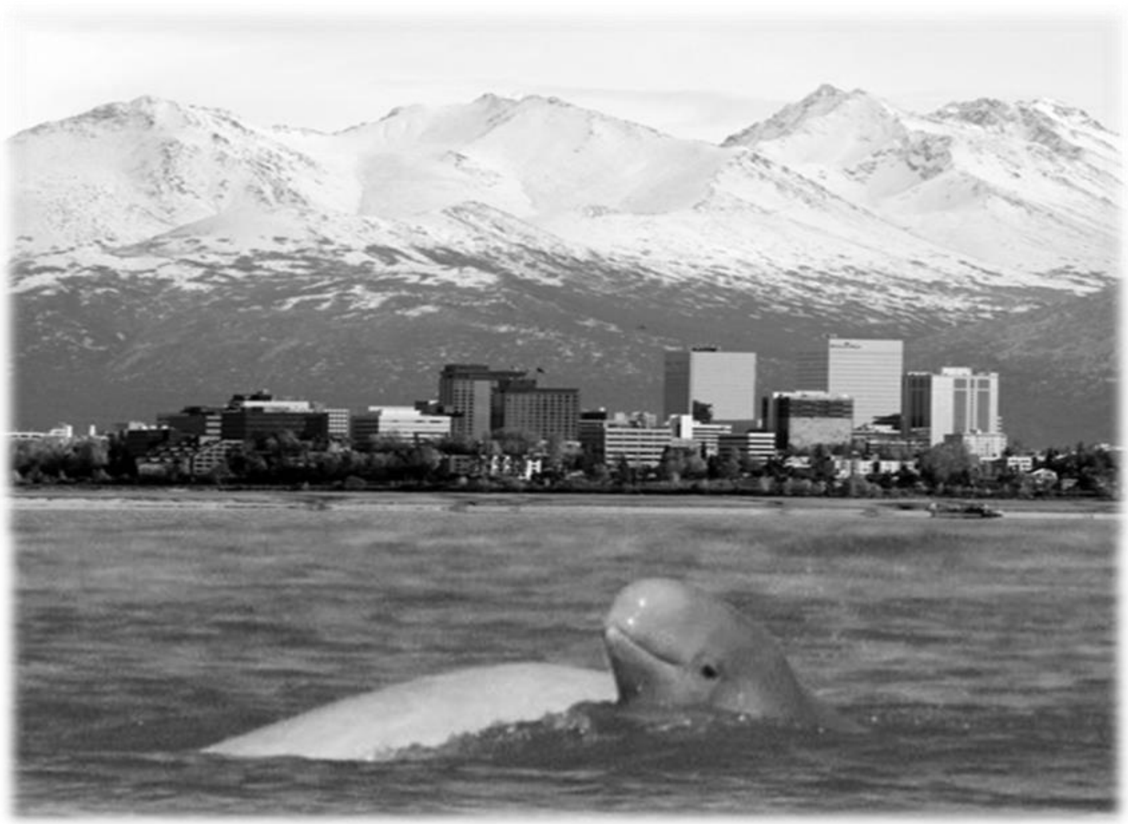
Draft Recovery Plan for the Cook Inlet Beluga Whale

(Delphinapterus leucas)



National Marine Fisheries Service
National Oceanic and Atmospheric Administration

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Draft Recovery Plan

for the

Cook Inlet Beluga Whale

(*Delphinapterus leucas*)

Prepared by:

National Marine Fisheries Service

Alaska Regional Office

Protected Resources Division

Approved:________________________________

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LITERATURE CITATION SHOULD READ AS FOLLOWS:

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Hard copies of this recovery plan may be obtained from:

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Digital copies of this recovery plan may be downloaded from the NMFS Alaska Region website:

http://www.alaskafisheries.noaa.gov/

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CIBRT Science Panel: Dr. Pierre Béland (St. Lawrence National Institute of Ecotoxicology); Dr. Bill Bechtol (Bechtol Research); Dr. Manuel Castellote (NMFS National Marine Mammal Laboratory); Dr. Carrie Goertz (Alaska SeaLife Center); Dr. Daniel Goodman (Montana State University); Dr. Rod Hobbs (NMFS National Marine Mammal Laboratory); Craig Matkin (North Gulf Oceanic Society); Dr. Tamara McGuire (LGL Alaska Research Associates); Dr. Robert Michaud (Group for Research and Education of Marine Mammals); Dr. Greg O'Corry-Crowe (Harbor Branch Oceanographic Institute); Randy Standifer, Sr. (preceded by the late Peter Merryman) (Cook Inlet Marine Mammal Council); Dr. Robert Suydam (North Slope Borough)

CIBRT Stakeholder Panel: Bruce Anders (Cook Inlet Region, Inc.); Joel Blatchford (Alaska Native Marine Mammal Hunters Committee); Jason Brune (Resource Development Council of Alaska, Inc.); Mayor David Carey (Kenai Peninsula Borough); Karla Dutton (Defenders of Wildlife); Chris Garner (Joint Base Elmendorf Richardson); Willie Goodwin (Alaska Beluga Whale Committee); Page Herring (Northern District Set Netters Association of Cook Inlet); Brett Jokela (Anchorage Water and Wastewater Utility); Nancy Lord (Cook Inletkeeper); Nikki Martin (Alaska Oil and Gas Association); Roland Maw (United Cook Inlet Drift Association); Andrew Niemiec (Knik Arm Bridge and Toll Authority); Eileen Probasco (Matanuska-Susitna Borough); Steve Ribuffo (Port of Anchorage); John Schoen (National Audubon Society); Paul Shadura (Kenai Peninsula Fishermen's Association); George Vakalis (Anchorage Municipality); Doug Vincent-Lang (Alaska Department of Fish and Game)

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Individuals: Marc Bourdon, Kathy Burek-Huntington, Joe Canesi, Dale Funk, Ken Goldman, Richard Gustafson, Glenn Hollowell, Sam Ivey, Jon Kurland, Michael Link, Barb Mahoney, Barry McPherson, Scott Meyer, Mandy Migura, Lucy Moore, Mark Nelson, Steve Okkonen, Ted Otis, Lori Quakenbush, Scott Raborn, Tim Ragen, Randall Reeves, Susan Saupe, Kate Savage, Kim Shelden, Patrick Shields, Bob Small, Brad Smith, Mark Willette, Sheyna Wisdom

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The *Cook Inlet Beluga Whale Recovery Team* dedicated their work to the memories of their esteemed and appropriately named colleagues, Mr. Peter Sunrise Merryman and Dr. Daniel Goodman. The belugas, the Recovery Team, and the Plan have all benefited from their care and efforts.

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ACMP	Alaska Coastal Management Program
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ASM	age at sexual maturity
°C	degrees Celsius
CFR	Code of Federal Regulations
CI beluga	Cook Inlet beluga
CIBRT	Cook Inlet Beluga Whale Recovery Team
CIMMC	Cook Inlet Marine Mammal Council
CIRI	Cook Inlet Region, Inc.
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	centimeter
Corps	United States Army Corps of Engineers
CV	coefficient of variation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel
DPS	distinct population segment
DDT	dichlorodiphenyltrichloroethane, a chlorinated pesticide
DFO	Department of Fisheries and Oceans
EPA	Environmental Protection Agency
ESA	Endangered Species Act
°F	degrees Fahrenheit
FR	Federal Register
ft	feet
FWCA	Fish and Wildlife Coordination Act
GIS	geographic information systems
GLG	growth layer group
HABs	harmful algal blooms
HCB	hexachlorobenzene
HCH	hexachlorocyclohexane
Hz	hertz
IHA	incidental harassment authorization
IUCN	International Union for the Conservation of Nature and Natural Resources
KABATA	Knik Arm Bridge and Toll Authority
Kg	kilogram

kHz	kiloHertz
km	kilometer
km^2	square kilometer
km/hr	kilometer per hour
lb	pound
LGL	LGL Alaska Research Associates, Inc.
m	meter
mg	milligram
MHW	mean high water
MMC	Marine Mammal Commission
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
mi	mile
mi^2	square mile
mi/hr	miles per hour
mtDNA	mitochondrial DNA
NGO	non-governmental organization
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSP	optimum sustainable population
PAH	polycyclic aromatic hydrocarbon
PFC	perfluorinated compound
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyls
ppt	parts per thousand
PTS	permanent threshold shift
PVA	population viability analysis
SE	standard error
SEDAR	SouthEast Data, Assessment, and Review
SLE	St. Lawrence Estuary
TEK	Traditional Ecological Knowledge
TTS	temporary threshold shift
URS	URS Corporation
µPa	microPascal
U.S.	United States
USFWS	United States Fish and Wildlife Service

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EXECUTIVE SUMMARY

Current Status

The best available historical abundance estimate of the Cook Inlet beluga whale population (CI belugas, *Delphinapterus leucas*) was from a survey in 1979 which resulted in an estimate of 1,293 whales (Calkins 1989). The National Marine Fisheries Service (NMFS) has adopted 1,300 as the value for the carrying capacity to be used for management purposes.

NMFS began conducting comprehensive and systematic aerial surveys of the CI beluga population in 1993. These surveys documented a decline in CI beluga abundance from 653 whales in 1994 to 347 whales in 1998, a decline of nearly 50%. This rapid decline was associated with a substantial, unregulated subsistence hunt.

In 1999, in response to this dramatic decline NMFS received one petition to designate CI belugas as depleted under the Marine Mammal Protection Act (MMPA) and two to list them as endangered under the Endangered Species Act (ESA). In 2000, NMFS designated the CI beluga whale population as depleted under the MMPA, but determined that listing CI beluga whales as threatened or endangered under the ESA was not warranted at that time.

Subsequent cooperative efforts between NMFS and Alaska Native subsistence users dramatically reduced subsistence hunts beginning in 1999. This reduction in hunting should have allowed the CI beluga population to begin increasing at an expected growth rate of between 2% and 6% per year if subsistence harvest was the only factor limiting population growth; however, abundance data collected since 1999 indicated that the population did not increase as expected. This lack of population growth led NMFS to reevaluate the status of CI belugas. In October 2008, NMFS finalized the Conservation Plan for the Cook Inlet Beluga Whale (Conservation Plan; NMFS 2008a), as required by the MMPA. The Conservation Plan reviewed and assessed the known and possible threats influencing CI beluga whales. During that same month NMFS listed the CI beluga whale distinct population segment (DPS[1]) as endangered under the ESA (73 FR 62919, October 22, 2008).

The most recent comprehensive survey for CI belugas from 2014 indicates a point estimate of 340 belugas, with the population continuing to show a negative trend since 1999 (a decline of 1.3% per year; Shelden et al. 2015).

Threats to Recovery

The CI belugas are the most reproductively and demographically isolated of all the Alaskan belugas, and are unique in Alaska given that their habitat, a semi-enclosed tidal estuary in southcentral Alaska, is in close proximity to the greatest concentration of Alaska's human population. Belugas are predominately found in nearshore waters. The distribution of CI belugas

[1] DPS is a vertebrate population or group of populations that is discrete from other populations and significant in relation to the entire taxon (61 FR 4722; February 7, 1996). The ESA defines "species" to include any subspecies and any DPS of vertebrate fish or wildlife that interbreeds when mature. 16 U.S.C. 1532 (16). Throughout this recovery plan, the terms "CI beluga population" and "CI belugas" refers to the CI beluga whale DPS.

has changed significantly since the 1970s and the summer range has contracted to the upper Inlet in recent years, coincident with the decline in population size.

Ten potential threat types are identified and assessed in this recovery plan, based on current knowledge of threat factors. Assessments were made based on the information and data gaps presented in the plan's background section. Climate change, while considered a potential threat to CI beluga recovery, is not addressed as a separate threat, but rather is discussed with respect to how it may affect each of the listed threats. The ten identified potential threats and their overall relative concern to the CI beluga population discussed in this plan include:

- Threats of High Relative Concern
    - Catastrophic Events (e.g., natural disasters; spills; mass strandings);
    - Cumulative and Synergistic Effects of Multiple Stressors;
    - Noise;
- Threats of Medium Relative Concern
    - Disease Agents (e.g., pathogens, parasites, and harmful algal blooms);
    - Habitat Loss or Degradation;
    - Reduction in Prey;
    - Unauthorized Take;
- Threats of Low Relative Concern
    - Subsistence Hunting;
    - Pollution; and
    - Predation.

Recovery Plan

The ESA requires the preparation and implementation of recovery plans for all listed species, unless the Secretary of Commerce determines that doing so does not promote the recovery of the species. In 2010, NMFS began the process of developing a recovery plan for the CI belugas by announcing its intent to prepare a recovery plan and soliciting public comments (75 FR 4528, January 28, 2010). In February 2010, NMFS prepared a recovery outline, which, in concert with the Conservation Plan, served as an interim guidance document to direct recovery efforts until a full recovery plan was finalized. In March 2010 NMFS convened a Recovery Team to aid in the development of a draft Recovery Plan for CI belugas. The Recovery Team was composed of two advisory groups: a Science Panel and a Stakeholder Panel. In March 2013, the Recovery Team provided NMFS with the first draft of the Recovery Plan. This marked the completion of the team's work; therefore it disbanded and NMFS took responsibility for finalizing the Recovery Plan.

Recovery Strategy

In light of the CI belugas' recent population decline, small overall population size, life history characteristics, and increasing number of potential threats, it is challenging to identify the most immediate needs for the recovery of CI belugas. Until we know which threats are limiting this species' recovery, the strategy of this recovery plan is to focus recovery efforts on threats identified as of medium or high relative concern,. This will focus efforts and resources on actions that are more likely to benefit CI beluga whale recovery. Therefore, the recovery criteria and recovery actions outlined in the following sections address the threats of medium or high relative concern, and do not discuss further the threats of low relative concern.

The recovery actions in this recovery plan include research, management, monitoring, and outreach efforts, since a comprehensive approach to CI beluga recovery is likely to have greater success than focusing on any one type of action. There are also actions targeted at incorporating new information and conducting regular reassessments, making this recovery plan an adaptive management plan. Threats-based recovery actions attempt to improve our understanding of whether a particular threat is limiting recovery. If a threat is determined to be limiting recovery, we recommend actions to eliminate or mitigate that threat, or to improve our understanding of, and ability to manage that threat. As such, the strategy of this recovery plan is to:

- assess and periodically reassess whether each threat identified as medium or high relative concern is likely to be limiting recovery of the CI beluga population;
- improve the understanding of the effects of recovery-limiting threats to CI belugas;
- improve the management of the recovery-limiting threats to reduce the effects of those threats on CI belugas;
- continue to monitor the status of the CI beluga population and improve the understanding of CI beluga whale biology;
- integrate research findings into current and future management actions; and
- keep the public informed and educated about the status of CI beluga whales, the threats limiting their recovery, and how they can help achieve recovery of these whales.

Recovery Goals

The goal of this recovery plan is to guide efforts that achieve the recovery of the CI beluga whales to a level sufficient to warrant their removal from the federal List of Endangered and Threatened Wildlife and Plants under the ESA (i.e., delist) by meeting the recovery criteria and addressing threats. The intermediate goal is to guide efforts that result in reclassification of CI belugas from endangered to threatened (i.e., downlist). The determinations regarding whether these goals are met include consideration of the population's risk of extinction and threats as identified under the ESA section 4(a)(1) factors. If a species is determined to be *recovered*, then the particular protections afforded by the ESA no longer apply, although other pertinent federal (e.g., MMPA) and state protections will still apply.

Recovery Objectives

Five statutory factors identified in ESA section 4(a)(1) inform NMFS's decision as to whether a species merits listing as threatened or endangered under the ESA (see Section I.B.

History of the Listing Status of CI Belugas). These factors must be considered in listing decisions as well as downlisting and delisting, with objectives related to each factor included as part of the recovery criteria. The following recovery objectives were identified for CI belugas and linked to the five ESA section 4(a)(1) factors:

- Ensure adequate habitat exists to support a recovered population of CI beluga whales. Habitat needs include sufficient quantity, quality, and accessibility of prey species (*Factor A: the present or threatened destruction, modification, or curtailment of its habitat or range)*;
- Ensure that commercial, recreational, scientific, or educational activities are not inhibiting the recovery of CI belugas (*Factor B: overutilization for commercial, recreational, scientific, or educational purposes*);
- Ensure that the effects of diseases and disease agents on CI beluga reproduction and survival are not limiting the recovery of the CI beluga population (*Factor C: disease or predation*);
- Ensure that regulatory mechanisms other than the ESA are adequate to prevent the recurrence of threats to the sustainability of the CI belugas (*Factor D: the inadequacy of existing regulatory mechanisms*); and
- Continue monitoring the population to identify and mitigate any new natural or manmade factors affecting the recovery of CI belugas *(Factor E: other natural or manmade factors affecting its continued existence*).

Recovery Criteria

Under section 4(f)(1) of the ESA, recovery plans must contain objective, measurable criteria which, when met, would result in a determination that the species be delisted. This recovery plan contains both demographic criteria (e.g., population size and trend) and threats-based criteria (i.e., addressing the five ESA section 4(a)(1) factors) which must be met prior to consideration of downlisting or delisting.

The threats-based recovery criteria are designed to evaluate the five factors described in the ESA listing determination of the CI belugas, with objectives related to each factor included as part of the recovery criteria. The downlisting and delisting criteria specified in the recovery plan are organized according to the five factors, then by the threat types ranked as medium or high relative concern.

Summary of Recovery Criteria for CI Beluga Whales

Status	Demographic Criteria		Threats-based Criteria
Reclassified from Endangered to Threatened *(i.e., downlisted)*	The abundance estimate for the CI beluga whale DPS is greater than or equal to 520 individuals and there is 95% or greater probability that the 25-year population abundance trend (representative of one full generation) is positive.	**AND**	The 15 downlisting threats-based criteria are satisfied.

Reclassified to Recovered (*i.e., delisted*)	The abundance estimate for the CI beluga whale DPS is greater than or equal to 780 individuals and there is 95% or greater probability that the 25-year population abundance trend (representative of one full generation) is positive.	**AND**	The 15 downlisting and 6 delisting threats-based criteria are satisfied.

Recovery Actions

This recovery plan provides a listing of recommended research, management, and education/outreach actions targeted at recovering the CI beluga whales. Overall, these actions are organized in two categories: *Population Monitoring and Recovery Plan Implementation Actions* and *Threats Management Actions*. The *Population Monitoring and Recovery Plan Implementation Actions* recognize the importance of continuing to monitor the population, not only to improve our understanding of the whales, but also as a means to determine if recovery of the CI beluga population is occurring. These actions are also designed to allow for the effective implementation of this recovery plan. The *Threats Management Actions* encompass actions aimed at assessing and managing the medium- and high-ranked threats. Each medium- or high-ranked threat type has three subsets of actions: 1) actions to assess whether that threat is limiting CI beluga recovery; 2) actions that, if the threat is limiting CI beluga recovery, will improve: the understanding of the threat, the understanding of the threat's effects to the whales, and the management of that threat; and 3) actions to keep the public informed and educated.

Implementation Schedule

The Implementation Schedule includes recovery action numbers, action descriptions, recovery priorities, parties responsible[2] for funding and/or carrying out actions, duration of actions, and estimated costs. Costs are estimated for the fiscal year in thousands of 2015 dollars and are not corrected for inflation. The cost estimates do not imply that appropriate levels of funding will necessarily be available for all CI beluga recovery tasks. The table covers a five-year period, in accordance with the standard five-year cycle of review and revision for all recovery plans. Any projections of total costs over the full recovery period are likely to be imprecise. The total cost of achieving recovery will be largely dependent upon how many of the second level actions (for the threats management actions) need to be implemented. Since that cannot be determined at this time, the total cost presented here assumes that every threat will be found to be limiting recovery and that every second level action will be implemented. Thus, we expect the total cost estimate presented here is high, and the actual costs will be reduced if some threats are determined to not be limiting the recovery of CI belugas and the second level actions do not need to be implemented. It is expected that recovery may take at least two generations (50 years); therefore, for ongoing actions costs have only been estimated for the next 50 years. If every identified recovery action must be implemented, and if it takes 50 years to recover the CI beluga whales, then the estimated cost of implementing this entire recovery program is approximately $78.3 million.

[2] Responsible parties have no legal or regulatory obligation to carry out any action. Rather, this is an indication of the entity that would most appropriately implement a particular action.

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I. INTRODUCTION

A. The Importance of Belugas to Cook Inlet

The Cook Inlet belugas (*Delphinapterus leucas)*, which have lived alongside people since the first indigenous hunters and fishermen came to the shores of Cook Inlet, hold an important place in both the regional ecosystem and the lives of those who have depended upon and interacted with them throughout that long, shared history. Alaska's Native people have relied upon Cook Inlet belugas (CI belugas) for food, other materials, cultural continuity, and community cohesion; indeed, there is a significant desire to rebuild a beluga population capable of again supporting subsistence use. For the last fifty years the white whales have held a primary position as remarkable animals people enjoy living with and observing in Cook Inlet. Apart from the belugas found in Canada's St. Lawrence Estuary (SLE), CI belugas are unique in forming the only other beluga population in the world to live in close proximity to urban centers and to be easily accessed via a road system.

Oral histories collected by Dutton et al. (2012) document both the values that today's Alaskans place on living beside these belugas and the loss of those opportunities as the beluga population declined. Visitors to Alaska also enjoy being able to watch belugas in the wild. Stories, artwork, the names of streets and businesses all emphasize these belugas' role within our lives and cultures. In addition to their subsistence, cultural, economic (tourism), and spiritual values, the CI belugas play a role as an indicator of environmental health and resilience in a region undergoing considerable natural and human-related change.

This recovery plan represents a significant step in increasing our understanding of the CI beluga population and assisting it to rebuild - not just for its own sake or that of the ecosystem, but also for future human generations.

B. History of the Listing Status of Cook Inlet Belugas

In response to the dramatic decline in the CI beluga stock between 1994 and 1998, NMFS initiated a status review of CI beluga whales pursuant to the MMPA and the ESA on November 19, 1998. In early 1999, NMFS received three petitions: one from Alaska Department of Fish and Game (ADF&G) to designate CI belugas as depleted under the MMPA and two from tribal and non-governmental organizations to list the population as endangered under the ESA. In May 2000, NMFS designated the CI beluga whale population as below its optimum sustainable population (OSP)[3] and, hence, depleted[4] as defined in the MMPA (65 FR 34590). Based on the best scientific data available at the time, NMFS determined that listing CI beluga whales as endangered or threatened under the ESA was not warranted, but based on genetic distinction from other Alaskan beluga stocks, NMFS determined CI belugas to be a DPS under the ESA (65 FR 38778, June 22, 2000). Appendices A and B provide more information regarding Federal actions, regulations, and existing protective measures pertaining to CI belugas.

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[3] Section 3 of the MMPA defines OSP as "the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element" (16 U.S.C 1362(9); see also 50 CFR 216.3).

[4] A species or population is said to be depleted under the MMPA when one of three conditions are met; one of which is when the Secretary of Commerce determines that a species or population stock is below its OSP.

The MMPA requires the Secretary of Commerce to prepare a Conservation Plan for any species or stock designated as depleted under the MMPA and for which NMFS has management responsibility. In October 2008, NMFS finalized the Conservation Plan for the Cook Inlet Beluga Whale (NMFS 2008a), which reviewed and assessed the known and possible threats to CI beluga whales. The Conservation Plan listed natural threats (including stranding events, predation, parasitism, disease, and environmental change) and potential human-caused threats (including subsistence harvest, poaching, fishing, pollution, vessel traffic, tourism and whale watching, coastal development, noise, oil and gas activities, and scientific research). In addition to identifying and assessing threats, the Conservation Plan also defined strategies for restoring the CI beluga whales to OSP and identified specific conservation actions to aid in that effort. The goal of the Conservation Plan was to conserve and restore the CI beluga whale population to its minimum OSP of 780 whales. NMFS has been working with its partners to implement conservation actions identified in the Conservation Plan, and is still using that document as a guide for conserving the CI beluga whales.

In March 2006, concerned that the stock had not recovered as expected, NMFS announced its intention to reevaluate the status of the CI belugas. The 2006 status review (Hobbs et al. 2006) drew several significant conclusions about the status of the CI beluga whales. First, the review concluded that the reduced summer range into the upper Inlet makes CI belugas far more vulnerable to catastrophic events that have the potential to kill or injure a significant portion of the population. Second, the population did not grow as anticipated after imposition of subsistence harvest reductions and regulations beginning in 1999 (which precluded any harvest in most years), but had continued to decline 4.1% per year from 1999 through 2006. Third, should this discrete population not survive, it was deemed highly unlikely that other belugas would repopulate Cook Inlet. Based on models that incorporated the latest data available at the time, the 2006 status review predicted a 68% probability that the CI beluga stock would continue to decline and become extinct within the next 300 years (with a 26% probability of extinction within the next 100 years), unless factors that determine beluga whale growth and survival were altered to improve the stock’s chances to recover (Hobbs et al. 2006).

Based on the findings of the 2006 status review, and in consideration of factors that may affect this species, on April 20, 2007 NMFS published a proposed rule to list the CI beluga whale DPS as an endangered species under the ESA (72 FR 19854). NMFS completed another status review in April 2008 (Hobbs et al. 2008), which supported the conclusions set forth in the 2006 status review. The April 2008 status review documented higher probabilities of extinction than those presented in the 2006 status review; the 2008 models showed a 79% probability of extinction within 300 years and a 39% probability of extinction within 100 years. On April 22, 2008, NMFS elected to postpone the ESA listing decision until October 2008 (73 FR 21578) to allow for consideration of the 2008 abundance estimate. In October, NMFS published a supplemental status review (Hobbs and Shelden 2008) which updated the April 2008 review by considering the 2008 CI beluga population abundance estimate. The general conclusions of the October 2008 supplemental status review were similar to the 2006 and 2008 status reviews, but the inclusion of the 2008 abundance estimate resulted in a 26% probability of extinction in 100 years and a 70% probability of extinction within 300 years.

On October 22, 2008 NMFS issued the final determination to list the CI beluga whale DPS as endangered under the ESA (73 FR 62919). The final listing rule for the CI belugas included the following statements regarding the ESA section 4(a)(1) factors:

A. *The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range.*

"Concern is warranted about the continued development within and along upper Cook Inlet and the cumulative effects on important beluga whale habitat. Ongoing activities that may impact this habitat include: (1) continued oil and gas exploration, development, and production; and (2) industrial activities that discharge or accidentally spill pollutants (e.g., petroleum, seafood processing waste, ship ballast discharge, effluent from municipal wastewater treatment systems, and runoff from urban, mining, and agricultural areas). Destruction and modification of habitat may result in ''effective mortalities'' by reducing carrying capacity or fitness of individual whales, with the same consequence to the population survival as direct mortalities. Therefore, threatened destruction and modification of CI beluga whale DPS habitat contributes to its endangered status."

B. *Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.*

"A brief commercial whaling operation existed along the west side of upper Cook Inlet during the 1920s, where 151 belugas were harvested in five years (Mahoney and Sheldon, 2000). There was also a sport (recreational) harvest for beluga whales in Cook Inlet prior to enactment of the Marine Mammal Protection Act (MMPA) in 1972. It is possible that some residual effects for this harvest may remain and may be a factor in the present status of this stock. Alaska Natives have legally harvested CI beluga whales prior to and after passage of the MMPA in 1972. The effect of past harvest practices on the CI beluga whale is significant. While subsistence harvest occurred at unknown levels for decades, the observed decline from 1994 through 1998 and the reported harvest (including estimates of whales which were struck but lost, and assumed to have perished) indicated these harvest levels were unsustainable. Annual subsistence take by Alaska Natives during 1995 to 1998 averaged 77 whales (Angliss and Lodge 2002). The harvest was as high as 20% of the population in 1996. Subsistence removals reported during the 1990s are sufficient to account for the declines observed in this population and must be considered as a factor in the proposed classification of the CI beluga whale DPS as endangered."

C. *Disease or Predation.*

"Killer whales are thought to take at least one CI beluga per year (Shelden et al., 2003). The loss of more than one beluga whale annually could impede recovery, particularly if total mortality due to predation were close to the recruitment level in the DPS."

D. *The Inadequacy of Existing Regulatory Mechanisms.*

"Cook Inlet beluga whales are hunted by Alaskan Natives for subsistence needs. The absence of legal authority to control subsistence harvest prior to 1999 is considered a contributing factor to the CI beluga whale DPS's decline. NMFS promulgated regulations on the long-term subsistence harvest of CI beluga whales on October 15, 2008 (73 FR 60976). These regulations constitute an effective conservation plan regarding Alaska Native subsistence harvest, but they are not comprehensive in addressing the many other issues now confronting CI beluga whales. At present, regulations cover the short-term subsistence harvest."

E. Other Natural or Manmade Factors Affecting its Continued Existence.

"Cook Inlet beluga whales are known to strand along mudflats in upper Cook Inlet, both individually and in number. The cause for this is uncertain, but may have to do with the extreme tidal fluctuations, predator avoidance, or pursuit of prey, among other possible causes. We have recorded stranding events of more than 200 CI beluga whales. Mortality during stranding is not uncommon. We consider stranding to be a major factor establishing this DPS as endangered."

C. Designation of Critical Habitat for Cook Inlet Belugas

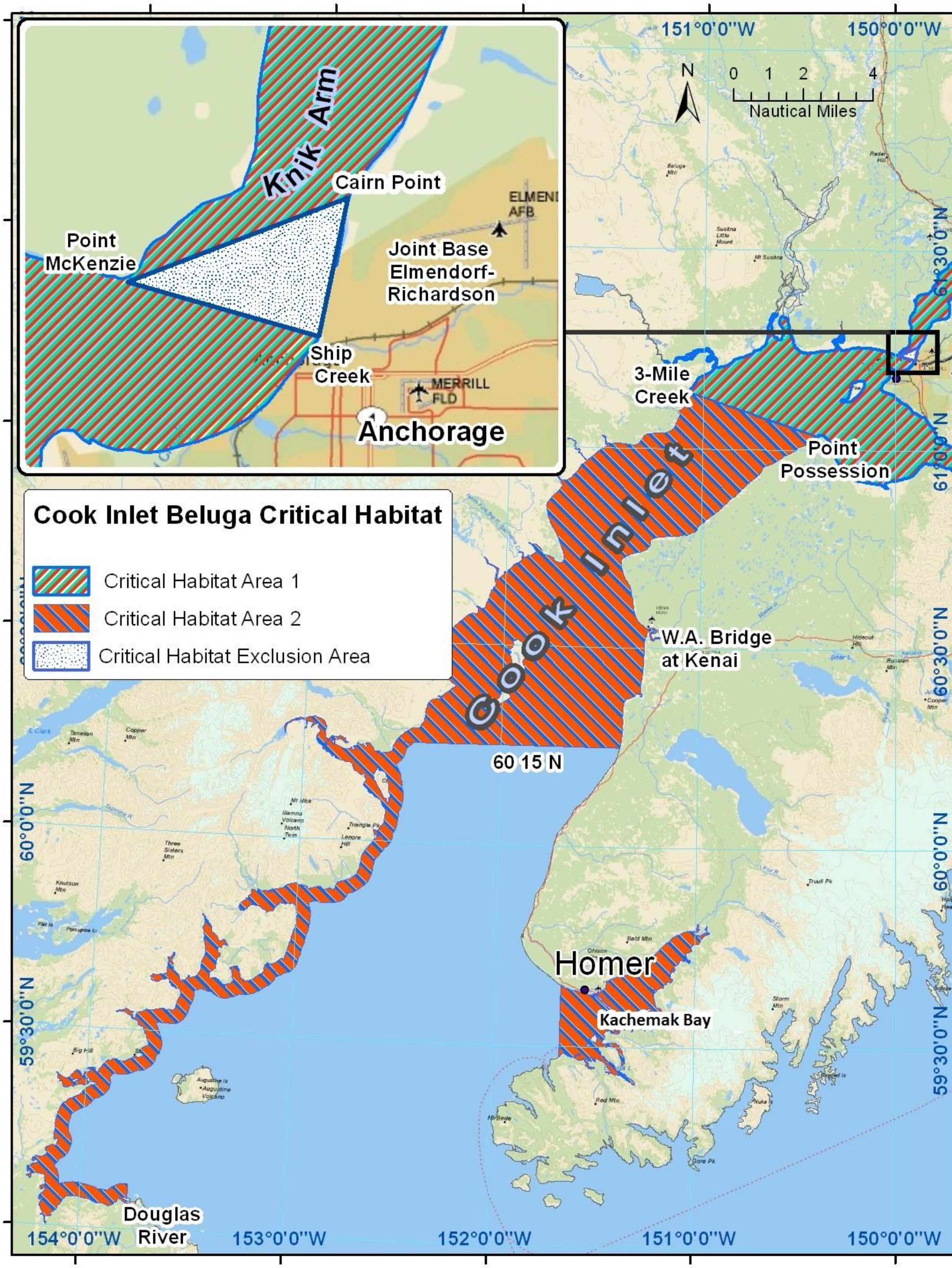
NMFS proposed to designate critical habitat for the CI beluga whale DPS on December 2, 2009 (74 FR 63080); two areas were proposed, consisting of 7,809 square km (km^2) (3,016 square miles [mi^2]) of marine habitat. On April 11, 2011, NMFS published the final rule designating the two areas (minus an exclusion zone) of Cook Inlet as critical habitat for the CI beluga whales (76 FR 20180; 50 CFR part 226.220; Figure 1).

In designating critical habitat, NMFS evaluated physical and biological features essential to the conservation of the species and which may require special management considerations or protection. Under NMFS regulations, these features may include: 1) space for individual and population growth, and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally 5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of the species. Based on the best scientific data available of the ecology and natural history of CI beluga whales and their conservation needs, NMFS determined the following physical or biological features are essential to the conservation of this species:

1. Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet mean lower low water (9.1 m) and within 5 mi (8 km) of high and medium flow anadromous fish streams.
2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.
3. Waters free of toxins or other agents of a type and amount harmful to CI beluga whales.
4. Unrestricted passage within or between the critical habitat areas.
5. Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by CI beluga whales.

In the critical habitat designation, NMFS identified two specific marine areas in Cook Inlet as containing one or more of the essential features (Figure 1). These areas, totaling 7,800 km2 (3,013 mi2) are bounded on the upland by the Mean High Water (MHW) line, except for the lower reaches of specific tributary rivers. Critical habitat does not extend into the tidally influenced channels of tributary waters of Cook Inlet, with the exceptions noted in the descriptions of each critical habitat area.

FIGURE 1: Cook Inlet Beluga Whale Critical Habitat



Source: 76 FR 20180, April 11, 2011;
http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/management.htm#habitat

D. Recovery and Recovery Plans

The ESA requires the preparation and implementation of recovery plans for all listed species with certain exceptions. Under the ESA, each recovery plan must contain at a minimum:

- a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
- objective, measurable criteria that, when met, would result in a determination that the species be removed from the list; and
- estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and achieve intermediate steps toward that goal.

In addition, the NMFS Recovery Planning Guidelines (NMFS 2010) stipulate that recovery plans must include a concise summary of the current status of the species and its life history, and an assessment of the factors that led to the population decline and/or which are impeding recovery. It is also important that the plan includes a comprehensive monitoring and evaluation program for NMFS to gauge effectiveness of recovery measures and overall progress toward recovery. The overall goal of a recovery plan is to guide efforts that achieve recovery of the species such that it may be removed from the List of Endangered and Threatened Wildlife.

While similar in content, recovery plans under the ESA and conservation plans under the MMPA do not necessarily have the same end goal. As discussed later, the goal of recovery plans is to aid in species' recovery such that ESA protection is no longer needed. The goal of MMPA conservation plans is to aid in the status of depleted population being upgraded so they are no longer considered "depleted".

E. The Cook Inlet Beluga Whale Recovery Team

Section 4(f) of the ESA requires NMFS to develop a recovery plan for listed species, unless such a plan will not promote the conservation of the species. On January 28, 2010, NMFS filed a notice of intent to prepare a Recovery Plan for the CI beluga whale (75 FR 4528).

The ESA authorizes (but does not require) NMFS to convene recovery teams to assist in the development and implementation of recovery plans. The Cook Inlet Beluga Whale Recovery Team (CIBRT) was appointed by NMFS's Alaska Regional Administrator to assist in developing a recovery plan, and to act as an advisory group to identify priority recovery actions and provide input and recommendations on specific recovery issues. NMFS may adopt the team's draft plan in whole or modify it. Prior to the final approval of any recovery plan, NMFS must provide the public with notice and an opportunity for comment.

The CIBRT was composed of two advisory groups: a Scientific Panel and a Stakeholder Panel. The goal was to produce a science-based plan to foster recovery of the CI belugas. In accordance with national policy, CIBRT members were selected based on their expertise and ability to advance CI beluga recovery.

Given that the ability to effectively manage and recover this population requires an in-depth understanding of the biological and ecological processes of Cook Inlet and the CI belugas, NMFS relied heavily on scientists when developing the recovery plan. The Scientific Panel was composed of beluga experts, scientists, and co-management partners who were appointed as independent experts based upon their specific areas of expertise. Science Panel members did not represent their agency or organization while serving on the panel. The primary functions of the Scientific Panel were to advise NMFS about key scientific data gaps and to draft the Recovery Plan.

NMFS also recognized there is public interest in CI beluga recovery. For this reason, in addition to utilizing a scientific panel to draft a recovery plan, NMFS invited organizations to be represented on a stakeholder panel to participate in aspects of the recovery planning process. The Stakeholder Panel consisted of representatives of organizations with identified interests in the recovery of CI belugas, or those who may be affected by particular actions taken to recover CI belugas. The function of the Stakeholder Panel was to provide additional information to the Science Panel and NMFS for consideration when drafting the recovery plan. The Stakeholder Panel was also given the opportunity to provide feedback on interim drafts of the Recovery Plan before the plan was submitted to NMFS.

The first of several CIBRT meetings took place March 2010 in Anchorage. Following each meeting and prior to the next meeting, a meeting summary was posted on the NMFS Alaska Region’s webpage dedicated to the CI beluga whale recovery planning process, available at: http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/recovery/ci.htm. Additional information on the website includes the CIBRT Terms of Reference, meeting dates and topics, and other recovery team and recovery planning documents.

The submission of a draft recovery plan to NMFS by the CIBRT in March 2013 culminated a three year process, and represented thousands of hours of volunteer effort from a team comprised of 12 Science Panelists and 19 Stakeholder Panelists. At that time, and with the thanks of NMFS’s Alaska Regional Administrator, the Recovery Team was disbanded and NMFS took responsibility for finalizing the Recovery Plan.

F. The Recovery Plan for CI Belugas

NMFS reviewed the CIBRT’s draft version of the Recovery Plan, and made modifications deemed necessary to meet applicable requirements and ensure a functional plan. Some modifications were minor (e.g., addition of an executive summary and a literature cited section; formatting the document for consistency), whereas other modifications were more substantial. Some of the more substantial modifications included streamlining the background section by moving some of the more detailed, but not necessarily essential, information to the appendices; adding section summaries for the different components of the background section; editing the threats assessment section; and modifying the list of recovery criteria and recovery actions. The modifications to the recovery criteria and recovery actions sections included, for example, a reduction in the redundancy of some criteria/actions; removal of some criteria/actions that did not provide a clear recovery benefit or that required a commitment of resources, authorizations, or continuation of programs that could not be guaranteed; an emphasis on criteria/actions pertaining to threats ranked as medium or high; a reassessment of some criteria that were not objective or measurable; and a restructuring of the list of recovery actions into a format that helps to focus limited resources on threats that have evidence of limiting the recovery of the CI beluga population. The restructuring of the recovery actions also led to a similar restructuring of the information presented in the implementation table. The intent of these revisions was to make this Recovery Plan a useful management document for NMFS while also providing a clear path forward for others to promote the recovery of the CI beluga whales.

It is challenging to identify the most immediate needs for recovery of CI belugas, because little is known about the effects of potential threats to recovery of this population. The documented decline of the CI beluga population during the mid-1990s has been attributed to subsistence harvest removals at a level that this small population could not sustain (65 FR 34590, May 31, 2000; NMFS 2008a, 2008b). NMFS and subsistence users dramatically reduced subsistence takes; such a reduction should have allowed the CI beluga population to rebound if subsistence harvest was the only factor preventing population growth. However, abundance data collected since 1999, during which the subsistence harvest has averaged less than one beluga per year, indicate that the population is not increasing as expected. It is unknown what specific factor(s) continue to limit growth and recovery of this population. It may be that the cumulative impacts of several threats are impeding recovery to a greater extent than the sum of the individual impacts of those threats.

This plan addresses each of the potential threats based on our current knowledge. In addition to examining threats, this plan provides background information on CI beluga life history, status, and existing protective measures. Furthermore, this plan identifies a strategy, goals, criteria, and actions targeted at recovering the species. Priorities and estimated costs for the recovery actions are provided in an implementation table.

The recovery actions recommended in this plan are based on the best available science at the time the plan was written. Research and monitoring are key components of the plan and will make an adaptive management approach possible. Recovery of CI belugas will require a long-term cooperative effort that will evolve as more is learned from research and monitoring. Continued monitoring of the status of the population will assist in evaluating the effectiveness of management actions. Research will help refine recovery actions and identify new actions to fill data gaps about the threats. An adaptive management approach will also provide information to adjust priorities as recovery progresses, and will allow the plan to be periodically modified and updated.

G. Section Summary: Introduction

<u>ESA Listing Status</u>

In response to a decline in the CI beluga population between 1994 and 1998, NMFS was petitioned to designate CI belugas as depleted under the MMPA and/or as endangered under the ESA. In 2000, NMFS designated the CI beluga whale population as depleted under the MMPA, but determined that listing CI beluga whales as endangered or threatened under the ESA was not warranted at that time. NMFS later reevaluated the status of the CI belugas and, in 2008, listed the CI beluga whale distinct population segment (DPS) as endangered under the ESA. Throughout this recovery plan, the term “CI beluga population”, “CI belugas”, and “CI beluga whales” refer to the CI beluga whale DPS.

In listing the CI beluga whale DPS as endangered, NMFS referenced the five factors set forth in section 4(a)(1) of the ESA:

A. *The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range.*

B. *Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.*

C. *Disease or Predation.*

D. *The Inadequacy of Existing Regulatory Mechanisms.*

E. Other Natural or Manmade Factors Affecting its Continued Existence.

The ESA listing of the CI belugas as endangered led to the 2011 designation of their critical habitat. The ESA requires all federal agencies to consult with NMFS regarding any action they authorize, fund, or carry out to ensure that the action does not jeopardize the continued existence of the species or result in the destruction or adverse modification of designated critical habitat.

Recovery Plan Development

The ESA requires the preparation and implementation of recovery plans for all listed species, with certain exceptions. In 2010, NMFS convened a Cook Inlet Beluga Recovery Team (CIBRT) to advise and assist NMFS with the development of a draft recovery plan. In 2013, the CIBRT submitted a draft recovery plan to NMFS. Since that time, NMFS made modifications deemed necessary to meet applicable requirements and ensure a functional plan.

The Cook Inlet Beluga Whale Recovery Plan begins with background information on CI beluga life history, population size and trends, and known sources of mortality or injury. It then discusses the current threats to the population's recovery, and presents the recovery strategy, goals, and criteria. It concludes with the recovery program, which includes recovery actions and an implementation schedule containing priorities and estimated costs for the actions.

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II. BACKGROUND

A. Physical Habitat of Cook Inlet

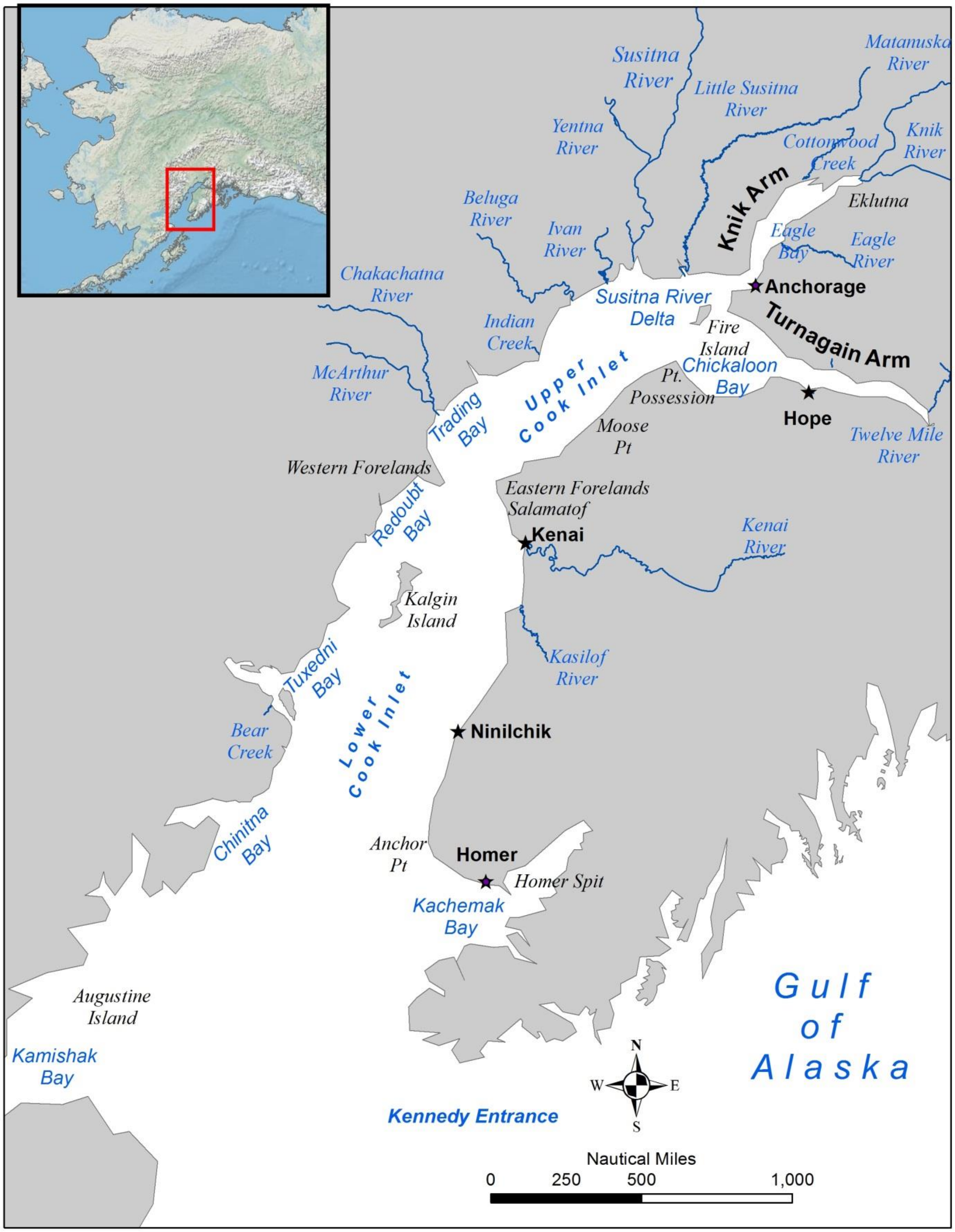
Cook Inlet is a semi-enclosed tidal estuary located in southcentral Alaska (Figure 2). The Inlet is approximately 370 kilometers (km) (230 miles [mi]) in length and extends in a northeast/southwest orientation from Knik and Turnagain Arms in the north to the southernmost reaches of Kamishak Bay in the south (Figure 2). Cook Inlet covers 20,000 km^2 (12,427 mi^2) and has 1,350 km (839 mi) of coastline (Rugh et al. 2000). The Cook Inlet watershed includes approximately 98,000 km^2 (60,894 mi^2). The Susitna River occupies the largest drainage basin (50,800 km^2, 31,566 mi^2), followed by the Matanuska (5,670 km^2, 3523mi^2), Knik, Chakachatna, and Kenai rivers (each exceeding 2,500 km^2,1,553 mi^2).

The bathymetry of Cook Inlet is varied and consists of shoals, canyons and mudflats (Figure 3). Cook Inlet is generally shallow, with most waters less than 73 meters (m) (240 feet [ft]) deep. However deeper waters exist along the channels and at the entrance to the Inlet near the Barren Islands, where depths range from 183–366 m (600–1200 ft; Mulherin et al. 2001). During low tides, large areas along the shoreline are exposed as mudflats in Knik Arm, Turnagain Arms, Chickaloon Bay, Redoubt Bay, Trading Bay, Kachemak Bay, and the Susitna River Delta. In other areas of Cook Inlet, bottom sediments consist of cobbles, pebbles, sand, and clay, with occasional patches of boulders or coal seams. Areas with stronger currents associated with constrictions in Cook Inlet’s width tend to have coarser bottom sediments.

The physical oceanography of Cook Inlet is characterized by a net inflow along the eastern boundary and a net outflow along the western boundary (Burbank 1977). A major inflow is the Alaska Coastal Current, a current driven by wind and water densities that flows along the southern coast of Alaska and passes through Kennedy Entrance (Figure 4). Upon entering lower Cook Inlet, the Alaska Coastal Current turns west just north of Anchor Point, mixing with western boundary outflow (Burbank 1977, Muench et al. 1978). A significant component of the water along the western boundary originates from Turnagain and Knik Arms, the Susitna River, and numerous other glacial streams. In the lower Inlet, this outflow is typically more turbid than the water further east due to the heavy glacial runoff from these drainages (Figure 3). These sources deposit considerable sediment into Cook Inlet, creating a highly turbid, low visibility environment, particularly in the northern portion of the Inlet. Seasonal stream discharges and sediment transports typically peak in July to August. In the upper Inlet, summer surface temperatures are about 10 degrees Celsius (^oC) (50 degrees Fahrenheit [^oF]) with salinities <20 parts per thousand (ppt). During summer in the lower Inlet, a relatively warm (10^oC, 50^oF), low salinity (<29 ppt), surface layer forms along the west side and a cooler (9^oC, 48^oF), higher salinity (>30 ppt) layer forms along the east side.

Cook Inlet experiences some of the greatest tidal fluctuations in the world (Mulherin et al. 2001). The difference between high and low tide levels may reach 12 m (39 ft). These large tidal ranges, combined with broad tidal flats, can result in currents reaching 6.2 meters per second (20.3 feet per second), sometimes causing significant changes to shorelines (Moore et al. 2000). Three distinct convergence zones, known as tide rips, have been identified in the Inlet (Figure 4). The east rip is typically located 2-3 km (1.2-1.9 mi.) offshore of the eastern shore. The west and mid-channel rips are located just east of Kalgin Island, and are associated with a 50–80 m (164–262 ft) deep channel running north to south (Figure 4).

FIGURE 2: Major Streams and Rivers Flowing into Cook Inlet.

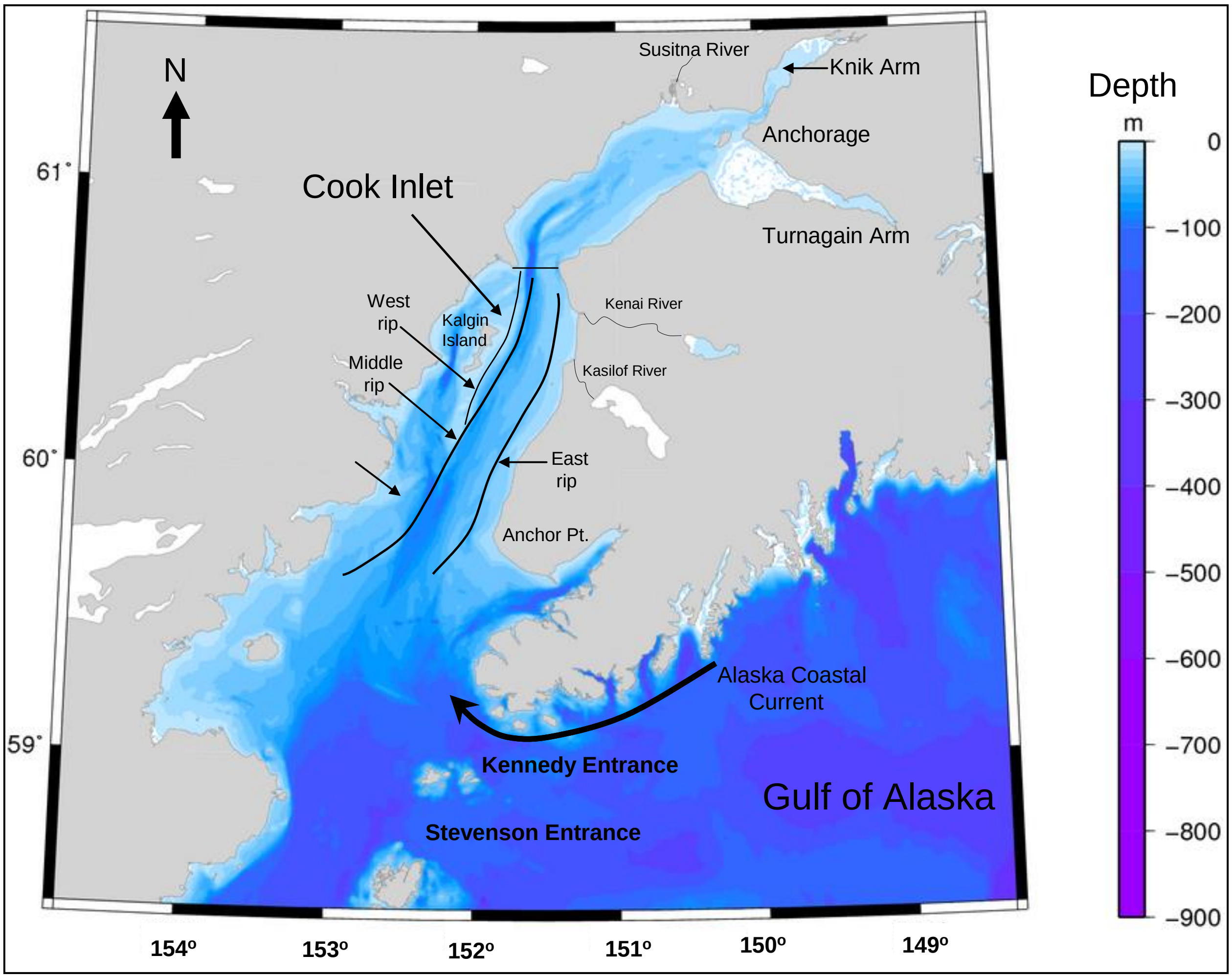


Source: Map created by NMFS 2013

FIGURE 3: Glacial Input into Cook Inlet

Source: MODIS true color image, acquired 2 September 2002; Okkonen 2005

FIGURE 4: Cook Inlet Bathymetry and Locations of Major Tide Rips



Source: Burbank 1977

In winter, ice covers much of upper Cook Inlet. Rivers begin to freeze in October and November and waters of upper Cook Inlet contain persistent ice by December. Large amounts of freshwater entering Knik and Turnagain Arms contribute to relatively high ice concentrations in the upper Inlet. South of the Forelands, small floes of open pack ice are typical. Maximum ice extent is typically reached in late January. Inlet circulation and winter winds tend to move the ice south down the west side of the Inlet. Ice breakup in the Inlet typically begins between March and May.

The physical environment of Cook Inlet is shifting towards increasingly long ice-free seasons as Alaska undergoes climate change. Alaska has experienced the greatest warming of any region in the United States (U.S.) (Karl et al. 2009) and Cook Inlet's reduction in duration of seasonal sea ice is consistent with other portions of the state. Alaska's regional warming is part of a larger Arctic-wide warming trend (ACIA 2004; IPCC 2013) that is projected to increase over time.

B. Natural History of Cook Inlet Beluga Whales

1. Physical Description of Beluga Whales

The beluga whale (*Delphinapterus leucas*), or "white whale," is a small odontocete (toothed-whale). Known for the striking white coloration of the adults, the word "beluga" is derived from the Russian word for white, and the specific name *leucas* is the Latin word for white. The Latin "*apterus*" refers to the lack of a dorsal fin, another prominent characteristic. Beluga whales have a stocky body, flexible neck, small rounded head, short beak, and conical teeth. The flippers are relatively small but broad and spatulate with edges that tend to curl with age. Their flukes are broad and notched with convex trailing edges. Physical characteristics that distinguish beluga whales from most other cetaceans include unfused cervical vertebrae accompanied by increased head mobility, a very bulbous flexible melon in the forehead region, the lack of a dorsal fin, and presence of a tough dorsal ridge. Beluga whales are relatively slow swimmers that often roll slowly at the surface, and their blow is often inconspicuous.

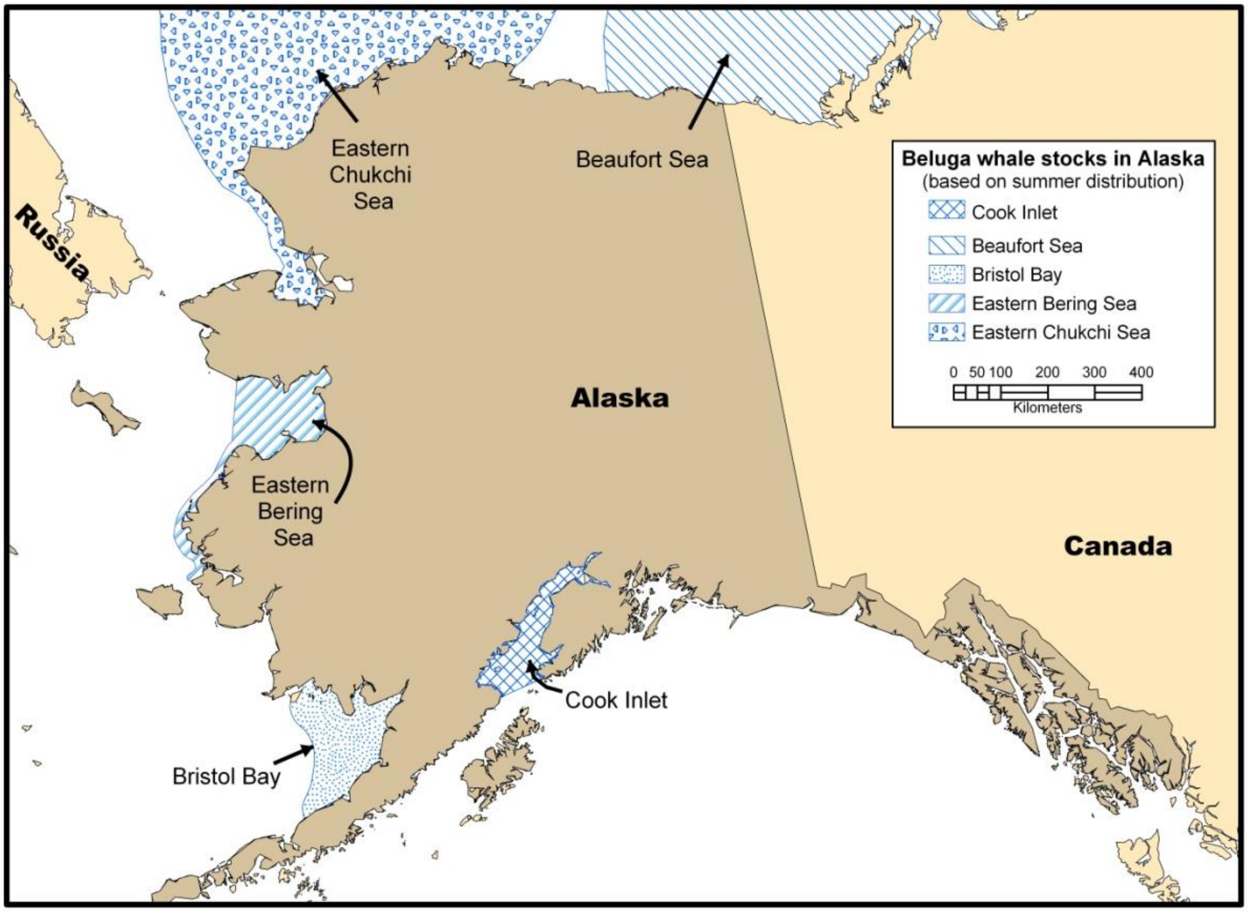
Calves are born dark gray to brownish gray and become lighter with age. Adults may become white to yellow-white at sexual maturity, although Burns and Seaman (1986) report females may retain some gray coloration for as long as 42 years (assuming one dentinal layer per year). McGuire et al. (2008) reported several photo-identified mothers that were still gray when they had calves, suggesting that coloration is not a definitive indicator of maturity. Belugas are sexually dimorphic, with length averaging 355 centimeters (cm) (11.6 ft) in adult females and 415 cm (13.6 ft) in adult males) (Burns and Seaman 1986). Males weigh up to 1,500 kg (3,307 pounds [lb]) and females 1,360 kg (2,998 lb) (Nowak 1991). Beluga calves in Alaska have been reported to average 150 cm (4.9 ft) in length and 72 kg (159 lb) at birth (Burns and Seaman 1986).

2. Taxonomy, Geographic and Genetic Variation

The beluga whale is a member of the Monodontidae, the taxonomic family it shares with the narwhal (*Monodon monoceros*). The earliest fossil record of the Monodontids is an extinct beluga (*Denebola brachycephala*) from late Miocene deposits in Baja California, Mexico, indicating that this family once occupied temperate ecozones (Barnes 1984). Fossils of belugas found in Pleistocene clays in northeastern North America reflect successive range expansions and contractions of this species associated with glacial maxima and minima. The beluga whale is a northern hemisphere species, ranging primarily over the Arctic Ocean and some adjoining seas and inhabiting fjords, estuaries, and shallow waters in Arctic and subarctic oceans, except for a small population in the Gulf of St. Lawrence, Canada. Some belugas seek out shallow coastal waters in summer and remain near the ice edge in winter. In Alaska, there are five recognized beluga stocks (Figure 5) delineated based on summer range: the Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet stocks (Allen and Angliss 2012). Murray and Fay (1979) suggested the CI beluga whale stock has been isolated from the other stocks for several thousand years. The lack of CI beluga whale observations along the southern side of the Alaska Peninsula (Laidre et al. 2000) and genetic data (O'Corry-Crowe et al. 1997, 2002, 2010) have corroborated Murray and Fay's (1979) suggestion of distinction from the other stocks.

Sightings of belugas in the Gulf of Alaska are rare outside of Cook Inlet (Laidre et al. 2000). The degree of genetic differentiation between the Cook Inlet stock and the other four Alaska

FIGURE 5: Map of Summer Distributions of the Beluga Stocks in Alaska.



Source: Map created by NMFS 2008

beluga stocks indicates the Cook Inlet stock is the most isolated (O'Corry-Crowe et al. 1997, 2002, 2010). This suggests that the Alaska Peninsula has long been an effective physical barrier to genetic exchange, and that migration of whales into Cook Inlet from other stocks is unlikely.

The exception to the rarity of belugas in the Gulf of Alaska outside of Cook Inlet may be a very small group of beluga whales that appear to reside year-round in Yakutat Bay (Fiscus et al. 1976; Consiglieri and Braham 1982; Hansen and Hubbard 1999; O'Corry-Crowe et al. 2006). Genetic samples collected from whales in Yakutat Bay are more closely related to each other than they are to whales sampled in other areas of Alaska (O'Corry-Crowe et al. 2006), and are unlikely to represent whales traveling from the Cook Inlet population. Since there is no evidence of interaction between CI belugas and beluga whales found in other areas of the Gulf of Alaska, including the Yakutat Bay area, this Recovery Plan focuses only on the belugas inhabiting Cook Inlet.

3. Beluga Distribution in Cook Inlet

Data on distribution and habitat use comes primarily from two main sources: aerial surveys (Hansen and Hubbard 1999, Rugh et al. 2010), and satellite transmitter tagging studies during August through March (Hobbs et al. 2005). Additional information is provided by traditional ecological knowledge (TEK) of Alaska Natives (e.g., Huntington 2000; Braun and Huntington

2011; Carter and Neilsen 2011), boat and land-based observations (e.g., Speckman and Piatt 2000; McGuire and Bourdon 2012), passive acoustic monitoring studies (e.g., Small 2011), opportunistic reports (e.g., Rugh et al. 2000; Vate-Bratstrom et al. 2010; NMFS unpub. data), NMFS stranding records (e.g., Vos and Shelden 2005; NMFS unpub. data), and a citizen science beluga sighting project (Švarný Carlson and Brunner 2012).

Localized information on distribution and habitat use of specific areas of Cook Inlet is available from studies conducted in conjunction with the development activities, universities, or other entities. Some of the available data sources are associated with: the Port of Anchorage Expansion Project; Ocean Renewable Power Company's Fire Island Tidal Project; Pac-Rim Coal's Chuitna Coal Project; CIRI's Fire Island Wind Project; the Alaska Department of Transportation's Seward Highway Expansion Project; the Port MacKenzie Expansion Project; the Knik Arm Bridge and Toll Authority's (KABATA) Knik Arm Crossing; the Alaska Communication Systems Fiber Optic Cable Project; seismic programs for Apache Alaska, ConocoPhillips Alaska, and Furie/Escopeta Oil; Joint Base Elmendorf Richardson's beluga studies program; and LGL's CI beluga Photo-Identification Project. Many of these projects' reports may be found on the NMFS Alaska Region's website at: www.alaskafisheries.noaa.gov/protectedresources/whales/beluga.

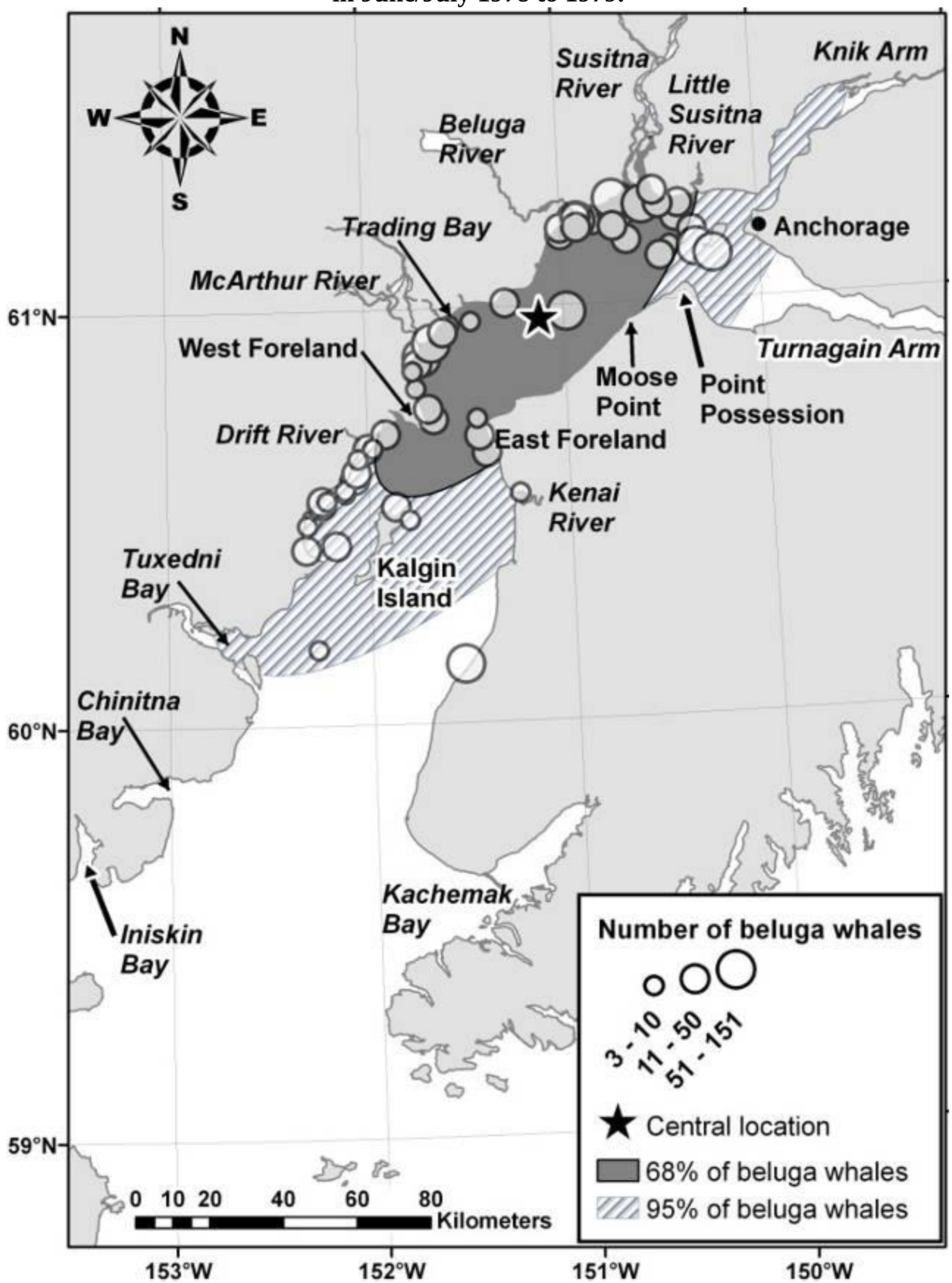
a. Inter-annual Distribution Patterns

The distribution of CI belugas has changed significantly since the 1970s, when aerial surveys for belugas were first conducted. ADF&G conducted aerial surveys of Cook Inlet in June and July in the late 1970s. These surveys were limited in scope and involved a single sample of a portion of Cook Inlet. While many of the early reports lacked sufficient descriptions of how and where the surveys occurred, good documentation is available for aerial surveys conducted on 18 June 1978 and 18-22 June 1979 (ADF&G, unpub. data). Beginning in 1993 NMFS started conducting comprehensive surveys annually (with the exception of 2013 when surveys were switched to a biennial schedule) lasting between 4-10 days each year, with 3-7 repetitions of coastal flights around the upper Inlet plus 1-2 days dedicated to a survey of the lower Inlet (Rugh et al. 2000, 2005a,b; National Marine Mammal Laboratory [NMML], unpub. data[5]).

Rugh et al. (2010) used three time periods to examine changes in historical distribution patterns of CI belugas: late 1978 to 1979 (when well-documented data are available; Figure 6); 1993 to 1997 (during a decline in abundance; Figure 7); and 1998 to 2008 (when hunting was regulated and recovery was anticipated; Figure 8). This analysis of aerial survey data showed that the extent of the late spring/early summer distribution (June/July) of CI belugas has changed considerably since the late 1970s. The whales were distributed over a relatively large area in 1978 and 1979, with the central location of the summer range occurring between the McArthur and Beluga rivers (Figure 6). The area of highest concentration included the region from Drift River to the Susitna Delta. The TEK also indicated that CI belugas had long been observed in the lower Inlet, including Kachemak Bay on the eastern side and Tuxedni and Trading bays on the western side, although rarely in large numbers (Huntington 2000; Braund and Huntington 2011).

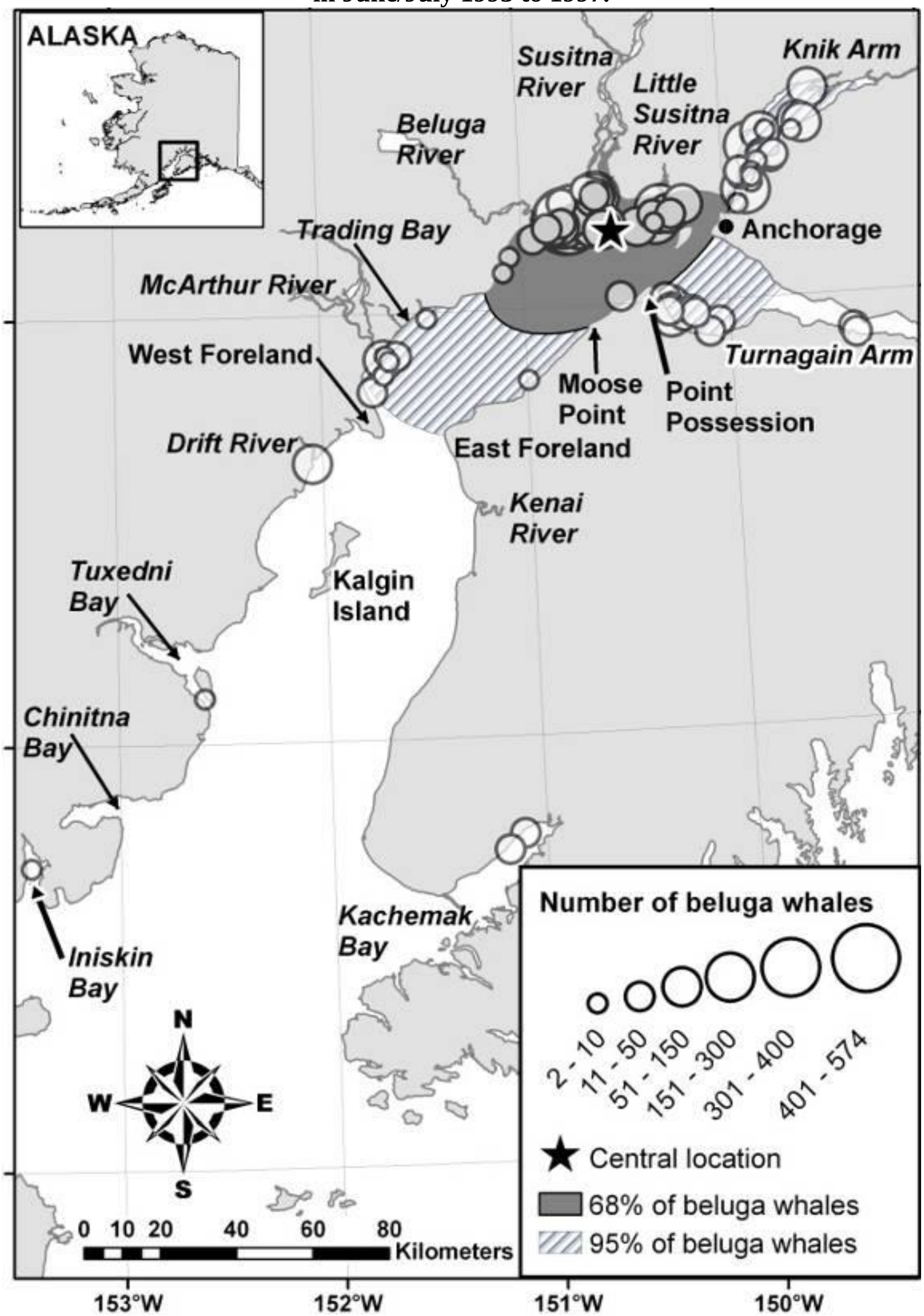
[5] For more information, contact Kim Shelden in the NMFS National Marine Mammal Laboratory

FIGURE 6: Areas Occupied by Beluga Whales in Cook Inlet, Alaska, in June/July 1978 to 1979.



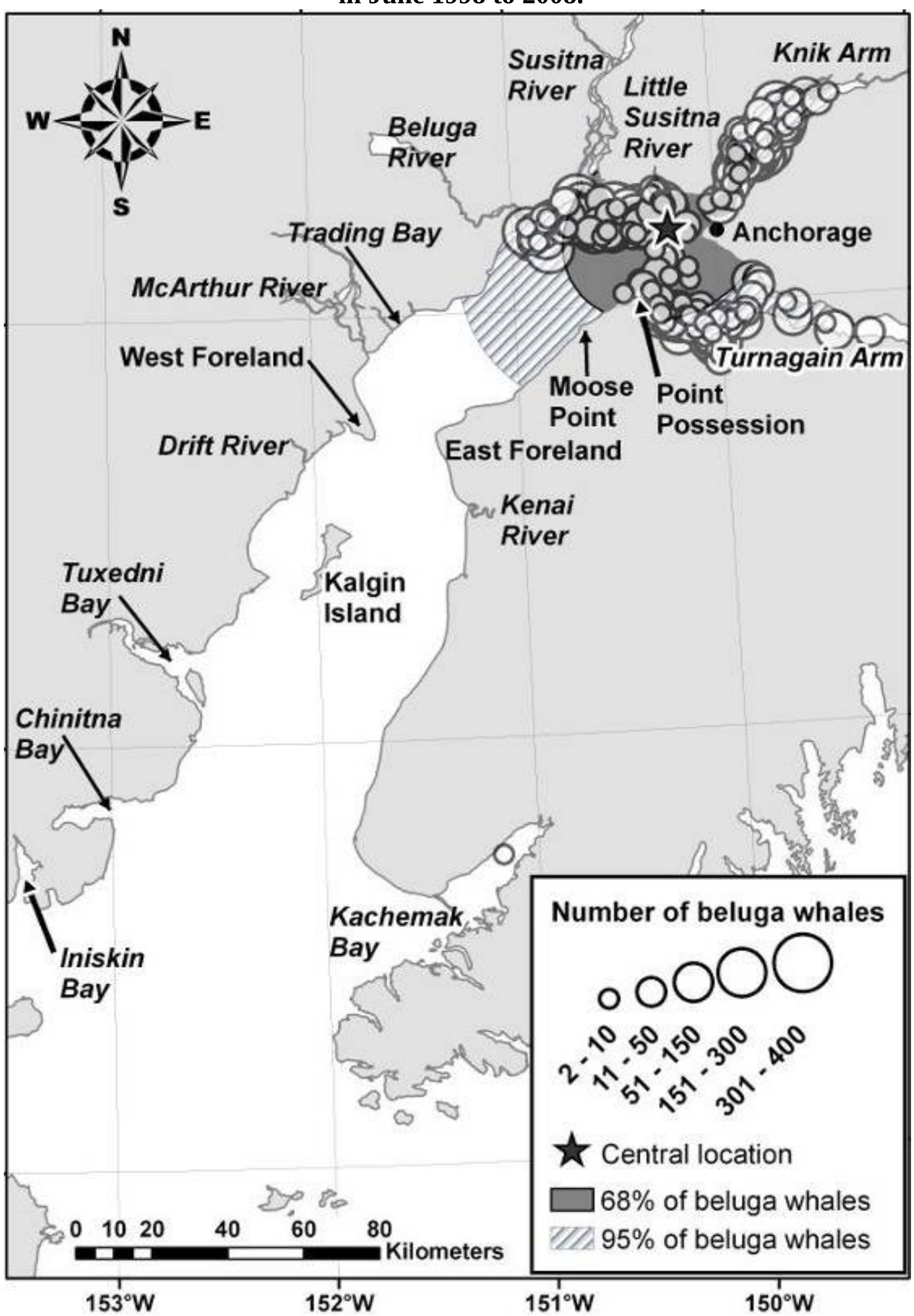
Source: Rugh et al. 2010

FIGURE 7: Areas Occupied by Beluga Whales in Cook Inlet, Alaska, in June/July 1993 to 1997.



Source: Rugh et al. 2010

FIGURE 8: Areas Occupied by Beluga Whales in Cook Inlet, Alaska, in June 1998 to 2008.



Source: Rugh et al. 2010

From 1993 to 1997, the central location of the summer range shifted northeast to the mouth of the Susitna River and the area of highest concentration contracted to a region north of Moose Point (Figure 7). From 1998 to 2008, the central location of the summer range shifted east, then occurring between the Little Susitna River and Fire Island (Figure 8); the area of highest concentration included Knik Arm and Chickaloon Bay (between Point Possession and Turnagain Arm). Changes in distribution over the three time periods were significant. These include the northeast contraction of the summer range of belugas into upper Cook Inlet from the 1970s to the 1990s and into the 2000s, as well as a longitudinal shift east toward Anchorage between 1993 and 2008. Core summer distribution was estimated to have contracted from over 7,000 km^2 (2,703 mi^2) in 1978 to 1979, to 2,800 km^2 (1,081 mi^2) in 1998 to 2008 (Rugh et al. 2010). Fewer sightings of CI belugas the lower Inlet in recent decades (Hansen and Hubbard 1999; Speckman and Piatt 2000; Rugh et al. 2000, 2004, 2010) indicate that the summer range of CI belugas has contracted to the mid and upper Inlet, coincident with their decline in population size.

