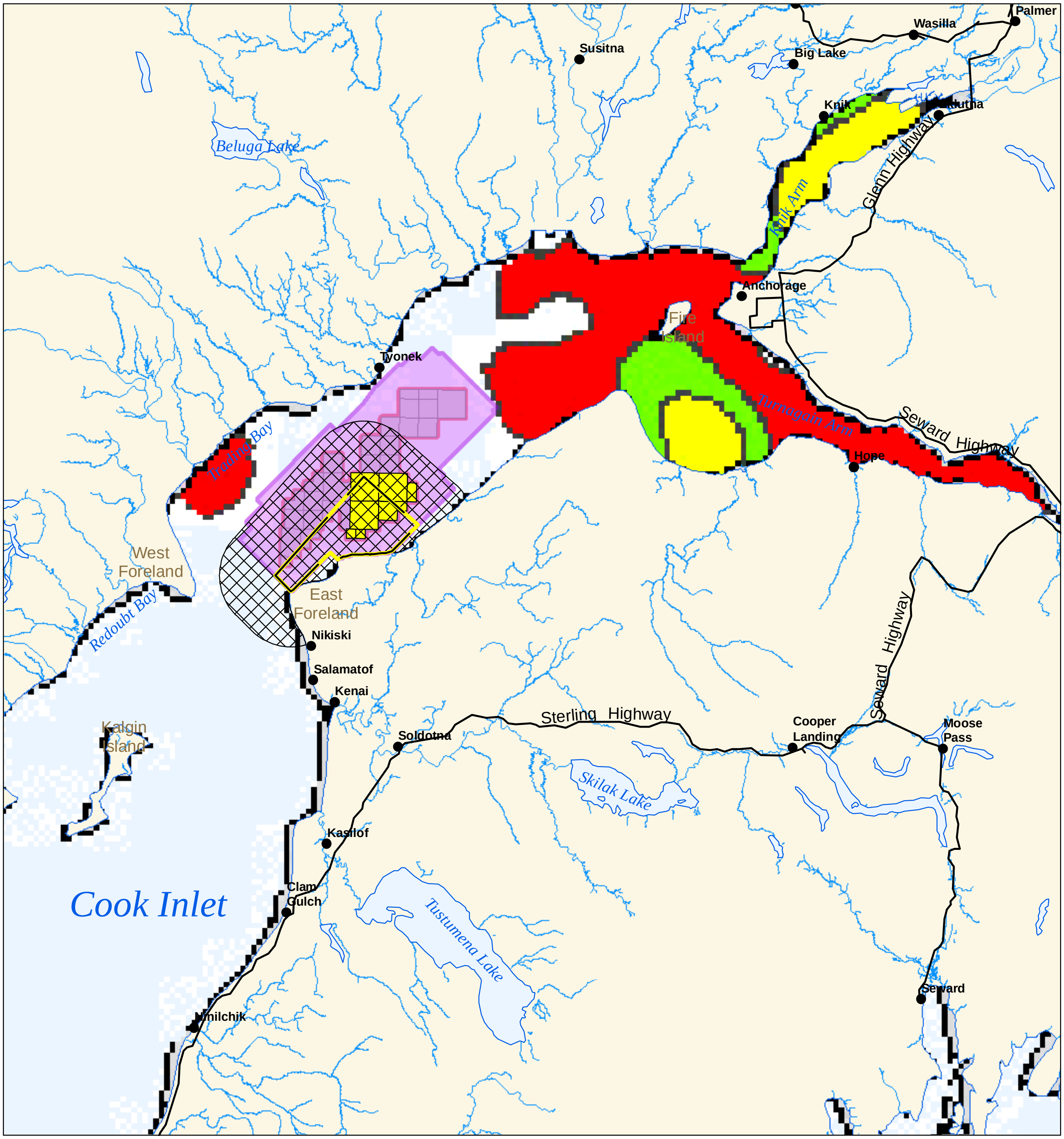
N

OCTOBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3a

COOK INLET, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	14 JAN 2013	T. HEIKKILA	A-19

