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BELUGA WHALE (*Delphinapterus leucas*): Cook Inlet Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). In Alaska, depending on season and region, beluga whales may occur in both offshore and coastal waters, with genetically distinct summer concentrations in upper Cook Inlet, Bristol Bay, and the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea (Hazard 1988, O'Corry-Crowe et al. 2018) (Fig. 1). Data from satellite transmitters attached to whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show month to month ranges that include summering areas and autumn migratory routes that are relatively distinct for each population (e.g., Hauser et al. 2014, Citta et al. 2017). Tag data for beluga whales found in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a, 2018) show tagged whales remained in those areas throughout the year.

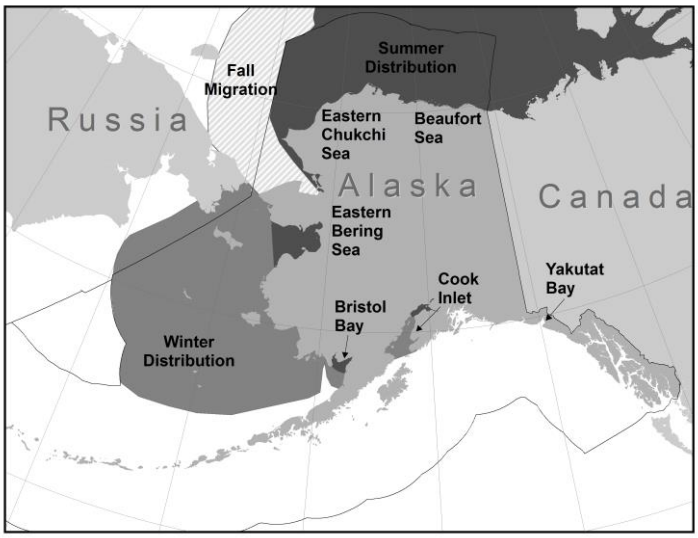

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration. The U.S. Exclusive Economic Zone is delineated by the solid black line.

Beluga whale stock structure was based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous (Frost and Lowry 1990); 2) Population response data: possible extirpation of local populations, distinct population trends among regions occupied in summer (O'Corry-Crowe et al. 2018); 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among populations in summering areas (O'Corry-Crowe et al. 2002). Based on this information, five beluga whale stocks are recognized within U.S. waters (Fig. 1): 1) Cook Inlet, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea.

During ice-free months, Cook Inlet beluga whales are often concentrated near river mouths (Shelden et al. 2015a). The fall-winter-spring distribution of this stock is not fully determined; however, there is evidence that most whales in this population inhabit upper Cook Inlet year-round (Lammers et al. 2013, Castellote et al. 2015, Shelden et al. 2015a). From 1999 to 2002, satellite tags were attached to a total of 18 Cook Inlet beluga whales to determine their movement patterns (Goetz et al. 2012a; Shelden et al. 2015a, 2018). All tagged beluga whales remained in Cook Inlet, primarily in the upper inlet north of the East and West Forelands, with brief trips to the lower inlet (Shelden et al. 2015a, 2018).

A review of all marine mammal surveys and anecdotal sightings in the northern Gulf of Alaska between 1936 and 2000 found only 28 beluga whale sightings, indicating that very few beluga whales occurred in the Gulf of Alaska outside Cook Inlet (Laidre et al. 2000). Yakutat Bay is the only area in the Gulf of Alaska outside of Cook Inlet where multiple sightings have occurred (Laidre et al. 2000, Lucey et al. 2015, O'Corry-Crowe et al. 2015). Based on genetic analyses, traditional ecological knowledge (TEK), and observations by fishermen and others, the Yakutat beluga whales likely represent a small, resident group (fewer than 20 whales) that has been observed year round and is reproductively separated from Cook Inlet (Lucey et al. 2015, O'Corry-Crowe et al. 2015). Furthermore, this group in Yakutat appears to be showing signs of inbreeding and low diversity due to their isolation and small numbers (O'Corry-Crowe et al. 2015). Although the beluga whales in Yakutat Bay are not included in the Cook Inlet Distinct Population Segment (DPS) of beluga whales under the Endangered Species Act (ESA), they are

considered part of the depleted Cook Inlet stock under the Marine Mammal Protection Act (MMPA) (50 CFR 216.15; 75 FR 12498, 16 March 2010) because insufficient information was available to identify Yakutat beluga whales as a separate population when Cook Inlet beluga whales were designated as depleted under the MMPA. Thus, Yakutat Bay beluga whales remain part of the Cook Inlet stock, are designated as depleted, and are provided the same protections as the Cook Inlet stock, including limitations on hunting.

