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BELUGA WHALE (*Delphinapterus leucas*): Eastern Bering Sea Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980). In ice-covered regions, they are closely associated with open leads and polynyas (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, eastern Bering Sea (i.e., Yukon River Delta, Norton Sound), eastern Chukchi Sea (i.e., Kotzebue Sound, Kasegaluk Lagoon), and Beaufort Sea (Mackenzie River Delta) (Hazard 1988; O'Corry-Crowe et al. 2018, 2021) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Frost and Lowry 1990). Data from satellite transmitters attached to a few beluga whales from the Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay stocks show ranges that are relatively distinct month to month for these stocks' summering areas and autumn migratory routes (e.g., Hauser et al. 2014, Citta et al. 2017, Lowry et al. 2019). Transmitters that lasted through the winter showed that beluga whales from these summering areas overwinter in the Bering Sea; these stocks are not known to overlap in space and time in the Bering Sea (Suydam 2009, Citta et al. 2017, Lowry et al. 2019).

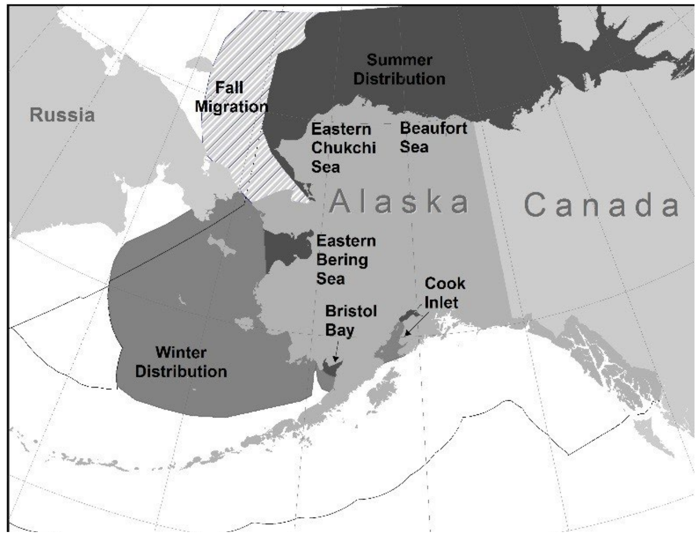

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration. The U.S. Exclusive Economic Zone is delineated by a black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

New genetic analyses have further defined six of the summering aggregations in the Bering, Chukchi, and Beaufort seas as follows: Bristol Bay, eastern Bering Sea (Norton Sound), Kotzebue Sound, Kasegaluk Lagoon/eastern Chukchi Sea, eastern Beaufort Sea (Mackenzie-Amundsen), and Gulf of Anadyr (Anadyr Bay) (O'Corry-Crowe et al. 2018, 2021). These genetic analyses, combined with new telemetry data, demonstrate that the demographically distinct summering aggregations return to discrete wintering areas and disperse and interbreed over limited distances but do not appear to interbreed extensively (O'Corry-Crowe et al. 2018, 2021).

The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering, Chukchi, and Beaufort seas. Beaufort Sea beluga whales depart the Bering Sea in early spring, migrate through the Chukchi Sea and into the Canadian waters of the Beaufort Sea where they remain in the summer before migrating back to the Chukchi Sea in the fall, returning to the Bering Sea in late fall (Hauser et al. 2014). Eastern Chukchi Sea beluga whales depart the Bering Sea in late spring and early summer, migrate through the Chukchi Sea and into the northern Chukchi and western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. Beluga whales tagged in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Goetz et al. 2012; Shelden et al. 2015, 2018; Lowry et al. 2019) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

In general, the Eastern Bering Sea beluga whale stock remains in the Bering Sea but migrates south near Bristol Bay in winter and returns north to Norton Sound and the mouth of the Yukon River in summer (Citta et al. 2017, Lowry et al. 2019). Two beluga whales from the Eastern Bering Sea stock were tagged with satellite transmitters in autumn 2012 near Nome. The beluga whales migrated south from Nome through ice-covered shelf waters during the winter, swimming near Hagemeister Island and the Walrus Islands in Bristol Bay, before returning to Norton Sound by spring (Citta et al. 2017). A beluga whale tagged near Nome in November 2016 remained in western Norton Sound and adjacent waters of the eastern Bering Sea through April 2017 (Lowry et al. 2019). In May-June, the whale migrated into Norton Sound and the mouth of the Yukon River Delta, where it remained through October, when it returned to western Norton Sound. A beluga tagged near Stebbins in May 2019 traveled north into the southern Chukchi Sea during November to mid-December, then back south into the Bering Sea where it swam west of St. Lawrence Island and continued south of Nunivak Island (ABWC unpubl. data).