P:\Furie\Seismic Survey BE\MXD\PriorityArea3_October.mxd beatycj



- Priority 3a Survey Area (180 Sq Km)
- Priority 3a Ensonified Area (775 Sq Km)
- Priority Area 3a Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

N

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

Miles: 0 3 6 9 12 15

Kilometers: 0 5 10 15 20 25

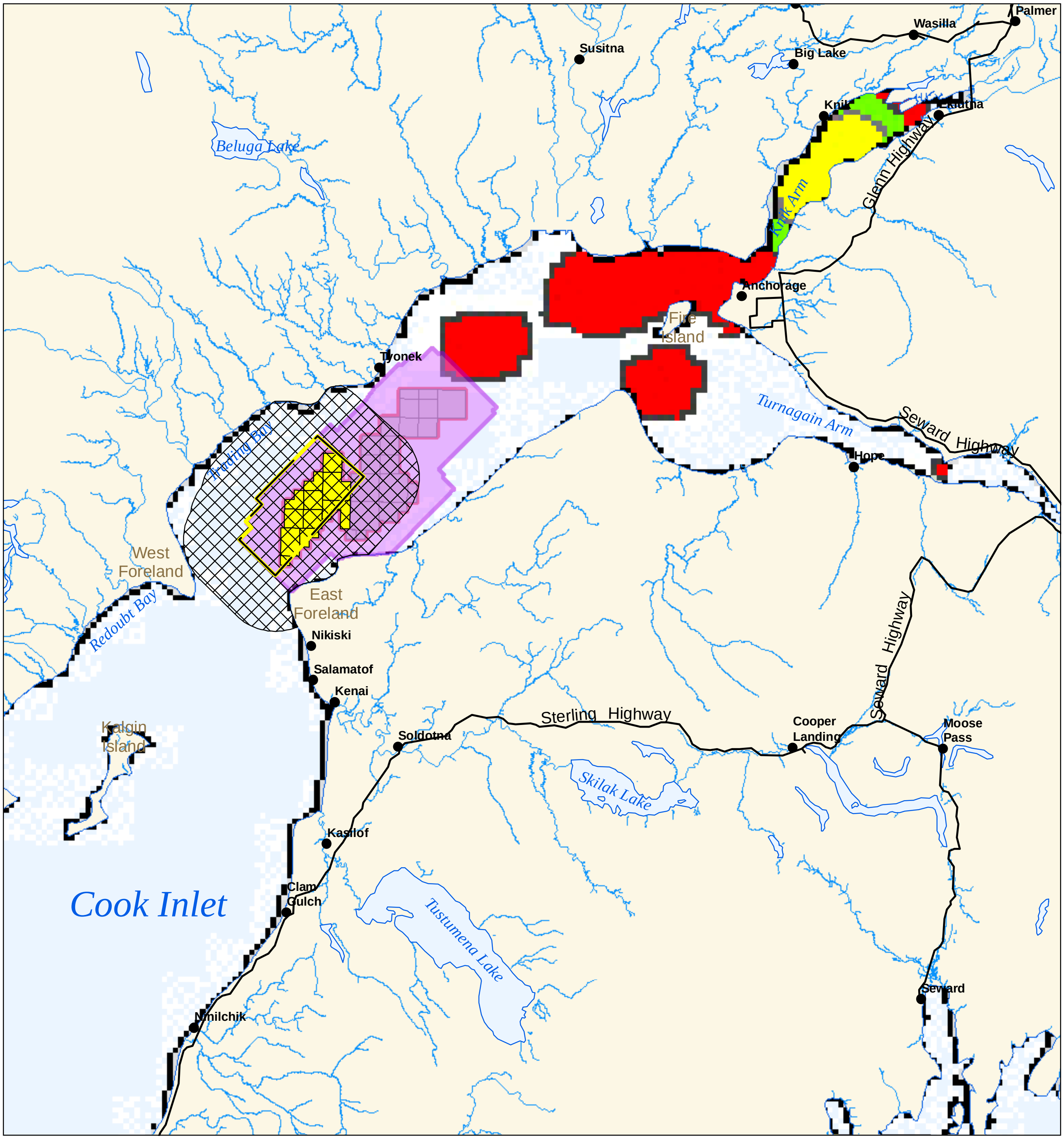
NAD 1983 StatePlane Alaska 4, Feet

NOVEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3a

COOK INLET, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	14 JAN 2013	T. HEIKKILA	A-20