POPULATION SIZE

Aerial surveys during June documented the distribution and abundance of Cook Inlet beluga whales and were conducted by NMFS each year from 1994 to 2012 (Rugh et al. 2000, 2005; Shelden et al. 2013), after which NMFS began biennial surveys in 2014 (Shelden et al. 2015b) (Fig. 2). NMFS changed to a biennial survey schedule after analysis showed there would be little reduction in the ability to detect a trend given the current growth rate of the population (Hobbs 2013).

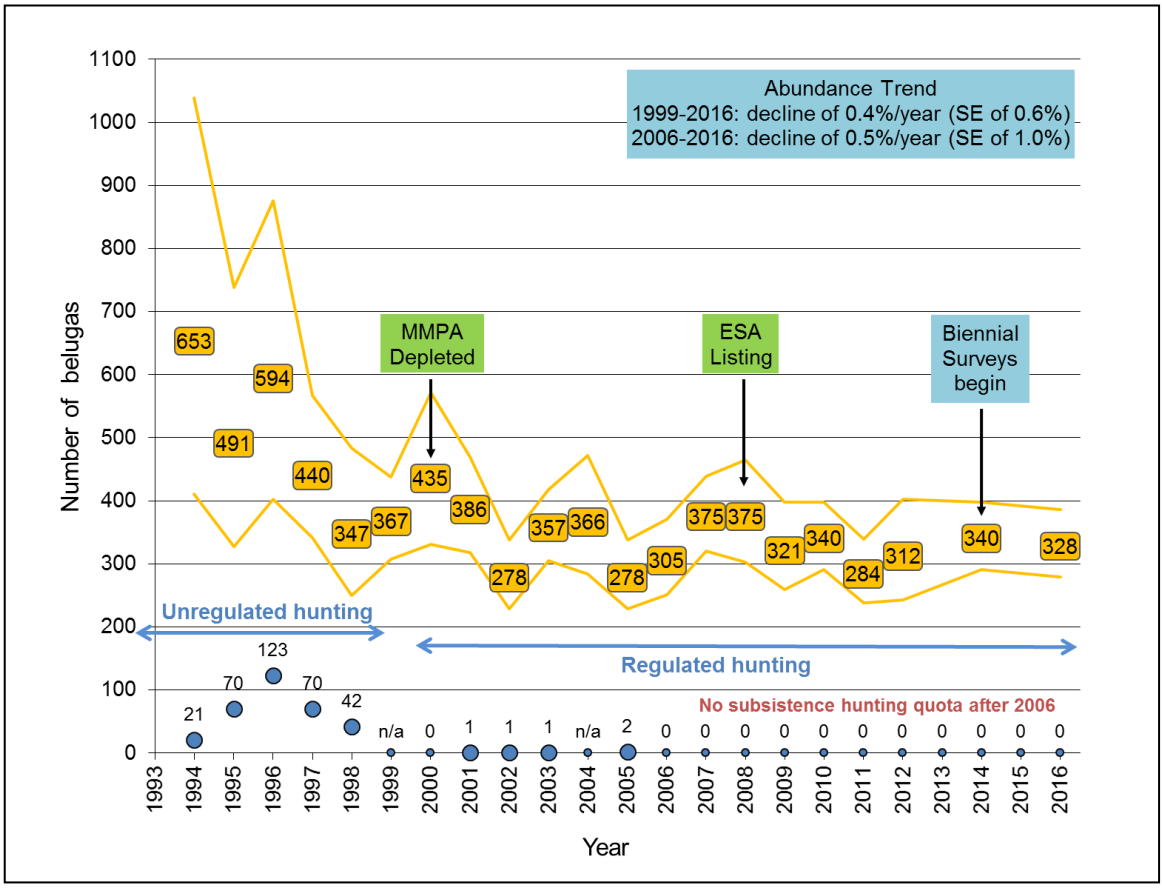

Figure 2. Annual abundance estimates of beluga whales in Cook Inlet, Alaska, 1994-2016 (Hobbs et al. 2015a, Shelden et al. 2017). Circles show reported removals (landed plus struck and lost) during the Alaska Native subsistence hunt. A struck and lost average was calculated by the Cook Inlet Marine Mammal Council (CIMMC) and hunters for 1996, 1997, and 1998. Lines above and below each abundance estimate (number shown in box) depict the upper and lower confidence limit.

The abundance estimate for Cook Inlet beluga whales is based on counts by aerial observers and video analysis of whale groups. Paired, independent observers count each whale group while video is collected during each counting pass. Each count is corrected for subsurface animals (availability correction) and animals at the surface that were missed (sightability correction) based on an analysis of the video tapes (Hobbs et al. 2000). When video counts are not available, observers' counts are corrected for availability and sightability using a regression of counts and an interaction term with an encounter rate against the video count estimates (Hobbs et al. 2000). The estimate of the abundance equation variance was revised using the squared standard error of the average for the abundance estimates in place of the abundance estimate variance and the measurement error (Hobbs et al. 2015a). This reduced all coefficients of variation (CVs) by almost half (Hobbs et al. 2015a). The June 2016 survey resulted in an abundance estimate of 328 whales (CV = 0.08) (Shelden et al. 2017). Annual abundance estimates based on aerial surveys of Cook Inlet beluga whales during the most recent 3-survey period were 312 (2012), 340 (2014), and 328 (2016) resulting in an average abundance estimate for this stock of 327 beluga whales (CV = 0.06). An abundance survey was conducted in June 2018 and results are undergoing analysis.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997). Thus, $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 3-survey average population estimate (N) of 327 whales and an associated CV(N) of 0.06, N_{MIN} for the Cook Inlet beluga whale stock is 311 beluga whales.