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990); 2) Population response data: 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 the five summering areas in Alaska (O'Corry-Crowe et al. 1997) and among stocks in Alaska and the Gulf of Anadyr (O'Corry-Crowe et al. 2018). Based on this information, five beluga whale stocks are recognized within U.S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) Eastern Bering Sea (Fig. 1), 4) Eastern Chukchi Sea, and 5) Beaufort Sea. The extent to which the beluga whales seen in Kotzebue Sound during summer may represent a separate stock is currently unclear and under review.

POPULATION SIZE

The Alaska Beluga Whale Committee (ABWC) has been working to develop a population estimate for the Eastern Bering Sea stock since the first systematic aerial surveys of the Norton Sound/Yukon River Delta region during May, June, and September 1992 and June 1993-1995 (Lowry et al. 1999). Beluga whale density estimates were calculated for the June 1992 surveys using strip-transect methods and for the June 1993-1995 surveys using line-transect methods. Correction factors were applied to account for whales that were missed during the surveys (those below the surface and not visible, and dark colored neonates and yearlings). Lowry et al. (1999) concluded that the best abundance estimate for the Eastern Bering Sea stock was 17,675 beluga whales (95% CI: 9,056-34,515, not accounting for variance in correction factors), based on counts made in early June 1995. Additional aerial surveys of the Norton Sound/Yukon River Delta region were conducted in June 1999 and 2000 (Lowry et al. 2017). Unlike previous survey years, sea ice persisted in western Norton Sound in 1999, resulting in a different distribution of beluga whales, and the data were not used for population estimation. In 2000, systematic transect lines were flown covering the entire study region, and the data were analyzed using a multiple covariates distance-sampling model in a geographically stratified analysis. The resulting estimate of beluga whales present at the surface in the study area was 3,497 beluga whales (coefficient of variation (CV) = 0.37) (Lowry et al. 2017). Lowry et al. (2017) applied a correction factor for availability bias (Marsh and Sinclair 1989) of 2.0 (Reeves et al. 2011) to correct for the proportion of whales that were diving and thus not visible at the surface, resulting in an estimate of total abundance for the Eastern Bering Sea stock of 6,994 beluga whales (95% CI: 3,162-15,472). The 2000 abundance estimate was likely an underestimate for the following reasons: 1) it did not include a correction factor for the probability of detecting belugas on the trackline (known as transect detection probability), 2) it did not account for dark-colored neonates and yearlings that were not seen, and 3) some beluga whales from this population could have been outside the study area (e.g., in the Yukon River) during the survey period.

In 2017, ABWC and NMFS collaborated on an aerial line-transect survey for beluga whales in the Norton Sound/Yukon River Delta region. To estimate the number of beluga whales present at the surface throughout the entire 2017 survey area, Ferguson et al. (In review) used a line transect analysis analogous to Lowry et al. (2017); the resulting estimate was 4,621 beluga whales (CV = 0.117, 95% CI: 3,635-5,873). As noted above, an additional four factors need to be taken into account to produce a total abundance estimate of the of Eastern Bering Sea stock of beluga whales: 1) availability bias (to correct for beluga whales not visible at the surface and not within the observers' field of view), 2) transect detection probability (to correct for beluga whales that are available to be seen but not detected), 3) lower detection probability of small or dark-colored individuals (to correct for such beluga whales that are not seen), and 4) survey area boundaries (to account for beluga whales that may have been outside the survey area).