The reason for this change of distribution is not known, but several hypotheses have been proposed, including: 1) an effect of changing habitat, such as through diminished prey availability (Moore et al. 2000); 2) avoidance of killer whales (Shelden et al. 2003); and 3) preference and ability of this remnant population to remain in preferred habitat areas due to reduced intra-specific competition as a result of a reduction in population size (Goetz et al. 2007). Regardless of the reason, the result of the CI beluga range contraction brings animals in a small range proximal to Anchorage during summer months, where there is increased potential for disturbance from human activities.

b. Seasonal Distribution Patterns

Multiple data sources indicate that beluga whales exhibit seasonal shifts in distribution and habitat use within Cook Inlet, however, belugas in Cook Inlet do not migrate out of Cook Inlet. The known seasonal shifts in distribution of CI belugas appear to be related to seasonal changes in the physical environment (e.g., ice and currents) and to shifts in food sources, specifically the timing of fish runs. Generally, belugas spend the ice-free months in the upper Inlet (often at discrete high-use areas), then expand their distribution south and into more offshore waters of the middle Inlet in winter (Hobbs et al. 2005), although they may be found throughout the Inlet at any time of year. These seasonal patterns have been long observed and utilized by subsistence hunters (Huntington 2000), and have more recently been documented by aerial surveys (Rugh et al. 2000, 2004), satellite telemetry (Hobbs et al. 2005, Ferraro et al. 2000), and during shore and boat-based observations (Funk et al. 2005; McGuire and Bourdon 2012). Most recently, passive acoustic monitoring is being used to assess seasonal movements throughout the Inlet (Castellote et al. 2011a).

Movement data is available from 15 CI belugas tracked for variable periods of time (2 – 240 days) with satellite transmitters between May 1999 and March 2003. Tags attached to nine whales logged movements into December, with four continuing to transmit movement data to the following March (Hobbs et al. 2005; Goetz et al. 2012a). All tagged CI belugas remained within Cook Inlet for the period they were tracked. Whales spent the summer and early autumn months in the upper Inlet, concentrating at river mouths. Within this time period, whales often made weekly movements between the mouth of the Little Susitna River, Knik Arm, Turnagain Arm and Chickaloon Bay. During the late summer the belugas remained in the upper Inlet, centered in Knik Arm (Figures 9a, 9b). During the fall the belugas concentrated in Chickaloon Bay and areas

FIGURE 9 (a-h): Predicted Cook Inlet Beluga Whale Distribution by Month based upon Known Locations of 14 Satellite Tagged Belugas.

Figure 9a

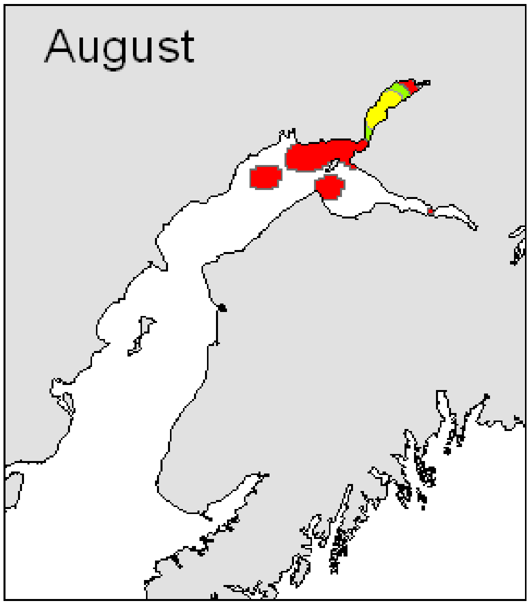


Figure 9b

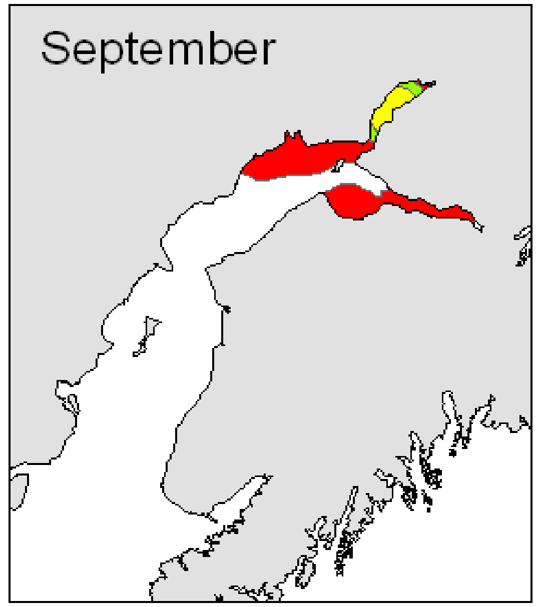


Figure 9c

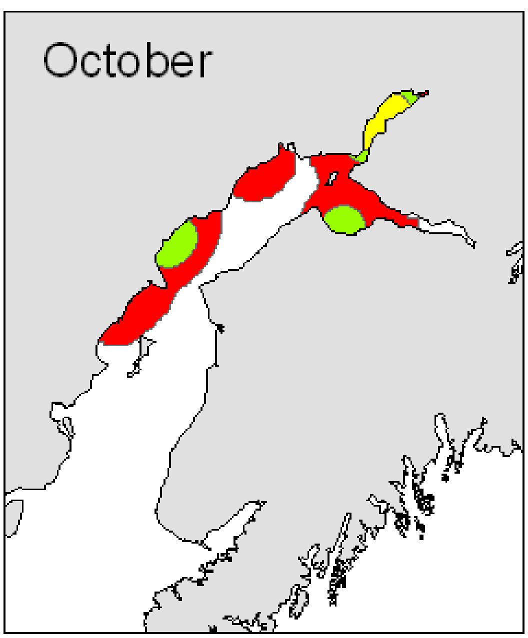


Figure 9d

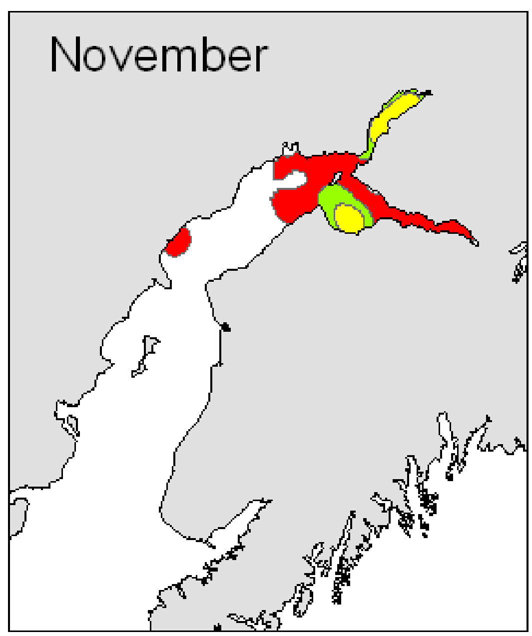


Figure 9e

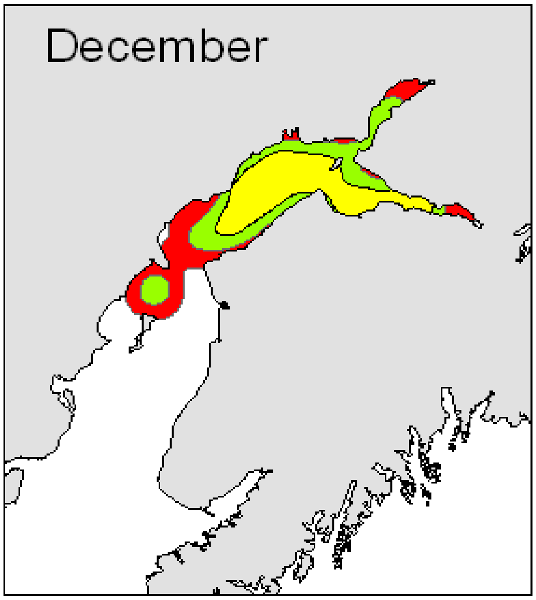


Figure 9f

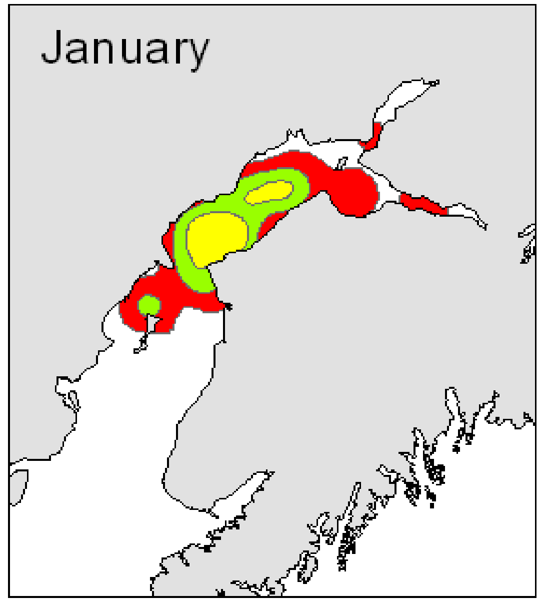


Figure 9g

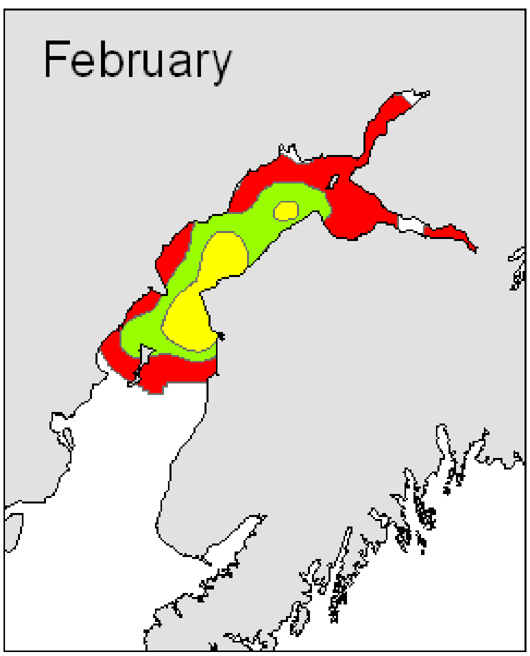
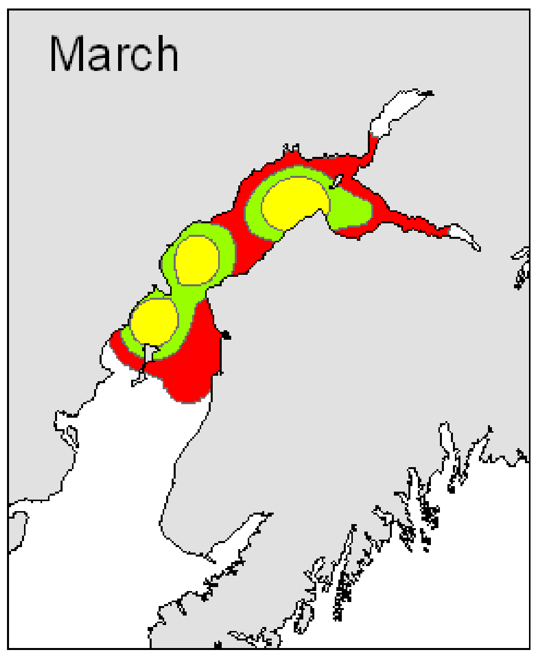


Figure 9h



Notes: A single best location was chosen for each day. Predictions derived via kernel probability estimates. Note the large increase in total area use and offshore locations beginning in December and continuing through March. The red area (95 percent probability) encompasses the green (75 percent) and yellow (50 percent) regions; the yellow area represents the highest density.

Source: Hobbs et al. 2005

of the west side near Tyonek (Figures 9c, 9d). In late fall, tagged whales began to make more extensive movements south into the middle Inlet and into deeper offshore waters (Figure 9e), and were not found in the large dense groups commonly seen in the summer months (Rugh et al. 2004). This pattern continued through winter (Fig. 9f-9h) when whales exhibited the most wide-ranging movements, spanning both near shore and offshore waters from the upper reaches of Knik Arm to the middle Inlet.

A year-round shore and boat-based observational study in Knik Arm (July 2004 to July 2005) revealed seasonal patterns in habitat use and abundance of this area, with peak abundances in fall (September) declining to lowest numbers in winter, and highest use of river mouths and mud flats (Funk et al. 2005). Shore-based studies during the ice-free months along Turnagain Arm found peak beluga abundances mid-August through October, with whales occasionally present mid-April to early May (Markowitz and McGuire 2007; McGuire and Bourdon 2012). An ongoing (2005-present) photo-identification study within the upper Inlet with sighting histories of 303 individual belugas to date has documented movements by individual whales among several high-use areas within a summer season, including Susitna Flats, Knik Arm, Chickaloon Bay, Turnagain Arm (McGuire et al. 2009), and the Kenai River (T. McGuire, LGL Alaska Research Associates, pers. obs.). Initial results from passive acoustic monitoring across the entire Inlet support seasonal patterns observed with other methods (M. Castellote et al., NMML, pers. comm.).

Large aggregations of belugas in specific areas of Upper Cook Inlet during May to October are presumed to indicate a critical time period for foraging, based on the need to assimilate resources for overwinter survival (Calkins 1983; Huntington 2000). It is during the ice-free months that calves are born and nursed, and that the whales acquire the thick blubber layer they will need to survive through the winter months, when anadromous fish runs end and prey move to deeper, offshore regions (Hobbs et al. 2005; Hobbs et al. 2008).

4. Use of Critical Habitat by Belugas

a. CI Beluga Feeding Habitat

CI belugas are frequently seen aggregating near the mouths of rivers and streams, when anadromous fish species are present and often at their peak availability (Moore et al. 2000). These concentrations of belugas within discrete areas of the upper Inlet and offshore of several important salmon streams are assumed to be the result of a feeding strategy that takes advantage of the bathymetry of the area: the fish are funneled into the channels formed by the river mouths and the shallow waters act as a gauntlet for fish as they move past waiting belugas. Hazard (1988) hypothesized that belugas were more successful feeding in rivers where prey were concentrated than in bays where prey were dispersed, implying that CI belugas seek areas where anadromous prey escapement (return to natal rivers) numbers are high, but also areas that have certain habitat features. Research by Frost et al. (1983) on beluga whales in Bristol Bay suggested those whales preferred certain streams for feeding based on the configuration of the stream channel. Their study theorized beluga whales' feeding efficiencies improved in relatively shallow channels where fish were confined or concentrated. Because beluga whales do not always feed at the streams with the largest runs of fish, bathymetry and fish density may be more important than sheer numbers of fish in their feeding success. For example, CI belugas today are seen less frequently at the mouth of the Kenai River than they were historically, despite large salmon returns to the river. This may also be due to preference for particular prey species.

Habitat use in the summer months consists of semi-predictable movements of groups of beluga whales between river mouths and shallow tidal flats in the upper Inlet. These movements are largely cued to physical conditions, especially tide, but may also be influenced by anthropogenic activities. TEK indicates that daily movements are determined by the ebb and flow of the tide and the related movements and size of fish runs, and also by the presence of killer whales (Huntington 2000). For example, whales often concentrate on the shallow mudflats of the Susitna River Delta and Chickaloon Bay at low tide, and may enter upper Inlet rivers on the flooding tide, although the reverse tidal pattern has been observed in Eagle River in Knik Arm (T. McGuire, LGL Alaska Research Associates, pers. obs.). Observational studies (Funk et al. 2005; Markowitz and McGuire 2007) and ocean circulation and inundation models, combined with tracks from tagged individual whales (Ezer et al. 2008), confirm long-held local knowledge that daily feeding movements are influenced greatly by tidal cycle.

In the fall, as anadromous fish runs begin to decline, belugas consume the fish species found in nearshore bays and estuaries; however, some belugas may feed on salmon kelts (spawned fish) during this time. Habitat associations of nonanadromous beluga prey species in Cook Inlet include preferences for sand and mud substrates (Eschmeyer et al. 1983; Cohen et al. 1990; ADF&G 2004), and a number of these species move seasonally from shallow to deep water. Movements of belugas within the Inlet during the months when anadromous fish runs are not present may reflect the seasonal movements of these other prey species. Unlike salmon and eulachon (*Thaleichthys pacificus*), the prey available in winter do not tend to form large concentrations, and it may be that belugas tend to disperse throughout the Inlet during November through April, to utilize the more-dispersed prey (Hobbs et al. 2005). In the winter, CI belugas use deeper waters in the mid Inlet past Kalgin Island and make deep feeding dives. The presence of Kalgin Island south of the Forelands may create upwelling and eddies which concentrate nutrients and provides a still-water refuge area for migrating anadromous fishes (Calkins 1983, 1989). This area may also be a late-winter staging area for eulachon before they return to streams in the upper Inlet. Given the unique oceanographic conditions and the diversity of fish and crustaceans found near Kalgin Island, this area may be rich in biological productivity, and thus an important winter feeding habitat for belugas. Passive acoustic monitoring of beluga whales in Cook Inlet has recently begun (Castellote et al. 2011a; Castellote et al. 2011b) and may provide important information about distribution, movements, and feeding habitat use of CI belugas during the winter months.

Goetz et al. (2007, 2012b) used geographic information systems (GIS) to develop quantitative models of the summer habitat preferences of the CI beluga population. Habitat models were used to examine ecological relationships among belugas and several environmental variables. Parameters used in the models were based on June/July beluga sightings (1993 to 2004) relative to available environmental data: 1) bathymetry; 2) mudflats; and 3) flow rates among freshwater tributaries entering Cook Inlet. The two quantitative models predicted similar size and location of beluga habitat and identified mudflats and river size as important environmental features. Belugas are found near mudflats and prefer medium and high flow accumulation areas (i.e., medium to large river basins). Although sighting data in this study were collected primarily in June, other aerial surveys (Rugh et al. 2000, 2004), shore-based systematic and opportunistic observations (Funk et al. 2005; NMFS, NMML unpub. data), boat-based photo-identification surveys (McGuire and Bourdon 2012), and whales tagged with satellite transmitters (Hobbs et al. 2005) show that the distribution documented in June is largely representative of the distribution throughout the ice-free months; Knik Arm, Turnagain Arm, Chickaloon River, and the Susitna River Delta are used extensively. In fact, belugas occasionally access these preferred habitats in winter despite thick ice cover (Hobbs et al. 2005). Tidal movement corridors are also important to CI belugas, as beluga movements with the tides may occur up to twice daily and allow or limit access to feeding areas (Hobbs et al. 2005; Funk et al. 2005; Markowitz and McGuire 2007). Access to these areas and to corridors between these areas is important to the CI beluga feeding strategy.

Additional analyses by Goetz et al. (2012b) concluded that belugas were found in areas of high fish availability and access to tidal flats and sandy substrates, and that belugas were negatively associated with anthropogenic disturbance. These habitat models predicted that beluga distribution would include coastal areas extending nearly the entire length of Cook Inlet (Goetz et al. 2007), and, historically belugas inhabited large parts of the Inlet, including its central and southern reaches (Rugh et al. 2000). However, since 1993, beluga sightings have been rare (0-4% of all reported sightings per year) in areas south of the Forelands, and almost all sightings have been in the upper Inlet, from the Susitna Delta to Knik Arm and Chickaloon Bay (Rugh et al. 2000, 2005a, b). A significantly reduced CI beluga population (Hobbs et al. 2000), in combination with beluga preference for estuarine waters with the largest concentration of prey species, may explain the current distribution of whales, but data on relative densities of fish by species and season are not available to test this hypothesis.

b. CI Beluga Calving Habitat

In addition to being important feeding habitats, the shallow waters of the upper Inlet may also play important roles in reproduction. Since newborn beluga whales do not have the thick blubber layer of adults, they may benefit from the warmer water temperatures in the shallow tidal flats areas where fresh water empties into the Inlet, and it is likely these regions are used as nursery areas (Katona et al. 1983; Calkins 1989). These shallow areas may also provide refuge from killer whale predation on calves. The TEK of Alaska Natives has described historical beluga calving and nursery habitats as the northern side of Kachemak Bay, the mouths of the Beluga and Susitna Rivers, as well as Chickaloon Bay and Turnagain Arm (Huntington 2000). Knik Arm is also used extensively in the late summer and fall by cow/calf pairs: Funk et al. (2005) noted a relatively high representation of calves in the uppermost part of Knik Arm; the mouth of Knik Arm has been reported to be transited in the summer and fall by cow/calf pairs (Cornick and Kendall 2008); and groups seen in Eagle Bay usually contain calves (McGuire and Bourdon 2012).

Because calving events have not been documented in Cook Inlet, specific calving grounds have not been identified, although it seems likely that the areas identified as nursery areas might also serve as calving grounds. Based on the presence of calves sighted in summer aerial surveys, Calkins (1983) speculated that calving might occur in the larger estuaries of upper western Cook Inlet. During boat-based surveys for calves conducted in 2007 to 2011, the first neonates of the season were seen at the Susitna River Delta (McGuire and Bourdon 2012). Later in the season, groups seen in Knik Arm were more likely to contain neonates than groups in other areas. However, distinct areas for neonate and calf rearing were not identified, as calves and neonates were seen in all locations surveyed in Upper Cook Inlet (the Susitna River Delta, Knik Arm, Chickaloon Bay/Southeast Fire Island, and Turnagain Arm). Surveys of the lower Kenai River and its delta were conducted in 2011 and 2012, and groups seen there also contained calves and neonates (T. McGuire, LGL, unpub. data).

c. Other Uses of Habitat

Other important uses of habitat by CI belugas may include avoidance/escape from predators, transiting among feeding and/or nursery habitats, refuge from human activities (e.g., in-water noise, ship traffic and hunting) and molting. In the 2008 Conservation Plan (NMFS 2008a), NMFS stated that warmer, fresher coastal waters may be important areas for belugas' seasonal summer molt (Finley 1982) and that shallow waters may provide conditions necessary to help facilitate the shedding of dead skin and regeneration of epidermal layers. However, eight years of photographic records of over 303 individual CI beluga whales photographed from April to November do not display signs of obvious molting; it may be that molting in CI belugas is a more diffuse, gradual process than it is for those beluga stocks found in more northern latitudes and that habitat specifically for seasonal molting is not required. Molting has also not been observed in SLE belugas, despite over 25 years of studies on this population (P. Béland, St. Lawrence National Institute of Ecotoxicology, pers. obs.).

d. Human Environment of Cook Inlet

Belugas in Cook Inlet are unique in Alaska given that their habitat is in close proximity to the largest urban area in the state. In 2010 (the most recent census year available), the population of the State of Alaska was 710,231 people, with 291,826 in the Municipality of Anchorage, 88,995 in the Matanuska-Susitna Borough, and 55,400 in Kenai Peninsula Borough[6]. The population in this region has been increasing; between 1980 and 2010 the population grew by 67% [7].

Beluga whales are not uniformly distributed throughout Cook Inlet, but are predominately found in nearshore waters, adjacent to areas of high human activity. Humans use the waters and shores of Cook Inlet for fishing, hunting, recreating, timber harvesting, mining, shipping, dredging, renewable energy production, discharge of wastewater, military activities, oil and gas development, transportation, and residential and industrial development (Figure 10).

The majority of land in the Cook Inlet Basin is publicly managed by State or Federal agencies. Native groups and individuals are among the most significant private landowners.

5. Age, Growth, Reproduction, and Survival

Beluga whales have a single calf every two, three, or more years, but devote considerable time to care for their young. To counter this extended parental responsibility, beluga whales are also relatively long-lived. Although some life history data are available for CI belugas, considerably more data exist for other beluga populations (see Table 1). Most life history data have been obtained through measurements and samples of animals taken in subsistence harvests, although some information has come from live stranded, dead beach-cast or floating whales, and some from captive belugas. Relatively little life history data are available specifically for CI belugas.

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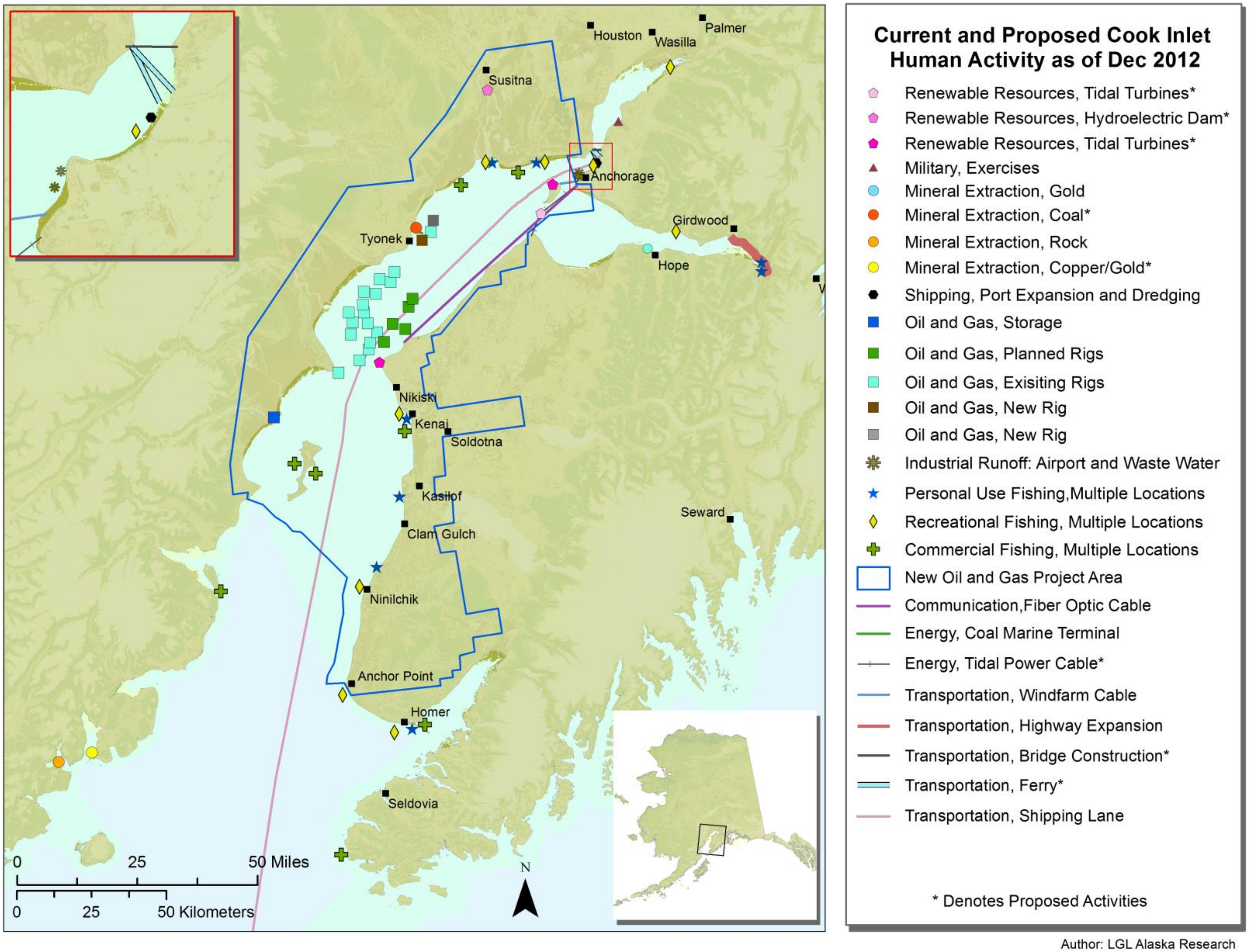
[6] Census information obtained from http://www.labor.state.ak.us/research/census/home.htm

[7] Census information obtained from http://quickfacts.census.gov/qfd/states/02/0203000.html

FIGURE 10: General Geographic Distribution of Current or Proposed Human Activities in Cook Inlet.



To understand growth, reproduction, and survival rates, the first step is to determine the age of individual belugas. Age is primarily assessed by counting the number of growth layer groups of teeth (GLGs) in thin longitudinal sections (see section IX.C – CI Beluga Natural History Supplement). Historically, it was believed that beluga whales might live more than 30 years (Burns and Seaman 1986), however, it is now thought that beluga whales may live 60 to 70 years or more (Suydam 2009). It is difficult to know the exact age of older belugas because their teeth wear down and some GLGs are lost as the animal ages; therefore it is likely that ages determined by counting GLGs are underestimates. For teeth of the 102 CI belugas that have been aged using the single GLG method, the oldest CI beluga was estimated to be at least 49 years (Vos 2003; NMFS unpub. data[8]).

While age is important, the age at sexual maturity (ASM) sheds light on reproduction and increasing or decreasing trends in ASM may help determine ecosystem dynamics. For instance, if ASM decreases over time in females, this might suggest that resources are not limiting population growth. In published literature, estimates of ASM in belugas ranged from 4-14 years for females and 8-15 years for males (Braham 1984; Nowak 1991; Heide-Jørgensen and Teilmann 1994; Suydam 2009; Table 1). While the cause of the wide range of ASM is currently unknown, possible reasons include: 1) animals may mature at different ages among stocks; 2) different counting methods may have been used to estimate ages; or 3) the definition of ASM may have differed (e.g., age at first ovulation vs. age at first conception vs. age at first birth). Burns and Seaman (1986) estimated the age at first conception for 22 female beluga whales in northeast Alaska to be between 8 and 13 years (based on 1 GLG per year).

Estimates of the length of gestation for belugas have also varied from 11 to 16 months (Table 1), although data from captive belugas where conception and birth are precisely known indicate a gestation of 15.6 months (Robeck et al. 2005). Birth of a single calf usually occurs in late spring or early summer. The lactation period is known to last at least a year, and likely longer in some cases. This estimate is based on observations of lactating females that are pregnant with a new fetus and with some estimates of weaning not occurring for about two years; thus, the entire reproductive process on average takes three years (Sergeant 1973; Burns and Seaman 1986). Depending on the age and experience of the mother, however, the calving interval may be as short as two years or over three years (Suydam 2009). Many studies suggest a calving interval for belugas of approximately three years, which equates roughly to a pregnancy rate of about 0.33 (Kleinenberg et al. 1969; Sergeant 1973; Ognetov 1985; Burns and Seaman 1986; Doidge 1990b; Heide-Jørgensen et al.1994). This would indicate that approximately one-third of mature females would be newly pregnant in any given year. However, belugas in Hudson Bay, Canada and Point Lay, Alaska had greater pregnancy rates of 0.47 (Hudson Bay; Sergeant 1973; Doidge 1990a) and 0.41 (Point Lay; Suydam 2009) indicating calving intervals shorter than three years. Several studies have also suggested a decrease in the pregnancy rate (based on studies of the ovaries) as a female beluga ages, particularly after 40 years (GLGs) (Brodie 1982; Heide-Jørgensen and Teilmann 1994; Suydam 2009). Kleinberg et al. (1969; as presented in Brodie 1971) arbitrarily estimated age at senescence to be around 42-43 years (GLGs). However, this does not mean that older female belugas are not capable of reproducing past this age, as the

[8] For more information, contact Barbara Mahoney in the NMFS Alaska Region Office, Protected Resources Division

TABLE 1: Review of Female Beluga Whale Life History Parameters Found in the Published Literature

Parameters	Data	Sources
Age at sexual maturity	9-11 GLGs (mean=10, excluded one immature animal age 15 GLGs, sample sizes not provided).	1
	7-13 GLGs (mean=10 GLGs), 5-6 to 11-12 GLGs (mean=9 GLGs, n=33, calculated from data collected by Khuzin [1961] in the Kara and Barents seas, Russia).	2
	0% at 8-9 GLGs, 33% at 10-11 GLGs, 94% at 12-13 GLGs, 100% at 16-17 GLGs (n=207).	3[a]
	9.1 ± 2.8 GLGs (captive beluga studies, n=23).	4
Age at color change (gray to white)	12 GLGs (minimum age)	1
	14 GLGs (minimum from Mackenzie Delta), 17 GLGs (minimums from western Hudson Bay)	2
Age at 1st conception	54% at 8-9 GLGs (n=12 of 22) 41% at 10-11 GLGs (n=9 of 22) 5% at 12-13 GLGs (n=1 of 22)	3
Age at senescence	42-43 GLGs (arbitrarily assumed by Kleinenberg et al. 1969)	1
Pregnancy and birth rates	With small fetuses: 0.055 at 0-11 GLGs 0.414 at 12-21 GLGs 0.363 at 22-45 GLGs 0.267 at 46-57 GLGs 0.190 at 58-77 GLGs	3
	With full-term fetuses or neonates: 0.000 at 0-11 GLGs 0.326 at 12-21 GLGs 0.333 at 22-45 GLGs 0.278 at 46-51 GLGs 0.182 at 52-57 GLGs 0.125 at 58-77 GLGs	3
Lifespan	60-61 GLGs	1
	50-53 GLGs	2[b]
	>60 GLGs (oldest female estimated at 70+ GLGs)	3
Adult annual survival	0.9064 (average based on mean annual mortality rate = 0.0936)	3
	0.91-0.92	5, 6
	0.842 and 0.905 (assuming 2GLGs/yr vs. 1 GLG/yr)	7
	0.96-0.97	8
	0.935	9

Parameters	Data	Sources
Immature annual survival	0.905 (for neonates in first half year of life, mortality rate=0.095)	2
	0.955 (based on pilot whale net recruitment)	10
Reproductive rate	0.13 (ratio of calves to adult females, modeled)	2
	0.143 (ratio of calves to adult females)	2
	0.114-0.117 (ratio of calves to whales)	2
	0.104 (a model population of 1,000 that included 94 calves)	3
	0.097 (ratio of calves to whales)	6
	0.08-0.10 (ratio of calves to whales)	10
	0.12 (ratio of calves to whales)	11
	0.056-0.10 (ratio of calves to whales)	12
	0.08-0.14 (ratio of calves to whales)	13
	0.08 (unknown)	14
Lactation period	At least 2 years	1
	21 months on average (based on length of gestation (14 months) x 33 lactating/22 pregnant whales)	2
	23 months (range:18-32 months, analysis of data collected by Seaman and Burns [1981])	6
Calving interval	3 years	1, 2[c], 3[d]
	>2 years (based on the assumption that females produce 10 calves within a 14-15 year active breeding period)	6[e]
	2-3 years	15

Notes: GLG = Growth Layer Group in teeth

Sources: 1. Brodie (1971) [Canada] Cumberland Sound, Baffin Island, population, n=124 animals (86% captured in nets which biased the sample toward females with newborns), Fig.3 appears to show 51 females in the sample. 2. Sergeant (1973) [Canada] Churchill and Whale Cove in western Hudson Bay, additional information from the Mackenzie Delta, Beaufort Sea and Kara/Barents seas, Russia. 3. Burns and Seaman (1986) [Northwest Alaska]; 4. Robeck et al. (2005) [captive belugas]; 5. Allen and Smith (1978) reviewed in 6. Braham (1984); 7. Ohsumi (1979); 8. Béland et al. (1992) [Canada] St. Lawrence population; 9. Lesage and Kingsley (1998) [Canada] St. Lawrence population; 10. Brodie et al. (1981) [Canada] Cumberland Sound, Baffin Island; 11. Ray et al. (1984); 12. Davis and Finley (1979) [eastern Arctic]; 13. Davis and Evans (1982) [eastern Beaufort Sea and Amundsen Gulf]; 14. Breton-Provencher (1981) [Poste-de-la-Baleine region]; 15. Suydam (2009) [eastern Chukchi Sea].

[a] Sampling occurred in June, a time when most Alaskan belugas are born. It is possible non-pregnant 8-9 GLGs belugas would have conceived before their 10-11 GLGs birth date.

[b] Found differences in maximum age based on sampling technique. Life span of netted whales tended to be lower (40 GLGs at Whale Cove) than those selected and harpooned (50 GLGs at Churchill, 53 GLGs at Mackenzie Delta). Similar results were reported by Brodie (1971) for whales netted in Cumberland Sound (40 GLGs).

[c] In 7 of the 29 pregnant females examined from Whale Cove, lactation was still occurring and for some analyses a 2 year calving cycle was assumed for 25% of the adult female population (p. 1084). Sergeant (1973) concluded "overlap of pregnancy and previous lactation is infrequent so that calving occurs about once in 3 years.

[d] For some female belugas. This was a tentative conclusion based on high conception rates noted in some females between the ages of 12-13 GLGs and 44-45 GLGs.

[e] Braham (1984) based this assumption on data from Brodie (1971) and Sergeant (1973) that age at first pregnancy is 6 years (12 GLGs) and last pregnancy is about 21 years (42 GLGs) resulting in a 14-15 year breeding period, which would allow only 6 calves rather than the 10 calves predicted by the authors if a female's reproductive cycle is 3 years. However, this calculation was based on 2 GLGs = 1 year, using 42-12 = a 30-year breeding period and a 3-year reproductive cycle would produce 10 calves

carcass of a 68 year old female beluga in the St. Lawrence Estuary population in Canada showed signs of recent reproductive activity (McAlpine et al. 1999 *as cited in* DFO 2012)

In 2005 NMFS began August calf surveys of Cook Inlet, by which time of year most calves of the year should be born. Calving indices were estimated for the period from 2006 to 2010, and indicated that more calves were produced in 2006 (12%) than in subsequent years 2007 to 2010, when the average rate was 4% (Hobbs et al. 2012b; Figure 11). These calving indices have several potential biases and should be used for trend analysis only, not for absolute estimates of calf production. The indices do indicate a considerable variability from year to year so that a much longer time series is required to determine an average. A similar observation has been made in the SLE beluga population where annual calf production appears to be cyclical (R. Michaud, Group for Research and Education of Marine Mammals, unpub. data).

Calkins (1983) suggested that most calving in Cook Inlet occurs from mid-May to mid-July, although Native hunters have reported calving from April through August (Huntington 2000). Neonates were not observed until mid-July during numerous photo-identification surveys of upper Cook Inlet conducted April to November between 2005 and 2011 (McGuire and Bourdon 2012). Based on gestation and timing of birthing, mating is believed to occur sometime between late winter and early spring; however, there is little documentation on the mating behavior of belugas. A reproductive study of belugas in captivity reported that all conception (n=13) occurred from February to June, with 80.6% of the conceptions occurring from March to May (Robeck et al. 2005). Suydam (2009) stated it was unlikely the eastern Chukchi Sea belugas became pregnant after late June since they did not observe fetuses of a length indicative of an August or September birth date.

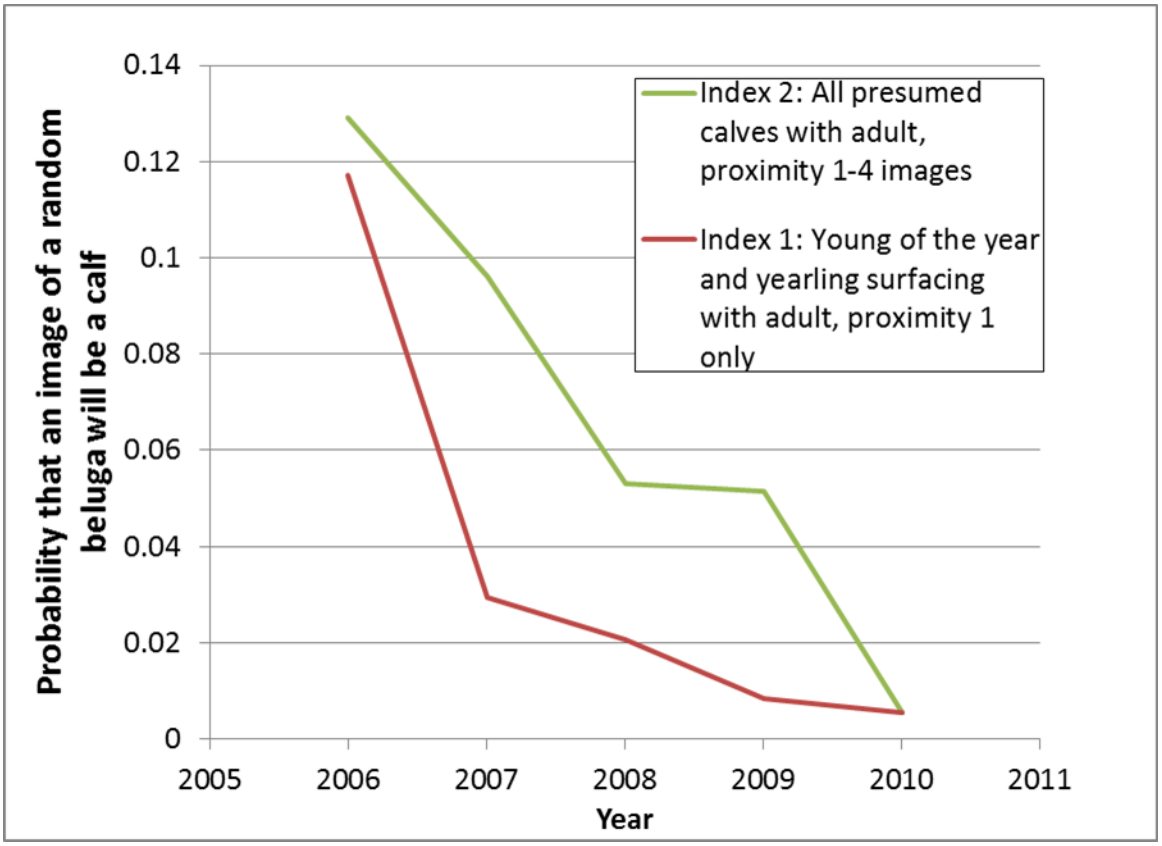
Survival data for CI belugas consist of annual summaries of beach-cast and floating carcasses reported to the NMFS Alaska Region, and consequently represent a minimum estimate of mortality for the CI beluga whales. From 1999 to 2005, when the population size averaged approximately 350 animals and a limited harvest of CI belugas occurred, an average of 12 mortalities were reported each year (Vos and Shelden 2005). This provided an estimated annual survival probability for CI belugas of 0.97 per year. From the literature, survival probabilities for belugas have been estimated as low as 0.84 per year but most were above 0.90 per year. The lactation period is known to last longer than one year, so calf survival closely relates to survival of the mother during the first year following birth. While survival rates and age at maturity have been estimated for males, these estimates did not significantly differ from those for females.

Data are not available for the Cook Inlet beluga whale population to precisely determine the generation time, however, when we consider available information regarding the age at first reproduction and age at senescence for beluga whales, we estimate a generation time for belugas of approximately 25 years[9]. The International Union for Conservation of Nature's (IUCN) Red List of Threatened Species[10] estimated the generation time for belugas in Cook Inlet

[9] Generation time was estimated by subtracting the age at first reproduction (~8-12 years) from the age at senescence (~40-43 years), multiplying by ½, and then adding the age at first reproduction. Given the imprecision of the data available, we determine 25 years is a reasonable estimate of generation time.

[10] The IUCN Red List of Threatened Species information webpage for Cook Inlet beluga whales was accessed October 17, 2014, and is available at: http://www.iucnredlist.org/details/full/61442/0

FIGURE 11: Cook Inlet Beluga Calf Indices by Year as Determined from Aerial Videography during August (2006 to 2010).



Notes: Proximity codes are assigned to images of calves near adults in in aerial video sequences. Very young calves (less than 2 months postpartum) are typically found in contact with the mother (proximity 1) while older calves are found within a few body lengths (proximity 2-4), thus we interpret distance from an adult in aerial video images as an indication of age. Index 1 (red) represents calves in contact with the mother (proximity 1) and probably born earlier the same summer but may include some year old calves. Index 2 (green) includes the proximity 1, 2, 3, and 4 all calves in contact or near an adult and probably represents one-year old and some two-year old animals as well as the young of the year.

Source: Hobbs et al. 2012b

to be 16 years based on the information provided by Burns and Seaman (1986), which considered a year to be represented by two GLGs, rather than the currently recognized one GLG/year. Thus, we believe 16 years may underrepresent the actual generation time for belugas. The generation time of between 26 to 30 years has been proposed for belugas in the St. Lawrence Estuary (David Lee, COSEWIC Member *pers comm. to* R. Hobbs, NMML October 2014). Therefore, we determine our estimate of generation time of 25 years to be reasonable.

6. Hearing and Vocalizations

a. Beluga Hearing

There are three published studies (Awbrey et al. 1988; Klishin et al. 2000; Mooney et al. 2008) and one unpublished study (White et al. 1978) of beluga hearing sensitivity. Collectively, these studies indicate beluga whales have an overall auditory bandwidth of approximately 40 hertz[11][Hz]) to 150 kilohertz (kHz), roughly eight times that of humans (Au 1993). Both Klishin et al. (2000) and Mooney et al. (2008) found overall low thresholds, near 45 decibels (dBs) [12], for some frequencies and a steep high-frequency cutoff near 100–128 kHz. The two studies also revealed two highly sensitive regions (<60 dB), a lower frequency region centering near 32 kHz and a higher frequency region from 70–80 kHz (Figure 12). Between these frequency bands, both studies found a clear dip at approximately 50 kHz. Unfortunately, while White et al. (1978) is the first report of beluga auditory thresholds, it is an unpublished technical report and therefore caution is required when considering the results. Additionally, whether this dip is found in all belugas cannot be certain, but to be observed in three of the four animals for which there are complete audiograms is intriguing. As is typical for all odontocetes, beluga hearing thresholds increase gradually at frequencies below <32 kHz and increase more steeply for higher frequencies starting at 90–100 kHz.

b. Beluga Echolocation

Beluga echolocation (sonar) has been well studied and described (Au et al. 1985, 1987). Studies show that belugas have highly developed and sophisticated echolocation capabilities, with the capacity to adapt their click energy distribution as a function of the ambient noise in order to maximize the echo reception (Au et al. 1985). The echolocation capabilities of belugas, when compared to bottlenose dolphins, appear to be superior in the ability to detect targets (e.g., short steel cylinders) in the presence of masking noise (Turl et al. 1987) and in the ability to detect targets in clutter (reverberation composed of echoes scattered back to a sonar from objects and heterogeneity in the water and on its boundaries) (Turl et al. 1991). In an effort to detect a target in the midst of masking noise, belugas were shown to gain signal-to-noise ratio by projecting and receiving signals off the surface of the water, a technique not observed in the bottlenose dolphin (Penner et al. 1986). Hypothetically, this may be a similar strategy to using the underside of ice cover to reflect signals, possibly an adaptation to living in an Arctic environment. Turl and Penner (1989) suggest that “the beluga lives in a high-noise and reverberant environment. It might be expected that the beluga’s sonar system has developed optimal adaptations to minimize the effects of interference found in the Arctic.”

c. Beluga Acoustic Social Signals

Belugas are among the noisiest cetaceans, making a wide variety of sounds that fall into two acoustic categories: whistles or narrow band frequency modulated vocalizations, and pulsed sounds or trains of broad band pulses. The latter can be divided into two functional categories: click trains, used largely for echolocation, and burst pulse sounds (bursts of pulses with rapid

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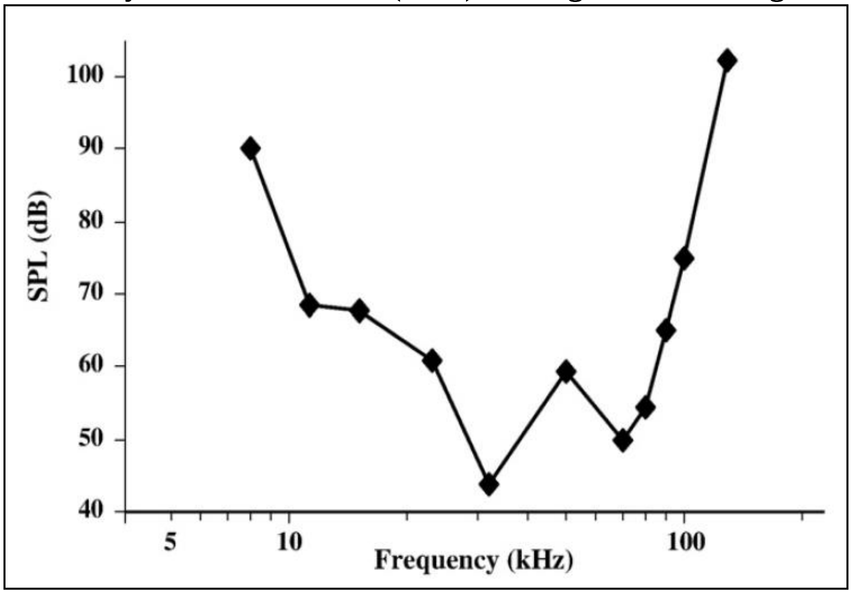
[11] The hertz (symbol Hz) is the unit of frequency defined as the number of cycles per second of a periodic phenomenon. One of its most common uses is the description of sound sine waves as the frequency of musical tones.

[12] The decibel (dB) is a logarithmic unit that indicates the ratio of a physical quantity (in this case sound intensity) relative to a specified or implied reference level. A ratio in decibels is ten times the logarithm to base 10 of the ratio of two power quantities. For sound in water, the reference quantity is 1 microPascal.

FIGURE 12: Auditory Evoked Potential (AEP) Audiogram of a Beluga Whale Subject.



Notes: Thresholds in dB (re: 1 μPa) were measured from 8-128 kHz. Lower thresholds (intensity of a signal heard by the beluga) indicate better hearing. Best hearing is in the 30-70 kHz range for this particular beluga.

Source: Mooney et al. 2008.

pulse repetition rates), believed to be social signals, which may sound to the human ear like grunts, squawks, screams, whines, and whistles.

These varied sounds earned belugas the nickname "Sea Canaries" by early Arctic whalers. There have been a number of attempts to classify the vocal repertoire of belugas (Fish and Mowbray 1962; Morgan 1979; Sjare and Smith 1986a, 1986b; Faucher 1988; Bel'kovich and Sh'ekotov 1993; Recchia 1994; Angiel 1997; Belikov and Bel'kovich 2001, 2003, 2006, 2007, 2008; Karlsen et al. 2002). This body of data provides some indication that sounds vary with behavioral and group context, and suggests geographic variation in signal use among populations. It is thought that these calls, both in captivity and in the wild, function to maintain group cohesion, and the variants shared by related animals are used for mother-calf recognition (Vergara et al. 2010). For example, belugas show an increase in the rate of vocalizations during social gatherings in the Canadian high Arctic, in Svalbard, Norway, and in the White Sea, Russia (Sjare and Smith 1986b' Karlsen et al. 2002; Belikov and Bel'kovich 2003). They become much quieter when disturbed by humans or frightened (Finley 1990, Karlsen et al. 2002; Sjare and Smith 1986b; Belikov and Bel'kovich 2003). There is evidence of a decrease or even a cessation in acoustic activity of beluga whales in the presence of natural predators (e.g., killer whales) or engine noise.

Belikov and Bel'kovich (2003) attempted to correlate specific beluga call types with four behavioral states: quiet swimming, social interactions, sexual behavior, and disturbance caused by humans. While all call types were heard during all four behavioral states, there was a significant increase in "chirps" heard during sexual behavior and social interactions, and a decrease in whistles during sexual behavior. The conclusion was that "chirping" was the best acoustic indicator of beluga behaviors, marking both social and sexual interactions (Belikov and Bel'kovich 2003).

d. Acoustics of CI Belugas

Little work has been done regarding acoustics of CI beluga whales and none has yet been published in peer-reviewed journals. Širović and Kendall (2009) deployed a passive acoustic array of sonobuoys during 20 days in summer 2009 to acoustically detect the presence of beluga whales in the vicinity of in-water pile driving at the Port of Anchorage expansion project site. Beluga whales were detected 55% of the monitoring time, with virtually all detection based on echolocation clicks (one whistle and over 65,000 clicks). The authors suggested that maybe belugas reacted to construction noise by decreasing their social call activity.

Small et al. (2011) continuously monitored the presence of belugas over a year in ten different areas of the Inlet. Beluga whales were commonly detected at sites in the upper and middle Inlet but were not detected at the two most southern sites of Tuxedni Bay and Homer Spit. The study suggested that belugas persist in the upper Inlet during the winter freeze, although their range extended further south than in summer. Detection of beluga calls was surprisingly low at Cairn Point, considering that the whales must pass this site in transit to and from Knik Arm. Cairn Point was reported as the noisiest of the monitored locations due to heavy industrial activity, and the authors hypothesized that noise masking could be the reason for the low detection of calls, or alternatively, belugas may suppress calling while in this area. It is also possible that the low detections may be the result of the area being used as a transit area rather than a foraging or gathering area, and thus the whales are in the area for only short periods of time. Similar to Širović and Kendall (2009), Small et al. (2011) also suggest that CI belugas might reduce their vocal activity when exposed to higher anthropogenic noise.

Castellote et al. (2011a,b) recorded the acoustic behavior of CI belugas concurrently with visual observations using both boat-based and land-based methods in open waters as well as inside river mouths (Eagle River and Little Susitna River). The authors described how the acoustic behavior of CI belugas is modified when feeding. During presumed feeding or prey search, social calls were absent and echolocation clicks often occurred in train packets. Burst pulses were also found more often, although the authors indicated that few of these were conclusively assigned as "terminal buzzes" related to prey capture since most of the events were partially incomplete, probably due to the highly directional nature of these sounds. The authors concluded that echolocation train packets ending with a terminal buzz were produced by feeding belugas, that this behavior was commonly recorded in river mouths, and that it could be acoustically monitored with the potential to be used as an indirect indicator of foraging behavior.

A review of available information reveals four main gaps regarding our acoustic knowledge on CI beluga whales:

1. The baseline information on auditory behavior and effects of noise on belugas has been established, however all of this information is based on data from fewer than 10 captive individuals with little or no known history of noise exposure or presence of auditory system pathology. Thus, variability within the species (especially age and sex based differences) or the applicability of results from captive to wild belugas is still unknown and this uncertainty must be taken into consideration when planning future research.

2. Anthropogenic noise sources in Cook Inlet have not yet been identified and acoustically characterized in the context of their effects on beluga hearing and communication. Very specific noise types (e.g., simulated underwater explosions, pure tones, seismic water gun, white noise, icebreaker noises) have been used in hearing experiments with belugas. Even if these studies set the baseline information on the effect of noise in the beluga auditory system, their results might not be applicable to CI belugas because most of the noise sources tested are foreign to Cook Inlet.
3. Little is currently known regarding chronic effects of noise exposure on belugas. The CI belugas are exposed to anthropogenic noise sources of notable prevalence (e.g., tug boats, pile driving, dredging) but most of the studies to date have been focused on short-term and acute exposure to noise. Similarly, most of the current studies on the effects of anthropogenic noise on belugas have been focused at the physiological level (e.g., masked temporary threshold shifts, TTS, PTS), and the effects of anthropogenic noise at the behavioral level (e.g., geographical displacements, changes in acoustic communication) have barely been considered.
4. The current understanding of social communication in different populations of belugas highlights an important lack of standardized methods. Considering that the repertoire of beluga vocalizations has been suggested to vary geographically, the standardization of acoustic analysis methods is needed to better understand the population structure and seasonal distribution of this species. Research efforts in this direction will probably be beneficial in a broader scale, not just towards the Cook Inlet population.

7. Other Senses

Beluga whales have acute vision both in and out of the water. A beluga's eye is particularly well adapted for seeing in water. In air, certain features of the lens and cornea correct for the nearsightedness that result from the refraction (bending) of light rays as they go from water to air. A beluga's retinas contain both rod and cone cells, indicating that they may have the ability to see in both dim and bright light (rod cells respond to lower light levels than do cone cells). As with other whales, belugas lack short wavelength sensitive visual pigments in their cone cells indicating a more limited capacity for color vision than most land mammals (Peichl et al. 2001; Levenson and Dizon 2003).

Among marine mammals, adaptation to a strictly marine environment has favored a primary sensory modality based on sound production and reception (Wood 1973). Other senses, such as smell, are diminished or even absent (Caldwell and Caldwell 1972). The available sensory channels that are utilized by marine mammals are acoustic, tactual, visual, and chemical (gustatory; Caldwell and Caldwell 1977; Winn and Schneider1977). Except for the bottlenose dolphin (Herman 1980) and California sea lion (Thomas et al. 1992), few studies have examined in any detail the sensory capabilities of marine mammals. Olfactory lobes of the brain are absent in all odontocetes, suggesting that they have no sense of smell, although these lobes are found in the embryos (Kellogg, 1958).

Some studies have noted sensory areas in beluga whale mouths that may function in taste (Haley 1986). There is further evidence of chemoreception in the mouth in some species including the beluga whale. Reports have suggested that belugas react to blood in the water by quickly retreating and showing unusual alarm. Furthermore, it has been proposed that belugas release a pheromone when alarmed (Dudzinski et al. 2002).

8. Social Organization

Throughout their distribution, beluga whales are extremely social animals that typically migrate, hunt, and interact together, often in dense groups. In areas of the Arctic, belugas aggregate in the hundreds and sometimes thousands (O'Corry-Crowe 2002). High group cohesion and large group sizes may provide benefits to group members in terms of information gathering and transfer with regard to resource availability (e.g., prey, calving sites, oceanographic conditions) and cooperation in predator avoidance and reduced predation risk (Hamilton 1971; Reluga and Viscido 2005). It is thought that the basic social units of these groups are maternal lineages of adult females and their offspring, and that males migrate separately (Smith et al. 1994). Genetic evidence for Canadian stocks of belugas indicates that migration routes and summer distribution are maintained by maternal lineages (Turgeon et al. 2012), however, this information is unavailable for Cook Inlet. It is possible the strong site fidelity belugas exhibit may be learned during the period of dependence when the mother teaches the weaning calf to forage.

In Cook Inlet, groups of four to 250 beluga whales have been observed during the ice-free months, and single whales are only occasionally seen (McGuire and Bourdon 2012; T. McGuire, LGL, pers. comm.). It is not known if groups represent distinct social divisions. Preliminary results from photo-identification research indicate beluga groups in upper Cook Inlet during the ice-free months of the field season are mixed and homogenous, without evident long-term sub groupings (McGuire et al. 2011). That is, there do not appear to be distinct groups consisting of CI belugas of the same gender or ages, and the available information suggest individual belugas spend time with different groups of belugas, many of which are found in all or several of the regions surveyed by the photo-identification project. Information on beluga social structure during months with ice and for groups found in the lower Inlet does not currently exist. Studies of beluga groups in the Kenai River and its vicinity were conducted 2011-2013 and indicate these are the same individuals that use the upper Inlet, with the same fluid social structure (McGuire et al. 2014).

9. Swimming and Diving Behavior

Beluga whales typically swim between 1 and 10 kilometer per hour (km/hr) (0.6-6.2 miles per hour [mi/hr]), but have been estimated to sustain speeds over 20 km/hr (12.4 mi/hr) for periods of a half hour (Richard et al. 1998). Suydam (2009) estimated typical speeds at 2.5-3.3 km/hr (1.5-2.0 mi/hr), and Smith and Martin (1994) estimated swimming speeds of 1.6-6.0 km/hr (1.0-3.7 mi/hr) during the fall migration.

According to Goetz et al. (2012a), CI belugas tagged from 1999-2000 displayed a mean transit rate of 2.8 (SD ±2.4) km/hr (1.7 mi/hr), with individuals' travel rates ranging from 1.6 (SD ± 2.0) km/hr to 4.3 (SD± 3.1) km /hr (1.0-2.7 mi/hr). Tagged CI belugas travelled faster during December to May than June to November, and travelled slower in coastal areas than they did in offshore waters of the Inlet (Goetz et al. 2012a). Based on an acoustic study conducted in Eagle River, swimming speeds of CI belugas were estimated to be from 1.8 - 7.56 km/hr (1.1-4.7 mi/hr) (Castellote et al. 2013).

Belugas from stocks found in regions with access to deep water are capable of dives as deep as 800 m (2,624.7 ft.) at vertical speeds of 2-7 km/hr (1.2-4.3 mi/hr; Heide-Jørgensen et al. 1998). In the areas of Cook Inlet occupied by belugas, the depth does not exceed 100 m and much of the time the belugas are in waters less than 20 m (65.6 ft.) depth. Consequently, CI belugas are able to access the entire water column. Typical dive sequences consist of three to five short intervals of 7-10 seconds followed by a longer dive of a minute or more. Mean dive depth ranged from 1.6 (SD ± 2.1) to 6.7 (SD ±10.4) m (5.2 to 22 ft.) and mean dive duration ranged from 1.1 (SD ±1.3) to 6.9 (SD ±9.5) minutes (Goetz et al. 2012a), with shorter dives occurring in nearshore areas. The average dive interval (the time from the beginning of one surfacing to the beginning of the next) is 24.1 seconds for CI beluga (Lerczak et al. 2000).

10. Foraging Behavior, Diet and Fisheries Management

a. Foraging Behavior

Beluga whales are known to feed on prey that concentrate, including shrimp and schooling or spawning fish (Seaman et al. 1982), and beluga presence has been used by fish harvesters as indicators of fish abundance. Feeding both independently and cooperatively, beluga whales capture and swallow their prey whole, using blunt teeth to grab prey. While belugas are known to eat large amounts of fish in spring and summer, little is known about winter distribution and less about winter feeding. An extensive review of potential CI beluga prey species, including their distribution and known abundances, is presented in section IX .E – CI Beluga Prey Supplement.

Current data on the foraging ecology of CI belugas are quite limited and based primarily on visual observations of whales in areas of seasonal prey concentrations. However, dive behavior data was obtained through satellite tags deployed on 11 belugas during 1999 to 2002 (Goetz et al. 2012a). Dives were significantly shorter and shallower June to November versus December to May. Over 50% of the dive effort occurred in shallow, near shore areas of Chickaloon Bay, Susitna Delta, Knik Arm, Turnagain Arm, and Trading Bay, a behavior suggesting feeding in these areas. These locations are also recognized as areas where anadromous prey concentrate when entering river mouths. Beluga whales in northern Cook Inlet likely benefit from the tendency of anadromous prey species to be concentrated by shallow water and the time required to transition from salt water to fresh as they enter the stream mouths, which presumably makes these prey easier to capture.

Belugas in Cook Inlet appear to feed extensively on concentrations of spawning eulachon in the spring; then shift to foraging on salmon species as eulachon runs diminish and salmon return to spawning streams. While winter foraging is not well known, some components of beluga whale populations in other areas forage more on benthic species (DFO 2011). It is presumed that CI belugas in winter forage more on benthic species or opportunistically on infrequently encountered pelagic species. Preliminary analysis of CI beluga stomach contents indicates gadid and flounder species are relatively important prey items in spring and fall (and likely winter); seasons when fewer salmon are available (L. Quakenbush, ADF&G, unpub. data). The degree of prey switching, either seasonally or on longer time scales, is not well understood, although beluga whales must be somewhat opportunistic with respect to foraging selectivity relative to prey availability.

b. Diet

The diet of beluga whales throughout their circumpolar range is dominated by fish and invertebrate prey. While published reports on beluga diets are available from Canada (Vladykov 1946, cited by Seaman et al. 1982; Doan and Douglas 1953, cited by Seaman et al. 1982; Sergeant 1973), Russia (Kleinenberg et al. 1969, cited by Seaman et al. 1982; Tomlin 1967, cited by Seaman et al. 1982), and Europe (Lono and Oynes 1961, cited by Seaman et al. 1982), published data for Alaska are limited to one published report (Seaman et al. 1982; n = 119 belugas from three stocks) and several unpublished reports from Bristol Bay (Brooks 1954, 1955, 1956, 1957; Lensink 1961, cited by Seaman et al. 1982; Klinkhart 1966, cited by Seaman et al. 1982). Diet data for CI belugas are currently limited to a relatively small sample of stomach contents and stable isotope analyses (Quakenbush et al. in review) as well as observations from Alaska Native subsistence hunters (Fall et al. 1984; Huntington 2000).

A total of 51 stomachs from CI belugas were collected from 1992 to 2010 (L. Quakenbush, ADF&G, unpub. data). Stomachs collected from 1992 to 2001 (April to October; n=24) were analyzed separately from stomachs collected during 2002 to 2010 (March to November; n=27). Thirty five non-empty stomachs were sampled; 17 from the earlier and 18 from the later time periods. For 1992 to 2001, the only prey items identified were eulachon and king salmon, with additional items identified only as "salmon." However, because only a portion of the contents from each stomach collected was analyzed, additional prey items were likely present. For non-empty stomachs from 2002 to 2010, fish were identified in 18 stomachs and invertebrates in nine (Table 2). Fish prey included seven families and at least 12 species. Fish frequencies of occurrence were greatest for salmon (67%), gadids (43%), smelts (11%), and flounders (11%); salmon frequencies included coho (28%), king (11%), and chum (*Oncorhynchus keta)* (17%). Gadid frequencies included saffron cod (*Eleginus gracilis*) (22%), walleye pollock (*Theragra chalcogramma*) (17%), and Pacific cod (*Gadus macrocephalus)* (6%). Eulachon was the only smelt identified, whereas two flounder species, yellowfin sole (*Limanda aspera)* (11%) and starry flounder (*Platichthys stellatus*) (6%), were identified. A longnose sucker was the only freshwater fish found. Seven types of invertebrates were found in the beluga stomachs, with the frequency of occurrence among non-empty stomachs being highest for shrimp (33%), followed by polychaetes (11%) and amphipods (Crustaceans, Order Amphipoda) (11%). Other invertebrates included Tanner crab (*Chionoecetes bairdi*) (6%) and sponges (animals of the phylum Porifera) (6%). Because fish appearing in beluga stomachs have also consumed a variety of prey, including polychaetes, shrimps, amphipods, and other fishes (Clausen 1981, 1983; Seaman et al. 1982), some prey items in the beluga stomachs could have resulted from secondary ingestion.

Alaska Natives have reported CI beluga whales feeding on freshwater/brackish fish, including trout (subfamily Salmoninae), whitefish (subfamily Coregoninae), northern pike (*Esox Lucius)*, grayling (*Thymallus thymallus)*, and Pacific tomcod (*Microgadus proximus*) (Fall et al. 1984; Huntington 2000).

Stomach samples from CI belugas are lacking for the winter months of December to February. Dive data from belugas tagged with satellite transmitters suggest whales feed in deeper waters south of the Forelands during winter (Hobbs et al. 2005), possibly on prey such as flatfishes, sculpins, and gadids. Diet data for early spring are limited to one dead whale found in March 2003 which had thinner blubber than beach-cast beluga whales found in summer. This beluga stomach contained saffron cod, walleye pollock, Pacific cod, eulachon, Tanner crab, shrimp, and polychaetes (NMFS unpub. data; Table 2).

TABLE 2: Prey Items from Cook Inlet Beluga Whale Stomachs, 2002 to 2010.

	Number of stomachs containing prey item[a]								
	March	June	July	August	Sept.	Oct.	Nov.	Total among months	Percent Frequency[b]
Total number of stomachs	1	3	4	7	3	8	1	27	
Total number of stomachs with prey	1	2	4	5	1	5	0	18	67
Stomachs that contained fish	1	2	3	6	1	5	0	18	100
Salmon	0	2	3	4	1	2	0	12	67
Gadid	1	0	0	1	1	4	0	7	39
Eulachon	1	0	1	0	0	0	0	2	11
Flounder	0	0	0	1	0	1	0	2	11
Other identified fish	0	0	0	2	0	1	0	3	17
Unidentified fish	1	0	0	1	0	0	0	2	11
Stomachs that contained invertebrates	1	0	3	1	0	4	0	9	50
Shrimp	0	0	1	1	0	4	0	6	33
Amphipod	0	0	1	0	0	1	0	2	11
Polychaete	1	0	0	0	0	1	0	2	11
Other identified invertebrates	1	0	2	1	0	0	0	4	22
Unidentified invertebrates	0	0	0	0	0	1	0	1	6

Note: [b] Percent frequency is the number of stomachs containing a prey item relative to the total number of non-empty stomachs.
Source: Quakenbush et al. in review

A recent analysis (L. Quakenbush, ADF&G, unpub. data) of stable carbon and nitrogen isotopes in 24 archived skull bones suggests CI beluga diets changed during the period 1965 to 2007. Prey isotope signatures were not identified to species, but preliminary results indicate CI beluga whales have been feeding at lower trophic level prey (i.e., lower in the food chain) in recent years.

Caution is warranted regarding interpretation of diet information. For example, more-recently ingested prey items are likely to be more identifiable owing to less digestion, although hard parts of prey may accumulate in the digestive tract. However, recently eaten prey are also more likely to be regurgitated from stimuli such as stress. The cause of mortality may create additional bias, as stranded belugas may have fed differently, due to poor health, compared to harvested belugas. Thus, depending on beluga health, prey type, and time since consumption, some prey items may be over or under-represented in diet analysis from stomach samples. The relatively small sample size for CI beluga stomachs remains a concern as aspects such as feeding preferences by individual whales may be underrepresented in the current analysis. While salmon is obviously important as a prey item throughout the spring to fall season, some whales may be more proficient at foraging on salmon, while other whales supplement salmon with other prey items. Thus, a better understanding of foraging selectivity by individual whales is compromised by the low sample size.

c. Fisheries Management

Fisheries management of anadromous fish populations in Alaska attempts to constrain harvests to be no greater than the level of surplus production, defined as returning adult salmon in excess of the spawning production that is needed to maintain productive salmon populations (Quinn and Deriso 1999). In addition to reproductive needs, harvest considerations must include commercial fisheries and upstream consumptive uses such as recreational, personal use, and subsistence fisheries (Shields 2010), as well as allowances for natural mortality, which includes predation by beluga whales, bears, and other species. However, it is unlikely that escapement goals will be met in all tributaries across all years. Thus, while fishery management, on average, should maintain sufficient total numbers of prey for belugas, the timing of prey concentration or densities in the river mouths can vary and may not always be adequate for efficient feeding by belugas.

An important concern is that some species of salmon that may be essential prey for CI belugas, most notably Chinook salmon (Quakenbush et al. *in review*), are experiencing reduced run strength in Cook Inlet and throughout Alaska Responding to a request from former Alaska Governor Sean Parnell, Acting U.S. Secretary of Commerce Rebecca Blank determined that commercial fishery failures due to fishery resource disasters had occurred for Chinook salmon stocks in the Yukon, Kuskokwim, and Cook Inlet regions[13]. The declaration acknowledged hardships for commercial, sport, and subsistence users as a result of the Chinook fishery failures. While it falls to the U.S. Congress to allocate disaster relief funding, ADF&G subsequently coordinated a Chinook salmon symposium, "Understanding the Abundance and Productivity Trends of Chinook Salmon in Alaska," in Anchorage during October 22–23, 2012[14].

More information on this topic is presented in section IX.E – CI Beluga Prey Supplement.

[13]See news release at: http://www.nmfs.noaa.gov/stories/2012/09/09_13_12disaster_determinations.html; A copy of the letter from Acting Secretary Blank to Governor Parnell can be viewed at: http://www.nmfs.noaa.gov/stories/2012/09/docs/blank_parnell_9_13_12.pdf.

[14] For more information about the Chinook salmon symposium, visit ADF&G's website at: http://www.adfg.alaska.gov/index.cfm?adfg=chinook_efforts_symposium.information

C. CI Beluga Population Size and Trends

1. Historic Abundance Estimate and Carrying Capacity

Aerial surveys in the 1960s, 1970s, and early 1980s counted belugas in Cook Inlet but only a few of these had sufficient coverage to estimate the population size (Calkins 1984, 1989). A survey in 1979 resulted in an estimate of 1,293. Calkins (1989) calculated the overall abundance estimate of 1,293 whales using a correction factor of 2.7 developed to account for submerged whales under similar conditions in Bristol Bay (Frost et al. 1985). This is the best available estimate of historical beluga abundance in Cook Inlet. NMFS has adopted 1,300 as the value for the carrying capacity to be used for management purposes (65 FR 34590, May 31, 2000).

Between 1979 and 1994, the CI beluga population went from 1,300 to 650 beluga whales, which represents an average decline of around 5% per year (i.e., $650 = 1300*0.955^{(1994-1979)}$). While the decline between 1994 and 1998 is well documented, empirical data are lacking for the period between 1979 and 1994 to identify a mechanism of decline. Native subsistence harvest (enumerated through hunter interviews) was significant during the 1970s and 1980s and may have been at levels similar to the hunts reported in the mid-1990s, but there was not an effort at a comprehensive count of subsistence harvest until the 1990s (Mahoney and Shelden 2000). Commercial and sport hunts also occurred during the 1960s and 1970s, but no information is available to assess whether the 1979 abundance estimate of 1,293 (based on the 1979 ADF&G survey; Calkins 1989) may represent a partially depleted population, and thus a conservative estimate of Cook Inlet carrying capacity for beluga whales.

2. Recent Abundance Estimates and Population Trends

NMFS began conducting comprehensive, systematic annual aerial surveys of the beluga population in Cook Inlet in 1993 (Hobbs et al. *in press*). Beginning with the 2012 annual survey, the survey schedule was switched from annually to biennially, to occur in even numbered years (see Hobbs 2013). These surveys occur in early June (except in 1995 when the survey was in late July), include the upper, middle, and lower sections of the Inlet, and are stratified to focus survey effort in the areas of the upper Inlet where belugas are typically at their highest concentrations during June.

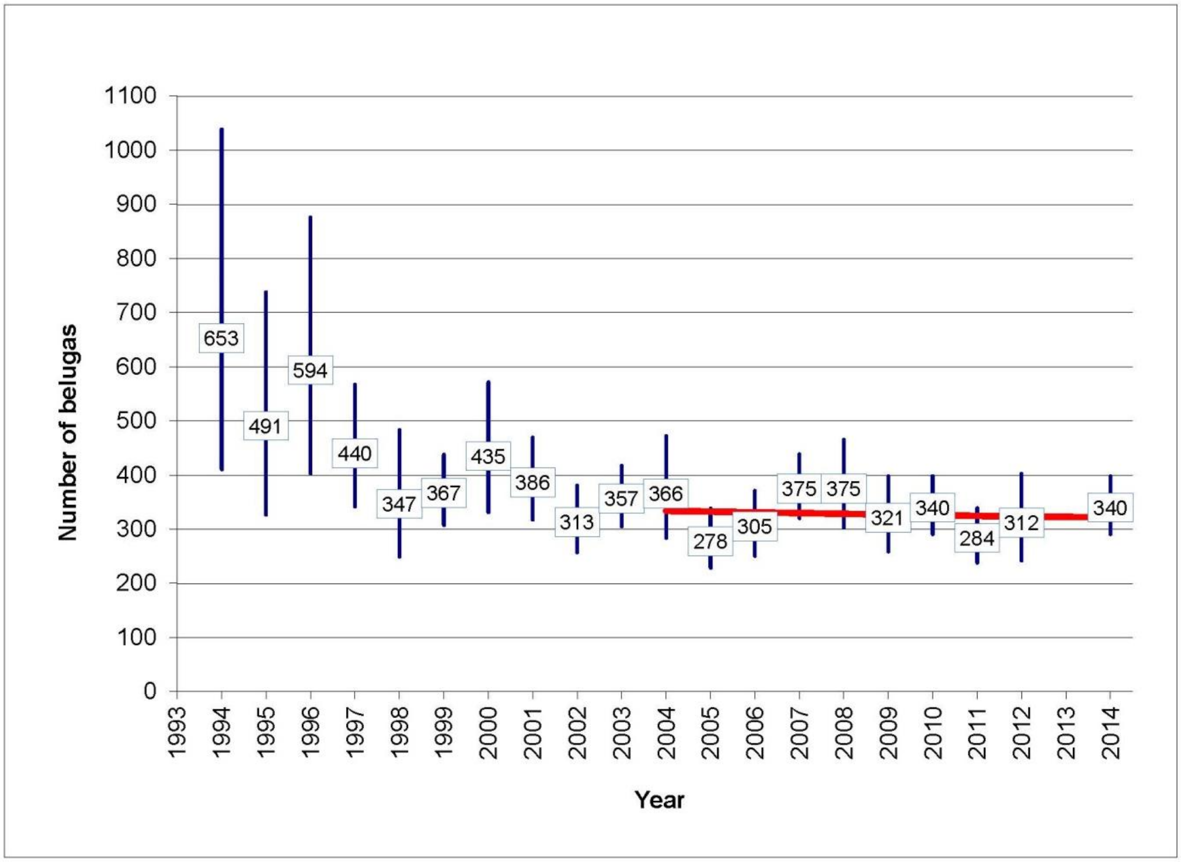
Annual estimates of the numbers of belugas resulting from these surveys documented a decline in abundance of nearly 50% between 1994 and 1998, from an estimate of 653 whales to 347 whales (Table 3). This period of rapid decline was associated with a substantial, unregulated subsistence hunt; although the hunt was regulated starting in 1998, CI beluga numbers did not increase. An analysis indicated the decline in beluga abundance from 1994 to 1998 was adequately explained by the estimated take from the subsistence hunt. With the very limited hunt beginning in 1999 (a total of five whales hunted from 1999-2014, 16 years) NMFS anticipated that the population would begin to increase at a growth rate of between 2% and 6% per year. However, the 2014 abundance estimate was only 340 belugas, with a declining trend for both the most recent 10-year time period (-0.4% per year; standard error [SE] = 1.3%) and since the hunt was managed in 1999 (-1.3% per year, SE = 0.7%) (Shelden et al. 2015; Figure 13). Thus, the population is not growing as expected despite the regulation of the subsistence harvest.

TABLE 3: Cook Inlet Beluga Whale Population Abundance Estimates and Estimate Coefficients of Variance (CVs), June/July 1994 to 2015.

Year	Survey dates	Abundance estimate	CV
1994	June 1-5	653	0.24
1995	July 18-24	491	0.21
1996	June 11-17	594	0.20
1997	June 8-10	440	0.13
1998	June 9-15	347	0.17
1999	June 8-14	367	0.09
2000	June 6-13	435	0.14
2001	June 5-12	386	0.10
2002	June 4-11	313	0.10
2003	June 3-12	357	0.08
2004	June 2-9	366	0.13
2005	May 31-June 9	278	0.10
2006	June 5-15	305	0.10
2007	June 7-15	375	0.08
2008	June 3-12	375	0.11
2009	June 2-9	321	0.11
2010	June 1-9	340	0.08
2011	May 31-June 9	284	0.09
2012	May 29-June 7	312	0.13
2013	NO SURVEYS	--	--
2014	June 3-12	340	0.8
2015	NO SURVEYS	--	--

Notes: Surveys in 1993 were not suitable for analysis using the abundance estimation methods of 1994 and later. CV estimates prior to 2011 used the method of Hobbs et al. 2000 in previous publications. These have been recalculated using a revised CV formula based on the standard error of the daily abundance estimates and an estimate of the variance in behavior of the whales which better reflects the sources of variability in the estimate. The method for calculating the CVs was revised in 2011; CV's for older estimates have been recalculated using the new formula.
Source: Shelden et al. 2015; Hobbs et al. *in review*

FIGURE 13: Abundance Estimates for Cook Inlet Beluga Whales 1994-2014, with 95% Confidence Intervals for each Estimate (vertical bars).