Current Population Trend

The corrected annual abundance estimates for 1994-2016 are shown in Figure 2. From 1999 to 2016, the rate of decline was 0.4% (SE = 0.6%) per year, with a 73% probability that the growth rate is negative, while the 10-year trend (2006-2016) is -0.5% per year (with a 70% probability the population is declining) (Shelden et al. 2017).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Cook Inlet beluga whale stock. Until additional data become available, the cetacean maximum theoretical net productivity rate of 4% will be used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.1, the value for cetacean stocks that are listed as endangered (Wade and Angliss 1997). Using the N_{MIN} of 311 beluga whales, the calculated PBR for this stock is 0.62 beluga whales (311 × 0.02 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2012-2016 is listed, by marine mammal stock, in Helker et al. (in press); however, only the mortality and serious injury data are included in the Stock Assessment Reports. No human-caused mortality or serious injury of Cook Inlet beluga whales was documented in 2012-2016. There are no observers in Cook Inlet fisheries, so the mean annual mortality and serious injury in commercial fisheries is unknown; although, it is likely low given that an observer program conducted in Cook Inlet in 1999-2000 did not observe mortality or serious injury of beluga whales (Manly 2006). Other potential threats most likely to result in direct human-caused mortality or serious injury of this stock include ship strikes.

Fisheries Information

Information (including observer programs, observer coverage, and observed incidental takes of marine mammals) for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is presented in Appendices 3-6 of the Alaska Stock Assessment Reports.

The estimated minimum average annual mortality and serious injury rate incidental to U.S. commercial fisheries is unknown, although probably low, given that an observer program directed at the Cook Inlet commercial set and drift gillnet fisheries in 1999-2000 did not observe mortality or serious injury of beluga whales (Manly 2006).