To account for availability bias, Ferguson et al. (In review) calculated a correction factor of 2.0 based on: 1) beluga surface interval and dive interval data reported in Frost and Lowry (1995), and 2) an estimate of the amount of time that an aerial observer during the 2017 Eastern Bering Sea beluga survey had to detect a beluga within their field of view. Because aerial observers aboard the survey aircraft had an unobstructed field of view within the 180° arc on each side of the aircraft, Ferguson et al. (In review) computed this time-in-view estimate based on the survey speed of the aircraft and the 95th percentile of perpendicular distances at which belugas were detected during the 2017 aerial line-transect surveys. The estimated time-in-view was 15.9 sec. Transect detection probability can be another large source of negative bias in aerial line-transect abundance estimates when it is incorrectly assumed to be equal to 1.0.

This source of perception bias can be estimated using a double-platform set-up during surveys. However, data were not collected during the 2017 Eastern Bering Sea beluga whale aerial survey to estimate a correction factor for transect detection probability that was specific to the survey. Therefore, Ferguson et al. (In review) used imagery and marine mammal observer data collected during aerial line-transect surveys for marine mammals in the eastern Chukchi and western Beaufort seas during July through October 2018 (Clarke et al. 2019) and 2019 (Clarke et al. 2020) to estimate transect detection probability, resulting in a value of 0.753.

Applying an availability bias correction factor of 2.0 and a transect detection probability of 0.753 to the estimated 4,621 belugas at the surface results in a total abundance estimate for the Eastern Bering Sea beluga whale stock in 2017 of 12,269 (CV = 0.118) (Ferguson et al. In review). The estimated CV for the corrected abundance estimate is negatively biased (i.e., the uncertainty is underestimated) because the availability bias correction factor had no associated CV. Additional potential sources of negative bias that may still affect this estimate of Eastern Bering Sea beluga abundance in 2017 include: 1) the possibility that belugas from this stock may not have been present in the survey area during the survey period, and 2) lower detectability of small, dark gray belugas (neonates and yearlings), which are harder to detect than large white belugas.

Minimum Population Estimate

For the Eastern Bering Sea stock of beluga whales, the minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2023): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 2017 population estimate (N) of 12,269 whales and an associated CV(N) of 0.118, N_{MIN} for the Eastern Bering Sea stock is 11,112 beluga whales.

Current Population Trend

Surveys to estimate population abundance in the eastern Bering Sea were not conducted prior to 1992. Annual estimates of population size from surveys flown in 1992-1995 and 1999-2000 have varied widely, due partly to differences in survey coverage and conditions between years. The comparable abundance estimates (that were not corrected for transect detection probability) from the surveys conducted in 2000 (6,994 beluga whales) and 2017 (9,242 beluga whales) were not statistically different (Lowry et al. 2019).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available specifically for the Eastern Bering Sea stock of beluga whales. The default value for the maximum theoretical net productivity rate for cetaceans is 4% (NMFS 2023). NMFS Guidelines suggest that, in general, substitution of other values for this default should be made with caution, when reliable stock-specific information is available on R_{MAX} (NMFS 2023). However, the Guidelines also state that for stocks subject to subsistence harvests, calculations of PBR will be determined from the analysis of scientific and other relevant information discussed during the co-management process. Co-management of the Eastern Bering Sea stock of beluga whales is conducted by the ABWC and NMFS. Through the co-management process, ABWC and NMFS considered that the nearby Bristol Bay stock of beluga whales has similar environmental conditions and habitat to the Eastern Bering Sea stock, and has exhibited an estimated rate of increase of 4.8% per year (95% CI: 2.1%-7.5%) over the 12-year period from 1993-2005 (Lowry et al. 2008). This 4.8% is not a theoretical R_{MAX}, but an actual realized value for the growth rate of the population at an intermediate density between zero and carrying capacity. For these reasons, NMFS considered 4.8% more appropriate than the default value, and therefore used an R_{MAX} of 4.8% for this stock.

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 ($F_R$) used for this stock is 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2023). Thus, the PBR for the Eastern Bering Sea stock is 267 beluga whales (11,112 × 0.024 × 1.0).