Notes: Abundance estimates for beluga whales in Cook Inlet with 95% confidence intervals for revised coefficients of variation (CVs) (vertical bars). From 1994 to 1998, when the harvest was unrestricted, the annual rate of decline was -13.7% (SE = 0.045) per year. In the years since a hunting quota has been in place (1999-2014), the rate of decline was -1.3% (SE = 0.7%) per year. The 10-year trend (2004-2014) was -0.4% (SE = 1.3%) per year.
Source: Shelden et al. 2015

3. Small Population Dynamics

Small populations, such as the CI beluga whale population, may face inherent risks that large populations do not, simply as a result of their small population size. Small population dynamics may be at play when the impact to individual survival and fecundity increases as the population abundance decreases, or when there are persistent effects that result from a population having been small at an earlier time. These small population dynamics may manifest in various ways, including inbreeding, loss of genetic or behavioral diversity, or Allee effects. The Allee effect refers to a positive relationship between individual fitness and either abundance or densities of individuals (Stephens et al. 1999). For example, a very small population may experience Allee effects such as reduced reproductive success due to difficulties finding mates or reduced foraging success due to difficulties in locating prey. Reduced population sizes could mean reduced breeding opportunities and an increased potential for breeding with relatives. If a population remains small, genetic diversity will decrease with each generation, resulting in a greater risk of extinction. Even if the population later increases in size, there may still be lingering consequences of the low genetic diversity. Reduced genetic diversity could result in:

- Increased susceptibility to disease due to reduced variety of immune responses within inbred individuals, such that each beluga is more susceptible to a disease organism and also more likely to suffer severe symptoms.
- Increased risk of epidemic disease due to loss of variability among individuals. With more similarity among individuals, the disease organism also requires less adaptation among individuals, resulting in greater virulence and more rapid spread.
- Decreased resilience to environmental change at both individual and population levels. Individual belugas will have a more limited phenotypic (i.e., the observable properties of an organism that are produced by the interaction of the genotype and the environment) response to changes in the environment; this limited response will narrow the adaptive range for the population.
- Decreased fecundity due to failed pregnancies and birth defects. With loss of diversity in the population, the likelihood increases for a fetus to develop a phenotype with decreased survival, resulting in a lost reproductive opportunity and reducing the net number of offspring that a female produces over her lifetime.

While these are potential consequences of small population size, NMFS concluded that the Allee effect is not a relevant concern for the CI beluga population unless the population size is smaller than 50 animals (Hobbs et al. 2006). Similarly, inbreeding depression and loss of genetic diversity do not pose a significant risk to the CI beluga population unless the population is reduced to fewer than 200 whales (Hobbs et al. 2006).

Although little is known about the social structure of CI belugas, some behaviors are transmitted from parents to offspring in other better-studied matriarchal odontocetes. In these other matriarchal odontocete groups, behavioral variation of females is passed to their offspring, much like genetic variation. As a result, social units or groups within the same population might display significant behavioral differences. Seasonal foraging strategies and site fidelity are examples of learned behaviors. Belugas show strong site fidelity which may be learned during the period of dependence when the mothers teach the weaning calves to forage. Loss of behavioral diversity could result in:

- Reduced spatial distribution, increased risk of stranding, reduced prey choices, and reduced predatory efficiency due to fewer learning opportunities and greater similarity of experiences among remaining females.
- Decreased juvenile survival due to a reduction of learned recognition of habitat and resources, such as alternative prey, refuge from predators or disturbance, or other use-specific areas (Wade et al. 2012).
- Reduced socialization with fewer opportunities to learn foraging techniques, mating, group cohesion, and hierarchical definition or strengthening, as well as a reduction in mutual defense against, or avoidance of, predators. A decline in the population will be paralleled by a reduction in behavioral diversity.
- Overall fitness and resilience to perturbations such as catastrophic events.

CI belugas have exhibited a marked contraction of their summer habitat range. If CI belugas are matriarchal and pass knowledge from female to offspring, it is possible that some knowledge regarding preferred summer habitats in mid- and lower-Inlet might not have been passed on to the current generation. If this is the case, it is unknown how long it would take for these habitats to be recognized again by individuals in the current or a recovered CI beluga population. Our knowledge regarding CI beluga social structure and differences in behavior among groups is quite limited, but the available information indicate that large groups of CI belugas observed in the Susitna River Delta do not appear to be segregated by color or age-class, with most groups consisting of both white and gray animals (McGuire et al. 2014a). Photo-identification studies of the upper CI also suggest that most, and perhaps all, of the CI beluga population uses Eagle Bay seasonally, with 90% of the CI belugas also having been seen elsewhere in upper CI (McGuire et al. 2014b). Thus there seems to be significant intermixing of age groups/color classes and a high resight rate of individuals in multiple locations, and at this time we have no information to suggest there has been a loss of behavior diversity in the CI beluga population.

Although reduction of range likely increases the risk of extinction, the implications of this shift are not entirely clear and are in need of investigation. Range contractions generally increase vulnerability to catastrophic loss from stochastic events and point sources of disturbance, disease, and mortality. These risks may have become exacerbated in the CI beluga population by a range contraction to the area of greatest human impact. It is not known how the range contraction may have altered behavior and habitat use within the consistently occupied areas in the upper Inlet. With fewer whales, prey may be relatively more abundant, thus reducing competition and the need for more wide ranging movements. Concentrating in large numbers in discrete areas appears to be a basic trait of beluga whales and a strategy by the Cook Inlet population. While likely increasing vulnerability to catastrophic events, such behavior may reduce risk from other factors such as predation. It is essential to focus research on understanding both the cause and implications of the range contraction in CI belugas.

4. CI Beluga Population Viability Analysis (PVA)

In 2008 NMFS presented results from a population viability analysis (PVA) for the CI belugas which indicated a risk of extinction in 100 years between 1% and 27% (Hobbs and Shelden 2008). The PVA was based on a Bayesian analysis[15] using a population model that accounts for the removals from the population by the subsistence hunt, births and deaths in the population, and time lags in the response of the population to changes. The Bayesian analysis used the population size estimates from 1994 through 2008 and projected there was only 5% probability that the growth rate was above 2%, and a 62% probability that the population would continue to decline (Hobbs and Shelden 2008). A more recent analysis using the abundance estimates from 1994 through 2011 and revised coefficients of variation (CVs)[16] estimated a less than 0.1% probability that the growth rate was greater than 2% per year and an 88% probability of further decline (Hobbs et al. in review). The best available data indicate the CI beluga

[15] Statistical modeling technique that factors in uncertainty.

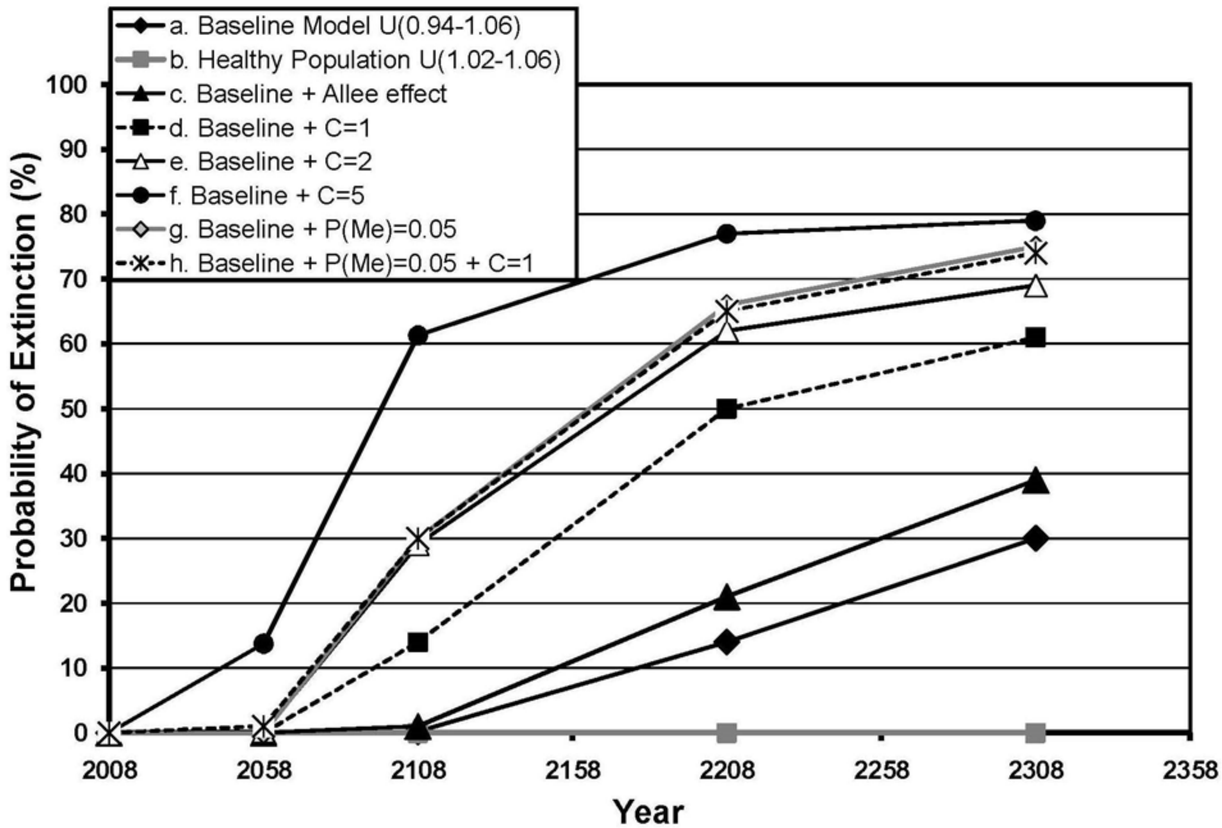
[16] Coefficient of variation: the ratio of the standard deviation to the mean; indicates the extent of variability in the estimate, a higher number indicates greater variability.

population is not growing as expected and is in fact declining despite the limits on the subsistence hunt.

The detailed PVA population model presented in 2008 used the abundance estimates for 1994 to 2008 and accounted for immature and mature stages of both sexes (Hobbs and Shelden 2008). The model included demographic stochasticity (the variability resulting from individual outcomes each year). Several variations of the population model were considered, including an Allee effect (reduced birth rate at smaller population sizes) (Stephens et al. 1999), predation mortality at various levels, and unusual mortality events occurring randomly resulting in a fixed percentage of mortality. These variations included possible models of the population as well as models with extreme values to test the sensitivity of the results to changes in the parameters. The modeled Allee effect and predation mortality both had a greater impact on smaller population sizes, so that the resulting population trend declined as the population declined, resulting in thresholds of population size below which the trend was always negative and the population could no longer recover; extinction was virtually certain if the population crossed the threshold. Each variation of the model was run 100,000 times using trends between -6%/year and +6%/year and was initialized using the population size in 1994. Models were evaluated on their ability to track observed abundance levels from 1994 to 2008. The simulated population was compared to the abundance estimates for those years to evaluate the model(s) most representative for this population (see Hobbs and Shelden 2008 for details). From the initial set of 100,000 parameters, 10,000 were selected based on their likelihood and were then projected 300 years into the future to determine if the population went extinct, recovered, or remained at an intermediate population size.

The model with no threshold effects (i.e., Allee or predation) or unusual mortality events but with a trend between -6%/year and +6%/year resulted in a 68% probability of decline, a 1% probability of extinction in 100 years and 29% probability of extinction within 300 years. Even with this most optimistic scenario, with no subsistence hunt after 2008, the probability that the population would be larger than 500 animals in 2108 (within 100 years) was only 24%. The model that NMFS considered to best represent the risk to the Cook Inlet beluga population (Figure 14 – line h) was a model that included an average of one predation mortality per year and a 5% annual probability of an unusual mortality event killing 20% of the population; the results indicated a 1% probability of extinction in 50 years, 26% probability of extinction in 100 years, 70% probability of extinction in 300 years, and an 80% probability that the population was declining.

FIGURE 14: Probability of Extinction by Year for the Cook Inlet Beluga Whale Population Resulting from Eight Variations of the Population Viability Analysis Model Estimated using a Bayesian Sampling-importance-resampling Routine with Data from 1994-2008.



Notes: To simplify comparisons, models using the same parameters are the same line style, shading, or symbol type with open symbols indicating the inclusion of the unusual mortality event parameter P_{Me} set at a 5% annual probability of a 20% mortality. The "Baseline model" allowed declining and increasing trends while the "Healthy Population model" allowed only increasing trends. Baseline refers to a model in which trend was drawn from the interval between -6%/year and +6%/year, i.e. U(0.94-1.06) per year while Healthy population refers to a model in which trend was drawn from the interval between +2%/year and +6%/year, i.e. U(1.02-1.06). The Allee effect was reduced birth rate at smaller population sizes, C, was number of mortalities that occurred each year regardless of population size (constant) such as predation by killer whales set at losses of 1, 2 or 5 whales per year, in addition to the mortalities already incorporated as natural mortality which acts on a per capita basis. P(Me) was the annual probability of a 20% mortality event in the population. Model h. was considered to be the preferred model for estimation of extinction risk.
Source: Hobbs and Shelden 2008

D. Sources of CI Beluga Whale Mortality or Injury

1. Natural Sources

a. Predation

The only known current natural predator of CI belugas is the "transient" or mammal-eating killer whale; there has not been a subsistence hunt by Alaska Natives in Cook Inlet since 2005. However, it is possible that sharks may also occasionally prey upon belugas.

Killer whales are infrequently reported (Table 4) in upper Cook Inlet (Shelden et al. 2003; NMFS unpub. data), which is now the primary summer range of CI belugas (Rugh et al. 2010). The contraction in CI beluga summer range to the shallow waters of the upper Inlet may reduce the opportunity for killer whales to purse belugas in this area.

Interviews with people that have fished the upper Inlet for 20 to 50 years reported few sightings of killer whales (Shelden et al. 2003). In his study of TEK, Huntington (2000) interviewed Alaska Native beluga hunters who reported that killer whales were rarely seen in the upper Inlet or near belugas. Currently, beluga sighting networks are scattered along those portions of Cook Inlet shorelines that are road-accessible, and interest among the public is high, so there is an increased opportunity for any killer whale occurrences near Cook Inlet road access points to be reported, especially when these include encounters with belugas.

Additional evidence that killer whale presence in upper Cook Inlet is rare comes from beluga observational and photo-identification work. Between 2004 and 2014, over 30,800 observational hours were logged between May and October in areas that included Turnagain Arm, western upper Cook Inlet, the area west of Fire Island to the Little Susitna, Knik Arm, and around the Kenai River, and no killer whales were sighted (McGuire, LGL Alaska Research Associates, Inc.[LGL], unpub. data).

Killer whales have been seen in the upper Cook Inlet in Turnagain Arm and Knik Arm, between Fire Island and Tyonek, and near rivers along the Susitna Delta (Shelden et al. 2003; NMFS unpub. data). Killer whales have also been reported in areas of the mid and lower Inlet, including near the Chuitna and Kenai Rivers (Table 4) and Kamishak Bay. From morphology, behavior, and the small group sizes described in sighting reports, it would appear the killer whales observed in upper Cook Inlet are a transient (marine mammal eating) group. Because the frequency of sightings is very low, killer whales observed in upper Cook Inlet apparently center their range elsewhere. Killer whales have stranded at least four times in Turnagain Arm since 1990: in May 1991, August 1993, September 2000, and August 2002. During the 1993 stranding event, a large male killer whale regurgitated pieces of beluga whale and harbor seal (*Phoca vitulina*) (Shelden et al. 2003) and subsequently died.

The number of different killer whales that use the upper Inlet is not known but appears to be small. Photographs taken of killer whales that stranded in Turnagain Arm in 1991, 1993, and 2000 provide evidence that the same adult male was sighted in both 1991 and 1993 (Shelden et al. 2003). Poor quality of additional photographs precluded the identification of other individuals, but they do suggest that the composition of the killer whale pod during these three encounters was similar and the same individuals may be involved in each event. No matches were found between the images of killer whales in Turnagain Arm and those in all available catalogs for Alaska south to Mexico (Shelden et al. 2003).

TABLE 4: Reported Killer Whale Observations in Upper Cook Inlet, and Reports of Killer Whale Predation on Cook Inlet Beluga Whales Inlet-wide from 1982 to 2014.

Year	Reported location of killer whale sighting / predation event	Number of reported killer whale sighting / predation events in Upper Cook Inlet *(including events in mid and lower CI if associated with a potential predation event)*	Number of reported killer whales observed per sighting event	Number of beluga mortalities suspected to be a direct result of killer whale predation
1982	Knik Arm	1	5	0
1983	*No Reports*	0	0	0
1984	*No Reports*	0	0	0
1985	Turnagain Arm	1	1	UNK
1986	*No Reports*	0	0	0
1987	*No Reports*	0	0	0
1988	*No Reports*	0	0	0
1989	*No Reports*	0	0	0
1990	Chickaloon Bay	1	>3	1
	Fire Island [*]	1	4	0
1991	Turnagain Arm	1	6	1
1992	Kenai River	(1)	6	0
1993	Turnagain Arm	1	5	1
1994	Susitna River	1 [ø]	UNK	0
1995	Ivan River	1	3	0
1996	Ivan River	1	UNK	0
1997	Ivan River	1	UNK	0
1998	Ivan River	1	UNK	0
	Port MacKenzie to Fire Island	1	3	0
1999	Turnagain Arm	1	3	0
	Ivan River	1	UNK	0
	Chinitna Bay	(1)	1	1 (2)[◊]
2000	Turnagain Arm	1	3-5	2 (4)[◊]
	Kenai River	(1)	3	1
	Kachemak Bay	(1)	1	UNK
2001	Turnagain Arm	1	1	0

Year	Reported location of killer whale sighting / predation event	Number of reported killer whale sighting / predation events in Upper Cook Inlet *(including events in mid and lower CI if associated with a potential predation event)*	Number of reported killer whales observed per sighting event	Number of beluga mortalities suspected to be a direct result of killer whale predation
2002	Turnagain Arm	3	1	0
	Knik Arm	1	1	0
	Chuitna River	1	2	0
2003	Knik Arm	1	2	1
2004	*No Reports*	0	0	0
2005	*No Reports*	0	0	0
2006	*No Reports*	0	0	0
2007	Turnagain Arm	1	3	0
2008	Tyonek	1	2	0
	Turnagain Arm	1	2 ‡	1
2009	Turnagain Arm	1	6	0
2010	Point Possession	2	4-5 and 3	1 ∞
2011	Turnagain Arm	1	1	0
2012	*No Reports*	0	0	0
2013	*No Reports*	0	0	0
2014	*No Reports*	0	0	0
Totals: 1982-2014		**33** *(29 upper CI + 4 mid-lower CI)*	**total: 75+ average: 2-3**	**10** (*13 if include potentially dependent calves*)

Notes: A predation event is defined as an event during which killer whales were observed chasing belugas, catching belugas, or when a beluga carcass was found with evidence of killer whale tooth marks on it. UNK = the information is unknown, undetermined, or unreported; * = Year of sighting estimated; this report was from Shelden et al. 2003 and was based upon an anecdotal report of a killer whale sighting in the "early 1990s". ø = This was an unconfirmed sighting of killer whales in the area of the Susitna River; see Shelden et al. 2003 for more details. ◊ = These reports suggest that a dependent calf may have been present; although there is no evidence the calf was killed, we assume the calf may also have died, either as a direct predation event or due to the death of its mother; thus we have reported the number of mortalities as a range (1-2) indicating the possibility that a mom/calf pair died. ‡ = This sighting of killer whales may have been the same two killer whales previously reported near Tyonek; ∞ = The necropsy report for this beluga mortality indicated that killer whale predation may have been a possible cause of death, but poor body condition of the beluga carcass prevented a positive determination.
Sources: Moore et al. 2000, Shelden et al. 2003, Vos and Shelden 2005, NMFS unpub. data. (Level A stranding and necropsy reports)

Between 1982 and 2014, NMFS received 29 reports of killer whales in upper Cook Inlet, 4 reports of killer whales possibly preying on CI belugas in mid- and lower Cook Inlet, and 10-13 CI beluga mortalities Inlet-wide suspected to be a direct result of killer whale predation (Table 4). The 10-13 CI beluga mortalities suspected to be a direct result of killer whale predation were identified based upon evidence of predation observed on beluga carcasses or eye witness reports. We present this number as a range to indicate our uncertainty if three calves still dependent upon their mothers for survival may have also perished either because they were consumed by killer whales themselves or because their mothers were killed by killer whales. However, there is no evidence available to document the deaths of these three calves.

A review of the original sightings reports has resulted in a change of opinion about some mortalities originally attributed to killer whale predation. Shelden et al. (2003) reported that two CI belugas died on October 6, 1992 with "killer whale teeth marks on their flukes." Although there were reports of killer whales in the Kenai River in September 1992, a review of the original Level A stranding reports for the two belugas reveal that there were "no gross injuries" observed and no mention of killer whale teeth marks on either beluga. A comparison of the photographs taken of the October 1992 beluga carcasses against photographs of CI beluga carcasses with confirmed killer whale teeth marks from 2000 led NMFS Alaska Region to determine that the whales stranded in the Kenai River in October 1992 were "not attacked by killer whales" (NMFS unpub. data; Level A stranding report). Additionally, Moore et al. (2000) reported that in early September 2000 a CI beluga carcass was documented near Nikiski with "possible orca teeth marks" (reproduced in Shelden et al. 2003). However, after review of the original Level A stranding report, NMFS Alaska Region confirmed the report never mentioned possible orca (a.k.a., killer whale) teeth marks, and given that the report states the whale was "very decomposed", "skeletal remains were visible", and it was "too deteriorated to collect skin for genetics" testing, there would be too little skin available to see teeth marks from a killer whale. Despite the person reporting the dead whale speculating that a "killer whale took bites from its belly", without evidence supporting killer whale predation, the stranding event in Nikiski in 2000 cannot be deemed to be the result of killer whale predation. Thus, although previously considered evidence of killer whale predation on CI belugas (see Moore et al. 2000 and Shelden et al. 2003), the mortalities from October 1992 and September 2000 are no longer determined to be the direct result of killer whale predation and are not included in Table 4.

Since 2001, only three CI beluga deaths have been suspected to be a result of killer whale predation: one in Knik Arm in August 2003; one in Turnagain Arm in September 2008; and one near Point Possession in June 2010. However, the 2010 mortality necropsy report stated although predation was a possible cause of death, it could not be positively determined due to the poor condition of the beluga carcass.

Killer whales in the vicinity or actively chasing belugas could also cause CI belugas to strand alive. Such events may have contributed to several more CI beluga mortalities beyond those listed in Table 4 (strandings are discussed in the next section). For instance, in August of 1999, approximately 60 belugas live stranded in Turnagain with reports of killer whales in the vicinity prior to the stranding. Five mortalities were associated with that stranding event. However, in the absence of trained observers documenting killer whales' pursuit of belugas directly to the location of a stranding, it is not possible to definitively attribute a mortality after a live stranding event to killer whale predation without physical evidence of predation on the carcass. Therefore, any mortalities associated with a live stranding event, despite reported killer whale presence in the area, are not included in Table 4.

There have been anecdotal reports and other observations of killer whales attacking or chasing Cook Inlet beluga whales in lower Cook Inlet when belugas were more frequently observed in lower Cook Inlet. For instance, one person reported in 2002 that in 1999 they saw a killer whale dragging an adult beluga by its flipper from Chinitna Bay into deeper water, with the beluga's calf following; and another person recalled seeing a killer whale chasing a beluga in Kachemak Bay in 2000 (Shelden et al. 2003; included in Table 4). Hobbs and Shelden (2008) and NMFS (2008a) also reported that killer whales chased and fed on a beluga near Anchor Point on June 14, 2007. However, after follow-up interviews and a review of additional photos and video, it was determined that it was a minke whale (*Balaenoptera acutorostrata*) that was killed by killer whales near Anchor Point, and not a CI beluga.

In directed killer whale surveys in lower Cook Inlet in July 2008 and July 2009, there were eleven encounters with resident type killer whales (fish-eaters) and five encounters with transient type killer whales (mammal-eaters; Matkin et al. 2009). During these directed, and other opportunistic, observations of killer whales in lower Cook Inlet, transient killer whales were recorded killing minke whales, harbor porpoises (*Phocoena phocoena*), and harbor seals, and attacking sea otters (*Enhydra lutris*) and humpback whales (*Megaptera novaeangliae*) (Matkin et al. 2009; C. Matkin, North Gulf Oceanic Society, unpub. data). No beluga predation was observed during directed or opportunistic observations by researchers or the public in the lower Inlet during this time period (Matkin et al. 2009).

The CI belugas may also be susceptible to shark predation, although attacks have not been witnessed, nor has clear evidence of shark predation been documented. Wounds from possible shark attacks have been observed in photographs of CI belugas (T. McGuire, LGL, unpub. data). Salmon sharks (*Lamna ditropis*) and Pacific sleeper sharks (*Somnoisus pacificus)* are found in Cook Inlet, although neither has been determined to attack free-swimming cetaceans. Salmon shark jaw and tooth structure is indicative of a fish predator and it is highly unlikely they would attack a marine mammal (K. Goldman, Alaska Department of Fish and Game [ADF&G], pers. comm.to C. Goertz). Pacific sleeper sharks are known to feed on whale carcasses (Barrett-Lennard et al. 2011), and although cetacean remains have been found in their stomachs, this was apparently the result of scavenging and conclusive evidence of predation on live cetaceans is lacking (Sigler et al. 2006). A counterpart in the Atlantic Ocean, the Greenland shark (*Somniosus microcephalus),* apparently consumes live pinnipeds (Sigler et al. 2006), but is not known to be a predator of free swimming cetaceans. It is possible that great white sharks (*Carcharodon carcharias)* make rare visits to the area (Martin 2005), but they are very unlikely to pose a threat to belugas due to their rarity.

b. Strandings

CI beluga whale strandings include beached or floating carcasses as well as live animals found in waters too shallow to permit them to swim. An extensive review of the NMFS AKR Level A stranding reports[17] resulted in some updates to the CI beluga stranding data presented in

[17] Level A stranding report forms are the forms used by NMFS to document stranding-related events.

Moore et al. (2000), Vos and Shelden (2005), and NMFS (2008a and 2008b). The total number of CI beluga carcasses reported in Table 5 reflects the most current information available regarding the number of reported, non-subsistence related mortalities since 1988.

Beluga whale live strandings in upper Cook Inlet are not uncommon, with a majority occurring in Turnagain Arm and Knik Arm (Table 5). Live stranded whales are often opportunistically spotted from the Seward Highway off of Turnagain Arm, or from small aircraft traveling over Cook Inlet. Since 1988, 202 dead CI belugas have been reported, and at least 874 belugas have been involved in live strandings in Cook Inlet (some individual belugas were likely involved in multiple live stranding events over the years; Table 5). Mass strandings (involving two or more whales) primarily occurred in Turnagain Arm and often coincided with extreme tides or killer whale sighting reports (Shelden et al. 2003). In 2003, an unusually high number of beluga live strandings (five separate events in Turnagain Arm involving between 2 and 46+ whales) and mortalities (n = 20) occurred in Cook Inlet (Vos and Shelden 2005).

Marine mammals strand alive for a variety of reasons. Belugas may intentionally ground themselves in shallow waters to more easily rub off molting skin, to avoid predation or other perceived threats (e.g., acoustic disturbances, vessel traffic, or other anthropogenic activity), when chasing prey, or as a result of an inability to properly navigate or maneuver when debilitated by injury or disease (Smith et al. 1992, Moore et al. 2000, Shelden et al. 2003, Vos and Shelden 2005, Burek-Huntington et al. *in press*). A prolonged period out of the water may ensue if animals strand during outgoing tides, especially with the extreme/rapid tidal changes and gently sloping mudflats of Cook Inlet. The perception is that belugas tolerate such events better than other cetaceans due to their relatively small size and flat abdomens which spread out their weight and allow them to remain upright, their light color which minimizes the absorption of heat from sunlight, and their ability to create wallows in the mud to retain at least some water to help them stay cool and moist. While belugas often appear calm and seem to float off without incident with the incoming tide, these animals have not been assessed or tracked other than during the stranding itself and from a great distance.

However, carcasses found following documented mass strandings, as well as carcasses found in the absence of such events, have shown evidence of death as a result of a live stranding. Findings from 34 CI belugas necropsied from 1998 to 2009 indicated nine died following a live stranding (Burek-Huntington et al. *in press*; note Table 5 documents a total of 13 whales may have died after a live stranding event; not all of these whales were accessible and necropsied, but were included in the table due to the close timing of a dead whale with a reported live stranding event). Five of these nine whales were found dead shortly after documented mass strandings. Some of these dead whales appeared to have been robust and otherwise healthy, with no other definitive causes of death. However, they did have debris deep in their airways suggesting forceful inspiration of mud while alive, such as might occur during a live stranding (Burek-Huntington et al. *in press;* NMFS AKR unpubl. data). In May 2014, two beluga whales found dead near Anchorage also had sand deposited within their airways suggesting a recent live stranding event (NMFS AKR unpub. data), although no live stranding event was reported.

Four additional individual carcasses had extensive post-mortem sampling and analyses which did not reveal a pre-existing health problem or other cause of death; however, sand and silt was found in the airways, again suggesting forceful inspiration of mud as might occur during a live stranding**.** In addition to the obstructive inhalation of debris leading to asphyxia (lack of oxygen), live strandings could also lead to death due to stress, hyperthermia (abnormally elevated temperature), pressure necrosis (cellular death due to excessive pressure) of internal organs, aspiration pneumonia (pneumonia due to inhaled material), and kidney damage secondary to myopathy (muscular damage) or muscle compartment syndrome (muscular swelling constricted by surrounding tissue resulting in reduction of blood supply). Some of these conditions may take weeks to months to fully develop and cause death. They may also exacerbate pre-existing conditions, making it difficult to determine whether death was caused by a previous live stranding. Understanding the true impact of live stranding on animals that survive the ordeal requires a more directed assessment and tracking of those animals. Live beluga whales have not been observed to strand in SLE and deaths attributed to such events have not been identified there (S. Lair, pers. comm. to C. Goertz).

TABLE 5: Cook Inlet Beluga Whale Stranding Records from 1988 through 2014.

Year	Total number of carcasses (beached or floating) reported each year	Date of live stranding event	Location of live stranding event	Number of belugas per live stranding event (suspected associated mortalities)
1988	0	Oct. 23	Turnagain Arm	27 (0)
1989	4	-NA-	-NA-	-NA-
1990	2	-NA-	-NA-	-NA-
1991	1	Aug. 31	Turnagain Arm	70-80 (0)
1992	5	Oct. 6	Kenai River	2 (2)
1993	2	July 6	Turnagain Arm	10+ (0)
1994	8	June 14	Susitna River	186 (0)
1995	3	-NA-	-NA-	-NA-
1996	12	June 12 Aug. 28 Sept. 2 Sept. 8 Oct. 2	Susitna River Turnagain Arm Turnagain Arm Knik Arm Turnagain Arm	63 (0) 60 (4) 20-30 (1) 1 (0) 10-20 (0)

Year	Total number of carcasses (beached or floating) reported each year	Date of live stranding event	Location of live stranding event	Number of belugas per live stranding event (suspected associated mortalities)
1997	3	-NA-	-NA-	-NA-
1998	14	May 14 Sept. 17	Turnagain Arm Turnagain Arm	30 (0) 5 (0)
1999	12	Aug. 29 Sept. 9	Turnagain Arm Turnagain Arm	58-70 (5) 12-13 (0)
2000	13	Aug. 27 Sept. 24 Oct. 24	Turnagain Arm Turnagain Arm Turnagain Arm	8 (0) 15-20 (0) 2 (0)
2001	10	-NA-	-NA-	-NA-
2002	10	-NA-	-NA-	-NA-
2003	20	April 18 Aug. 28 Sept. 6 Sept. 14 Oct. 6 Oct. 17	Turnagain Arm Turnagain Arm Turnagain Arm Turnagain Arm Turnagain Arm Ship Creek	1-2 (0) 46+ (5) 26 (0) 32 (0) 4-9 (0) 1 (0)
2004	13	-NA-	-NA-	-NA-
2005	6	Aug. 24	Knik Arm	7 (1)
2006	8	Sept. 12	Knik Arm	12 (0)
2007	15	-NA-	-NA-	-NA-
2008	11	Aug. 7 Sept. 28	Knik Arm Turnagain Arm	28-30 (2) 20-40 (0)
2009	4	Aug. 22	Knik Arm	16-21 (0)
2010	5	Aug. 21 Aug. 29	Knik Arm Knik Arm	11 (0) 2 (0)

Year	Total number of carcasses (beached or floating) reported each year	Date of live stranding event	Location of live stranding event	Number of belugas per live stranding event (suspected associated mortalities)
2011	3	Aug. 10	Knik Arm	2 (0)
2012	3	May 8 Aug. 21 Aug. 29	Turnagain Arm Turnagain Arm Turnagain Arm	12(0) 23 (0) 3 (0)
2013	5	-NA-	-NA-	-NA-
2014	10	UNK (late May?) Aug. 23	UNK Eagle Bay	UNK (2) * 76+ (0)
TOTAL	**202**	**--**	**--**	**874-951 (22)**

Notes: Known subsistence harvested belugas are not included. This table includes data for two types of stranding events: beach-cast or floating carcasses, and live strandings. "-NA-" indicates there were no live strandings reported to NMFS that particular year. *On May 26, 2014 NMFS received a report of two dead beluga whales on the shore of Kincaid Park along Turnagain Arm; although there was no live stranding event reported, the necropsy of these two whales suggests they were recently live stranded and that the live stranding may have contributed to their death.

Source: Moore et al. 2000; NMFS 2008a, 2008b; NMFS Alaska Region unpub. data (Cook Inlet beluga whale stranding database).

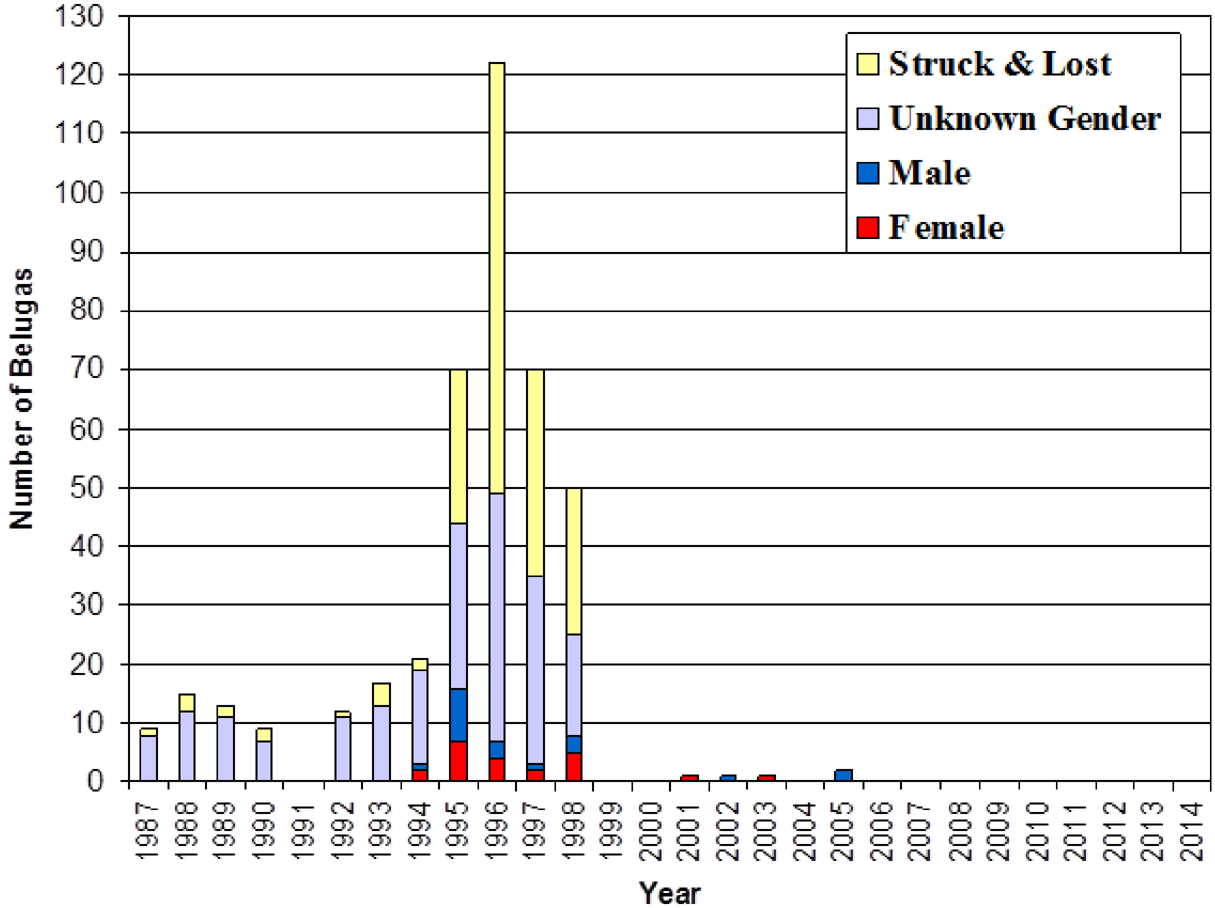
2. Anthropogenic Sources

a. Subsistence Harvest

Alaska Natives harvested CI beluga whales for cultural, subsistence, and handicraft purposes prior to and after passage of the MMPA in 1972. The effect of past harvest practices on the CI beluga whale population is significant, particularly the harvests of the mid-to late-1990s. While harvests occurred at traditional (but undocumented) levels for decades, the subsistence harvest removals apparently increased substantially beginning in the 1980s, with unsustainable removals in the 1990s (Figure 15; CIMMC [Cook Inlet Marine Mammal Council] 1996, CIMMC 1997, Mahoney and Shelden 2000, Angliss et al. 2001, National Oceanic and Atmospheric Administration [NOAA] 2007, NMFS AKR PRD unpub. data[18]). This increase in harvest numbers may have been the result of an increased Native population in the Cook Inlet region, with new participation by hunters who previously lived in areas without a traditional history of hunting in the Inlet.

[18] For more information, contact Barbara Mahoney in the NMFS Alaska Region Office, Protected Resources Division

FIGURE 15: Summary of Known Cook Inlet Beluga Whale Subsistence Harvests, 1987 to 2014.



Source: NMFS 2008b; NMFS AKR PRD unpub. data

A study conducted by ADF&G, in cooperation with the Alaska Beluga Whale Committee and the Indigenous People's Council for Marine Mammals, estimated the subsistence take of belugas in Cook Inlet in 1993 at 17 whales. In consultation with Native Elders from the Cook Inlet region, the CIMMC estimated the annual number of belugas taken by subsistence hunters during this time to be over 30 per year. However, without a complete survey of hunters, this may be a minimum estimate (Hill and DeMaster 1998; DeMaster 1995). There was no systematic CI beluga harvest survey in 1994; instead, harvest data were compiled at the November 1994 Alaska Beluga Whale Committee meeting. The most thorough CI beluga subsistence harvest surveys, including struck and lost estimates, were completed by CIMMC during 1995 and 1996 (CIMMC 1996, 1997; Angliss and Lodge 2002). While there was no survey during 1997 or 1998, NMFS estimated the subsistence harvest from hunter reports. The known annual subsistence harvest by Alaska Natives during 1995 to 1998 averaged 77 beluga whales per year which, in combination with struck and lost estimates, can account for the estimated population decline during this interval (Figure 15). The harvest was sufficiently high to account for the nearly 50% total decline in the population during the period from 1994 through

1998 (Hobbs et al. 2000). If subsistence takes prior to 1994 were at levels approaching the levels recorded in the mid-1990s, that potentially unsustainable level of take could account for the CI beluga decline from 1,300 to 653 from 1979 to 1994.

A voluntary moratorium by hunters in 1999 resulted in no CI beluga harvest that year. During 2000 to 2003 and 2005 to 2006, NMFS entered into co-management agreements for the CI beluga subsistence harvest, limiting harvest to one or two whales per year starting in 1999. From 2000 to 2005, subsistence harvests were 0, 1, 1, 1, 0, and 2 whales, respectively. There has been no subsistence harvest of CI belugas since 2005.

b. Commercial Whaling

A brief commercial whaling operation existed along the west side of upper Cook Inlet during the 1920s, where 151 belugas were killed in five years (Mahoney and Sheldon 2000). There was also a recreational hunt for beluga whales in Cook Inlet prior to enactment of the MMPA. The potential impacts of these pre-MMPA hunts on the present status of this stock cannot be determined.

c. Poaching or Intentional Harassment

Due to their approachable nature, the potential for poaching belugas in Cook Inlet exists. Although NOAA Law Enforcement is present in Cook Inlet, the area they have to cover is extensive. NOAA Law Enforcement has investigated several incidences of reported harassment of CI belugas, but to date there have been no prosecutions or convictions. There are reports and photographs of CI belugas with wounds consistent with harpoon or gunshot trauma (McGuire et al. 2011), but these animals have not been examined further, and no poaching incidents have been confirmed.

d. Incidental Mortalities or Injuries

The following section discusses mortalities or injuries to CI belugas incidental to the associated human activity. In this context, “incidental” refers to the death or injury (to include entanglement) of animals that were not the intended target of the activity. Activities with the potential to cause incidental injury or death include fisheries activities, vessel activities, or research projects. There is also documented evidence of CI belugas being entangled in marine debris. This section does not consider injuries that may occur as a result of noises associated with human activities. Those are discussed separately.

Fisheries Activities: NMFS has only documented one CI beluga whale mortality associated with personal use, subsistence, or recreational fisheries. In May 2012, a yearling CI beluga carcass was recovered from a 60 ft subsistence set net with 8 inch mesh located approximately 1-2 miles south of the Kenai River. Histopathological analysis of tissues indicated cause of death was most likely drowning. However, this animal also suffered from severe bronchopneumonia and it appeared unusually small for its age. The whale may have been unable to extract itself from the net when an otherwise healthy individual may have escaped. While there have been other sporadic reports over the years of single beluga whales becoming entangled in fishing nets, mortalities could not be confirmed.

The only other reports of fatalities of CI beluga whales incidental to fishing in Cook Inlet are from the literature. Murray and Fay (1979) stated that commercial salmon gillnet fisheries in

Cook Inlet caught five beluga whales in 1979. Burns and Seaman (1986) estimated incidental take rates by commercial salmon gillnet fisheries in the Inlet at 3-6 beluga whales per year during 1981 to 1983. Neither report, however, differentiated between set gillnet and drift gillnet fisheries.

NMFS placed observers in the Cook Inlet salmon drift net and upper and lower Inlet set gillnet fisheries in 1999 and 2000 (Angliss and Lodge 2002, Manly 2006). During the two years of observations, an estimated total of 384 net-days were observed for the drift gillnet fishery, and an estimated 614 net days were observed for the set gillnet fishery. Only three sightings of beluga whales were made at set gillnet locations in upper Cook Inlet (Moore et al. 2000). Although one harbor porpoise was reported dead in the Upper Cook Inlet driftnet fishery, beluga whales were never observed within 10 m (32.8 ft.) of a net (i.e., within a distance categorized as an interaction) in the drift or set gill net fisheries; therefore, no beluga whale injuries or mortalities were reported from drift or set gillnets in either 1999 or 2000 (Manly 2006). The most likely impacts from personal use, subsistence, recreational and commercial fisheries include disturbance from the operation of watercraft in stream mouths and shallow waters, ship strikes, displacement from important feeding areas, harassment, and prey competition.

Vessel Activities: Ship strikes have not been confirmed, but could not be ruled out in CI beluga deaths caused by trauma. For example, in September 2007, a dead beluga was found to have a wide, blunt trauma along the right side of its chest (NMFS AKR unpubl. data). While a cause of the trauma was not determined, it may have been caused by the animal being hit by a boat or other watercraft (e.g., jet ski). Additionally, there are reports and photographs of CI belugas with scarring patterns consistent with propeller injuries (McGuire et al. 2011).

Research Activities: Passive research with a low potential to affect whales may include aerial surveys, shore-based observations, passive acoustic studies (non-tagging), prey studies, habitat studies, pathology and disease studies on dead animals, and contaminant studies. Other research may change the behavior of, harass, injure, or kill belugas. Such activities include capturing whales, applying satellite tags, applying suction cup dive tags, taking blood and biopsies from live animals, and any boat or in-water work that changes whale behavior or movements. Between 1999 and 2002, NMFS researchers captured and affixed satellite tags to a total of 18 CI belugas. In 2002, data from one satellite-tagged CI beluga whale indicated a weak swim pattern for 32 hours post-tagging; the whale was found floating dead a short time later and was positively identified by a fin tag. The beluga's belly-up position while floating prevented detection of satellite tag transmissions. Two other satellite-tagged whales captured during the same season exhibited similarly weak swim patterns prior to the loss of the satellite tags' signals less than 48 hours post-tagging. These whales were not found, but were presumed to have died less than 54 hours after tagging. While these data do not conclusively point to the cause of death of these whales, NMFS concluded these whales died as a result of the capture and tagging activities (NMFS unpub. data).

Photo-identification studies by McGuire et al. (2013) reported identification of seven individual beluga whales with scarring due to satellite tags, providing evidence that at least seven of the previously tagged CI belugas survived at least four years after the tagging event, with five of the seven whales re-photographed in 2011 (McGuire et al. 2013). Five of these seven whales are presumed to be females based on close associations with calves (McGuire et al. 2013).

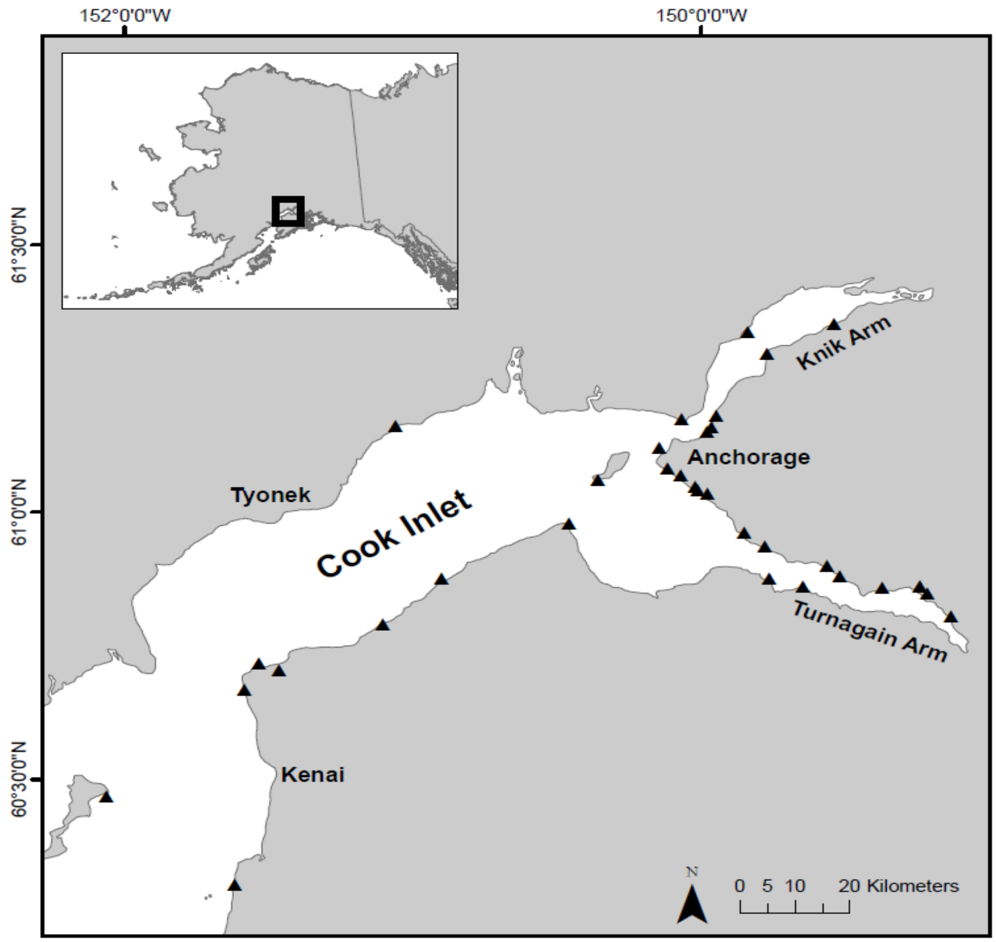
Marine Debris: There have been reports of CI belugas alive, but entangled in marine debris. In 2005, a CI beluga whale was photographed in Eagle Bay, entangled in an unknown object, perhaps a tire rim or a culvert liner (McGuire et al. 2013). In 2010, 2011, 2012, and 2013, another CI beluga was repeatedly photographed with what appeared to be a rope entangled around the upper portion of its body near the pectoral flippers (McGuire et al. 2014). NMFS determined that attempts to disentangle the whale were not warranted because there was no apparent physical injury due to its entanglement, and the benefit of disentanglement did not outweigh the harassment-induced risks that such an operation would posed to that and other whales.

3. Cause of Death Analysis of Necropsied CI Belugas

Causes of death for most stranded CI beluga whales remain largely unknown. Post-mortem exams are hampered by the lack of road access and extensive hazardous tidal flats in Cook Inlet. In addition, the remote nature of much of Cook Inlet's coastline preclude the timely reporting of carcasses suitable for necropsy and make responding with a necropsy team logistically difficult. Additional carcasses may go unexamined because animals may sink after dying or be surrounded by winter ice and swept out of the Inlet prior to detection. From 1998 to 2009, only 34 carcasses out of 136 observed dead stranded belugas (Table 6) were subjected to some degree of post-mortem examination or necropsy. These carcasses were concentrated close to Anchorage and along the road system (Figure 16). Burek-Huntington et al. (*in press*) reviewed the causes of morbidity and mortality determined from these examinations. Their findings are summarized in Tables 6 and 7 below, and in detail in section IX.G – Cause of Death Analysis.

Of the 34 CI beluga carcasses examined from 1998 to 2009, the cause of death was not identified in a third of the cases, primarily because most carcasses were in an advanced state of decomposition (Burek-Huntington et al. *in press*). Identification and reporting of strandings, both live and dead, as well as the subsequent response, need to be accelerated and enhanced in order to obtain the quality information necessary to understand the causes of morbidity and mortality in CI belugas. Nevertheless, it is often difficult to determine a cause of death even when carcasses are examined promptly under laboratory conditions. Categories of identified causes of death in CI belugas included perinatal, traumatic, nutritional, disease, and association with previous mass or single live strandings (Table 6). It has been noted that the number of documented mortalities of CI beluga whales seems to be equivalent to that of beluga whales in the St. Lawrence Estuary in Canada (P. Béland, St. Lawrence National Institute of Ecotoxicology, unpub. data), which has a much larger estimated population size of about 1,000 individuals.

FIGURE 16: Distribution of 34 Examined Cook Inlet Beluga Carcasses.



Source: Burek-Huntington et al. *in press*

TABLE 6: Summary of Causes of Death, Contributing Factors, and Incidental Findings from Carcasses of 34 Cook Inlet Belugas that were Examined (1998-2009) as part of Mortality and Morbidity Study.

	COD	% CODs	CF	I
Unknown	11	32%	0	0
Perinatal	5	15%	0	0
Mass Stranding	5	15%	0	0
Single Stranding	4	12%	0	0
Trauma	3	9%	1	1
Nutrition	3	9%	3	0
Disease	3	9%	33	31
Environmental	0	0%	5	0
Totals	**34**	**100%**	**42**	**32**

Notes: COD - Causes of Death, CF - Contributing Factors, I – Incidental; see Appendix H for more details
Source: Burek-Huntington et al. *in press*

TABLE 7: Synthesis of Primary Cause of Death of Animals from Different Beluga Whale Populations as Assessed by the References.

	CI Beluga (1998 to 2009, n=34) [1]	SLE Beluga (1983 to 2012, n=222) [2]	North American Oceanaria Beluga (1974 to 2000, n=45) [3]
Degenerative	0%	4%	7%
Neonatal	15%	7%	11%
Infectious Disease:	9%	32%	51%
○ Bacterial	6%	14%	31%
○ Viral	3%	0%	7%
○ Parasitic	0%	18%	2%
○ Fungal	0%	0%	7%
○ Not determined	0%	0%	4%
Nutritional	9%	-	-
Neoplasia	0%	15%	5%
Trauma	9%	6%	2%
Post Live Stranding	30%	-	Not applicable
Miscellaneous	0%	8%	11%
Not determined	32%	28%	13%

Notes: SLE= St. Lawrence Estuary. Infectious disease causes are further broken down into different types of pathogens when possible. Parasitic diseases include those due to protozoa and to metazoan parasites. When a specific pathogen could not be isolated but the lesions were consistent with an infectious etiology, the cause of death was categorized as Disease-Not determined. Miscellaneous causes of death included conditions with vague causation or conditions that did not fit well in the other categories including anaphylaxis and drowning in captive belugas, dystocia (abnormal labor or birth) in wild belugas, and fishing gear entanglement.

Sources: [1] Burek-Huntington et al. *in press*, [2] S. Lair, pers. comm. to C. Goertz, [3] L. Dunn, pers. comm. to C. Goertz

E. Section Summary: Background

Cook Inlet

Cook Inlet is a semi-enclosed tidal estuary located in southcentral Alaska and is approximately 370 km (230 mi) in length and extends in a northeast/southwest orientation from Knik and Turnagain Arms in the north to the southernmost reaches of Kamishak Bay in the south. Considerable amounts of sediment are naturally deposited into Cook Inlet, creating a highly turbid, low visibility environment, particularly in the northern portion of the Inlet. Cook Inlet experiences some of the greatest tidal fluctuations in the world, with the difference between high and low tide levels reaching 12 m (39 ft). These large tidal ranges, combined with broad tidal flats, can result in currents reaching 6.2 m/sec (20.3 ft/sec). In winter, ice covers much of upper Cook Inlet as rivers begin to freeze in October and November.

Relevant CI Beluga Life History

In Alaska, there are five recognized beluga stocks delineated based on summer range: the Beaufort Sea, the eastern Chukchi Sea, the eastern Bering Sea, Bristol Bay, and Cook Inlet. The degree of genetic differentiation among the Cook Inlet stock and the other four Alaska beluga stocks indicates the Cook Inlet belugas are the most isolated reproductively and demographically. This isolation is long established, resulting in localized adaptation and indicating that the possibility of rescue from neighboring populations is remote.

CI belugas are unique in Alaska given that their habitat is in close proximity to the greatest concentration of Alaska's human population. Belugas are not uniformly distributed throughout Cook Inlet, but are predominately found in nearshore waters of the upper Inlet. Humans use the waters and shores of Cook Inlet for fishing, hunting, timber harvest, mining, shipping, dredging, renewable energy production, wastewater discharge, military activities, oil and gas development, transportation, and residential and industrial development.

The distribution of CI belugas has changed significantly since the 1970s; as their population declined, their summer range has contracted to the upper Inlet. Belugas spend the summer and early autumn months in the upper Inlet, concentrating at river mouths. In late fall, belugas disperse south into the middle Inlet and into deeper offshore waters. This pattern continues through winter, when whales exhibit the most wide-ranging movements, spanning both near shore and offshore waters from the upper reaches of Knik Arm to the middle Inlet. Large aggregations of belugas in specific areas of Upper Cook Inlet during May to October likely indicate a critical time period for foraging; it is during the ice-free months that calves are born and nursed and that the whales acquire the thick blubber layer they will need to survive through the winter months. In addition to comprising important feeding habitats, the shallow waters of the upper Inlet may also play important roles in reproduction. Other critical uses of habitat by CI belugas may include avoidance/escape from predators, transiting among feeding and/or nursery habitats, and refuge from human activities (e.g., in-water noise, ship traffic and hunting).

Beluga whales have low reproductive potential; that is, they have a single calf only every two or more years, and devote considerable time to care for their young. Age at sexual maturity, length of gestation, and calving interval are unknown for CI belugas. Data are not available for the Cook Inlet beluga whale population to precisely determine the generation time, however, when we consider available information regarding the age at first reproduction and age at senescence for beluga whales, we estimate a generation time for belugas of approximately 25 years.

Belugas make a wide variety of sounds and have highly developed echolocation capabilities. Their high auditory sensitivity, wide frequency bandwidth, and dependence upon sound to navigate, communicate, and find prey and breathing holes in the ice make belugas vulnerable to noise pollution, which may mask beluga signals or lead to temporary or permanent hearing impairment.

Beluga whales are extremely social animals that typically travel and hunt together. High group cohesion and large group sizes may provide benefits to group members in terms of information gathering and transfer with regard to resource availability (e.g., prey, calving sites, oceanographic conditions, etc.) and cooperation in predator avoidance and reduced predation risk. The evidence available for CI belugas suggests that individual belugas intermix and interact with various beluga groups across the Inlet.

The diet of CI beluga whales is dominated by fish and invertebrates. Recent analysis suggests CI beluga diets changed in the last few decades and whales have been feeding at lower trophic levels. Pacific salmon, including Chinook (king) salmon, may be essential prey for CI belugas. There is therefore concern that recent reductions in run strength of Chinook salmon stocks across Alaska, particularly in Cook Inlet, may be affecting CI belugas.

CI Beluga Whale Population Size and Trends

Aerial surveys in the 1960s, 1970s, and early 1980s counted belugas in Cook Inlet but only a few of these had sufficient coverage to estimate the population size. A 1979 survey resulted in an estimate of 1,293 belugas in Cook Inlet; NMFS has adopted 1,300 as the value for the carrying capacity to be used for management purposes. Between 1979 and 1994 the CI beluga population declined roughly 5% annually from about 1,300 whales to 650 whales. Between 1994 and 1998 the population declined nearly 50% from 650 whales to 347 whales, likely a result of unsustainable levels of subsistence harvest. Since 1999, when subsistence hunting was restricted, the population has continued to decline at a rate of 1.3% per year. The 2014 abundance estimate was 340 Cook Inlet belugas.

Sources of Mortality or Injury

In the past, there have been both natural and anthropogenic sources of mortality or injury of CI beluga whales. Natural sources include predation by “transient” killer whales, live strandings, and potentially disease; anthropogenic sources include subsistence harvest, poaching or intentional harassment, and mortalities or injuries incidental to other human activities. Although the cause of death for most CI beluga whales remains unknown, 34 CI belugas were necropsied between 1998 and 2009; identified causes of death included perinatal, traumatic, nutritional, disease, and association with previous mass or single live strandings.

III. THREATS TO RECOVERY

While the recent downward trends in CI beluga abundance and range are well documented, little is known about the mechanisms impeding recovery. Previous hypotheses for the delay in recovery include: 1) reduced fecundity because the mature female segment of the population is depleted; 2) reduced fecundity or survival due to potential population-wide stressors such as reduced prey, contaminants, disease, or inbreeding effects; 3) loss of whales as a result of predation by killer whales or stranding events; and 4) risks associated with contracting range and grouping behavior of the whales (NMFS 2008a). A population model that implicitly considered the time lags inherent in long-lived populations where sexual maturity does not occur for many years (Litzky 2001; Hobbs and Shelden 2008) indicated that the depletion of females is an unlikely cause for the current continued decline. While concluding that other effects besides the subsistence hunt have contributed to the decline and failure to rebuild, the population model was unable to narrow down the causal effects using the available data (Hobbs and Shelden 2008). The model also projected population abundance into the future and demonstrated that extinction risk varied considerably under different scenarios of risk factors for CI beluga whales.

The following section examines potential obstacles to the recovery of CI belugas. It is unlikely that all threats listed in this Recovery Plan significantly impact CI beluga recovery, so ideally each threat would be investigated and either dismissed as insignificant or prioritized for action according to defined criteria. In the absence of such an assessment, the CIBRT Science Panel took a qualitative approach using the members' best professional judgement. Table 8 lists each threat and summarizes the CIBRT Science Panel's assessment of the major effect of the threat, its extent, frequency, trend, probability, magnitude, and rating of relative concern for CI beluga recovery (definitions of these terms are provided in Table 8). Assessments were made based on the information and data gaps presented in the Background Section of this Recovery Plan.

Climate change, while considered a potential threat to CI beluga recovery, is not addressed as a separate threat in this Recovery Plan, but rather is discussed with respect to how it may affect each of the listed threats. Although climate change occurs naturally, the effects of greenhouse gas emissions are fundamentally changing global processes. This Recovery Plan does not attempt to identify the sources of such emissions nor to assess the relative contribution of each potential source. Instead it focuses on the effects of a changing climate to CI belugas. For example, climate change may result in increased frequency and intensity of storms and droughts, and these events can have effects on belugas. Thus, since we are assessing effects of climatic changes to the species and not the causes of climatic changes, in many instances in this recovery plan climate change is referenced as a factor that affects natural events, even though we acknowledge that certain natural events may be exacerbated by human-induced climate change.

As previously discussed (see section II.C.4), there are inherent risks associated with small populations, such as loss of genetic or behavioral diversity. The effects of threats on small populations may be greater than on large populations due to these inherent risks. Small populations may be more susceptible to disease, inbreeding, predator pits, or catastrophic events than large populations. In this section, we address ten principal threats to the CI beluga population and consider how they may be exacerbated by these types of inherent risks due to small population size.

Section 4(a) of the ESA and the associated regulations (50 CFR part 424) set forth the following considerations for the listing status of a species: 1) the present or threatened destruction, modification, or curtailment of its habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) inadequacy of existing regulatory mechanisms; or 5) other natural or human-made factors affecting its continued existence. In the 2008 decision to list CI beluga whales as endangered, NMFS cited all five listing factors (73 FR 62919). In Table 8, the ten threats identified below are associated with the relevant ESA section 4(a)(1) factors (identified as Factors A-E).

TABLE 8: Summary of Potential Threats, with Factors Leading to the Determination of Relative Concern for CI Belugas.

THREAT TYPE	ESA §4(a)(1) FACTOR	MAJOR EFFECT	EXTENT	FREQUENCY	TREND	PROB-ABILITY	MAGNITUDE	RELATIVE CONCERN
Reduction in Prey	A,D,E	Reduced fitness (reproduction and/or survival); reduced carrying capacity	Localized & Range wide	Continuous, Intermittent, & Seasonal	Unknown	Unknown	Unknown	Medium
Pollution	A	Compromised health	Localized & Range wide	Continuous, Intermittent, & Seasonal	Increasing	High	Low	Low
Disease Agents (e.g., pathogens; parasites; harmful algal blooms)	C	Compromised health, reduced reproduction	Range wide	Intermittent	Unknown	Medium to High	Variable	Medium
Noise	A,D,E	Compromised communication & echolocation, physiological damage, habitat degradation	Localized & Range wide	Continuous, Intermittent, & Seasonal	Increasing	High	Unknown Potentially High	High
Habitat Loss or Degradation	A	Reduced carrying capacity, reduced reproduction	Localized & Range wide	Seasonal	Increasing	High	Medium	Medium
Subsistence Hunting	B	Injury or mortality	Localized	Intermittent	Stable or Decreasing	Low	Low	Low
Predation	C	Injury or mortality	Range wide	Intermittent	Stable	Medium	Low	Low
Unauthorized Take	A,E	Behavior modification, displacement, injury or mortality	Range wide, localized hotspots	Seasonal	Unknown	Medium	Variable	Medium
Catastrophic Events (e.g., natural disasters; spills; mass strandings)	A,E	Mortality, compromised health, reduced fitness, reduced carrying capacity	Localized	Intermittent & Seasonal	Stable	Medium to High	Variable Potentially High	High
Cumulative and Synergistic Effects	C,D,E	Chronic stress; reduced resilience	Range wide	Continuous	Increasing	High	Unknown Potentially high	High

Definitions used in Table 8: Summary of Potenial Threats to Cook Inlet Beluga Whales:

ESA §4(a)(1) Factor: The ESA factors NMFS relied upon for listing CI beluga whales (73 FR 62919; October 22, 2008)

A. *The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range*

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

C. Disease or Predation

D. The Inadequacy of Existing Regulatory Mechanisms

E. Other Natural or Manmade Factors Affecting its Continued Existence

Major Effect: A brief description of immediate/proximate/primary effect of the threat on a biological process or the mechanism by which it impacts belugas. Ultimately all threats have an impact on fitness, reproduction, and/or mortality but often there is an immediate effect on a specific aspect of life history which is listed here.

Extent: The portion of the CI beluga whale range over which the threat is found.

Range wide: The threat occurs throughout the CI beluga whale distribution.

Localized: The threat is primarily found in only a portion of the range, or is present at low levels throughout the range but is greatest in discrete areas.

Frequency: The occurrence/regularity of the threat over time.

Continuous: The threat is relatively constant through the year.

Seasonal: The threat is greatest during specific seasons, but may occur at other times of the year.

Intermittent: The threat may occur at any time of the year or at irregular/sporadic intervals not associated with specific seasons or time frequencies.

Trend: The change in frequency or intensity of a threat over time; described as increasing, decreasing, stable, or unknown.

Probability: Qualitative description of the chance of a threat occurring in the future.

Magnitude: Describes the experts perceived qualitative impact of the threat (if it were to occur) on the CI beluga whale population.

Relative Concern: The overall perception of how a threat affects CI beluga recovery, after accounting for other parameters listed in the table.

A. Discussion of Threat Types

The ten potential threat types discussed below were identified as having at least a low level of relative concern for affecting the CI beluga whale population (see Table 8). Information presented in this section is summarized in table 8, and used to determine the relative concern of each threat type to the CI beluga population. The identified threat types and their level of relative concern are:

- reduction in prey (relative concern: medium);
- pollution (relative concern: low);
- disease agents (relative concern: medium);
- noise (relative concern: high);
- habitat loss or degradation (relative concern: medium);
- subsistence hunting (relative concern: low);
- predation (relative concern: low);
- unauthorized take (relative concern: medium);
- catastrophic events (relative concern: high); and
- cumulative and synergistic effects of multiple stressors (relative concern: high).

1. Threat Type: Reduction in Prey

Several factors may result in the reduction of the abundance, quality, availability, or seasonality of CI beluga whale prey. The impact of reduction of available prey on CI belugas is poorly understood, but may be the result of competition with humans or other animals. It may also result from habitat disturbances or modifications as a result of anthropogenic or natural factors. Factors, whether anthropogenic or natural, that affect the available prey species may have a greater impact on one prey species or species subcomponent (e.g., age or size-related). Resultant changes in relative abundance of prey will affect the prey composition available (Pyke et al. 1977).

a. Competition for Prey Resources

CI beluga whales compete with humans and other animals for prey resources, particularly salmon and eulachon. Quantitative data on the spatial and temporal distribution of beluga prey in upper Cook Inlet are limited (see section IX.E – CI Beluga Prey Supplement). Although management of fisheries targeting anadromous species in Alaska attempts to constrain harvests to be no greater than the level of surplus production, it is unlikely that escapement goals will be met in all tributaries across all years. Effects of fishing by humans on beluga whale foraging success are not well known, yet may include spatial and temporal components for any specific prey resource. Effects to belugas will depend on the extent to which a reduction occurs to the abundance, quality, or availability of prey, and if the belugas can compensate for losses of preferred prey by shifting to less-preferred prey. If a non-preferred prey species is reduced, the relative or absolute abundance of preferred prey may increase over time, depending on the ecological linkages and response times. The temporal distribution of these prey resources may be as important as their magnitude, particularly for growing juveniles and pregnant and/or lactating female belugas. Changes in seasonality of prey may occur due to seasonality and species preference of fisheries, changes in seasonal fish habitat, or seasonal environmental changes affecting Cook Inlet. The extent to which shifts in the seasonality of prey species or temporal gaps in prey availability impact reproductive success and survival of beluga whales, particularly during critical life stages, is unknown. However, these impacts are likely to be most important if affecting temporal availability of high-lipid prey. Alternatively, events that result in decreases of specific runs or changes in the availability of prey (e.g., by changing schooling patterns or altering nearshore terrain) may leave temporal gaps in the availability of prey at sufficient densities resulting in the reduction in total days when beluga blubber fat storage can occur. See section IX.E – CI Beluga Prey Supplement for more information.

The CI belugas may also compete against other predators (harbor porpoise, harbor seals, killer whales, sea lions, large whales, sea otters, sea birds, etc.) for available prey resources, particularly in upper Cook Inlet where the available prey resources may be more limited in abundance or diversity. Although there may be some foraging specialization upon available prey species, there is also likely to be a high degree of dietary overlap due to the limited prey diversity available. In upper Cook Inlet, belugas are most likely to compete for prey resources with harbor seals and harbor porpoises, which have been documented to also be present in Cook Inlet year round and co-occur in the same general locations as CI belugas (Small et al. 2011; AEA 2013; T. McGuire, LGL, unpub. data).

b. Disturbance or Modification of Prey Habitat

The amount or types of prey available to CI belugas may also be reduced as a result of disturbances or modifications to prey habitat. Anthropogenic activities which may detrimentally affect prey habitat, and possibly reduce the availability of prey to belugas, are present both seasonally and continuously in Cook Inlet. Anthropogenic activities in Cook Inlet which may disturb or modify the habitat of beluga prey include dredging; oil or gas activities; hard rock quarrying; laying of electrical, communication, or fluid lines; construction of docks, bridges, breakwaters or other structures; and other activities. These activities may cause avoidance or destruction of an area used by beluga prey as a result of anthropogenic disturbance. Permanent structures, such as docks, platforms, or bridges, alter the Cook Inlet habitat by altering local tidal flow. However, because anthropogenic structures may repel some species, but attract others, the net effect on beluga prey remains unknown.

In addition to loss of habitat available to beluga prey species by displacement or avoidance, anthropogenic activities may reduce the quality of the prey as a result of contamination of the habitat. For example, mechanical disturbance of the seafloor (e.g., dredging) re-suspends silt, and potentially buried chemicals, into the water column. A sewer outfall plume alters both the abiotic and biotic environment, releasing various hormones, pharmaceuticals and other chemicals into Cook Inlet. Catastrophic events such as oil or chemical spills are infrequent, but may have significant effects on beluga prey, whether through changes to spawning or migration patterns, direct mortality, or potential long-term sub-lethal impacts (Moles et al. 1994; Marty et al. 1997; Murphy et al. 1999). While some of these contaminants are known to bioaccumulate and be passed up the food chain, they also may impact the survival, quality and reproduction of the prey species itself.

The habitat upon which beluga prey depend may also be affected by natural events, including: Pacific decadal oscillation (potentially affecting rainfall, freshwater runoff, water temperature, and water column stability); climate change (potentially affecting glacial output and siltation and salinity in downstream estuarine environments); volcanic ash outfall (affecting siltation and water chemistry); and earthquakes and associated landslides, elevation changes, and tsunami waves. Some of these natural threats are infrequent, but may have instantaneous and substantial impacts upon abundance, quality, or seasonality of CI beluga prey. However, other threats, such as Pacific decadal oscillations, may occur more regularly, may or may not be readily detectable, may develop over an extended time period, and may have long-lasting ecological effects.

Ecological regime shifts, in which species composition is restructured, have been identified in the North Pacific (Hollowed and Wooster 1992; Anderson and Piatt 1999; Hare and Mantua 2000; Spies 2007) and are believed to have affected prey species availability in Cook Inlet. For example, in the 1970s, dominance in the Gulf of Alaska ecosystem transitioned from crustaceans to ground fish, particularly gadid (e.g., cods) species. In another analysis, Hare and Mantua (2000) reaffirmed the 1976 to 1977 ecosystem change in the Gulf of Alaska and identified a less dramatic shift in 1989. Analyses of multi-decadal data from small-mesh trawl surveys conducted by NMFS and ADF&G showed ecosystem reorganization in the 1970s at Kachemak Bay in southern Cook Inlet and around Kodiak Island and in Shelikof Strait located in the northern Gulf of Alaska south and west of Cook Inlet Gulf waters (Bechtol 1997; Anderson and Piatt 1999). Of particular note was a decline in forage species, particularly pandalid shrimp and capelin, and increases in cod, pollock, and flatfish.

c. Anthropogenic Noise Effects on CI Beluga Prey

Recent literature reviews on the effects of sound on fish (Popper and Hastings 2009) conclude that little is known about these effects and that it is not yet possible to extrapolate from one experiment to other signal parameters of the same noise, to other types of noise, to other effects, or to other species. Limited available scientific literature indicates that noise can evoke a variety of responses from fish. Pile driving can induce a startle response, an avoidance response, and can cause injury or death to fish close to the noise source (Caltrans 2001, Abbott and Bing-Sawyer 2002, NMFS 2011, Halvorsen et al. 2011).

Some noises may evoke flight and avoidance response in juvenile salmon. Other studies have shown that the avoidance response is temporary. Salmon have been found to respond to low frequency sounds, but only at very short ranges (Chamberlin 1991). Carlson (1994), in a review of 40 years of studies concerning the use of underwater sound to deter salmonids from hazardous areas at hydroelectric dams and other facilities, concluded that salmonids were able to respond to low-frequency sound and to react to sound sources within a few feet of the source. He speculated that the reason that underwater sound had no effect on salmonids at distances greater than a few feet is because they react to water particle motion/acceleration, not sound pressures. Detectable particle motion is produced within very short distances of a sound source, although sound pressure waves travel farther (USDOT 2005). It is likely that fish will avoid sound sources within ranges that may be harmful (McCauley et al. 2003).

Of all known CI beluga prey species, only coho salmon (*Oncorhynchus kisutch*) have been studied for effects of exposure to pile driving noise (Casper et al. 2012, Halvorsen et al. 2012). These studies defined very high noise level exposures (210 dB re 1μPa^2.s) as threshold for onset of injury, and supported the hypothesis that one or two mild injuries resulting from pile driving exposure at these or higher levels are unlikely to affect the survival of the exposed animals, at least in a laboratory environment. Hart Crowser Inc. et al. (2009) studied the effects to juvenile coho salmon from pile driving of sheet piles at the Port of Anchorage in Knik Arm of Cook Inlet. The fish were exposed in-situ to noise from vibratory or impact pile driving at distances ranging from less than 1 meter to over 30 meters. The results of this studied showed no mortality of any of the test fish within 48 hours of exposure to the pile driving activities, and for the necropsied fish, no effects or injuries were observed as a result of the noise exposure.

The effects of noise on other CI beluga prey species, such as eulachon, gadids, and flounder species is unknown.

d. Relative Concern

While the potential exists for fishing pressure to change the abundance, seasonality, or composition of beluga whale prey, fisheries are generally managed relatively conservatively, with in-season reductions or closures if targeted fish stocks appear to be weak. However, not all fish stocks are assessed and it is unknown whether management of fisheries for optimal returns provides sufficient densities in beluga feeding areas for efficient foraging by belugas.

It is likely there is interspecific competition for limited prey resources between CI belugas and other predators in Cook Inlet (e.g., harbor seal, harbor porpoise). However, the impact of this competition on the availability of prey to CI belugas has not been determined.

Habitat modification may result in changes in prey species availability and/or species composition throughout the range of CI belugas. While potentially having substantial effects on local ecosystems, natural threats are difficult to predict and mitigate. Many changes are tied to infrequent, short-term, uncontrollable events such as earthquakes or volcanic eruptions. Habitat disturbances may cause beluga prey to avoid an area, reduce viability of prey species, or interfere with belugas' predation success. Anthropogenic noise may also have negative effects upon CI beluga prey. Noise impacts on fish may range from temporary displacement to barotrauma induced death (Popper and Hastings 2009).

Depending on the source, prey reduction can be a local or rangewide event, with a variable frequency of occurrence. While reduction of prey may result in reduced carrying capacity of the environment or reduce the fitness of the CI belugas, the magnitude of the impact of a reduction of prey on CI belugas is unknown, as is the trend and future probability. As such, the threat to CI beluga recovery due to the reduction of prey is of medium concern.

2. <u>Threat Type: Pollution</u>

Pollution is the introduction of contaminants into the environment that causes adverse change. For the purpose of this review, pollution is synonymous with acute and chronic events that release notable/reportable quantities of chemicals or substances into the environment. Exposure to industrial chemicals as well as to natural substances released into the marine environment is a potential health threat for CI belugas and their prey. For an in-depth review of available information on this topic, see section IX.F – CI Beluga Pollution and Contaminants Supplement.

a. Sources and Types of Pollution in Cook Inlet

A number of sources of chemical and biological pollution have been identified in and around Cook Inlet, but a comprehensive water quality survey of Cook Inlet is not available. Potential sources of pollution which could affect CI belugas include: offshore oil and gas development; municipal waste and bilge discharge; marine oil spills; runoff from roads, airport, military sites, mines, construction sites, and farms; terrestrial and marine spills of contaminants other than oil; resuspension of contaminants through dredging; ship ballast discharge; watercraft exhaust and effluent; coal transportation and burning; auto exhaust; antifouling paint; and trash.

Possible contaminants CI belugas could be exposed to include: persistent organic pollutants; aromatic hydrocarbons; chlorinated hydrocarbons; heavy metals; endocrine disruptors; pharmaceuticals; antibiotics; sanitizers; disinfectants; detergents; insecticides; fungicides; and deicers. While NMFS has some data about levels of traditionally studied contaminants in CI belugas (e.g., Dichlorodiphenyltrichloroethane [DDT], polychlorinated biphenyls [PCBs], polycyclic aromatic hydrocarbons [PAHs], etc.), virtually nothing is known about other emerging pollutants of concern and their effects on CI belugas. The emerging pollutants of concern include endocrine disruptors (substances that interfere with the functions of hormones), pharmaceuticals, personal care products (chemicals such as soaps, fragrances, insect repellants, etc.), prions (infectious proteins that cause neurodegenerative disease), and other bacterial and viral agents that are found in wastewater and biosolids.

URS (2010) evaluated the level of potential concern (probable, possible, unlikely) to CI belugas from various classes of chemicals. Chemicals identified by URS (2010) to be of probable and possible concern and for which at least some data are available for either CI belugas or other beluga populations are described in Table 9. URS (2010) categorized the following as chemicals as unlikely to be of potential concern for CI belugas: hydrocarbons (other than PAH compounds), glycols, diagnostic agents, dietary supplements, personal care products, engineered particles (<100 nanometers), or prions. Acute effects associated with oil spills and natural gas blowouts are considered in the threat type Catastrophic Events.

b. Relative Concern

Pollution occurs rangewide with localized hotspots throughout the CI belugas' habitat, at variable frequencies depending on the source of the pollution. Point source pollution enters the water from a specific source (e.g., a sewage outfall pipe; in-water construction site; etc.); these sources of pollution may result in localized effects. Non-point sources of pollution in Cook Inlet occur over broader geographic areas which can ultimately have rangewide effects (e.g., runoff from roads, airports, agricultural sites, military training areas, etc.). Individually and collectively, point and non-point source pollutants may have either local or widespread effects, depending upon the location, size and abundance of the outfall sites, time of release, tidal conditions at the point(s) of release, and characteristics of the pollutant(s).

The amount of pollution entering Cook Inlet is likely increasing as the regional human population grows, a trend that is likely to continue. However, upgrading the Asplund Wastewater Treatment Facility, Alaska's largest wastewater treatment facility, from a primary to a secondary treatment facility could make a notable difference in total pollutants released into Cook Inlet, particularly into Cook Inlet beluga whale critical habitat. The decision of whether to upgrade this facility is currently under review by the Environmental Protection Agency (EPA).

TABLE 9: Compounds of Probable and Possible Concern for CI Belugas, for which Data are Available either for Cook Inlet Beluga Whales or for Other Beluga Whale Populations.