P:\Furie\Seismic Survey BE\MXD\PriorityArea3_November.mxd beatycj



- Priority 3b Survey Area (230 Sq Km)
- Priority 3b Ensonified Area (1050 Sq Km)
- Priority Area 3b Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles

0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

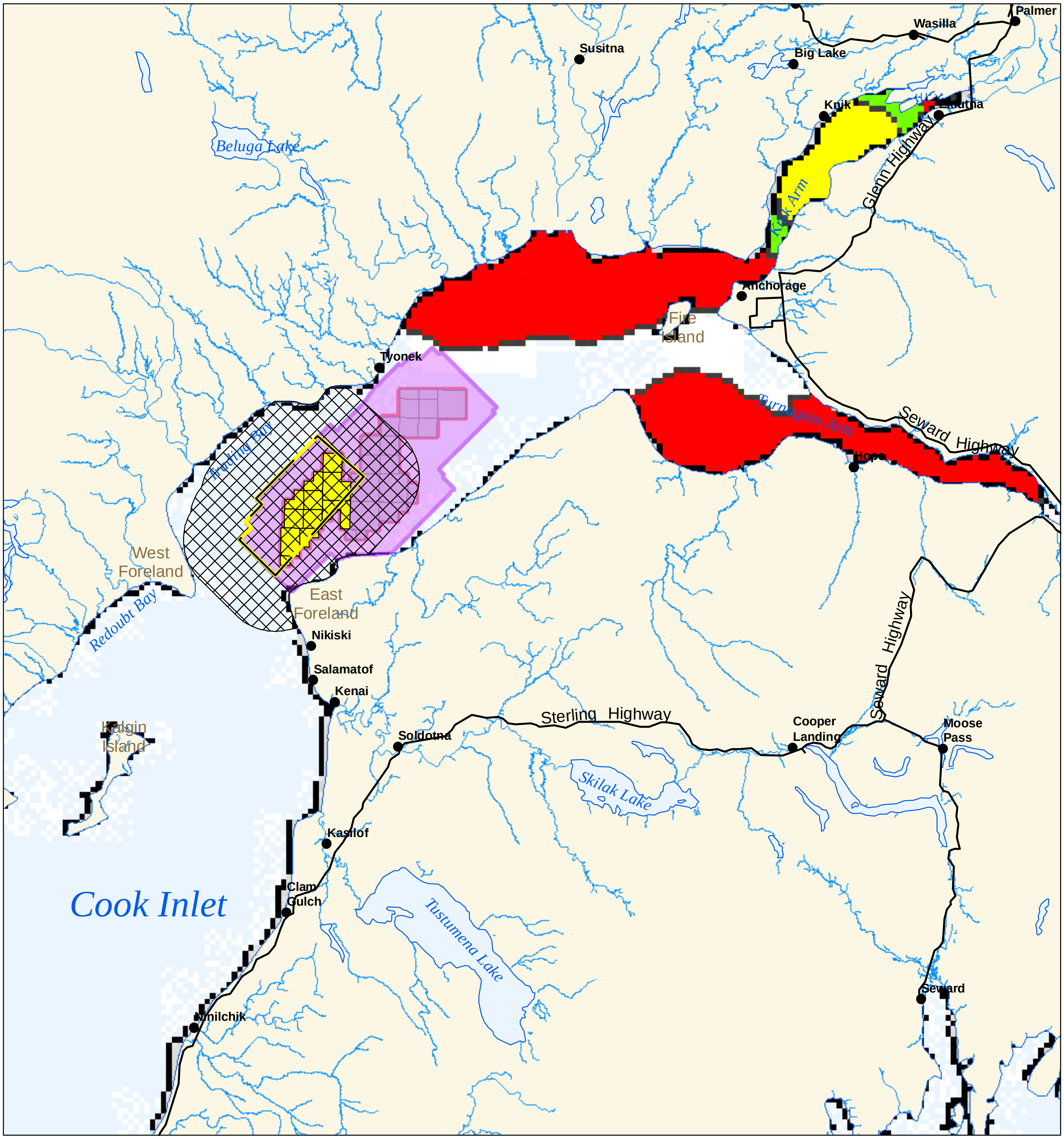
N

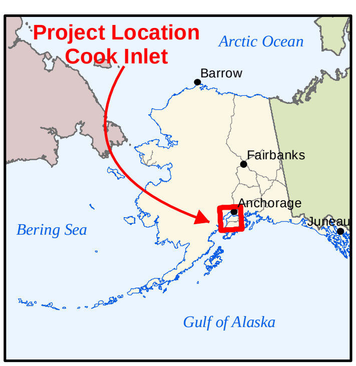
AUGUST PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3b

COOK INLET, ALASKA

JACOBS	DATE: 14 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-21

P:\Furie\Seismic Survey BE\MXD\PriorityArea4_August.mxd beatycj





- Priority 3b Survey Area (230 Sq Km)
- Priority 3b Ensonified Area (1050 Sq Km)
- Priority Area 3b Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

