STATUS REVIEW FOR THE EASTERN CHUKCHI SEA BELUGA WHALE STOCK
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1. Distribution and stock identity

The eastern Chukchi Sea (ECS) beluga stock occurs in the lagoons and adjacent waters of the ECS in late spring and early summer (Frost *et al*. 1993). Individuals of this stock range widely throughout the ECS and Beaufort Sea and into the Arctic Ocean during summer and early fall (Suydam 2009, Hauser *et al*. 2014) and then move through the Bering Strait into the Bering Sea in the winter, returning to the Chukchi Sea the following spring (Citta *et al*. 2017).

The non-uniform distribution of beluga whales in coastal waters of the Bering, Chukchi, and Beaufort Seas in summer is indicative of likely population subdivision and formed the basis for original, but provisional, stock designations (Frost and Lowry 1990). It was recognized at the time that identification of more biologically meaningful stocks would require genetic studies to elucidate the underlying patterns of demographic and reproductive relationships among seasonal groupings (O'Corry-Crowe and Lowry 1997). Over the past two decades several genetic studies have been conducted on seasonal groupings that occur adjacent to Alaska and Chukotka (Russian Federation) primarily summering and migrating groups, to resolve patterns of dispersal and gene flow. The studies revealed substantial mitochondrial DNA (mtDNA) differentiation among summering groups in Bristol Bay, Norton Sound, and Anadyr Gulf in the Bering Sea, in nearshore waters along Kasegaluk Lagoon in the Chukchi Sea, and in the Mackenzie Delta-Amundsen Gulf region in Beaufort Sea that likely reflects long-established patterns of female-mediated philopatry and demographic isolation (O'Corry-Crowe *et al*. 1997, 2002; Brown-Gladden *et al*. 1997, Meschersky *et al*. 2008; Fig. 1). This has led to their identification as the following five demographically distinct management stocks: 1) Bristol Bay, 2) eastern Bering Sea, 3) Gulf of Anadyr, 4) ECS, and 5) eastern Beaufort Sea (Muto *et al*. 2016, Laidre *et al*. 2015). A few studies have documented lower levels of nuclear DNA (microsatellite) heterogeneity among geographic strata compared to mtDNA. This has been taken as evidence of male-mediated gene flow among summering groups, possibly in shared wintering areas (Brown-Gladden *et al*. 1999, Meschersky *et al*. 2013), or it could reflect a slower rate of drift in markers with higher effective population size (O'Corry-Crowe *et al*. 2010). Recent studies question the common wintering area hypothesis (Citta *et al*. 2017) and whether gene flow is extensive among stocks in the Bering, Chukchi, and Beaufort seas (O'Corry-Crowe *et al*. in prep.).

Beluga whales in the ECS have traditionally occupied two geographically distinct coastal concentration areas, Kotzebue Sound and the nearshore waters along Kasegaluk Lagoon (Fig. 1). Studies conducted in the 1970s and early 1980s reported beluga whales entering Kotzebue Sound in mid- to late-June each year with or following ice breakup, while whales began to congregate in nearshore waters and passes near Kasegaluk Lagoon typically in late June (Seaman *et al*. 1988, Frost and Lowry 1990). The whales tended to remain in these nearshore locations for periods of weeks to a month or so before moving on, presumably to areas further north and/or offshore. Traditional knowledge of the local Inuit confirmed that these were long established migration routes and summer concentration areas (Huntington *et al.* 1999). The pattern of beluga whales returning to these two traditional locations, however, has diverged dramatically since the mid-1980s. Numbers of whales returning to Kotzebue Sound declined dramatically after 1983 and have not recovered, despite a few years when large numbers of whales briefly entered the Sound in summer (Frost and Lowry 1990, Seaman *et al*. 2015). By contrast, the return of belugas to the Kasegaluk Lagoon area has been very consistent throughout much of the past three decades (Suydam 2009).