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 between 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused mortality and serious injury for Eastern Bering Sea beluga whales between 2016 and 2020 is 227 beluga whales (comprising intentional subsistence takes by Alaska Natives and belugas incidentally taken in net fisheries – see below).

A reliable estimate of mortality and serious injury in U.S. commercial fisheries is not available because there has never been an observer program for nearshore commercial fisheries in the eastern Bering Sea region. Potential threats most likely to result in incidental human-caused mortality or serious injury of this stock include entanglement in fishing gear.

Fisheries Information

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2023).

In the nearshore waters of the eastern Bering Sea, substantial effort occurs in commercial and subsistence fisheries, mostly for salmon and herring. The salmon fishery uses gillnet gear similar to that used in Bristol Bay, where it is known that beluga whales are incidentally taken (Frost et al. 1984). In 2018, three beluga whale mortalities in the Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet fishery were reported to the NMFS Alaska Region marine mammal stranding network: one beluga whale was caught in a subsistence fishery net and two whales were caught in commercial fishery nets. In 2019, one dead beluga whale found entangled in an unknown fishing net was reported (Freed et al. 2022). However, complete data on beluga whale incidental takes from this stock are not available because there have never been observer programs in these commercial fisheries and there is no reporting requirement for takes in personal use fisheries. Incidental beluga whale mortalities used for subsistence purposes are reported to the ABWC. Reports of incidental takes in fishing gear are included in the NMFS human-caused mortality and injury reports (e.g., Freed et al. 2022) as subsistence takes and are also included in the Alaska Native Subsistence/Harvest Information section below.

The minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2016 and 2020 for this stock is estimated to be 0.4. However, because there has never been an observer program for state-managed nearshore commercial fisheries in the eastern Bering Sea, a reliable estimate of the mortality and serious injury incidental to U.S. commercial fisheries is not available.

Alaska Native Subsistence/Harvest Information

NMFS has an agreement with the ABWC to co-manage western Alaska beluga whale populations in the Bering Sea (including Bristol Bay), Chukchi Sea, and Beaufort Sea. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of beluga whales (to the maximum extent allowed by law) as a tool for conserving beluga whale populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed May 2023).

Data on the subsistence take of Eastern Bering Sea beluga whales are collected annually from more than 20 Eastern Bering Sea villages and reported to NMFS by the ABWC.The most recent subsistence harvest estimates for this stock are provided in Table 1. Beluga whales harvested in Kuskokwim villages are included in the total harvest for the Eastern Bering Sea beluga whale stock, but there are no genetics data indicating to what stock Kuskokwim belugas belong; those takes are included here for completeness. The annual subsistence take by Alaska Native hunters between 2016 and 2020 averaged 227 Eastern Bering Sea beluga whales landed, struck and lost, or caught incidentally in fisheries and subsequently used for subsistence purposes.

Table 1. Summary of Eastern Bering Sea beluga whales landed and struck and lost by Alaska Native subsistence hunters between 2016 and 2020 (ABWC, unpubl. data, 2021).

Year	Number landed	Number struck and lost	Total (landed + struck and lost)
2016	184	14*	198
2017	186	18*	204
2018	190	25	215
2019	225	21	246
2020	256	14*	270
Mean annual number	208	18	227

* No data were reported for the number of struck and lost whales in Kuskokwim in 2016, 2017, and 2020.

STATUS OF STOCK

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries for the Eastern Bering Sea beluga stock of beluga whales between 2016 and 2020 is 0.4 whales. This figure is less than 10% of the PBR (10% of 267 = 26.7), and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. The minimum estimated mean annual level of human-caused mortality and serious injury (227 beluga whales) is less than the calculated PBR (267 beluga whales). The Eastern Bering Sea stock of beluga whales is not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. Therefore, the Eastern Bering Sea stock of beluga whales is not classified as a strategic stock.