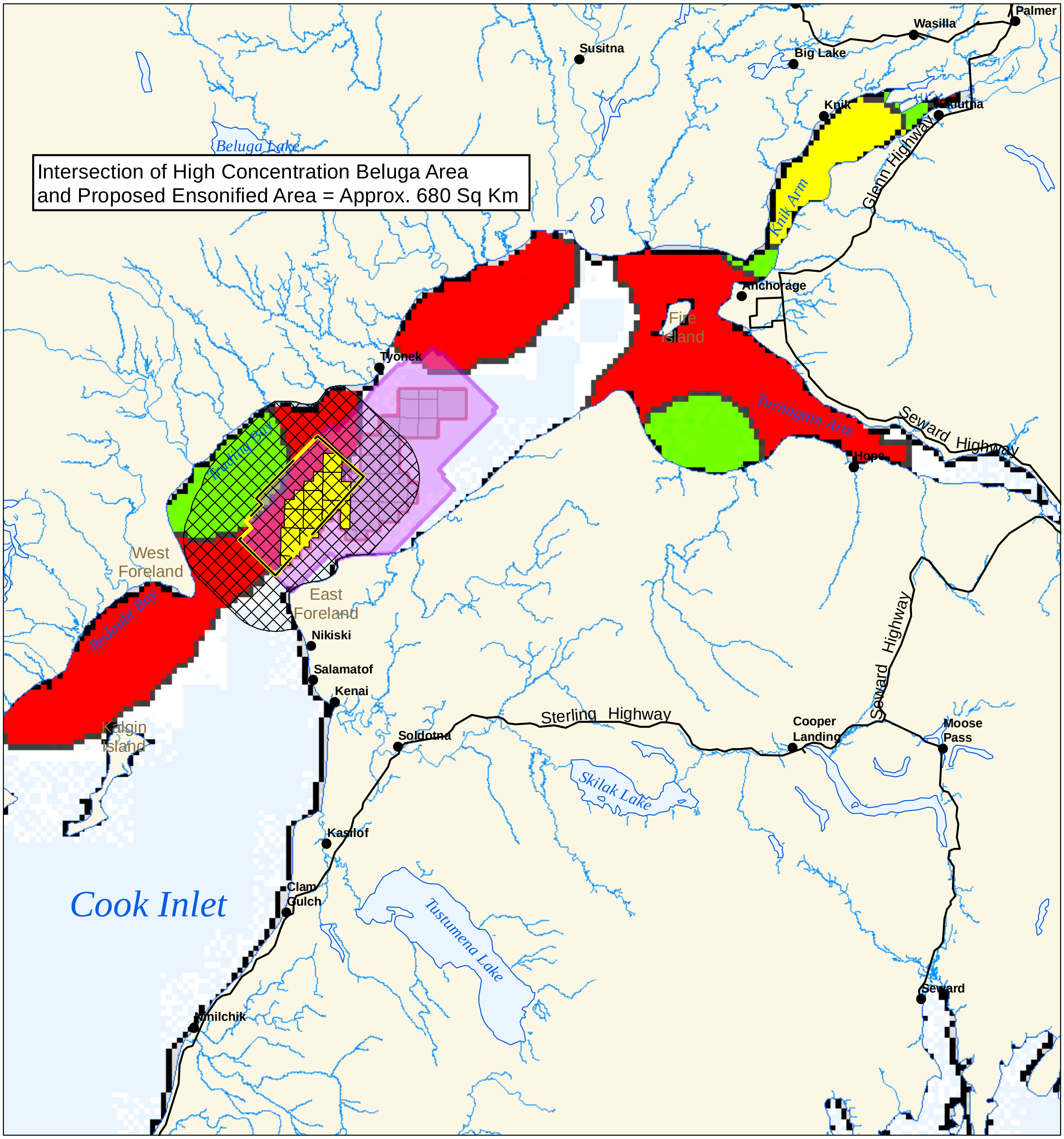
N

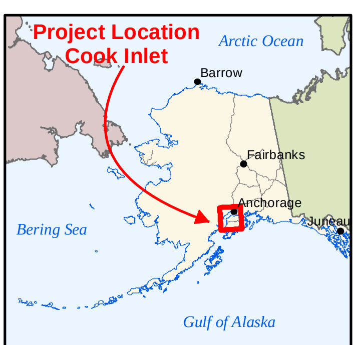
SEPTEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3b

COOK INLET, ALASKA

JACOBS	DATE: 14 JAN 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-22

P:\Furie\Seismic Survey BE\MXD\PriorityArea4_September.mxd beatycj





- Priority 3b Survey Area (230 Sq Km)
- Priority 3b Ensonified Area (1050 Sq Km)
- Priority Area 3b Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

