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 summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea (Mackenzie River Delta) (Hazard 1988, O'Corry-Crowe et al. 1997) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). Data from satellite transmitters attached to a few whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show ranges that are relatively distinct month to month for these populations' summering areas and autumn migratory routes (e.g., Hauser et al. 2014, Citta et al. 2017). 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) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

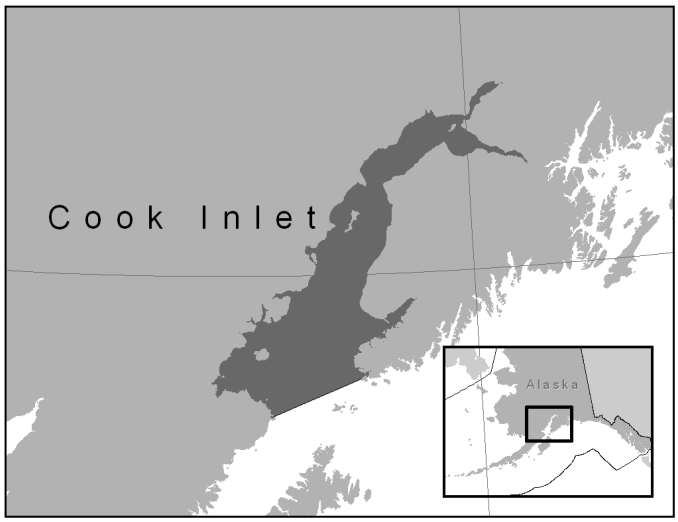

Figure 1. Approximate distribution of beluga whales in Cook Inlet.

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; 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: 1) Cook Inlet (Fig. 1), 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea.

During ice-free months, Cook Inlet beluga whales are typically concentrated near river mouths (Rugh et al. 2010). 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 (Hansen and Hubbard 1999, Rugh et al. 2004, Lammers et al. 2013, Castellote et al. 2015, Shelden et al. 2015a). During summers from 1999 to 2002, satellite tags were attached to a total of 18 beluga whales in Cook Inlet to determine their distribution through the fall and winter months (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a). Ten tags transmitted whale locations from September through November (fall) and, of those, three stopped transmitting in January (winter), three in March, and one in late May (spring) (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a). All tagged beluga whales remained in Cook Inlet, primarily in upper inlet waters (Shelden et al. 2015a).

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). A small number of beluga whales (fewer than 20 animals: Laidre et al. 2000, Lucey et al. 2015, O'Corry-Crowe et al. 2015) are regularly observed in Yakutat Bay. Based on genetic analyses, traditional ecological knowledge (TEK), and observations by fishermen and others that were reported year-round, the Yakutat beluga whales likely represent a small, resident group that 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). Thus, Yakutat Bay beluga whales remain part of the Cook Inlet stock and designated as depleted.

POPULATION SIZE

Aerial surveys during June documenting the early summer distribution and abundance of beluga whales in Cook Inlet were conducted by NMFS each year from 1993 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 detailed analysis showed that there would be little reduction in assessment quality (Hobbs 2013).

