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) 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). The few transmitters that lasted through the winter showed that beluga whales from these summering areas overwinter in the Bering Sea; the stocks may use separate wintering locations and probably remain separated through the winter (Suydam 2009, Citta et al. 2017).

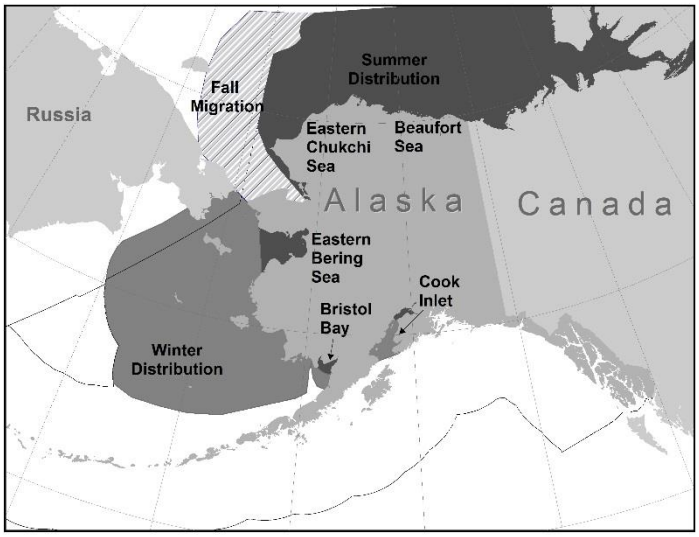

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration.

The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering and Beaufort seas. Beaufort Sea beluga whales depart from the Bering Sea in early spring, through the Chukchi Sea and into the Canadian waters of the Beaufort Sea where they remain in the summer and fall, returning to the Bering Sea in late fall. Eastern Chukchi Sea beluga whales migrate out of the Bering Sea in late spring and early summer, into the Chukchi Sea and western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. The Eastern Bering Sea stock remains in the Bering Sea but moves south near Bristol Bay in winter and returns north to Norton Sound and the mouth of the Yukon River in summer (Suydam 2009, 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. 2012, Shelden et al. 2015) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

Two beluga whales from the Eastern Bering Sea stock were tagged with satellite transmitters in 2012 near Nome. The beluga whales moved south from Nome through ice covered shelf waters during the winter, swimming south near Hagemeister Island and the Walrus Islands in Bristol Bay, before returning to Norton Sound in the spring (Citta et al. 2017). A beluga whale tagged near Nome in September 2016 has remained in the vicinity of Nome and Norton Sound through mid-January 2017 due to low ice cover in the Bering Sea (Alaska Beluga Whale Committee, 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; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, five beluga whale stocks are recognized within U.S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 1).

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 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). 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 Delta region were conducted in June 1999 and 2000 (Lowry et al. 2017). Unlike previous survey years, in 1999 sea ice persisted in western Norton Sound resulting in a much 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 covariate line-transect model. Results indicate 3,497 beluga whales (CV = 0.37) were seen at the surface in the study area (Lowry et al. 2017). If this estimate were doubled to correct for the proportion of whales that were diving, and thus not visible at the surface, the total abundance for the Eastern Bering Sea stock would be 6,994 beluga whales (95% CI: 3,162-15,472).

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 (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 6,994 and an associated coefficient of variation CV(N) of 0.37, N_{MIN} for this stock is 5,173 beluga whales. However, because the survey data are more than 8 years old, it is not considered a reliable minimum population estimate for calculating a PBR, and N_{MIN} is considered unknown.

Current Population Trend

Surveys to estimate population abundance in Norton Sound 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. Available data do not allow an evaluation of population trend for the Eastern Bering Sea stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is unavailable for the Eastern Bering Sea stock of beluga whales. Lowry et al. (2008) estimated the rate of increase of the Bristol Bay beluga whale stock was 4.8% per year (95% CI = 2.1%-7.5%) over a 12-year period. However, until additional data become available specific to the Eastern Bering Sea stock, 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 1.0, the value for cetacean stocks that are thought to be stable in the presence of a subsistence harvest (Wade and Angliss 1997). However, the 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. Therefore, the PBR for the Eastern Bering Sea stock of beluga whales is considered undetermined.

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. The total estimated annual level of human-caused mortality and serious injury for Eastern Bering Sea beluga whales in 2011-2015 is 206 beluga whales: 0.2 in U.S. commercial fisheries and 206 in subsistence takes by Alaska Natives; however, 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.

Assignment of mortality and serious injury to the Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay stocks when stock is unknown, and the event occurred at a time and in an area where the three stocks could occur, may result in overestimating stock specific mortality and serious injury in federal commercial fisheries. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include entanglement in fishing gear.

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.