Chemical Class	Example Individual Constituents	Level of Concern for CI Beluga	CI Beluga Data	Other Beluga Data
Chlorinated pesticides	Many banned in the U.S. in the 1970s, but are still used in other parts of the world: DDTs, aldrin, dieldrin, chlordane, endosulfan, mirex, toxaphene mixtures	Probable	Yes	Yes
Chlorinated dielectric fluids, transformer oils	Banned in the U.S. since the 1970s, but previously used as coolants and lubricants in transformers and other electrical equipment. 209 PCB congeners, aroclor mixtures	Probable	Yes	Yes
Chlorinated dibenzo-p-dioxins and furans	Not intentionally used; byproduct emitted from waste incinerators, chlorinated bleaching, wood preservation, chemical synthesis. 75 Dioxin congeners (PCDDs), 135 furan congeners (PCDFs)	Probable	No	Yes
Metals	Methyl mercury, selenium, butyltins, cadmium, arsenic*, lead*, manganese*, mercury*, organic tin*	Probable	Yes	Yes
Aryl and Polycyclic aromatic hydrocarbons (PAHs)	This is naturally occurring and also released from industrial products (asphalt, coal tar) and combustion of coal, oil, gas, wood or organic waste. Of major concern are: Benzo(a)pyrene, anthracene, pyrene, toluene*, benzene*, xylene*	Probable	No	Yes
Polybrominated flame retardants	Commonly used as flame retardants in computers, textiles, construction, and electrical equipment. Polybrominated diphenylethers (PBDEs) (PBBs, polybrominated biphenyls are no longer produced in the U.S.)	Possible	Yes	Yes
Perfluorinated Compounds	Commonly used as a water and oil repellant, protective coatings in food packaging, textiles and carpeting: Teflon coating, Perfluorooctane sulfonates, Perfluorooctanoic acid	Possible	Yes	No

* Denotes compounds with known ototoxic (i.e., damaging to hearing) effects.
Source: Modified and reproduced with permission from URS 2010, Table 5, and the factsheets

Exposure to contaminants found in pollution may be the result of CI belugas' direct contact with contaminants found in the water; inhalation of contaminants in the air; or ingestion of contaminants found in prey, mud, or silt. It is also possible that adult males may have higher levels of contaminants stored in the body than do adult females because females may have the ability to transfer some of their contaminant load to their calves during the pregnancy and lactation. There is little information on the potentially deleterious effects of contaminants on the CI beluga whale population, but it is likely that chronic exposure to contaminants may compromise an individual whale's health, with the potential for population-level impacts.

For the contaminants that have been studied, CI belugas generally have lower contaminant loads than do belugas from other populations (Becker et al. 2000, Lebeuf et al. 2004, NMFS 2008a, Becker 2009, DFO 2011, Reiner et al. 2011, Wetzel et al. 2010, Hoguet et al. 2013). Based on these results, it is possible that either the levels of pollution in Cook Inlet, or the exposure to pollution by CI belugas, is lower than that for other beluga populations. The more temperate habitat of Cook Inlet belugas compared to belugas residing at higher latitudes may help explain why persistent organic pollutants are not as prevalent in whales living in Cook Inlet[19]. Additionally, chemical analyses of water and dredging sediments from Cook Inlet found that contaminants analyzed were below management levels, some below detection limits (Frenzel 2002; U.S. Army Corps of Engineers [Corps] 2003).

The available information suggests that the magnitude of the pollution threat to CI belugas appears low. Even though the existing studies are not comprehensive of all possible contaminants to which belugas may be exposed, the comparatively low levels of contaminants documented in the CI beluga whales themselves as well as in the Cook Inlet water and sediment samples analyzed suggest that the relative concern of these known and tested contaminants to CI belugas is most likely low.

3. Threat Type: Disease Agents

a. Sources and Types of Disease Agents in Cook Inlet

A number of potential sources of disease-causing agents exist in and around Cook Inlet. Disease agents may include pathogens (such as bacteria, viruses, and fungi), parasites, and harmful algal blooms (HABs). Belugas may be exposed to disease agents through: interactions with, or proximity to, other infected belugas or other species; ingestion of contaminated material or organism; open wounds; or inhalation. Natural sources of disease include other belugas, other wild animals, and environmental and water-borne pathogens of natural origin. Anthropogenic sources of disease include untreated sewage outfalls; malfunctioning septic systems; pet waste; runoff from agricultural operations; and discharge from vessels. No comprehensive survey of disease sources or their characteristics are available. Transfer of disease and parasites between belugas and other wild or domestic species are poorly understood, and endemic disease and parasite loads of CI belugas in comparison to other populations are unknown. For an in-depth review of available information on this topic, see section IX.G – Cause of Death Analysis.

b. Relative Concern

Diseases have the potential to compromise health, reduce reproductive potential, and increase the chance of mortality. Diseases can have population-level effects throughout a species range. Although disease outbreaks among CI beluga whales are currently expected to be intermittent, climate change and increased pollution could cause an increase in disease frequency. In 2011, 62% of CI belugas photographically identified in Eagle Bay had signs of some level of current or previous infection (McGuire et al. 2014).

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[19] Alaska Community Action on Toxins website accessed January 2, 2015: http://www.akaction.org/tackling_toxics/world/global_transport_toxics_arctic.html/

The necropsy record of stranded CI beluga carcasses shows only low levels of parasitism, and parasites that were present did not appear to have a significant negative impact (i.e., were not attributed to be the cause of death). Additionally, parasites most likely would only have a detrimental effect to the individual whale, and not result in population-wide effects. Although HABs have the potential to detrimentally impact a large portion of the population, the reported incidence of HABs in Cook Inlet, and Alaska in general, is very low (RaLonde 2001; Alaska Sea Grant 2012). Thus, the threat of parasites and HABs are currently of low concern for the CI beluga population.

However, climate change is rapidly altering the global movement of pathogens, bringing diseases to new areas. Guimarães et al. (2007) modeled the dynamics of an infectious disease spreading through a reproductively isolated group of killer whales in the Pacific Northwest. That study's results indicated that small populations, such as the CI beluga population, are susceptible to population-wide disease outbreaks. A population-wide outbreak of a novel (new) disease could be catastrophic to the CI beluga population. We assume some unknown level of disease is present in CI belugas, with a medium to high probability that disease will occur in the future. Currently, the incidence of disease as a factor in the deaths of CI belugas appears to be low, and there is little evidence to suggest diseases of concern are present in other mammals in the area. As such, the threat to CI beluga recovery due a disease outbreak associated with novel pathogens is of medium concern.

4. Threat Type: Noise

Anthropogenic noise effects to CI beluga prey are discussed in the "Threat Type: Reduction of Prey" section; and cumulative effects and synergisms involving noise are considered in the "Threat Type: Cumulative and Synergistic Effects of Multiple Stressors" section.

a. Sources of Noise in Cook Inlet

The acoustic environment of Cook Inlet is naturally noisy, complex, and dynamic. Natural sources of noise are particularly abundant in the CI beluga hearing range and include: bottom substrate being transported by high currents; sand and mud bars generating breaking waves during low tide/high current periods; river mouths becoming rapids at low tide periods; and fast and pancake ice being formed during winter months and under continuous mechanical stress by high tide oscillations and currents. Furthermore, the inflow of cold freshwater of glacial origin can vary considerably near major river mouths and arms in the upper Inlet, creating a complex sound propagation environment due to changes in both salinity and temperature as a result of sharp water mass fronts. These differences in water density and temperature act as sound barriers, reflecting and refracting sound energy. In addition, the large volume of fresh water from glacial areas surrounding Cook Inlet introduces suspended glacial silt and sediments into the beluga habitat. Silt and other fine sediments suspended in the water column create acoustic clutter (a volume of scattered sound reflection) that can further impede echolocation performance. The presence of all of these natural sources of noise varies over time and space, as does their contribution to the overall ambient noise of Cook Inlet. Their contribution is important as a wide range of frequencies overlap with beluga signals, including both lower frequency ranges used for social communication and higher frequency ranges used for echolocation. The effects of these natural conditions, while difficult to quantify, may compromise CI beluga acoustic communication and echolocation, particularly as the sound transmission distance increases. Consequently, the natural acoustic space for CI belugas may be more limited than for belugas found elsewhere. This particular condition enhances the potential for negative effects when anthropogenic sources of noise are introduced into CI beluga habitat.

Due to the co-occurrence of Alaska's urban center and the current range of CI beluga, a wide variety of anthropogenic noises that could affect recovery exists, especially in the upper Inlet. Most sources of anthropogenic noise in Cook Inlet are seasonal and occur during the ice-free months, although some sources are present year-round. Sources of anthropogenic noise in Cook Inlet include: propeller cavitation, engines, and depth sounders associated with vessels; dredging activities; pile driving activities; military detonations; aircraft; airguns used for seismic surveys; drilling associated with oil and gas exploration; hydraulic/mechanical noise; and sounds associated with other noise-producing activities. Although there are several technical reports documenting specific Cook Inlet noise sources and their signal characteristics[20], a comprehensive survey of anthropogenic noise sources in Cook Inlet and beluga exposure to these sources has not been conducted. Most of the identified sources in the Inlet are not well documented, and many are not controlled, monitored, or regulated.

Due to the industrial activity and development in the current range of CI beluga, a wide variety of anthropogenic noise sources that could potentially interfere with recovery are present in the beluga habitat. Most sources of anthropogenic noise in Cook Inlet are seasonal and occur during the ice-free months, although some sources are present year-round. Sources are listed below by order of importance, based on signal characteristics and the spatio-temporal acoustic footprint. The order was determined by considering the following factors: intensity (loudness), frequency (range of tones), and duration of acoustic signal; area affected by the sound source; and duration of sounds in both seasonal terms (e.g., happening all summer) and frequency of occurrence (e.g., happening once per week throughout the summer; M. Castellote, NMFS, unpub. data).

- Tug boat noise: propeller cavitation (the formation of bubbles in a liquid) and engine noise including azimuth/bow thruster noise
- Cargo/tanker noise: propeller cavitation and engine noise including bow thruster noise
- Small vessel noise: outboard and inboard engine noise and propeller cavitation
- Dredging: suction and/or grabbing operations
- Pile driving noise: hammering or vibratory noise (rotatory or oscillatory to a lesser extent)
- Military detonations of high explosives[21]: demolition and projectile explosions in military firing ranges
- Oil/gas exploration: airgun sources for seismic survey and high power active transducers (multibeam echosounders, sub-bottom profilers, etc.)

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[20] See a sample listing of acoustic reports pertaining to Cook Inlet and Cook Inlet beluga whales available on the NMFS Alaska Region's Cook Inlet Beluga Whale Research webpage: http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/research.htm#ci

[21] Demolition activities and mortar/artillery firing on military ranges

- Shore construction noise: other than pile driving
- Oil/gas exploitation: platform noise (in-air noise radiated into the water), drilling noise (in water and/or bottom substrate), air/water vessels during operations
- Commercial jet aircraft: take offs and landing approaches
- Military jet aircraft: overflights, take offs, and landing approaches
- Propeller aircraft: overflights, take offs, and landing approaches
- Depth sounders: from vessels
- Fishing related noise (other than engine noise): hydraulic/mechanical operations
- Research related noise: sonars such as acoustic Doppler current profilers and dual-frequency imaging sonars ; scientific echo sounders and other active transducers, boat transit for photo-identification surveys, and instrument deployment/retrievals, etc.
- Pipe and cable laying operations

Climate change is having an indirect effect on ocean noise pollution (Reeder and Chiu 2010). As levels of carbon dioxide rise in the atmosphere, ocean waters are becoming more acidic. Ocean acidification reduces concentrations of seawater salts that absorb sound, particularly low-frequency sound. This ocean pH change is predicted to be greatest in higher latitudes, allowing lower frequency sound to carry farther and to be stronger at a given distance. Shallow sound channeling exists in Cook Inlet, which allows potential noise impacts to be concentrated in shallow waters and become more spatially extensive. At the same time, climate change may directly result in either an increase or decrease of in-water noise. For example, warming temperatures may reduce the prevalence of ice cover, and thus reduce ice-associated noise, but warmer temperatures may also result in higher wind speeds resulting in higher noise levels at the waters' surface.

b. Potential Effects of Noise to CI Belugas

There is an extensive body of literature regarding the effect of anthropogenic noise on marine mammal behavior. Most of the studies addressing this problem have used behavioral attributes such as changes in site fidelity, dive patterns, swimming speed, orientation of travel, herd cohesiveness, and dive synchrony to indicate possible disturbance or stress caused by noise (Richardson et al. 1995). A review and summary of available information regarding effects from anthropogenic noise to beluga hearing and behavior is presented in section IX.D - CI Beluga Hearing, Vocalization, and Noise Supplement.

Studies on belugas have revealed that anthropogenic noises have the possibility to cause threshold shifts in beluga hearing capabilities (e.g., Finneran et al. 2000, 2002a; Schlundt et al. 2000); to mask the ability of animals to hear and decipher specific sounds (e.g., Erbe et al. 1999; Erbe 2000); to result in belugas altering their vocal behaviors (e.g., Lesage et al. 1999; Sheifele et al. 2005); or to result in displacement of animals from habitats (e.g., Finley et al. 1990; Richardson et al. 1997; Harris et al. 2007).

c. Relative Concern

Anthropogenic noise, particularly the combined effect of different sound sources occurring simultaneously or consecutively, has the potential to affect beluga acoustic perception, communication, echolocation, and behavior (such as foraging and movement patterns). Behavioral effects include processes of sensitization (increased response following repeated exposure) or habituation (decreased response following repeated exposure), and physiological processes related to hearing and stress. In the long term, anthropogenic noise may induce chronic effects altering the health of individual CI belugas, which in turn have consequences at the population level (i.e., decreased survival and reproduction). Although the effects on CI beluga of the diverse types of anthropogenic noises occurring in their habitat have not been analyzed and are currently unknown, there is enough evidence from other odontocete species (and for some effects in other beluga populations) to conclude that the potential for a negative impact to CI beluga recovery is of high relative concern.

5. Threat Type: Habitat Loss or Degradation

This section does not include habitat loss or degradation from reduction of prey, pollution, or noise, which are discussed individually in other sections.

a. Sources of Habitat Loss or Degradation in Cook Inlet

In contrast to most beluga whale populations which are observed seasonally in estuarine habitats, belugas in Cook Inlet are year-round residents (NMFS 2008a). With the CI beluga population decline in the mid-1990s, the spatial distribution of the CI beluga population in the summer contracted such that whales are primarily found in the upper portion of Cook Inlet near Anchorage (Rugh et al. 2010). Range contraction proportionate to population decline is consistent with the theory that populations tend to concentrate in areas of optimal habitat during periods of low abundance and expand outside those areas during increased abundance (MacCall 1990). Upper Cook Inlet would thus represent preferred habitat, with the suitability of that habitat depending on both biotic and abiotic characteristics.

Ecological changes such as increased water temperature, siltation, and salinity changes due to changing volumes of freshwater runoff may occur over the long-term in response to climate change. Such changes may also occur due to episodic events such as earthquakes or volcanic eruptions. Anthropogenic activities can result in substantial changes in habitat, or temporary or permanent loss of habitat. Such activities include in-water construction, port expansion, highway and bridge construction, culvert placement, changes in freshwater inflow from dams, dredging and channeling (NMFS 2008a). Seasonal anthropogenic activities that disturb the substrate can re-suspend sediments and chemicals and also degrade the acoustic propagation characteristics of the habitat, whereas continuous activities, such as sewage outfalls, can alter the chemical composition, prevalence of pathogens, or temperature of the habitat, particularly in the immediate environment of the outfall. Permanent structures, such as docks, platforms, bridges, or trestles, alter localized water flow and characteristics as long as the structure exists. While losses of area from in-water fill may be quite visible, changes in benthic substrate and currents resulting from other types of human infrastructure are less obvious and may have significant impacts on available prey.

b. Relative Concern

While some habitat loss or degradation within the core range of CI belugas is evident, the population level effects of this degradation are unknown. Habitat impacts of past activities are poorly documented, and impacts of current and planned projects are not fully understood. Anthropogenic causes of habitat loss or degradation tend to be localized, seasonal, and increasing in frequency, whereas natural causes (e.g., warmer water temperatures under climate change scenarios) may operate range-wide.

All of these factors may limit suitable habitat either directly through whale disturbance (e.g., chemical impacts to skin tissue) and reduction of fitness, or indirectly through impacts to prey populations and reduced carrying capacity of the environment. Many of the anthropogenic activities affecting CI beluga critical habitat are concentrated in the coastal areas and are often seasonal. Anthropogenic activities in Cook Inlet are increasing and there is a high probability there will be more habitat loss or degradation in the future. However, most of the beluga habitat in Cook Inlet is still undisturbed and not degraded to the point that adverse effects to CI belugas are apparent. The extreme tidal ranges, land use patterns, and bathymetry of much of Cook Inlet may make it unsuitable for many types of development activities. Even though the majority of Cook Inlet is undeveloped, the loss or degradation of habitat is of medium concern for the CI beluga whale population due to a limited understanding of how this habitat might be altered by various factors and the resilience of this habitat.

6. Threat Type: Subsistence Hunting

a. Legal Subsistence Hunting

Legal subsistence hunting of CI beluga whales by Alaska Natives is currently conservatively managed; no subsistence harvest has occurred since 2005. However, some past subsistence hunting practices have had negative population level impacts on the CI beluga whale population. The dramatic decline in beluga abundance during the mid-1990s, and likely during the 1980s as well, corresponds to a time of unregulated subsistence hunting. These practices were a major contributor to the observed population decline (64 FR 56298, October 19, 1999; NMFS 2008b). This spike in subsistence harvest was largely attributed to participation by new hunters from non-traditional harvest areas.

Because the average CI beluga population estimate for 2007-2012 was below 350 whales, no subsistence hunting is authorized through 2017, as outlined in the final subsistence harvest regulations for these whales (73 FR 60976, October 15, 2008; NMFS 2008b). Per these regulations, the average CI beluga population abundance estimate from 2013-2017 will be reviewed in 2017 to determine if a legal hunt will be authorized for the five year period 2018-2022. However, because CI belugas are an endangered species, NMFS will not authorize a hunt if it is determined that the activity is likely to jeopardize the continued existence of the CI beluga whale population. Only Alaska Natives are eligible for subsistence hunting authorizations, and in order to qualify for subsistence hunting of CI beluga whales, a valid co-management agreement with NMFS must be in place. Because CIMMC disbanded in 2012, NMFS does not have a co-management agreement with any Alaska Native organization specific to CI beluga whales.

b. Relative Concern

In the past, subsistence hunts resulted in injury (if the whale was struck but lost) or mortality (if the hunt was successful). There were localized hotspots within Cook Inlet where most hunting occurred, seasonally or intermittently. However, the last CI beluga taken as a result of subsistence hunting was in 2005. The current conservative management of legal subsistence hunting means no subsistence hunts will be considered until the year 2018, and will only be authorized if the associated mortality would not jeopardize the continued existence of the species (i.e., the magnitude of the effect to the population would be low). Therefore, there is no immediate threat to the CI beluga population or its recovery as a result of legal subsistence harvests, and the relative concern is low.

7. Threat Type: Predation

Predation may represent a continuing source of mortality for CI belugas. Predation rates may be a function of the size of the predator population and availability of alternative prey, rather than by the size of the prey (beluga) population. The frequency of predator induced mortality among belugas may also be influenced by anthropogenic factors, including climate change.

a. Predation by Killer Whales

Predation by killer whales has been identified as a source of mortality for CI belugas that may be independent of the size of the beluga population and may prove to be unsustainable for such a small population. While killer whales are regularly reported in lower Cook Inlet, the majority appear to be the resident (fish eating) type that would not prey on belugas (Matkin et al. 2009). There have been no documented sightings of resident killer whales in upper Cook Inlet. Transient (marine mammal-eating) killer whales are known to prey on CI belugas (Shelden et al. 2003; NMFS, unpub. data), although rates of predation are uncertain and can only be estimated. Based on the information available, 10-13 CI beluga mortalities since 1982 were suspected to be a direct result of killer whale predation (see Table 4). Beluga predation events recorded in upper Cook Inlet appear to have involved transient killer whales, but none have matched individuals in the catalog of transient killer whales identified from the Gulf of Alaska (including lower Cook Inlet) over the past 25 years (C. Matkin, North Gulf Oceanic Society, unpub. data). Apparently the cataloged killer whales do not regularly travel to upper Cook Inlet (at least during the seasons when predation events have been reported).

A passive acoustic monitoring study examining the seasonal distribution of belugas throughout Cook Inlet (Lammers et al. 2013) also detected the presence of killer whales. Between June 2009 and May 2010, the acoustic recorders detected killer whales 17 times. Most detections were at the Homer Spit location, with a single detection at both the Tuxedni Bay and Beluga River locations. Of these 17 killer whale detections, only the one recorded near the Beluga River in upper Cook Inlet was likely from a transient killer whale, which has an acoustic behavior very different and distinguishable from resident killer whales (Barrett-Lennard et al. 1995). The killer whale detection off the Beluga River was concurrent with the presence of belugas at that site. Therefore, it appears that only a small group of transient killer whales may occasionally prey on the beluga population in upper Cook Inlet. However, there were no sightings of killer whales in upper Cook Inlet reported to NMFS from 2012 through 2014.

It is not known whether there is a relationship between the rate of killer whale predation and the reduced size of the CI beluga population or the contraction in the range of CI beluga. The shallow, highly turbid, and restricted waters of the upper Inlet provide challenges for foraging killer whales which may lead to killer whales stranding (e.g., killer whales stranded in Turnagain Arm in 1991, 1993, 2000, and 2002), and reduce the benefit of preying on belugas in that region. The presence of killer whales in Cook Inlet may also increase beluga live-stranding events, thus indirectly contributing to mortality.

b. Predation by Sharks

Sharks have been proposed as a predator of CI belugas, but there is insufficient evidence at this time to consider them a serious threat. Shark predation attempts have been suggested by tooth-rake marks on observed on beluga whales (LGL 2009), but there is no conclusive evidence that shark predation occurs. Pacific sleeper and salmon sharks are found in the region, but it is unknown whether these sharks prey on or attack living cetaceans. As water temperatures of Cook Inlet rise with climate change, the incidence of sharks in Cook Inlet may increase (O'Brien et al. 2013).

c. Predation Effects on a Small Population (i.e., predator pit)

Annual losses due to predation may depend, in part, on the density of both the predator and the prey. However, predation rates may also be partially independent of the prey population; predation rates on a small population may increase as the prey population declines. At low population levels of prey, this predator:prey relationship can create a predator pit. That is, the prey population may decrease to a level from which it cannot recover unless the predation pressure is reduced (Liermann and Hilborn 2001). Although belugas form only a small part of the transient killer whale diet, a numerically constant annual removal of belugas by killer whales from a small and declining beluga population would represent a threat that is inversely proportionate to the beluga population level.

d. Relative Concern

As previously states, there is no conclusive evidence that shark predation on CI belugas occurs. Killer whale predation on CI belugas appears to occur at fairly low levels, with only 10-13 suspected CI beluga mortalities occurring since 1982 as a direct result of killer whale predation. There is no information to suggest the level of predation by killer whales has increased over time. Rather, killer whale predation appears to occur intermittently at very low levels (e.g., three suspected CI beluga mortalities in the past 17 years). In 2008, killer whale predation was identified as a "moderate" threat in the Conservation Plan for Cook Inlet Beluga Whales (NMFS 2008) when it was assumed there was an average of one killer whale-related mortality per year. However, between January 2008 and December 2014, there have only been two suspected predation-related mortalities, and one of these two beluga carcasses was in such poor condition that a definitive determination of a predation event was not possible. No killer whale sightings in upper Cook Inlet were reported to NMFS in 2012, 2013, or 2014.

Predation is currently of low concern for the recovery of the CI beluga whale population, primarily because it occurs at such low levels, and has long been a part of Cook Inlet beluga population dynamics. However, any increase in predation removals in excess of one beluga whale per year from this small population could reduce or reverse the rate of recovery.

8. Threat Type: Unauthorized Takes

In certain instances, NMFS may authorize or permit directed or incidental "takes"[22] of CI beluga whales under the MMPA and ESA. "Directed take" occurs when an activity is intentionally harassing or harming the animals, such as occurs when conducting research on those animals; "incidental take" occurs when an activity results in harassment or harm to animals that were not the intended target of an activity, such as may occur when a construction activity introduces loud noises into the water. As part of ESA section 7 consultations, NMFS reviews and considers the effects of these types of requested takes on CI belugas to ensure authorization of these takes are not likely to jeopardize the continued existence of the CI belugas nor result in adverse modification of their critical habitat. In recent years, due to the precarious nature of the CI beluga population, no lethal takes have been authorized. NMFS has authorized a limited number of directed research projects, but the majority of the take authorizations have been for incidental take which would result in harassment only. Given that extensive reviews of the proposed activities' effects to CI belugas are conducted prior to issuing take authorizations, these authorized takes are not considered to be a threat to the CI belugas.

Activities which result in harassment or harm to CI belugas but which NMFS has not authorized (i.e., unauthorized takes) may result in changes in CI beluga behavior, displacement of CI belugas from important areas, or injury or mortality to CI beluga whales. Some activities with potential to result in unauthorized take or trauma include entanglements from fisheries operations, strikes from vessel activities, unanticipated mortalities or harassment associated with research projects, mortalities or injuries from poaching and intentional harassment, and other adverse outcomes (e.g., displacement) associated with miscellaneous activities such whale watching.

a. Sources of Unauthorized Take

Entanglements: Prior to the mid-1980s, the only reports of fatal takes of beluga whales incidental to fishing activities in Cook Inlet are from the literature (Murray and Fay 1979; Burns and Seaman 1986). While there have been sporadic reports since the mid-1980s of single beluga whales becoming entangled in fishing nets, the only known mortality associated with entanglement in a fishing net was the young CI beluga carcass recovered from a subsistence set net in 2012. Overall, the current rate of direct mortality from fisheries in Cook Inlet appears to be insignificant. There have been reports of non-lethal entanglement of CI belugas. For example, in 2005, a CI beluga whale entangled in an unknown object, perhaps a tire rim or a culvert liner, was photographed in Eagle Bay (McGuire et al. 2013), and another CI beluga was repeatedly photographed 2010-2013 with what appeared to be a rope entangled around the upper portion of its body near the pectoral flippers (McGuire et al. 2014). It is not known if these animals were able to disentangle themselves or if they died as a result of the entanglements.

[22] "Take" is defined by the MMPA as "to harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal." The listing of a species as endangered makes it illegal to "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to do these things) that species under the ESA, with certain exceptions. Similar prohibitions usually extend to threatened species.

Strikes: Most of Cook Inlet is navigable and used by various classes of water craft which pose the threat of striking to beluga whales. Presently, there are no restrictions on vessel speed limits, areas in which vessels may operate, or on the type or horsepower of vessels allowed in the upper Inlet. Due to their slower speed and straight line movement, ship strikes from large vessels are not expected to pose a significant threat to CI beluga whales. Smaller boats that travel at high speed and change direction frequently present a greater strike threat. NMFS researchers have witnessed avoidance and overt behavioral reactions by CI belugas when approached by small vessels (e.g., Lerczak et al. 2000). While ship strikes have not been a confirmed source of CI beluga mortality, a CI beluga washed ashore dead in September 2007 with "wide, blunt trauma along the right side of the thorax" that could be the result of ship strike trauma. In October 2012, a necropsy of another CI beluga carcass indicated the most likely cause of death was "blunt trauma such as would occur with a strike with the hull of the boat" (NMFS Alaska Region unpubl. data). Scarring consistent with propeller injuries has also been documented among CI belugas (Burek 1999; LGL 2009; McGuire et al. 2011). Further scar analysis would be required to estimate vessel size, and it would be difficult to determine whether the scars resulted from commercial, private, or research vessel interactions.

Research: Research activities conducted in Cook Inlet have the potential to take CI belugas. Research activities not targeting belugas, such as research activities studying CI beluga prey or habitat, may incidentally harass CI belugas. If these research projects are not authorized by NMFS, and harass or harm CI belugas, these are unauthorized takes. Directed CI beluga research activities also have the potential to harass or harm CI belugas. NMFS has authorized take associated with several CI beluga research projects over the years. Such activities have included captures, tagging activities, biopsy activities, and aerial and boat-based activities. While certain invasive and non-invasive research activities targeting CI belugas are authorized by NMFS, none of the authorizations since the ESA-listing have allowed for mortality. Since 2003, the only research effort involving contact with the whales was an effort to apply acoustic recorders to the whales via suction cup tags. The limited amount of invasive research efforts in recent years is due in part to the probability that three CI belugas died (an unanticipated outcome) as a result of a capture and satellite tagging research project in 2002. Photo-identification studies have identified and tracked seven individual beluga whales with scars attributable to the satellite tags; five of these whales were re-sighted in 2011 providing evidence that at least five whales survived a minimum of nine years after tagging (McGuire et al. 2013). With the exception of the suction cup acoustic recorders, all research activities on CI belugas since 2003 have involved non-invasive techniques (e.g., passive acoustic recordings; aerial, boat, and land-based observations; photographic studies) with a low potential to adversely affect the CI belugas. Although there is interest in pursuing a biopsy program for CI belugas, and NMFS has issued a permit to the National Marine Mammal Laboratory (NMML) for biopsies, no biopsies have been collected to date.

Poaching or Intentional Harassment: Cook Inlet is bordered by the densest human population in Alaska. This juxtaposition of people and belugas in and near coastal waters heightens the potential for illegal hunting, poaching, or intentional harassment (e.g., chasing whales with vessels). Much of the information on illegal harassment is based on data from beach-cast carcasses and anecdotal reports, which may underestimate illegal harassment due to lack of timely access to carcasses. Photographs of scars present on living CI beluga whales suggest that some injuries may be the result of illegal hunting (McGuire et al. 2011). However, there have been no reported fresh wounds or mortalities of CI belugas associated with firearms since the harvest was regulated in 1999; NMFS has documentation of only two potential gunshot victims (one in 1995 and one in 1998; NMFS AKR unpub. data). Some scars have been speculated to be healed bullet wounds or possible harpoon marks (McGuire et al. 2011), however, photo-identification studies since 2005 have not documented fresh injuries suspected to be the result of illegal hunting or harassment (T. McGuire, pers. comm., LGL Alaska Research Associates, Inc., unpub. data). There is little information available to suggest illegal hunting or harassment is currently occurring, perhaps in part due to increased awareness of the status of CI beluga whales and the prohibitions against hunting, shooting, or harassing the whales. There is little information available to suggest illegal hunting or harassment is currently occurring, perhaps in part due to increased awareness of the status of CI beluga whales and the prohibitions against hunting, shooting, or harassing the whales. The NOAA Office of Law Enforcement patrols Cook Inlet and investigates any reports of illegal hunting or harassment of CI belugas. To date, no poaching incidents have been confirmed and there have been no convictions related to illegal hunting or harassment.

Other: Other activities also have the potential to take CI belugas. For instance, although there is currently no commercial whale watching industry for CI belugas, there are numerous small boats, planes and other recreational water sports (e.g., jet skis, windsurfing, kite surfing, kayaks, etc.) in the Cook Inlet area used for personal, recreational, or commercial purposes which have been observed approaching CI belugas for closer viewing. These close approaches can result in the CI belugas changing their behavior or leaving an important area in an effort to escape the harassment caused by the close approaches.

b. Relative Concern

Unauthorized takes (i.e., those without NMFS authorization) have the potential to harass, disturb, displace, injure, or kill CI belugas. The activities of greatest concern to the recovery potential of CI beluga whales are those with the potential to injure or kill a CI beluga whale. Activities with the potential to result in unauthorized takes can be found rangewide in Cook Inlet, with certain localized hotspots. These activities are primarily seasonal, but the number of these activities in Cook Inlet is likely increasing in frequency. However, just because the activities that may result in unauthorized take may be increasing doesn't automatically correlate to an increase in unauthorized takes. The frequency of occurrence of unauthorized takes is unknown. There is a medium probability that unauthorized take will occur to some degree in the future, but the magnitude of the impact to the CI beluga population is variable, depending upon the effect. If the effect is displacement or a short-term change in behavior, the magnitude of the threat on the CI beluga population is low, but if the effect is a mortality, then the magnitude is high. However, there is little information to definitively conclude mortalities are associated with unauthorized takes. More information is available to suggest injuries may be a notable concern, but photographic data of healed scars suggest some injuries are not life threatening. Therefore, the overall relative concern of the impact of unauthorized takes is considered to be medium.

9. Threat Type: Catastrophic Events

A catastrophic event in Cook Inlet may be the result of a natural or anthropogenic event. Regardless of source, the potential for injury or mortality of CI belugas exists. A catastrophic could directly affect CI belugas (e.g., harm due to spilled contaminants), or could indirectly affect them through effects upon their habitat or prey. A catastrophic event may also be a contributing factor to a mass stranding event. A mass stranding resulting in numerous mortalities would be catastrophic to the recovery of the CI beluga population; as such, we consider mass strandings as a potential catastrophic event.

a. Potential Sources of a Catastrophic Event

Several natural factors may result in a catastrophic event with potential to adversely affect CI beluga whales, including effects from environmental or climatic changes, earthquakes, volcanos, disease outbreaks, lethal mass strandings, and failures of key salmon runs. Anthropogenic events, such as oil spills and natural gas blowouts, may also have detrimental effects on CI beluga whales. Catastrophic events may also affect CI beluga prey, whether through changes to spawning or migration patterns, direct mortality, or potential long-term sub-lethal impacts (Moles et al. 1994; Marty et al. 1997; Murphy et al. 1999).

The State of Alaska maintains a record of all spills of harmful substances. From 1994 to 2011, there were 255 events in or near Cook Inlet releasing more than 100 gallons or 100 lb (378.5 liters or 45.4 kg) of reportable substances (Alaska Department of Natural Resources, Division of Oil & Gas, 2011, unpub. data). These spills included 90 events releasing a total of 84,195 gallons (318,713 liters) of various types of oils (diesel, hydraulic, gasoline, engine lube, aviation fuel, and natural gas); 48 events releasing a total of 25,404 gallons (96,165 liters) and 11,364,847 kg (25,055,199 lb) of hazardous materials (bases or alkaline substances, drilling muds, glycols, and urea); and 73 events releasing 110,332 kg (243,241 lb) and 1,574 gallons (5,958 liters) of extremely hazardous substances (anhydrous ammonia, hydrochloric acid, and sulfur dioxide). The most significant events releasing more than 10,000 lb or 10,000 gallons (4,536 kg or 37,854 liters) are listed in Table 10 (Alaska Department of Natural Resources, Division of Oil & Gas, 2011, unpub. data). There are no reports of CI belugas being directly impacted by any of these events.

Belugas may live-strand in response to a variety of natural and anthropogenic stimuli that may occur singly or in combination, including predator avoidance, chasing prey, changes in water flow, disease, illness, injury, acoustic events, or catastrophic events. Belugas are usually able to survive through a live stranding event and escape to deeper water on the rising tide, however, some deaths do occur from these events (see Table 5). If a large number of mortalities were associated with a live stranding, the effects to the population could be catastrophic. Fortunately, mortalities associated with a live stranding event do not appear to be common. The last mortalities suspected to be associated with a live stranding event were in May 2014 when two CI belugas were found dead with evidence of glacial silt in their lungs (NMFS Alaska Region unpubl. data). Although NMFS received no reports of a live stranding, the presence of silt in the airway is indicative of a likely live stranding event. Prior to 2014, the last suspected mortalities from a live stranding event were in 2008 (Table 5). For the purposes of this section, we would consider mass mortalities associated with a live stranding as a catastrophic event.

TABLE 10: Events releasing more than 10,000 pounds or gallons of reportable substances for Cook Inlet, 1994-2011.

Year	Spill Name/Description	Region	Quantity	Unit	Substance
Refineries, Pipelines, and Production					
2003 to 2008	Agrium Ammonia	Nikiski	78,123	Pounds	Ammonia, anhydrous 37 Events
2008	Aurora Gas Moquawkie	West Kenai	11,000	Gallons	Drilling mud
2004	Marathon Beaver Creek Fire	Beaver Creek Field	21,000	Gallons	Natural gas liquid
1995 to 1996	UNOCAL	Central Kenai	57,940	Pounds	Ammonia, anhydrous 16 events
2008 to 2009	Tesoro Refinery SO2	Nikiski	104,595	Pounds	Sulfur dioxide 13 Events
1999	UNOCAL SRF	Swanson River Field	10,500	Gallons	Produced water*
Vessels					
1997	Crowley Oregon Barge	South Cook Inlet	25,000,000	Pounds	Urea (solid)

* The water produced when oil and gas are extracted from the ground.
Source: Alaska Department of Natural Resources, Division of Oil & Gas, 2011, unpub. data

b. Relative Concern

Effects from catastrophic events are variable, ranging from mortality to compromised health or injury to individual whales, reduced overall fitness or resilience of the population, or reduced carrying capacity of the environment. A catastrophic event resulting in CI beluga mortality will increase the likelihood of extinction, currently projected at a 26% probability in the next 100 years (Hobbs et al. 2008b). A catastrophic event in which only carrying capacity was affected will likely have minimal impact to the CI belugas because the population (300-400) is small compared to carrying capacity (K = at least 1300). Compared to other effects of catastrophes, decreased survival and fecundity have a much greater impact on recovery than does a decrease in carrying capacity. For example, an anthropogenic spill of some chemical in a marginal area of habitat would result in limited exposure of the CI beluga population to that chemical. However, a spill in a more centrally located area will increase the exposure to CI belugas and increase the severity of the impact, to the point recovery of the population could be delayed (Hobbs et al. 2009).

Small populations, such as the CI belugas, may be more susceptible than large populations to adverse effects resulting from catastrophic events. The reduced summer range of CI beluga whales into the upper Inlet makes them vulnerable to catastrophic events that have the potential to kill or injure a significant portion of the population. It is expected that most catastrophic events would be localized events, affecting only a portion of the CI belugas' range. However, depending on the location of the event, the exposure or effect to the whales will vary. With the exception of live strandings, a catastrophic event in lower Cook Inlet which occurs in the summer when most of the CI beluga population is in the upper Inlet will have less effect than if the same event had occurred in the upper Inlet. Fortunately, the frequency of catastrophic events in Cook Inlet has been low, and such events occur only intermittently. Although past experience has suggested the frequency of catastrophic events is low, the anthropogenic activity in Cook Inlet is increasing and environmental and climatic conditions are changing, thus the probability of a catastrophic event occurring in the future is medium to high. There is no information to suggest catastrophic events are occurring either more or less frequently than historically, thus we assume the trend is stable. The magnitude of effect of a catastrophic event on the CI beluga population is assumed to be variable and dependent upon several factors including type of event, location of event, timing of event, and exposure of whales to the event. However, we ranked the magnitude as variable, but potentially high given the fact that live strandings have been documented to result in mortalities, and mortalities have a greater and more immediate adverse effect on the recovery potential of the population than other types of effects (e.g., behavior modification; reduced carrying capacity). When we consider all these factors, we conclude the overall relative concern of the impact of catastrophic events on the CI beluga whale population to be of high concern.

10. Threat Type: Cumulative and Synergistic Effects of Multiple Stressors

a. Cumulative Effects of Multiple Stressors

While it is difficult to quantify or characterize individual stressors, it is even more difficult to quantify the potential impacts that a combination of stressors, either concurrently or sequentially, would have on beluga whale recovery. Exposure to any given stressor at a sub-lethal level may predispose individual beluga whales to greater susceptibility to mortality or long-term effects (e.g., reproductive failure) from other stressors.

Anything that affects the probability of reproduction or survival of an individual affects that individual's fitness. For example, reduced population size leads to decreased spatial distribution, making the population more susceptible to localized catastrophic events as well as limiting the choice of mates and the genetic and behavioral diversity of a population, lowering resilience to parasites or diseases, and increasing the risk of reproductive failure. Death can also result from different combinations and intensities of multiple stressors. Because body condition (one measure of health) varies among individual whales, deaths observed from the cumulative effects of multiple stressors are likely to occur over a period of time rather than as a single instantaneous event as progressively less robust individuals succumb. However, peaks in mortalities are likely to be associated with periods of greatest stress, such as over winter or during the birthing/nursing season. Environmental factors can also interact with other factors to impact beluga whale health. For example, a reduction in availability of preferred, high-lipid prey, such as salmon, will reduce individual body condition, increasing susceptibility to parasites, disease, and predation, and possibly reduce reproductive potential. Also, a period of restricted food access can cause belugas to use their fat reserves, resulting in the short-time release into the blood stream of contaminants that may have bioaccumulated in that tissue (Couillard et al. 2008a; Couillard et al. 2008b).

Cumulative impacts have been a long-standing, seemingly intractable issue in the debate over noise effects on marine mammals (Clark et al. 2009). The additive effects of multiple noise sources, as well as the combination of noise and other stressors, are of particular concern, but this field remains poorly understood (NRC 2005, Kuczaj 2007).

b. Synergistic Effects of Multiple Stressors

Perhaps more important than cumulative efforts are potential synergistic effects in which two stressors interact to cause greater harm than the sum of the effects of the individual component stressors. For example, there is the potential for synergistic effects occurring as a result of co-exposure to certain chemical pollutants and noise. Ototoxins are substances that temporarily or permanently damage hearing. These chemicals can be absorbed through the respiratory tract, the skin, or the gastrointestinal tract. Understanding the effects of these compounds on the hearing of marine mammals is limited; however, hearing deficits have been established in cetaceans, including belugas, which were treated with aminoglycosides, a class of antibiotics known to be ototoxic (Finneran et al. 2005). When exposure to ototoxic chemicals is combined with exposure to noise, hearing loss is exacerbated by increasing both the breadth and severity of permanent threshold shifts; hearing loss can even occur at subtoxic chemical and sub-traumatic noise levels when neither exposure to the chemical or noise would cause hearing loss in isolation (Steyger 2009). The synergistic effect of noise and organic solvents is more serious after repeated exposure at lower levels (Steyger 2009).

The synergistic effect between certain chemical pollutants and noise is of increasing concern in the marine environment, especially in coastal areas where chemical pollutants are concentrated. Well-known chemicals that, when combined with excessive noise exposure, can have synergistic effects on hearing in humans include organic solvents (e.g., paint, adhesive solvents, or fuel fumes), some insecticides, heavy metals like lead and mercury, and some clinical drugs known to impact hearing (e.g., aminoglycoside antibiotics). It has been shown that the physiological impact can exponentially increase if the individual is concurrently or sequentially exposed to these chemicals and noise. For example, loud noise and solvent inhalation by dockyard workers has proven to generate a hearing deficit five times stronger than the one generated just by the loud noise exposure (Sliwinska-Kowalska et al. 2004). Jet fuel vapor inhalation and jet noise exposure led to permanent hearing loss in laboratory rats; however, when rats were exposed to the same concentration of jet fuel but not exposed to noise, no effects on hearing were detected (Fechter et al. 2007). To our knowledge, these synergistic effects have not yet been described in marine mammals. However, the fact that CI beluga habitat is surrounded by many human activities that generate chemicals known to impact hearing (e.g., jet fuel from the airplane activity around the Inlet) and the fact that CI beluga habitat is noisy, raises the concern of potential synergistic effects on CI belugas from chemicals in the water and noise.

Another example of synergistic effects of multiple stressors is the toxicity among various contaminants that augment each other, whereas individual exposure to the same concentrations of those contaminants may yield little to no detectable effect (De Guise et al. 1998). There are well-documented examples of multiple stressors in terrestrial species, that individually have little impact, but when combined can have major, negative, synergistic impacts that may cause death. For example, two studies (Relyea and Mills 2001; Relyea 2003) reviewed in Sih et al. (2004) found that several species of North American tadpoles exposed to the common pesticide carbaryl at a concentration only one-third of the recommended level, suffered 10% mortality. However, when only the smell of a predatory newt was added, tadpole mortality increased to 80%, meaning that the introduction of the predator's smell somehow increased the lethality of carbaryl eightfold. This synergistic effect was even more pronounced with bullfrog tadpoles; carbaryl alone caused only 2% mortality (indistinguishable from carbaryl-free controls), but when combined with the smell of predatory newts caused 92% mortality, a 46-fold amplification. This work showed that adding the stressor (the perceived risk of predation) to sublethal concentrations of carbaryl unexpectedly increases tadpole mortality, and the drastic increase in mortality did not require that actual predation take place.

In Chester Creek, a stream draining urban areas in Anchorage and directly discharging into Cook Inlet, the pesticide carbaryl was detected in high concentrations. This broad-spectrum insecticide, widely used throughout the Cook Inlet Basin to control spruce bark beetles, was detected in 79% of the samples from this creek (Glass et al. 2004) with concentrations as great as 0.33 µg/L. Fifteen percent of the samples had carbaryl levels exceeded drinking water standards and Canadian guidelines (Canadian Council of Ministers of the Environment, 2002) for the protection of aquatic life (0.2 µg/L). Therefore, CI belugas in upper Cook Inlet near Chester Creek, and potentially in other streams with urban and residential watersheds, could be exposed to high levels of carbaryl. Since contaminants (e.g., the pesticide carbaryl) and predators (e.g., transient killer whales) may co-occur in the preferred beluga habitat, a potential for synergistic effects may exist, if, like in the case of the tadpoles, the contaminants make the belugas more susceptible to predation. We note, however, that a direct comparison cannot be made between tadpoles and belugas, and we do not have information about the level of exposure to, or absorption of, carbaryl by CI belugas. Nevertheless, these studies underscore the possibility that CI belugas might be at risk from the negative synergistic effects as a result of co-exposure to anthropogenic noise, widespread pollutants, and the presence of transient killer whales (e.g., detecting their presence acoustically without the need of actual physical encounters).

Climate change can also amplify the effects of some contaminants as climate-driven changes in temperature, pH, and salinity can alter contaminant toxicity and bioavailability (Schiedek et al. 2007). For example, the half-life of the pesticide malathion increases substantially under a lower pH, suggesting increased persistence of this contaminant under expected conditions of climate-driven ocean acidification (Relyea 2004). Malathion serves here as an example of how contaminant toxicity may change as the climate changes. There is no evidence to suggest that this pesticide, with low toxicity for mammals, short half-life in water (2-18 days), and low level of use in Alaska, is a threat to CI beluga whales.

c. Relative Concern

Predicting cumulative and synergistic effects is extraordinarily difficult, as it requires knowledge of a myriad of contextual factors for each exposure (e.g., acoustic exposure; contaminant exposure; predatory exposure), and synergistic effects can be very unpredictable (Wright et al. 2007). Because susceptibility varies among individuals in a population, and mortalities may be dispersed over time, factors contributing to synergistic or cumulative effects are difficult to detect, making mitigation of these effects challenging. Stressors related to the current small population size of CI belugas, when combined with anticipated trends of increased anthropogenic impacts, can increase the likelihood of co-occurring and interacting multiple stressors that may combine effects in a synergistic manner to the detriment of the CI belugas' recovery.

Stress resulting from anthropogenic noise, a threat of high concern, need to be evaluated in combination with other stressors because noise has been demonstrated as a component of harmful synergistic effects in several animals and humans (Steyger 2009).

Given the increase of human activities in Cook Inlet and the presence of contaminants in Cook Inlet and CI belugas, the trend for cumulative and likelihood of synergistic effects is increasing over time, with a high probability that these effects will increase with time. Cumulative and synergistic effects are categorized as a high level threat for CI belugas due to the following: 1) multiple stressors occur year-round and throughout range of the CI beluga population; 2) uncertainty regarding the magnitude of future cumulative effects; 3) uncertainty over the mechanisms of existing and future synergistic effects (if any); 4) difficulty in detecting impacts attributable to cumulative and synergistic mechanisms; and 5) difficulty in mitigating cumulative and synergistic effects due to multiple stressors.

B. State of Alaska's List of Threats to CI Belugas

The ADF&G currently uses the Alaska Wildlife Action Plan (ADF&G 2005) to assess the needs of species with conservation concerns and to prioritize conservation actions and research. The "problems, issues, or concerns" for CI beluga whales listed by the Wildlife Action Plan closely resemble the list of threats identified above (Table 8), and are as follows:

- resource prey competition with people;
- incidental mortality of belugas in fisheries (entanglements in nets, shooting);
- potential impacts from pollution and contaminants that need monitoring:
  - oil and gas developments,
  - municipal waste and bilge discharge,
  - marine oil spills;
- subsistence harvests;
- vessel interactions (recreational, commercial, high speed vessel);
- anthropogenic noise (seismic testing, vessel traffic, drilling, dredging, industrial activities like pile driving, aircraft overflights);
- predation by killer whales;
- strandings;
- potential impacts from environmental change;
- loss of genetic diversity;
- potential for ESA listing changing ability to manage, gather information, take action;
- unknowns (age-specific survival and reproduction, parasites, diet, life history parameters); and
- highly concentrated, clustered distribution increasing vulnerability (e.g., oil, spills, vessel traffic, harassment, etc.).

C. Section Summary: Threats to Recovery

At this time, it is unknown what factor(s) continue to limit growth and recovery of the CI beluga population. It may be that the cumulative or synergistic effects of multiple threats are impeding recovery whereas the effects of individual stressors in isolation would not impede recovery.

Ten potential threats are identified and assessed in this recovery plan, based on current knowledge of threat factors. Assessments were based on the information and data gaps presented in the plan's background section, as well as in the supplemental information presented in the appendices. Climate change, which has both natural and anthropogenic sources, is not addressed as a separate threat, but rather is discussed with respect to how it may affect other threats. Table 8 provides: 1) a listing of each threat discussed in this section; 2) summarizes the major effect of the threat on CI belugas; 3) qualitatively describes the threat's extent, frequency, trend, probability, and magnitude;, and 4) a qualitative rating of each threat's relative concern for CI beluga recovery.

The "problems, issues, or concerns" for CI beluga whales listed by the State of Alaska's Wildlife Action Plan closely resemble the list of threats identified here.

<u>Threat Type: Reduction in Prey</u>

The impact of reduction of available prey on CI belugas is poorly understood and may have several effect pathways including: changes in the total availability, quality, species composition, and seasonality of prey. While the potential exists for human fishing pressure to dramatically change the abundance, seasonality, or composition of beluga whale prey, fisheries in Alaska are generally managed conservatively, with in-season reductions or closures if targeted fish stocks appear to be weak. It is likely there is interspecific competition for limited prey resources between CI belugas and other predators in Cook Inlet (e.g., harbor seal, harbor porpoise). Habitat modification may result in changes in species availability and/or species composition throughout the range distribution of CI belugas. Depending on the source, a reduction of prey can be a localized event or occur rangewide, with a variable frequency of occurrence. While reduction of prey may result in reduced carrying capacity of CI beluga habitat or reduce CI beluga fitness, the magnitude of the impact of a reduction of prey on CI belugas is unknown, as is the trend and future probability. As such, the threat to CI beluga recovery due to the reduction of prey is of medium concern.

<u>Threat Type: Pollution</u>

CI belugas may be exposed to contaminants through direct contact in the water; inhalation of contaminants in the air; or ingestion of contaminants found in prey, mud, or silt. Pollution often enters the water from a specific source (e.g., a sewage outfall pipe; in-water construction site; etc.); these sources of pollution may result in localized effects. Other sources of pollution in Cook Inlet occur over broader geographic areas which can ultimately have rangewide effects (e.g., runoff from roads, airports, agricultural sites, military training areas; etc.). Thus, depending on the source of the pollution, the extent of the effect may be either localized or rangewide, with a variable frequency of occurrence. Given the increases in the human population and development of Cook Inlet, it is likely that the level of pollution entering Cook Inlet is increasing and will continue to increase in the future. However, if the Asplund Wastewater Treatment Facility, Alaska's largest wastewater treatment facility, is upgraded in the future from a primary treatment facility to a secondary treatment facility the overall pollution entering Cook Inlet could stabilize or decline in the future. It is possible that CI beluga whales have been chronically exposed to low levels of contaminants in Cook Inlet for some time. CI belugas typically have lower levels of measured contaminants stored in their bodies than do other populations of beluga whales, and thus the magnitude of the threat to CI belugas from pollution is assumed to be low. Even though data do not include assessment of all possible contaminants to which belugas may be exposed, those that have been tested appear to be a low-level threat. As such we assume that the relative concern of contaminants in general to CI belugas is low.

Threat Type: Disease Agents (Pathogens, Parasites, Harmful Algal Blooms)

Potential sources of disease-causing agents exist in and around Cook Inlet. Disease agents may include pathogens (such as bacteria, viruses, and fungi), parasites, and harmful algal blooms (HABs). The necropsy record of stranded CI beluga carcasses shows only low levels of parasitism, and parasites that were present did not appear to have a significant negative impact (i.e., were not attributed to be the cause of death). Additionally, parasites most likely would only have detrimental effects at the scale of individual whales, with population-wide effects unlikely. Although HABs have the potential to detrimentally impact a large portion of the population, the reported incidence of HABs in Cook Inlet, and Alaska in general, is very low. Thus, the threat of parasites and HABs are currently of low concern for the CI beluga population. However, climate change is rapidly altering the global movement of pathogens, bringing diseases to new areas. Small populations, such as the CI beluga population, are susceptible to population-wide disease outbreaks. A population-wide outbreak of a novel (new) disease could be catastrophic to the CI beluga population. Based on the number of whales photographed in Eagle Bay in 2011 with indications of past infection, we assume disease of some sort is present in the population at unknown levels, and recognize there is a medium to high probability that disease will increase in the future. Currently, the incidence of disease as a factor in the deaths of CI belugas appears to be low, and there is little evidence to suggest diseases of concern are present in other mammals in the area. As such, the threat to CI beluga recovery due a disease outbreak associated with novel pathogens is of medium concern.

Threat Type: Noise

The acoustic environment of Cook Inlet is naturally noisy, complex, and dynamic. Natural sources of noise are particularly abundant and loud in the CI beluga range and include: bottom substrate being transported by high currents; sand and mud bars generating breaking waves during low tide/high current periods; river mouths becoming rapids at low tide periods; and fast and pancake ice being formed during winter months and under continuous mechanical stress by high tide oscillations and currents. The effects of these natural conditions, while difficult to quantify, may compromise CI beluga acoustic communication and echolocation, particularly as the sound transmission distance increases. This particular condition enhances the potential for negative effects when anthropogenic sources of noise are introduced into CI beluga habitat. Due to the highly concentrated human population in the current range of CI belugas, a wide variety of anthropogenic noise sources that may affect fitness are present in the beluga habitat, especially in the upper Inlet. Most sources of anthropogenic noise in Cook Inlet are seasonal and occur during the ice-free months, although some sources are present year-round. Sources of anthropogenic noise in Cook Inlet include: propeller cavitation, engines, and depth sounders associated with vessels; dredging activities; pile driving activities; military detonations; aircraft; airguns used for seismic surveys; drilling associated with oil and gas exploration; and hydraulic/mechanical noise.

The effect of anthropogenic noise, particularly the combined effect of different sound sources occurring simultaneously or consecutively, has the potential to affect beluga acoustic perception, communication, echolocation, and behavior (such as foraging and movement patterns). In the long term, anthropogenic noise may induce chronic effects altering the health of individual CI belugas, which in turn have consequences at the population level (i.e., decreased survival and reproduction). Despite the fact that direct and indirect effects of these sounds on CI belugas have not been analyzed and are currently unknown, there is enough evidence from other odontocete species (including other beluga populations) to conclude that a high potential exists for negative impacts. Anthropogenic noise also has the potential to indirectly affect the survival and reproduction success of CI belugas by having negative effects to their prey. Depending on the source, a noise can be localized or occur rangewide, with a variable frequency of occurrence depending on the source of the noise. While noise may result in compromised communication and hearing of the CI belugas and may contribute to habitat degradation, the magnitude of the impact of noise on CI belugas is unknown, but potentially high. There is a high probability that anthropogenic noise in Cook Inlet will continue and increase in the future, and given that the natural noise is already limiting, the threat to CI beluga recovery due to anthropogenic noise is of high concern.

Threat Type: Habitat Loss or Degradation

Concurrent with the CI beluga population decline in the mid-1990s, the spatial distribution of the CI beluga population contracted such that whales are found primarily in the upper portion of Cook Inlet near Anchorage during the summer. Climate-driven increased water temperature, siltation, changes in volume of freshwater runoff and reduced salinity may occur gradually. However, when they result from episodic events such as earthquakes or volcanic eruptions, effects may be immediate. Examples of anthropogenic activities which can result in substantial changes in habitat, or temporary or permanent loss of habitat may include in-water construction, port expansion, highway and bridge construction, dredging, changes in freshwater inflow from dams, and river dredging or channeling. These types of anthropogenic threats tend to be localized, seasonal, and increasing in frequency, whereas natural threats may operate range-wide at either unknown or increasing frequency (e.g., warmer water temperatures under climate change scenarios). Both natural and anthropogenic factors may limit suitable habitat either directly in the form of whale perturbation and reduction of fitness (e.g., chemical impacts to skin tissue), or indirectly through impacts to prey populations and reduced carrying capacity of the environment. Most of the anthropogenic activities disturbing CI beluga critical habitat are concentrated in the coastal zone and are often seasonal. Although much of Cook Inlet is undisturbed, anthropogenic activities in Cook Inlet are increasing and there is a high probability there will be more habitat loss or degradation in the future. Concurrent with increasing anthropogenic activities in Cook Inlet, the trend of habitat loss or degradation for CI belugas is also increasing over time. Due to a limited understanding of how this habitat might be altered by various factors and its resilience to perturbations, the loss or degradation of habitat is of medium concern for the CI beluga whale population.

Threat Type: Subsistence Hunting

In the 1990s, legal subsistence hunting of CI beluga whales by Alaska Natives had a direct negative impact on the beluga whale population of Cook Inlet, however, subsistence hunting is currently conservatively managed and no harvests are authorized through 2017. Harvests after 2017 will only be considered if specific population size parameters are met, and it is determined that allowing a mortality will not jeopardize the continued existence of the CI beluga population. As such, there is no immediate threat to the CI beluga population or its recovery as a result of legal subsistence harvests, and the relative concern from subsistence hunting is low.

Threat Type: Predation

Transient (mammal eating) killer whales are known to prey on CI belugas, however, there have only been 10-13 CI beluga mortalities since 1982 suspected to be a direct result of killer whale predation. In addition to directly reducing the beluga population via mortality, the presence of killer whales in Cook Inlet may increase beluga live-stranding events. It appears that only a small group of transient killer whales may occasionally prey seasonally on the beluga population in upper Cook Inlet. No killer whale sightings in upper Cook Inlet were reported to NMFS in 2012-2014. The shallow, highly turbid, and restricted waters of the upper Inlet may lead to killer whales stranding, and reduce the benefit of preying on belugas in that region. Although predation on CI belugas by sharks has been postulated, there is no conclusive evidence that shark predation on CI belugas occurs. There is a medium probability that a low level of predation will occur at some point in the future, but if the trend remains stable, the magnitude of effect upon the CI beluga population is low. Predation is currently of low concern for the recovery of the CI beluga whale population.

Threat Type: Unauthorized Take

In certain instances, NMFS may authorize or permit directed or incidental "takes" of CI beluga whales under the MMPA and ESA, which undergo extensive reviews prior to issuance of the authorizations or permits; these authorized takes are not considered to be a threat to the CI belugas. Activities which result in harassment or harm to CI belugas but which NMFS has not authorized (i.e., unauthorized takes) may result in changes in CI beluga behavior, displacement of CI belugas from important areas, or injury or mortality to CI beluga whales. Some activities with potential to result in unauthorized take include entanglements from fisheries operations, strikes from vessel activities, unanticipated harassment or mortalities from research activities, mortalities or injuries from poaching and intentional harassment, and other adverse outcomes (e.g., displacement) associated with miscellaneous activities such as whale watching. While there have been sporadic reports over the years of individual beluga whales becoming entangled in fishing nets, the only known fishery-related mortality in recent years was the yearling CI beluga carcass recovered in 2012 from a set net. Ship strikes have not been confirmed in a CI beluga death, but there are two instances where death by ship strike was highly probable given the blunt trauma sustained by the whales. Scarring consistent with non-lethal propeller injuries has also been documented in the CI beluga whale photo-identification catalog. Research activities not targeting belugas, such as research activities studying CI beluga prey or habitat, may incidentally harass CI belugas, and if not authorized by NMFS, these are unauthorized takes. NMFS has authorized take associated with several directed CI beluga research projects over the years, including capture, tagging, biopsies, and aerial and boat-based surveys, but recent authorizations have not allowed for mortality. It is possible that three CI belugas died (an unanticipated outcome) as a result of a capture and satellite tagging research project in 2002. Since 2003, the only research effort involving contact with CI belugas was an effort to apply acoustic recorders to the whales via suction cup tags; all other directed research activities have involved non-invasive techniques (e.g., passive acoustic recordings; aerial, boat, and land-based observations; photographic studies) with a low potential to adversely affect the CI belugas. There is little information available to suggest illegal hunting or harassment is currently occurring, perhaps in part due to increased awareness of the status of CI beluga whales and the prohibitions against hunting, shooting, or harassing the whales. The lack of reports to NMFS regarding illegal hunting attempts; the absence of convictions by the NOAA Office of Law Enforcement for suspected cases of illegal hunting and harassment; the lack of mortalities associated with firearms for over 15 years; and the lack of fresh injuries documented through photo-identification studies leads to a conclusion that the threat of illegal hunting or harassment has decreased in recent years, and currently occurs at levels at or near zero. There is a medium probability that unauthorized takes will occur to some degree in the future, but the magnitude of the impact to the CI beluga population is variable, depending upon the effect. If the effect is displacement or a short-term change in behavior, the magnitude of the threat on the CI beluga population is low, but if the effect is a mortality, then the magnitude is high. The overall relative concern of the impact of unauthorized takes resulting from activities such as fisheries, vessel operations, research, whale watching and other miscellaneous activities is medium.

Threat Type: Catastrophic Events

Several natural factors may result in a catastrophic event with potential to adversely affect CI beluga whales, including effects from environmental or climatic changes, earthquakes, volcanos, novel disease outbreaks, mass strandings resulting in large numbers of mortalities, and failures of key salmon runs. Anthropogenic activities, such as oil spills and natural gas blowouts, among others, may also result in a catastrophic event with detrimental effects to CI beluga whales. Catastrophic events may also have significant effects on CI beluga prey, whether through changes to spawning or migration patterns, direct mortality, or potential long-term sub-lethal impacts. A catastrophic event on its own may not always directly adversely affect the CI belugas; rather, it may lead to a mass stranding event, which could have catastrophic results if there are multiple mortalities as a result of the stranding. Mortalities associated with a live stranding event do not appear to be common. Effects from catastrophic events are variable, and in addition to mortality, may also result in compromised health or injury to individual whales, reduced overall fitness or resilience of the population, or reduced carrying capacity of the environment, however, depending on the location of the event, the exposure or effect to the CI beluga whales will vary. Small populations, such as the CI beluga population, may be more susceptible to adverse effects resulting from catastrophic events than large populations. The reduced summer range of CI beluga whales into the upper Inlet makes them far more vulnerable to catastrophic events that have the potential to kill or injure a significant portion of the population. It is expected that most catastrophic events would be localized events, affecting only a portion of the CI belugas' range. Past experience has suggested the frequency of catastrophic events in Cook Inlet is low. Anthropogenic activity in Cook Inlet is increasing, however, as environmental and climatic conditions change. Thus the probability of adverse effects resulting from a future catastrophic event is thought to be medium to high. The magnitude of effect upon the CI beluga population of a catastrophic event is a function of several factors, including type of event, location of event, and exposure of whales to the event. However, given the history of live stranding-related mortalities, and the fact that mortalities have an immediate and greater impact to the recovery potential of the population than other effects (e.g., behavior modification; reduced carrying capacity), we ranked the magnitude of the effects of catastrophic events as variable, but potentially high. We conclude the overall relative concern of the impact of catastrophic events on the CI beluga whale population is of high concern.

Threat Type: Cumulative and Synergistic Effects of Multiple Stressors Multiple stressors occur continuously throughout range of the CI beluga population. While it is difficult to quantify or characterize effects on CI belugas from individual stressors, it is even more difficult to characterize the potential cumulative or synergistic effects from a combination of stressors. Exposure to any given stressor at a sub-lethal level may predispose individual beluga whales to greater susceptibility to mortality or long-term effects (for example, reproductive failure) from other stressors. For example, reduced population size leads to decreased spatial distribution, making the population more susceptible to localized catastrophic events as well as limiting the choice of mates and the genetic and behavioral diversity of a population, further lowering resilience to parasites or diseases, and increasing the risk of reproductive failure. Death can also result from different combinations and intensities of multiple stressors. Cumulative impacts have been a long-standing, seemingly intractable issue in the debate over noise effects on marine mammals; the additive effects of multiple noise sources, as well as the combination of noise and other stressors, are of particular concern. Perhaps more important are potential synergistic effects in which two stressors interact to cause greater harm than the sum of the effects of the stressors individually. For example, a stressor may increase cortisol levels, which in turn tends to reduce immune response. There are well-documented examples of multiple stressors in terrestrial species, that individually have little impact, but when combined can have major, negative, synergistic impacts that may cause death. In the case of CI belugas, contaminants and predators (e.g., transient killer whales) may occur in the preferred habitat, creating a potential for synergistic effects if the contaminants make the belugas more susceptible to predation. CI belugas might be at risk from the negative synergistic effects from anthropogenic noise exposures coupled with other stressors such as widespread pollutants or the presence of transient killer whales (e.g., detecting their presence acoustically without the need of actual physical encounters). Accurate prediction of all the potential cumulative and synergistic effects requires a reasonable knowledge of all the various contextual factors for each exposure and is therefore not an easy proposition. Stressors related to the current small population size of CI belugas, when combined with anticipated trends of increased anthropogenic impacts, can increase the likelihood of co-occurring and interacting multiple stressors, reducing the likelihood of population recovery in the near term. Of particular concern are the cumulative effects of multiple stressors (acoustic and non-acoustic), given the noisy environment of Cook Inlet. Given the growth of activities in Cook Inlet, the trend for cumulative and synergistic effects is increasing over time, with a high probability that these effects will continue in the future. Uncertainty over the complexity of potential mechanisms and difficulty in detection of their impacts and their potential mitigation make the cumulative effects of multiple stressors a threat category of high concern regarding potential impediments to recovery of CI beluga whales.

IV. RECOVERY STRATEGY

We know the CI beluga whale population is not recovering as expected after the regulation of subsistence hunting in 1999. What is unknown is why the population is not recovering. Before this question can be answered, more information must be obtained about the basic biology and effects of potential threats on the CI belugas. Without an understanding of this basic information, we will not be able to adequately ascertain if an increase in population size is the result of recovery, or simply a short-term response to a temporary cessation of a key threat(s). If the population is only positively responding to a short-term threat reduction, then once the threat(s) resumes the population is likely to respond negatively and any population growth will cease or decline. Thus, both the biology of the whales and effects of threats to the individuals and the population as a whole need to be understood.

This complex situation requires a comprehensive, integrated, adaptive recovery strategy. This strategy consists of data acquisition (on CI beluga biology, life history, ecology, and anthropogenic activities), integration of data sets from multiple sources, and application of these results to management (e.g., development and implementation of mitigation to avoid or reduce adverse effects), with continuous feedback between research and management actions.

In light of the recent decline, small population size, life history characteristics, and increasing number and magnitude of potential threats, it is challenging to identify the most expedient way to achieve recovery of CI belugas. Given the lack of clear reason or reasons for the failure to recover following the regulation of the subsistence harvest in 1999, in an effort to avoid expending limited resources on actions that may have little benefit to the CI belugas' recovery, the strategy of this recovery plan is to focus recovery efforts on threats identified as of medium or high relative concern (see Table 8). Therefore, the recovery criteria and recovery actions outlined in the following sections address the threats of medium or high relative concern, and do not discuss threats of low concern.

The actions in this recovery plan include research, management, monitoring, and outreach efforts that take a comprehensive approach to addressing CI beluga recovery. We expect that this strategy will have greater success than would be achieved if we focused on any one type of action. There are also actions targeted at incorporating new information and conducting regular reassessments, making this recovery plan an adaptive management plan. Threats-based recovery actions attempt to improve our understanding whether a particular threat is limiting recovery. If a threat is determined to be limiting recovery, we recommend actions to eliminate or mitigate that threat, or to improve our understanding of, and ability to manage, that threat. We recognize that situations and our understanding of situations are continually changing. If new information is obtained to suggest a medium or high ranked threat is not actually limiting recovery, or that a low ranked threat is limiting recovery, this plan allows for modifications and "course-corrections" to focus on actions that are more likely to improve the recovery potential for the CI belugas. As such, continued monitoring of the CI beluga population is essential.

Recognizing the importance of keeping the public apprised of the status and outcome of the actions, each threat type not only has recommended research and management actions, but also has a specific outreach action. In addition to addressing the threats, we recognize that steps must be incorporated into this recovery plan to continue monitoring the CI beluga population, and that management actions are required to implement this recovery plan. Thus, we also included recovery actions specific to those goals.

As such, the strategy of this recovery plan is to:

- assess and periodically reassess whether each threat identified as medium or high relative concern is likely to be limiting recovery of the CI beluga population;
- improve the understanding of the effects of recovery-limiting threats to CI belugas;
- improve the management of the recovery-limiting threats to reduce the effect of those threats on CI belugas;
- continue to monitor the status of the CI beluga population and improve the understanding of CI beluga whale biology;
- integrate research findings into current and future management actions; and
- keep the public informed and educated about the status of CI beluga whales, the threats limiting their recovery, and how they can help achieve recovery of these whales.

V. RECOVERY GOALS, OBJECTIVES, AND CRITERIA

Section 4(f)(1)(B) of the ESA requires that each recovery plan contain objective measurable criteria which, when met, would result in a determination that the species be delisted.

A. Recovery Goals

The ultimate goal of this plan is to achieve the recovery of the CI beluga whales to a level sufficient to warrant their removal from the List of Endangered and Threatened Wildlife and Plants under the ESA (delist). The intermediate goal is to reclassify the CI belugas from endangered to threatened (downlist). To downlist the CI belugas from endangered to threatened, NMFS must determine that the population is no longer “in danger of extinction throughout all or a significant portion of its range.” To delist the CI belugas, NMFS must further determine that the population is not “likely to become endangered in the foreseeable future throughout all or a significant portion of its range.” These determinations include consideration of the population’s abundance and demographic parameters, taken together with threats as identified under the ESA section 4(a)(1) factors considered for listing.

B. Recovery Objectives

When considering the listing of a species, five statutory factors (see section IX.B. History of the Listing Status of CI Belugas) are analyzed. These same factors must be considered in downlisting and delisting, with objectives related to each factor included as part of the recovery criteria. The following recovery objectives were identified for CI belugas and linked to the five listing factors:

- Ensure adequate habitat exists to support a recovered population of CI beluga whales. Habitat needs include sufficient quantity, quality, and accessibility of prey species (*Listing Factor A)*;
- Ensure that commercial, recreational, scientific, or educational activities are not inhibiting the recovery of CI belugas (*Listing Factor B*);
- Ensure that the effects of diseases and disease agents on CI beluga reproduction and survival are not limiting the recovery of the CI beluga population. (*Listing Factor C*);
- Ensure that regulatory mechanisms other than the ESA are adequate to manage threats to the sustainability of the CI belugas (*Listing Factor D*); and
- Continue monitoring the population to identify and mitigate any new natural or manmade factors affecting the recovery of CI belugas *(Listing Factor E*).

C. Recovery Criteria

The ESA requires recovery plans to incorporate “objective, measurable criteria which, when met, would result in a determination…that the species be removed from the list”. For many species, these criteria have focused primarily on a population size, trend, or some other demographic factor, but neglected to address the threats that resulted in the need to list the species. This recovery plan contains both demographic criteria and threats-based criteria for downlisting and delisting. All the demographic and threats-based criteria listed below must be met in order for the CI beluga population to be considered “recovered”; but only the downlisting criteria must be met for consideration for reclassification from “endangered” to "threatened"

(Table 11). The threats-based downlisting and delisting criteria below are organized according to the five ESA section 4(a)(1) factors (labeled A-E, respectively).

In the initial draft recovery plan the CIBRT provided to NMFS, there were over 70 recovery criteria identified which would have to be satisfied in order for these whales to be considered for delisting. Upon review, NMFS determined some were not feasible or realistic to implement, some did not contribute to recovery, and others were specific to low ranked threats. These criteria were either modified or excluded from this document. After review of the demographic criteria suggested by the CIBRT, NMFS determined that biologically-based demographic recovery criteria, specified below, would be more meaningful and effective for this species than the population viability analysis (PVA) approach recommended by the CIBRT, especially given the uncertainty around some of the PVA model parameters and available data. The CIBRT's recommendation for demographic recovery criteria, and primer text discussing the use of PVAs for recovery criteria, are presented in Appendix H for comparison.

1. Downlisting Criteria for Reclassifying the CI Beluga DPS from "Endangered" to "Threatened"

All of the following demographic and threats-based criteria must be satisfied in order to downlist the ESA status of the CI beluga whales from endangered to threatened. The threats-based recovery criteria are designed to evaluate the five ESA section 4(a)(1) factors and are organized accordingly (labeled A-E).

a. Downlising Demographic Criterion

1. The abundance estimate for the CI beluga whale DPS is greater than or equal to 520 individuals, and there is a 95% or greater probability that the 25-year population abundance trend (representative of one full generation) is positive.

Justification: NMFS considers the historical abundance estimate of 1,300 whales to be the carrying capacity of CI belugas. The 2014 abundance estimate of 340 belugas represents roughly one quarter (26%) of carrying capacity. The threshold of 520 whales represents 40% of carrying capacity and is a level which the population should not be considered in danger of extinction assuming it has exhibited positive population growth over the previous generation (previous 25 years) and threats have been adequately addressed. We recognize there is variability around survey point estimates, and a single population point estimate may over- or under-estimate the true population size. Survey variance should be taken into consideration as the population size approaches 520 to help ensure that consideration of downlisting is not based solely on anomalous conditions and accounts for the population trend over a full generation.

b. Downlisting Threats-based Criteria

Listing Factor A**:** The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

Objective: Ensure adequate habitat exists to support a recovered population of CI beluga whales. Habitat needs include sufficient quantity, quality, and accessibility of prey species.

A.1 Observations indicate that prey abundance is not limiting recovery and beluga whale fitness, survival, and reproduction suggest good body condition in a significant number of CI belugas comparable to a healthy reference population. Available data on body condition from necropsies and photo-identification studies indicate that the mean of body condition index parameters for this population are within two standard deviations of the same index parameters for healthy, stable or increasing beluga populations. If body condition index parameters are not available for comparison, then this criterion may be met if 95% of CI belugas sampled within the most recent 10 years are determined by cetacean experts to display no signs of poor nutrition.

A.2 Research programs have been initiated to determine the metabolic requirements and foraging efficiency of CI belugas, with a goal of assessing the amount of prey necessary for population growth vs. maintenance.

A.3 The level at which acoustic impacts begin to result in a decrease of individual fitness, survival or reproductive success of CI beluga whales has been determined.

A.4 The summer range of the CI belugas expands so that it reaches the historic range as documented by Rugh et al. (2010) for the area where 95% of CI belugas were observed during the time period 1993-1997 (see Figure 7 in this plan), and as determined by at least the most recent six years of survey data comprised of at least three biennial abundance surveys.

A.5 The habitats that CI belugas are using are sufficient to meet the needs for reproduction, survival, and recovery of a threatened population as defined by the demographic criterion.

A.6 An outreach program has been established which provides voluntary guidelines to commercial, recreational, scientific, and education users of Cook Inlet regarding methods to reduce/avoid human-caused trauma or harassment of CI belugas.

<u>Listing Factor B</u>: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Objective: Ensure that commercial, recreational, scientific, or educational activities are not inhibiting the recovery of CI belugas.

B.1 The best available scientific data indicate that activities that directly affect CI belugas (i.e., commercial, recreational, educational whale watching, research, or other uses) or have the potential to cause injuries or mortalities to CI belugas are not limiting recovery (e.g., by reducing individual beluga whale fitness, survival, reproduction, or the carrying capacity of Cook Inlet).

B.2 All research on CI beluga whales is conducted under protocols that include methods to mitigate or avoid delays in the recovery of CI beluga whales.

<u>Listing Factor C</u>: Disease or Predation

Objective: Ensure that the effects of diseases and disease agents on CI beluga reproduction and survival are not limiting the recovery of the CI beluga population.

C.1 CI beluga deaths due to disease agents (e.g., pathogens, parasites, and harmful algal blooms) are sufficiently below CI beluga recruitment levels to allow for population growth even when deaths due to other causes are included. In other words, "CI beluga population growth rate remains positive over at least a 10-year period, despite effects of disease and all other sources of mortality combined."

Listing Factor D: The Inadequacy of Existing Regulatory Mechanisms

Objective: Ensure that regulatory mechanisms other than the ESA are adequate to manage threats to the sustainability of the CI belugas.

D.1 Cook Inlet fisheries management programs account for the energetic needs of CI belugas and allow for adequate numbers of prey to sustain a recovering population.

D.2 Oil spill prevention and response plans are more protective than those in place at the time of the CI beluga listing, and as appropriate, specifically provide protections for CI belugas.

D.3 Subsistence harvest is managed in accordance with the Final Rule for the Taking of Cook Inlet Alaska Beluga Whale Stock by Alaska Natives (73 FR 60976) which ensures that harvests are sustainable and do not contribute to declines in this population.

D.4 Management actions take into consideration cumulative and synergistic effects of current and proposed activities that may limit recovery (e.g., by reducing individual beluga whale fitness, survival, reproduction, or the carrying capacity of Cook Inlet).

D.5 CI beluga foraging and reproductive habitats (e.g., calving, nursing) are protected through appropriate management measures (e.g., time and area closures) to ensure the integrity of these habitats for meeting the needs of a growing CI beluga population.

Listing Factor E: Other Natural or Manmade Factors Affecting its Continued Existence

Objective: Continue monitoring the population to identify and mitigate any new natural or manmade factors affecting the recovery of CI belugas.

E.1 A comprehensive stranding response program for CI belugas: 1) is implemented in partnership with the CI beluga stranding network members, 2) establishes protocols for responding to live strandings and/or tracking belugas after a live stranding event, 3) collects data to determine cause of death (e.g., disease, injury, predations, etc.), and 4) includes annual drills to review and practice stranding response protocols.

2. Delisting Criteria for Considering the CI Beluga DPS "Recovered"

The CI beluga population will be considered for "delisting" and hence, recovered (i.e., no longer classified as an endangered or threatened species) when, in addition to meeting the downlisting criteria above, the following demographic and threats-based delisting criteria are also met. The threats-based recovery criteria are designed to evaluate the five ESA section 4(a)(1) factors and thus are organized accordingly (labeled A-E). There are no additional delisting criteria identified for Listing Factors B or C beyond those previously identified for the downlisting criteria.

a. Delisting Demographic Criteria

1. The abundance estimate for the CI beluga whale DPS is greater than or equal to 780 individuals, and there is a 95% or greater probability that the 25-year population abundance trend (representative of one full generation) is positive.

Justification: NMFS considers the historical abundance estimate of 1,300 whales to be the carrying capacity of CI belugas. The 2014 abundance estimate of 340 belugas represents roughly one quarter (26%) of carrying capacity. The delisting threshold of 780 whales represents 60% of carrying capacity, and is a level which the population would be considered unlikely to become endangered within the foreseeable future within all or a significant portion of its range assuming the population has exhibited positive population growth over the previous generation (previous 25 years) and threats have been adequately addressed. We recognize there is variability around survey point estimates, and a single population point estimate may over- or under-estimate the true population size. Survey variance should be taken into consideration as the population size approaches 780 to help ensure that consideration of delisting is not based solely on anomalous conditions and accounts for the population trend over a full generation.

b. Delisting Threats-based Criteria

Listing Factor A: The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

Objective: Ensure adequate habitat exists to support a recovered population of CI beluga whales. Habitat needs include sufficient quantity, quality, and accessibility of prey species.