Other than the annual return to the Kasegaluk Lagoon area, essentially nothing was known about distribution of this stock until belugas were tagged with satellite depth recorders (SDRs). During 1998-2012, 29 belugas were captured in conjunction with the annual subsistence hunt at Point Lay and equipped with SDRs that provided location data for 5-522 days (Suydam 2009, Hauser *et al.* 2014).

Results showed that after leaving Point Lay in July, whales moved northward into the northern Chukchi and Beaufort seas and into the Arctic Ocean with some animals penetrating heavy ice cover to north of 80° N latitude (Suydam *et al*. 2001). During summer, they ranged widely, but belugas of all ages and both sexes were most often found in water deeper than 200 m, along and beyond the continental shelf break and into very deep waters. They rarely used inshore waters of the Beaufort Sea (Suydam 2009). Hauser *et al*. (2014) used these same data to describe beluga distributions and home ranges for July through November, by which time the whales had moved southward through the Chukchi Sea to the Bering Strait region. The six whales whose tags transmitted long enough passed through Bering Strait in November-December then remained in the northern Bering Sea, between Bering Strait and St. Lawrence Island, into May. One tag lasted long enough to re-enter the Chukchi Sea in late May and another stopped transmitting in early May, just south of Bering Strait (Citta *et al*. 2017).