0 3 6 9 12 15
Miles
0 5 10 15 20 25
Kilometers

NAD 1983 StatePlane Alaska 4, Feet

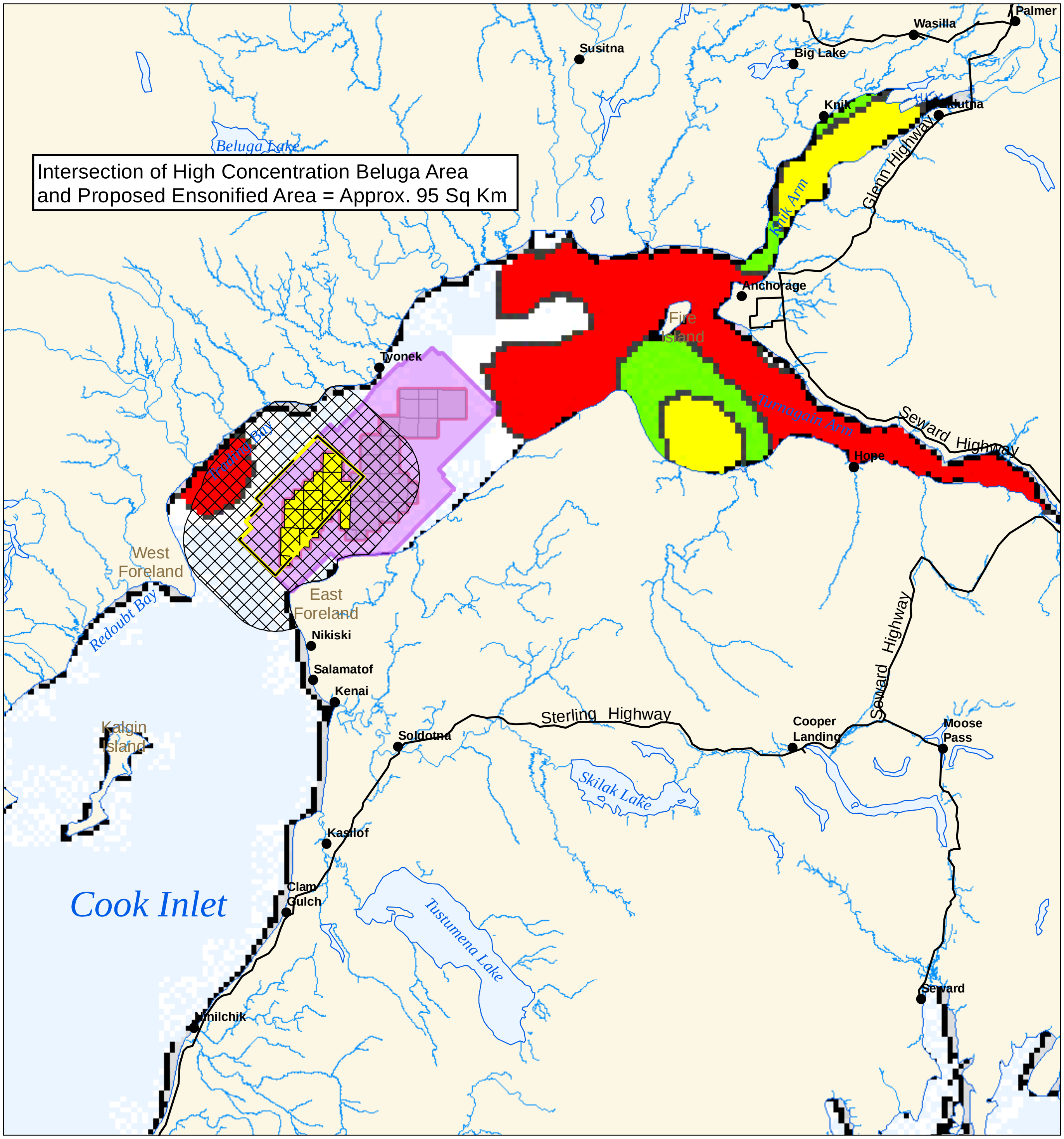
N

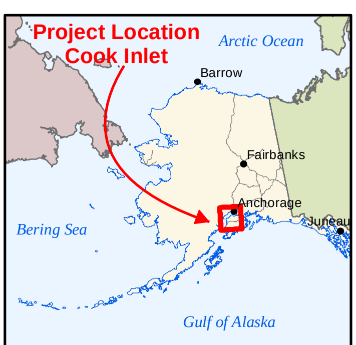
OCTOBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3b

COOK INLET, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	14 JAN 2013	T. HEIKKILA	A-23

P:\Furie\Seismic Survey BE\MXD\PriorityArea4_October.mxd beatyd





- Priority 3b Survey Area (230 Sq Km)
- Priority 3b Ensonified Area (1050 Sq Km)
- Priority Area 3b Leases
- Proposal A Seismic Survey Area
- Kitchen Lights Unit Leases
- Kitchen Lights Unit

Notes:
The yellow shading represents the focal point of the predicted distribution. The red shading represents 95% probability of including the entire range, while the green and yellow represent decreasing probabilities of 75% and 50%.
Source: Hobbs et. al. 2005

All Locations Are Approximate

Miles: 0 3 6 9 12 15

Kilometers: 0 5 10 15 20 25

NAD 1983 StatePlane Alaska 4, Feet

N

NOVEMBER PREDICTED BELUGA DISTRIBUTION & PROPOSED SEISMIC SURVEY, PRIORITY AREA 3b

COOK INLET, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
14 JAN 2013	T. HEIKKILA	A-24