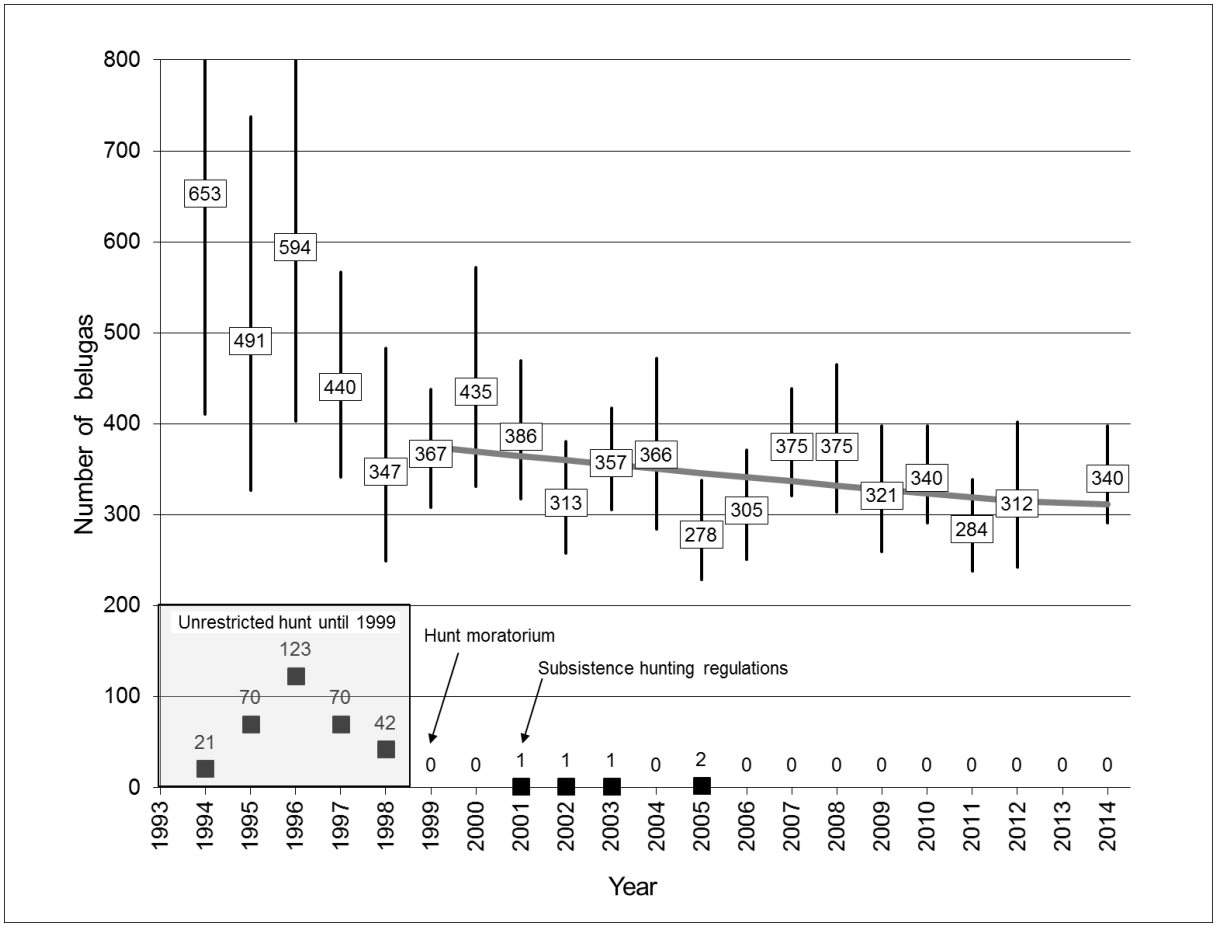

Figure 2. Annual abundance estimates of beluga whales in Cook Inlet, Alaska, 1994-2014 (Hobbs et al. 2015a, Shelden et al. 2015b). Black squares show reported removals (landed plus struck and lost) during the Alaska Native subsistence hunt. A struck and lost average was calculated by the Cook Inlet Marine Mammal Council (CIMMC) and hunters for 1996, 1997, and 1998. Black vertical bars depict plus and minus one standard error for each abundance estimate (number in box). From 1999 to 2014, the rate of decline (gray trend line) is 1.3% per year (with a 97% probability that the growth rate is declining), while the 10-year trend (2004-2014) is -0.4% per year (with a 76% probability of declining).

The abundance estimate for beluga whales in Cook Inlet 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 the coefficients of variation (CVs) by almost half. The June 2014 survey resulted in a corrected estimate of 340 whales (CV = 0.08) (Shelden et al. 2015b). This estimate is more than the estimate of 312 beluga whales for 2012; however, it falls within the statistical variation around the recent trend line and probably represents variability of the estimation process rather than an increase in the population from 2012 to 2014. Annual abundance estimates based on aerial surveys of Cook Inlet beluga whales during the most recent 3-survey period were 284 (2011), 312 (2012), and 340 (2014), resulting in an average abundance estimate for this stock of 312 beluga whales (CV = 0.10). An abundance estimate survey was conducted in June 2016 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 312 whales and an associated CV(N) of 0.10, N_{MIN} for the Cook Inlet beluga whale stock is 287 beluga whales.