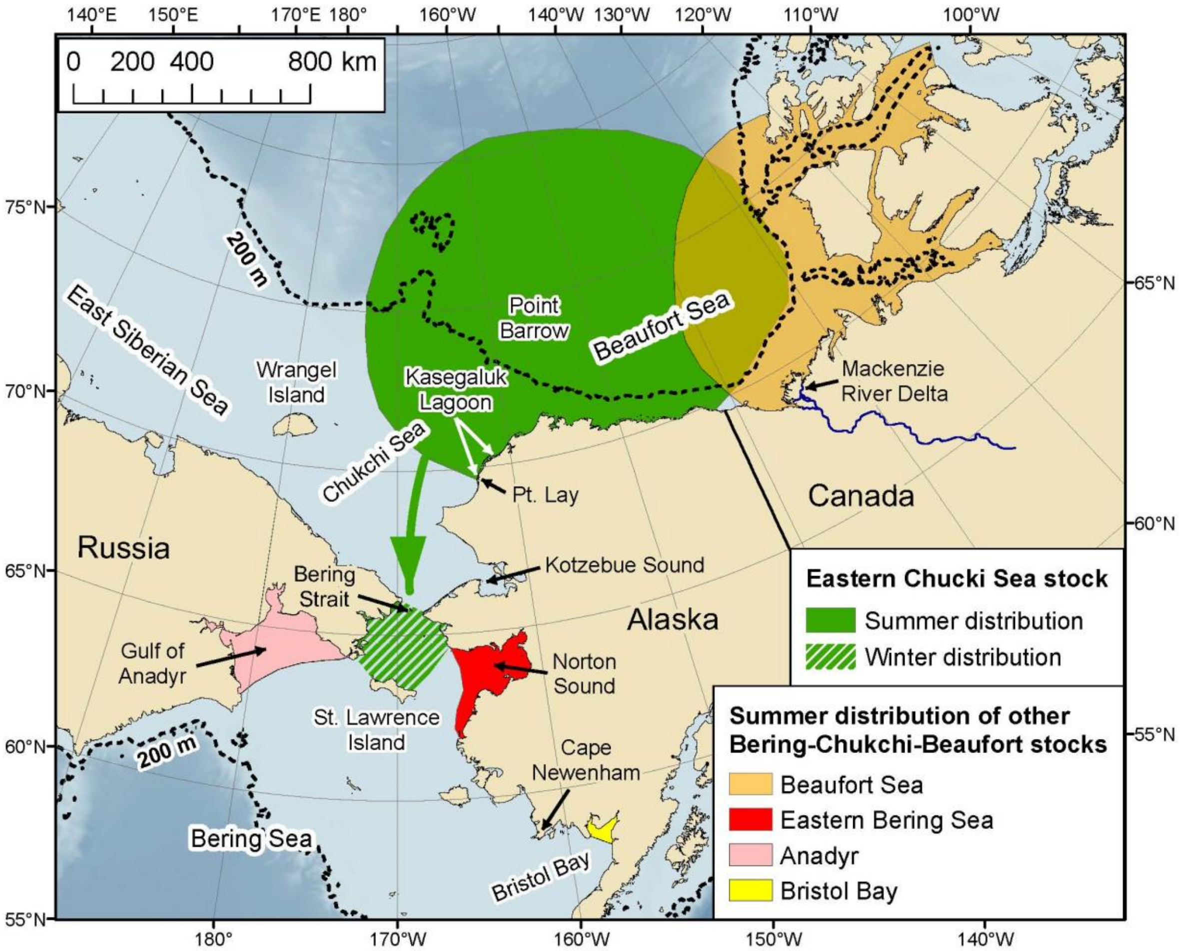

Figure 1. Map of the Bering-Chuckhi-Beaufort sea region showing summer distribution of all beluga stocks in the region and the winter distribution of the eastern Chukchi Sea stock.

Studies on patterns of mtDNA variation revealed that the summering concentration along Kasegaluk Lagoon was demographically distinct from other summering groups in the Beaufort and Bering seas and these whales were subsequently identified as the ECS stock (O'Corry-Crowe and Lowry 1997, O'Corry-Crowe *et al*. 1997, 2002, Brown-Gladden *et al*. 1997, Muto *et al*. 2016). Based on the pattern of annual return, it was initially hypothesized that the original Kotzebue and Kasegaluk summering groups were part of the same demographically distinct subpopulation and thus the same stock. A series of genetic studies, however, have revealed that beluga whales from the pre-decline era in Kotzebue Sound were genetically distinct from the ECS stock (i.e., those that use Kasegaluk Lagoon). Additionally, whales from two subsequent anomalous years (1996 and 2007), when large numbers of animals entered the Sound, were also genetically distinct from the pre-1983 Kotzebue Sound beluga and from the ECS stock (O'Corry-Crowe *et al*. 2001, 2016). Those atypical years most likely involved whales from the Beaufort Sea stock and the anomalous events coincided with anomalous ice years in the Bering-Chukchi-Beaufort region (O'Corry-Crowe *et al*. 2016).

2. Abundance

Sightings of beluga whales in the ECS in summer occur mostly in June-July in Kotzebue Sound and off Kasegaluk Lagoon (Seaman *et al*. 1988, Frost and Lowry 1990, Lowry *et al*. 1999), and initial abundance surveys were focused in those areas. At that time it was thought that belugas in those two areas belonged to the same stock, but genetic evidence now shows that they are different (see above). Distribution, abundance, and movements of the potential "Kotzebue stock" are essentially unknown and it will not be further considered in this assessment.

The first efforts to assess abundance of the ECS beluga stock were made in the late 1970s by Seaman *et al*. (1988). They took photographs of belugas concentrated at Kasegaluk Lagoon passes, and estimated that there were 2,282 animals there on 15 July 1979. The estimate included correction factors for whales outside the concentration area (+10%), whales too deep to be seen on the photographs (+20%), and dark colored yearlings that are difficult to see (+8%). Frost and Lowry (1990) flew an aerial strip transect survey over a large concentration of belugas off Point Lay on 8 July 1987. They counted 723 whales, and suggested that there may have been 1,400-2,100 animals in that group (using correction factors of 2 and 3 to account for animals missed because they were diving in relatively deep water).