A.1 The type, amount, and quality of prey available to CI belugas is not limiting recovery (e.g., by reducing individual beluga whale fitness, survival, reproduction, or the carrying capacity of Cook Inlet).

Listing Factor D: The Inadequacy of Existing Regulatory Mechanisms

Objective: Ensure that regulatory mechanisms other than the ESA are adequate to manage threats to the sustainability of the CI belugas.

D.1 A written agreement signed by NMFS and the State of Alaska is implemented which describes: how the State's fishery management plan for Cook Inlet salmon and eulachon is linked to goals for stock specific spawning escapements which provide sustained yield for harvest and account for prey needed by belugas (and other ecosystem components); how such a plan minimizes the take of CI belugas pursuant to fishery activities in State waters of Cook Inlet; and how future actions taken by the State will comport with the MMPA.

D.2 A cooperative program, which includes coordination with local authorities to obtain sufficient information about human activities affecting Cook Inlet, is in place to reduce the negative impacts of noise-producing activities.

Listing Factor E: Other Natural or Manmade Factors Affecting its Continued Existence

Objective: Continue monitoring the population to identify and mitigate any new natural or manmade factors affecting the recovery of CI belugas.

E.1 A post-delisting monitoring plan for CI belugas is developed and approved prior to delisting.

E.2 Information available about the effects of stranding-associated morbidity and mortalities determines that live strandings are not impeding recovery of CI belugas.

E.3 Information available regarding cumulative and synergistic effects of multiple stressors indicates that they are not limiting recovery (e.g., by reducing individual beluga whale fitness, survival, reproduction, or the carrying capacity of Cook Inlet).

TABLE 11: Criteria for Considering Reclassification (from endangered to threatened, or from threatened to not listed) for Cook Inlet Beluga Whales.

Status	Demographic Criteria		Threats-based Criteria
Reclassified to Threatened *(i.e., downlisted)*	The abundance estimate for the CI beluga whale DPS is greater than or equal to 520 individuals and there is a 95% or greater probability that the 25-year population abundance trend (representative of one full generation) is positive.	**AND**	The 15 downlisting threats-based criteria are satisfied.
Reclassified to Recovered **(***i.e., delisted***)**	The abundance estimate for the CI beluga whale DPS is greater than or equal to 780 individuals and there is a 95% or greater probability that the 25-year population abundance trend (representative of one full generation) is positive.	**AND**	The 15 downlisting and 6 delisting threats-based criteria are satisfied

VI. RECOMMENDED RECOVERY ACTIONS

This section provides a listing of recommended research, management, and education/outreach actions targeted at achieving recovery of this DPS. These recommended actions are organized into two categories: *Population Monitoring and Recovery Plan Implementation Actions* and *Threats Management Actions.* The *Population Monitoring and Recovery Plan Implementation Actions* recognize the importance of continuing to monitor the population, not only to improve our understanding of the whales but also as a means to determine if recovery of the CI beluga population is occurring. These actions are also designed to allow for the implementation and oversight of recovery activities. The *Threats Management Actions* encompass actions aimed at assessing and managing the threats ranked as of medium- and high-relative concern.

The *Threats Management* actions are further subdivided based upon the threat type to which the action relates. Each medium- or high-ranked threat type has three subsets of actions:

1. Actions that allow us to assess whether that threat is limiting CI beluga recovery;
2. If the threat is limiting CI beluga recovery, then these actions allow us to improve understanding of the threat; improve understanding of the threat's effect upon the whales; and improve management of the threat; and
3. Outreach action(s) to ensure the public is informed of the status of that threat and actions taken, if any, to reduce the effect of that threat to the CI belugas.

In general terms, the actions in this section are structured in the following manner:

<u>Population Monitoring and Recovery Plan Implementation Actions:</u>

1. *action (e.g., to monitor population, increase population understanding, or implement recovery plan)*
2. *action (e.g., to monitor population, increase population understanding, or implement recovery plan)*
3. *action (e.g., to monitor population, increase population understanding, or implement recovery plan)*
4. *etc.*

<u>Threats Management Actions:</u>

Threat Type X

5. *Actions to determine if threat type X is limiting recovery*
   - *5.a. action to determine if limiting recovery*
   - *5.b. action to determine if limiting recovery*
   - *5.c. etc.*
6. *<u>IF</u> threat type X is determined to be limiting recovery, <u>THEN</u>*
   - *6.a. action (e.g., to obtain more info about effect of threat type X, mitigate threat type X, reassess if threat type X is still limiting recovery)*

6.b. action (e.g., to obtain more info about effect of threat type X, mitigate threat type X, reassess if threat type X is still limiting recovery)

6.c. action (e.g., to obtain more info about effect of threat type X, mitigate threat type X, reassess if threat type X is still limiting recovery)

6.d etc.

7. Outreach Action(s) pertaining to threat type X

The narrative provided for each action is intended to provide guidance to resource managers, stakeholders, industry, researchers, and the public. These actions are intended to reduce or eliminate medium- and high-ranked threats and recover the CI beluga population. These recommended actions are forward looking and do not include those actions previously recommended by the CI Beluga Recovery Team which NMFS or others have already implemented or are in the process of implementing, nor does it include tasks that address a threat of low concern. For example, the following are a few of the CI Beluga Recovery Team recommended recovery actions which were omitted from the set of recommended recovery actions in this plan (*reason for exclusion in italics)*:

- Monitor abundance and distribution of harbor seals in Cook Inlet (*already a component of tasks conducted by NMFS*);
- Conduct a workshop to consider the risks and benefits of a darting biopsy program for CI belugas (*NMFS hosted a CI beluga biopsy workshop in April 2014*);
- Assess airborne contaminants and particulates in primary CI beluga habitat (*ranked as a threat of low concern*);
- Enforce noise impact mitigation requirements (*already a component of tasks conducted by NMFS*);
- Evaluate the CI beluga photo-identification catalog for signs of vessel impact on whales (*NMFS funded a comprehensive CI beluga photo-identification catalog synthesis review in 2012; any information regarding vessel impacts will be a component of the report*); and
- Review beluga stranding records and the CI beluga photo-identification catalog for documentation of shark bite scars on belugas (*shark predation was ranked as a threat of low concern*).

We recognize that implementing the recommended recovery actions listed in this section are not the only viable path forward, and that actions not included in this plan may contribute to recovery of the CI beluga whales. For example, there may be better methods for assessing if a particular threat is limiting recovery. We also recognize that some research or monitoring actions may be dependent on continued funding, and may not be achieved if funding is unavailable. Actions intended to obtain the same information as actions contemplated in this plan should not be dismissed just because they are not included in this plan. Also, any action which may harass or harm the CI belugas, even if on this list, should first involve discussions with NMFS AKR staff to ensure the benefits to CI beluga recovery outweigh the potential costs to individual whales or the population. Actions which may result in any form of take to CI belugas must be authorized by NMFS well in advance of the proposed implementation date.

A. Recovery Actions and Narrative

POPULATION MONITORING AND RECOVERY PLAN IMPLEMENTATION ACTIONS:

1. *Continue to conduct aerial and photo-identification surveys to estimate abundance, and analyze population trends, calving rates, and distribution.*

Aerial surveys of belugas conducted by NMFS are used to derive population estimates, a calf index, and distribution and movement patterns. Results provide a long-term record of population trend. Results of aerial surveys were used in the ESA listing decision, to determine critical habitat, and to determine whether the population has reached the numerical threshold required before subsistence hunting can legally resume. While conducting aerial surveys less than annually will result in reduced precision in the short term trend estimates, trends greater than 10 years may not require annual results. Of particular value are synoptic[23] distribution data that are not available by any other means for Cook Inlet.

A photo-identification study of CI beluga whales has been ongoing since 2005. The photo-identification study has the potential to provide information about individual and population characteristics of CI beluga whales including survivorship, calving rates, maternal investment to calves, residency and movement patterns, and life history characteristics for many individually identified beluga whales, including mothers with calves. The current non-invasive methods should be continued into the future.

2. *Create and support a CI Beluga Recovery Coordinator position.*

The biggest challenges in creating this recovery plan were: (1) a lack of information; and (2) identifying and accessing information that already existed. The CIBRT recommended that NMFS hire a full time, permanent Cook Inlet Beluga Recovery Coordinator based out of Anchorage, Alaska, to serve as a central point of contact for all information and activities relevant to CI beluga recovery. We note that NMFS has on staff Recovery Coordinators for the Hawaiian monk seal, Steller sea lion, and Pacific salmon.

The duties of the Cook Inlet Beluga Recovery Coordinator should include the following:

- coordinate and support CI beluga research activities
- organize an annual late-winter CI beluga research workshop to:
  - review strandings and carcass data from the previous year
  - review research results from the previous field seasons
  - plan and coordinate future research for upcoming field seasons and for longer-term projects, with the goal of increasing collaboration among projects and information acquired
- coordinate management, monitoring, and mitigation activities (consultations, regulations, take allocations, and permits)

[23] data obtained nearly simultaneously over a large area

- create and maintain a CI beluga geospatial database with information from research projects, strandings, sightings, environmental data, prey data, and monitoring and mitigation efforts. Make data available to researchers, stakeholders, industry, and the public. Duties include archiving, managing, and disseminating information from multiple sources
- coordinate the CI beluga stranding network and stranding data
- develop sighting networks, and educational outreach
- coordinate a community-based beluga and habitat monitoring program
- keep current on global beluga research (including captive animals) and update the CI beluga research and stakeholder community
- maintain and expand the current library of beluga related research papers, monitoring reports, gray literature (unpublished reports), conference posters, presentations, permits, and take allocations; these items should continue to be made available to the public on the NMFS Alaska Region website
- improve communications and coordination among various NMFS offices - the Anchorage field office, the regional office in Juneau, NMML, the national permit office, the national stranding program office, and the national recovery program office; improved communications with the MMC, ADF&G, and NGOs would also be a goal of this position

3. *Create and support a CI Beluga Recovery Implementation Task Force.*

A CI beluga recovery implementation task force should work with and advise the Cook Inlet Beluga Recovery Coordinator. The group, led by the Coordinator, should meet annually to review recovery progress and to oversee implementation of recovery actions recommended by this recovery plan.

4. *Increase efforts to identify and monitor individual CI belugas, coordinating photo-identification, genetic studies, and body condition assessments via biopsy samples of skin and blubber.*

Identifying and quantifying threats to the CI belugas will require obtaining a great deal of information about the individual animals that remain. To maximize our ability to detect and quantify risks, we recommend that the existing individual CI beluga photo-identification database that is primarily photo-based be expanded to include genetic identification and data gathered from any future biopsy sampling effort. This would provide a multidimensional record of individual histories to include information on movements, and interactions among genetics, reproductive states, condition, stress levels, and other health indicators. In turn, these results can be analyzed to estimate abundance, determine age structure, mating patterns, and social structure, and to detect changes in fecundity, health, condition, and mortality risk with respect to variation in environmental and anthropogenic factors.

5. *Determine annual mortality and reproductive rates of CI beluga.*

Promote and coordinate research efforts to measure and monitor annual mortality rates and reproductive rates of CI belugas and relate these to variation in available prey and other environmental variables. A number of research methods such as skin and blubber biopsy, photo-identification, stranding investigation, aerial survey, or scat collection can contribute data to this effort. Analyses such as mark recapture using photo-identification and genetic data, hormone levels in scat or blubber, and population distribution, abundance and calving rates from aerial survey and individual database data will contribute to this effort. Knowing the relative significance of change in reproduction versus survival rates may also guide other research.

6. *Conduct regular biopsy surveys of CI belugas to monitor changes in condition and reproductive success in relation to environmental changes.*

Body condition, contaminant loads, reproductive status, and stress levels can be monitored using a skin and blubber biopsy (this sampling approach has been effective and benign on a number of species). Regular biopsy surveys of the CI beluga could provide data necessary to relate survival and reproductive success to environmental and anthropogenic factors and could better inform population models. A biopsy protocol should be developed and adhered to.

Note: Because this recovery task involves invasive methods, it will require both MMPA and ESA authorizations from NMFS. Inclusion of an invasive research activity as a recovery action is not intended to imply NMFS support or to signal that NMFS will authorize such a project. Any invasive research project for CI belugas should be developed in conjunction with the NMFS Alaska Region.

7. *Monitor threats ranked low to determine if the status has elevated to the point specified actions need to be defined.*

Given changing conditions in Cook Inlet, either from environmental forces (e.g., as a result of climate change or an increase in predation) or anthropogenic activities (e.g., increased development), threats currently ranked as being of low relative concern may be of greater concern in the future. Due to the uncertainty of the level of change or the effect of change, we cannot entirely dismiss low-ranked threats. The status of the low ranked threats should be reassessed periodically to ensure the recovery program remains strategic and effective in addressing the threats that matter most at a given time.

8. *Organize an annual review and coordination workshop to review existing data on individual CI belugas, plan expansion of future data collection and analyses, and facilitate linkage of all existing and new CI beluga-related research.*

NMFS should hold annual workshops to review and integrate existing CI beluga data, to discuss approaches to collecting more integrative individual data in the future, and to plan analyses that would improve our understanding of the CI beluga population. One of the midwinter meetings in Anchorage, such as the Alaska Marine Science Symposium or the Forum on the Environment, should be used for an annual public review of CI beluga research findings and future research plans.

The CI beluga population is sufficiently small that data on individual whales' histories are needed to identify and quantify risks to this small population. Currently only photo-identification data are collected in a systematic manner. Other types of individual data such as genetics, acoustics, contaminant loads, body condition and mortality are collected opportunistically and held by several different research groups. Hosting an annual research workshop to connect projects working on different analyses would also encourage sharing of data, and maximize linkages among the stranding response program and other ongoing research efforts.

The CI belugas that are necropsied or sampled alive can be identified and linked to individuals in the photo-identification catalog, which also maintains a sighting history (i.e., dates and locations individuals have been seen, as well as group associations and female reproductive history). Expanding the database to be a multidimensional record of analytical findings from individual whales, paired with each individual's life history, would allow synergistic analyses across disciplines. Meta-analysis of life history information, contaminant levels, and other findings from related analyses could better highlight critical life stages and/or contaminants.

9. *Hold a workshop to consider the feasibility, risks and benefits of different sampling techniques such as breath capture, remote ultrasound, and live captures to obtain samples and measures for further analyses.*

A complete health assessment requires capture of a beluga for blood sampling and other procedures, but can provide invaluable information not generally obtainable by other less invasive techniques, such as crossbow biopsies or breath capture. Such less invasive techniques can provide some information about the health of an animal and do not require capture and handling of animals. However, these techniques still require close approaches to the whales to collect samples (and therefore pose a risk of physical harm) and also carry the risk of disturbing animals due to close boat approaches and related exposure to boat noise. Caution in close approaches is warranted to ensure that the research itself does not adversely affect the whales or alter their behavior.

Before committing to or approving any large-scale invasive research sampling program of CI belugas, NMFS should convene a workshop to review research techniques and CI beluga behavior, and to recommend best practices that will minimize impacts to CI beluga and ensure maximum benefits from the sampling. Workshop participants should consider the risks and benefits of all available procedures, develop recommendations for sampling and assessment, and specify which information can only be obtained through live captures. The workshop should also develop a protocol to monitor the effects of such sampling, including criteria to determine whether sampling should be discontinued if adverse effects are detected. Potential protocols should be evaluated through a pilot study with a healthy beluga population before being applied to the Cook Inlet population. The report from a NMFS-sponsored workshop specific to biopsy sampling is available on the NMFS Alaska Region website (www.alaskafisheries.noaa.gov).

10. *Conduct a workshop to update a model to determine the probability of extinction of CI beluga.*

The PVA model used by NMFS in the decision to list CI belugas as endangered should be reviewed, and if appropriate, updated at each 5-year review or status review to include information available following the 2008 listing. The updated population model should include spatial distribution, and incorporate explicit models of threats and those threats' interactions and impacts on CI beluga survival and reproduction by age and sex. The model should also address levels of quasi-extinction[24] and thresholds that result from small population effects. A workshop,

[24] Quasi-extinction is defined as the population threshold where risk factors such as inbreeding depression, loss of genetic diversity, vulnerability to disease, vulnerability to predation, or dependence on limited resources intensify as the population declines to the point that there is no possibility of recovery for the population. This is

or series of workshops, should be conducted to address these issues, possibly following the model of the SouthEast Data, Assessment, and Review (SEDAR) program[25]. Workshop topics could include: 1) defining what data are missing and discussing how to design and fund studies to obtain the missing data; 2) compiling and reviewing the latest data to be used in the PVA; 3) developing a PVA which incorporates various threats and considers cumulative effects; and 4) evaluating the results from a new PVA to estimate probability of extinction. If these topics are covered in a series of workshops, the first cycle of workshops should begin in 2015, with no more than four months between each workshop, and the final workshop concluding within a year of the first one. This workshop(s) should repeat on a five-year cycle, incorporate new information, and be compatible with the five-year update requirement for NMFS ESA status reviews.

11. Create an annual Cook Inlet Beluga Watch Day.

Using the example of the Audubon Society's Christmas Bird Count, or the "Whale Watch Week" along the Oregon Coast, create an annual Cook Inlet Beluga Watch Day to promote local pride, awareness, and stewardship of Cook Inlet and CI belugas. Select a day to conduct Inlet-wide beluga counts, educational talks, public service announcements, and outreach events. Ideal days would be in late August when whales are most-visible around Anchorage and along Turnagain Arm, and when many summer visitors are still in the state and local schools are back in session; alternatively a day in the spring when many schools in southcentral Alaska would be available to participate during Sea Week.

<u>THREATS MANAGEMENT ACTIONS:</u>

<u>Prey Reduction</u>

12. Assess if the availability or quality of food is limiting CI beluga recovery by adversely affecting CI beluga reproduction or survival.

A primary uncertainty in trying to understand the failure of the CI beluga population to recover is whether the quantity or quality of available prey is limiting population recovery through constraints to CI beluga reproduction and/or survival. Prior to conducting expensive research or changing fisheries management plans, it is important to conduct analyses to understand if a reduction in prey is occurring and if so, the effect such reductions are exerting upon CI beluga recovery.

12a. Evaluate how prey abundance has changed over time in comparison to CI beluga abundance and if there are direct correlations between the two suggestive of a positive link between prey abundance and CI beluga abundance, productivity or mortality.

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likely beyond a level that is fully accounted for in the PVA model so that while extinction may be considered certain, the timing of extinction may not be well determined. For example, Krahn et al (2004) defined the quasi-extinction level for Southern Resident killer whales as the level at which the population would be "doomed" to extinction, even though literal extinction might still take decades for long-lived mammals.

[25] The SEDAR website can be found at: http://www.sefsc.noaa.gov/sedar/

Abundance estimates are lacking for many potential prey within the range of CI belugas. However, some information may be generated by examining historical trends in population indices. In particular, a retrospective analysis should be conducted to explore correlations among annual deviations in population indices of CI beluga and their potential prey. One particular aspect to be examined is the potential impact that expansion of northern pike may have had on the abundance of CI beluga prey. Any such analysis is likely to be highly qualitative, as data on many of these parameters (especially time series of abundance for non-commercial fish prey species) are lacking.

12b. Monitor body condition of living and deceased CI belugas to assess the presence/absence of nutritional distress or nutritional-related mortalities, and determine the percentage of necropsied CI belugas with mortalities attributed to nutritional distress.

Body condition of individual CI belugas can provide insight to the nutritional status of the whale. For live whales, non-invasive methods such as photo-identification studies or minimally invasive methods such as biopsies may prove useful for assessing body condition over time. Necropsies of dead whales and subsequent analyses of samples will be necessary to determine if nutritional distress was associated with cause of death. A review of the photo-identification catalog and previous necropsy reports looking for evidence of nutritional distress or nutritional-related mortalities may be useful in determining the proportion of the population that may be exhibiting signs of nutritional distress. However, any assessment will have to take into consideration the seasonal changes in CI beluga body condition (animals thin out during the winter and fatten up during the summer). Assessments should also consider that poor body condition of a dead whale may be associated with a condition unrelated to prey abundance. Also, body condition may not be responsive to nutritional stress until that condition becomes severe. This is because a portion of the blubber may be dedicated to insulation rather than active energy storage, and not reduced until other fat reserves are depleted.

12c. Analyze the existing collection of CI beluga teeth to determine if the age at first reproduction for each individual female CI beluga for which teeth are available can be determined, and assess if there has been a significant change in the age at first reproduction over time.

In addition to assessing body condition, which may be misleading for various reasons, another method to try to determine if animals are experiencing nutritional distress is to examine the age at first reproduction. If the age at first reproduction increases over time (i.e., the first reproduction occurs later in life), it may be an indication of nutritional stress adversely affecting reproduction, whereas a decrease in age at first reproduction over time (i.e., the first reproduction occurs earlier in life) may indicate that food is not limiting recovery. Studies have successfully analyzed teeth to determine the age at first reproduction (e.g., see vonBiela et al. 2008). This is a non-invasive method that does not require any harassment or harm to living CI beluga whales, as the teeth are collected only from dead whales and CI beluga teeth have previously been analyzed for age. NMFS is currently in possession of previously collected teeth. This methodology has the potential to improve our understanding of whether CI belugas are nutritionally stressed, and could more accurately and precisely define an important life history parameter (age at first reproduction) which is currently extrapolated for the CI beluga population from other beluga populations and captive belugas.

12d. Review available data which may provide information about calving rate and assess if the calving rate (population-wide) or calving interval (individual whales) is correlated with prey abundance.

When animals are nutritionally stressed they may forego or postpone costly reproductive activities until they have the energetic reserves to undertake such a physically costly activity. Like age at first reproduction, changes in the calving rate may be correlated with individual health and food availability. If there is a reduction in prey, the calving rate may decrease, or the calving interval may increase. Thus, information about calving rate and calving interval collected via photo-identification surveys or systematic aerial surveys, or other non-invasive methods, should be reviewed to determine if there has been a change in these life history parameters over time, and to see if there is any correlation in the calving rate with prey abundance.

13. If at least two of the actions under item 12 above are strongly suggestive that prey availability or quality is limiting CI beluga recovery, improve 1) the understanding of CI beluga prey dynamics, CI beluga energetic requirements, and interspecific competition; and 2) the management of fisheries to accommodate CI beluga consumption requirements.

Survival and recovery of CI beluga whales depend on an adequate quantity, quality, and accessibility of prey resources. At this time, there is only limited information on the characteristics of potential prey in CI beluga habitat, and available data are largely from the summer season. To develop appropriate mitigation measures, it is imperative that information on available prey resources be collected and monitored to determine which, if any, prey resources may be limiting CI beluga recovery and to ensure implemented mitigation measures have the greatest likelihood of facilitating CI beluga recovery. Throughout this research, it is critical that emphasis be placed on determining prey quality (e.g., energetic content, contaminants, stable isotopes, and fatty acids) because a large quantity of poor-quality prey may have little utility to CI belugas relative to high-quality prey. Increased information allows a focus of mitigation efforts on aspects likely to promote, or not inhibit, CI beluga recovery.

13a. Research the seasonal and spatial variation in prey distribution, diversity, and quality to improve assessments of relationships between CI belugas and their prey.

Because not all CI beluga prey species are created equal, and the nutritional characteristics of a given prey species vary seasonally, research is needed to understand the quantity, quality, and distribution of prey available in CI beluga habitat and how these characteristics vary spatially and seasonally. Although some information is available on the upstream spawning escapements of some species in select Cook Inlet tributaries, this does not provide a clear understanding of the prey available in the marine/estuarine areas, particularly in upper Cook Inlet where belugas occur. There is also a severe lack of information on prey available from late fall to early spring, and on the quality of CI beluga prey resources (e.g., energy content, contaminants, stable isotopes, fatty acids). Standardized surveys are needed to determine the spatial and seasonal distribution of beluga prey in upper Cook Inlet. Data on levels and types of fatty acids and stable isotopes among predator and prey organisms can be used to better understand seasonal trophic linkages (i.e., the relationship between potential predators and potential prey species at different times of the year). This information is an important component of the data needed to understand CI beluga foraging patterns. Data are collected through tissue samples of prey species for comparison to stable isotopes in beluga blubber fatty acids and skin.

13b. Research the effects of environmental and anthropogenic factors on CI beluga prey to assess if any particular factor is having a significant detrimental effect to the prey and thus a detrimental effect to CI beluga recovery.

Factors such as tidal mixing, temperature, salinity, sedimentation, and contaminants affect the characteristics of the aquatic environment. Prey species that have high mobility may seek better aquatic habitat conditions in areas not currently exploited by CI belugas. While prey that spend extended periods of time in suboptimal environments are not likely to attain optimal body condition and will not provide optimal CI beluga forage, the relationships among environmental factors and prey distribution and quality remain poorly understood and need further research. This research could include collaborative studies to understand the status of upper Cook Inlet salmon stocks, particularly the declines of Chinook salmon. Spatial distribution of many fish species is often associated with aquatic fronts defined by environmental boundaries. Anthropogenic factors can introduce new aquatic fronts, such as boundaries created by chemical releases or downstream plumes resulting from sediment disturbances, sewage outfalls or other point sources of pollution requiring mixing zones. Given our lack of understanding about how different aquatic fronts determine CI beluga prey distribution, additional research is needed to determine how anthropogenic alterations to the aquatic fronts may affect the timing and distribution of prey.

The impact of fishing pressure on spatial and temporal prey availability within CI beluga habitat is poorly understood, especially for non-salmonid species, such as eulachon and Pacific herring, that are targeted by fisheries, but for which stock assessments are lacking. While fishing can reduce prey availability in CI beluga habitat within the fishing season, the impact on future recruitment is less well known. Also, the impacts of anthropogenic noise on potential prey in CI beluga habitat is poorly understood, rarely considered, and in need of further study. If the result of anthropogenic activities, such as fishing or noise, is a loss of feeding opportunities or reduction in prey for the CI belugas, there will likely be an adverse effect to the belugas. Consequently, these effects will be most important to beluga recovery in areas preferred for feeding and during times of the year when energetic demands are greatest (e.g., pregnancy and lactation). Mitigation techniques have already been proposed to reduce impacts upon fish from some sources, such as pile driving. Further research is needed to improve mitigation techniques, especially for noise sources where no mitigation is yet proposed.

13c. Determine the level of interspecific competition for prey with other marine mammals, especially harbor seals.

Competition for prey undoubtedly exists among CI belugas and other fish-eating marine mammals and birds. Existing anecdotal reports indicate competition is probably highest between CI belugas and harbor seals. The level of this competition, and its possible effects on CI beluga recovery, should be determined by conducting studies of historic and current distribution and abundance of harbor seals in Cook Inlet, diet studies of both predators, and behavioral studies of beluga/seal interactions in areas and seasons of observed overlap (e.g., mouths of the Susitna, Little Susitna, Eagle, and Kenai rivers, and along Turnagain Arm).

13d. Determine energetic requirements/metabolic needs of CI belugas at different life stages to determine whether nutritional stress is a function of life stage.

Energetic requirements of belugas and the utility of potential prey items to meet metabolic needs vary seasonally and by CI beluga life stage. For example, newborn CI beluga calves have few fat reserves and are dependent on milk to quickly grow in length and girth, and develop fat reserves over the first year. Pregnant and nursing females are subjected to additional energetic demands, and all belugas must enter the winter with sufficient energetic reserves to survive several months of presumed low energetic input and high basal metabolic demand. While the rate at which energetic reserves are used presumably varies by CI beluga sex and life stage, details are currently unknown. Sampling to determine seasonal body condition by CI beluga sex and life stage would facilitate a better understanding of potential stressors and how to mitigate against such stressors. Understanding metabolic needs may also be informed through analyses of body condition and food intake by belugas maintained in aquaria.

13e. Study the diet selectivity of different CI beluga demographic groups (e.g., age, sex, and reproductive state).

Because CI beluga metabolic needs vary by sex and life stage, dietary needs typically respond to metabolic demand. Diet selectivity would conceivably be a function of caloric return on metabolic investment of foraging. That is, predators target prey providing high nutritional input, but if high nutritional prey are encountered only infrequently, the predator diet would include less-nutritional but more frequently encountered prey. Few data exist to understand prey selectivity by CI beluga and how selectivity might change over time and in response to changes in the available prey.

Prey selectivity by CI belugas is also expressed in foraging habitat preferences. For example, foraging may be easier in river mouths with steep banks, in areas of good echolocation conditions (good water mixing and limited suspended sediment), or in areas where prey behavior favors capture (e.g., anadromous fish adapting to changes in salinity when entering rivers). Spatial considerations must be included when examining foraging behavior and developing a foraging model for CI belugas. This action would use stomach contents and other observations to examine what prey are consumed relative to the available prey.

13f. Using currently available information, develop a CI beluga foraging model informed by prey characteristics and beluga dietary needs.

Combining data on CI beluga dietary needs, beluga foraging strategies and efficiencies, and prey characteristics will allow development of a CI beluga foraging model. Such a model will allow examination of tradeoffs among potential prey species and the importance of potential prey in different seasons and at different CI beluga life stages. This model would be informed by seasonal fatty acid and stable isotope signatures of prey species, energetic requirements/metabolic needs by life stage, and observed foraging selectivity by different CI beluga life stages. A foraging model would provide insights into whether CI beluga reproduction and survival are being limited by available prey and would help to identify potential mitigation measures to improve CI beluga recovery.

13g. Ensure fisheries management (e.g., escapement goals for CI beluga prey species) adequately accommodates CI beluga prey requirements, and if necessary, expand the number of species with escapement goals.

Escapement goals and management measures for salmon and other CI beluga prey do not explicitly incorporate CI beluga dietary needs. Salmon production models that provide the basis for ADF&G management measures typically allocate mortality as either human harvests or natural mortality, which implies that CI beluga prey needs are treated as an unspecified component of natural mortality. In addition, natural mortality for salmon is either treated as fixed or assumed to occur across a relatively small range of values. At the simplest, a perceived reduction in a stock targeted for human consumption results in management measures to reduce harvest levels, with the harvest reduction (down to some threshold level) often proportional to the level of stock reduction. However, because the consumptive prey needs are relatively stable for a given CI beluga population size, a declining prey resource base implies a relative increase in the proportion of a prey resource needed for CI beluga consumption. Thus, the aggregate natural mortality rate may actually increase as the prey resource declines.

Consideration of measures to adequately provide for CI beluga prey consumption may be even more important for prey resources for which there are no ongoing stock assessments. For example, many of the salmon stocks returning to Cook Inlet tributaries are not actively assessed, but may be assumed to fluctuate similar to an index salmon stock returning to a nearby tributary. However, in the case of eulachon, there is no assessment program, and any decline in eulachon stock productivity or at-sea mortality rate might not be detected until after several years of fishery harvest declines. ADF&G should ensure the management of anadromous species considers CI beluga dietary needs, particularly in a way that provides for a sustained abundance and density of returning fish available as prey in CI beluga feeding areas.

13h. Once every five years, reassess the status of the actions in item 12 to see if consideration of any new information results in a determination that prey reduction is not limiting CI beluga recovery.

Every five years, the status of the CI beluga population will be reassessed and a determination made if downlisting or delisting is warranted. Thus, at least once every five years, a reassessment should be undertaken to determine if prey reduction is limiting recovery, and that information can be used in the CI beluga population status review. If a reassessment suggests prey are not limiting CI beluga recovery, then this threat should continue to be monitored and reassessed in the subsequent five years to confirm the previous assessment. If a reassessment indicates there is still concern regarding prey limiting CI beluga recovery, the actions in item 13 should continue to be implemented or new actions defined.

14. Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether prey is limiting CI beluga recovery.

Public meetings, website postings, and news releases should be used to apprise stakeholders and the general public of information developed through studies of seasonal and spatial distributions of potential CI beluga prey in Cook Inlet. Information should clearly identify data gaps and information still being collected.

<u>Disease Agents</u>

15. Assess if disease agents (pathogens, parasites, harmful algal blooms) are limiting CI beluga recovery by monitoring living (via non-invasive methods such as photo-identification studies, or minimally invasive methods such as biopsies) and deceased (via necropsies) CI belugas to assess the presence/absence of disease agents or disease-related mortalities.

15a. Analyze images from the CI beluga photo-identification catalog for the presence of external signs of disease in photographically identified CI belugas to 1) assess the percentage of identified CI belugas with external indications of disease, and 2) track the persistence of, or changes in, the external indications of the disease agent in individual whales over time.

The CI beluga photo-identification catalog includes many beluga whales bearing skin lesions consistent with localized and systemic infections. The number of individual beluga whales in the photo-identification catalog with such lesions should be quantified, analyzed by disease experts to identify probable cause, and monitored over time to determine trends in the incidence and prevalence of these conditions.

15b. Continue examining beach-cast carcasses of CI belugas for disease-related mortalities, assessing the percentage of necropsied CI belugas with mortalities attributed to disease agents, and linking results from examinations of known individual belugas with the CI beluga photo-identification catalog. When feasible, determine the presence and relevance of disease agents in other Cook Inlet marine mammal mortalities.

The current primary method of obtaining samples from CI belugas for disease testing is by sampling of stranded carcasses. Because evidence of disease is quickly obliterated by post mortem decay, it is essential to be able to initiate necropsies as soon as possible after death. Examination of other marine mammals found dead in the Inlet (as well as any fish-eating mammals in Cook Inlet) may provide evidence of diseases of concern that may be transmissible to belugas. Identifying the individual whale being necropsied, when possible, will allow life history information in the photo-identification catalog to be linked with disease findings, potentially highlighting life stages or other life-history information associated with increased risk of exposure.

15c. Using currently available information, compare data on diseases from the CI belugas with other beluga populations to determine if there are abnormal levels or atypical types of disease agents present in Cook Inlet affecting CI belugas.

Diseases are present in all animal populations, even healthy ones. Understanding which diseases, and at what levels, are present in other beluga populations is key to understanding which diseases may be negatively impacting this endangered population. Therefore, having disease data that were obtained and analyzed using techniques similar to those used on other beluga populations (e.g., Bristol Bay or Point Lay, Alaska) helps to determine whether CI belugas are experiencing an abnormally high incidence of disease.

16. If any of the actions under item 15 above indicate that disease agents are limiting CI beluga recovery, improve 1) the understanding of sources of disease agents in Cook Inlet and the health of other marine mammals in Cook Inlet, and 2) the stranding response to beach-cast or floating CI beluga carcasses to allow for quicker response and necropsies.

16a. Determine types and sources of disease agents identified to be of concern specifically to CI belugas and assess management actions targeted at mitigating the disease agents.

Beluga whales can be exposed to disease agents through ingestion (of prey, or of water consumed with prey), close contact with other mammals, inhalation, and contact with the water in which disease agents are present. Disease agents demonstrated to affect CI belugas should be investigated to determine possible routes of transmission and potential for disease. Investigations should focus first on the most likely disease source or with the disease agent that is most readily mitigated. In conjunction with nutritional and toxicological analyses, prey could be analyzed as possible vectors of disease. Transmission from terrestrial sources should also be considered (e.g., sewage outflow, animal waste, anthropogenic contaminants in runoff). Additionally, routine water quality monitoring and disease monitoring in other Cook Inlet mammals should be established or continued. Collaboration contributing to the analysis of such monitoring is encouraged, especially as it relates to CI beluga recovery.

16b. Evaluate the feasibility/usefulness of health assessments on a surrogate sympatric species to better understand threats to CI belugas.

Given the limited number of CI belugas available for sampling for disease assessment, researchers should consider alternate methods of inferring disease risk to CI belugas such as testing 'surrogate' sympatric species that use similar prey resources (e.g., harbor seals or harbor porpoise).

16c. Given the limited time after death during which viable information about disease agents can be obtained, improve the response time for the CI beluga stranding response program so that full necropsies can yield more useful information. Make annual announcements encouraging immediate reporting of carcasses.

The current primary method of obtaining samples from CI belugas for any analysis is through beach-cast carcasses. Certain disease agents are only detectable for a short time after death. The longer it takes for a necropsy of a dead beluga to begin, the greater the loss of information regarding disease agents. A revised and robust stranding plan is required to expand the existing program for responding to live or dead-stranded belugas in a manner that is safe for both response personnel and the animals, and which allows for timely access to carcasses for necropsies.

Prompt identification and proper reporting of carcasses is essential to maximize the quality and quantity of samples. All posted signs that encourage such reporting should be evaluated annually for accuracy of information. Annual reminders with a single 24/7 phone number should be sent directly to people who are most likely to encounter carcasses, such as ADF&G and commercial entities active on the Inlet. Additionally, repeated, annual public service announcements through a variety of avenues (radio, TV, the web, social media, fishing license distributors, printed material available for boaters and fisherman via harbormasters, and pilots via flight control centers) will serve to remind the general public of the importance of such reporting. These announcements could be combined with messages regarding responsible viewing of CI belugas while boating and how to report incidental sightings.

16d. Once every five years, reassess the status of the actions in item 15 to see if consideration of any new information results in a determination that disease agents are not limiting CI beluga recovery.

Every five years, the status of the CI beluga population will be reassessed and a determination made if downlisting or delisting is warranted. Thus, at least once every five years, a reassessment should be undertaken to determine if disease agents are limiting recovery, and that information can be used in the CI beluga population status review. If a reassessment suggests disease agents are not limiting CI beluga recovery, then this threat should continue to be monitored and reassessed in the subsequent five years to confirm the previous assessment. If a reassessment indicates there is still concern regarding disease agents limiting CI beluga recovery, the actions in item 16 should continue to be implemented or new actions defined.

17. Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether disease agents are limiting CI beluga recovery.

Throughout the CI beluga recovery process, the steps taken to identify disease agents, the results of those steps, the initial proposed mitigation measures, and any proposed revisions to the mitigation measures should be clearly presented to the stakeholders and the general public by developing educational materials, disseminating news releases to the media, presenting at public meetings or conferences, and by posting the updates on the NMFS Alaska Region's website.

<u>Noise</u>

18. Assess if noise is limiting CI beluga recovery by resulting in behavioral responses such as live strandings or displacement from important habitats.

18a. Conduct a retrospective analysis of documented CI beluga live strandings and noise-producing anthropogenic activities in Cook Inlet, possibly to include the development of a database of anthropogenic activities that introduce noise to Cook Inlet, and assess if a correlation exists which may indicate noise is limiting CI beluga recovery.

If certain noise conditions have the potential to trigger CI beluga strandings, it is critical to consider these noise conditions in the CI Beluga Recovery Plan. Although CI belugas are known to strand, the relationship with anthropogenic activities has not been thoroughly evaluated. Because anthropogenic noise may cause mass strandings, this risk needs to be evaluated for CI belugas. Archived information on CI beluga strandings and the timing of historical anthropogenic activities known to introduce acoustic energy into the water should be compared.

A geospatial database should be developed to record data on anthropogenic activities known to introduce acoustic energy into the water (e.g., the timing, duration, intensity, cumulative energy output and location of these activities, along with any mitigation applied). This data should be linked to the NMFS CI beluga stranding database to allow detection of potential relationships between anthropogenic noise events and strandings. This open-access database should be developed, maintained, and managed by NMFS in collaboration with university, private, agency, and industry researchers working in Cook Inlet.

Due to the lack of long-term background noise monitoring and the absence of baseline data on background noise in Cook Inlet, historical trends can only be determined by analyzing the history of anthropogenic activities known to introduce acoustic energy into the water. Changes in these activities spatially or temporally over time could have strongly modified the acoustic environment of certain areas. This analysis could also identify anthropogenic activities that have the potential to generate future chronic changes to the acoustic environment of CI belugas.

18b. Conduct a retrospective analysis of anthropogenic noise-producing activities in Cook Inlet and information on CI belugas' behavior and distribution to assess if a correlation exists which may indicate noise is limiting CI beluga recovery.

To understand whether noise is limiting CI beluga recovery we need better information on noise-producing activities in Cook Inlet, and CI beluga exposure and response to those activities. We know there are both anthropogenic and natural sources of noise in beluga habitat, and belugas in general are very dependent on acoustic communication. But these two things alone do not provide us information useful to determine if anthropogenic noise in Cook Inlet is limiting CI beluga recovery. To try and answer that, a retrospective analysis of both noise-producing activities and CI beluga distribution and behavior needs to be compared over time in an effort to determine if noise is having an adverse effect to CI belugas (e.g., does the evidence suggest potential displacement or behavioral disruption of CI belugas due to anthropogenic noise). However, a correlation alone may not be sufficient evidence to indicate noise is limiting CI beluga recovery, and a short-term displacement likely has less recovery implications than a long-term displacement.

18c. Within areas designated as critical habitat Type 1, determine areas with high vs. low levels of anthropogenic noise, if there are significant typical changes (e.g., seasonal differences) in the levels of overall (natural plus anthropogenic) noise in that area, and assess if a correlation exists between CI beluga use of the area and the noise levels in the area.

NMFS has designated two areas of Cook Inlet as critical habitat, with Type 1 representing the high use areas in the summer where large groups of belugas congregate, and areas which are important to reproduction and foraging activities. Given these areas are of particular importance to the survival and recovery of CI belugas, it is appropriate to focus an assessment of in-water noise on these areas. To understand if noise may be limiting CI beluga recovery requires, in part, a better understanding of the current characteristics of noise in the beluga habitat as defined by critical habitat Type 1. Both natural and anthropogenic noise sources should be assessed when determining the overall noise, taking into consideration that some times of the year may have higher levels of noise than other times (e.g., due to decreased water flows or reduced coastal human activity during the winter season). Once the acoustic environment of critical habitat Type 1 has been assessed, that information should be compared to known CI beluga use of critical habitat Type 1 throughout the year to determine if a correlation exists between beluga use and noise levels of specific areas within critical habitat Type 1. However, a correlation alone may not be sufficient evidence to indicate whether noise is liming CI beluga recovery. Factors independent of noise (e.g., seasonal anadromous fish runs) may also be influencing CI belugas' use of the area. Sometimes belugas may tolerate high noise levels if the benefits of remaining in an area outweighs the costs of being exposed to noise in that area. If possible, these other parameters should be considered.

19. If any of the three actions under item 18 above are strongly suggestive that noise is limiting CI beluga recovery, improve 1) the understanding of the acoustic environment of Cook Inlet, and 2) management of noise-producing activities in Cook Inlet.

19a. Describe the acoustic characteristics of different anthropogenic noise sources in Cook Inlet and rate the potential acoustic impacts from each type of noise source to CI belugas.

Different anthropogenic noise sources in Cook Inlet should be recorded and their acoustic characteristics (e.g., source level[26], spectral contents[27], tonal[28] and pulsive[29] nature, etc.) described. These noise sources should be analyzed to map their temporal and spatial occurrence in CI beluga habitat. All identified noise sources in CI beluga habitat should be rated based on potential impacts to CI beluga hearing; noise sources with higher overlap with beluga hearing, higher source levels, and greater spatial and temporal occurrence should receive the highest rating. This rating system should classify all identified noise sources in CI beluga habitat on a scale ranging from low (unlikely to impede recovery) to high (greatest potential to impede recovery). This effort should identify sources of natural and anthropogenic noise, quantify the overlap with CI beluga hearing, and quantify the magnitude of perturbations over space and time. This data should be used to map seasonal noise that is audible to CI belugas within critical habitat and to create a rated list of sound sources.

19b. Conduct year-round monitoring of background noise (level and spectrum) in key areas where CI belugas currently and historically concentrated to characterize the acoustic environment and identify sources, levels, and types of anthropogenic noise.

Year-round monitoring of background noise in both present-day and historical key areas for CI belugas (e.g., Susitna Delta and the Kenai River) has the potential to identify areas where the acoustic environment may no longer be suitable for belugas, either seasonally or year-round. Furthermore, long-term monitoring allows the establishment of present-day baseline levels of background noise, which are required to identify potential changes in the acoustic environment caused by future anthropogenic activities in Cook Inlet.

19c. Conduct long-term monitoring of noise levels in CI beluga critical habitat to monitor and mitigate cumulative risks.

Long-term monitoring of noise levels will build the baseline information needed to identify periods or areas of increased noise due to specific anthropogenic activities. Similarly, when noise levels increase due to several sources of input, potential cumulative risks can be documented.

19d. Work with local, State, and Federal agencies and stakeholders to develop methods and plans for reducing or mitigating the levels of anthropogenic noises in Cook Inlet, including incorporation of pre- and post-activity surveys for major noise-producing activities to monitor CI beluga presence.

Entities (including NMFS and industry) involved in oversight and management of noise-generating activities should develop cooperative measures to ensure proper compliance with noise impact mitigation regulations (e.g., sound field verification, schedule and duration of

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[26] Sound intensity at the source, normally measured as dB re 1 µPa at a distance of 1 meter from the central part of the sound source.

[27] The distribution of acoustic energy across all frequencies influenced by the noise source.

[28] Narrowband (few frequencies), modulated or not, acoustic signal of long duration (in the order of tenths of seconds to many seconds), (e.g., a whistle).

[29] Broadband (many frequencies), normally sharp, short (in the order of milliseconds to tenths of seconds) acoustic signal, (e.g., explosion).

activity, model and validation of exclusion zones, proper shut downs, observers and their working conditions, reporting audit, etc.). The NMFS has a responsibility to audit those noise-generating activities that fall under its purview and to enforce existing regulations.

Most regulatory actions and mitigation efforts focus on the time of the activity, when noise is introduced into the water. However, it is equally important to obtain baseline data on the presence of CI belugas in areas to be affected *before* and *after* the activity. Without the information collected in pre and post-surveys, it is difficult to quantify the potential impact generated by the activity. Because wildlife displacements due to noise have been documented at distances far beyond the detection ranges of visual marine mammal observers (MMOs) and/or passive acoustic monitoring systems, this impact can only be documented if there is knowledge of the presence of CI belugas before and after the activity. Several monitoring designs have been successfully applied to marine mammals, with before-after/control-impact design (BACI; Underwood 1994) being the most effective.

19e. Incorporate into the noise monitoring/mitigation plans a protocol to identify the onset (received levels and distance) of CI beluga behavioral reactions to specific activities.

Behavioral reactions to noise are among the most difficult responses to document. As part of standard mitigation plans, data are collected by MMOs situated on shore or on vessels generating underwater noise. This data can help identify the onset of behavioral reactions. Because these plans normally include the modeling and validation of noise introduced into the water, MMO data can be used to obtain distance and noise exposure levels triggering behavioral reactions. Implementing a requirement during the permitting of all activities in Cook Inlet that introduced noise into the aquatic environment to obtain this data and calculate onset of reactions would generate valuable information needed to update mitigation regulations in CI beluga habitat.

19f. Improve the CI beluga stranding response program for dead belugas so that full necropsies can be performed as soon after death as possible, to include appropriate collection and testing of the auditory system to determine if there has been damage, and making annual announcements encouraging immediate reporting of carcasses.

It is not current practice to analyze the auditory system of all deceased CI belugas. Reasons include the remoteness of many of the dead whales (either floating away from shore, or in locations limiting easy access), and the timeliness of the response (either because it wasn't reported in a timely manner, or other constraints prevented an immediate response). Some of these factors are uncontrollable, but others can be improved upon. By encouraging immediate reporting of carcasses, the overall time to response can be improved and better quality data (i.e., less decomposed tissues) can be collected. Also, by incorporating collection of the auditory system into the standard necropsy protocol, collection will be a planned component of the necropsy rather than an ad hoc collection. Collection of the auditory system will allow for later analyses to determine if damage may have been present. More information about improving the stranding response program is discussed in action 28d below.

19g. Once every five years, reassess the status of the actions in item 18 to see if consideration of any new information results in a determination that noise is not limiting CI beluga recovery.

Every five years, the status of the CI beluga population will be reassessed and a determination made if downlisting or delisting is warranted. Thus, at least once every five years, a reassessment should be undertaken to determine if noise is limiting recovery, and that information can be used in the CI beluga population status review. If a reassessment suggests noise is not limiting CI beluga recovery, then this threat should continue to be monitored and reassessed in the subsequent five years to confirm the previous assessment. If a reassessment indicates there is still concern regarding noise limiting CI beluga recovery, the actions in item 19 should continue to be implemented or new actions defined.

20. Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether noise is limiting CI beluga recovery.

For stakeholders and regulatory bodies to make well-informed decisions, it is important for results of noise impact studies and related mitigation measures to be conveyed to the public. There is a general underestimation for the importance of the acoustic environment to CI belugas and other odontocetes in general. There may also be an underestimation of the impacts of anthropogenic noise to CI belugas. Many users of Cook Inlet are not aware of the noise their activities (e.g., outboard motors) can introduce into the water and how this noise can negatively affect CI belugas. An awareness campaign about underwater noise pollution and the importance of sound to CI belugas would make this information available to the public and would encourage good habits and responsible, considerate, co-existence. Such information can be shared by developing educational materials, disseminating news releases the media, presenting at public meetings or conferences, and by posting the updates on the NMFS Alaska Region’s website.

Habitat Loss or Degradation

21. Assess if habitat loss or degradation has resulted in a significant reduction in the carrying capacity of Cook Inlet for CI belugas, or a loss or degradation of areas important to CI belugas for foraging or reproduction, to the point such loss or degradation is limiting CI beluga recovery.

Carrying capacity largely depends on environmental conditions over a series of years, or within a given ecological regime, and is likely to change over time. Analytical modeling techniques can be used to estimate current carrying capacity and to quantify the uncertainty of the estimate. However, the ability to estimate carrying capacity accurately depends to a large extent on the quality of available data. Of particular importance are the estimated numbers of CI belugas at different life stages, the distribution, abundance and availability of prey species, and the distribution and magnitude of habitat features that may influence the productivity of CI belugas. For long-lived species such as belugas, development of a life-stage population model that accounts for differing nutritional and habitat needs across age and sex will be necessary to account for potential life stage variations.

We note that NMFS has previously determined the carrying capacity of Cook Inlet to be 1300 CI belugas. At the 2014 estimated population size (340 whales), a small reduction in carrying capacity (e.g., from 1300 to 1000 CI belugas) is unlikely to have significant impacts to the current CI beluga population given its small size relative to projected carrying capacity. In this hypothetical scenario, the reduction would be unlikely to limit the recovery potential of the CI belugas; however, a large reduction in the carrying capacity (e.g., from 1300 to 500 CI belugas) is likely to be a factor impairing the recovery of the CI beluga population. Thus, when conducting the assessments recommended below, these factors should be kept in consideration when determining if habitat loss or degradation is limiting CI beluga recovery.

21a. Develop a comprehensive Cook Inlet environmental database using currently available information to conduct a retrospective spatial and temporal evaluation of the biological, physical, and anthropogenic features in CI beluga habitat since the 1970s and assess how the habitat has changed over time, including likely causes of change.

To address potential measures to facilitate CI beluga recovery, it is first necessary to determine how the CI beluga habitat has changed over time, particularly during the last 40 years when the beluga decline has occurred, and the likely causes of the change (e.g., hydrologic, anthropogenic, acidification, siltation, shoaling, temperature, tides, loss of upstream shade, installation of culverts, or other factors). Of particular interest are the biological and physical features of the current CI beluga habitat and how those features change seasonally. For example, siltation, the development or movement of sand or gravel bars, water temperature, and chemical characteristics of the marine and estuarine environment can be affected by localized or upstream drivers. Dredging, in-water construction, dams, and siltation from runoff and erosion can change the currents, flow, and mixing of fresh and salt water and the seasonality of fresh water inflows. These changes in water bodies can impact their value as prey or beluga habitat. Changes in hydrology of the Inlet should be studied to determine if there are impacts to belugas. These characteristics directly impact the suitability of the CI beluga habitat, including the carrying capacity. Studies are needed to determine how these habitat characteristics are affected by both ongoing environmental changes (e.g., overall environmental change) and by anthropogenic factors (e.g., in-water construction or other activities).

Comprehensive mapping and spatial analyses of the characteristics of current CI beluga habitat in relation to current and earlier beluga distribution is needed. Analysis of the CI beluga survey and tagging data has been initiated by NMFS, but with limited environmental data. Continuation and expansion of this effort would expand the environmental aspect of this analysis. Unfortunately much environmental data is extremely localized or proprietary in association with resource development around the Inlet. Mechanisms should be developed for sharing and using the proprietary data and extending valuable local data to larger areas. A starting point would be to collect and assess the quality of data that are currently available in the public realm. A comprehensive Cook Inlet environmental database should be established to include both natural environmental data and human impacts and development, and ideally should result from collaborative efforts among a wide variety of public and private organizations.

21b. Compare the changes in habitat availability or quantity over time with changes in CI beluga distribution and abundance over time to assess if a correlation exists which may suggest habitat loss or degradation is limiting the recovery of CI belugas.

Simply understanding if the habitat has changed over time does not resolve whether observed changes are resulting in detrimental effects to belugas. Even negative changes or loss of habitat may have limited effect to the CI belugas if those changes are in locations only sporadically visited by just a couple of individuals. However, similar changes in locations used by large numbers of belugas or by few belugas all year may have significant effects on the whales. Therefore, there is a need to compare the habitat changes over time with patterns of CI beluga distribution and abundance in order to determine if habitat changes are limiting CI beluga recovery. As previously mentioned, such a comparison will need to consider the seasonality and frequency of use by various whale group sizes when interpreting the results, preferably in a geospatial format.

21c. Review losses or degradation of habitats in areas known to be important to CI belugas for foraging or reproduction, and assess if a correlation exists between habitat changes and changes in CI beluga use of the area, possibly indicating that habitat loss or degradation is limiting the recovery of CI belugas.

Not all of Cook Inlet has the same value to the CI belugas. Some areas are more important for foraging or reproduction, whereas other areas seem to be primarily transit corridors or are only occasionally visited. This variability in degree of use is reflected in the designation of two critical habitat areas. An effort focused on areas most important for foraging or reproduction may provide a better indication of the effect of habitat loss or degradation to the current CI beluga population. While this may be useful for the current population size and distribution, we note that if the population grows and expands its distribution to include more of mid and lower Cook Inlet in the summer, this focused assessment should be expanded in geographic scope to reflect range expansion.

22. If any of the actions under item 21 above are strongly suggestive that habitat loss or degradation is limiting CI beluga recovery, improve 1) the understanding of the impacts of a changing habitat to CI belugas, and 2) management of habitat degrading activities in Cook Inlet.

While both short and long-term changes occur in ecological systems, characterization of those changes can be difficult. Projection of future changes and ecological response to projected changes is even more uncertain. Characteristics of CI beluga habitat, and changes in that habitat over time, have not been well documented, or the documentation involves proprietary information associated with potential resource development. Mitigation measures to prevent loss or degradation of CI beluga habitat must start with an understanding of existing habitat and changes that have already occurred, particularly over the past 40 years when the documented beluga decline occurred.

22a. Update the comprehensive Cook Inlet environmental database developed in action 21a. and project the future extent and quality of CI beluga habitat.

A potentially more complex step in assessing the quality of CI beluga habitat is to project the future extent and quality of CI beluga habitat. Because it is difficult to project the rate and magnitude of future change, given all the contributing factors, this approach should address the range of possible outcomes. Future habitat and development projections would then be informed by our updated understanding of CI beluga habitat characteristics, and the temporal and spatial scales on which it appears changes have occurred. It is particularly important to examine ongoing coastal and in-water development trends and determine if anticipated development will negatively impact CI beluga recovery. Data compiled under action 21a. should be updated and analyzed to identify temporal changes in CI beluga habitat and develop ongoing or periodic monitoring program(s) for comparison to this baseline data.

22b. Conduct a detailed habitat survey to begin long-term habitat monitoring (quality and quantity), including the use of volunteers and community members.

While the critical habitat of the CI beluga has been identified, there is very limited information on the current status of the habitat, existing impacts, and the prey available to the CI beluga. In addition, seasonal variation of many features is poorly known. A comprehensive survey of the habitat available to CI beluga should be conducted to identify available prey species, to estimate the prey biomass density by season and area, and to determine the seasonal levels by area of anthropogenic impacts to the CI beluga habitat and prey. A survey of the prey habitat and anthropogenic changes would provide a baseline for the current level of impacts to the CI beluga and provide a basis of comparison for future improvements to, or losses of, that habitat. Given the projected "potential futures" (described in action 22a.) of CI beluga habitat and the suitability of those future habitats for CI beluga recovery, long-term monitoring will be critical to guide potential mitigation measures.

Given the remoteness of the CI beluga habitat, knowledge acquisition and ongoing baseline monitoring of CI beluga habitat use could occur to some extent at the local level. A community-based beluga monitoring program should be developed and implemented throughout Cook Inlet. This could be modeled after the Alaska Native Sentinel Program. Much of the monitoring and assessment of current and future CI beluga habitat characteristics will involve periodic collection of index data. To some extent, much of the required data can be collected either directly in the CI beluga habitat or at index sites serving as proxies to nearby CI beluga habitat. Contingent on the frequency and location of data collection, the community-based CI beluga monitoring program could serve as a mechanism to increase stakeholder involvement in the sampling program while reducing overall costs of the sampling program. Program members could include pilot organizations, boaters, fishing groups, hunters, school groups, and senior groups, as well as existing sighting networks (e.g., Friends of the Anchorage Coastal Wildlife Refuge Beluga Surveys, Cook Inletkeeper, the Alaska Ocean Observing System, and the CI beluga photo-identification project's "Seen Belugas?" sighting program). The monitoring program could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (see action 2).

22c. Evaluate impacts to CI beluga from anthropogenic activities with potential to result in degradation or loss of CI beluga habitat, with emphasis in known and historic feeding areas.

Construction and operation of new physical structures (e.g., bridges, docks, dams, etc.) and increased numbers of vessels in CI beluga habitat can potentially affect the distribution, migration, or behavior of CI beluga or their prey. However, a lack of understanding of distribution, migration, and behavior patterns of prey inhibits potential mitigation measures and argues for a more precautionary approach to maximize opportunity for CI beluga recovery. Additional information is needed on the impacts to CI belugas from construction and operation of physical structures, including structures located both within Cook Inlet proper and upstream of CI beluga habitat (which could affect beluga prey). Particular emphasis should be given to areas of known and historic feeding importance (e.g., Susitna River and Delta; Kenai River; Knik Arm).

22d. Determine if restoration is needed for particular CI beluga habitats by examining the cost/benefit of functional value, stability, and resiliency of restored habitats.

Considering the ecological value, stability, and resiliency of CI beluga habitats, a cost/benefit analysis will be needed to determine if restoration measures are warranted, and whether previous mitigation measures may no longer be needed. Throughout the long term, a variety of potential mitigation measures may be applied, representing a range of likely outcomes for CI beluga habitat and future CI beluga recovery. An analysis must first be conducted to evaluate the costs and benefits of potential restoration measures. For some potential restoration measures, realistic benefits may be achieved at little cost, whereas other measures may be expensive to implement and are likely to offer questionable or limited positive results. Implementation of any restoration measures must be accompanied by long-term monitoring to determine the effects on CI beluga recovery. Because CI beluga recovery is likely to be an ongoing process, NMFS should periodically examine the array of potential restoration measures and revise the implemented measures as needed.

22e. Work with local, State, and Federal agencies and stakeholders to develop a comprehensive Cook Inlet habitat database, and methods and plans for reducing or mitigating the levels of habitat loss or degradation in areas of known importance to CI belugas for foraging and reproduction, including restoration of habitats if necessary.

Ongoing and future coastal development projects that are deemed likely to degrade CI beluga habitat should be mitigated. Potential effects of individual development projects should be evaluated on the basis of the aggregate and comprehensive impacts to beluga habitat, taking into account existing projects and disturbance, and not simply as the incremental impact of an additional individual project. Such mitigation efforts will be most effective if they are developed collaboratively between government and non-government entities.

22f. Identify potential likely sources of contamination and evaluate their potential to discharge contaminants.

Given the potential for adverse cumulative impacts to CI belugas from the multiple human activities occurring in Cook Inlet, it is important to have a detailed understanding of exactly where those activities are occurring, if activities involve contaminants of concern that may be purposefully or accidentally discharged, and the proximity across time or space to other activities. Although some individual discharges might be deemed insignificant, combinations of discharges, or discharges in combination with other dissimilar threats, could cause adverse effects at the individual and population levels. Although assessing cumulative and synergistic impacts from multiple activities is challenging, such impacts might be particularly relevant in the case of CI belugas given the population's failure to recover despite the curtailment of hunting. A comprehensive inventory or database that maps: activities producing chemicals of concern; sites containing chemicals of concern; and other stressors with a potential synergism with chemicals (e.g., predators, noise; see action 30a). This inventory or database should be developed and updated annually.

22g. Once every five years, reassess the status of the actions in item 21 to see if consideration of any new information results in a determination that habitat loss or degradation is not limiting CI beluga recovery.

Every five years, the status of the CI beluga population will be reassessed and a determination made if downlisting or delisting is warranted. Thus, at least once every five years, a reassessment should be undertaken to determine if habitat loss or degradation is limiting recovery, and that information is incorporated into a CI beluga population status review. If a reassessment suggests habitat loss or degradation is not limiting CI beluga recovery, then this threat should continue to be monitored and reassessed in the subsequent five years to confirm the previous assessment. If a reassessment indicates there is still concern regarding habitat loss or degradation limiting CI beluga recovery, the actions in item 22 should continue to be implemented or new actions defined.

23. Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether habitat loss and degradation are limiting CI beluga recovery.

Reducing the rate of habitat loss or restoring lost habitat comes with a cost and often involves tradeoffs. Public meetings, a website, and periodic news releases should be used to acquaint/update stakeholders and the general public regarding the costs and benefits of ongoing mitigation and restoration measures and results of such measures. Throughout the Cook Inlet recovery implementation process, stakeholders and the public need to be apprised of CI beluga habitat research results on historic and current changes in CI beluga habitat by developing educational materials, disseminating news releases the media, presenting at public meetings or conferences, and by posting the updates on the NMFS Alaska Region's website.

<u>Unauthorized Take</u>

24. Assess if unauthorized take is limiting CI beluga recovery as a result of injury or harassment of CI belugas, especially in areas important to CI belugas for foraging or reproduction.

24a. Review available data which may provide information about the types and level of unauthorized take in living and dead CI belugas to assess the prevalence, frequency, and severity of effects to CI belugas from these activities.

While infrequent, there has been evidence of unauthorized take of CI beluga whales in recent years. There have been sporadic reports of CI beluga entanglements either in fishing gear or marine debris, photographic evidence of scars from boat propellers and possible bullet wounds, and necropsies documenting signs of blunt force trauma, possibly as a result of vessel strikes. In addition, there were possibly three research-induced CI beluga mortalities in 2002. However, there has been no systematic review of all available take-related information. This information should be reviewed and compiled to assess the prevalence of the different types and levels of unauthorized take, and to determine the frequency and effects of this take on CI belugas.

24b. Review and continue to monitor for signs of trauma in living and deceased CI belugas to assess the presence/absence of indications of trauma from entanglements or vessel strikes in living whales, and the percentage of necropsied CI belugas with mortalities attributed to or associated with anthropogenic trauma.

In order to understand if unauthorized take is limiting the recovery of CI belugas, information is needed to determine the prevalence of signs of injury or trauma in living whales and the number of mortalities associated with anthropogenic activities (as determined via necropsy). For living whales, non-invasive methods such as a review of the photo-identification catalog should be employed to determine past signs of trauma, and can be used to continue to monitor signs in the future. This type of monitoring may also help determine the effects of any particular trauma to the individual whale. For deceased whales, necropsies will be necessary to determine if the cause of death is related to unauthorized take, and a review of past necropsy reports may help determine the percentage of whales suffering mortalities due to anthropogenic activities. These types of monitoring activities should be continued into the future to help determine if the levels and/or effects of this threat are changing over time.

25. If any of the actions under item 24 above suggest that unauthorized take is limiting CI beluga recovery, improve 1) the understanding of the causes of unauthorized take, to include potential effects to the CI belugas, and 2) management of activities causing unauthorized take in Cook Inlet.

25a. Refine research techniques, evaluate alternatives, and implement research methods which minimize harassment, harm, and general adverse impacts to CI belugas. Only conduct research on CI belugas that has a clear connection to their recovery.

The potential impacts of various research methods (e.g., crossbow biopsy, breath analysis, live captures, and accessing live strandings) needs to be evaluated and the method with the least adverse impact to the animals should be used as much as possible. Existing and new research techniques and mitigation strategies should be reevaluated to minimize their impact. Minimally invasive techniques, such as collection of floating fecal or skin material, or well-designed skin/blubber biopsy surveys, should be given priority over more invasive methods with higher potential for harassment or harm (e.g., activities involving chase, or requiring capture of animals). For invasive research techniques, the use of surrogate sympatric species within Cook Inlet (harbor seal and/or harbor porpoise) and other healthy beluga populations should be considered for testing protocols and obtaining comparative data prior to use on CI belugas. Methods to monitor the effects of research and what criteria should be used to determine if research should be discontinued need to be developed. Research with high harassment or harm potential and which does not have a clear benefit to advancing recovery of CI belugas should not be authorized.

25b. Evaluate the relative effect of different types of vessels and speed on CI belugas.

Vessel activity around whales needs to be monitored and evaluated to determine the relative effect of different types of vessels and traveling speed on CI beluga behavior as well as the potential for collision (indirect and direct effect). Efforts should be focused in areas of high vessel traffic, such as the Port of Anchorage, Cook Inlet shipping lanes, the Susitna Delta and the lower reaches of the Kenai River.

25c. Work with local, State, and Federal agencies and stakeholders to: 1) monitor vessel activity in areas of known importance to CI belugas for foraging and reproduction, 2) develop a cooperative program to reduce whale interactions with vessels and fisheries; and 3) develop methods and plans for reducing or mitigating the levels of entanglements, vessel strikes, or other sources of anthropogenic trauma for areas of critical importance to CI belugas for reproduction and foraging.

There are multiple photos of individual CI belugas with scars consistent with boat strike indicating direct impact, but the relative importance of the effect of boat-induced injury is poorly understood. Indirect impacts could include acoustic impacts, inhalation of harmful engine exhaust, and disruption of critical behavioral activities (e.g., foraging, breeding, and calving). Data on vessel traffic in Cook Inlet, monitoring of vessel activity, and consideration of the development of regulations regarding vessel speed may be necessary. At a minimum, whale-safe boating recommendations should be developed which include advisories to forewarn operators of times and areas with heightened risk of CI beluga encounters. Boating guidelines based on observed effects of boating on belugas and knowledge of preferred beluga habitat should be developed to minimize interactions (e.g., reduced speed areas and temporal and spatial restrictions to traffic).

25d. Once every five years, reassess the status of the actions in item 24 to see if consideration of any new information results in a determination that unauthorized take is not limiting CI beluga recovery.

Every five years, the status of the CI beluga population will be reassessed and a determination made if downlisting or delisting is warranted. Thus, at least once every five years, a reassessment should be undertaken to determine if unauthorized take is limiting recovery, and that information can be used in the CI beluga population status review. If a reassessment suggests unauthorized take is not limiting CI beluga recovery, then this threat should continue to be monitored and reassessed in the subsequent five years to confirm the previous assessment. If a reassessment indicates there is still concern regarding unauthorized take limiting CI beluga recovery, the actions in item 25 should continue to be implemented or new actions defined.

26. Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether unauthorized take is limiting CI beluga recovery.

Annual notices/reminders to private boaters, subsistence users, commercial fisheries, cargo ships, and other vessels describing how to avoid whales and share Cook Inlet with belugas and other marine mammals should be distributed by developing educational materials, disseminating news releases the media, presenting at public meetings or conferences, and by posting the updates on the NMFS Alaska Region’s website. If boating or other guidelines are developed, distribute those annually to users, and encourage immediate reporting of harassment or trauma.

<u>Catastrophic Events</u>

27. Assess if catastrophic events are limiting CI beluga recovery as a result of injuries or mortalities, especially in areas important to CI belugas for foraging or reproduction.

27a. Using currently available information, conduct a retrospective spatial and temporal evaluation of known catastrophic events in Cook Inlet since the 1970s, and assess if there are changes in the frequency, distribution, or types of catastrophic events over time.

Currently there is no single place to obtain information about catastrophic events in Cook Inlet (e.g., natural disasters, oil spills, mass CI beluga strandings, key prey run declines, etc.) and no assessment conducted to determine if the frequency, distribution, or types of catastrophic events are changing over time or are influencing the CI beluga population. As such, an analysis needs to be conducted examining the available information regarding catastrophic events in Cook Inlet since the 1970s to determine if the frequency, magnitude, or severity of these events are changing over time. Such changes, especially in important CI beluga foraging or reproduction areas, could indicate that this type of threat may have greater impacts to CI beluga recovery.

27b. Review catastrophic events in areas known to be important to CI belugas for foraging or reproduction and assess if a correlation exists with CI beluga distribution, *abundance, or reported mortalities which may suggest catastrophic events are limiting recovery.*

Catastrophic events have resulted in adverse effects to other cetaceans (e.g., killer whale mortalities after the *Exxon Valdez* oil spill), but with the exception of information about CI beluga mass strandings, there has been no comprehensive review of catastrophic events in Cook Inlet. While the effects of catastrophic events are variable, population modeling indicates that any additive mortality of CI belugas will have a significant negative effect to the recovery potential of these whales. Non-stranding related catastrophic events that occur in areas known to be important to CI belugas for foraging, reproduction, or where large groups of whales congregate (e.g., Susitna Delta) have a greater potential for negative effects to the whales than do catastrophic events in areas less frequently used by belugas or occupied by only a small number of belugas at a given time (e.g., areas south of the Forelands during summer). Therefore, to restrict the spatial extent of this action to the most important areas with the greatest potential for adverse effects, an analysis should examine if a correlation exists between catastrophic events north of the Forelands and CI beluga distribution, abundance, and reported mortalities.

27c. Conduct a retrospective analysis of documented CI beluga live strandings and catastrophic events in Cook Inlet and assess if a correlation exists which may indicate catastrophic events such as natural or anthropogenic disasters are limiting recovery by causing mass strandings.

The causes of live mass strandings of CI belugas are not clearly known, and may result from a variety of factors including tidal stage or the presence of predators in the vicinity. However, it is also possible that catastrophic events may also lead to mass strandings for reasons unknown. Although the reasons may not be clear, it is clear that some animals are found dead after a mass stranding. Thus, even if a catastrophic event itself does not directly lead to mortality, if that event leads to a mass stranding, the potential for mortality increases. Loss of individuals from the population has the greatest immediate effect to the recovery potential of the population. A retrospective analysis examining a correlation between catastrophic events and mass strandings may help determine if catastrophic events are limiting CI beluga recovery.

27d. Review available data which may provide information about mortality rates (e.g., CI beluga stranding records) and assess if the occurrence of mortality is correlated with known catastrophic events.

Given that additive reduce the recovery potential of the CI beluga population, any additive mortalities associated with catastrophic events must limit CI beluga recovery. The information obtained from actions16a-16d should provide the basis for a review to determine if catastrophic events are limiting CI beluga recovery by resulting in increased mortalities.

27e. Assess CI belugas for signs of catastrophe-induced distress to determine whether mortalities or reduced fitness can be directly or indirectly attributed to catastrophes.

Although mortalities have the most immediate effect to recovery, catastrophic that lead to injuries and reduced health or fitness can lead to reduced recovery potential for the population. In anticipation of future catastrophic events, actions should be taken to monitor CI belugas, via non-invasive methods, for signs of distress which may indicate compromised health. Any mortalities in the months following a catastrophic event should undergo a thorough necropsy to assess if the catastrophic event contributed to the cause of death. Results from examinations of dead CI belugas should be linked with the CI beluga photo-identification catalog, if possible. If there is sufficient available information from previous catastrophic events, that information should be considered when determining if catastrophic events are limiting CI beluga recovery.

28. If at least two of the five the actions under item 27 above suggest that catastrophic events are limiting CI beluga recovery, improve 1) the understanding of the causes and sources of catastrophic events, to include potential effects to the CI belugas, and 2) management of the causes, responses to, and prevention of catastrophic events resulting in injuries or mortalities of CI belugas.

28a. Review and update oil spill response plans to minimize effects of spills to CI belugas, including strategies to deter CI belugas from entering oiled areas.

NMFS should work with the U.S. Coast Guard and industry groups to develop and test oil spill wildlife response plans and to acquire and maintain the necessary equipment and supplies to deter belugas from entering oiled habitat, move animals back out of oiled habitat should they enter it, and monitor, and if necessary, rehabilitate belugas directly impacted by a spill.

28b. Evaluate and test deterrent or hazing strategies aimed at preventing belugas from entering contaminated areas.

When responding to an oil or chemical spill, primary strategies focus on spill containment. Secondary strategies seek to prevent wildlife from entering areas affected by the spill and dispersants. Various hazing methods have been used successfully with other marine mammals but have not been evaluated for use with belugas. Their routine exposure to high ambient noise and boat traffic may make CI belugas more resistant to acoustic techniques used to deter other species or populations. Existing techniques should be evaluated for deterring CI beluga from areas of concern. If successful, such techniques would potentially also be useful in deterring CI beluga from areas with a high risk of live stranding. Actual testing of techniques with any beluga population is highly encouraged.

28c. Hold annual drills to respond to belugas impacted by toxic spills.

Plans are only as effective as the training and preparedness of those who execute those plans. While the risk of an accidental discharge of a hazardous substance from any single anthropogenic activity is considered to be low, but the probability of a toxic spill increases with the number of anthropogenic activities, increasing the potential for catastrophic loss of CI belugas. Therefore, it is important to develop plans to respond to incapacitated belugas involved in such an event, and to train and rehearse for actual responses. Such training and drills should be combined with drills to respond to live strandings due to natural causes.

28d. Review and update the stranding response plan for both live and dead CI belugas, to include: 1) convening a workshop to revise the existing CI beluga stranding plan, 2) developing a strategy to allow securing and necropsying dead CI beluga carcasses without delay, and 3) conducting drills for live stranding response.

A revised and robust stranding response plan is required in order to expand the existing program for responding to live-or dead-stranded belugas in a manner that is safe for both response personnel and the animals. Documentation of information obtained from both live stranded individuals and carcasses needs to be improved and should include collection of supplemental data for these events, such as weather, tidal height, fish run status, acoustic disturbances, and killer whale presence.

CI beluga stranding workshops should be conducted by NMFS. In addition to reviewing and revising the stranding response protocol, there is a need to better integrate the CI beluga stranding database with the photo-identification catalog and other CI beluga databases, including incidental sightings. Priority should be given to the identification of individual animals for comparison and inclusion in the photo-identification catalog to enable linking diagnostic findings with life history data. There should be ongoing (at least annual) analysis of stranding data rather than sporadic reviews. Workshop participants should include past and present stranding responders from Cook Inlet, CI beluga researchers, and beluga stranding responders from other regions (namely the St. Lawrence marine mammal emergency response). The first workshop should review and revise the CI beluga stranding response plan and review case studies of past responses to CI beluga strandings. A second workshop should train Cook Inlet stranding responders (present and future) in the revised response protocols, and upon completion of certain training requirements, pre-authorize them for limited emergency stranding response in the event a NMFS stranding coordinator is unavailable when an immediate response is needed. Subsequent workshops should be conducted every five years.

The current primary method of obtaining samples from CI belugas for determining cause of death, presence of disease agents, and contaminant testing is to collect samples from carcasses found stranded. Prompt discovery and proper reporting of carcasses is essential to maximize the quality and quantity of samples. Only a few NMFS employees are authorized to handle a CI beluga carcass due to their endangered status, with other Alaska Marine Mammal Stranding Network responders requiring a case by case authorization from NMFS to handle CI beluga carcasses. With the highly dynamic tides in Cook Inlet, stranded carcasses rarely stay in one place for long and floating carcasses can move a mile within 15 minutes. Thus, the best time to secure a carcass is when it is first observed. However, logistical and communications difficulties around Cook Inlet often prevent carcasses from being secured by authorized personnel. In order to achieve maximal use of beached carcasses, the process needs to be streamlined; authorization for observers to secure carcasses should be issued within 15 minutes of the request, and sampling teams should be on site within three hours. A stranding response plan need to be quick, efficient, effective, and user-friendly. A sufficient number of trained response personnel need to be available, and supplies need to be on hand and ready for deployment. Some Alaska Marine Mammal Stranding Network members have recommended that NMFS should consider pre-authorizing individuals or organizations to: secure carcasses; obtain photos and external documentation of length/girth/sex, skin samples; and start necropsies (within limitations) to facilitate faster responses. Additionally, to minimize cross-contamination or environmental contamination that can obscure the presence of disease in samples, necropsies are better done in covered areas, ideally within a necropsy laboratory. The Alaska Marine Mammal Stranding Network should have access to indoor laboratory space sufficient to examine a beluga whale and should have the means to transport carcasses to the laboratory.

One factor that could be limiting recovery of CI belugas is live strandings. The development of methods to support whales that have live-stranded and better monitor their disposition could help to reduce mortality and enhance recovery. As such, regular trainings and drills for live stranding responses should be conducted to maintain skills of responders to provide supportive care to the whales during live stranding events. During such trainings and drills, stranding response kits that include cameras, measuring, recording and sampling equipment should be distributed. Live-stranded animals can also provide a vast amount of information obtained through bio-sampling (including appropriate testing for contaminants), individual identification of animals, and tracking animals after they re-float and resume swimming freely. Results from a thorough bio-sampling program of live strandings could inform researchers about the current causes of decline or impediments to recovery. In general, greater communication and coordination is needed to increase the speed and completeness of responses, and options to achieve hands-on responses to live strandings need to be more thoroughly explored. Policies/protocols on the collection of samples, hearing testing, and attachment of tags to live animals are needed. In updating the plan, consideration should be given to responding pre-emptively to atypical situations, such as live entangled whales, prior to animals becoming stranded. Additionally, plans should be developed to conduct directed searches for strandings, especially during the winter when reports from the public drop off, but when death rate may potentially be higher due to the increased seasonal stress.

28e. Improve the Alaska Marine Mammal Stranding Network by obtaining separate funding for CI beluga stranding responses that is independent of funding for other research or management activities, and expanding the geographic scope and support capacity of the network within Cook Inlet.

Improvements need to be made to increase the number of stranding responses (relative to reported strandings), and to decrease the stranding response time. Improvements will require increased and reliable funding for CI beluga stranding response personnel and for increased effort for training, coordination, and outreach. This funding should be independent of funding for other research or management activities.

NMFS should further encourage, develop, and maintain marine mammal sighting networks around Cook Inlet to immediately report CI beluga stranding events (live or dead) so that warranted response efforts can be implemented as quickly as possible. Currently, most of the stranding reports and responses occur near Anchorage, thus it is possible that strandings away from Anchorage are not being detected or reported to NMFS. The geographic range of the stranding network should be expanded and the establishment and oversight of new network hubs in areas currently lacking coverage should be coordinated by NMFS with assistance from the Cook Inlet Beluga Recovery Coordinator. The Marine Mammal Stranding Network in Cook Inlet should be improved to better document and report CI beluga strandings and suspected causes of strandings..

28f. Once every five years, reassess the status of the actions in item 27 to see if consideration of any new information results in a determination that catastrophic events are not limiting CI beluga recovery.