One entanglement in a subsistence fishery was reported to the NMFS Alaska Region on 7 May 2012; a fisherman reported a juvenile beluga whale entangled and dead in a salmon set net near Kenai, Alaska. The beluga

whale was necropsied and the results indicated it was in poor health and the cause of death was drowning. However, it was not determined whether the beluga whale died before or after the net entanglement.

Alaska Native Subsistence/Harvest Information

Subsistence harvest of Cook Inlet beluga whales is important to the Native Village of Tyonek and the Alaska Native subsistence hunter community in Anchorage. Between 1993 and 1998, the annual subsistence take ranged from 17 to more than 123 beluga whales (Fig. 2), including struck and lost whales (NMFS 2016).

Following a significant decline in Cook Inlet beluga whale abundance estimates between 1994 and 1998, the Cook Inlet hunters voluntarily stood down in 1999 and the Federal government took actions to conserve, protect, and prevent further declines in the abundance of these whales. Public Laws 106-31 (1999) and 106-553 (2000) established a moratorium on Cook Inlet beluga whale harvests unless such taking occurs pursuant to a cooperative agreement between NMFS and affected Alaska Native organizations. A cooperative agreement, also referred to as a co-management agreement, was not signed in 1999 and 2004. In December 2000, an administrative hearing was held to create interim harvest regulations for 2001 through 2004 (69 FR 17973, 6 April 2004). Three Cook Inlet beluga whales were harvested under this interim harvest plan (2001-2004). In August 2004, an administrative hearing was held to create a long-term harvest plan, which allowed up to eight whales to be harvested between 2005 and 2009 (NMFS 2008). Two whales were harvested in 2005 and whales were not successfully hunted in 2006. The long-term harvest plan was signed in 2008 and established a harvest level for a 5-year period, based on the average abundance in the previous 5-year period and the growth rate during the previous 10-year period (NMFS 2008). A harvest is not allowed if the previous 5-year average abundance is less than 350 beluga whales. Under the long-term harvest plan, the 5-year average abundance during the first review period (2003-2007) was 336 whales and, therefore, a harvest was not allowed during the subsequent 5-year period (2008-2012) (73 FR 60976, 15 October 2008). The average abundance of Cook Inlet beluga whales remained below 350 whales during the second review period (2008-2012); therefore, a harvest was not allowed for the current 5-year period (2013-2017). NMFS changed to a biennial survey schedule after 2012, therefore, the 5-year average abundance is now based on either two or three surveys in a 5-year period. Hobbs (2013) showed that biennial rather than annual surveys may lead to higher variation in harvests, but it is not expected to change the probability of recovery while using the algorithm that determines the allowable harvest level.

Other Mortality

Reports from the NMFS Alaska Region stranding network are another source of information on beluga whale mortality. Beluga whale carcasses are found along the shore from lower Cook Inlet to Knik and Turnagain Arms.

Mortality related to live stranding events, where a beluga whale group strands as the tide recedes, has been regularly observed in upper Cook Inlet (Table 1). Improved reports include the number of live stranded beluga whales, as well as floating and beachcast carcasses (NMFS 2016; https://alaskafisheries.noaa.gov/sites/default/files/16strandings.pdf, accessed December 2018). Most whales involved in a live stranding event survive, although some associated deaths may not be observed if the whales die later from live-stranding-related injuries (Vos and Shelden 2005, Burek-Huntington et al. 2015). Between 2012 and 2016, there were approximately 116 beluga whales involved in six known live stranding events, with two associated deaths reported (Table 1; NMFS 2016). In 2014, necropsy results from two whales found in Turnagain Arm suggested that a live stranding event contributed to their deaths as both had aspirated mud and water. No live stranding events were reported prior to the discovery of these dead whales, suggesting that not all live stranding events are observed (Table 1). Most live strandings occur in Knik Arm and Turnagain Arm, which are shallow and have extensive mudflats and strong currents. Turnagain Arm has the largest tidal range in the U.S., with a mean of 9.2 m (30 ft).

Table 1. Cook Inlet beluga whale strandings investigated by NMFS during 2012-2016 (NMFS 2016).