Frost *et al*. (1993) conducted aerial surveys of ECS coastal waters during 1989-1991. Survey effort was concentrated along the shore near Kasegaluk Lagoon, an area regularly used by belugas during the open-water season. They made numerous sightings of beluga whales in that region with the highest single day count of 1,200 whales. Offshore waters where belugas also occur were not surveyed. If this minimum count is corrected using radio tag data for the proportion of animals that were diving and thus not visible at the surface (2.62; Frost and Lowry 1995), and for the proportion of newborns and yearlings not seen due to small size and dark coloration (1.18; Brodie 1971), the total abundance of the eastern Chukchi stock was estimated as 3,710 (1,200 × 2.62 × 1.18) whales. This is the figure that has been used in National Marine Fisheries Service (NMFS) Stock Assessment Reports (Muto *et al*. 2016) and elsewhere (e.g., Laidre *et al*. 2015).

The Alaska Beluga Whale Committee (ABWC) conducted additional surveys in the Kasegaluk Lagoon region in 1996-98 and found belugas in the nearshore areas previously surveyed but also detected groups of whales further offshore (Lowry *et al*., 1999). Subsequent survey efforts in 2001-03 included more offshore flight lines, but while belugas were occasionally sighted more than 50 km offshore, sightings were very infrequent (Lowry and Frost 2002, 2003). Also, data from whales equipped with satellite depth recorders (SDRs) at Kasegaluk Lagoon showed that many whales were outside of the area surveyed during the survey period (Suydam *et al*. 2001). Because of the high cost of aerial surveys and the relatively low value of results for population assessment, beluga-specific surveys in the ECS were suspended by the ABWC after 2003.

An analysis of data from SDRs attached to belugas in coastal concentration areas of the ECS and Beaufort Sea stocks (Hauser *et al*. 2014) provided an overview of distribution and movements of the stocks and allowed the identification of an area (140°W to 157°W in the Beaufort Sea) and time period (19 July-20 August) when the distributions of the two stocks do not overlap (Lowry *et al*. in prep.). Aerial survey data collected in 2012 in that region during those dates by the Aerial Surveys of Arctic Marine Mammals (ASAMM) project (Clarke *et al*. 2013) were used in a line transect analysis that estimated there were 5,547 (coefficient of variation (CV) = 0.22) surface-visible belugas in the study area. Data from SDRs were used to develop correction factors to account for animals that were missed because they were outside of the study area or diving too deep to be seen, resulting in a total abundance estimate of 20,675 (CV = 0.66; Lowry *et al*. in prep.). Additional survey data were collected in that region in 2013-2016 and a full analysis of ECS beluga abundance using all available ASAMM data is anticipated.

3. Anthropogenic removals

Subsistence harvest

The ABWC and the North Slope Borough Department of Wildlife Management have collected data since 1987 on Alaska Native subsistence harvests by villages harvesting from the ECS. Harvest data through 2006 were reported by Frost and Suydam (2010). However, in that publication data for Kotzebue Sound were included in the ECS harvest. Here, we report revised 1987-2006 ECS harvest data, as well as data for 2007-2016 (Fig. 2; ABWC, unpublished data). Harvest data for Kotzebue Sound are not reported here since the stock from which belugas have been harvested is not known for all years.

Harvest of the ECS stock occurs mainly at two communities, Point Lay and Wainwright. The revised average annual harvest for 1987-2006 was 48 belugas (range 0-86; 95% CL = 37-59). During 2007-2016, the average annual harvest increased to 57 belugas (range 14-121; 95% CL = 35-79; Fig. 2a). The increase in average harvest is almost certainly due to improved reporting for the village of Wainwright. Annual variation in the harvest is high and can differ more than tenfold. During 2007-2016, there was a slight negative trend in harvest (Fig. 2b) that was statistically insignificant ($p = 0.15$). The current potential biological removal (PBR) is more than four times the average harvest during the last 10 years (see Section 5, below).