Every five years, the status of the CI beluga population will be reassessed and a determination made if downlisting or delisting is warranted. Thus, at least once every five years, a reassessment should be undertaken to determine if catastrophic events are limiting recovery, and that information can be used in the CI beluga population status review. If a reassessment suggests catastrophic events are not limiting CI beluga recovery, then this threat should continue to be monitored and reassessed in the subsequent five years to confirm the previous assessment. If a reassessment indicates there is still concern regarding catastrophic events limiting CI beluga recovery, the actions in item 28 should continue to be implemented or new actions defined.

29. Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether catastrophic events are limiting CI beluga recovery.

Throughout the CI beluga recovery process, the steps taken to improve 1) the understanding of the causes and sources of catastrophic events, to include potential effects to the CI belugas, and 2) management of the causes, responses to, and prevention of catastrophic events resulting in injuries or mortalities of CI belugas, should be clearly presented to the stakeholders and the general public by developing educational materials, disseminating news releases the media, presenting at public meetings or conferences, or by posting the updates on the NMFS Alaska Region's website.

29a. Develop and broadcast annual announcements promoting the use of citizen science and encouraging reporting of strandings and sightings by the public.

Given the remoteness of the CI beluga habitat, ongoing monitoring for strandings or other catastrophic events could occur to some extent at the local level. NMFS should further develop and implement a community-based, citizen science beluga monitoring, sighting, and stranding program throughout Cook Inlet. The community-based CI beluga stranding program could serve as a mechanism to increase stakeholder involvement in the stranding program while reducing overall costs. Prompt identification and proper reporting of beluga carcasses is essential to maximize the quality and quantity of samples. All posted signs that encourage such reporting should be evaluated annually for accuracy of information. Annual reminders with a single 24/7 stranding reporting phone number should be sent directly to people who are most likely to encounter carcasses such as ADF&G and commercial entities active on the Inlet. Additionally, repeated, annual public service announcements through a variety of avenues (radio, TV, the web, social media, and printed material for boaters, fisherman, and pilots via harbormasters, fishing license distributors, or flight control centers) will serve to remind the general public of the importance of promptly reporting strandings. Such announcements could be combined with messages regarding responsible viewing and boating and how to report incidental sightings. The community-based beluga program members could include pilot organization, boaters, fishing groups, hunters, school groups, senior groups, as well as existing sighting networks (e.g., Coastal Observation and Seabird Survey Team, Alaska Native Sentinel Program, Friends of the Anchorage Coastal Wildlife Refuge Beluga Surveys, Cook Inlet Keepers, the Alaska Ocean Observing System, and the CI beluga photo-identification project's "Seen Belugas?" sighting program). The Cook Inlet community-based beluga program could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator.

<u>Cumulative and Synergistic Effects from Multiple Threats</u>

30. Assess if cumulative or synergistic effects of multiple threats are limiting CI beluga recovery, especially in areas important for foraging or reproduction.

The compounded effect of multiple factors in constraining CI beluga recovery can be greater than the effect of any single factor or sum of factors. Thus, recovery actions to address cumulative and synergistic effects of multiple stressors require a complex approach. A first step is to identify single factors contributing to stress, followed by the identification of additive accumulation of stress (cumulative impacts) and the identification of interactions between factors that produce a combined effect greater than the sum of their separate effects (synergisms). Following identification of these three components of multiple stress factors, mitigation measures can be identified and potentially implemented. Identifying and monitoring cumulative and synergistic effects will depend on accumulation of individual beluga life-history data and associated environmental data, and the analyses of these data using the techniques of epidemiology and population modeling to identify and characterize the population level impact of these effects.

As noted previously, in the absence of a single threat clearly limiting recovery, the cumulative and synergistic effects from multiple threats limiting recovery is the most plausible explanation for why the CI beluga population has not recovered. Thus, additional assessments, research, and management actions should be implemented to reduce the effects of all threats characterized as being a medium or high concern for CI belugas. Such actions are listed below, and include some of the previously identified actions for the single threats.

30a. Conduct a temporal and spatial analysis of all types and sources of threats to CI belugas, documenting times and areas where threats overlap, and assess if a correlation exists with CI beluga abundance or distribution which may suggest the effects of multiple threats are limiting CI beluga recovery.

The CI belugas exist in a dynamic environment, in which specific conditions may persist throughout the year, may occur seasonally over a series of years, or may occur infrequently over an indeterminate time frame. The identification of potential multiple or cumulative effects that may have constrained productivity or recovery of CI beluga will help to identify factors that may be critical to CI beluga recovery in the future. These factors may become important due to short or long-term changes in ecological, environmental, or anthropogenic conditions, and may also operate across changing spatial scales. Evaluation of changes and subsequent impacts on CI beluga recovery will need to consider both sequential effects and co-occurring factors. There is a need for coordinated spatial and temporal analyses of human activities and of beluga presence (determined from sightings and/or acoustic detections), in order to measure potential overlap of project activities with beluga presence. On a single day, a single beluga moving through Upper Cook Inlet might be exposed to multiple stressors from multiple sources, and the course of a beluga lifetime may encompass exposure to threats from numerous human activities throughout Cook Inlet.

Threats identified in this recovery plan should be analyzed both independently and cumulatively. This may require the generation of a comprehensive, geospatial database of past and present anthropogenic activities (e.g., development, industry, transportation, military, and research projects) in Cook Inlet. CI belugas are exposed to many threats and the risk of accumulation of negative effects is high. Increasing the number of threat sources also increases the probability for synergistic effects to occur. Because exposure could occur during a given time period (e.g., summer) or in specific areas (e.g., near Anchorage), a temporal and spatial analysis of the distribution of all the threats would allow identification of peak periods or areas of higher risk of cumulative or synergistic effects. Furthermore, movements of CI belugas throughout the Inlet are not random, but are driven by tide cycles, the seasonal presence of beluga prey, and winter ice. If temporal presence of threats in different areas overlaps with CI beluga movement patterns (i.e., belugas move among areas but encounter different threats in each area), impacts could accumulate with spatial overlap. Similarly, synergistic effects could derive from the exposure to multiple stressors accumulated within a specific time period or in a specific area.

For example, information regarding the types of anthropogenic activities known to introduce acoustic energy into the water, the timing and location of these energy sources, any mitigation applied, and the noise levels recorded should be logged into a database to track all potential noise stressors and their temporal and spatial coverage. This data should be linked to the NMFS CI beluga stranding database to allow detection of potential relationships between anthropogenic noise events and strandings. This open-access database should be developed, maintained, and managed by NMFS, with contributions from university, private, agency, and industry researchers in Cook Inlet.

Analyses of identified threats in a GIS format would help determine spatial and temporal associations and overlaps. For example, patterns in historical or prolonged coastal or upstream development could be identified as a combination of factors associated with anthropogenic development. Such overlaps could be examined for correlations to changes in CI beluga distribution patterns to better understand factors with the greatest potential to impact CI beluga recovery.

30b. Conduct a meta-analysis of previously documented cumulative and synergistic effects for other populations and species, based on known threats for CI belugas, and prioritize risk to CI belugas based on how these threats have been shown to negatively affect other beluga populations, other odontocetes, or other marine mammals.

Because many potential factors may be impeding CI beluga recovery, it is important to narrow the list by identifying spurious correlations (e.g., haphazard or non-causal relationships) between given factors and a lack of recovery. Available data on potential cumulative and synergistic factors are often limited, so an initial step would be to examine historical data from other marine mammal populations. Such research would require a meta-analysis of available data, prioritized to focus first on other beluga populations, then other odontocetes, then other cetaceans, and, finally, other marine mammal populations.

Based on results of the meta-analysis described above, the next step would be to evaluate whether the combinations of threats found to be constraining productivity in other marine mammal populations might be similarly impeding recovery of the CI beluga population. This step would require characterization of potential threats in Cook Inlet such that co-occurrences of these threats in time, space, or both may be examined.

30c. Analyze the potential synergism among noise exposure, chemical pollutants, and potential predation to identify if there are activities, locations, or periods of time for which CI belugas may be at high risk for synergistic effects.

It has been shown in other vertebrates that even weak stressors, when combined with other equally weak though dissimilar stressors, can have negative, synergistic impacts on reproduction and survival. Synergistic effects have not been studied for cetaceans, but there is evidence in other species of synergism associated with noise in combination with the presence of chemical pollutants and predators. All these factors are present in CI beluga habitat. By analyzing the potential synergism among noise exposure, chemical pollutants, and potential predation in CI belugas, specific locations, time periods, and certain human activities could result in unexpected severe threats because of synergism with other concurrent or sequential threats.

31. If two of the three actions under item 30 above are strongly suggestive that cumulative or synergistic effects of multiple threats are limiting CI beluga recovery, improve 1) the *understanding of the causes, relationships, and impacts of cumulative or synergistic effects to CI belugas, and 2) management of the causes and prevention of cumulative or synergistic effects to CI belugas.*

31a. Review the CI beluga stranding records for co-occurrence of multiple threats.

To date, the CI beluga stranding database has been examined to only a limited extent for the primary factors potentially related to observed CI beluga strandings. Additional information may be extrapolated from the CI beluga stranding database by reviewing stranding records for indications of multiple or secondary factors such as gunshot or propeller wounds, poor body condition (e.g., little blubber, muscle atrophy, etc.). Such an analysis would facilitate a better understanding of the prevalence of multiple threats and the contribution of co-occurring stressors to overall CI beluga mortality.

31b. Evaluate sequential effects compared to synergistic effects.

Evaluations of the effects of multiple stressors on organisms have often focused on factors that occur simultaneously. However, the aspect of latent effects due to sequential, but not co-occurring, stressors is often difficult to evaluate. The results from the meta-analysis of potential threats in CI beluga (see action 30b) and related species will provide guidance on sequential factors that may be detrimental to CI beluga recovery.

31c. Develop a PVA model component to incorporate covariance effects of multiple stressors.

The current approach for predicting trends in CI beluga population abundance is through a PVA model. The PVA population model should be: transparent, publicly available, and well documented with meta-data embedded in its code or as a separate document. It should include risk of cumulative stressors impacting individual survival or reproduction. This could then be used to evaluate the potential interaction of multiple stress factors, and their impacts on the risk of extinction and potential for recovery of the population.

31d. Review the current system for allocation of takes (by harassment) of CI belugas to see if a comprehensive approach, rather than by individual project, increases managers ability to reduce the cumulative effects of harassment takes by numerous projects.

Although individual activities might be deemed insignificant when considered independently, creeping normality[30] (e.g., death by a thousand cuts) can cause substantial adverse effects to nearly any entity, including CI belugas, at both individual and population levels. Applications for Incidental Harassment Authorizations (IHAs) historically have been reviewed on the basis of an individual activity in isolation. But the high level of human activity in Cook Inlet has increased such that cumulative effects of multiple activities must be appropriately accounted for. Although assessing cumulative impacts from multiple activities is challenging, results of such an assessment might be particularly relevant for understanding the lack of recovery for CI beluga

[30] Creeping Normality: the way a major negative change, which happens slowly in many unnoticed increments, is not perceived as objectionable. For more information about the concept of creeping normality, see the book "Collapse: How Societies Choose to Fail or Succeed" by Jared Diamond.

whales. A framework should be developed by NMFS for assessing cumulative impacts to beluga whales from the numerous activities occurring in Cook Inlet.

In 2012, the CI beluga population was estimated at 312 whales, and over 2,700 takes were requested for research and development projects (NMFS unpub. data). To monitor how many allocated takes are actually used (as opposed to how many takes are granted), the process for reporting takes needs to be streamlined and expedited. For example, research takes occurring in the summer are not required to be reported until fall of the following year. Requiring more frequent reporting of takes will better inform NMFS of how many takes are actually occurring, and will allow better take allocation in subsequent years.

The CIBRT recommended NMFS establish a limit for annual takes granted to development projects, research projects, and all projects combined. The CIBRT envisioned the total allocated take would be capped annually at some fraction of the population estimate from the previous year.

31e. Encourage the resources users/development community in Cook Inlet to create a joint industry program to gather and compile data to share for consultation, permitting, and mitigation processes, and to fund research to improve mitigation of impacts to CI belugas and their habitat.

Individually, several development projects in Cook Inlet have conducted a variety of studies to define baselines for the distribution, abundance, and habitat use of CI belugas in project areas. Many of these areas are within CI beluga critical habitat. In some cases, study results have been made public, but others remain proprietary. The E&P Sound and Marine Life Joint Industry Programme[31] (JIP) is used elsewhere by the oil and gas industry to direct research that will help industry and managers identify effective and efficient mitigation measures for oil and gas development, and may be a useful model for all development projects (not just the oil and gas industry) in Cook Inlet. Such a coalition would allow participants to pool their administrative resources and efficiently focus their efforts on environmentally responsible development that will not impede the recovery of the CI beluga whales.

31f. Consider analysis of results for cumulative and synergistic effects of multiple stressors to update regulations.

Regulations should not only consider the noise type and overall levels introduced into the CI beluga habitat by each activity independently, but also the potential effects of different stressors (acoustic and non-acoustic) occurring concurrently or sequentially over time or space. Research results on cumulative and synergistic effects could inform appropriate revisions to existing regulations that would improve management of acoustic impacts to CI belugas.

31g. Once every five years, reassess the status of the actions in item 30 to see if consideration of any new information results in a determination that cumulative or synergistic effects are not limiting CI beluga recovery.

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[31] The E&P Sound and Marine Life Joint Industry Programme website can be found at: http://www.soundandmarinelife.org/

Every five years, the status of the CI beluga population will be reassessed and a determination made if downlisting or delisting is warranted. Thus, at least once every five years, a reassessment should be undertaken to determine if cumulative or synergistic effects are limiting recovery, and that information can be used in the CI beluga population status review. If a reassessment suggests cumulative or synergistic effects are not limiting CI beluga recovery, then this threat should continue to be monitored and reassessed in the subsequent five years to confirm the previous assessment. If a reassessment indicates there is still concern regarding cumulative or synergistic effects limiting CI beluga recovery, the actions in item 31 should continue to be implemented or new actions defined.

32. Update stakeholders, interested parties, and the public about whether cumulative or synergistic effects are limiting CI beluga recovery.

Throughout the CI beluga recovery process, the steps taken to identify multiple or cumulative threats, the results of those steps, the initial proposed mitigation measures, and any proposed revisions to the mitigation measures should be clearly presented to the stakeholders and the public by developing educational materials, disseminating news releases the media, presenting at public meetings or conferences, or by posting the updates on the NMFS Alaska Region's website.

VII. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program for the Cook Inlet beluga whales as set forth in this recovery plan. It is a guide for meeting the recovery goals outlined in the plan. This schedule indicates action numbers, action descriptions, recovery priorities, the potential parties responsible for actions (either funding or carrying out), duration of actions, and estimated costs.

Priority: Priorities are assigned to each action in the Implementation Schedule. Assigning priorities does not imply that some recovery actions are of low importance; instead it implies they may be deferred while higher priority recovery actions are being implemented. It is important to remember that we have focused this section only on the threats identified as medium or high concern.

- Priority 1 – Actions that must be taken to prevent extinction or to prevent the species from declining irreversibly.
- Priority 2 – Actions that must be taken to prevent a significant decline in species population/habitat quality or in some other significant negative impact short of extinction.
- Priority 3 – All other actions necessary to provide for full recovery of the species.

The definitions for priority 1, 2, and 3 are defined in the Interim Endangered and Threatened Species Recovery Planning Guidance developed by NMFS[32]. Based on these definitions, and given that we do not know which threats are preventing the CI beluga population from recovering to the point where they are not in danger of becoming extinct in the foreseeable future, there are few priority 1 actions in this plan. We have limited priority 1 actions to those associated with monitoring the population's status since doing so is crucial to determine the effectiveness of this recovery plan. As the results of research and reassessments become available, we recognize the levels of concern for the threats, as well as the priorities, may change. This plan is meant to be adaptive to allow for such changes.

Responsible Parties: The group(s) identified as "Responsible Parties" have been identified as the best lead party/parties to implement discrete recovery actions. When more than one party has been identified, the proposed lead party is listed first. Many lead parties are agencies or organizations with authority, responsibility, or expressed interest to implement a specific conservation action. Inclusion as a Responsible Party does not commit any entity to taking action. Rather, it conveys who NMFS believes is best suited for completing the action. The listing of a party in the Implementation Schedule does not require the identified party to implement or fund the implementation of any action.

Estimated Costs and Duration: Costs are estimated for the fiscal year in thousands of 2015-value U.S. dollars ($K) and are not adjusted for inflation. Estimates of costs were derived from a variety of sources, including government agencies and other organizations. Tabular cost estimates do not imply that funding will be available for accomplishing that recovery task. Costs were estimated in accordance with the number of years necessary to complete the task once

[32] Interim Endangered and Threatened Species Recovery Planning Guidance version 1.3 (2010) http://www.nmfs.noaa.gov/pr/recovery/

implementation has begun. The table below covers a five-year period, in accordance with the standard five-year cycle of review and revision for all recovery plans.

The total time and cost to recovery are very difficult to predict with the current information, and the total cost to recovery will be largely dependent upon the number of the second level actions (for the threats management actions) requiring implementation. Since that cannot be determined prior to implementation of portions of this plan, the total cost presented here assumes implementation of all recovery actions. Thus, we expect the total estimated cost to achieve recovery presented here is high; actual costs will be lower if actions addressing some threats are not implemented because those threats have been determined not to be limiting the recovery of CI belugas. It is expected that recovery may take at least two generations (50 years), therefore, for ongoing actions costs have only been given for the next 50 years. If every identified recovery action must be implemented, and if it takes 50 years to recover the CI beluga whales, then the estimated cost of implementing this entire recovery program is approximately $78.3 million.

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
POPULATION MONITORING AND RECOVERY PLAN IMPLEMENTATION ACTIONS:											
1.	Continue to conduct aerial and photo-identification surveys to estimate abundance, and analyze population trends, calving rates, and distribution.	1	NMFS, LGL	500	200	500	200	500	ongoing	17500	Currently, NMFS conducts biennial aerial surveys for population estimate purposes (began in 1993), and LGL conducts annual photo-identification studies (began in 2005)
2.	Create and support a CI Beluga Recovery Coordinator position.	1	NMFS	150	150	150	150	150	ongoing	7500	This estimate includes fringe benefits as well as salary
3.	Create and support a CI Beluga Recovery Implementation Task Force.	1	NMFS	50	50	50	50	50	ongoing	2500	
4.	Increase efforts to identify and monitor individual CI belugas, coordinating photo-identification, genetics, and condition assessment via biopsy samples of skin and blubber.	2	NMFS, ADFG, LGL	0	100	0	0	0	once, with updates every 5 years	325	This effort is targeted at compiling different datasets and does not include data collection. The initial effort is likely to be more costly than subsequent updates (estimated at $25K). Results to be integrated in to annual reviews and coordination meetings per Action 8.
5.	Determine annual mortality and reproductive rates of CI belugas.	2	NMFS, AVPS, ASLC	0	0	0	0	0	ongoing	0	Costs associated with this effort are incorporated into other actions (e.g., Actions 1, 8, 12d, 15b)
6.	Conduct regular biopsy surveys of CI belugas to monitor changes in condition and reproductive success in relation to environmental changes.	2	NMFS, ADFG	300	300	300	300	300	yearly for 5 years, then once every 5 years	2700	Biopsy surveys during the first five years will build the dataset and allow for initial analyses, with subsequent surveys allowing for population monitoring.
7.	Monitor threats ranked low to determine if the status has elevated to the point specified actions need	3	NMFS	0	0	0	0	500	once every 5 years	5000	these should be reviewed in association with the 5-year status reviews

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	to be defined.										
8.	Organize an annual review and coordination workshop to review existing data on individual CI belugas, plan expansion of future data collection and analyses, and facilitate linkage of all existing and new CI beluga-related research.	1	NMFS	50	50	50	50	50	yearly	2500	All new information from other recovery actions should be shared during these annual meetings
9.	Hold a workshop to consider the feasibility, risks and benefits of different sampling techniques such as breath capture, remote ultrasound, and live captures to obtain samples and measures for further analyses.	3	NMFS	50	0	0	0	0	once	50	In April 2014, NMFS hosted a workshop of experts in the field of biopsy. The workshop report is recommended for use in planning any biopsy-related study, and is available on the NMFS AKR website.
10.	Conduct a workshop to update a model to determine the probability of extinction of CI belugas.	2	NMFS	75	0	0	0	0	once every 5 years	750	This may be a single workshop, or a series of workshops held within the same year.
11.	Create an annual Cook Inlet Beluga Watch Day.	3	NMFS, ADFG, NGO	25	25	25	25	25	yearly	1250	
THREATS MANAGEMENT ACTIONS:											
PREY REDUCTION											
12.	Assess if the availability or quality of food is limiting CI beluga recovery by adversely affecting CI beluga reproduction or survival.										
12a.	Evaluate how prey abundance has changed over time in comparison to CI beluga abundance and if there are direct correlations between the two suggestive of a positive link between prey abundance and CI beluga abundance, productivity or mortality.	2	NMFS, ADFG	80	0	0	0	0	once every 5 years	800	
12b.	Monitor body condition of living	2	NMFS,	30	0	0	0	0	once	300	Much of the costs for collecting

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	and deceased CI belugas to assess the presence/absence of nutritional distress or nutritional-related mortalities, and determine the percentage of necropsied CI belugas with mortalities attributed to nutritional distress.		LGL, ASLC, AVPS						every 5 years		this information are associated with other actions, notably stranding response and photo-identification efforts.
12c.	Analyze the existing collection of CI beluga teeth to determine if age at first reproduction for each individual female CI beluga for which teeth are available can be determined, and assess if there has been a significant change in the age at first reproduction over time.	2	NMFS, ADFG, UA	40	0	0	0	0	once every 5 years	400	NMFS will need to be contacted regarding access to the teeth collected from dead belugas.
12d.	Review available data which may provide information about calving rate and assess if the calving rate (population-wide) or calving interval (individual whales) is correlated with prey abundance.	2	NMFS, LGL	50	0	0	0	0	once every 5 years	500	NMFS has some data available from previous aerial surveys in August looking at a calving index. Long-term photo-identification studies may provide information useful in the assessment of calving rates/intervals.
13.	If at least two of the actions under item 12 above are strongly suggestive that prey availability or quality is limiting CI beluga recovery, improve 1) the understanding of CI beluga prey dynamics, CI beluga energetic requirements, and interspecific competition; and 2) the management of fisheries to accommodate CI beluga consumption requirements.										
13a.	Research the seasonal and spatial variation in prey distribution, diversity, and quality to improve assessments of relationships between CI belugas and their prey.	2	NMFS, ADFG, UA	0	300	300	300	300	yearly for 5 years, then once every 5 years	4200	
13b.	Research the effects of environmental and anthropogenic factors on CI beluga prey to assess	2	NMFS, ADFG, UA,	0	70	70	70	70	yearly for 5 years,	910	Supplemental to action 13a.; partly implemented as part of Noise actions

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	if any particular factor is having a significant detrimental effect to the prey and thus a detrimental effect to CI beluga recovery.		CIRCAC						then once every 5 years		
13c.	Determine the level of interspecific competition for prey with other marine mammals, especially harbor seals.	2	NMFS, ADFG, UA	0	0	30	30	30	3 Years	90	Data analysis; supplemental to action 13a.
13d.	Determine energetic requirements/metabolic needs of CI belugas at different life stages to determine whether nutritional stress is a function of life stage.	2	ADFG, UA, NMFS, ASLC, APU	0	150	150	0	0	2 years	300	Study Cook Inlet and Bristol Bay belugas, and potentially captive belugas in aquaria, in conjunction with other projects
13e.	Study the diet selectivity of different CI beluga demographic groups (e.g., age, sex, and reproductive state).	2	ADFG, NMFS, UA, APU	0	100	100	50	50	4 years	300	Consider aquaria studies
13f.	Using currently available information , develop a CI beluga foraging model informed by prey characteristics and beluga dietary needs.	2	NMFS, UA, ADFG, APU	0	0	0	60	0	once	60	
13g.	Ensure fisheries management (e.g., escapement goals for CI beluga prey species) adequately accommodates CI beluga prey requirements, and if necessary, expand the number of species with escapement goals.	2	ADFG, NMFS	0	0	0	0	0	5 years	0	Implemented as part of ongoing management processes; assumes no additional costs
13h.	Once every five years, reassess the status of the actions in item 12 to see if consideration of any new information results in a determination that prey reduction is not limiting CI beluga recovery.	2	NMFS, ADFG	0	0	0	0	0	once every 5 years	0	Funds for 5-year updates already factored in the action 12 items

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
14.	Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether prey is limiting CI beluga recovery.	3	NMFS, ADFG	0	0	0	0	0	yearly	0	Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops
DISEASE AGENTS											
15.	Assess if disease agents (pathogens, parasites, harmful algal blooms) are limiting CI beluga recovery by monitoring living (via non-invasive methods such as photo-identification studies, or minimally invasive methods such as biopsies) and deceased (via necropsies) CI belugas to assess the presence/absence of disease agents or disease-related mortalities.										
15a.	Analyze images from the CI beluga photo-identification catalog for the presence of external signs of disease in photographically identified CI belugas to 1) assess the percentage of identified CI belugas with external indications of disease, and 2) track the persistence of, or changes in, the external indications of the disease agent in individual whales over time.	2	NMFS, ASLC, AVPS, LGL	50	0	0	0	0	once every 5 years	500	Costs also include analyses for action
15b.	Continue examining beach-cast carcasses of CI belugas for disease-related mortalities, assessing the percentage of necropsied CI belugas with mortalities attributed to disease agents, and linking results from examinations of known individual belugas with the CI beluga photo-identification catalog. When feasible, determine the presence and relevance of disease agents in other Cook Inlet marine mammal	2	NMFS, ASLC, AVPS, LGL	8	8	8	8	8	ongoing	400	NMFS already provides separate funding to specific Marine Mammal Stranding Network responders for necropsies; photo-identification component associated with Action 15a; linkage of results can be associated and incorporated in Action 8

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	mortalities.										
15c.	Using currently available information, compare data on diseases from the CI belugas with other beluga populations to determine if there are abnormal levels or atypical types of disease agents present in Cook Inlet affecting CI belugas.	2	NMFS, AVPS, ASLC	15	0	0	0	0	once every 5 years	150	
16.	If any of the actions under item 15 above indicate that disease agents are limiting CI beluga recovery, improve 1) the understanding of sources of disease agents in Cook Inlet and the health of other marine mammals in Cook Inlet, and 2) the stranding response to beach-cast or floating CI beluga carcasses to allow for quicker response and necropsies.										
16a.	Determine types and sources of disease agents identified to be of concern specifically to CI belugas and assess management actions targeted at mitigating the disease agents.	2	NMFS	0	10	0	10	0	every other year	250	
16b.	Evaluate the feasibility/usefulness of health assessments on a surrogate sympatric species to better understand threats to CI belugas.	2	NMFS, ADFG, ASLC	0	0	50	0	0	once	50	
16c.	Given the limited time after death during which viable information about disease agents can be obtained, improve the response time for the CI beluga stranding response program so that full necropsies can yield more useful information. Make annual announcements encouraging immediate reporting of carcasses.	2	NMFS, ASLC, AVPS	0	0	0	0	0	ongoing	0	Improvement of the stranding protocol identified in Action 16c can be combined with Action 19f and Action 28d. Costs for this included in Action 28d.
16d.	Once every five years, reassess the status of the actions in item 15 to	2	NMFS, ASLC,	0	0	0	0	0	once every 5	0	Funds for 5-year updates already factored in the action 15 items

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	see if consideration of any new information results in a determination that disease agents are not limiting CI beluga recovery.		AVPS						years		
17.	Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether disease agents are limiting CI beluga recovery.	3	NMFS	0	0	0	0	0	ongoing	0	Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops
NOISE											
18.	Assess if noise is limiting CI beluga recovery by resulting in behavioral responses such as live strandings or displacement from important habitats.										
18a.	Conduct a retrospective analysis of documented CI beluga live strandings and noise-producing anthropogenic activities in Cook Inlet, possibly to include the development of a database of anthropogenic activities that introduce noise to Cook Inlet, and assess if a correlation exists which may indicate noise is limiting CI beluga recovery.	2	NMFS	250					once with updates every 5 years	700	Year 1 funds include the development of the anthropogenic activities database, linkage of that dataset to the NMFS stranding database (which is being finalized and available on the NMFS AKR website soon), and for conducting the retrospective analysis. The funds for the 5 year updates ($50k each) include costs for updating the database with new data and updating the analysis.
18b.	Conduct a retrospective analysis of anthropogenic noise-producing activities in Cook Inlet and information on CI belugas' behavior and distribution to assess if a correlation exists which may indicate noise is limiting CI beluga recovery.	2	NMFS, ADFG, CIBA	0	75	0	0	0	once with updates every 5 years	525	Part of the funding from NMFS (and others) to the Cook Inlet Beluga Acoustics (CIBA) group was aimed at starting to collect some of this data and conduct initial analyses necessary for this task. NMFS expects a final report in December 2015. This action's funding is for the retrospective analysis, with 5-year updates

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
											estimated at $50K each.
18c.	Within areas designated as critical habitat Type 1, determine areas with high vs. low levels of anthropogenic noise, if there are significant typical changes (e.g., seasonal differences) in the levels of overall (natural plus anthropogenic) noise in that area, and assess if a correlation exists between CI beluga use of the area and the noise levels in the area.	2	NMFS, ADFG, CIBA	250	0	0	0	0	once with updates every 5 years	1600	Some of this information may be available soon as a result of the acoustics work conducted by the CIBA group. The costs presented could supplement that project. Five-year updates are estimated at $150K each.
19.	If any of the three actions under item 18 are strongly suggestive that noise is limiting CI beluga recovery, improve 1) the understanding of the acoustic environment of Cook Inlet, and 2) management of noise-producing activities in Cook Inlet.										
19a.	Describe the acoustic characteristics of different anthropogenic noise sources in Cook Inlet and rate the potential acoustic impacts from each type of noise source to CI belugas.	2	NMFS, ADFG, CIBA	0	300	0	0	0	once every 10 years	1500	Some of this information may be available soon as a result of the acoustics work conducted by the CIBA group. This action could supplement that project. Costs associated with data collection are mostly captured in Action 19b. These costs include data analysis and rating the potential impacts to CI belugas.
19b.	Conduct year-round monitoring of background noise (level and spectrum) in key areas where CI belugas currently and historically concentrated to characterize the acoustic environment and identify sources, levels, and types of anthropogenic noise.	2	NMFS, ADFG, CIBA	0	450	450	450	450	5 years	2250	Some of this information may be available soon as a result of the acoustics work conducted by the CIBA group. The costs presented for data collection in this action supplement Actions 19a and 19c.
19c.	Conduct long-term monitoring of noise levels in CI beluga critical habitat to monitor and mitigate	2	NMFS, ADFG, CIBA	0	150	150	150	150	5 years	750	Some of this information may be available soon as a result of the acoustics work conducted by the

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	cumulative risks.										CIBA group. This action could supplement that project. Costs associated with data collection are mostly captured in Action 19b. These costs include data analysis and assessing cumulative effects to CI belugas.
19d.	Work with local, State, and Federal agencies and stakeholders to develop methods and plans for reducing or mitigating the levels of anthropogenic noises in Cook Inlet, including incorporation of pre- and post-activity surveys for major noise-producing activities to monitor CI beluga presence.	2	NMFS, ADFG	0	85	0	0	0	once every 5 years	850	Costs depends on each activity to be monitored/mitigated; these costs assume logistics of working with all pertinent agencies and stakeholders to develop methods and plans
19e.	Develop and incorporate into the noise monitoring/mitigation plans a protocol to identify the onset (received levels and distance) of CI beluga behavioral reaction s to specific activities.	2	NMFS, CIBA	255	255	255	255	0	4 years	1020	
19f.	Improve the CI beluga stranding response program for dead belugas so that full necropsies can be performed as soon after death as possible, to include appropriate collection and testing of the auditory system to determine if there has been damage, and making annual announcement encouraging immediate reporting of carcasses.	2	NMFS, ASLC, AVPS	0	0	0	0	0	ongoing	0	Improvement of the stranding protocol identified in Action 19f can be combined with Action 16c and Action 28d. Costs for this included in Action 28d.
19g.	Once every five years, reassess the status of the actions in item 18 to	2	NMFS	0	0	0	0	0	once every 5	0	Funds for 5-year updates already factored in the action 18 items

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	see if consideration of any new information results in a determination that noise is not limiting CI beluga recovery.								years		
20.	Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether noise is limiting CI beluga recovery.	3	NMFS	0	0	0	0	0	ongoing	0	Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops
HABITAT LOSS OR DEGRADATION											
21.	Assess if habitat loss or degradation has resulted in a significant reduction in the carrying capacity of Cook Inlet for CI belugas, or a loss or degradation of areas important to CI belugas for foraging or reproduction, to the point such loss or degradation is limiting CI beluga recovery.										
21a.	Develop a comprehensive Cook Inlet environmental database using currently available information to conduct a retrospective spatial and temporal evaluation of the biological, physical, and anthropogenic features in CI beluga habitat since the 1970s and assess how the habitat has changed over time, including likely causes of change.	2	NMFS, ADFG, ADEC, ADNR, UAF	400	0	0	0	0	once every 5 years	850	Year 1 funds include the development of the environmental database and for conducting the retrospective analysis. The funds for the 5 year updates ($50k each) include costs for updating the database with new data and updating the analysis.
21b.	Compare the changes in habitat availability or quantity over time with changes in CI beluga distribution and abundance over time to assess if a correlation exists which may suggest habitat loss or degradation is limiting the recovery of CI belugas.	2	NMFS, ADEC, CIK, DOW	85	0	0	0	0	once every 5 years	850	
21c.	Review losses or degradation of habitats in areas known to be important to CI belugas for	2	NMFS, ADEC, CIK,	85	0	0	0	0	once every 5 years	850	

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	foraging or reproduction, and assess if a correlation exists between habitat changes and changes in CI beluga use of the area, possibly indicating that habitat loss or degradation is limiting the recovery of CI belugas.		DOW								
22.	If any of the actions under item 21 are strongly suggestive that habitat loss or degradation is limiting CI beluga recovery, improve 1) the understanding of the impacts of a changing habitat to CI belugas, and 2) management of habitat degrading activities in Cook Inlet.										
22a.	Update the comprehensive Cook Inlet environmental database developed in action 21a. and project the future extent and quality of CI beluga habitat.	2	NMFS, UAF, ADEC	0	0	50	50	20	3 years	120	Will require data acquisition through other action items, coupled with predictive modeling.
22b.	Conduct a detailed habitat survey to begin long-term habitat monitoring (quality and quantity), including the use of volunteers and community members.	2	NMFS, ADFG, UAF, NGOs, CIRCAC	0	0	125	125	125	5 years	625	Supplemental to Action 21a by focusing on habitat characteristics. Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2)
22c.	Evaluate impacts to CI belugas from anthropogenic activities with potential to result in degradation or loss of CI beluga habitat, with emphasis in known and historic feeding areas.	2	NMFS, UAF	0	50	50	0	0	2 years	100	Perhaps involving aquaria studies
22d.	Determine if restoration is needed for particular CI beluga habitats by examining the cost/benefit of functional value, stability, and resiliency of restored habitats.	2	NMFS, UAF	0	0	40	40	40	3 years	120	This action item addresses only the analyses of the cost/benefit of potential restoration and not any potential restoration activities.
22e.	Work with local, State, and Federal agencies and stakeholders to develop a comprehensive Cook Inlet habitat database, and methods	2	NMFS, ADFG, NGOs	0	0	0	0	0	5 years	0	Implemented as part of ongoing management processes; assumes no additional costs apart from those identified in Action 21a. Could be

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	and plans for reducing or mitigating the levels of habitat loss or degradation in areas of known importance to CI belugas for foraging and reproduction, including restoration of habitats if necessary.										organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2)
22f.	Identify potential likely sources of contamination and evaluate their potential to discharge contaminants.	2	NMFS, EPA, CIK	0	0	50	0	0	once every 5 years	500	Costs associated with developing a comprehensive inventory or database
22g.	Once every five years, reassess the status of the action s in item 21 to see if consideration of any new information results in a determination that habitat loss or degradation is not limiting CI beluga recovery.	2	NMFS	0	0	0	0	0	once every 5 years	0	Funds for 5-year updates already factored in the action 21 items
23.	Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether habitat loss and degradation are limiting CI beluga recovery.	3	NMFS	0	0	0	0	0	ongoing	0	Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops
UNAUTHORIZED TAKE											
24.	Assess if unauthorized take is limiting CI beluga recovery as a result of injury or harassment of CI belugas, especially in areas important to CI belugas for foraging or reproduction.										
24a.	Review available data which may provide information about the types and level of unauthorized take in living and dead CI belugas to assess the prevalence, frequency, and severity of effects to CI belugas from these activities.	2	NMFS, ASLC, AVPS, LGL		70	0	0	0	once every 5 years	700	

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
24b.	Review and continue to monitor for signs of trauma in living and deceased CI belugas to assess the presence/absence of indications of trauma from entanglements or vessel strikes in living whales, and the percentage of necropsied CI belugas with mortalities attributed to or associated with anthropogenic trauma.	2	NMFS, ASLC, AVPS, LGL	50	0	0	0	0	once every 5 years	500	AVPS and ASLC conduct majority of CI beluga necropsies and document signs of trauma in dead whales; LGL documents signs of trauma in living whales. Costs are associated with reviewing the information to determine levels of injury/mortality from anthropogenic causes.
25.	If any of the actions under item 24 suggest that unauthorized take is limiting CI beluga recovery, improve 1) the understanding of the causes of unauthorized take, to include potential effects to the CI belugas, and 2) management of activities causing unauthorized take in Cook Inlet.										
25a.	Refine research techniques, evaluate alternatives, and implement research methods which minimize harassment, harm, and general adverse impacts to CI belugas. Only conduct research on CI belugas that has a clear connection to their recovery.	2	NMFS	0	0	0	0	0	yearly	0	These evaluations and decisions can be associated with the annual meetings recommended in Action 8.
25b.	Evaluate the relative effect of different types of vessels and speed on CI belugas.	2	NMFS, ADFG	0	0	60	0	0	once	60	
25c.	Work with local, State, and Federal agencies and stakeholders to: 1) monitor vessel activity in areas of known importance to CI belugas for foraging and reproduction; 2) develop a cooperative program to reduce whale interactions with vessels and fisheries; and 3) develop methods and plans for reducing or mitigating the levels of entanglements, vessel strikes, or other sources of anthropogenic	2	NMFS, ADFG	0	20	20	30	30	yearly for 5 years, then once every 5 years	550	Discussions should start in Year 1 (at no additional costs); monitoring vessel activity starts in Year 2; and assessing the need for boating guidelines and plans for mitigation begin in Year 4. Initial 5 years estimated at $100k, with a 5-year review cost of $50k

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	trauma for areas of critical importance to CI belugas for reproduction or foraging.										
25d.	Once every five years, reassess the status of the actions in item 24 to see if consideration of any new information results in a determination that unauthorized take is not limiting CI beluga recovery.	2	NMFS	0	0	0	0	0	once every 5 years	0	Funds for 5-year updates already factored in the action 24 items
26.	Update stakeholders, interested parties, and the general public about the status of the original and each subsequent assessment regarding whether unauthorized take is limiting CI beluga recovery.	3	NMFS	0	0	0	0	0	ongoing	0	Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops
CATASTROPHIC EVENTS											
27.	Assess if catastrophic events are limiting CI beluga recovery as a result of injuries or mortalities, especially in areas important to CI belugas for foraging or reproduction.										
27a.	Using currently available information, conduct a retrospective spatial and temporal evaluation of known catastrophic events in Cook Inlet since the 1970s, and assess if there are changes in the frequency, distribution, or types of catastrophic events over time.	2	NMFS, ADEC	100	0	0	0	0	once every 5 years	1000	
27b.	Review catastrophic events in areas known to be important to CI belugas for foraging or reproduction and assess if a correlation exists with CI beluga distribution, abundance, or reported mortalities which may	2	NMFS, ADEC	50	0	0	0	0	once every 5 years	500	may be informed by results of Action 27a

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	suggest catastrophic events are limiting recovery.										
27c.	Conduct a retrospective analysis of documented CI beluga live strandings and catastrophic events in Cook Inlet and assess if a correlation exists which may indicate catastrophic events such as natural or anthropogenic disasters are limiting recovery by causing mass strandings.	2	NMFS, ASLC	50	0	0	0	0	once every 5 years	500	may be informed by results of Action 27a
27d.	Review available data which may provide information about mortality rates (e.g., CI beluga stranding records) and assess if the occurrence of mortality is correlated with known catastrophic events.	2	NMFS, ASLC	50	0	0	0	0	once every 5 years	500	may be informed by results of Action 27a
27e.	Assess CI belugas for signs of catastrophe-induced distress to determine whether mortalities or reduced fitness can be directly or indirectly attributed to catastrophes.	2	NMFS, LGL, ASLC	30	0	0	0	0	review is once every 5 years; monitoring is ongoing	300	Funds for monitoring are assumed to be included in other actions that fund population monitoring (e.g., Action 1)
28.	If at least two of the five actions under item 27 suggest that catastrophic events are limiting CI beluga recovery, improve 1) the understanding of the causes and sources of catastrophic events, to include potential effects to the CI belugas, and 2) management of the causes, responses to, and prevention of catastrophic events resulting in injuries or mortalities of CI belugas.										
28a.	Review and update oil spill response plans to minimize effects of spills on CI belugas, including strategies to deter CI belugas from entering oiled areas.	2	NMFS, USCG, ADEC, EPA, CISPRI	0	25	0	25	0	Every other year	625	
28b.	Evaluate and test deterrent or hazing strategies aimed at	2	NMFS, USCG,	0	20	20	25	0	3 years then	290	

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	preventing belugas from entering contaminated areas.		ADEC, EPA, CISPRI						once every 5 years		
28c.	Hold annual drills to respond to belugas impacted by toxic spills.	2	NMFS, USCG, EPA, ADEC, CISPRI	0	20	20	20	20	yearly	980	Could be coordinated with the annual Alaska Marine Mammal Stranding Network meeting
28d.	Review and update the stranding response plan for both live and dead CI belugas, to include: 1) convening a workshop to revise the existing CI beluga stranding plan; 2) developing a strategy to allow securing and necropsying dead CI beluga carcasses without delay; and 3) conducting drills for live stranding response.	2	NMFS, ASLC, AVPS	0	70	15	15	15	yearly	1285	Improvement of the stranding protocol identified in Action 28d includes costs for Action 16c and Action 19f. Costs are higher once every 5 years ($70K vs $15K) to account for additional expenses associated with convening a workshop and conducting drills every 5 years.
28e.	Improve the Alaska Marine Mammal Stranding Network by obtaining separate funding for CI beluga stranding response that is independent of funding for other research or management activities, and expanding the geographic scope and support capacity of the network within Cook Inlet.	2	NMFS, ASLC	0	50	50	50	50	yearly	2450	
28f.	Once every five years, reassess the status of the actions in item 27 to see if consideration of any new information results in a determination that catastrophic events are not limiting CI beluga recovery.	2	NMFS	0	0	0	0	0	once every 5 years	0	Funds for 5-year updates already factored in the action 27 items
29.	Update stakeholders, interested	3	NMFS	0	0	0	0	0	ongoing	0	Could be organized and supported

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	parties, and the general public about the status of the original and each subsequent assessment regarding whether catastrophic events are limiting CI beluga recovery.										by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops
29a.	Develop and broadcast annual announcements promoting the use of citizen science and encouraging reporting of strandings and sightings by the public.	3	NMFS	5	5	5	5	5	yearly	250	Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops
CUMULATIVE AND SYNERGISTIC EFFECTS OF MULTIPLE THREATS											
30.	Assess if cumulative or synergistic effects of multiple threats are limiting CI beluga recovery, especially in areas important for foraging or reproduction.										
30a.	Conduct a temporal and spatial analysis of all types and sources of threats to CI belugas, documenting times and areas where threats overlap, and assess if a correlation exists with CI beluga abundance or distribution which may suggest the effects of multiple threats are limiting CI beluga recovery.	2	NMFS	150	0	0	0	0	once every 5 years	1500	
30b.	Conduct a meta-analysis of previously documented cumulative and synergistic effects for other populations and species, based on known threats for CI belugas, and prioritize risk to CI belugas based on how these threats have been shown to negatively affect other beluga populations, other odontocetes, or other marine mammals.	2	NMFS	100	0	0	0	0	once every 5 years	1000	

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
30c.	Analyze the potential synergism among noise exposure, chemical pollutants, and potential predation to identify if there are activities, locations, or periods of time for which CI belugas may be at high risk for synergistic effects.	2	NMFS	100	0	0	0	0	once every 5 years	1000	
31.	If two of the three actions under item 30 are strongly suggestive that cumulative or synergistic effects of multiple threats are limiting CI beluga recovery, improve 1) the understanding of the causes, relationships, and impacts of cumulative or synergistic effects to CI belugas, and 2) management of the causes and prevention of cumulative or synergistic effects to CI belugas.										
31a.	Review the CI beluga stranding records for co-occurrence of multiple threats.	2	NMFS, ASLC	0	10	5	5	5	yearly	250	
31b.	Evaluate sequential effects compared to synergistic effects.	2	NMFS	0	10	10	10	10	yearly for 5 years, then once every 5 years	140	
31c.	Develop a PVA model component to incorporate covariance effects of multiple stressors.	2	NMFS	0	0	0	50	0	once	50	similar to other PVA model parameters, once developed, this parameter will be incorporated into the model
31d.	Review the current system for allocation of takes (by harassment) of CI belugas to see if a comprehensive approach, rather than by individual project, is more appropriate for reducing the cumulative effects of allowing harassment takes by numerous projects.	2	NMFS	0	0	300	0	0	once	300	
31e.	Encourage the resources	2	MMC,	0	30	25	20	20	yearly	995	Assumes higher costs initially to

Action #	Action Description	Priority	Potential Resp. Parties	FY 1 $K	FY 2 $K	FY 3 $K	FY 4 $K	FY 5 $K	Duration or frequency of Action	50-year Cost ($K)	Comments
	users/development community in Cook Inlet to create a joint industry program to gather and compile data to share for consultation, permitting, and mitigation processes, and to fund research to improve mitigation of impacts to CI belugas and their habitat.		AOGA, NGOs, Cook Inlet resource users								start program, then $20K annually.
31f.	Consider analysis of results for cumulative and synergistic effects of multiple stressor to update regulations.	2	NMFS, MMC	0	0	0	0	85	once	85	
31g.	Once every five years, reassess the status of the actions in item 30 to see if consideration of any new information results in a determination that cumulative or synergistic effects are not limiting CI beluga recovery.	2	NMFS	0	0	0	0	0	once every 5 years	0	Funds for 5-year updates already factored in the action 30 items
32.	Update stakeholders, interested parties, and the public about whether cumulative or synergistic effects are limiting CI beluga recovery.	3	NMFS	0	0	0	0	0	ongoing	0	Could be organized and supported by the NMFS Cook Inlet Beluga Recovery Coordinator (Action 2); implemented as part of ongoing management processes or in association with other workshops

Potential Responsible Parties: ADEC = Alaska Department of Environmental Conservation; ADFG = Alaska Department of Fish and Game; ADNR = Alaska Department of Natural Resources; AOGA = Alaska Oil and Gas Association; ASLC = Alaska SeaLife Center; AVPS = Alaska Veterinary Pathology Services; CIBA = Cook Inlet Beluga Acoustics group; CIK = Cook Inletkeeper; CIRCAC = Cook Inlet Regional Citizens Advisory Committee; CISPRI = Cook Inlet Spill Prevention Response, Inc.; DOW = Defenders of Wildlife; EPA = Environmental Protection Agency; LGL = LGL Alaska Research Associates, Inc.; MMC = Marine Mammal Commission; NGOs = Non-governmental Organizations; NMFS = National Marine Fisheries Service; UA = University of Alaska ; USCG = United States Coast Guard

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IX. APPENDICES

A. Federal Actions and Regulations for CI Belugas

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C. CI Beluga Life History Supplement

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I. Common and Scientific Names

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A. Federal Actions and Regulations for CI Beluga Whales

Date	Action	Regulation
August 31, 1988	CI belugas included in the List of Candidate Vertebrate and Invertebrate Marine Species	53 FR 33516
November 19, 1998	NMFS initiated a status review of CI belugas	63 FR 64228
March 1999	NMFS received petitions to list CI belugas as endangered under ESA	N/A
April 9, 1999	NMFS agreed petitions are warranted	64 FR 17347
May 21, 1999	MMPA amended to require cooperative agreements to harvest CI belugas between NMFS and affected Alaska Native organizations	Pub. L. No. 106-31, Section 3022, 113 Stat. 57, 100
October 19, 1999	NMFS proposed designating the CI belugas as depleted under MMPA	64 FR 56298
May 31, 2000	CI belugas listed as depleted under the MMPA	65 FR 34590
June 22, 2000	NMFS determined ESA listing not warranted; established CI belugas as a DPS and thus as a "species" as defined under the ESA	65 FR 38778
October 4, 2000	NMFS proposed regulations to regulate subsistence harvests	65 FR 59164
December 21, 2000	MMPA amendment (May 21, 1999) on harvest of CI belugas made permanent	Pub. L. No. 106-553, 114 Stat. 2762, 2762A-108
September 26, 2003	NMFS released a Notice of Availability of Subsistence Harvest Management of CI Beluga Whales Final Environmental Impact	68 FR 55604
April 6, 2004	NMFS released final interim regulations to govern the subsistence harvest of CI belugas for Alaska Natives	69 FR 17973
April 15, 2004	CI belugas transferred from the Candidate Species List to the newly created Species of Concern List	69 FR 19975
March 16, 2005	NMFS completed a draft Conservation Plan for CI belugas	70 FR 12853
March 24, 2006	NMFS initiated a status review to determine if CI belugas should be listed under the ESA	71 FR 14836
March 29, 2006	NMFS published a Notice of Intent to prepare a SEIS for the CI Beluga Whale Subsistence Harvest	71 FR 15697
April 2006	NMFS received a petition to list CI belugas as endangered under ESA	N/A
August 7, 2006	NMFS agreed petitions are warranted	71 FR 44641
April 20, 2007	NMFS published a proposed rule to list CI belugas as endangered under ESA	72 FR 19854
December 28, 2007	NMFS released a Notice of Availability of the CI Beluga Whale Subsistence Harvest Draft SEIS	72 FR 73798
April 22, 2008	NMFS postponed the ESA listing decision six months	73 FR 21578

Date	Action	Regulation
June 20, 2008	NMFS published the CI Beluga Whale Subsistence Harvest Final Supplemental Environmental Impact Statement	73 FR 60976
October 22, 2008	NMFS issued the final determination to list a DPS of the CI beluga whale found in Cook Inlet, Alaska, as endangered under the ESA of 1973, as amended	73 FR 62919
December 2, 2009	NMFS proposed to designate critical habitat for the CI beluga whale	74 FR 63080
January 28, 2010	NMFS filed notice of intent to prepare a Recovery Plan for the CI beluga whale.	75 FR 4528
April 11, 2011	NMFS issued the final rule designating critical habitat for the CI beluga whale	76 FR 20180

B. Existing Protective Measures

NOTE TO READER: The text below was included in the draft recovery plan developed by the Cook Inlet Beluga Whale Recovery Team as a detailed description of existing protective measures that cover Cook Inlet beluga whales. All of this information is reproduced from publicly available laws, reports, or other sources of information. In an effort to improve readability of the recovery plan, and to give the reader the basic information necessary to understand the recovery criteria and actions, we removed the following text from the body of the document. However, we have preserved this text to present to readers interested in the details of the discussion.

1. Federal Protections

The Department of Commerce, through the National Oceanographic and Atmospheric Administration's (NOAA) NMFS, is charged with protecting whales, dolphins, porpoises, seals, and sea lions. Management responsibility for beluga whales in Alaska has been delegated by the Secretary of Commerce to NMFS and the Service's Alaska Region assumes primary responsibility for beluga whale recovery.

Walrus, manatees, otters, and polar bears are protected by the Department of the Interior through the U.S. Fish and Wildlife Service (USFWS). The Animal and Plant Health Inspection Service, a part of the Department of Agriculture, is responsible for regulations managing marine mammals in captivity.

a. The Marine Mammal Protection Act

All marine mammals in U.S. waters, including CI beluga whales, are federally protected under the MMPA of 1972, as amended. The MMPA established a national policy to prevent marine mammal species and population stocks in U.S. waters from declining to the point where they cease to be significant functioning elements of the ecosystems of which they are a part. The MMPA presents a single comprehensive federal program to take the place of formerly state-run programs, and includes protection for population stocks in addition to species and subspecies. Nowhere else in the world had a government made the conservation of healthy and stable ecosystems as important as the conservation of individual species

The MMPA was enacted in response to increasing concerns that some marine mammal species or stocks may be in danger of extinction or depletion as a result of human activities, and that measures should be taken to replenish these species or stocks so that they did not fall below their optimum sustainable population (OSP) level, thus resulting in a "depleted" population. The MMPA established the concept of OSP to ensure healthy ecosystems.

The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

The MMPA has been amended several times since 1972, but the most substantial amendments were in 1994 and provided:

- Certain exceptions to the take prohibitions, including: small takes incidental to specified activities; when access by Alaska Natives to marine mammal subsistence resources can be preserved; and permits and authorizations for scientific research;

- A program to authorize and control the taking of marine mammals incidental to commercial fishing operations;
- Preparation of stock assessments for all marine mammal stocks in waters under U.S. jurisdiction; and
- Studies of pinniped-fishery interactions.

The MMPA is organized into five "titles." Title I, Conservation and Protection of Marine Mammals, is the most comprehensive. Title I established a moratorium on the taking of marine mammals in U.S. waters. "Take" is defined by the MMPA as "to harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal." Under the 1994 amendments to the MMPA, harassment is further defined as any act of pursuit, torment, or annoyance which--

- ***(Level A Harassment)*** has the potential to injure a marine mammal or marine mammal stock in the wild; or,
- ***(Level B Harassment)*** has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

The moratorium generally does not apply to Alaska Natives who live on the Alaskan coast. The MMPA contains provisions (Section 119) allowing for take by Alaska Natives for subsistence use or to create and sell "authentic articles of handicrafts and clothing" without permits or authorizations. However, the taking must not be "accomplished in a wasteful manner," and the Secretaries of Commerce and the Interior may regulate the taking of a depleted species or stock, regardless of the purpose for which it is taken. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other nonfishing activities (Section 118), for scientific research (Section 104), and for public display at licensed institutions such as aquaria and science centers (Section 104). The MMPA shifts the burden from resource managers to resource users to show that proposed taking of living marine resources will not adversely affect the resource or the ecosystem.

Section 115 of Title I requires that the Secretary of Commerce make a determination if a species or stock should be designated as depleted, or should no longer be designated as depleted, solely on the basis of the best scientific information available. For any species or stock designated as depleted under the MMPA, and for which NMFS has management responsibility, this Section also requires the Secretary of Commerce to prepare a Conservation Plan. Conservation plans should be prepared as soon as possible for any species or stock designated as depleted. Each plan shall have the purpose of conserving and restoring the species or stock to its OSP. The MMPA requires that Conservation Plans to be modeled after recovery plans required under Section 4(f) of the ESA of 1973. In May 2000, NMFS designated the CI beluga whale stock as depleted under the MMPA. In October 2008, NMFS published the Conservation Plan for the Cook Inlet Beluga Whale and identified 780 whales as the OSP required to reconsider the depleted designation.

Section 119 of Title I (Marine Mammal Cooperative Agreements in Alaska) states that the Secretary may enter into cooperative agreements with Alaska Native organizations to conserve marine mammals and provide co-management of subsistence use by Alaska Natives. The MMPA also authorizes NMFS to implement subsistence harvest limits through regulation of depleted marine mammal stocks, following an administrative hearing on the record. In October 2000, NMFS proposed regulations to limit the beluga harvest in Cook Inlet, Alaska. An administrative hearing was held in December 2000 and interim harvest regulations for 2001 to 2004 were developed. In August 2004, a second administrative hearing was held to determine the long term harvest regime. NMFS signed a co-management agreement with the CIMMC in 2005 and 2006, allowing two belugas to be successfully harvested in those years. In June 2008, NMFS published the CI beluga whale Subsistence Harvest Final Environmental Impact Statement; in September 2008, the record of decision was signed for the Final Supplemental Environmental Impact Statement for the CI beluga subsistence harvest. Final Subsistence Harvest Regulations were published in October 2008.

Title II established the Marine Mammal Commission (MMC), an agency of the U.S. Government responsible for providing independent oversight of the marine mammal conservation policies and programs being carried out by federal regulatory agencies. The MMC is charged with the following duties:

- Undertake a review and study of the activities of the United States pursuant to existing laws and international conventions relating to marine mammals, including, but not limited to, the International Convention for the Regulation of Whaling, the Whaling Convention Act of 1949, the Interim Convention on the Conservation of North Pacific Fur Seals, and the Fur Seal Act of 1966.
- Conduct a continuing review of the condition of the stocks of marine mammals, of methods for their protection and conservation, of humane means of taking marine mammals, of research programs conducted or proposed to be conducted under the authority of the MMPA, and of all applications for permits for scientific research, public display, or enhancing the survival or recovery of a species or stock.
- Undertake or cause to be undertaken such other studies as it deems necessary or desirable in connection with its assigned duties as to the protection and conservation of marine mammals.
- Recommend to the Secretary of Commerce and to other federal officials such steps as it deems necessary or desirable for the protection and conservation of marine mammals.
- Recommend to the Secretary of State appropriate policies regarding existing international arrangements for the protection and conservation of marine mammals and suggest appropriate international arrangements for the protection and conservation of marine mammals.
- Recommend to the Secretary of Commerce such revisions of the endangered species list

and threatened species list published pursuant to Section 4(c)(1) of the ESA of 1973 as may be appropriate with regard to marine mammals.

- Recommend to the Secretary of Commerce, other appropriate federal officials, and Congress such additional measures as it deems necessary or desirable to further the policies of the MMPA, including provisions for the protection of the Indians, Eskimos, and Aleuts whose livelihood may be adversely affected by actions taken pursuant to the MMPA.

The MMC is primarily an oversight and advisory body. Although federal agencies are not required to adopt the MMC's recommendations, the MMPA specifies that an agency that declines to follow any such recommendations is required to provide detailed written explanations to the MMC within 120 days.

Title III of the MMPA focuses on the International Dolphin Conservation Program. Title IV is the origination of the Marine Mammal Health and Stranding Response program, and includes information about stranding response agreements, the National Marine Mammal Tissue Bank, and the John H. Prescott Marine Mammal Rescue Assistance Grant Program. Title V is dedicated to polar bears.

b. The Endangered Species Act of 1973

Congress passed the ESA on December 28, 1973, recognizing that the natural heritage of the United States was of "esthetic, ecological, educational, recreational, and scientific value to our Nation and its people." It was understood that, without protection, many of our nation's living resources would become extinct. The ESA provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. The USFWS and NMFS share responsibility for implementing the ESA. There are more than 1,900 species listed under the ESA. The NMFS is responsible for 74 marine species, including the CI beluga whales.

A species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become endangered in the foreseeable future. The listing of a species as endangered makes it illegal to "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to do these things) that species. Similar prohibitions usually extend to threatened species. Federal agencies may be allowed limited take of species through interagency consultations with NMFS or USFWS. Non-federal individuals, agencies, or organizations may have limited take through special permits with conservation plans. Effects to the listed species must be minimized, and in some cases conservation efforts are required to offset the take. The NMFS Office of Law Enforcement works with the U.S. Coast Guard and other partners to enforce and prosecute ESA violations.

NMFS conserves and recovers marine resources by implementing the different programs provided for by the ESA. The ESA is divided into 18 sections; only a few will be highlighted here, with emphasis placed on Sections 4, 6, and 7.

Under the authority provided by Section 4 (Determinations of endangered species and threatened species), NMFS lists species as endangered or threatened, designates critical habitat, and develops and implements recovery plans for listed species. NMFS conducts periodic reviews of species to ensure that they are listed appropriately. Because the ESA requires such reviews to be conducted at least once every five years, these reviews are referred to as five-year reviews. Section 4(f) of the ESA directs NMFS to develop and implement recovery plans for threatened and endangered species, unless such a plan would not promote conservation of the species. According to the statute, these plans must incorporate, at a minimum:

- a description of site-specific management actions necessary to achieve the plan's goal for the conservation and survival of the species;
- objective, measurable criteria which, when met, would result in a determination that the species may be removed from the list; and
- estimates of the time and cost required to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

The NMFS is authorized to procure the services of public and private entities to assist in the development and implementation of recovery plans, including the appointing of recovery teams. Many, but not all, recovery plans are written by recovery teams and, in some cases, implementation of plans is guided by recovery teams. NMFS has made a concerted effort in recent years to include representative stakeholders (those with an interest in the species) on recovery teams, and to involve the public in recovery planning. All recovery plans are made publically available in draft form and public comments are solicited before the plan is finalized, ensuring that the public has an opportunity to provide input in the recovery planning process. Implementation of recovery actions is the responsibility of all Americans, but tends to fall largely on federal, state and local agencies, tribes, interested organizations, and individuals within the range of the species.

Section 6 of the ESA (Cooperation with states) provides a mechanism for cooperation between NMFS and states in the conservation of threatened, endangered, and candidate species. NMFS is authorized to enter into agreements with any state that establishes and maintains an "adequate and active" program for the conservation of endangered and threatened species. Once a state enters into such an agreement, NMFS is authorized to assist in, and provide federal funding for, implementation of the state's conservation program. In 2009, the State of Alaska and NMFS formalized a limited cooperative conservation partnership agreement for the conservation and protection of endangered and threatened species pursuant to Section 6 of the ESA[33]. This agreement gives the State of Alaska eligibility to compete against other states for Section 6 funding under the Species Recovery Grant Program, an annual national competition. This federal grant funding is to be used to support management, outreach, research, and monitoring projects that have direct conservation benefits for listed species, recently de-listed species, and candidate

[33] A copy of the agreement can be viewed on NMFS's Alaska Region website at: http://www.alaskafisheries.noaa.gov/protectedresources/esa/section6/s6_nmfs_adfg.pdf

species that reside within that State. To date, no funding has been awarded to the State of Alaska under this program. Section 6 of the ESA also allows state laws to be more restrictive than the ESA regarding taking of listed species, however, state laws cannot be less restrictive.

Section 7 of the ESA (Interagency Cooperation) requires federal interagency cooperation as another means to conserve federally listed species and designated critical habitat. Section 7(a)(1) requires NMFS to review other programs administered by NMFS and utilize such programs to further the purposes of the ESA. It also directs all other federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of listed species. Under Section 7(a)(2), federal agencies must consult with NMFS on activities that may affect a listed species or its designated critical habitat. These interagency, or Section 7, consultations are designed to assist federal agencies in fulfilling their duty to ensure any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. In fulfilling these requirements, each agency must use the best scientific and commercial data available.

Section 8 (International Cooperation) allows NMFS to partner with other nations to ensure that international trade does not threaten species. Section 9 (Prohibited Acts) addresses enforcement of the ESA and investigations of violations. Section 10 (Exceptions) allows NMFS to cooperate with non-federal partners to develop conservation plans for the long-term conservation of species, as well as permitting research to learn more about protected species. States, local agencies and private entities may conduct conservation actions as a means to minimize or mitigate incidental take of a species as part of a Conservation Plan under Section 10 of the ESA. Any entity or individual may also take proactive measures to promote recovery of listed species, although some of these activities may require a Section 7 consultation or Section 10 permit.

c. The Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) of 1934, as amended, requires that fish and wildlife resources receive equal consideration to other project features, and that all federal agencies consult with NMFS, USFWS, and state wildlife agencies when proposed actions might result in modification of a natural stream or body of water. Thus, FWCA provides the basic authority for NMFS and USFWS involvement in evaluating impacts to fish and wildlife from proposed water resource development projects.

Specifically, consultation is required in instances where the "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted, or otherwise controlled or modified" by any agency under a federal permit or license. The purpose of the consultation is to prevent "loss of and damage to wildlife resources" by determining the possible harm to fish and wildlife resources, and the measures that are needed to both prevent the damage to and loss of these resources, and to develop and improve the resources, in connection with water resource development.

FWCA allows NMFS to submit comments and recommendations to federal licensing and permitting agencies, and to federal agencies conducting construction projects on the potential harm to living marine resources caused by the proposed water development project, and submit recommendations to prevent harm. NMFS routinely provides comments to the Corps during review of projects under Section 404 of the Clean Water Act (CWA)(concerning the discharge of dredged materials into navigable waters) and Section 10 of the Rivers and Harbors Act of 1899 (obstructions in navigable waterways).

d. The Coastal Zone Management Act of 1972

The U.S. Congress recognized the importance of meeting the challenge of continued growth in the coastal zone by passing the Coastal Zone Management Act (CZMA) in 1972. The Act, administered by NOAA's Office of Ocean and Coastal Resource Management, provides for management of the nation's coastal resources, including the Great Lakes, and balances economic development with environmental conservation.

The CZMA outlines two national programs, the National Coastal Zone Management Program and the National Estuarine Research Reserve System. The coastal programs aim to balance competing land and water issues in the coastal zone, while estuarine reserves serve as field laboratories to provide a greater understanding of estuaries and how humans impact them. Through the CZMA, Congress declared it is national policy "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations."

The National Coastal Zone Management Program is a voluntary partnership between the federal government and U.S. coastal and Great Lake states and territories authorized by the CZMA to address national coastal issues. The act provides the basis for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources. To meet the goals of the CZMA, the National Coastal Zone Management Program takes a comprehensive approach to coastal resource management—balancing the often competing and occasionally conflicting demands of coastal resource use, economic development, and conservation. Some of the key elements of the National Coastal Zone Management Program include:

- protecting natural resources;
- managing development in high hazard areas;
- giving development priority to coastal-dependent uses;
- providing public access for recreation; and
- coordinating state and federal actions.

In 2015, 34 states and territories had approved coastal management programs that address a wide range of issues, including coastal development, water quality, public access, habitat protection, energy facility siting, ocean governance and planning, coastal hazards, and climate change. By using both federal and state funds, the program strengthens the capabilities of each partner to address coastal issues. While the Act includes basic requirements for state partners, it also gives them the flexibility to design programs that best address their unique coastal challenges and laws and regulations.

The Alaska Coastal Management Program (ACMP) was discontinued July 1, 2011. This program was previously under the Alaska Department of Natural Resource's Division of Coastal and Ocean Management, and set forth statewide standards governing natural resource development and conservation in Alaska's coastal zones, including specific standards for habitats and subsistence. Section 307 of the CZMA requires the state to review most federal activities and federally-permitted activities affecting resources within the state's coastal zone, and to ensure that state-permitted activities are consistent with standards and policies of the ACMP. However, on May 14, 2011, the Alaska State Legislature adjourned a special legislative session without passing legislation necessary to extend the ACMP (AS 44.66.030). Alaska is the only coastal state in the United States without a Coastal Management Program.

e. The Clean Water Act

The primary objective of the Federal Water Pollution Control Act of 1948, more commonly known as the Clean Water Act (CWA), is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. The EPA is the federal agency responsible for creating and enforcing national water quality regulations under the CWA. The CWA regulates the discharges of pollutants into the waters of the U.S., and in doing so, is aimed at ensuring that the Nation's waters are fishable, swimmable, and drinkable.

The EPA, the Corps, and the State of Alaska all have a role in the implementation and enforcement of the CWA in Alaska. Section 303(d) of the CWA requires states to prepare a list of all impaired waters within their jurisdiction. The State of Alaska's Department of Environmental Conservation (ADEC) assesses the quality of Alaska's water bodies by utilizing a multi-agency task force, and reviews information provided on water bodies through a nomination and public solicitation process. Each nominated water body is then analyzed to determine if the existing protections are sufficient to meet water quality, water quantity, and habitat needs. These reviews occur every two years and, after a public review, the assessments are presented to the EPA for approval.

Section 401 of the CWA requires that any applicant for a federal permit which may result in effluent being discharged into navigable waters must first be granted certification by the state that the proposed action will not violate state water quality standards. Such certification will define effluent limitations and monitoring requirements necessary for ensuring that: 1) the water quality sections of the CWA are upheld, and 2) applicable state laws are complied with. These requirements are to be incorporated as requirements in the federal permit. The purpose of this section is to allow the states, who define water quality standards, the opportunity to ensure that the Federal permits issued are protective of the designated use(s) of the receiving waters. Thus, this section gives significant authority to the states to have a say in the compliance with water quality issues for waters within their jurisdiction.

Section 402 of the CWA requires that all discharges to surface waters be permitted under the National Pollutant Discharge Elimination System (NPDES) permit program. All dischargers from point sources are required to obtain a permit from the EPA under the NPDES program, which outlines effluent limitations based on two levels of control: technology-based criteria, and water quality-based criteria. The more stringent of the two criteria apply. Discharging without an NPDES permit is unlawful. The CWA allows for states to implement (to have "primacy" for) the NPDES program with the EPA acting in an oversight role.

The State of Alaska's application for a state-run Section 402 program was approved by the EPA on October 31, 2008. The State of Alaska's program is referred to as the Alaska Pollutant Discharge Elimination System Program (APDES). The transfer of authority for permitting, compliance, and enforcement of the Section 402 program to the ADEC includes an implementation plan that transfers the administration of specific program components from EPA to the ADEC in phases over a multi-year period. Phases I-III have successfully transferred from EPA to ADEC. Transfer of the final phase, Phase IV, was scheduled for October 31, 2011. In March 2011, ADEC proposed a one year extension of the transfer of Phase IV. ADEC assumed full authority to administer the wastewater and discharge permitting and compliance program for Alaska on October 31, 2012.

Section 404 prohibits the discharge of dredged or fill material into the waters of the U.S., including wetlands, without specific authorization from the Federal Government. Section 404 of the CWA describes how such discharge is to be regulated and authorized. A primary goal of this Section is the preservation of the nation's wetlands. The EPA is responsible for general oversight of the program, while the Corps issues the permits authorizing discharge of dredged or fill materials into navigable waters of the United States, including wetlands. The EPA may authorize states to issue 404 permits (EPA/Corps still retain 404 authority in the State of Alaska). All authorized discharges must avoid and minimize, to the extent practicable, adverse impacts to wetlands, streams and other aquatic resources. If impacts are unavoidable, then the Corps may require the permittee to replace the loss of the function of that wetland or resource in the form of compensatory mitigation.

In Alaska, NMFS provides direct consultations to the EPA and the Corps regarding impacts to marine mammals, fish, and their habitats as a result of proposed activities and methods for avoiding such impacts.

f. Treaty Trust Responsibilities

The NMFS must also consider treaty trust responsibilities to recognize the rights and authorities of tribes related to the ESA and CI beluga whale recovery. Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments) outlines the responsibilities of the Federal Government in matters affecting tribal interests. In addition, Secretarial Order "American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act" outlines NMFS's responsibilities regarding Indian tribal rights and federal trust responsibilities when implementing the ESA.

2. State of Alaska Protections

In addition to the State of Alaska's involvement under the federal laws previously discussed, the State also has regulatory protections in place to protect the habitat of beluga whales, as well as other fish and wildlife populations. Article 8 of the Alaska Constitution ("Natural Resources") outlines the framework for management of Alaska's renewable resources and emphasizes Alaska's regard for its natural resources.

The ADF&G is responsible for determining and maintaining a list of endangered species in Alaska under Alaska Statute 16.20.190. A species or subspecies of fish or wildlife is considered a State of Alaska endangered species when the Commissioner of ADF&G determines that its numbers have decreased to such an extent as to indicate that its continued existence is threatened.

The State Endangered Species List does not currently include beluga whales, although ADF&G has designated the beluga whales in Cook Inlet as a "species of special concern." This designation provides ADF&G with management responsibility and authority that includes: habitat management and guidelines; monitoring; information gathering and dissemination; management research on beluga prey species including Pacific salmon; and the recommendation and imposition of mitigation requirements on state-regulated activities. Because the species of special concern list has not been reviewed or revised since 1998, as of August 15, 2011, ADF&G instead uses the Alaska Comprehensive Wildlife Conservation Strategy (a.k.a. the Wildlife Action Plan)[34] for management of species with conservation concerns, including the CI beluga whales. The Wildlife Action Plan, finalized in August 2005 and updated since, contains conservation measures, including co-management with Alaska Native populations and cooperation with other government agencies, for the protection and conservation of wildlife, including the CI beluga whales. The plan also provides the basis for the development of stipulations or conditions on State-issued permits to protect the beluga whale and its habitat.

More than 15 million acres of protected land surrounding Cook Inlet, including State game refuges, critical habitats, and special legislated management areas, support healthy populations of fish on which beluga whales prey. Each of these protected areas has a detailed management plan in effect that incorporates management guidelines, regulations, and permit stipulations implemented by Alaska's resource conservation agencies.

Many of the municipal governments of the communities within the Cook Inlet watershed have also enacted laws and regulations affecting land use, development, and other matters providing important local protection.

3. International Protections

a. The Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a voluntary international agreement among governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. The CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of the International Union for the Conservation of Nature and Natural Resources (IUCN) and finalized in 1975.

Countries that have agreed to be bound by CITES are known as Parties. The treaty now has 166 Parties, including the United States. Although CITES is legally binding on the Parties, it does not take the place of national laws, but instead provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level. All import, export, re-export, and introduction of species covered by the Convention has to be authorized through a licensing system.

[34] Alaska's Wildlife Action Plan can be viewed on the ADF&G website at: http://www.adfg.alaska.gov/index.cfm?adfg=species.wapabout

The structure of CITES is similar to the ESA, in that species are listed in appendices according to their conservation status. However, listed CITES species must also meet the test that trade is at least in part contributing to their decline. The CITES regulates international trade in species of animals and plants according to their conservation status, and does not protect species from other factors which may contribute to a species' decline, as would the ESA.

CITES lists the species covered in three appendices according to the degree of protection needed. CITES Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. CITES Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. CITES Appendix III contains species that are protected in at least one country which has asked other CITES Parties for assistance in controlling the trade. Countries may unilaterally list species for which they have domestic regulation in CITES Appendix III at any time. Decisions concerning CITES Appendix I and II species listings and resolutions are made at meetings of the Conference of the Parties, which are convened approximately every two years.

For the United States, the USFWS is the lead agency for implementation of the Convention since the bulk of CITES-listed species are under USFWS jurisdiction. However, many species under the jurisdiction of NMFS are also listed, either on CITES Appendix I or II. CI beluga whales are listed on CITES Appendix II.

b. The International Union for the Conservation of Nature and Natural Resources

The International Union for the Conservation of Nature and Natural Resources, commonly referred to as the IUCN or World Conservation Union, is the oldest and largest global environmental organization. The IUCN is composed of over 1,200 member organizations, of which more than 200 are government groups, including NOAA. The IUCN Red List assesses the extinction risk of species with the overall aim "to convey the urgency and scale of conservation problems to the public and policy makers, and to motivate the global community to work together to reduce species extinctions."[35]

The IUCN classified CI beluga whales as "critically endangered" in 2006 having met IUCN criterion C2a(ii)[36]: "The population is estimated to number 207 mature individuals. There is a 71% probability that the growth rate of the population is negative, with the best estimate indicating that the population is declining by 1.2% per year. All of the mature individuals are in one subpopulation."

4. Management Measures Implemented by NMFS

[35] See IUCN's website (http://www.iucn.org) and the Red List Classification for CI belugas (http://www.iucnredlist.org/details/61442/0)

[36] Guidelines and criteria for IUCN's Red List classifications are available at: http://jr.iucnredlist.org/documents/RedListGuidelines.pdf

The following discussion describes several of the protective management measures implemented by NMFS for CI beluga whales. See Appendix A for a summary of federal regulations specifically related to CI beluga whales.

a. Subsistence Harvest Management

The MMPA authorizes NMFS, acting on behalf of the Secretary of Commerce, to implement subsistence harvest limits through regulation of depleted marine mammal stocks, following an administrative hearing on the record. In accordance with Public Laws 106-31 (1999) and 106-553 (2000), the annual subsistence harvest of CI beluga whales is allowed only under cooperative management agreements between NMFS and affected Alaska Native organizations. On October 4, 2000 NMFS proposed regulations to limit the beluga harvest in Cook Inlet, Alaska. An administrative hearing was held in December 2000 and interim harvest regulations for 2001 to 2004 were developed and published in the Federal Register in 2004. These interim harvest regulations allowed for a limited harvest (1-2 belugas annually), regulated the use of beluga products, and established requirements for the harvests within a co-management agreement. With the collection of more information pertaining to the CI belugas, a second administrative hearing was held in August 2004 to determine the long-term harvest regime (2005 and subsequent years, until the population recovered). Following the long-term harvest plan as recommended by the administrative law judge, NMFS signed a co-management agreement with CIMMC in 2005 and 2006 for the harvest of CI beluga whales, which resulted in two belugas harvested in 2005. NMFS published the Cook Inlet Beluga Whale Subsistence Harvest Final Supplemental Environmental Impact Statement in June 2008 (NMFS 2008b; 73 FR 60976), where four harvest alternatives were considered. A Record of Decision and harvest regulations were published in October 2008, and provided a subsistence harvest plan for Alaska Natives until the CI beluga stock recovers.

CIMMC was disbanded by unanimous vote by the CIMMC member Tribes' representatives on June 20, 2012. CIMMC was the only Alaska Native organization to obtain a co-management agreement with NMFS for CI beluga whale harvest. Currently, NMFS has no co-management agreements with any Alaska Native organization pertaining to the CI beluga whales. This lack of a co-management agreement for Cook Inlet beluga whales precludes the authorization of subsistence harvest of this stock

b. Project Review, Environmental Analyses, and Mitigation Identification

Any action that may “take” a CI beluga whale requires authorization from NMFS under the MMPA and ESA (i.e., via an Incidental Harassment Authorization [IHA] or Letter of Authorization [LOA] as per the MMPA, or by an Incidental Take Statement [ITS] as per the ESA). MMPA authorizations for take can only be granted if an activity, by itself or in combination with other activities, would not cause a significant adverse impact on the stock. ESA authorization for take can only be issued if such take does not jeopardize the continued existence of the species or destroy or adversely modify designated critical habitat. NMFS works with agencies and applicants to determine whether their actions could harm CI belugas or damage habitats essential to their survival, and to identify measures to avoid or minimize possible adverse effects. In addition to MMPA and ESA reviews, activities with authorized takes are analyzed under the National Environmental Policy Act (NEPA).

Research projects may be conducted at federal, state, and/or private levels. Any research that may take a CI beluga requires authorization under the MMPA and ESA. NMFS will continue to provide specific recommendations under its authorities provided by the MMPA, ESA, and FWCA to minimize and mitigate effects of anthropogenic actions in an effort to conserve CI beluga whales.

c. Noise Guidelines

From what is known about the hearing sensitivity of beluga whales and the movements, distribution, and habitat use of the CI beluga whales, the ESA and MMPA require steps be taken to minimize the likelihood of noise having adverse impacts upon these whales and to minimize the possibility of injury or possible abandonment of critical habitats. NMFS regularly reviews and comments on applicable permits and recommends specific conditions to reduce or avoid potential impacts from noise. Mitigation measures may be incorporated into project permits to avoid incidental taking of beluga whales. Such taking is prohibited by the MMPA and ESA, unless authorized by NMFS.