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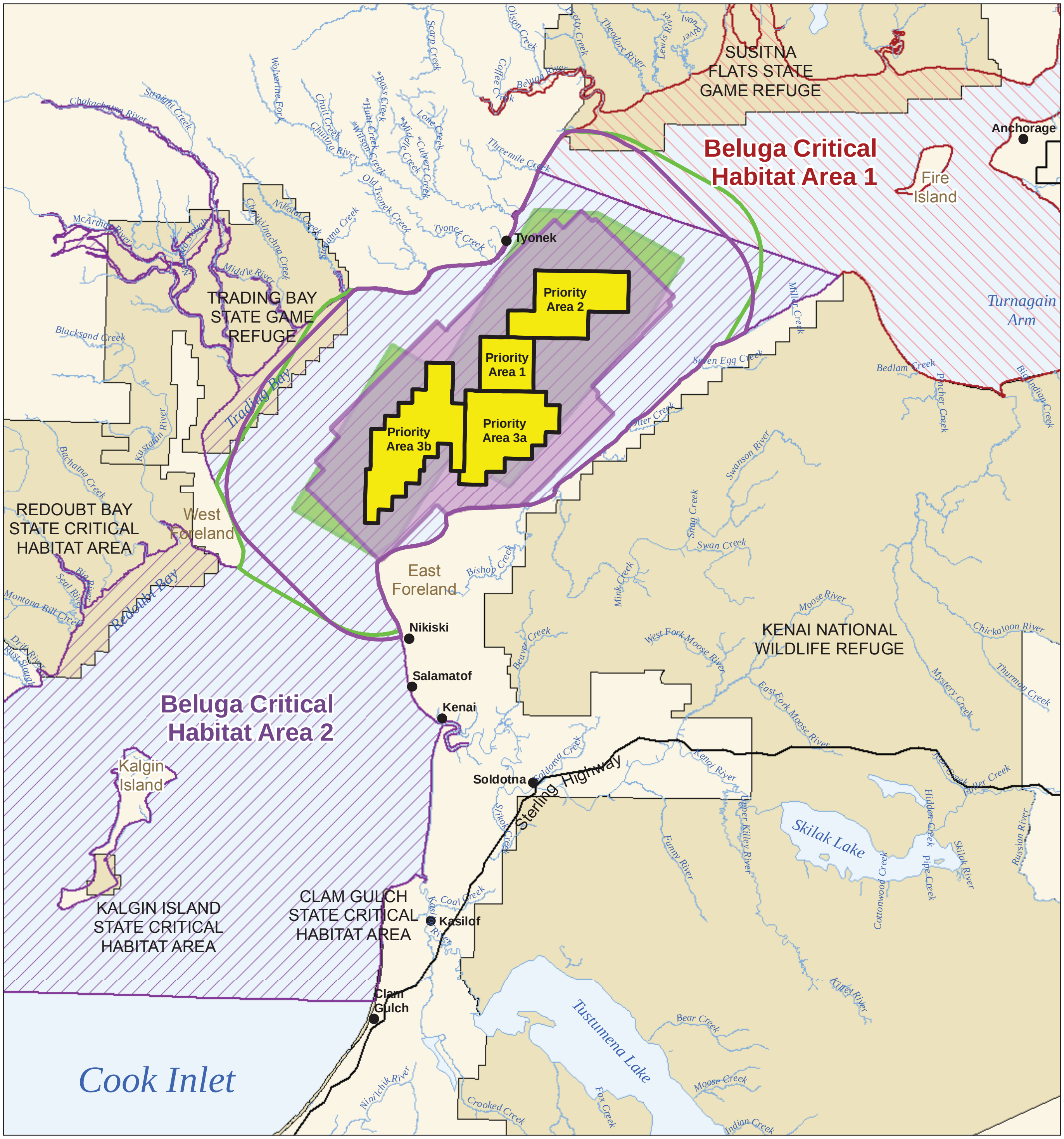

- Proposal A Maximum Extent Ensonified Area
- Proposal B Maximum Extent Ensonified Area
- Proposal A Seismic Survey Area
- Proposal B Seismic Survey Area
- Beluga Critical Habitat Area 1
- Beluga Critical Habitat Area 2
- Refuge/State Critical Habitat
- KLU Priority Area

All Locations Are Approximate

Miles: 0 2 4 6 8 10

Kilometers: 0 5 10 15 20 25

NAD 1983 StatePlane Alaska 4, Feet

N

FURIE OPERATING ALASKA, LLC

PROPOSED SEISMIC SURVEY AREA AND ENSONIFICATION ZONES

COOK INLET, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
17 JAN 2013	T. HEIKKILA	A-25

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