Year	Floating and beachcast carcasses	Number of beluga whales per live stranding event (number of associated known or suspected resulting deaths)
2012	3	12 (0), 23 (0), 3 (0)
2013	5	0
2014	10	unknown (2), 76+ (0)
2015	3	2 (0)
2016	8	0
Total	29	116+ (2)

Another source of beluga whale mortality in Cook Inlet is predation by transient-type (mammal-eating) killer whales. Killer whale sightings were not well documented and were likely rare in the upper inlet prior to the mid-1980s. From 1982 through 2016, NMFS received 31 reports of killer whale sightings in upper Cook Inlet (north of the East and West Forelands). Up to 12 beluga whale deaths, inlet-wide, were suspected to be a direct result of killer whale predation (NMFS 2016). The last confirmed killer whale predation of a Cook Inlet beluga whale occurred in 2008 in Turnagain Arm. From 2012 through 2016, NMFS received two separate killer whale sighting reports (both in 2015) in upper Cook Inlet, but there were no reports of predation attempts. Transient killer whale signals have been detected on acoustic moorings in upper Cook Inlet (Castellote et al. 2016a), but only once in a 5-year period (Castellote et al. 2016b).

Between 1998 and 2013, 38 necropsies were performed on beluga whale carcasses (23% of the 164 known stranded carcasses) (Burek-Huntington et al. 2015). The sample included adults (n = 25), juveniles (n = 6), calves (n = 3), and aborted fetuses (n = 4). When possible, a primary cause of death was noted along with contributing factors. Cause of death was unknown for 29% of the necropsied carcasses. Other causes of death were attributed to various types of trauma (18%), perinatal mortality (13%), mass stranding (13%), single stranding (11%), malnutrition (8%), or disease (8%). Several animals had mild to moderate pneumonia, kidney disease, and/or stomach ulcers that likely contributed to their deaths.

A photo-identification study (Kaplan et al. 2009) did not find any instances where Cook Inlet beluga whales appeared to have been entangled in, or to have otherwise interacted with, fishing gear. However, in 2010, a beluga whale with a rope entangled around its girth was observed and photo-documented during May through August. The same whale was photographed in July and August 2011, August 2012, and July 2013, still entangled in the rope line (McGuire et al. 2014). This whale is currently considered to have a non-serious injury (Helker et al. in press).

STATUS OF STOCK

The Cook Inlet beluga whale stock was designated as depleted under the MMPA in 2000 (65 FR 34590, 21 May 2000) and listed as endangered under the ESA in 2008 (73 FR 62919, 22 October 2008). Therefore, the Cook Inlet beluga whale stock is considered a strategic stock.

There are key uncertainties in the assessment of the Cook Inlet stock of beluga whales. The stock decline is well documented. While the early decline was likely due to unrestricted subsistence hunting, it is unknown what has prevented recovery of this stock, because subsistence harvest has not been allowed since 2006, and the mortality and serious injury in commercial fisheries is likely low. PBR is designed to allow stocks to recover to, or remain above, the maximum net productivity level (Wade 1998). An underlying assumption in the application of the PBR equation is that marine mammal stocks exhibit certain dynamics. Specifically, it is assumed that a depleted stock will naturally grow toward Optimum Sustainable Population and that some surplus growth could be removed while still allowing recovery. However, the Cook Inlet beluga whale population is far below historical levels and yet, for unknown reasons, is not increasing. If the Cook Inlet beluga whale population was increasing at an expected rate of ~2-4%, it would currently be adding, on average, about 7-13 whales per year to the population. Although there is currently no known direct human-caused mortality (e.g., from fisheries bycatch, hunting, or other sources), even if the PBR level (~1 whale every 2 years) was taken, it is clear this would have little consequence for the overall population trend given the unexplained lack of increase by 7-13 whales per year. However, given the endangered status of this population, even one take every 2 years may still impede recovery.