Currently, NMFS uses the following thresholds when evaluating harassment or harm to CI beluga whales resulting from in-water noises: the levels at which harassment is considered to occur are at or above 120 dB re: 1µPa RMS for continuous noises or 160 dB re: 1µPa RMS for impulsive noises. Injury to the whales is assumed to occur with sounds at or above 180 dB re: 1µPa RMS. NMFS is considering new acoustic guidelines to determine noise levels that result in injury or harassment. However, until such guidelines are approved, NMFS will continue to apply the current threshold levels when evaluating in-water construction and other actions with the potential to introduce noise into Cook Inlet.

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C. CI Beluga Natural History Supplement

NOTE TO READER: The text below was developed by the Cook Inlet Beluga Whale Recovery Team and reproduces information readily available in other reports. In Section II.B of this document, we provided information sufficient to justify the recovery criteria and actions. Additional natural history information follows.

1. Body Size

Geographic variation in body size has been documented across the beluga's range (Kleinenberg et al. 1969; Sergeant and Brodie 1969) and may be indicative of ecological differences, such as the availability of winter prey. Sergeant and Brodie (1969) documented a positive correlation between beluga whale size and marine productivity, with belugas in estuarine and Arctic waters being the smallest whereas belugas in the subarctic were the largest. Furthermore, Native hunters remarked that CI beluga whales are larger than belugas in other parts of Alaska (Huntington 2000), but a systematic analysis of body size across Alaskan populations has not been completed. However, belugas from Cook Inlet and Bristol Bay (both estuarine areas) and the eastern Chukchi Sea (the high Arctic) were documented to be of similar size (Suydam 2009). An examination of five beluga populations of the Canadian Arctic showed that growth was positively correlated with latitude (Luque and Ferguson 2010), with belugas harvested at the highest latitude attaining the longest adult body lengths. Luque and Ferguson (2010) postulated that this latitudinal variation in body size may result from the seasonality of important environmental resources. From a preliminary analysis of a small number of specimens, Murray and Fay (1979) suspected there may be differences in skull morphology between Cook Inlet belugas and other beluga populations. Similarly, differences in vocal repertoires and acoustic signatures among CI belugas and other Alaskan populations were investigated by Angiel (1997) but results are inconclusive.

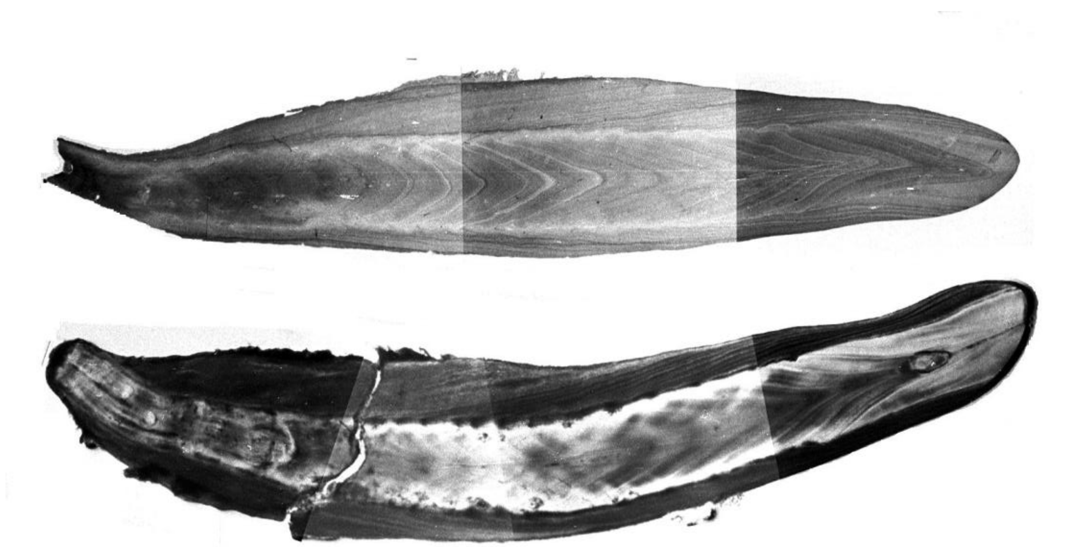
2. Distribution

A review by Laidre et al. (2000) of cetacean surveys conducted from 1936 to 2000 in the Gulf of Alaska (Unimak Pass to Dixon Entrance) confirmed that beluga sightings are rare outside Cook Inlet. During dedicated surveys covering over 150,000 km (93,205 mi) of the Gulf of Alaska (including Cook Inlet), only five belugas (four sightings) were reported outside of Cook Inlet (four near Kodiak Island and one in Prince William Sound) out of over 23,000 individual cetacean sightings (Laidre et al. 2000). In addition to these dedicated surveys (with records of effort and other cetaceans seen), the NMFS Platforms of Opportunity database (data from surveys without defined effort) contained only 39 individual belugas (from five sightings) out of over 100,000 individual cetaceans sighted (Laidre et al. 2000). Other incidental sightings from 1936 and 2000 (from commercial or recreational fishing boats, tourists, and bird surveys with no information about survey effort or other cetaceans seen) documented over 260 individual belugas (from approximately 19 sightings) (Laidre et al. 2000), with only 28 sightings of belugas outside of Cook Inlet (nine near Kodiak Island, 10 in or near Prince William Sound, eight in Yakutat Bay, and one sighting well south of the Gulf of Alaska).

3. Age Determination

There has been recent discussion about the deposition rate of growth layer groups (GLGs) in beluga teeth (Figure C1), including questions on whether belugas produce one or two GLG per year. The initial hypothesis was that two GLGs were deposited annually (Sergeant 1959), which was supported by many successive studies (Brodie 1971, 1982; Sergeant 1973; Burns and Seaman 1986; Goren et al. 1987; Brodie et al. 1990; Heide-Jørgensen et al. 1994). This deposition rate was previously assumed for most odontocetes. Although further investigation revealed that other odontocetes deposited only one GLG per year, the notion of two GLGs per year persisted for belugas. After re-evaluation of previous studies, analyses of teeth of two captive belugas, and examination of tetracycline-marked teeth, several studies concluded that belugas deposited only one GLG per year (Hohn and Lockyer 1999; Stewart et al. 2006; Lockyer et al. 2007; Luque et al. 2007; NAMMCO 2011). Deposition of a single GLG per year among beluga whales would double most of the previous estimates of age, with associated changes to vital rates (such as longevity, age at sexual and physical maturity, age at first birth, etc.). Here, it is assumed that one GLG is deposited annually and some of the estimates in Table 1 have been revised to reflect this change.

FIGURE C1: Photo of Beluga Whale Tooth Cross Section.



Notes: Photo of a beluga whale tooth cross section showing the pulp cavity at the left and progressive layers of dentin towards the right. The oldest dentin layers are on the outer margins of the tooth with progressively thinner layers of dentin deposited in later years near the central pulp cavity. Each layer is considered a growth layer group and is used for aging the individual.

Source: The North Atlantic Marine Mammal Commission; image acquired 24 July 2013 http://www.nammco.no/Nammco/Mainpage/Publications/Miscellaneous/report_of_the_workshop_on_age_estimation_in_monodontids.html

D. CI Beluga Hearing, Vocalization, and Noise Supplement

NOTE TO READER: The text below was developed by the Cook Inlet Beluga Whale Recovery Team and reproduces information readily available in other reports. In Sections II.B.6 and III.A.4 of this document, we provided information sufficient to justify the recovery criteria and actions. Additional CI beluga hearing, vocalization, and noise information follows.

1. Beluga Hearing

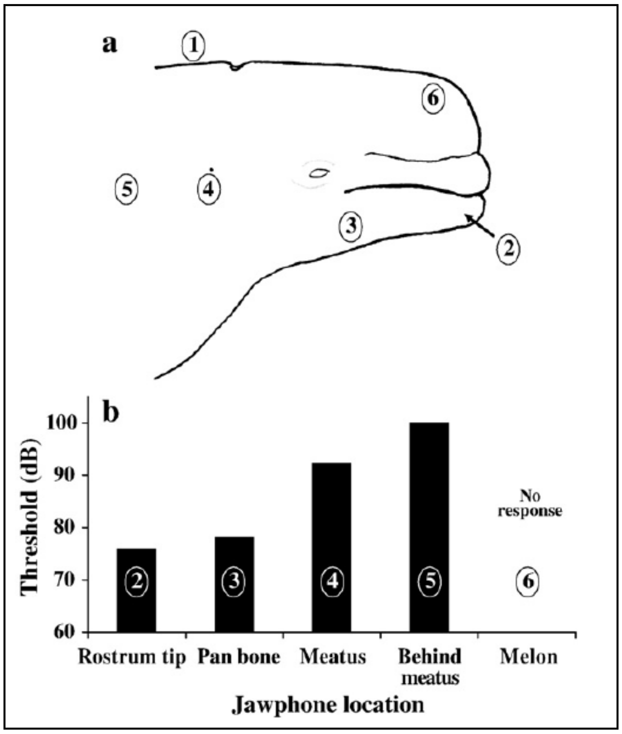
Having evolved from land based mammalian ancestors, cetaceans have inherited an ear that was first adapted to hearing sounds through air, which then readapted to receiving sounds through water (Thewissen and Hussain 1993). Cetaceans have retained the ear drum, ossicles, Eustachian tube, and middle ear structures, including an air-filled cavity within the temporal bone or bulla, connected by the Eustachian tube to the nasal cavity for equalization of pressure during dives (Gingerich et al. 1983; Thewissen and Hussain 1993; Ridgway et al. 2001). As a consequence, it was hypothesized that cetacean hearing might attenuate at depth due to the increased air pressure and density of air in the middle ear, which might make them less susceptible to the impacts of loud underwater sounds. This has been shown not to be the case in belugas, as their hearing was determined to be as good at 300 m (984 ft.) depth as at the surface (Ridgway et al. 2001). This is consistent with the theory that sound may be received through odontocetes' lower jaw "acoustic window" and transmitted directly to the ear (Norris 1968; Cranford et al. 2008). In fact, a study conducted with a captive beluga showed that the most efficient hearing pathway is from the rostrum tip (Figure D1), and may indicate that there are acoustic fat channels which begin at the beluga rostrum tip that effectively guide sound to the inner ear (Mooney et al. 2008). To date, belugas are the only odontocetes known to hear from the rostrum tip, although a similar pathway has been recently proposed for Cuvier's beaked whale (*Ziphius cavirostris*; Cranford et al. 2008). This feature probably gives belugas greater directional hearing abilities than other odontocetes. It is possible that belugas' unfused vertebrae, which allows for a highly movable head, facilitates increased hearing directionality.

2. Beluga Echolocations and Vocalizations

Belugas utilize an alternative echolocation strategy compared with the bottlenose dolphin when performing identical echolocation tasks (Turl and Penner 1989; Rutenko and Vishnyakov, 2006). Bottlenose dolphins will emit a click and wait until the echo returns before emitting the next signal (i.e., the inter-click interval is always greater than the two-way time travel). Belugas appear to be able to transmit, receive and process signal packets simultaneously, with the first click about two dB higher than the other clicks that follow, which may serve to identify the beginning of each signal packet (Turl and Penner 1989).

The first vocal repertoire description of beluga was made in the Canadian high Arctic by Sjare and Smith (1986a). They classified a total of 807 tonal calls (whistles) into 16 contour types and some 436 pulsed calls into three major categories that they describe as "click series", "pulsed tones", and "noisy vocalizations." Subsequent studies have obtained varied results. The vocalizations of adult male beluga groups in Svalbard, Norway were subjectively classified into 21 call types, which were dominated by a variety of whistles (Karlsen et al. 2002). Karlsen et al. (2002) highlighted the highly graded nature of these beluga calls, as one "call type" can merge into another type with very subtle changes, making the classification very challenging. A

FIGURE D1: Diagram of Beluga's Head for Electrophysiological Hearing Tests with Points of Acoustic Stimulation



Notes: 1, location of active Auditory Evoked Potential electrode; 2, rostrum tip; 3, pan bone; 4, external auditory meatus; 5, behind meatus; 6, melon. Thresholds are presented in dB re: 1 μPa using p-p SPLs measured at 1 m.
Source: Mooney et al. 2008

reproductive gathering of belugas in the White Sea, Russia, has been the subject of several repertoire studies (Belikov and Bel'kovich 2001, 2003; Bel'kovich and Kreichi 2004; Belikov and Bel'kovich 2007, 2008). Whistle-like signals were found to comprise approximately 10% of the total vocal production of this whale group. Of these, 750 signals were divided into 43 classes (Belikov and Bel'kovich 2001) with at least 16 whistle types (Belikov and Bel'kovich, 2007) and vowel-like signals and pulsed signals (Bel'kovich and Kreichi 2004; Belikov and Bel'kovich 2008).

The response of a decrease or cessation in acoustic activity has been observed in both captive and free-ranging beluga whales (Morgan 1979; Lesage et al. 1999; Karlsen 2002; Van Parijs et al. 2003; Castellote and Fossa 2006) and free-ranging narwhals (Finley 1990) and has been associated with threat, startle, fright, alarm, or stress contexts and interpreted as a survival strategy to avoid detection by predators (Schevill 1964; Fish and Vania 1971; Morgan 1979; Finley 1990; Lesage et al. 1999). A broad band pulsed call labelled "Type A" (Vergara and Barrett-Lennard 2008) was identified as a contact call between mothers and their calves in a captive environment. It is thought that these calls, both in captivity and in the wild, function to maintain group cohesion, and the variants shared by related animals are used for mother-calf recognition (Vergara et al. 2010). The only study on vocal development in belugas suggests that neonates only produce pulse trains before they acquire rudimentary whistles at two weeks of age

(Vergara and Barrett-Lennard 2008), although this is based on observations of one captive male beluga calf. However, sound production of another neonate captive beluga whale also consisted exclusively of low-frequency, short duration pulse trains that were not part of the adult's repertoire (Castellote et al. 2007). Despite differences in populations of origin, captive facilities, health and in acoustic context, the sound production observed in these two neonate whales suggests a species-specific pattern of developmental stages in sound acquisition. Whether these observed captive neonate vocalization characteristics may prove useful in detecting the presence of wild neonates is still to be determined.

The most recent study on beluga social signals (Vergara et al. 2010) emphasized the two persistent problems commonly encountered in the study of animal communication: first, the great variability in the physical features of the sounds, with general call types grading into each other (Recchia 1994) introduces great uncertainty in the categorization schemes; secondly, the inherent difficulty in categorizing sounds that are biologically meaningful without testing how belugas themselves perceive or use them (Tyack and Clark 2000). Despite the challenges, some progress has been made in the attempt to correlate vocalization rate and call type with specific beluga behavioral states.

3. Effects to Beluga Hearing and Behavior from Anthropogenic Noise

There is an extensive body of literature regarding the effect of anthropogenic noise on marine mammal behavior. Most of the studies addressing this problem have used behavioral attributes such as changes in site fidelity, dive patterns, swimming speed, orientation of travel, herd cohesiveness, and dive synchrony to indicate possible disturbance or stress caused by noise (Richardson et al. 1995). However the current knowledge of the effects of anthropogenic noise to marine mammal acoustic behavior is more limited and only a few studies have focused on belugas.

Their high auditory sensitivity, wide frequency bandwidth, and dependence upon sound to navigate, communicate, and find prey make belugas vulnerable to noise pollution. Noise pollution may mask beluga signals, or if intense, may lead to temporary or permanent hearing impairment (Awbrey et al. 1988; Finley 1990; Green et al. 1994; Richardson et al. 1995, 1988). Exposure to intense sound can produce an elevated hearing threshold, referred to as a threshold shift (TS). If the threshold later returns to normal it is considered a temporary threshold shift (TTS), but if not, it is considered a permanent threshold shift (PTS). Studies of TTS and PTS have helped to establish noise exposure limits in humans. There are no PTS data for cetaceans, yet a few studies have attempted to establish the TTS for beluga (Finneran et al. 2000, 2002a; Schlundt et al. 2000). Results from one study suggest that beluga whales might be more sensitive than bottlenose dolphins to particular impulsive pressure waveforms (Finneran et al. 2000). Belugas were interpreted as having displayed negative behavioral reactions to water gun impulses. A similar study confirmed that beluga whales may be susceptible to TTS, but that small levels of TTS may be fully recoverable.

Finneran et al. (2000) simulated sounds resembling signatures of underwater explosions from 5 or 500 kg HBX-1 charges at ranges from 1.5 to 55.6 km (0.9-34.5 mi), and while the simulated sounds were not intense enough to affect the beluga hearing capabilities, sound levels simulating explosions of 500 kg (1,102 lb) at 1.9 km (1.2 mi) and closer did disrupt the behavior of the belugas. Finneran et al. (2002a) measured hearing thresholds in a bottlenose dolphin and a beluga whale before and after exposure to underwater impulsive sounds produced from a seismic water gun.

Schlundt et al. (2000) performed a study exposing five bottlenose dolphins and two belugas (same individuals as Finneran's studies) to intense 1 second tones at different frequencies. The resulting levels of fatiguing stimuli necessary to induce 6 dB or larger masked TTSs were generally between 192 and 201 dB re: 1 microPascal (µPa). Dolphins began to exhibit altered behavior at levels of 178–193 dB re: 1µPa and above; belugas displayed altered behavior at 180–196 dB re: 1 µPa and above. At the conclusion of the study, all thresholds were at baseline values. Results of this study indicate that at least these two odontocetes species are susceptible to TTS, but that they seem to recover from at least small levels of TTS.

A number of studies have examined other characteristics of beluga hearing. Johnson (1991) analyzed hearing thresholds, bandwidths, and integration times (basic descriptive parameters of the cetacean sonar system) for single pulsed tones and multiple pulsed tones of 60 kHz in the presence of noise. He found negative correlations between hearing thresholds and pulse repetition rate with abrupt 5-6 dB steps, and linear correlations between pulse repetition rate and integration times. The author related the abrupt hearing steps to a change in the echolocation strategy based on target distance, as has been described in some beluga whale echolocation studies, and is discussed in the next section. This result, together with a variable integration time and a constant system bandwidth of 1,000 Hz (much lower than previously reported) led the author to suggest that beluga whale sonar systems could not be fully described by a single filter model. In essence, this conclusion was a technical appreciation of the complexity of the beluga whale biosonar system. Finneran et al. (2002c) analyzed beluga sensitivity to acoustic particle motion, which is one of the two physically linked components of sound in water (together with pressure waves), and the main feature detected by all fish species (Fay and Popper 1975). Results suggested that the two beluga whales tested responded to changes in the acoustic pressure alone and were not able to use acoustic particle motion cues.

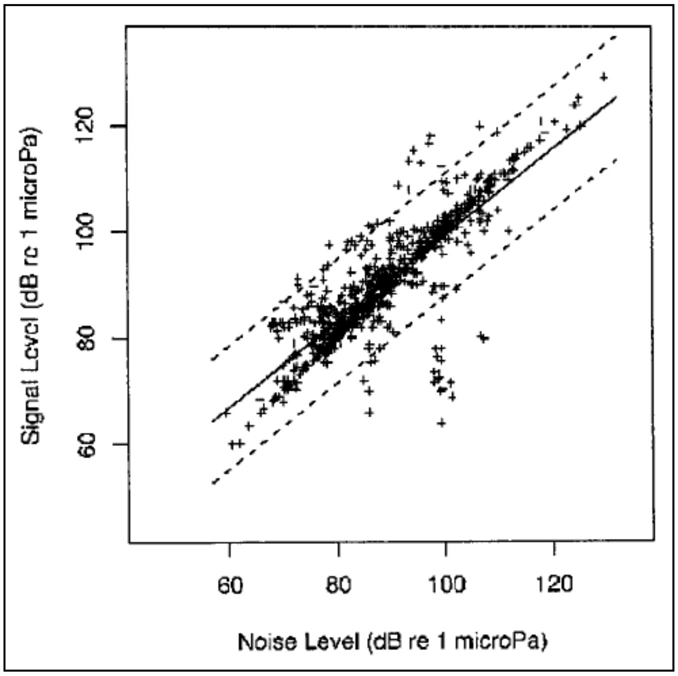
The possibility that noise conditions might mask the ability of animals to hear and decipher specific sounds has been studied in beluga whales in order to understand the potential impacts of anthropogenic noise on belugas. When a tonal signal is played in a broad spectrum of white noise (noise with equal loudness across all frequencies), only the noise energy in a relatively narrow band on either side of the tone frequency is effective in masking the signal, and the rest of the noise spectrum contributes little or nothing to the masking effect. Johnson et al. (1989) analyzed this feature in the hearing of a beluga in a wide frequency range (40–115 kHz) and found that the whale's ability to detect the signal in noise was slightly better than results previously reported for bottlenose dolphins. Erbe et al. (1999) and Erbe (2000), analyzed the effect of masking of beluga calls by exposing a trained beluga to icebreaker propeller noise, an icebreaker's bubbler system, and ambient Arctic ice cracking noise, and found that the latter was the least problematic for the whale detecting the calls. Finneran et al. (2002b) analyzed the ability of a beluga whale to detect acoustic signals in noise. A primary feature of the auditory system in these animals is the ability to resolve a complex sound into its individual frequency components by a set of auditory filters, and the filter shape and size affect the loudness and detectability of complex sounds and broadband signals (Scharf 1970). The authors analyzed 20 and 30 kHz pure-tone underwater hearing thresholds in one beluga whale and two bottlenose dolphins in the presence of broadband noise at two intensities: 90 and 105 dB re:1 µPa^2/Hz. The filter shapes obtained for the dolphins and beluga whale were similar, but the filter width was consistently smaller for the beluga whale, conferring better ability to detect acoustic signals in noise.

Sheifele et al. (2005) studied a population of belugas in the SLE to determine whether beluga vocalizations showed intensity changes in response to shipping noise. This type of behavior has been observed in humans and is known as the Lombard vocal response (Lombard 1911). Sheifele et al. (2005) demonstrated that shipping noise did cause belugas to vocalize louder (Figure D2). The acoustic behavior of this same population of belugas was studied in the presence of ferry and small boat noise. Lesage et al. (1999) described more persistent vocal responses when whales were exposed to the ferry than to the small-boat noise. These included a progressive reduction in calling rate while vessels were approaching, an increase in the repetition of specific calls, and a shift to higher frequency bands used by vocalizing animals when vessels were close to the whales. The authors concluded that these changes, and the reduction in calling rate to almost silence, may reduce communication efficiency which is critical for a species of a gregarious nature. However, the authors also stated that because of the gregarious nature of belugas, this "would not pose a serious problem for intraherd communication" of belugas given the short distance between group members, and concluded a noise source would have to be very close to potentially limit any communication within the beluga group (Lesage et al. 1999).

The fact that SLE belugas alter their vocal behavior by increasing the intensity or repetition rate, or by shifting to higher frequencies when exposed to shipping noise (from merchant, whale-watching, ferry and small boats) is indicative of an increase of energy costs (Bradbury and Vehrencamp 1998). If noise exposure is chronic, long-term adverse energetic consequences could occur for belugas, as it has been shown for birds (Oberweger and Goller, 2001). Chronic noise exposure could also increase stress levels for CI belugas, as has been shown in northern right whales (Rolland et al. 2012). Definitively linking adverse energetic consequences and chronic stress responses to detrimental health effects in belugas or other cetaceans is extremely difficult because of the logistics of studying free-swimming whales and the inability to conduct a controlled study. However, a large body of literature has demonstrated that chronic stress can lead to detrimental effects on health and reproduction across a variety of vertebrate taxa (Rolland et al. 2012). Both the degradation of the beluga acoustic communication and echolocation space, as well as the noise-induced chronic increase of signaling costs and stress, could lead to negative biological consequences at the population level. Even if these consequences are not yet well understood, there is sufficient evidence to suggest that the reproductive success and survival of cetaceans can be negatively impacted by noise (NRC 2000, 2003, 2005; Cox et al. 2006; Southall et al. 2007; Clark et al. 2009; Payne and Webb 1971; Tyack and Clark 2000).

While exhibiting a Lombard response provides a mechanism for animals to cope with varying levels of noise, the need for and use of this response suggests that the animal is attempting to cope with noise levels that are near a point where masking will occur. The effect of shipping noise in the acoustic environment of the endangered SLE beluga was studied recently by Gervaise et al. (2012) in the lower SLE. Noise from a car ferry line as well as a seasonal whale watching fleet were analyzed. The study found both beluga communication and echolocation bands were dramatically affected by these noise sources. Based on the background noise levels, spectra, and periodicity reported, and assuming no behavioral or auditory compensation, beluga communication and echolocation signals could be masked 50% of the time with a reduction of potential communication ranges to less than 30% of their values under

FIGURE D2: Regression of Beluga Vocalization Level Versus Changing Noise Levels from Extracted Beluga Vocalizations in the Presence of Noise.



Notes: Beluga signals are louder when background noise level is higher.
Source: Scheifele et al. 2005

natural ambient noise conditions. Similarly, echolocation could be reduced to 80% of their range under natural ambient noise conditions. The study concludes that noise from these sources could easily limit long-range communication (in the order of 1-2 mi[1.6-3.2 km]) among scattered individuals or pods and affect echolocation efficiency in all exposed belugas.

There are some documented beluga spatial displacements caused by loud sources of noise. Two different research teams and data from several years showed that belugas typically avoided icebreakers at distances of 35-50 km (22-31 mi), at the point where they could probably just detect them. They travelled up to 80 km (50 mi) from the ship track and usually remained away for 1-2 days (Finley et al. 1990, Cosens and Dueck 1993). When drilling sounds were played to belugas in industry-free areas, the belugas only showed a behavioral reaction when received levels were high (Richardson et al. 1997). Belugas have been observed to show startle responses when drilling noises were played with a received level greater than or equal to 153 dB re 1 μPa. Considerable displacements have also been suggested for noise from air guns typically used during seismic surveys. One seismic survey in the Canadian Beaufort Sea determined behavioral reactions of belugas occurred when two 24 gun arrays of 2,250 in^3 were operating (Miller et al. 2005). Results of the analysis of the differences between vessel-based and aerial-based beluga sighting distributions provided evidence of reactions of belugas to seismic operations at distances above 20 km (12.4 mi), beyond the effective visual range of the MMOs on the seismic vessel (Miller et al. 2005). Aerial surveys conducted in the southeastern Beaufort Sea in summer found that sighting rates of belugas were significantly lower at distances of 10–20 km compared with

20–30 km from an operating airgun array (Miller et al. 2005). The low number of beluga sightings by marine mammal observers on the vessel seemed to confirm there was a strong avoidance response to the 2250 in^3 airgun array; however, it is unclear if the observed movement of the belugas was a direct consequence of the seismic surveys or related to the natural offshore migration at that time of year. More recent seismic monitoring studies in the same area seem to confirm that the apparent displacement effect on belugas extends farther than has been shown for other small odontocetes exposed to airgun pulses (e.g., Harris et al. 2007).

Similarly, aerial survey results from another seismic (array specifications unknown) and exploratory drilling activity conducted in the same area and same season in 2007 to 2008 showed belugas widely distributed offshore during the operation period, yet rarely sighted from seismic ships. This was interpreted as a tendency to temporarily avoid areas of seismic activity by greater distances than the range covered by MMOs on board seismic vessels (Harwood et al. 2010). However, the authors highlighted the temporary nature of these displacements, as belugas were observed back in the seismic operation area within days after the end of the seismic operations.

Belugas have been shown to have greater displacement in response to a moving sound source (e.g., air gun activity on a moving vessel) and less displacement or behavioral change in response to a stationary sound source. The presence of belugas has been documented within ensonified zones of industrial sites near platforms and stationary dredges, and the belugas did not seem to be disturbed by the activity (Richardson et al. 1995).

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E. CI Beluga Prey Supplement

NOTE TO READER: The text below was developed by the Cook Inlet Beluga Whale Recovery Team and reproduces information readily available in other reports. In section II.B.10 of this document, we provided information sufficient to justify recovery criteria and actions. Additional CI beluga prey information follows.

1. Prey Abundance and Distribution

Eulachon is a primary prey item of CI belugas from May to early June. They enter glacial rivers to spawn shortly after the river ice has melted and the water flows freely. Eulachon have high oil-content (17-21% of the wet weight; Payne et al. 1999) and migrate in dense schools. Large eulachon runs in Cook Inlet occur in the Susitna River and at Twenty Mile River in Turnagain Arm, with smaller runs in other glacial rivers entering Cook Inlet (Figure E1). Eulachon biomass in these rivers is unknown. The NMFS biennial bottom trawl survey estimates of eulachon biomass in the central Gulf of Alaska are highly variable (5,255 short tons in 1984, 104,709 tons in 2003, and 54,246 tons in 2011) (Ormseth 2011). In the Susitna River and Twenty Mile River, the eulachon spawning migration peaks in late May and is largely completed by mid-June (Barrett et al. 1984; Spangler et al. 2003). Commercial fishing for eulachon/smelt (eulachon are not distinguished from other smelt in ADF&G harvest reporting) occurs annually in saltwater between the mouths of the Chuitna and Susitna rivers (Figure E1). Harvests have ranged from 41-91 metric tons (45-100 short tons) since 2006 (Table E1) (Shields and Dupuis 2012; P. Shields, ADF&G, pers. comm.). Commercial harvest of eulachon has increased substantially in recent years (Table E1).

Personal use harvests in Cook Inlet are summarized by ADF&G Division of Sport Fish reporting areas (Figure E2). Although fishing effort for personal use harvests of smelt responds to socioeconomic variables (e.g., gasoline prices), recreational effort likely reflects population abundance of spawning smelt. Thus, strong spawning returns likely generate increased fishing effort such that recreational harvests index the relative magnitude of the spawning populations. Recreational harvests for Cook Inlet during 1996 to 2011 showed high interannual variability within and among harvest reporting areas (Figure E3). Although the late 1990s and mid-2000s exhibited generally higher smelt harvests, the correlation of annual harvests among reporting areas was relatively low (the maximum correlation was 0.50 between log transformed values for the Susitna River drainage and the Kenai Peninsula freshwater). In general, the largest personal use harvests occurred in the Anchorage area, mainly represented by Twenty Mile River in Turnagain Arm. Harvests in most areas increased in recent years, particularly for the Anchorage area.

From June to September, salmon are the primary beluga prey in Cook Inlet. Quakenbush et al. (in review) found primarily coho, chum, and Chinook salmon in analyses of salmon remains in stomach contents, indicating that some salmon species may be of greater importance (Table 2). During this period, beluga whales are often found from Tyonek to the Little Susitna River and in river mouths of Knik and Turnagain arms. The largest salmon runs in Cook Inlet enter the Kenai, Kasilof, and Susitna rivers. Chinook salmon runs peak in the Susitna and Little Susitna rivers in mid-June, in the Kenai River in mid-July, and in the Kasilof River in late June to early July (Figure E4). Sockeye salmon (*Oncorhynchus nerka*) runs typically peak in mid-July, pink

TABLE EI: Commercial Eulachon/Smelt Harvests in Cook Inlet

	Harvest		
Year	Pounds	Metric tons	Permits issued
1978	300	0.1	NA
1980	4,000	1.8	NA
1998	18,610	8.4	2
1999	100,000	45.4	NA
2006	90,783	41.2	8
2007	125,044	56.7	11
2008	127,365	57.8	6
2009	78,258	35.5	6
2010	126,135	57.2	3
2011	201,570	91.4	5
2012[a]	195,910	88.9	4

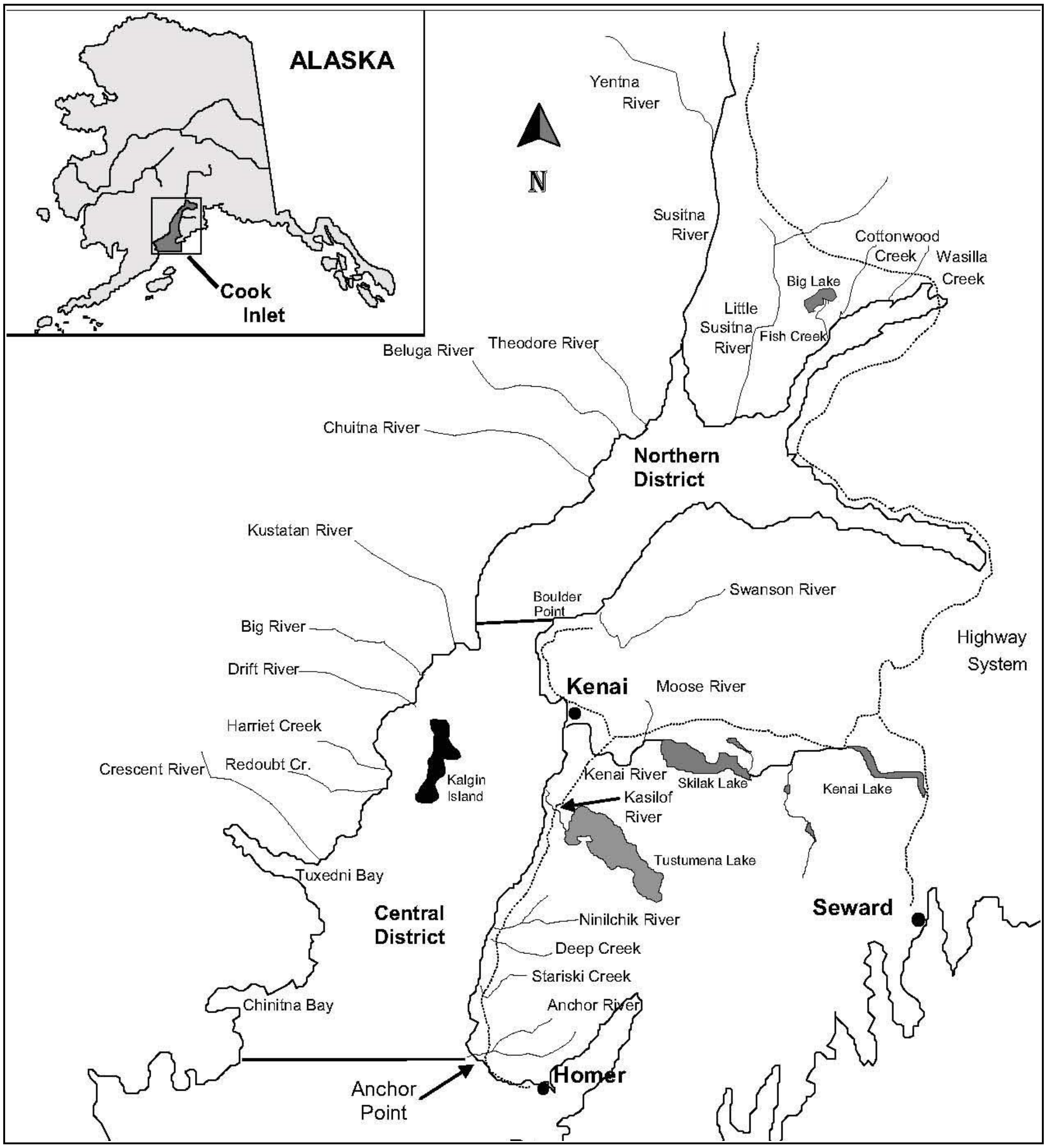
[a] Preliminary data.
Source: Shields and Dupuis 2012; P. Shields, ADF&G, pers. comm.

salmon (*Oncorhynchus gorbuscha*) and chum salmon runs peak in late July or early August, and coho salmon runs peak in August (Figure E4). However, run timing differs among species, streams, and years.

Sockeye salmon are the dominant species in the Kenai and Kasilof rivers with significant numbers of Chinook, coho, and pink salmon also spawning in the Kenai River. The Chuitna, Beluga, Theodore, and Lewis rivers support relatively small runs of Chinook salmon and somewhat larger runs of coho salmon (Figure E5). The Susitna River drains the largest watershed entering Cook Inlet and supports substantial runs of all five salmon species (Figure E5). The Little Susitna River supports moderately sized runs of pink, chum, and coho salmon (Figure E5). Numerous small streams along Knik and Turnagain arms support relatively small runs of all five salmon species.

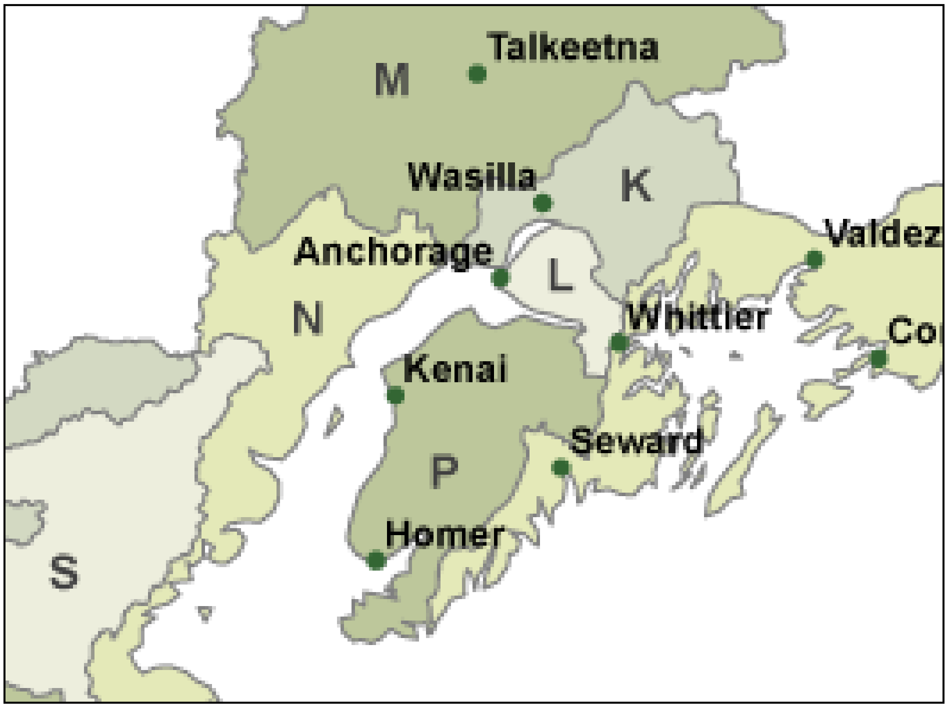
Indices for upper Cook Inlet since the early 1970s show general increases in sockeye and coho salmon return abundances, an odd/even year cycle in pink salmon abundances, and a decline in chum salmon abundances (Figure E6). Sockeye salmon run sizes, indexed as catches and escapements into major river systems, increased primarily due to larger returns to the Kenai and Kasilof rivers. Pink, coho, and chum salmon indices, derived from test fishery catches, provide temporal trends, but give only an order of magnitude indication of abundances. Mark-recapture abundance estimates for coho and chum salmon are more accurate, but are only

FIGURE E1: Major Tributaries of the Cook Inlet Basin Relative to the Two Fishery Management District Boundaries.



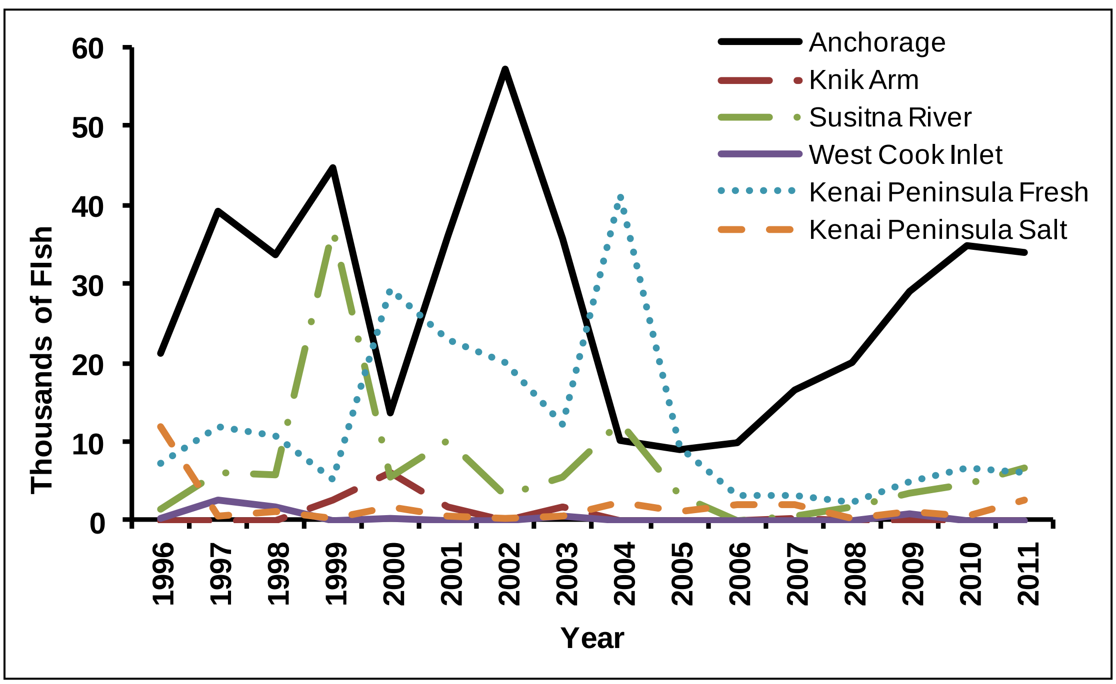
Source: Shields and Dupuis 2012

FIGURE E2: Cook Inlet Reporting Areas for the ADF&G Statewide Survey of Recreational and Personal Use Harvests



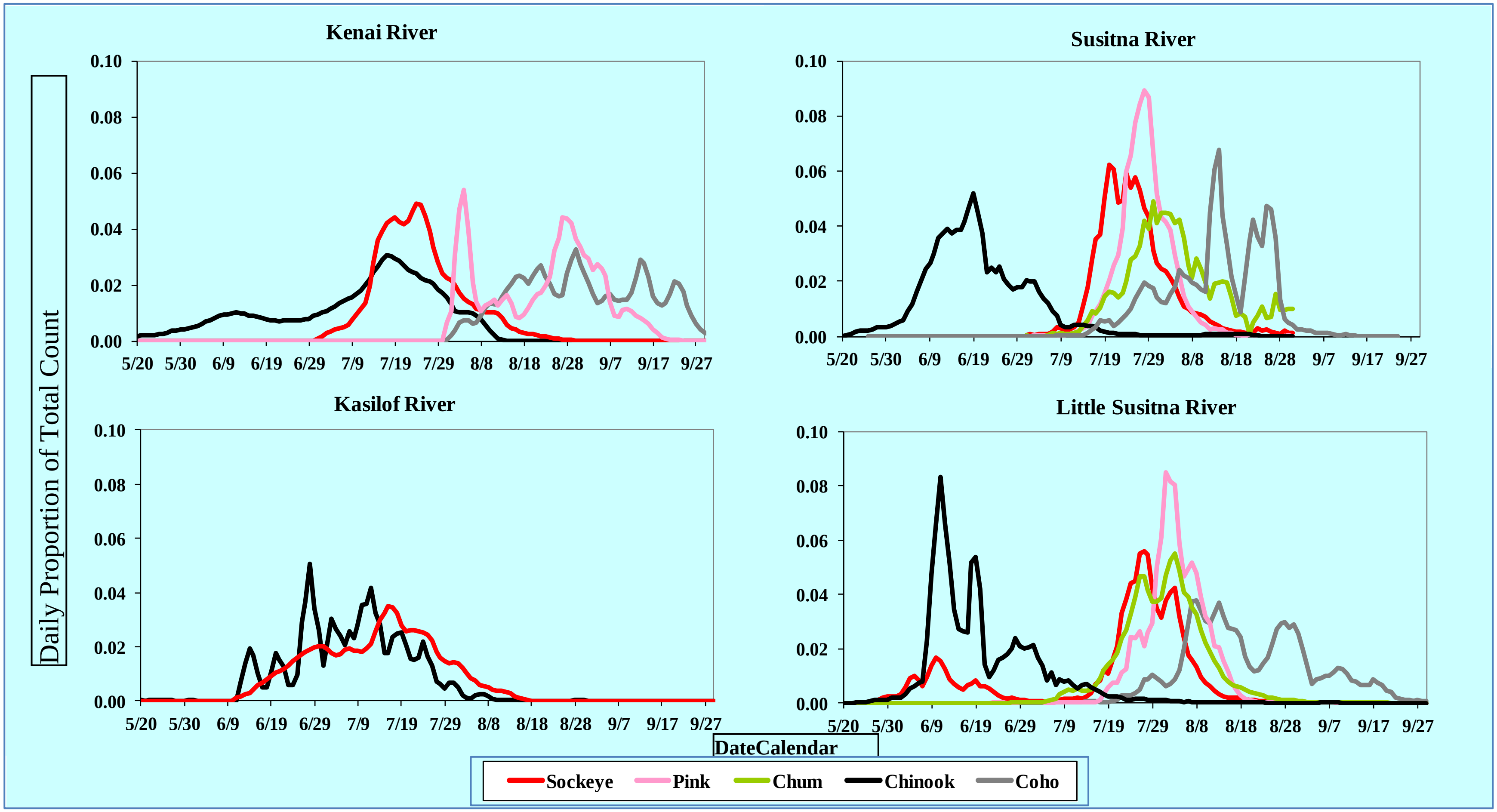
Source: http://www.adfg.alaska.gov

FIGURE E3: Personal Use Harvest of Smelt (Eulachon) by Reporting Areas from the ADF&G Statewide Harvest Survey, 1996 to 2011.



Source: Adapted from http://www.adfg.alaska.gov/sf/sportfishingsurvey

FIGURE E4: Mean Run Timing of Sockeye, Pink, Chum, Chinook, and Coho Salmon Entering the Kenai, Kasilof, Susitna, and Little Susitna Rivers, 1982 to 2009



Source: Westerman and Willette 2010

FIGURE E5: Historical Mean In-river Abundances of Chinook, Sockeye, Coho, Pink, Chum Salmon Entering the Major Rivers Flowing into Cook Inlet.

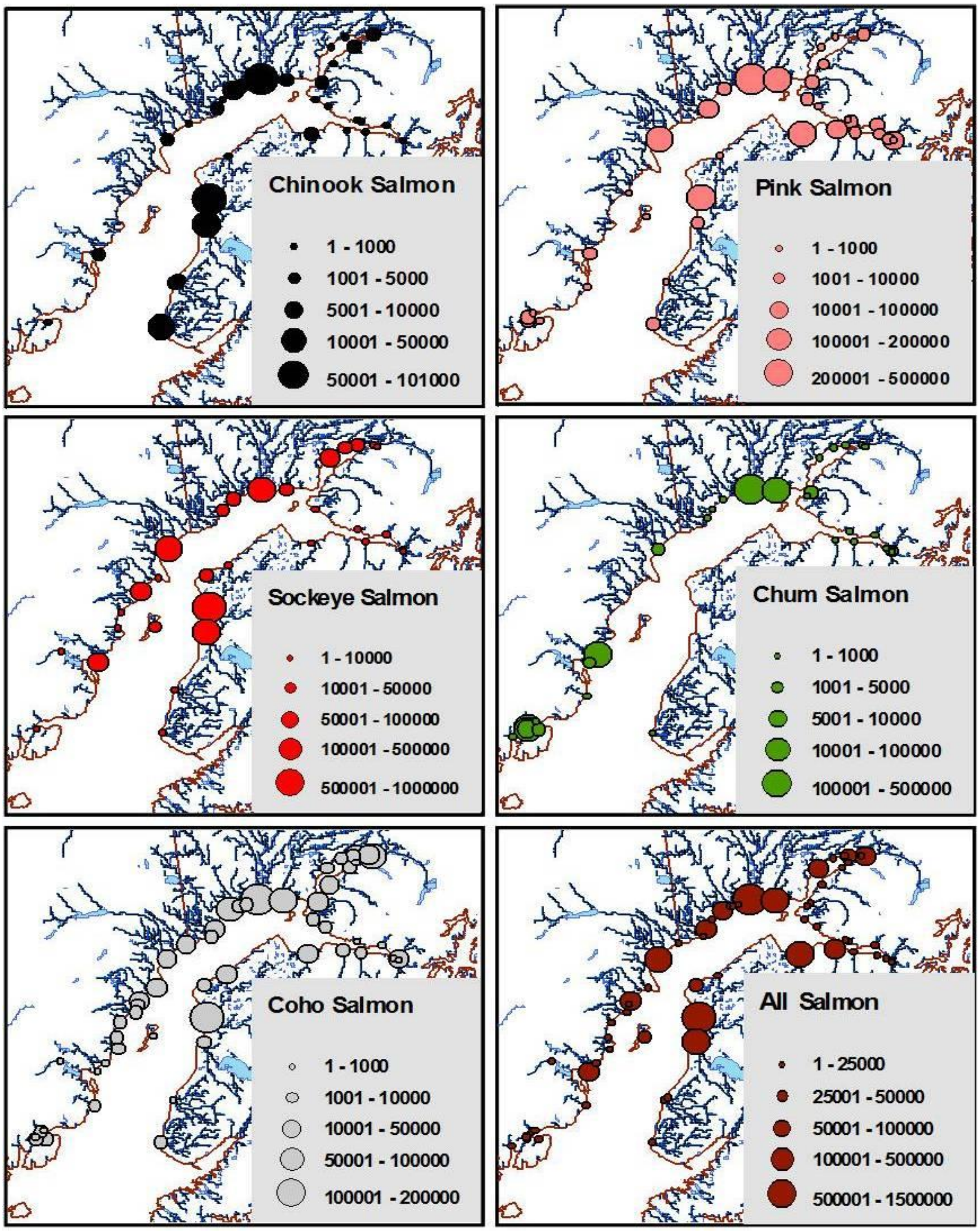
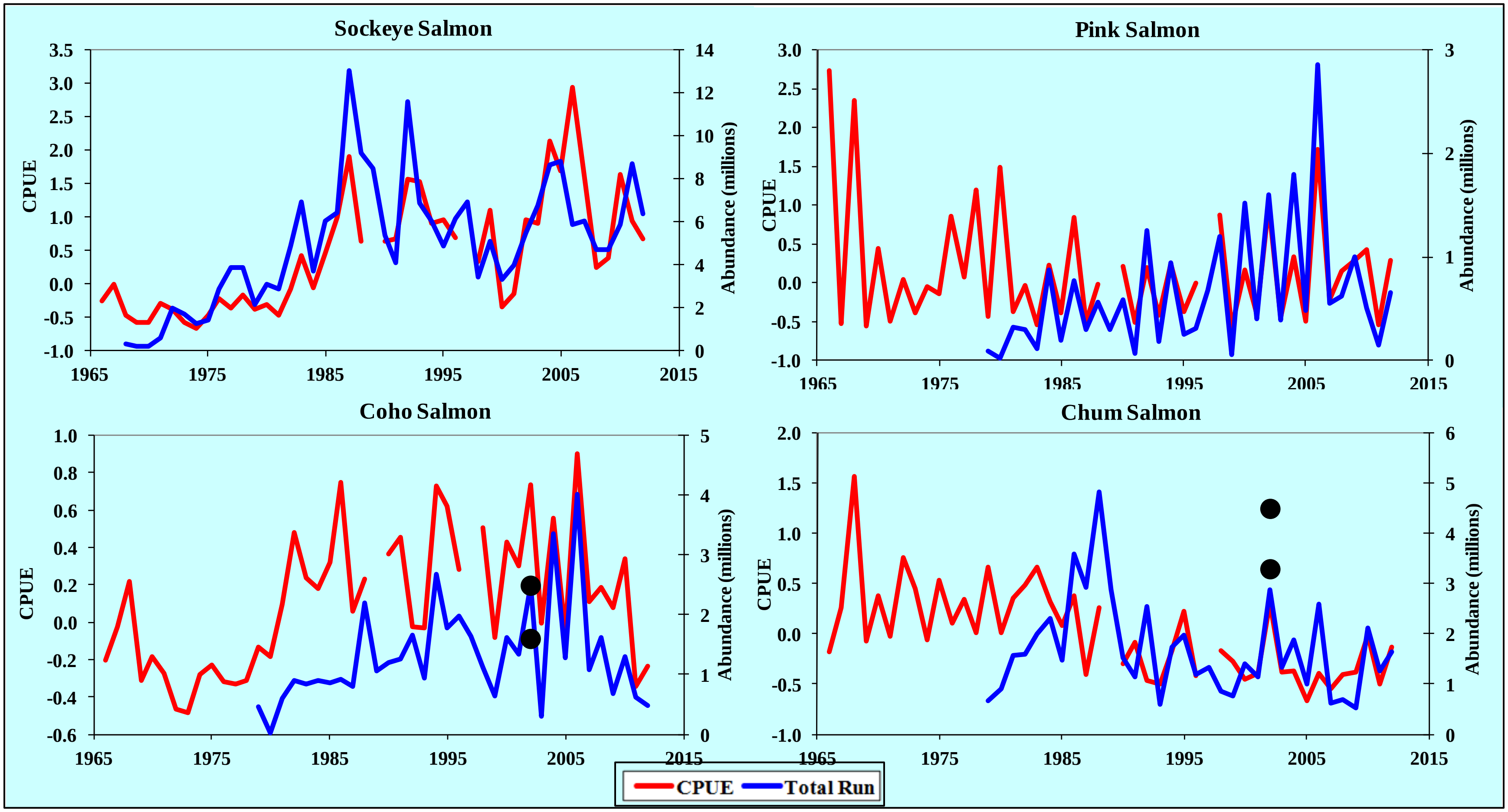


FIGURE E6: Trends in Abundance Indices for Sockeye, Coho, Pink, and Chum Salmon Returns to Upper Cook Inlet, 1966 to 2012.



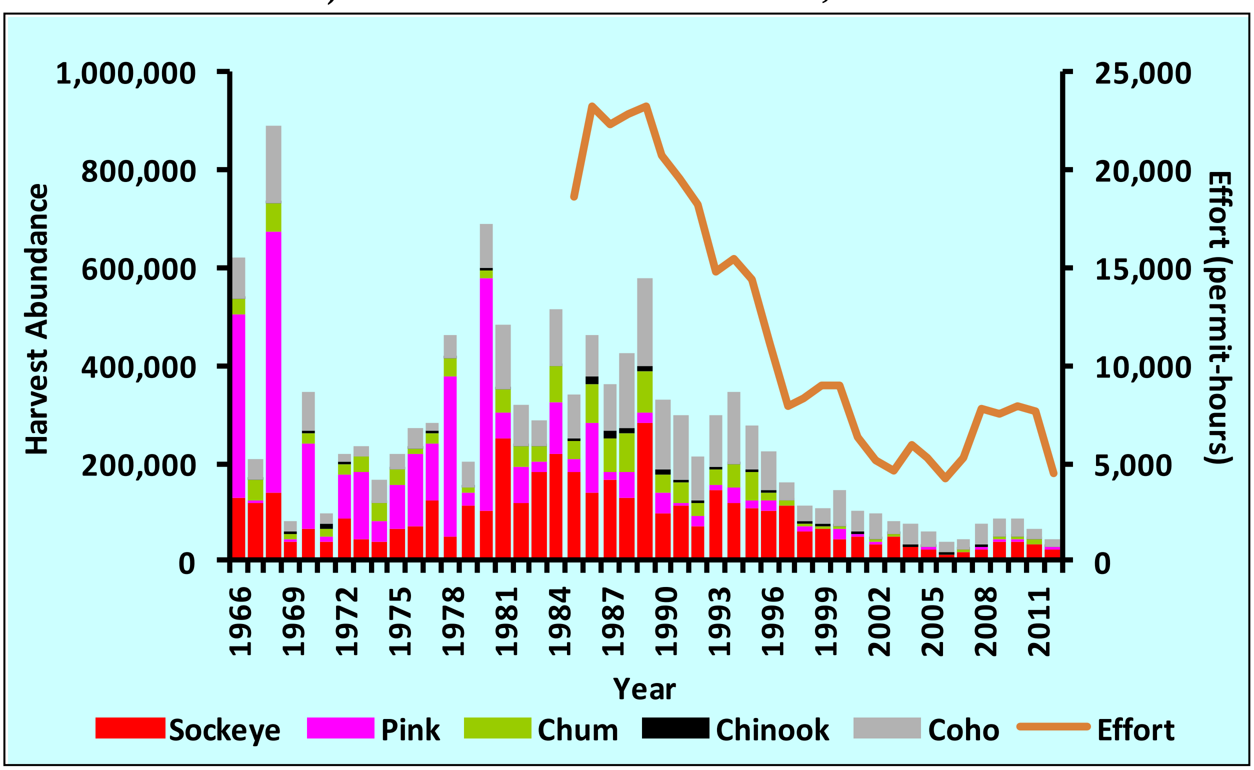
Notes: The commercial drift gillnet fishery catch per unit effort indicates annual deviations from long-term mean catch after standardizing for fishing time and gear length. Abundance estimates represent offshore test fishery catches extrapolated to total run size assuming equal catchability among species (Shields and Willette 2010; M. Willette, ADF&G, pers. comm.). For comparison, mark-recapture estimates of coho and chum salmon run sizes are shown as black dots for 2002.

Source: Willette et al. 2003

available for 2002. Although commercial drift gillnet catch per unit effort is based on harvests by several hundred boats and test fishery estimates are based on catches of a single boat, these indices show similar trends (Figure E6).

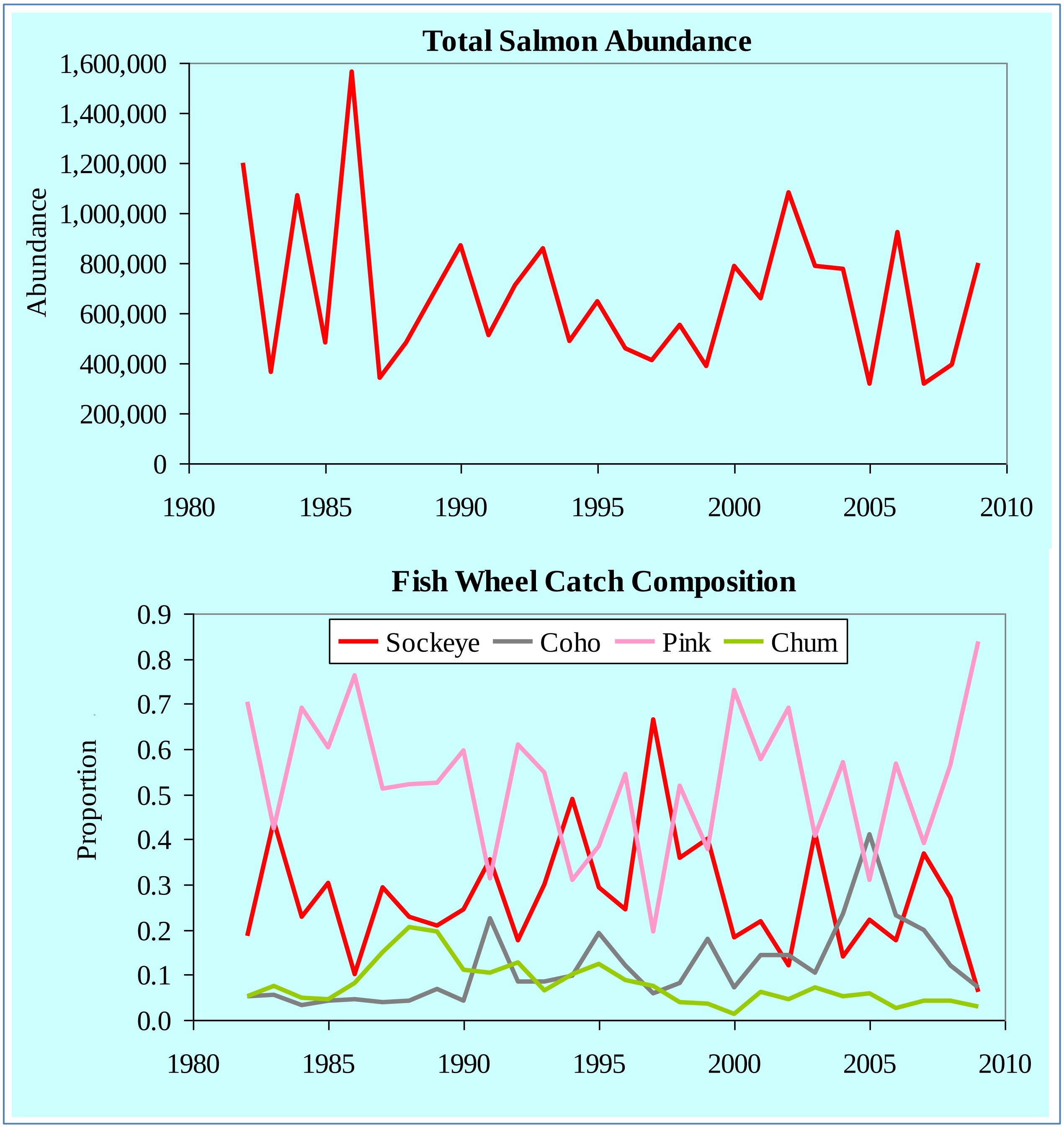
Commercial salmon catches in northern Cook Inlet (above the Forelands), where belugas have concentrated in recent years, were relatively low in the late 1960s and early 1970s, relatively high in the 1980s, and have subsequently declined (Figure E7). This catch decline is partly attributed to fisheries management constraints on fishing effort in order to increase escapements of primarily Chinook, sockeye, and coho salmon. Although salmon returns to the major river systems of northern Cook Inlet have exhibited broad swings in return abundance, many stocks and systems have shown declines in recent years. Sonar estimates of total salmon entering the Yentna River (a Susitna River tributary) ranged from about 0.4 to 1.6 million fish with no clear temporal trend during 1982 to 2009 (Figure E8). However, the contribution of most species to fish wheel catches in the Yentna River declined as the run was increasingly comprised of pink salmon after 2005 (Figure E8). Chinook and coho salmon weir counts on the Deshka River (a major tributary of Susitna River), and coho salmon weir counts on Little Susitna River peaked in 2004 and have since declined (Figure E9). Sockeye salmon weir counts on Fish Creek (Knik Arm) have been weak in some recent years, but the 2010 weir count was the highest since 1985 before declining dramatically in 2011 and 2012. Coho salmon entering Jim Creek (Knik Arm) increased from the late 1990s to 2006, but have decreased since 2008 (S. Ivey, ADF&G, pers. comm.; Figure E7).

FIGURE E7: Commercial Salmon Catch (numbers of fish) and Fishery Effort (permit-hours) in the Cook Inlet Northern District, 1966 to 2012



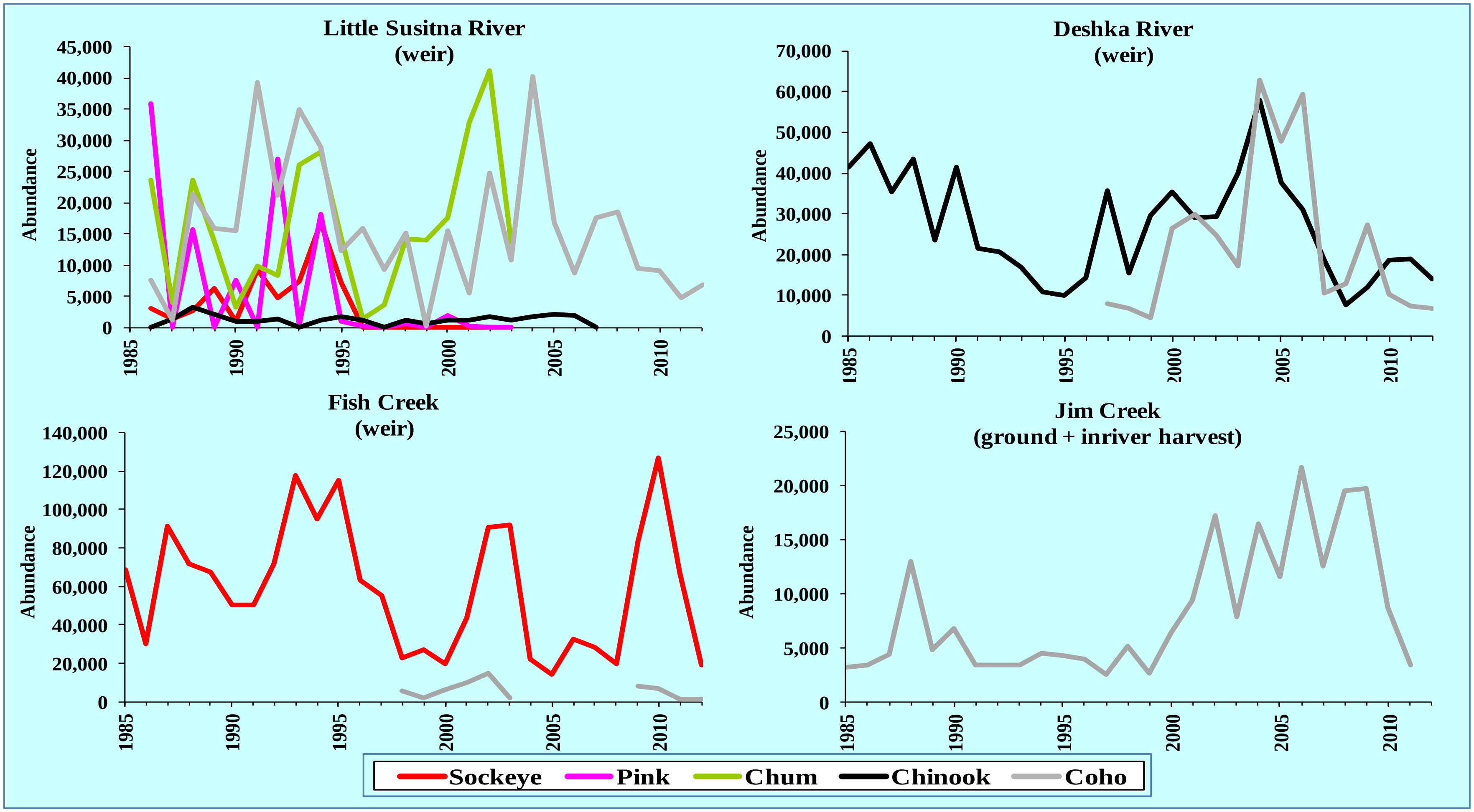
Source: Shields and Dupuis 2012; M. Willette, ADF&G, pers. comm.

FIGURE E8: Sonar Estimates of Total Salmon Return Entering the Yentna River (a Susitna River Tributary) and Fish Wheel Catch Composition at the Sonar Site, 1982 to 2009



Source: Westerman and Willette 2010

FIGURE E9: Salmon Run Sizes Entering the Little Susitna River, Deshka River, Fish Creek, and Jim Creek, 1985 to 2012



Notes: Little Susitna weir counts for species other than coho salmon are uncertain because the weir was in 1996 and the weir operations did not always encompass the entire run (Sweet et al. 2003).

Source: http://www.sf.adfg.state.ak.us/FishCounts/; S. Ivey, ADF&G, pers. comm.; M. Willette, ADF&G, pers. comm.

An important consideration is that salmon species are not of equal importance to belugas; Chinook salmon may be essential prey for beluga (Quakenbush et al. in review). However, in recent years reduced run strength of Chinook salmon stocks has been documented across Alaska, including Cook Inlet. Responding to a request from Alaska Governor Sean Parnell, Acting U.S. Secretary of Commerce Rebecca Blank determined that commercial fishery failures due to fishery resource disasters had occurred for Chinook salmon stocks in the Yukon (2010, 2011, 2012), Kuskokwim (2011, 2012), and Cook Inlet (2012) regions[37]. The declaration acknowledged hardships for commercial, sport, and subsistence users as a result of the Chinook fishery failures. While it falls to the U.S. Congress to allocate disaster relief funding, ADF&G subsequently coordinated a Chinook salmon symposium, "Understanding the Abundance and Productivity Trends of Chinook Salmon in Alaska," in Anchorage during October 22–23, 2012[38].

Northern pike were not found in any Cook Inlet streams until being illegally introduced in the 1960s. The spatial distribution of pike has since expanded to include many northern Cook Inlet streams and lakes. In the Susitna watershed, invasive northern pike have impacted many salmonid populations (e.g., Alexander Creek, Shell, and Hewitt lakes), and largely eliminated salmon from some lakes (e.g., Trapper, Red Shirt, Sucker, and Caswell). The capture of northern pike by commercial salmon fishermen in upper Cook Inlet waters also indicates a potential expansion to other watersheds. Although, we do not know to what extent salmon production in Cook Inlet has been impacted by northern pike, pike have clearly reduced salmon production in some areas.

Prior to 1990, belugas were often found in central and lower Cook Inlet, but it is not known what prey were consumed in these areas. In the 1970s, Kamishak Bay supported large commercial catches of Tanner and red king crabs (*Paralithodes camtschatica)*, and summer concentrations of Pacific halibut (*Hippoglossus stenolepis*) were found north of Augustine Island (NOAA 1977; Bechtol et al. 2002). While commercial fisheries have not occurred since the early 1980s for red king crab and the early 1990s for Tanner crab, Pacific halibut still support fisheries extending north into central Cook Inlet (Meyer et al. 2008). In spring, Pacific herring (*Clupea pallasi*) aggregate in shallow, nearshore areas of Kamishak Bay to spawn. Peak biomass reached 35,513 short tons in 1983 (Figure E10), declined to 2,906 tons in 2004, and has subsequently ranged from 3,100 to 4,100 tons (Otis and Hammarstrom 2004; Hammarstrom and Ford 2011; Hollowell et al. 2012). Due to low spawning biomass, the commercial herring fishery in lower Cook Inlet has remained closed since 1999. Although herring resources in upper Cook Inlet are not formally assessed, low-level commercial fisheries occur with annual harvests generally totaling less than 20 tons over the past 15 years (P. Shields, ADF&G, pers. comm.). At Chisik Island, large shallow schools of eulachon, herring, and crangonid and pandalid shrimps were found in May 1997 and 1998, while lower density schools of herring, eulachon, and longfin smelt (*Spirinchus thaleichthys*) were found deeper in this area during summer (Fechhelm et al. 1999). Piatt (2002) found cold, nutrient-rich Gulf of Alaska waters upwelling at the entrance to

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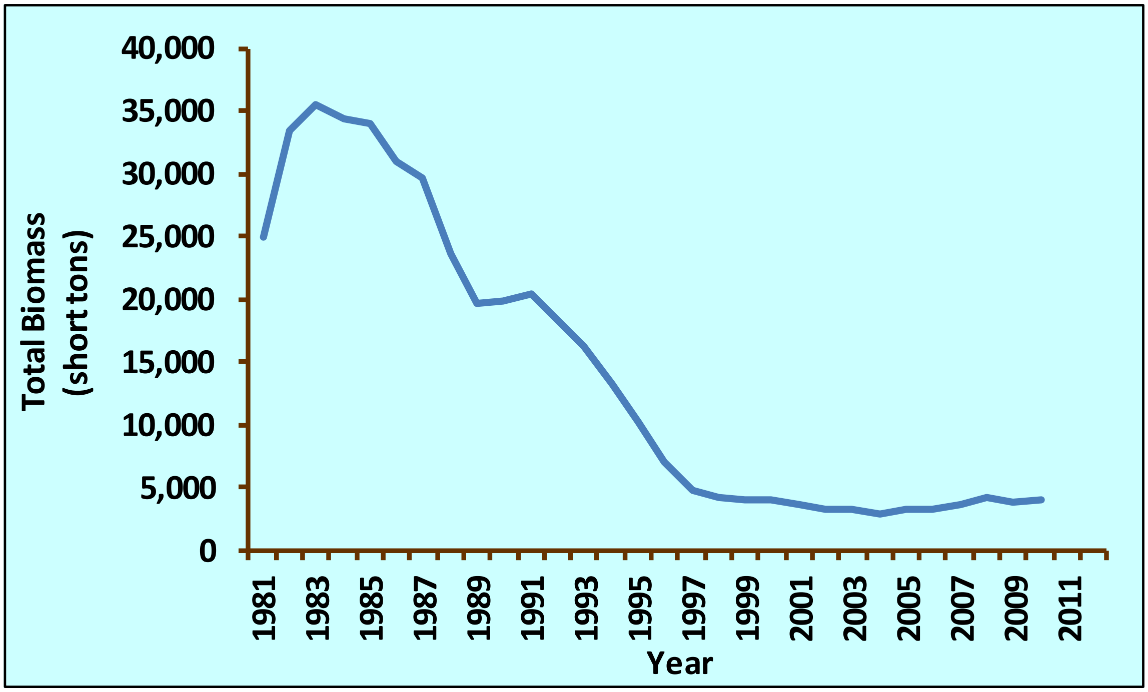
[37]See news release at: http://www.nmfs.noaa.gov/stories/2012/09/09_13_12disaster_determinations.html; A copy of the letter from Acting Secretary Blank to Governor Parnell can be viewed at: http://www.nmfs.noaa.gov/stories/2012/09/docs/blank_parnell_9_13_12.pdf.

[38] For more information about the Chinook salmon symposium, visit ADF&G's website at: http://www.adfg.alaska.gov/index.cfm?adfg=chinook_efforts_symposium.information

FIGURE E10: Historic Biomass (short tons) of Spawning Pacific Herring in Kamishak Bay, 1981 to 2010



Source: Otis and Hammarstrom 2004, Hollowell et al. 2012

lower Cook Inlet supported high densities of juvenile pollock, sandlance, and capelin *(Mallotus villosus)*. Demersal fish resources in this area were dominated by walleye pollock, Pacific cod, butter sole (*Isopsetta isolepis)*, and Pacific halibut (Blackburn et al. 1980).

Historically, belugas were often observed in the fall along the northern shore of Kachemak Bay. Pacific sandlance (*Ammodytes hexapterus)*, which spawn on beaches in the fall, were the most abundant nearshore fish species found in Kachemak Bay (Robards et al. 1999), but it is unknown if these fish were beluga prey. An abundant shallow subtidal fauna largely comprised of polychaetes and clams (animals of the class Bivalvia) has also been found along this northern shore (NOAA 1977). Offshore, the benthic invertebrate community in Kachemak Bay was dominated by hermit crabs, pandalid shrimp, and Tanner, Dungeness, and king crabs (NOAA 1977). Halibut, rock sole, yellowfin sole, and weathervane scallops (*Patinopecten caurinus*) were abundant in outer Kachemak Bay (NOAA 1977).

Belugas have been observed around Kalgin Island in both summer and winter (Hansen and Hubbard 1999; Hobbs et al. 2005), although the summer occurrence around Kalgin Island appears to have diminished with the concurrent summer range contraction of the population (NMFS 2008a). The Upper Subdistrict, located east of Kalgin Island to the Kenai Peninsula, can account for 60% or more of the commercial salmon harvests from upper Cook Inlet (Shields and Dupuis 2012). This area may be very productive due to current convergence/divergence and associated upwelling with shrimp, crabs, and clams found offshore (NOAA 1977).

Belugas have also been observed in the Kenai River Estuary, likely feeding on eulachon or adult salmon. In 2003, 31 taxonomic groups of fishes and macroinvertebrates were found in this area (Willette et al. 2004). In April, epibenthic invertebrates (*Crangon* spp., *Neomysis* spp., and

Saduria spp.) were most abundant, and finfish (mostly longfin smelt) were present, but rare. In June, finfish (mostly eulachon, juvenile sockeye, coho, and Chinook salmon, Pacific staghorn sculpin (*Leptocottus armatus)*, snake prickleback (*Lumpenus sagitta)*, and starry flounder) were most abundant. In September, eulachon, juvenile coho salmon, Pacific herring, Pacific sandfish (*Trichodon trichodon)*, and starry flounder were most abundant. In deep mid-channel habitats, spiny dogfish (*Squalus suckleyi*) and starry flounder were most abundant. Thus, there appears to be high species diversity with species abundance dependent on season and habitat.

Belugas have frequented Knik Arm where they likely feed on migrating adult salmon (Huntington 2000, NMFS 2008a). However, Pacific staghorn sculpin also occur in Knik Arm at low densities, primarily nearshore from July to November and offshore from April to July (KABATA 2006). Walleye pollock also occur in Knik Arm at low densities in nearshore habitats from April to July. Eulachon, mostly post-spawning fish, were found primarily in nearshore habitats from May to July (KABATA 2006). Pentec Environmental (2005) identified 19 fish species in Knik Arm, and Morsell et al. (1983) identified 18 fish species in upper Knik Arm. All five species of juvenile salmon use Knik Arm as a migratory corridor. Chinook and coho salmon enter the Arm at a larger body size, reside in nearshore habitats, and remain in the Arm during May to November. Chum, sockeye, and pink salmon juveniles enter the arm at a smaller body size and reside in more offshore habitats for May to August. In recent years, belugas have also been found along the northern shore of Cook Inlet between Tyonek and the Little Susitna River, likely feeding on migrating eulachon and adult salmon. While surveys for juvenile fish identified 19 species in this area, herring and pink salmon were the most abundant (Moulton 1997).

2. Fisheries Management

For commercially fished species, the availability of potential beluga prey in upper Cook Inlet during spring and summer can be somewhat inferred from the timing and location of fishery harvests and upriver spawning migrations (also referred to here as "escapements"). However, actual quantitative data on the spatial and temporal distribution of these beluga prey in upper Cook Inlet are limited. For example, long-term salmon escapement estimates are available for the three large middle Inlet rivers, the Kenai, Kasilof, and Crescent river systems, and for the Yentna River, a tributary of the Susitna River, with less frequent estimates available for some other Cook Inlet tributaries (Westerman and Willette 2011). Because sockeye salmon returns to the Kenai and Kasilof rivers comprise the largest component of upper Cook Inlet salmon returns, the bulk of fishing pressure by humans occurs south of these river systems and, thus, "downstream" of the current primary beluga summer habitat. While more salmon are available in the central Cook Inlet areas, few belugas venture into the central Cook Inlet area in most years. Beluga whales in northern Cook Inlet likely benefit from the tendency of anadromous prey species to be concentrated by shallow water and the time required to transition from salt water to fresh as they enter the stream mouths, which presumably makes these prey easier to capture.

Management of anadromous fish populations in Alaska attempts to constrain harvests to be no greater than the level of surplus production, defined as returning adult salmon in excess of the spawning production needed to maintain productive salmon populations (Quinn and Deriso 1990). In addition to reproductive needs, harvest considerations must include upstream consumptive uses such as recreational and subsistence fisheries (Shields 2010), as well as allowances for natural mortality, which includes predation by beluga whales, bears, and other species. Stock productivity and the level of surplus production are notoriously difficult to predict and estimate accurately due to high annual variation in factors such as freshwater and marine survival. To account for this uncertainty, fisheries management tends to be conservative in allowing for adequate spawning stock escapement. However, the potential for overfishing exists annually, and it is unlikely that escapement goals will be met in all tributaries across all years. While corrective management measures are typically implemented in any year following an under-escapement, prediction of future fish returns, and managing for optimal harvest of those returns, remains uncertain. Thus, while fishery management, on average, should provide sufficient total numbers of prey for belugas, the timing of prey concentration or densities in the river mouths may not be adequate for efficient feeding by belugas.