There are key uncertainties in the 2017 abundance estimate for the Eastern Bering Sea stock of beluga whales, including biases that warrant further attention as noted above. The abundance estimate for this stock could be further refined with additional information about availability probability, transect detection probability, small/dark animal detection probability, and the uncertainties associated with these probabilities. The availability bias correction factor for aerial surveys is thought to range from 2 to 3 (Citta et al. 2021). Ferguson et al. (In review) derived an availability bias correction factor of 2.0 based on beluga surface and dive behavior from five belugas, but a more precise estimate of this correction factor and a reliable estimate of the associated CV are needed. It would be desirable to explore this key topic through field studies and analyses as soon as feasible. The estimate of transect detection probability that was used in the 2017 abundance estimate was derived from a similar aerial survey for cetaceans that was conducted in the eastern Chukchi and western Beaufort seas, where the surface waters are relatively clear. Vacquie-Garcia et al. (2020) found that the sightability of beluga whales is greatly reduced in turbid water like the nearshore habitat off the Yukon River Delta where the highest densities of belugas were found during the aerial survey in 2017. Therefore, the extent to which the water color and lack of clarity in this area affect transect detection probability requires further evaluation. Additionally, several studies have documented that large numbers of dark-colored neonates and young age classes of beluga whales are not seen in surveys (e.g., Brodie 1971, Richard et al. 1994, Kingsley and Gauthier 2002). Other analyses (e.g., Lowry et al. 1999) applied correction factors for the effects of beluga coloration on detectability; however, it is not known how or to what extent coloration or beluga size affected detectability during the 2017 surveys and the appropriate data needed to evaluate this issue do not exist. Expanding the geographic area covered during the aerial surveys might also encompass a greater proportion of the habitat being used during the survey. For example, due to relatively high densities of belugas found at the southern boundary of the 2017 survey area and the lack of survey effort up the Yukon River where belugas are known to occur, it is possible that belugas from the Eastern Bering Sea stock were outside of the surveyed area at the time of the 2017 survey, resulting in a negative bias to the abundance estimate. Extending the boundary of future surveys farther south until beluga density diminishes considerably or gathering additional data from satellite telemetry or imagery could help address this question of stock range during the survey period. New analytical approaches (e.g., spatially explicit models) may offer improved methods for estimating abundance.

Beluga mortality associated with fisheries is also difficult to quantify. Coastal commercial fisheries that overlap with this stock have either never been observed or have not been observed recently. Therefore, mortality and serious injury of Eastern Bering Sea beluga whales in U.S. commercial fisheries is likely underestimated.

HABITAT CONCERNS

Evidence indicates that the arctic climate is changing significantly and that one result of the change is a reduction in the extent and duration of sea ice in most regions of the Arctic (ACIA 2004, Johannessen et al. 2004).

These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, are sensitive to changes in arctic weather, sea-surface temperatures, and sea-ice extent, and the concomitant effect on prey availability (Hauser et al. 2017b, Bailleul et al. 2012). There are indications that decreases in seasonal sea ice have influenced beluga whale phenology. Lowry et al. (2019) reported that ABWC members who live and hunt in the eastern Bering Sea and Bristol Bay observed that sea ice has formed later, melted earlier, and has not been as thick as in previous decades. Furthermore, since 2013, hunters observed that some areas have remained ice free throughout winter and other areas have experienced extremely rapid ice retreat in spring. Decreases in seasonal sea ice may also increase the risk of killer whale predation (O'Corry-Crowe et al. 2016, Castellote et al. 2022). It is unknown whether Eastern Bering Sea beluga whales have changed their areas of use in the winter; however, information from the Beaufort Sea and Eastern Chukchi Sea stocks, where tag data are more extensive, suggest that changes in timing of migration, diving behavior, and summer-fall distribution may have occurred (Hauser et al. 2017a, 2018b). There are insufficient data to make reliable predictions of the effects of arctic climate change on beluga whales; however, Laidre et al. (2008) and Heide-Jørgensen et al. (2010) concluded that on a worldwide basis beluga whales were likely to be less sensitive to climate change than other arctic cetaceans because of their wide distribution and flexible behavior.

Increased human activity in the Arctic, including increased oil and gas exploration and development, commercial vessel activity, and increased nearshore development, has the potential to impact beluga whale habitat (Moore et al. 2000, Lowry et al. 2006, Halliday et al. 2019, Halliday et al. 2021, Hauser et al. 2018a). However, predicting the type and magnitude of these impacts is difficult.

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