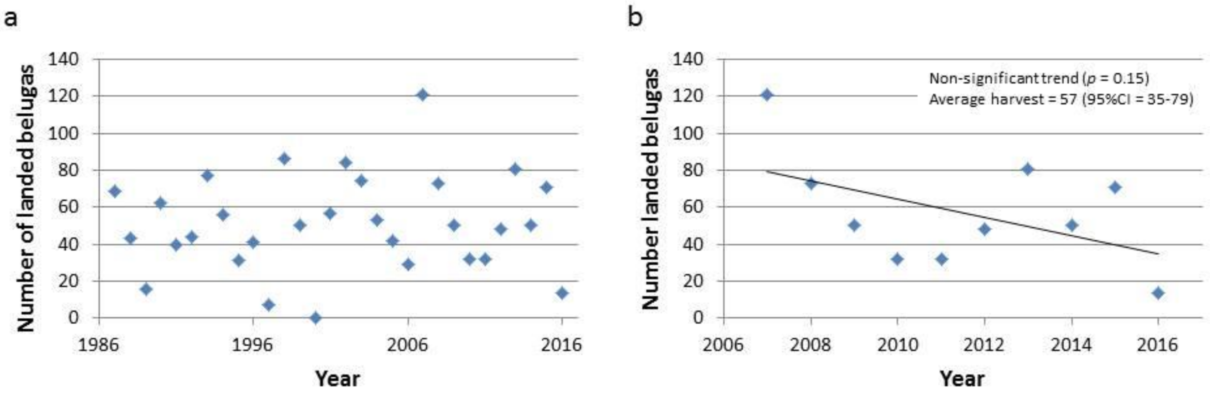

Figure 2. The number of ECS belugas landed by Alaska Native subsistence hunters during 1987–2016 (a), and trend in the number of belugas landed during 2007–2016 (b). For more information on how harvest is documented, see Frost and Suydam (2010).

Reporting of struck and lost belugas has been sporadic but because the hunts at Point Lay and Wainwright are drive hunts, the number of whales struck and lost is low. There were some struck and lost whales reported for the ECS stock in 3 of the last 10 years, although more animals may have been lost. During those years, the number of belugas struck and lost averaged 7% of the landed harvest (ABWC, unpublished data). Frost and Suydam (2010) also reported a struck and lost rate of 7% for the ECS stock.

Bycatch
In the USA, some commercial fisheries that operate in federal waters (3-200 nm offshore) and may take marine mammals as bycatch are regularly monitored. In Alaska, three commercial fisheries that could have interacted with beluga whales from the ECS beluga stock have been monitored: Bering Sea and Aleutian Islands groundfish trawl, longline, and pot fisheries. No mortality or serious injury to beluga whales was reported in those fisheries. State-managed commercial, personal use, and subsistence gillnet fisheries occur in nearshore waters of the eastern Chukchi Sea. While they are a potential source of bycatch mortality and bycatch is not systematically monitored, no beluga whale takes have been reported in those fisheries (Muto *et al*. 2016). Low numbers of belugas have been entangled and killed in subsistence fishing nets at Barrow, Alaska. Those animals were reported and are included as subsistence harvests for the Beaufort Sea stock (ABWC, unpublished data) but may have been from the ECS stock.

4. Population trajectory

There are no data on maximum growth rate (R_{MAX}) for ECS belugas. For the Bristol Bay beluga stock the estimated rate of increase over the 12-year period 1992-2005 was 4.8%/year (95% CI = 2.1%-7.5%; Lowry *et al*. 2008). The measured value for Bristol Bay is close to the 4%/year that is used by NMFS as the default R_{MAX} for cetaceans (Wade1988).

Peak counts made at Kasegaluk Lagoon during 1978-2003 have varied considerably but do not give any clear indication of changes in abundance over that period (Table 1). The trend in abundance of ECS belugas is considered unknown (Laidre *et al*. 2015, Muto *et al*. 2016).

Table 1. Results of counts of ECS beluga whales in the Kasegaluk Lagoon region, 1978-2003.