A contrasting management situation for beluga prey exists with eulachon, which also return to freshwater to spawn. Although eulachon spawning stocks can be found in numerous central Cook Inlet rivers, human fishing effort occurs primarily in tributaries in Knik and Turnagain arms. Because fishing tends to occur near the river mouths or upriver, this fishing effort often occurs "upstream" of beluga foraging, such that population level effects of overfishing would be reflected by poor spawning escapement and reduced prey availability in subsequent years. Eulachon populations are not assessed or monitored, but ADF&G uses the Statewide Harvest Survey to derive recreational harvest estimates post-season. These estimates are presumed to be somewhat related to eulachon population abundance. If a decline in annual harvests occurs and is suspected of indicating a substantive decline in eulachon abundance, ADF&G may implement more restrictive fishing measures in subsequent years. There had been a sporadic commercial fishery for eulachon since 1978 (taking from 300-100,000 pounds in 1978, 1980, 1998 and 1999; Shields 2005). Based on a concern that a reduction in the availability of eulachon could be detrimental to belugas, NMFS recommended to the Alaska Board of Fisheries that this fishery be discontinued effective beginning in 2000, in part due to the lack of data on the eulachon runs into the Susitna River, and due to the absence of any evaluation of the effect of this fishery on beluga whales in terms of disturbance/harassment or competition for these fish. Additionally, it was noted that: beluga whales may be heavily dependent on the oil-rich eulachon early in the spring (preceding salmon migrations), the runs are very short in duration, and large eulachon runs may occur in only a few upper Inlet streams. The commercial fishery for eulachon was closed in 2000, but reopened in 2005, under restrictions to hand-operated dip nets in saltwater between the Chuitna River and the Little Susitna River, with a total harvest of 100 tons or less (Shields 2005, Shields and Dupuis 2012; P. Shields, ADF&G, pers. comm.).

Beluga whale prey resources, such as salmon and eulachon, typically represent a mixture of spawning stocks that are also harvested in mixed-stock fisheries (Shields 2010; Westerman and Willette 2011). Effects of overfishing by humans on beluga whale foraging success are not well known, yet likely include spatial and temporal components for any specific prey resource that is overfished. Stock composition is dynamic and varies annually in both the run strength and run timing of individual contributing stocks. For major stocks or indicator stocks, harvest managers have tried to determine the relationship between annual escapements and returns in subsequent years. These relationships often have an optimal range such that escapement larger or smaller than this range are presumed to generate reduced adult salmon returns in future years. Harvest managers attempt to regulate fishing effort, typically in mixed-stock fisheries, to ensure that spawning escapement goals are achieved for each monitored salmon stock. However, it is not always possible to ensure that the lower bound of an escapement goal range is achieved for all stocks so that none are under fished, without exceeding the upper bound (over fishing) on some stocks.

3. Competition for CI Beluga Prey Resources

Over time, selective fishing pressure, or other factors, can alter reproductive migration timing of some prey species. For instance, intensive fishing during the early part of a salmon run can reduce the portion of the stock that returns early in the run and slightly shift future run timing, but the extent of that shift is limited as survival decreases outside of an optimal migration timing (Smoker et al. 1998). Thus, the timing of prey concentration or densities in the river mouths may not be adequate for efficient feeding by belugas. Chronic and persistent overharvesting of one or more unique salmon stocks or stocks from a specific spatial and/or temporal component (e.g., repeated overharvesting of upper Cook Inlet, early season runs) also has the potential to restructure the ecosystem. Such a pattern could cause a shift in beluga foraging toward less-nutritious prey items or a geographic displacement from the optimal foraging habitat, ultimately with reduced survival and reproductive success. However, the time frame over which such shifts could occur is unknown, and no baseline data currently exist to detect such shifts.

Although there is no definitive analysis of competition between CI belugas and other marine mammals that consume the same prey, the possibility of competitive overlap in prey exists. For example, Chinook and coho salmon were found to be prey items for CI belugas (Quakenbush et al. in review), so that any predator (including humans) that takes these species from stocks used by belugas are potential competitors. Resident (fish-eating) killer whales along the north Gulf Coast of Alaska are known to focus on salmonids, particularly Chinook, chum, and coho salmon (Matkin et al. 2010). These fish-eating resident killer whales are common in lower Cook Inlet and may intercept salmon destined for rivers and streams in the upper Inlet that are potential beluga prey; however, resident killer whales are not known to range into the upper Inlet where they might compete directly with CI belugas for prey. Harbor seals and Steller sea lions *(Eumetopias jubatus)* are also known salmonid predators that occur within the range of CI belugas and could compete with belugas and each other for these prey. Harbor seals, Steller sea lions, killer whales, humpback whales, gray whales, Minke whales, harbor porpoises, sea birds, sea otters, and humans may also have competition effects on belugas through their consumption of eulachon.

The estimated annual rate of increase in sea otters in Kachemak Bay between 2002 and 2008 was 26% per year, exceeding the maximum productivity rate for this species and is presumably due in part to immigration from other areas (Gill et al. 2008). Sea otters have been found as far north as Ninilchik (V. Gill, USFWS, pers. comm.). Systematic surveys have not been done for several years and trends are unknown for Cook Inlet/Shelikof stocks of harbor seals, the Gulf of Alaska stock of harbor porpoise, the Alaska stock of Dall's porpoise, or the Alaska stock of Minke whales (Allen and Angliss 2012). The Eastern North Pacific gray whale stock and both the Western and Central North Pacific Stocks of Humpback Whales have been increasing based on recent abundance estimates (Allen and Angliss 2012). None of these potential competitive effects have been quantified.

Resident killer whales likely do not directly compete for prey resources given limited to no overlap in the distribution with CI belugas (Lammers et al. 2013). Similarly, sea otters and Steller sea lions are likely not effective competitors with CI belugas, as they overlap with belugas in only a small portion of their range in lower Cook Inlet. While likely not in direct competition for adult salmon, the introduction of northern pike, an invasive species found in freshwaters of northern Cook Inlet, has likely reduced local salmon stocks, particularly Chinook, through predation on juveniles (Oslund and Ivey 2010).

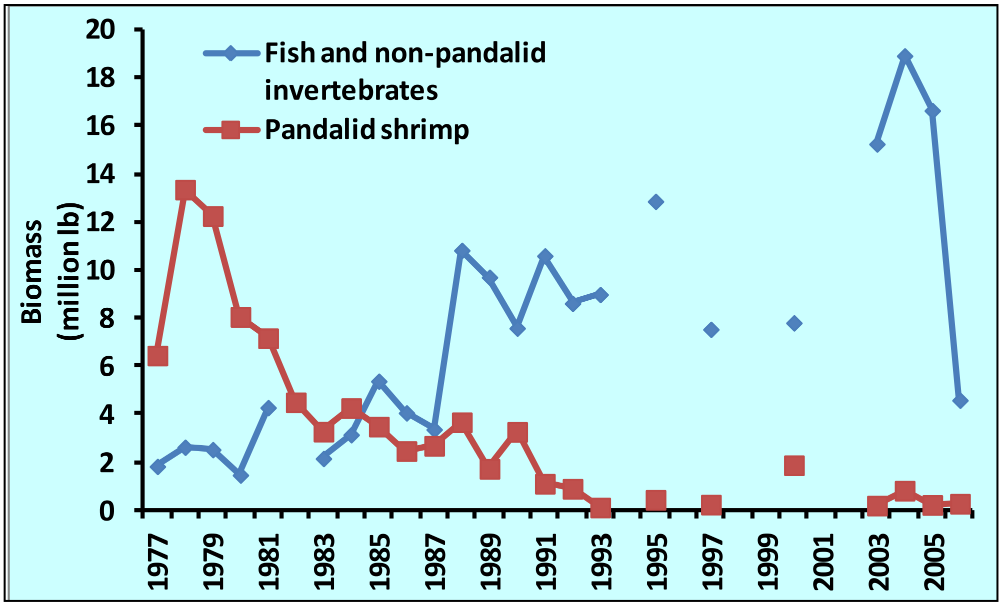
4. Ecosystem Shifts and CI Beluga Prey

Both the relative and total abundances of any beluga prey item are not constant and can be expected to change over both space and time. Productivity of many marine species, including, but not limited to, potential beluga prey, may have responded to decadal-scale climate shifts in the North Pacific (Hollowed and Wooster 1992; Beamish and Bouillon 1993; Hare and Mantua 2000). Recognized climate regime shifts that occurred around 1976 and 1989 (Anderson and Piatt 1999; Zheng and Kruse 2000; Hare and Mantua 2000; Kruse 2007; Mueter et al. 2007) may have affected the productivity of marine species in the North Pacific, although response to ecological changes can vary temporally by species, with some responding sooner than others, or in different trends, or greater magnitudes (Rodinov and Overland 2005). For example, the northern Gulf of Alaska changed from an ecosystem dominated largely by invertebrate (crabs and shrimps) biomass in the 1960s to 1970s to dominance by gadids and flatfishes. Robards et al. (1999) found a 1,000-fold increase in gadid abundance in lower Cook Inlet between the 1970s and 1990s, and a lesser increase in abundances of pleuronectids and salmonids. Small-mesh trawl surveys in Kachemak Bay documented a decline in pandalid shrimps and an increase in demersal fishes since the 1970s (Figure E11). Walleye pollock, flathead sole (*Hippoglossoides elassodon)*, and starry flounder became the dominant demersal fishes, comprising over 40% of the survey catch in 2004 to 2006 (Goldman et al. 2007). A similar change was observed in small-mesh surveys from Kodiak Island to Pavlof Bay (Anderson and Piatt 1999), with ongoing surveys indicating continued low levels of stock biomass for many potential forage species including shrimp, juvenile pollock, and herring (Figure E12; D. Urban, NMFS, pers. comm.). Eulachon exhibited a resurgence in the 2000s, but declined in 2010, coincident with an increase in commercial harvest. The climate regime shift in the North Pacific during the late 1970s was associated with aspects such as increased ocean temperatures and increased abundances of predatory fishes, such as Pacific cod. A study of the decline in the Kachemak Bay stock of northern shrimp (*Pandalus borealis*) found that a strong increasing trend in natural mortality followed the 1976 to 1977 regime shift, paralleling trends in increased Pacific cod abundance (Fu and Quinn 2000; Fu et al. 2000). A study of red king crab around Kodiak Island attributed the initial population crash to overfishing, but suggested that despite a fishery closure since 1983, the stock has failed to recover due to increased juvenile mortality associated with higher ocean temperatures and greater abundance of predatory fishes, such as Pacific cod (Bechtol and Kruse 2010). Pacific cod and walleye pollock, while not historically "rare" in Cook Inlet, occurred at much lower levels of biomass and abundance prior to the late 1980s, when recent commercial fisheries developed (Bechtol 1995). Surveys show biomass of Pacific cod and walleye pollock remained relatively high through the 1990s (Figure E13; R. Gustafson, ADF&G, pers. comm.). Meanwhile, Tanner crab data from lower Cook Inlet indicates dramatic declines in abundance of harvestable crabs after the mid-1970s (Figure E14; Bechtol et al. 2002; R. Gustafson, ADF&G, pers. comm.); these crabs are seasonally important to belugas in Upper Cook Inlet.

While ecosystem response to environmental forcing is likely nonlinear (Hare and Mantua 2000), evidence exists for climate-driven changes in the physical environment affecting other fish populations in the Gulf of Alaska and eastern Bering Sea. For example, strong pollock recruitment in the eastern Bering Sea appears connected to above normal air and bottom temperatures and reduced sea ice cover, factors that promote zooplankton production (Quinn and Niebauer 1995). Solid sea ice is not a factor in the northern Gulf of Alaska, but the pre-1976 regime was associated with low sea surface temperature and low biomasses of predatory fishes, such as flatfishes and Pacific cod. During and following the 1976 regime shift, high sea surface temperatures enhanced zooplankton production in the Gulf of Alaska, supporting strong pollock recruitment amid low demersal fish predation (Bailey 2000; Ciannelli et al. 2005). However, high zooplankton populations may have been detrimental to phytoplankton needed for first-feeding larvae of many species. Sea surface temperatures declined somewhat following the regime shift, but ecosystem "maturation" in the subsequent decade resulted in increased biomass of predatory fishes, particularly Pacific halibut, arrowtooth flounder, flathead sole, and Pacific cod (Bailey 2000). The North Pacific ecosystem has been generally characterized by moderate sea surface temperature in recent decades, but relatively high demersal fish biomass (Hare and Mantua 2000; Mueter and Norcross 2002; Ciannelli et al. 2005). As a result, a compromised feeding environment for many larval forage species was coupled with intensified groundfish predation.

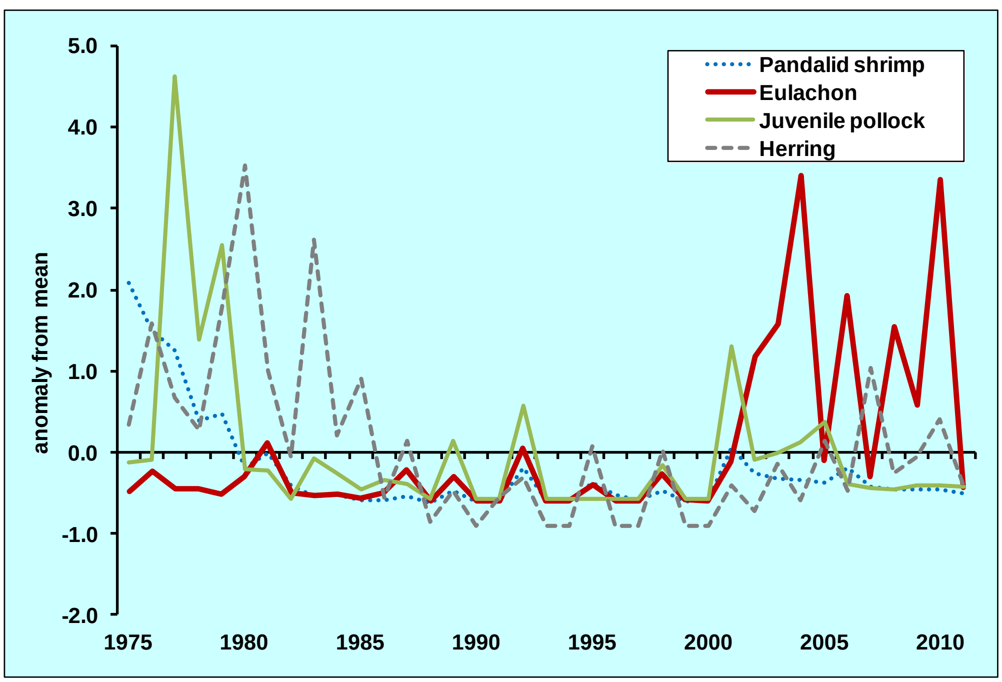
A cautionary note is warranted regarding interpretation of the role of long-term environmental effects as drivers of potential ecological change. Ecological systems are complex and trends in abundance and biomass are typically the result of a variety of factors. A first step in understanding ecosystem change is to have a sufficiently long time series of indices for both potential ecosystem drivers and the species of interest. Unfortunately, these indices are often discontinuous over time or of an inappropriate spatial coverage. Surveys of potential CI beluga prey in marine or estuarine areas of upper Cook Inlet have been infrequent and short-term, typically implemented to address *ad hoc* environmental assessment needs for resource development. Use of commercial harvests to represent potential CI beluga prey is likely biased because harvests typically occur "downstream" of feeding CI beluga. Use of salmon escapements to represent CI beluga prey is also biased because escapements occur "upstream" of CI beluga foraging areas. In addition, many escapement indices are discontinuous over time as monitoring techniques or tributaries change in response to management priorities and agency budget limitations. The small-mesh trawl survey in Kachemak Bay dates to 1977 and provides a basis for long-term ecosystem changes, but was reduced in frequency, and then discontinued after 2006 due to financial priorities. A multi-species trawl survey, focused on Tanner crab, but also providing population estimates of species like Pacific cod, walleye pollock, and arrowtooth flounder in lower Cook Inlet, dates to 1990 but has also been reduced in frequency due to budget priorities.

FIGURE E11: Historic Biomass (millions pounds) of Pandalid Shrimp, Demersal Fishes and Other Invertebrates from Small-Mesh Trawl Surveys in Kachemak Bay



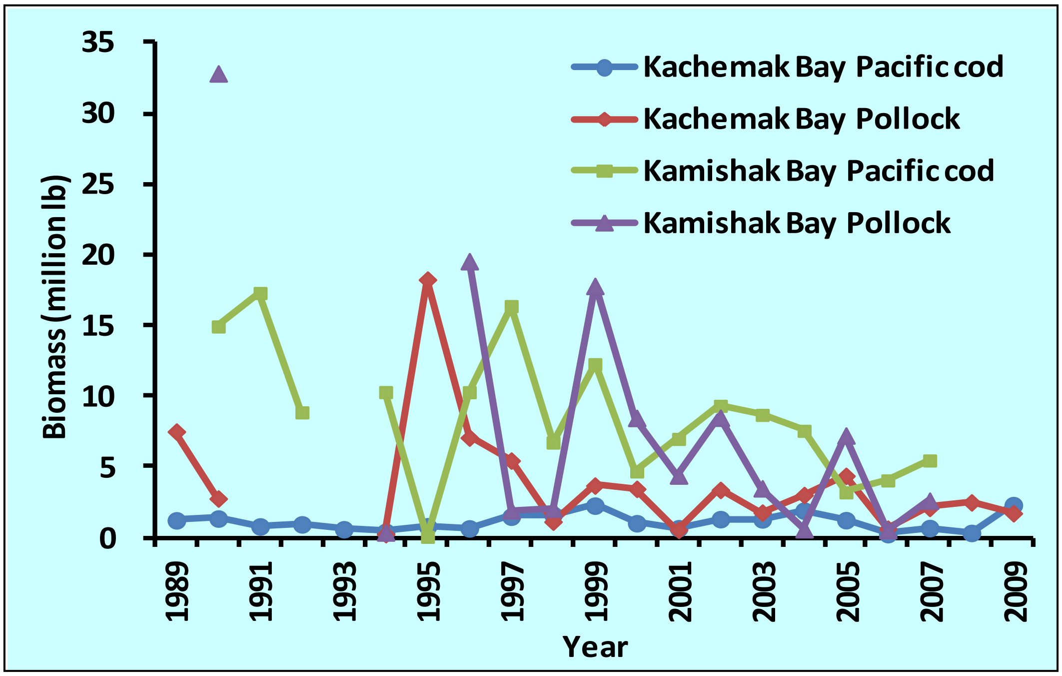
Source: Gustafson and Bechtol 2005; Goldman et al. 2007; R. Gustafson, ADF&G, pers. comm.

FIGURE E12: Anomalies in the Mean Catch of Dominant Forage Species in the Kodiak Small-Mesh Trawl Survey, 1975 to 2010



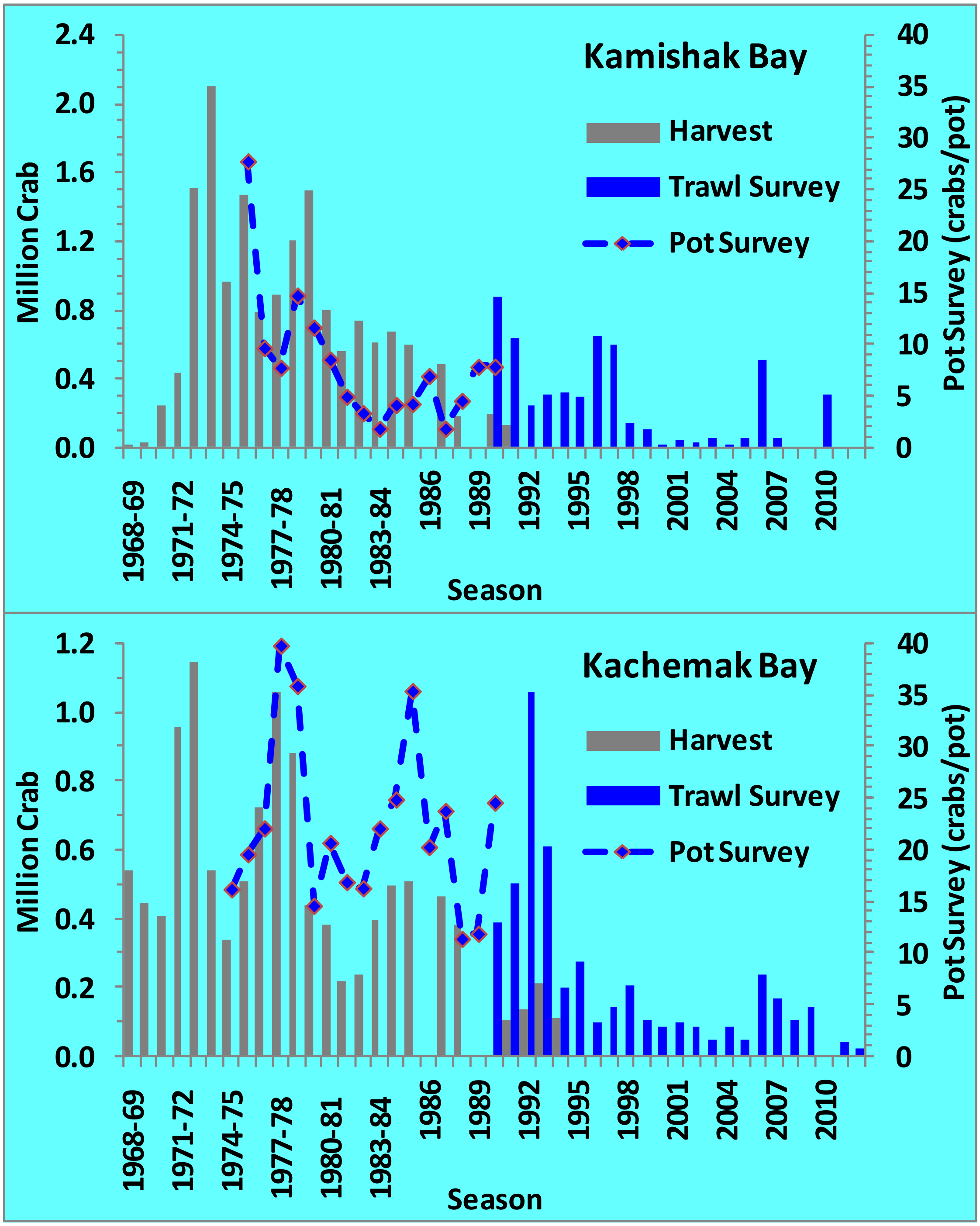
Source: D. Urban, NMFS, pers. Comm

FIGURE E13: Bottom Trawl Survey Biomass Estimates of Pacific Cod and Walleye Pollock in Kachemak Bay and Kamishak Bay, Lower Cook Inlet, 1989 to 2009



Source: R. Gustafson, ADF&G, pers. comm.

FIGURE E14: Pot and Trawl Survey Estimates, and Subsequent Harvests, for Legal (i.e., legal size to harvest) Male Tanner Crabs in the Kamishak and Barren Islands Districts (top panel) and the Southern District (Kachemak Bay, lower panel), 1968 to 2012



Source: Bechtol et al. 2002; R. Gustafson, ADF&G, pers. Comm

F. CI Beluga Pollution and Contaminants Supplement

NOTE TO READER: The text below was developed by the Cook Inlet Beluga Whale Recovery Team and reproduces information readily available in other reports. In section III.A.2 of this document, we provided information sufficient to justify recovery criteria and actions. Additional information about pollution and contaminants reviewed for Cook Inlet and CI belugas follows.

1. Pollution and Contaminants

Pollution is the introduction of contaminants into the environment that causes adverse change. For the purpose of this review, pollution is synonymous with acute or chronic events that release notable/reportable quantities of chemicals or substances into the environment. Exposure to industrial chemicals as well as to natural substances released into the marine environment is a potential health threat for CI belugas and their prey.

Available literature was recently reviewed by NMFS for the Cook Inlet Beluga Whale Conservation Plan (NMFS 2008a) and by URS Corporation (2010). The reviewed publications vary in their use of terminology regarding lipid, blubber, dry weight and wet weight. In particular, some authors consider blubber and lipid to be synonymous and interchangeable terms, whereas others consider blubber to be a combination of lipids and water. Therefore, it is important to ensure that comparisons of tissue concentrations and threshold levels are based on consistent assumptions of measurement media and units.

There is little information on the potentially deleterious effects of chemicals on the CI beluga whale population. Potential sources of anthropogenic contaminants include wastewater treatment, freshwater runoff, airport de-icing chemicals, ballast water discharges, gas and oil releases or spills, military training areas, and other industrial development and activities. While NMFS has some data about levels of traditionally studied contaminants in CI belugas (e.g., Dichlorodiphenyltrichloroethane [DDT], polychlorinated biphenyls [PCBs], polycyclic aromatic hydrocarbons [PAHs], etc.), virtually nothing is known about other emerging pollutants of concern and their effects on CI belugas. The emerging pollutants of concern include endocrine disruptors (substances that interfere with the functions of hormones), pharmaceuticals, personal care products, and prions (proteins that may cause an infection), amongst other bacterial and viral agents that are found in wastewater and biosolids.

URS (2010) evaluated the level of concern for various classes of chemicals that were of probable, possible, or unlikely concern. Chemicals of concern for which data are available are described in Table 9, and representative values from various beluga populations and marine mammals in Cook Inlet are listed in Table F1. Table F2 lists those chemicals of possible concern for which there are no data available for any beluga population. Chemicals considered by URS (2010) to be unlikely of concern for CI belugas include: hydrocarbons (other than PAH compounds), glycols, diagnostic agents, dietary supplements, personal care products, engineered particles (<100 nanometers), or prions. Figure F1 summarizes data for known concentrations of various contaminants found in the blubber of male belugas from North America.

TABLE F1: Tissue Concentrations of Analyzed Substances for Belugas from Cook Inlet and Other Regions

		Male	Female	
Group	**Group[Ref1]**	**Mean Concentration ± 1SD (Range)**	**Mean Concentration ± 1SD (Range)**	**Tissue**
Organochlorides (mg/kg wet)				
Total PCBs	CI (1992-97) [a]	1.49 ± 0.70	0.79 ± 0.56	blubber
	Pt Lay (1990, 1996) [a]	5.20 ± 0.90	1.50 ± 1.12	blubber
	SLE (1986-87) [a]	75.8 ± 15.3	37.3 ± 22.0	blubber
Total DDTs	CI [a]	1.35 ± 0.73	0.59 ± 0.45	blubber
	Pt Lay [a]	3.63 ± 0.90	0.93 ±0.85	blubber
	SLE [a]	101 ± 32.6	23.0 ± 17.3	blubber
Toxaphene	CI	2.40 ± 1.06	2.02 ± 0.46	blubber
	Pt Lay [a]	3.93 ± 1.16	2.62 ± 2.07	blubber
	SLE [a]	14.7 ± 2.46	6.34 ± 3.51	blubber
Chlordane compounds	CI [a]	0.56 ± 0.25	0.30 ± 0.22	blubber
	Pt Lay [a]	2.42 ± 0.46	0.79 ± 0.61	blubber
	SLE [a]	7.43 ± 0.63	3.55 ± 1.99	blubber
Dieldrin	CI [a]	0.09 ± 0.05	0.06 ± 0.05	blubber
	Pt Lay [a]	0.39 ± 0.09	0.12 ± 0.10	blubber
	SLE [a]	0.93 ± 0.12	0.56 ± 0.31	blubber
Hexachlorobenzene (HCB)	CI [a]	0.22 ± 0.09	0.15 ± 0.13	blubber
	Pt Lay [a]	0.81 ± 0.12	0.23 ± 0.28	blubber
	SLE [a]	1.34 ± 0.44	0.60 ± 0.43	blubber
Hexachlorocyclohexane (Sum HCH)	CI [a]	0.21 ± 0.07	0.17 ± 0.05	blubber
	Pt Lay [a]	0.33 ± 0.76	0.25 ± 0.12	blubber
	SLE [a]	0.37 ± 0.11	0.24 ± 0.10	blubber
Mirex	CI [a]	0.01 ± 0.01	0.01 ± 0.00	blubber
	Pt Lay [a]	0.06 ± 0.02	0.02 ± 0.01	blubber
	SLE [a]	1.00 ± 0.64	1.11 ± 0.99	blubber
Perfluorinated Compounds				
Perfluorooctane sulfonate ng/g ww	SC NSO 1992 to 2007 [b]	(< 0.9-21.2)		liver
	CI 1992 to 2006 [c]	22.5 (14.4-30.4)	13.0 (4.61-70.3)	liver
	E. Chukchi 1989 to 2000 [c]	9.2 (4.29-28.4)	4.76 (1.81-38.1)	liver
Perfluorooctane sulfonamide	SC NSO 1992 to 2007 [b]	(< 1.7 -15.2)		liver
	CI 1992 to 2006 [c]	11.4 (4.52-17.9)	18.4 (10.4-27.8)	liver
	E. Chukchi 1989 to 2000 [c]	31.8 (17.7-63.8)	27.8 (11.2-65.7)	liver
Perfluorononanoic acid	SC NSO 1992 to 2007 [b]	(< 0.9-9.4)		liver
	CI 1992 to 2006 [c]	1.79 (0.454-3.08)	1.66 (<0.502-5.67)	liver
	E. Chukchi 1989 to 2000[c]	0.670 (0.170-2.55)	0.960 (<0.180-5.46)	liver
Total PFCs	SC NSO 1992 to 2007 [b]	(7.1-34.6)		liver
Polycyclic aromatic hydrocarbons (PAHs) µg/g lw				
Total PAHs	CI [d]	2.6 ± 3.8	1.2 ± 1.9	liver

		Male	Female	
Group	Group[Ref1]	Mean Concentration ± 1SD (Range)	Mean Concentration ± 1SD (Range)	Tissue
	CI [d]	6.9 ± 7.4	27.8 ± 29.4	blubber
Polybrominated diphenyl ethers (PBDEs) (ng/g lipid)				
	CI 1989 to 2006 [e]	13.8 (6.56-45.6)		blubber
	E. Chukchi 1989 to 2000[e]	12.8 (4.33-32.2)		blubber
	SLE 1988 to 1999 [f]	430 (170-780)	540 (300-1060)	blubber
	SLE 2000 to 2003[g]	2,210 (246-3030)		liver
Metals/Inorganics (mg/kg dry)				
Cadmium (Cd)	CI [a]	2.39		liver
	Pt Lay [a]	9.38 ± 3.39		liver
	SLE [a]	0.53 ± 0.41		liver
Mercury (Hg)	CI [a]	16.3 ± 13.0		liver
	Pt Lay [a]	179 ± 78.6		liver
	SLE [a]	126 ± 161		liver
Copper (Cu)	CI [a]	162 ± 130		liver
	Pt Lay [a]	61.6 ± 42.3		liver
	SLE [a]	0.58 ± 0.41		liver
Mercury (Hg)	CI [a]	16.3 ± 13.0		liver
	Pt Lay [a]	179 ± 78.6		liver
	SLE [a]	126 ± 161		liver
Selenium (Se)	CI [a]	14.3 ± 7.0		liver
	Pt Lay [a]	97.2 ± 76.7		liver
	SLE [a]	79.2 ± 110		liver

Notes: CI - Cook Inlet belugas, Pt. Lay - Point Lay belugas, SLE - St. Lawrence Estuary belugas

Sources: a. Becker et al. 2000; b. Hart et al. 2009; c. Reiner et al. 2011; d. Wetzel et al. 2010; e. Hoguet et al. 2013; f. Lebeuf et al. 2004; g. McKinney et al. 2006

a. Organochlorines in CI Belugas

PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications. Though their production has been banned since 1979 in North America, PCBs still pose a risk to humans and wildlife because they are highly toxic and persist in the environment. These and other organochlorines such as DDT have high-fat, low-air, and poor-water solubility, allowing them to accumulate in fatty tissues. Being highly persistent in the environment and resistant to metabolic degradation, these compounds bioaccumulate through trophic transfer, resulting in higher concentrations in upper level predators such as marine mammals. High concentrations in animals are associated with poor health and reproduction. Concentrations of various organochlorines in CI belugas were consistently lower than levels observed in belugas from Point Lay and one to two orders of magnitude lower than levels seen in SLE belugas (Becker et al. 2000). The PCB values for CI belugas were at levels associated with endocrine disruption, lower than established

TABLE F2: A Brief Description of Compounds of Possible Concern to CI Belugas, but for which No Data are Available for CI or Other Beluga Populations.

Class Of Substance	Specific Examples
Organophosphates*/ carbamates	Commonly used as broad-spectrum insecticides: Malathion*, methyl-parathion, chlorpyrifos, diazinon, carbaryl, aldicarb
Phthalates	Commonly used in vinyl softeners in flooring and in adhesives, plastic clothing, toys, and kitchen ware: Diethyl phthalate, butyl benzyl phthalate
Prescription and over the counter drugs	Commonly used medicinally for humans and animals: Penicillins, tetracyclines, clofibric acid, aspirin, ibuprofen, prozac, agricultural animal growth promoters, aminoglycosides*, aspirin*, furosemide*
Alkylphenols	Commonly used in detergents and cleaning agents: Nonylphenol, octylphenol
Consumer plastics	Commonly used in CDs, DVDs, eyeglasses lenses, and bottles: Bisphenol A (BPA) (2,2-bis(4-hydroxydiphenyl) propane)
Natural and synthetic hormones	Commonly used medicinally for humans and animals: Estradiols, thyroxine analogs
Surfactants	Commonly used in detergents, cosmetics, and spermicides: 4-nonylphenol; "alkylphenol polyethoxylate surfactants"; o-, m-, or p-nonylphenol
Pesticides/Herbicides	Commonly used to control “pests” including insects, fungi, plants, rodents, birds, spiders, mites: Lindane, methyl-parathion; permethrin; triazines, bifenthrin, cypermethrin, esfenvalerate; pyrethroids*, paraquat*

* Denotes compounds with known ototoxic effects.
Source: URS 2010

thresholds for immunosuppression, but close to levels that disrupted immune function in free ranging harbor seals (as low as 2.5 milligrams [mg] per kilogram[kg] of PCBs; Levin et al. 2005, Shaw 2005).

In a study of California sea lions (*Zalophus californianus),* LeBoeuf et al. (2003) did not find any evidence that population growth or the health of individual sea lions had been compromised at mean total PCB concentrations of 12 mg/kg blubber weight and mean total DDTs concentrations of 37-41 mg/kg blubber wet weight, which are substantially higher than levels seen in CI belugas. Bristol Bay and CI beluga populations appear to carry very similar body burdens of most persistent organic pollutant contaminants, although CI belugas may be exposed to larger amount of PCBs of aroclor origin (Northwest Fisheries Science Center, NMFS, unpub. data). Additionally, contaminant signatures were consistent with Bristol Bay beluga whales consuming prey originating from Asia and the arctic, whereas the signatures in CI beluga whales did not exhibit indications of consumption of prey originating from outside Cook Inlet and the Gulf of Alaska (Herman et al., NMFS, unpub. data).

In a study of PCBs and organochlorine pesticides from blubber biopsies of free-ranging SLE beluga whales, concentrations had overlapping but lower ranges when compared to samples obtained from dead stranded belugas from Cook Inlet (Hobbs et al. 2003). The authors suggest that the differences observed are due to different feeding habits, particularly with regard to eels, and that elevated organochlorines were having an effect on the health of the SLE whales to an extent that led to higher mortality. Additionally, the authors caution that relying only on samples from stranded whales could bias study results because contaminant concentrations are likely elevated in stranded whales relative to what occurs in the population as a whole. Interestingly, this study also compared values to those obtained from SLE harbor seals, noting that most major compounds in the biopsied belugas occurred at similar levels in the seals, and followed similar age and sex-related trends (Bernt et al. 1999). This suggests sampling Cook Inlet harbor seals may be a viable surrogate species for investigating contaminant loads in CI belugas.

b. Perfluorinated compounds

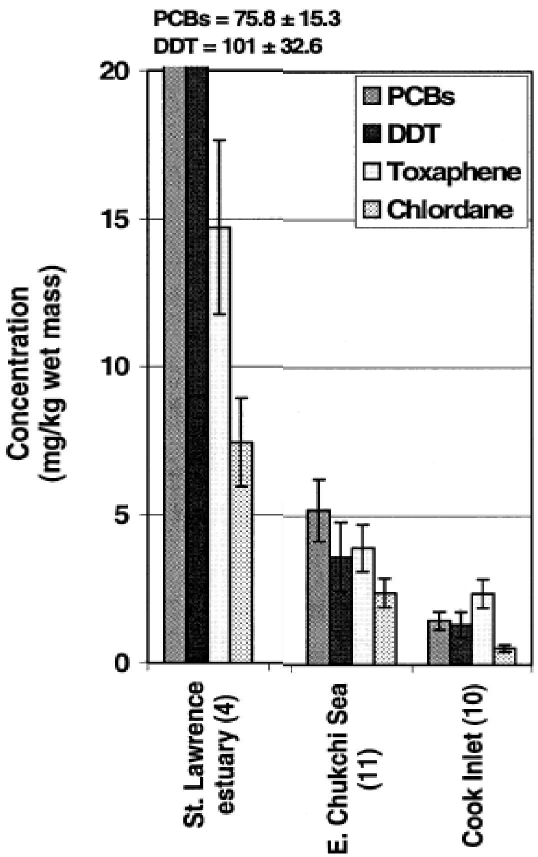
The perfluorinated compounds (PFCs), which include Teflon, are compounds commonly used as water and oil repellants, in protective coatings in food packaging, textiles and carpeting. While PFCs are not well studied in marine mammals, PFCs have recently become contaminants of possible concern. The CI belugas had higher concentrations of most PFCs compared to beluga from the eastern Chukchi but a lower median concentration of one particular type of PFC, namely perfluorooctane sulfonamide (Reiner et al. 2011). Temporal trends indicated most PFC concentrations have steadily increased from 1989 to 2006, whereas a study involving sea otters from lower Cook Inlet has shown a general decrease since about 2001 (Hart 2009). Previous studies examining PFCs in beluga livers from the Canadian Arctic have found individual PFC concentrations >150 ng/g (Kelly et al. 2009 and Tomy 2009 as cited in Reiner et al. 2011), notably higher than values from CI belugas. Differences suggest different sources or transport pathways for these compounds, which can be related to the geographic differences in long-range atmospheric transport of PFCs, oceanic transport of PFCs, local releases, and/or feeding habits (Reiner et al. 2011).

c. Polycyclic aromatic hydrocarbons

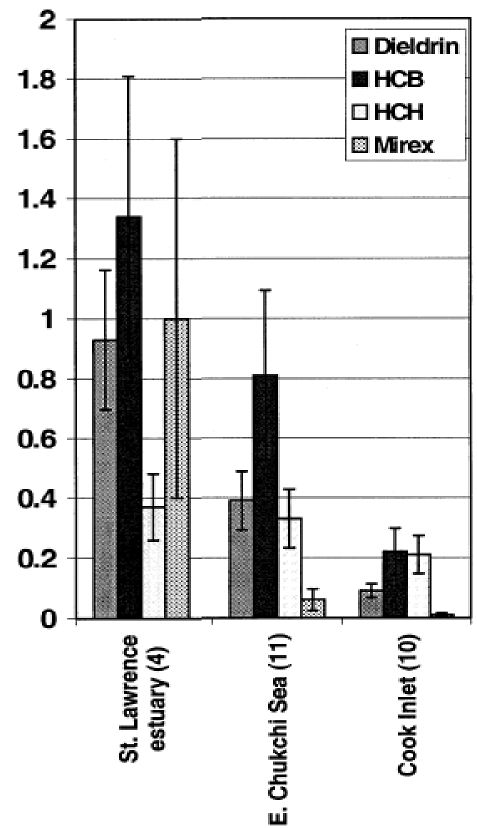
This class of compounds is naturally occurring in fossil fuels and is also released from forest fires, industrial products (e.g., asphalt and coal tar) and the incomplete combustion of coal, oil, gas, or organic waste (compounds of particular concern are benzo(a)pyrene, anthracene, and pyrene). These are some of the most widespread organic pollutants. The PAH compounds are lipophilic (oil-loving), with larger compounds even less water-soluble and volatile. Because of these properties, PAHs in the environment are found primarily in soil, sediment, and oily substances, as opposed to water or air. However, they are also a component of concern in particulate matter suspended in air. Representing the most toxic components of oil, and including 16 compounds, PAHs are considered priority pollutants by the World Health Organization and the U.S. Environmental Protection Agency (EPA). The PAHs can enter the environment in a number of ways, including, but not limited to: oil and gas development activities; run-off from streets or parking areas; leakage from watercraft; oil spills; natural oil seeps and forest fires. One PAH, benzo(a)pyrene, has been identified as the most likely cause of high numbers of cancers in belugas from the SLE, and PAHs have numerous known effects besides carcinogenesis in mammals; these include effects on reproduction and survival of offspring.

FIGURE F1 (a-f): Concentrations (mean +/- 1 standard deviation) of Various Contaminants in the Blubber of Male North American Belugas

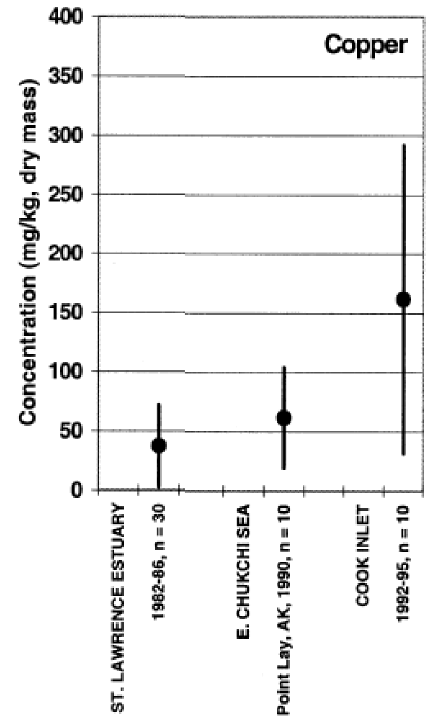
a) PCBs, DDT, toaxaphene, and chlorane



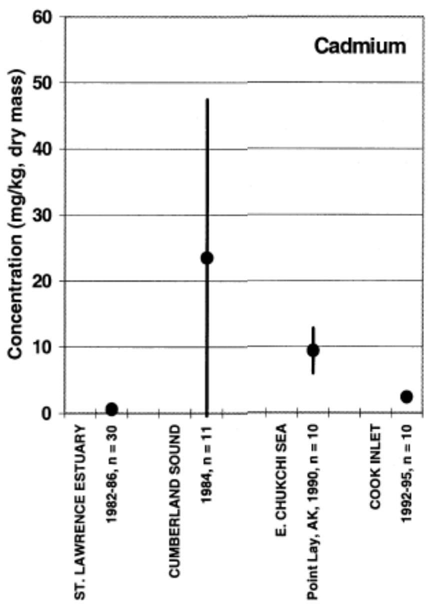
b) Dieldrin, HCB, HCH, and mirex



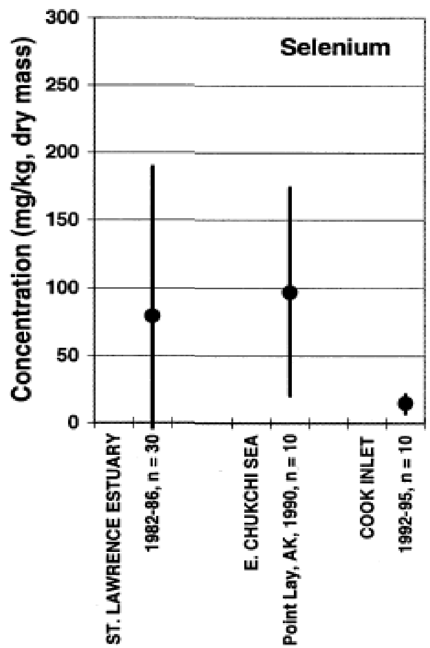
c) Copper



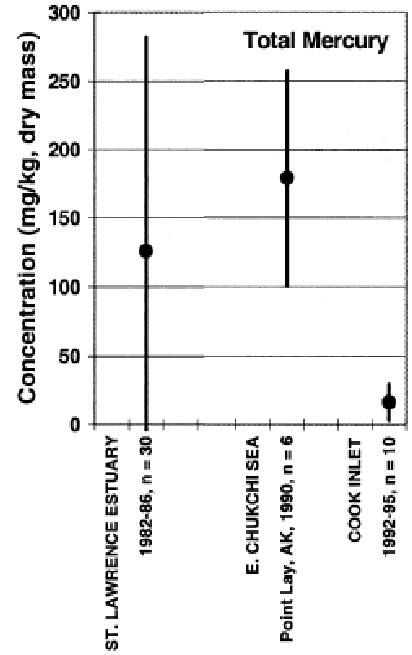
d) Total Mercury



e) Selenium



f) Cadmium



Notes: When available, geographic locations, dates of sample collections, and number of animals are shown on the X axis.
Source: Becker 2000

A study analyzed PAH levels in beluga, prey species, and sediments from Cook Inlet. The highest PAH levels in the sampled sediments were found in Eagle Bay (Wetzel et al. 2010). Although naphthalenes, anthracenes, and phenanthrenes were the most ubiquitous classes of PAHs found, benzo(a)pyrene was also detected in all sediment samples (Wetzel et al. 2010). The data suggested inputs from both combustion and fresh oil. Total PAH levels were moderate, relative to those found in other locations known to have environmental problems with PAH contamination (Wetzel et al. 2010). The same general patterns occurred in the salmon, eulachon and saffron cod, but the fish contained slightly higher amounts of pyrene and fluorine constituents than did the sediments (Wetzel et al. 2010). The highest PAH values were in eulachon taken from the Little Susitna River (Wetzel et al. 2010). Some king salmon from Ship Creek contained notable levels of total PAHs in their flesh; roe from some sockeye salmon was also notably high in total PAHs (Wetzel et al. 2010).

As noted above, an especially strong correlation was found between high levels of PAHs and illness and mortality of beluga whales in the SLE and humans living in the vicinity (Martineau et al. 1994, 2002), underscoring the susceptibility of both species to this class of contaminants. Although the correlation suggests a cause and effect relationship, none has been proven for the beluga. The chronic PAH contamination in SLE represents a clear threat to the health status of resident species; SLE belugas have shown a greater prevalence of cancer than any other group of cetaceans in the world (Martineau et al. 2002). One particular PAH, benzo(a)pyrene, appears to be the primary culprit.

The CI belugas appear to bioaccumulate PAHs from the environment, including from their prey. CI belugas have much higher PAH levels than do subsistence-harvested belugas from MacKenzie River Delta (Wetzel et al. 2010). Highest PAH levels in CI beluga livers were found in three adult males and a female fetus; the highest levels in blubber were from adult females and fetuses (Wetzel et al. 2010). The most prevalent types of PAHs found in beluga liver samples were fluorenes, anthracenes, and phenanthrenes (Wetzel et al. 2010). No benzo(a)pyrene was detected. PAH concentrations in the blubber of females were statistically higher than in males (Wetzel et al. 2010). The most prevalent types of PAHs found in beluga blubber were naphthalenes, fluorenes, anthracenes, and fluoranthracenes; small amounts of benzo(a)pyrene were found in some blubber samples (Wetzel et al. 2010).

d. Metals

CI belugas had lower levels of metals of concern than other beluga populations, including mercury which was below the liver threshold value of concern of 60mg/kg. The one element that did not follow this pattern was copper; copper levels in livers of CI belugas were two to three times higher than in Arctic Alaska belugas and similar to Hudson Bay belugas (Becker 2000). While copper has not been associated with toxic effects in CI belugas, these levels are substantially higher than the renal damage values (29 mg/kg) reported for Australian bottlenose dolphins (*Tursiops truncatus*) (Lavery et al. 2009).

e. Emerging chemicals

Becker (National Institute of Standards and Technology, pers. comm.) reported that CI belugas have significantly higher total levels of the brominated flame retardant Hexabromocyclododecane than the Eastern Chukchi Sea belugas from Point Lay, but demonstrated that levels in Alaskan belugas are lower than those measured in SLE belugas (Lebeuf et al. 2004) and California sea lions (Stapleton et al. 2006). However, other studies report that another class of flame retardants, PBDEs are increasing over time in Chukchi Sea belugas and in CI Inlet belugas (Hoguet et al. 2013) as they are in SLE beluga (Lebeuf et al. 2004).

Data for the other chemicals of possible concern (Table F2) are either not available or could not be evaluated at this time due to a lack of readily available threshold concentrations. However, toxicity reference values are available for some non-cetacean marine mammals, and these could be used to develop body burden-based screening levels for belugas.

In general, for the contaminants that have been studied, CI belugas appear to have lower levels of contaminants stored in their bodies than do other populations of belugas. Additionally, chemical analyses of water and dredging sediments from Cook Inlet found that contaminants analyzed were below management levels, some below detection limits (Frenzel 2002; U.S. Army Corps of Engineers [Corps] 2003). However, new chemicals of concern are developed or recognized on a regular basis. One study of organohalogen contaminants in Canadian beluga whale liver contained previously unidentified compounds and metabolites which may be impacting the health of Canadian beluga whale populations (McKinney et al. 2006).

f. Ototoxic compounds

Ototoxins are substances that temporarily or permanently damage hearing. These compounds include several chemicals already discussed (Table 9 and F2) and come from several classes of chemicals including: organic solvents (carbon disulphide, heptane, hexane, perchloroethylene, Stoddard solvent, trichloroethylene); pesticides; alcohols (butanol, ethanol); heavy metals (arsenic, lead, manganese, mercury, organic tin); drugs (aminoglycosides, aspirin, furosemide); PAHs (toluene, benzene, styrene, xylene); and other miscellaneous compounds (acrylonitrile, carbon monoxide, cyanide, organophosphates, paraquat) (Morata and Little 2002, Teixeira et al. 2002, Steyger 2009). Organic solvents include alcohols, paints, adhesives, and fuels, including jet fuel (both commercial and military grade) which contain a variety of ototoxic aromatic hydrocarbons including toluene, styrene, ethyl benzene, and xylene (Steyger 2009). These chemicals can be absorbed through the respiratory tract, the skin, or the gastrointestinal tract. Our understanding of the effects of these compounds on the hearing of marine mammals is limited; however, hearing deficits have been established in cetaceans, including belugas, which were treated with aminoglycosides, a class of antibiotics known to be ototoxic (Finneran et al. 2005). When exposure to ototoxic chemicals is combined with exposure to noise, hearing loss is exacerbated by increasing both the breadth and severity of permanent threshold shifts; hearing loss can even occur at subtoxic chemical and sub-traumatic noise levels which would cause little or no hearing loss in the absence of the other agent (Steyger 2009). The synergistic effect of noise and organic solvents is more serious after repeated exposure at lower levels (Steyger 2009).

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G. Summary of a Cause of Death Analysis of 34 Necropsied CI Beluga Whales

NOTE TO READER: *The text below was developed by the Cook Inlet Beluga Whale Recovery Team and is a detailed description of an analysis of necropsies of 34 CI belugas conducted by Burek-Huntington et al. (in press) from 1998-2009. In section II.D.3 of this document, we provided information sufficient to justify recovery criteria and actions. Additional information about the necropsy results of these 34 CI belugas follows.*

From 1998 to 2009, only 34 carcasses out of 136 observed dead stranded belugas (Table 5) were subjected to some degree of post-mortem examination or necropsy. These carcasses were concentrated close to Anchorage and along the road system (Figure 16). In the 34 CI beluga carcasses examined between 1998 to 2009, the cause of death was not identified in a third of the cases examined, primarily because the vast majority were in an advanced state of decomposition (Burek-Huntington et al. *in press*). Categories of identified causes of death in CI belugas are discussed below.

1. Perinatal/Neonatal Mortality

Perinatal mortalities included deaths of four fetuses and one neonatal beluga calf in Cook Inlet (Burek-Huntington et al. *in press*). All four fetuses were in an advanced state of decomposition and a clear cause for the abortion or stranding was not found. It is noteworthy that all four fetuses were recovered in 2008 which may suggest a common cause, but the sample size and insufficient common findings from postmortem exams and testing makes it impossible to support such a conclusion. Neonatal mortalities and dystocia (complications during birth) have also been observed in aquariums and in animals from the SLE (Table 5). In the wild, carcasses of young animals would be harder to find due to their small size and tendency to sink, so perinatal mortalities are undoubtedly underreported. Olesiuk et al. (1990) inferred that mortality during the first few months of life of killer whales in British Columbia could be as high as 37-50%. Hammill (2007) reported a fairly low rate of neonatal mortalities in SLE belugas during the time period covered by the report; however, in 2010 to 2012 there has been a notable increase in perinatal morality for SLE beluga adult females and calves (P. Béland, St. Lawrence National Institute of Ecotoxicology, unpub. data).

2. Infectious Diseases

Nineteen of the 34 examined stranded CI belugas had at least one disease and 11 had two or more diseases considered contributory to death, including bacterial, viral, and parasitic diseases (Table G1). However, diseases are easily missed in decomposed carcasses, which describes most of those examined from Cook Inlet. Therefore, the reported contribution of disease to overall mortality rates represents a minimum (Burek-Huntington et al. *in press*). A greater proportion of deaths due to infectious diseases was seen in SLE, 32% (S. Lair pers. comm. to C. Goertz), and in oceanaria, 51% (L. Dunn, pers. comm. to C. Goertz) where carcasses are more reliably accessed in a timely manner.

Bacteria: Bacterial infections implicated as the cause of death in examined CI belugas included a systemic infection, pneumonia, and lung abscess (Burek-Huntington et al. *in press*). Culture of specific bacteria was not possible because of advanced decomposition, but organisms were seen on microscopic examination of tissues. Bacterial infection was the major cause of mortality in

TABLE G1: Types of Diseases Described in Stranded Cook Inlet Belugas and their Coded Significance from 34 Carcasses of Cook Inlet Belugas that were examined (1998-2009) as part of Mortality and Morbidity Study.

Type of disease	COD	CF	I
Combined bacterial / parasitic infections	2		
Herpesviral infection	1		3
Parasites:			
Protozoa-Muscle			3
Metazoan parasites:			
Nematode - Kidney		14	5
Nematode - Blubber			9
Nematode - Lung		11	2
Nematode – Stomach			5
Trematode - Liver		1	
Cardiopulmonary disease		6	2
Inflammatory, misc.		1	2
Total	**3**	**33**	**31**

Source: Burek-Huntington et al. *in press*

captive beluga (L. Dunn, pers. comm. to C. Goertz). Pathogenic bacteria isolated from captive beluga include *Nocardia* spp. (MacNeil et al. 1978), *Erysipelothrix* (Calle et al. 1993), *Vibrio parahaemolyticus* (Higgins 2000), *Edwardsiella* (Higgins 2000), and *Mycobacterium* (Bowenkamp et al. 2001). Several bacteria (*Edwarsiella tarda*, *Aeromonas hydrophila*, *Vibrio. cholera, V. fluvialis, Kingella kingae, Morganella morganii, Pleisiomonas shigelloides, Shewanella putrefaciens, and Nocardia* spp.*)* that affected SLE beluga are generally found in water with high loads of organic pollutants (L. Dunn, pers. comm.to C. Goertz; Martineau et al. 1988; De Guise et al. 1995a; Martineau 2003). The high bacterial load of the SLE likely contributes to these bacterial infections (St. Lawrence Centre 1996). Bacteria identified in the deaths of SLE belugas were typically opportunistic, normally found in the environment and/or healthy hosts, but usually only causing disease when the host's immunological defenses are compromised. Any factor that results in a compromised immune system may render SLE belugas, and presumably other belugas, more susceptible to opportunistic bacteria.

Viruses: The only virus identified in CI belugas was the herpes virus which was the cause of death in one case (Burek-Huntington et al. *in press*). Herpes viral dermatitis was an incidental finding in other CI belugas examined post-mortem, and herpes-like marks have been observed in photographs of live CI belugas (T. McGuire, LGL Alaska Research Associates, pers. comm.). This type of herpes infection is typically localized, usually not significant to the overall health of the animal, and eventually becomes latent leaving a distinctive scar. However, latent infections can be reactivated by such factors as stress and immune-suppression and can further compromise the individual (Kennedy et al. 1992). Serological testing for antibodies to viral diseases of concern is only possible with blood from a live or very freshly dead animal, which does not include any of the carcasses in the CI beluga mortality study, and has not been done on samples from live-captured CI beluga whales, so it is unknown what other viruses may be active in this population. Viruses have been implicated in the death of three captive belugas including one with herpes virus-like particles identified by transmission electron microscopy (L. Dunn, pers. comm. to C. Goertz). A few SLE animals had microscopic lesions of non-suppurative encephalitis, most consistent with a viral etiology, however subsequent test could not identify a specific virus and the clinical significance of these lesions was not always clear, even if this inflammation of the brain was believed to have been the cause of the stranding in the most severe cases (S. Lair, pers. comm. to C. Goertz).

Parasites: Significant parasitic infestations were noted in the lungs and kidneys of many necropsied CI belugas, sometimes in both sets of organs in the same individual. Thirteen animals (38%) had varying degrees of lungworm infection from incidental infection to association with bronchopneumonia. The species of pulmonary nematodes or roundworms in CI belugas has not been identified; species known to affect belugas include *Pharurus pallasii*, *Stenurus artomarinus*, *Halocercus monoceris*, and *Stenurus minor* (Measures 2001). In some beluga populations, infection with pulmonary nematodes was found in otherwise healthy robust animals, possibly suggesting a commensal relationship (Woshner et al. 2001). However in SLE belugas, lungworms were listed as a significant factor in stranding mortalities (Martineau et al. 2003) and pneumonia, usually of parasitic origin, was one of the most common causes of death (De Guise et al. 1995b).

Single kidneys from 19 of 26 CI belugas contained a nematode identified as *Crassicauda giliakiana* which has been only rarely observed in other beluga populations (Martineau et al. 1988, De Guise et al. 1995a, Vlasman and Campbell 2003, Burek-Huntington et al. i*n press*). While extensive damage and tissue replacement has been noted in some kidneys from CI belugas, it is unclear whether this change results in functional damage since up to 75% of a kidney can be damaged in other species before causing renal failure. However, heavy burdens could compromise young animals or individuals stressed by other conditions. The life cycle of *C. giliakiana* is not well understood. If an intermediate host is involved, the relatively high prevalence of kidney nematodes in CI belugas likely reflects a variation in their diet as compared to other beluga populations.

Other parasites found in CI belugas includes nematodes in the gastrointestinal tract (*Anisakis* or *Contracaecum* sp.) and in blubber (a *Crassicauda* sp.) as well as protozoa in muscle (*Sarcosystis* sp.), but were considered incidental and did not contribute to death (Burek-Huntington et al. *in press*). One instance of a trematode infection, most likely a *Campulid*, was noted in a liver. Endoparasites found in other beluga populations include: gastrointestinal nematodes (*Contracaecum* spp., *Anisakis simplex* sometimes in association with ulcers, *Leucastella arctica*) (Klinkhart 1966; Department of Fisheries and Oceans [DFO] and World Wildlife Fund 1995); trematodes or flukes (*Hadwenius seymouri*); and protozoa (*Toxoplasma* and *Sarcocysitis* spp.) (Kenyon and Kenyon 1977, Wazura et al. 1986, De Guise et al. 1993, Martineau et al. 1994, Mikaelian et al. 2000, Measures 2001, Woshner 2001, Houde et al. 2003). *Trichinella spiralis*, a nematode found in muscle, was reported from one beluga whale from the arctic coast of Alaska (Brandly and Rausch 1950). Many of these parasites are transmitted primarily through the ingestion of infected prey and often do not affect the host's general health. Parasitic disease in captive animals is rarely seen due to the use of anthelminthics (i.e., drugs that expel parasitic worms from the body) and the practice of feeding restaurant-quality, frozen fish, disrupting parasitic life cycles.

Fungi: Fungal organisms, including candida and *Aspergillus fumigatus*, have been implicated in the deaths of some captive animals but may be related to the use of antibiotics which, in addition to suppressing pathogenic bacteria, can also suppress normal flora which helps protect against fungal diseases. Additionally, captive facilities put belugas in closer proximity to environmental sources of fungal organisms which are not normally found in open waters. However, fungal and other infectious organisms can be liberated during major earth-moving operations and may travel airborne some distance (Bowenkamp et al. 2001). There have been no reports of fungus-related death in Cook Inlet or SLE animals.

Harmful Algal Blooms (HABs): HABs have the potential of producing toxins that can kill marine mammals or make them more susceptible to death due to other causes, such as predation or boat strikes. Additionally, algal blooms are expected to increase with the warmer ocean conditions anticipated for Alaska in the coming years. As part of Food and Drug Administration requirements, the ADEC tests all commercial shellfish for Paralytic Shellfish Poisoning (caused by harmful algae) as part of their Marine Biotoxin Program. However, commercial shellfish harvesting in Cook Inlet is limited to the area between Polly Creek and Crescent River in upper Cook Inlet and to Kachemak Bay in lower Cook Inlet, leaving large areas unmonitored. Furthermore, ADEC does not routinely test for other harmful algal toxins. The Kachemak Bay Research Reserve participates in NOAA's Phytoplankton Monitoring Network, though participation is relatively new and has been sporadic. A high-mortality event of SLE belugas was caused by an algal bloom in 2008 (Lair et al. 2009).

Findings of disease in other marine mammals in Cook Inlet: There is limited evidence of disease transfers among marine mammal species. However, because beluga and other species may be exposed to the same disease source via prey or the environment, understanding conditions that affect other marine mammals in Cook Inlet could provide insight into pathogens that might also affect beluga whales. Stranded harbor seals (n=59) found in Cook Inlet during 1997 to 2011 were screened for a variety of diseases (Goertz, in prep). Most seals were young of the year and found by serology to be negative for evidence of exposure to the following diseases: avian influenza, canine distemper virus, dolphin morbillivirus, porpoise morbillivirus, *Leptospira canicola, L. grippotyphosa, L. pomona, Neospora, Sarcocystis*, and *Toxoplasma*. One animal tested positive for antibodies against *Brucella* spp. and another was positive for phocine distemper virus. A few animals tested positive for antibodies to seal herpesvirus-1, *L. Bratislava, L. hardjo, and L. icterohemorrhagiae*. All titers were stable or declining, suggesting waning maternally derived antibodies, except one animal had an increasing titer for seal herpesvirus-1. Fecal pathogen screenings yielded low levels of pathogenic and opportunistic bacteria though none of concern for seal health. Causes of mortality and morbidity of Northern sea otters in Cook Inlet have also been intensely investigated, in part because of an unusual mortality event in lower Cook Inlet involving a streptococcal infection associated with heart damage, encephalitis, and sepsis. The source of the highly pathogenic bacteria and the conditions that may predispose sea otters to infection were not determined (Counihan-Edgar et al. 2012).

3. Trauma

Trauma was the cause of death in three (9%) of the cases that formed the basis of the mortality review in Cook Inlet (Burek-Huntington et al. *in press*); two cases involved killer whale interactions and one was blunt trauma from an unknown source. Two lactating females were found dead with rake marks consistent with killer whale attacks, following an observed interaction between killer whales and a large group of belugas on 23-26 of September 2000 (Vos et al. 2005). Only one of these lactating females was necropsied and included in the mortality review. Another adult female found in 2007 had extensive blunt trauma, and the final trauma case was coded based on tissues collected in September 2008 from the site of a witnessed killer whale attack on a beluga. Net entanglements or propeller injuries were not confirmed in nonspecific trauma cases, which may have been due to the poor carcass conditions. Photo-identification studies have documented several live CI belugas with scars consistent with propeller injuries and rake marks (LGL 2009). Shelden et al. (2003) estimated killer whales kill an average of one beluga/year, although this could be an underestimate. Additional information about killer whale interactions is included in Sections II.D.1.and III.A.7. Of the 6% of SLE deaths attributed to trauma, the majority were due to boat strike (S. Lair, pers. comm. to C. Goertz). One beluga from an aquarium was euthanized due to complications associated with a mandibular infection secondary to a traumatic injury (L. Dunn, pers. comm. to C. Goertz).

4. Nutritional Stress

Six belugas from Cook Inlet included in the mortality review were in poor body condition; namely, they were so thin that poor nutrition was considered either the cause of, or a contributing factor to, death (Burek-Huntington et al. *in press*). One of the contributory cases involved a fetus with no measurable blubber layer, implying poor nutritional status of the mother. Causes of poor nutrition could be due to lack of appropriate prey, inability to obtain prey due to debilitation from secondary injury or infection, or a disease process itself. Most of these animals were young; only one was a mature whale. This category was not used in assigning cause of death in the SLE data that were provided, however primary starvation is being considered as a cause of death in some cases currently assigned to the ‘other’ category (S. Lair, pers. comm. to C. Goertz).

5. Degenerative Conditions

Cardiomyopathy, or heart damage, was noted but not considered a cause of, or contribution to, death in three older CI belugas and may have been age related. Ruptured vessels have been diagnosed in a captive animal with an aortic rupture (Bowenkamp et al. 2001) and in three SLE adult males with pulmonary trunk aneurysms (Martineau et al. 1986). Central nervous system abnormalities, namely encephalomalacia (softening of the brain) and encephalopathy (brain degeneration) of unknown cause, have been diagnosed in captive animals (L. Dunn, pers. comm. to C. Goertz). Due to the difficulties involved in opening a beluga skull in the field, it is rare that the brain of CI beluga is examined.

6. Miscellaneous

Ice entrapment: While reported in other cetaceans and other populations of belugas (Armstrong 1985, Heide-Jørgensen et al. 2002), there have not been reports of ice entrapment of CI belugas nor of mortalities that may have been due to such an event. Given the environmental conditions during the winter and decreased human presence in the inlet, such an event may go unnoticed.

Cancer: Cancer is a major cause of mortality in SLE beluga (15%) and may relate to their heavy contaminant loads (Martineau et al. 2002). Cancers have also been observed in captive belugas (Ridgway et al. 2002) and accounted for 5% of the deaths in oceanaria (L. Dunn, pers. comm. to C. Goertz). There have been no reports of cancer in CI belugas.

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H. The Recovery Team's Demographic Recovery Criteria and Primer Text

NOTE TO READER: *The text below was developed by the Cook Inlet Beluga Whale Recovery Team (CIBRT) as a primer to the demographic criteria the CIBRT presented to NMFS. The CIBRT's suggested demographic recovery criteria are also reproduced (see below section 3. CIBRT's Demographic Recovery Criteria for the Cook Inlet Beluga Population). As indicated in the Recovery Criteria section of this document (Section V.C), NMFS determined that biologically-based demographic recovery criteria, to include both a minimum population size and a sustained positive growth trend, would be less influenced by uncertainty of parameters and data used in a population viability analysis (PVA) model, and hence, is recommending the demographic criteria defined in the Recovery Criteria section. However, we have preserved this text to present the demographic criteria as provided by the CIBRT for comparison.*

1. Standard Recovery Criteria

Objectives of the ESA are to prevent the extinction of species and to conserve the endangered species for the future. If the results of conservation and protection measures sufficiently reduce the danger of extinction for an endangered or threatened species, it may be determined that some level of recovery has been achieved and the status of the species as listed under ESA may then be revised. The status of a species listed as endangered may be revised to being listed as threatened (i.e., downlisted), or a species listed as endangered or threatened may be determined to be recovered (i.e., delisted). If a species is determined to be *recovered*, then the particular protections afforded by the ESA no longer apply; however, other pertinent federal (e.g., MMPA) and state protections will still apply. A delisted species could subsequently be relisted as endangered or threatened if stock status declines. The ESA may be applied to species, subspecies, and DPS.

Recovery criteria are used to facilitate the decision to determine whether an endangered species' listed status should be revised. These criteria are intended as quantifiable characteristics of the species which, if met, indicate a sufficiently reduced risk of extinction such that downlisting or delisting should be considered. The NMFS requires that recovery criteria: (1) be objective and measureable; (2) address threats as well as demographic factors; and (3) for those criteria addressing threats, be written in terms of the five listing factors described in the ESA listing determination of the species, with objectives related to each factor included as part of the recovery criteria. Recovery criteria are required components of recovery plans.

Recovery criteria have often been stated as concrete demographic parameters, such as numbers of subpopulations, numbers of individuals, population growth rates, birth rates, and survival rates. However, it is desirable that these concrete, case-specific rules are based on a common and consistent standard (Tear et al. 1993; Easter-Pilcher 1996; Goodman 2003).

As part of the process for determining the recovery criteria for CI belugas, the CIBRT Science Panel considered some of the available look-up tables that have been used to determine concrete recovery criteria for other endangered species (IUCN 1994; Musick 1999). The difficulty with these table-based systems was that their guidance was in fact qualitative and subjective, and failed to capture the specific biological or ecological features of CI belugas. In addition, many of the parameters commonly used in look-up tables (e.g., effective population size[39], population growth rates, birth rates, and survival rates) are currently unknown for CI belugas.

Recognizing that the concrete recovery criteria derived from look-up tables have been inherently case and taxon specific, the CIBRT Science Panel preferred to use context-dependent "indicators" that meet a more general standard (Goodman 2003). Because the intent of the ESA is to control and minimize the risk of extinction, the CIBRT Science Panel preferred to base recovery criteria for CI beluga whales on a fundamental standard of a critical probability of extinction over some period of time. This approach has been discussed extensively in the literature (reviewed by Goodman 2002a, 2002b), and had been recommended by participants in a NMFS-convened workshop that attempted to standardize recovery criteria using large whales (e.g., humpback and sperm whales *[Physeter macrocephalus]*) as a case study (Angliss et al. 2002), but is applicable to other species.

Within the context of the large whale case study, the NMFS workshop recommended explicit numerical values for implementation of the general recovery criteria: that "*endangered*" means greater than 1% probability of extinction in 100 years, and "*threatened"* means greater than 10% probability of becoming endangered within 10 to 25 years (20 years was recommended as a general guideline, with the actual time frame depending on species-specific considerations such as longevity and age of maturity). The workshop report explains the logic of these extinction probability based recovery criteria in terms of their generality and consistency with the common-sense goal of the ESA. The workshop report explains the choice of the numerical values in the criterion for "*endangered*" as a policy judgment that seemed reasonable to the participants and was consistent with their collective experience about the tolerance of managers for uncertainty and for the possibility that continued decline in the population's actual status will require emergency interventions (which might still fail). The workshop report further explains that the choice of the numerical values in the criterion for "*threatened*" was a practical judgment concerning both the uncertainty of a marine mammal population's circumstances and the time frame necessary for the management process to respond. Although these criteria were developed for large whale populations, the CIBRT Science Panel determined that the key characteristics of the CI beluga whales (longevity, late age at maturity, and low birth rates) were similar to those of large whales and, therefore, similar recovery criteria should be applied. Consequently, this probability-based standard is adopted in this recovery plan to define recovery criteria for the CI beluga.

The general standard is related to other management standards under ESA, such as the definition of “jeopardy.” Under the ESA, jeopardy occurs when a proposed federal action is determined to “reasonably be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species” (50 CFR 402.2). A finding of jeopardy requires revision of the proposed federal action through “reasonable and prudent alternatives” that reduce the population risk below the jeopardy level.

[39] The number of breeding individuals in an idealized population.

2. The Connection Between Standard and Concrete Recovery Criteria

In light of these general (that is, extinction probability based) standards for "*endangered*" and "*threatened*," the justification for any particular concrete recovery criterion (for example, achieving a target effective population size) must demonstrate that the chosen biological/ecological indicators for the CI belugas have met the general standard for extinction probability. In other words, the justification for selected biological indicators would be to describe conditions that result in a less than 1% probability of extinction within 100 years.

A general, probability-based approach for ESA recovery criteria requires a method for relating the concrete criteria to the risk of extinction. The CIBRT Science Panel determined that a PVA model was the best available scientific approach for assessing extinction probability for CI beluga whales. A PVA incorporates a mathematical model of the population and knowledge of particular ecological mechanisms operating on this population into a statistical framework that relates the state of the population to the probability of extinction. A PVA can be used to help identify factors directly contributing to extinction risk, to quantify the effects of these factors on extinction probability, and to relate these factors to specific indicators. Although PVA is a relatively recent scientific development, there is a rapidly growing literature on its theory, implementation, and use (MMC 2007).

Our knowledge about factors affecting recovery for CI belugas is limited. In the absence of detailed or extensive information, we are faced with a problem of connecting a PVA for this population to discrete and well-defined indicators of the population's condition. However, a direct specification of concrete recovery criteria (e.g., recovery defined as numbers of individuals or population growth rates) by other means will be even more difficult to justify when ecological information is lacking. The strongest argument for using PVA as the "best science" in ESA applications is that a properly constructed PVA model provides a framework for integrating all available knowledge about the population, as well as a means to quantify both the levels and uncertainty of the model's predictive power (Goodman 2002b).

The problem of insufficient ecological knowledge about the CI beluga population and the possible problem of low predictive power of a particular PVA are both manifestations of *uncertainty*. Bayesian statistical methods are useful in this context because they give a probabilistic representation of uncertainty, and have been used in this way for classification of population status (Taylor et al. 1996). The use of Bayesian statistics allows for a quantifiable response to uncertainty as a form of risk-averse environmental decision-making, allowing for a precautionary principle[40] to establish margins of safety. The proposed recovery criterion of less than 1% probability of extinction in 100 years explicitly includes a safety margin.

For use as a PVA, a population model must represent uncertain components probabilistically. This applies both to process uncertainty and parameter uncertainty (Goodman 2002a). Process uncertainty represents "sampling" of future potential events, such as climate variation or epidemiological catastrophes. A PVA model incorporates process uncertainty through random

[40] The precept that "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" (The Wingspread Statement; Raffensperger and Tickner 1999).

processes, which are sampled repeatedly to determine how the results may vary. Parameter uncertainty, indicating our imperfect knowledge about rates of population processes such as survival and reproduction, is quantified from available data when estimating these parameters.

An example of the importance of parameter uncertainty in a PVA model can be seen with density dependence, an aspect of population dynamics that can be important for long-term population survival (Quinn and Deriso 1999). Density dependence is an expression of change in the population's mean growth rate as a function of the population size. Generally, as a population becomes more crowded, the population growth rate is expected to decrease, keeping the population within bounds of its environmental resources. At low population density, the growth rate is expected to be higher, allowing the population to recover from low numbers unless another cause is interfering. But at very low population size, other factors can depress the population growth rate and increase growth variability, increasing the risk of further decline and possibly of extinction. Because parameters governing density dependence in a real population may be difficult to resolve from available data, parameter uncertainty about density dependence must be estimated through PVA analyses or sensitivity analyses.

Our current knowledge of CI belugas is limited with respect to understanding carrying capacity[41], and how carrying capacity may change in response to environmental conditions or community shifts owing to climate change, oceanographic regime change, or human interventions such as habitat alterations. A PVA prediction of the probability of extinction within 100 years requires a model that formally treats the uncertainty about density-dependent processes that are influential on that time scale.

Some PVA models have already been applied in the regulatory history of the CI beluga population, both under the MMPA (harvest regulation) and the ESA (listing decision and status assessments). These uses of PVA attempted to incorporate the best modeling practice and the relevant data available at the time, and the conclusions were convincing. Because techniques and standards for PVA modeling are continuing to evolve, the PVA model used for recovery criteria should be adaptable to future changes in data availability and, perhaps, management goals. For example, if monitoring surveys of the CI beluga population continue, the PVA model will be better informed about population trends and summer distribution. If the research recommended as recovery actions in this recovery plan is carried out, more information will also become available for future PVA modeling of this population. Because a future PVA will incorporate the best science available at that time, specific model configuration and data inputs used for making future decisions about changes in listing status for CI belugas will likely differ somewhat from the present PVA structure.

The failure of the CI beluga population to grow following cessation of the subsistence harvest suggests that some factor ("*threat"*), or combination of factors, is inhibiting reproduction and/or survival. Until the responsible factor(s) have been identified and the influence on the population is quantified, all plausible alternative hypotheses remain part of the overall uncertainty to be encompassed by the PVA model, and all feasible threats are examined as model variables. When the causes of lack of recovery are better understood and some are eliminated,

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[35] The maximum, equilibrium population of a particular species that can be supported indefinitely under given environmental and ecological conditions.

they can be modeled explicitly or removed from the model and the uncertainty addressed within the PVA will diminish accordingly. In other words, the model can help direct the search for causative factors, and as causes are better known, the model can be refined.

3. CIBRT's Demographic Recovery Criteria for the Cook Inlet Beluga Population

Downlisting:

1. Given the prevailing and projected threats and environmental conditions, the population has less than a 1% probability of extinction in 100 years (Angliss et al. 2002). The probability of extinction will be determined by a scientifically rigorous PVA model that incorporated parameter and process uncertainty, and includes summer range as a variable.

2. The threats have been investigated scientifically and are dismissed, resolved, controlled, or mitigated to a level that the PVA model predicts is compatible with the extinction risk criterion.

Delisting:

1. Given the prevailing and projected threats and environmental conditions, the population has less than a 10% probability of becoming endangered in 20 years (Angliss et al. 2002). The probability of endangerment will be determined by a scientifically rigorous PVA model that incorporates parameter and process uncertainty, and includes summer range as a variable.

2. The threats have been investigated scientifically and are dismissed, resolved, controlled, or mitigated to a level that the PVA model predicts is compatible with the extinction risk criterion.

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I. Common and Scientific Names of Species

The following is a list of common and scientific names of species identified in this recovery plan.

Common Name	Scientific Name
Amphipod	Crustaceans, Order Amphipoda
Beluga whale	*Delphinapterus leucas*
Blue whale	*Balaenoptera musculus*
Bottlenose dolphin	*Tursiops truncatus*
Budgerigar	*Melopsittacus undulates*
Butter sole	*Isopsetta isolepis*
California sea lion	*Zalophus californianus*
Capelin	*Mallotus villosus*
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Clams	Animals of the class Bivalvia
Coho salmon	*Oncorhynchus kisutch*
Cuvier's beaked whale	*Ziphius cavirostris*
Dall’s porpoise	*Phocoenoides dalli*
Eulachon	*Thaleichthys pacificus*
Flathead sole	*Hippoglossoides elassodon*
Gray whale	*Eschrichtius robustus*
Grayling	*Thymallus thymallus*
Great white shark	*Carcharodon carcharias*
Greenland shark	*Somniosus microcephalus*
Harbor porpoise	*Phocoena phocoena*
Harbor seal	*Phoca vitulina*
Hermit crab	Crabs, superfamily Paguroidea
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Longfin smelt	*Spirinchus thaleichthys*
Minke whale	*Balaenoptera acutorostrata*
Narwhal	*Monodon monoceros*
Nightingale	*Luscinia megarhynchos*
Northern pike	*Esox lucius*

Common Name	Scientific Name
Northern shrimp	*Pandalus borealis*
Pacific cod	*Gadus macrocephalus*
Pacific halibut	*Hippoglossus stenolepis*
Pacific herring	*Clupea pallasi*
Pacific sandfish	*Trichodon trichodon*
Pacific sandlance	*Ammodytes hexapterus*
Pacific sleeper shark	*Somnoisus pacificus*
Pacific staghorn sculpin	*Leptocottus armatus*
Pacific tomcod	*Microgadus proximus*
Pink salmon	*Oncorhynchus gorbuscha*
Polar bear	*Ursus maritimus*
Red king crab	*Paralithodes camtschatica*
Right whale	*Eubalaena glacialis and E. borealis*
Saffron cod	*Eleginus gracilis*
Salmon shark	*Lamna ditropis*
Sea otter	*Enhydra lutris*
Snake prickleback	*Lumpenus sagitta*
Sockeye salmon	*Oncorhynchus nerka*
Sperm whale	*Physeter macrocephalus*
Spiny dogfish	*Squalus suckleyi*
Sponges	*Animals of the phylum Porifera*
Starry flounder	*Platichthys stellatus*
Steller sea lion	*Eumetopias jubatus*
Tanner crab	*Chionoecetes bairdi*
Trout	*Freshwater fish, subfamily Salmoninae*
Walleye pollock	*Theragra chalcogramma*
Weathervane scallops	*Patinopecten caurinus*
Whitefish	*Freshwater fish, subfamily Coregoninae*
Yellowfin sole	*Limanda aspera*