Current Population Trend

The corrected annual abundance estimates for 1994-2014 are shown in Figure 2. From 1999 to 2014, the rate of decline was 1.3% (SE = 0.7%) per year, with a 97% probability that the growth rate is negative, while the 10-year trend (2004-2014) is -0.4% per year (with a 76% probability the population is declining) (Shelden et al. 2015b).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is not available for the Cook Inlet beluga whale stock. Hence, until additional data become available, the cetacean maximum theoretical net productivity rate (R_{MAX}) 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 287 beluga whales, the calculated PBR for this stock is 0.57 beluga whales ($287 \times 0.02 \times 0.1$). Given the low abundance relative to historical estimates and low known levels of human-caused mortality since 1999, it was anticipated that this stock would grow at a rate between 2% and 6%, but for unknown reasons the Cook Inlet beluga whale stock is not increasing. Because this stock does not meet the assumption that it will increase when human-caused mortality is reduced, inherent to the use of the PBR, the calculated value for PBR is likely biased and any removals from this stock will likely further prevent recovery.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); 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 2011-2015. There are no observers in fisheries in Cook Inlet, 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 and 2000 did not observe any 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 contaminants and ship strikes.

Fisheries Information

Detailed 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 set and drift gillnet fisheries in 1999-2000 did not observe any 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 in his salmon set net near Kenai, Alaska. The beluga whale was dead and necropsy findings indicated that it was in poor health prior to entanglement 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 beluga whales in Cook Inlet is important to one local village (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 did not hunt in 1999 and the Federal government took actions to conserve, protect, and prevent further declines in the abundance of these whales. In 1999 and 2000, Public Laws 106-31 and 106-553 established a moratorium on Cook Inlet beluga whale harvests except for subsistence hunts conducted under cooperative agreements between NMFS and affected Alaska Native organizations. A cooperative agreement, also referred to as a co-management agreement, was not signed in 1999, so harvest was not authorized in 1999 and 2000. Harvests from 2001 through 2004 were conducted under harvest regulations (69 FR 17973, 6 April 2004) following an interim harvest management plan developed through an administrative hearing. Three beluga whales were harvested in Cook Inlet under this interim harvest plan. In August 2004, an administrative hearing was held to create a long-term harvest plan. An interim plan would have allowed up to eight whales to be harvested between 2005 and 2009 (https://alaskafisheries.noaa.gov/pr/interim-harvest-plan, accessed December 2017). Two whales were taken in 2005 and no takes were authorized in 2006 and later under this agreement. A long-term harvest plan (https://alaskafisheries.noaa.gov/pr/cib-long-term-harvest-management, accessed December 2017) established allowable harvest levels 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. 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), so the cooperative agreement was not signed and no hunt occurred. 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). The AFSC's Marine Mammal Laboratory changed to a biennial survey schedule after 2012, so the 5-year average abundance will now be based on either two or three surveys. Analysis in Hobbs (2013) showed that biennial rather than annual abundance surveys may lead to higher variation in harvests but is not expected to change the probability of recovery while using the algorithm that determines the allowable harvest level.

Other Mortality

Mortality related to live stranding events, where a group of beluga whales becomes stranded as the tide recedes, has been reported in Cook Inlet (Table 1). Improved record-keeping was initiated in 1994, and reports have since included the number of floating and beachcast carcasses and live stranded beluga whales (NMFS 2016; https://alaskafisheries.noaa.gov/sites/default/files/15strandings.pdf, accessed December 2017). Most whales involved in a live stranding event survive, although some deaths may be missed by observers if whales die later from live-stranding-related injuries (Vos and Shelden 2005, Burek-Huntington et al. 2015). Between 2011 and 2015, there were approximately 118 beluga whales involved in seven known live stranding events, with two deaths reported (Table 1). In 2014, necropsy results from two dead whales found in Turnagain Arm suggested the whales had recently live stranded and that the live stranding may have contributed to their deaths. No live stranding events were reported to NMFS prior to the discovery of these whales, suggesting that not all strandings are observed (Table 1). Most live strandings occur in Knik Arm or Turnagain Arm, both of which are shallow and dangerous waterways. 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 2011-2015 (NMFS 2016).