Year	Maximum count	Date	Number of surveys	Comments
1978[1]	703	10-Jul	5	nearshore, count from photos
1979[1]	1,601	15-Jul	5	nearshore, count from photos
1981[1]	670	8-Jul	5	nearshore, visual count
1987[2]	724	8-Jul	1	offshore, visual count
1990[3]	1,212	5-Jul	12	nearshore, visual count
1991[3]	938	6-Jul	12	nearshore, visual count
1996[4]	1,035	30-Jun	10	nearshore and offshore, visual count
1997[4]	130	7-Jul	4	mostly poor survey conditions
1998[4]	1,172	6-Jul	5	nearshore and offshore, visual count
2001[4]	667	6-Jul	5	nearshore and offshore, visual count
2002[4]	582	6-Jul	7	nearshore and offshore, visual count
2003[4]	369	5-Jul	6	early spring, counts not comparable to previous years

[1] Seaman *et al*. 1988
[2] Frost and Lowry 1990
[3] Frost *et al*. 1993
[4] Alaska Beluga Whale Committee, unpublished data

5. Potential biological removals or other information on safe (sustainable) limits of anthropogenic removals

The U.S. Marine Mammal Protection Act (MMPA) defines the PBR as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times FR$. However, because the most recent abundance estimate available at the time of the last NMFS Stock Assessment Report was more than eight years old the PBR for the stock was considered to be "undetermined" (Muto *et al*. 2016).

A PBR can be calculated using the abundance estimate provided in Lowry *et al*. (in prep) as follows: N_{BEST} = 20,675; CV = 0.66; N_{MIN} = 12,461, R_{MAX} = 0.04; FR = 1.0; PBR = 249. The average annual Alaska Native subsistence harvest from the ECS stock for the last 10 years (57 belugas) is about 0.3% of the population estimate (Lowry *et al.* in prep.). Although coastal fisheries are not regularly monitored for incidental take, all indications are that anthropogenic removals from the ECS beluga stock are sustainable.

6. Habitat and other concerns

Because they are an ice-associated species there is concern about the possible effects on belugas of climate warming and associated loss of sea ice habitat. Laidre *et al*. (2015) showed that the duration of the reduced ice (summer) period increased by 44 days in the Chukchi Sea and 52 days in the Beaufort Sea from 1979 to 2013. In a long-term study of belugas off West Greenland, Heide-Jørgensen *et al*. (2010) found that belugas responded to changing sea ice by shifting their distribution but that abundance increased during a period of generally declining ice cover. They stated that "Global warming and sea-ice declines may pose less of a problem for belugas than to other Arctic marine mammals." Laidre *et al*. (2008) concluded that on a rangewide basis the beluga would be the arctic cetacean least sensitive to climate change because of their wide distribution and flexible habits.

There have been two studies that specifically address the potential influence of changes in ice conditions on Pacific Arctic belugas. O'Corry-Crowe *et al*. (2016) analyzed long-term sighting and genetic data on belugas in the Bering, Chukchi, and Beaufort seas in conjunction with multi-decadal patterns of sea-ice to investigate the influence of sea-ice on spring migration and summer residency patterns. While substantial variations in sea-ice conditions were found across seasons, years, and sub-regions, the pattern of beluga migration and residency was quite consistent. Those results suggest that belugas can accommodate to varying sea-ice conditions to perpetuate philopatry to traditionally used areas. Hauser *et al*. (2016) compared the timing of the autumn migration of ECS and Beaufort Sea belugas during the periods 1993-2002 and 2004-2012. They found that in the later period ECS beluga migration from the Beaufort and

Chukchi seas was delayed by 2 to >4 weeks, but that Beaufort Sea belugas did not shift migration timing between periods. Although some stocks may focus on certain prey, such as Beaufort Sea belugas specializing on arctic cod, *Boreogadus saida* (Loseto *et al.* 2009), belugas are capable of consuming a wide variety of prey and are best classified as generalist predators. For example, examination of stomach contents from harvested ECS belugas found 5 species of fish from 4 families and 15 species of invertebrates (Quakenbush *et al.* 2015). Belugas clearly show flexibility and adaptive capacity which makes it particularly difficult to predict how they may be affected by climate change.