HABITAT CONCERNS

Beluga whale critical habitat includes two geographic areas of marine habitat in Cook Inlet that comprise 7,800 km^2 (3,013 mi^2), excluding waters of the Port of Anchorage (76 FR 20180, 11 April 2011). Based on

available information from aerial surveys, tagged whales, and opportunistic sightings, beluga whales remain within the inlet year-round. Review of beluga whale presence data from aerial surveys, satellite tagging, and opportunistic sightings collected in Cook Inlet from the late 1970s to 2014 show their range has contracted remarkably since the 1970s (Shelden et al. 2015a). Almost the entire population is found in northern Cook Inlet from late spring through the summer and into the fall. This differs markedly from surveys in the 1970s when beluga whales were found in, or would disperse to, lower Cook Inlet by midsummer. Since 2008, on average, 83% of the total population occupied the Susitna Delta in early June during the aerial survey period, compared to roughly 50% in the past (1978-1979, 1993-1997, 1998-2008). The 2009-2014 distribution was estimated to be only 25% of the range observed in 1978-1979 (Shelden et al. 2015a). Rugh et al. (2000) first noted that whales had not dispersed to the lower inlet in July during surveys in the mid-1990s. This was also evident during aerial surveys conducted in July 2001 (Rugh et al. 2004). Whales transmitting locations from satellite tags during July in 1999 and 2002 also remained in the northern reaches of the upper inlet (Shelden et al. 2015a). During surveys in the 1970s, large numbers of whales were scattered throughout the lower inlet in August (Shelden et al. 2015a). This was not the case in 2001, when counts in the upper inlet in August were similar to those reported in June and July (Rugh et al. 2004). In August, only 2 of 10 tagged whales spent time in offshore waters and the lower inlet (Shelden et al. 2015a). The number of whales observed during the August calf index surveys, conducted from 2005 to 2012, was similar to the June surveys (Hobbs et al. 2015a, Shelden et al. 2015a), suggesting the contraction in range continued into late summer. While surveys were not conducted in September during the 1970s and 1980s, aerial surveys in 1993 showed some dispersal into lower inlet waters by late September (Shelden et al. 2015a). However, surveys in September and October of 2001 resulted in counts that were similar to June (Rugh et al. 2004). With the exception of three whales that spent brief periods of time in the lower inlet during September and/or October, most whales transmitting locations in 1999, 2000, 2001, and 2002 remained in the upper inlet north of the East and West Forelands (Shelden et al. 2015a). Counts during aerial surveys in September 2008 were also similar to June (Shelden et al. 2015a). The population appears to be consolidated into habitat in the upper-most reaches of Cook Inlet for much longer periods of time, in habitat that is most likely to be noisy (e.g., Moore et al. 2000, Lowry et al. 2006, Hobbs et al. 2015b, Kendall and Cornick 2015, Norman et al. 2015). Whether this contracted distribution is a result of changing habitat (Moore et al. 2000), prey concentration, or predator avoidance (Shelden et al. 2003) or can simply be explained as the contraction of a reduced population into small areas of preferred habitat (Goetz et al. 2007, 2012b) is unknown.

Goetz et al. (2012b) modeled habitat preferences using NMFS' 1994-2008 June abundance survey data. In large areas, such as the Susitna Delta (Beluga to Little Susitna rivers) and Knik Arm, there was a high probability that beluga whales were in larger group sizes. Beluga whale presence also increased closer to rivers with Chinook salmon (*Oncorhynchus tshawytscha*) runs, such as the Susitna River. The Susitna Delta also supports two major spawning migrations of a small, schooling eulachon (*Thaleichthys pacificus*) in May and June (Goetz et al. 2012b). Identified in the Cook Inlet Beluga Recovery Plan (NMFS 2016) are potential threats of 1) high concern: catastrophic events (e.g., natural disasters, spills, mass strandings), cumulative effects of multiple stressors, and noise; 2) medium concern: disease agents (e.g., pathogens, parasites, and harmful algal blooms), habitat loss or degradation, reduction in prey, and unauthorized take; and 3) low concern: pollution, predation, and subsistence hunting. The recovery plan did not treat climate change as a distinct threat but rather as a consideration in the threats of high and medium concern.

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