Year	Floating and beachcast carcasses	Number of beluga whales per live stranding event (number of associated known or suspected resulting deaths)
2011	3	2 (0)
2012	3	12 (0), 23 (0), 3 (0)
2013	5	0
2014	10	unknown (2), 76+ (0)
2015	3	2 (0)
Total	24	118+ (2)

Another source of beluga whale mortality in Cook Inlet is predation by 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 2015, 31 reports of killer whale sightings in upper Cook Inlet (north of the East and West Forelands) were reported to NMFS. It is not known which of these were mammal-eating killer whales (i.e., transient killer whales) that might prey on beluga whales and which were fish-eating killer whales (i.e., resident killer whales) that would not prey on beluga whales. Up to 12 beluga whale deaths, inlet wide, during this time were suspected to be a direct result of killer whale predation (NMFS 2016). The last confirmed killer whale predation of a beluga whale in Cook Inlet occurred in 2008 in Turnagain Arm. In June 2010, a beluga whale carcass found near Point Possession was speculated to have injuries associated with killer whale predation; however, the poor condition of the beluga whale carcass prevented a positive determination of cause of death. From 2011 through 2015, NMFS received three reports of killer whale sightings (1 in 2011 and 2 in 2015, with one killer whale per sighting) in upper Cook Inlet but 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).

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. 2017).

Between 1998 and 2013, 38 necropsies were performed on beluga whale carcasses (23% of the known stranded carcasses during this time period) (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. Cause of death in the others was 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.

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, in 2008, listed as endangered under the ESA (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 has been well documented. While the early cause of the decline was likely unrestricted subsistence hunting, it is unknown what has been preventing recovery of this stock since no takes have been allowed for subsistence purposes since 2006 and the mortality and serious injury in commercial fisheries is likely to be very low. The calculated PBR level is based on a default maximum net productivity rate which may not be relevant to this stock; the PBR level is likely biased.

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 by 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 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 range 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). Only 2 of 10 tagged whales spent time in offshore waters and the lower inlet in August (Shelden et al. 2015a). Numbers of whales observed during August calf index surveys conducted from 2005 to 2012 were also within the range of counts reported during the June surveys (Hobbs et al. 2015a, Shelden et al. 2015a). This contraction in range appears to have continued into late summer. While surveys were not conducted in September during the 1970s and 1980s, aerial surveys in 1993 suggest 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 within the range of counts made in June that same year (Rugh et al. 2004). With the exception of three whales that spent brief periods of time in the lower inlet in 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 within the range of counts obtained during surveys in June (Shelden et al. 2015a). The population appears to now be consolidated into habitat in the upper-most reaches of Cook Inlet for much longer periods of time, habitat that is most likely to be developed (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 a small number of preferred habitat areas (Goetz et al. 2007, 2012b) is unknown. Goetz et al. (2012b) modeled habitat preferences using NMFS' 1994-2008 abundance survey data. In large areas, such as the Susitna Delta and Knik Arm, they found a high probability of beluga whale presence 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 smelt (eulachon, *Thaleichthys pacificus*) in May and July. Potential threats identified in the Cook Inlet Beluga Recovery Plan (NMFS 2016) are threats of high concern, including catastrophic events (e.g., natural disasters, spills, mass strandings), cumulative effects of multiple stressors, and noise; threats of medium concern, including disease agents (e.g., pathogens, parasites, and harmful algal blooms), habitat loss or degradation, reduction in prey, and unauthorized take; and threats of low concern, including 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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