An increase in the duration of the open water season and the decline in multi-year sea ice has generated concern that increases in oil and gas exploration and development and shipping may have negative consequences for belugas (e.g., Moore *et al.* 2000, Lowry *et al.* 2012, Reeves *et al*. 2014). Most oil and gas activity within the range of ECS belugas currently occurs over the continental shelf in the Beaufort Sea, although from 2006 to 2015 there was also considerable activity in Chukchi Sea. In the Beaufort Sea, the distribution of ECS belugas is predominantly limited to offshore areas, near the shelf break and within the Arctic Basin. At present, oil and gas activity in the Alaskan portion of the Beaufort Sea is far inshore of where belugas typically range (Suydam *et al*. 2005). Oil and gas activity in the Canadian portion of the Beaufort Sea is largely limited to shallow shelf waters northeast of the Mackenzie River Delta (Fig. 1) and is outside of the range of ECS belugas. In 2016, President Obama used the Outer Continental Shelf Lands Act of 1953 to remove most of the U.S. portion of the Chukchi Sea from future leasing. However, there are still active oil and gas leases in the Camden Bay area of the Alaskan Beaufort Sea and in the Russian portion of the Chukchi Sea. In the summer of 2016 hydrophones detected active seismic surveys near Wrangel Island (Catherine Berchock, pers. comm.). Russian lease areas are largely outside the range of ECS belugas, however, the effects of oil and gas development (e.g., noise or oil spills) could extend into their range.

Although shipping is increasing with declining sea ice (Eguíluz *et al.* 2016, Pizzolato *et al.* 2016), belugas are not known to be particularly susceptible to ship strikes, even in congested areas such as the Saint Lawrence River (Kingsley 2002). Furthermore, factors in addition to sea ice, such as where resources are being developed and commodity pricing, determine shipping trends (e.g., Brigham 2011, Bensassi *et al*. 2016, Pizzolato *et al*. 2016). As such, predicting how patterns in shipping will change is difficult, as is how belugas will respond to those changes. Impacts to belugas in the far north from sounds associated with shipping, including ice breaking, may be more of a concern than ship strikes. There is scant information about how belugas respond to sounds associated with shipping. Dedicated studies are needed that 1) overlay shipping routes with the temporal distribution of ECS belugas, and 2) investigate the response of belugas to shipping activity.

7. Status of the stock

The ECS stock of beluga whales is one of four stocks in western Alaska that is co-managed by NMFS and the ABWC (Adams *et al*. 1993, Fernandez-Gimenez *et al*. 2006). Two of the agreed upon objectives of the management plan are to “conserve the Western Alaska beluga whale population” and to “protect Alaska Native beluga whale subsistence hunting traditions and culture” (ABWC 1999).

ECS beluga whales are not designated as “depleted” or “strategic” under the MMPA nor are they listed as “threatened” or “endangered” under the U.S. Endangered Species Act. In an assessment done in 2008, the IUCN listed belugas as a species as “Near Threatened” and also noted that the various subpopulations should be assessed separately (Jefferson *et al*. 2012). The population estimate from 2012 of approximately 20,000 belugas (Lowry *et al*. in prep) and the relatively low subsistence harvest suggests that ECS belugas are not at immediate risk from anthropogenic activities or climate change. However, additional monitoring of population size and trend, subsistence harvest, and health of belugas is warranted.

Biological samples have been collected from ECS belugas since the 1980s (Suydam 2009). One objective of that study was to examine reproduction, including pregnancy rates. From 1987 to 2005, the pregnancy rate for adult females was 0.41, which indicates a calving interval of between 2 to 3 years. That pregnancy rate appears to be somewhat higher than other studies (e.g., Burns and Seaman 1988, Heide-Jørgensen and Teilmann 1994) suggesting that ECS belugas are reproductively healthy and producing many calves. Data collections have recently focused on assessing the health status of ECS belugas by monitoring body condition, exposure to contaminants, disease, and other measures.

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