During 2011-2015, one beluga whale mortality occurred in the Bering Sea/Aleutian Islands pollock trawl fishery (Table 1; Breiwick 2013; MML, unpubl. data). A genetics sample was collected but has not been analyzed. Since the stock of the beluga whale is unknown, and the event occurred at a time and in an area where the Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay stocks could occur, this mortality has been assigned to all three stocks (NMFS 2016).

Table 1. Summary of incidental mortality and serious injury of Eastern Bering Sea beluga whales due to U.S. commercial fisheries in 2011-2015 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. pollock trawl	2011	obs data	98	0	0	0.2 (CV = 0.09)
	2012		98	0	0	
	2013		97	1	1.0	
	2014		98	0	0	
	2015		99	0	0	
Minimum total estimated annual mortality						0.2 (CV = 0.16)

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 have been incidentally taken (Frost et al. 1984). However, there are no useful data on beluga whale incidental takes from this stock because there have never been observer programs in these commercial fisheries and there is no reporting requirement for takes in personal use fisheries. NMFS assumes that all beluga whales killed in these fisheries are used for subsistence, regardless of the method of harvest, and are reported to the ABWC. These subsistence takes are 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 in 2011-2015 is 0.2 beluga whales from this stock. However, because there has never been an observer program for state-managed nearshore commercial fisheries in the eastern Bering Sea region, a reliable estimate of the mortality and serious injury incidental to U.S. commercial fisheries is not available.

Alaska Native Subsistence/Harvest Information

The subsistence take of beluga whales from the Eastern Bering Sea stock is provided by the ABWC. The most recent subsistence harvest estimates for the stock are provided in Table 2 (ABWC, unpubl. data, 2016). Beluga whales harvested in Kuskokwim villages are included in the total harvest for the Eastern Bering Sea beluga whale stock. The annual subsistence take by Alaska Native villages averaged 206 beluga whales landed from the Eastern Bering Sea stock in 2011-2015.

Table 2. Summary of Eastern Bering Sea beluga whales landed by Alaska Native subsistence hunters in 2011-2015 (ABWC, unpubl. data, 2016). These are minimum estimates of the total number of beluga whales taken, since struck and lost data are not consistently provided.

Year	Reported total number landed
2011	205
2012	181
2013	216
2014	237
2015	193
Mean annual number landed	206

STATUS OF STOCK

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries is 0.2 whales. Because the PBR is undetermined, the mean annual U.S. commercial fishery-related mortality and serious injury rate that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The total estimated annual level of human-caused mortality and serious injury is 206 beluga whales. Eastern Bering Sea beluga whales are not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. Therefore, the Eastern Bering Sea stock of beluga whales is classified as a non-strategic stock.

There are some key uncertainties in the assessment of the Eastern Bering Sea stock of beluga whales. The abundance is based on a line-transect survey; the resulting estimate is doubled to account for the proportion of whales that are diving and thus missed by the observers. It is not known whether doubling the estimate accurately accounts for whales missed. The population rate of increase is unknown. Coastal commercial fisheries that overlap with this stock have either never been observed or have not been observed recently, so mortality and serious injury of Eastern Bering Sea beluga whales in commercial fisheries could be underestimated. Coastal subsistence fisheries for fish will occasionally cause incidental mortality or serious injury of a beluga whale; these incidental takes used for subsistence purposes are not always reported to the ABWC and included in the estimate of subsistence harvest for the stock.

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 ice extent, and the concomitant effect on prey availability. Decreases in seasonal sea ice may also increase the risk of killer whale predation (O'Corry-Crowe et al. 2016). 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 populations (Hauser et al. 2017), where tag data are more extensive, suggest that changes in timing of migration and winter distribution may have occurred. 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 and increased nearshore development, has the potential to impact habitat for beluga whales (Moore et al. 2000, Lowry et al. 2006); however, predicting the type and magnitude of the impacts is difficult.

CITATIONS

Arctic Climate Impact Assessment (ACIA). 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK.

Breiwick, J. M. 2013. North Pacific marine mammal bycatch estimation methodology and results, 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-260, 40 p.

Citta, J. J., L. T. Quakenbush, K. J. Frost, L. Lowry, R. C. Hobbs, and H. Aderman. 2016. Movements of beluga whales (*Delphinapterus leucas*) in Bristol Bay, Alaska. Mar. Mammal Sci. 32:1272-1298. DOI: dx.doi.org/10.1111/mms.12337 .

Citta, J. J., P. Richard, L. F. Lowry, G. O'Corry-Crowe, M. Marcoux, R. Suydam, L. T. Quakenbush, R. C. Hobbs, D. I. Litovka, K. J. Frost, T. Gray, J. Orr, B. Tinker, H. Aderman, and M. L. Druckenmiller. 2017. Satellite telemetry reveals population specific winter ranges of beluga whales in the Bering Sea. Mar. Mammal Sci. 33:236-250. DOI: dx.doi.org/10.1111/mms.12357 .

Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. Conserv. Biol. 6:24-36.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska, p. 39-57. *In* T. G. Smith, D. J. St. Aubin, and J. R. Geraci (eds.), Advances in research on the beluga whale, *Delphinapterus leucas*. Can. Bull. Fish. Aquat. Sci. 224.

Frost, K. J., L. F. Lowry, and R. R. Nelson. 1984. Belukha whale studies in Bristol Bay, Alaska, p. 187-200. *In* Proceedings of the workshop on biological interactions among marine mammals and commercial fisheries in the southeastern Bering Sea, October 18-21, 1983, Anchorage AK. Alaska Sea Grant Report 84-1.

Goetz, K. T., P. W. Robinson, R. C. Hobbs, K. L. Laidre, L. A. Huckstadt, and K. E. W. Shelden. 2012. Movement and dive behavior of beluga whales in Cook Inlet, Alaska. AFSC Processed Rep. 2012-03, 40 p. Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Gurevich, V. S. 1980. Worldwide distribution and migration patterns of the white whale (beluga), *Delphinapterus leucas*. Rep. Int. Whal. Comm. 30:465-480.

Hauser, D. D. W., K. L. Laidre, R. S. Suydam, and P. R. Richard. 2014. Population-specific home ranges and migration timing of Pacific Arctic beluga whales (*Delphinapterus leucas*). Polar Biol. 37:1171-1183. DOI: dx.doi.org/10.1007/s00300-014-1510-1 .

Hauser, D. D. W., K. L. Laidre, K. M. Stafford, H. L. Stern, R. S. Suydam, and P. R. Richard. 2017. Decadal shifts in autumn migration timing by Pacific Arctic beluga whales are related to delayed annual sea ice formation. Glob. Change Biol. 23:2206-2217. DOI: dx.doi.org/10.1111/gcb.13564 .

Hazard, K. 1988. Beluga whale, *Delphinapterus leucas*, p. 195-235. *In* J. W. Lentfer (ed.), Selected Marine Mammals of Alaska. Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, DC.

Heide-Jørgensen, M., K. Laidre, D. Borchers, T. Marques, H. Stern, and M. Simon. 2010. The effect of sea-ice loss on beluga whales (*Delphinapterus leucas*) in West Greenland. Polar Res. 29:198-208. DOI: dx.doi.org/10.1111/j.1751-8369.2009.00142.x .

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. 2017. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2011-2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-354, 112 p.

Hobbs, R. C., K. L. Laidre, D. J. Vos, B. A. Mahoney, and M. Eagleton. 2005. Movements and area use of belugas, *Delphinapterus leucas*, in a subarctic Alaskan estuary. Arctic 58(4):331-340.

Johannessen, O. M., L. Bengtson, M. W. Miles, S. I. Kuzmina, V. A. Semenov, G. V. Alexseev, A. P. Nagurnyi, V. F. Zakharov, L. P. Bobylev, L. H. Pettersson, K. Hasselmann, and H. P. Cattle. 2004. Arctic climate change: observed and modeled temperature and sea-ice variability. Tellus 56A:328-341.

Laidre, K. L., I. Stirling, L. Lowry, Ø. Wiig, M. P. Heide-Jørgensen, and S. Ferguson. 2008. Quantifying the sensitivity of arctic marine mammals to climate-induced habitat change. Ecol. Appl. 18(2):S97-S125.

Lowry, L. F. 1985. The belukha whale (*Delphinapterus leucas*), p. 3-13. *In* J. J. Burns, K. J. Frost, and L. F. Lowry (eds.), Marine mammals species accounts. Alaska Department of Fish and Game, Game Tech. Bull. 7.

Lowry, L. F., D. P. DeMaster, and K. J. Frost. 1999. Alaska Beluga Whale Committee surveys of beluga whales in the eastern Bering Sea, 1992-1995. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/51/SM34). 22 p.

Lowry, L., G. O'Corry-Crowe, and D. Goodman, D. 2006. *Delphinapterus leucas* (Cook Inlet population). In IUCN 2006. 2006 IUCN Red List of Threatened Species.

Lowry, L. F., K. J. Frost, A. Zerbini, D. DeMaster, and R. R. Reeves. 2008. Trend in aerial counts of beluga or white whales (*Delphinapterus leucas*) in Bristol Bay, Alaska. J. Cetacean Res. Manage. 10(3):201-207.

Lowry, L. F., A. Zerbini, K. J. Frost, D. P. DeMaster, and R. C. Hobbs. 2017. Development of an abundance estimate for the Eastern Bering Sea stock of beluga whales (*Delphinapterus leucas*). J. Cetacean Res. Manage. 16:39-47.

Moore, S. E., K. E. W. Shelden, L. K. Litzky, B. A. Mahoney, and D. J. Rugh. 2000. Beluga, *Delphinapterus leucas*, habitat associations in Cook Inlet, Alaska. Mar. Fish. Rev. 62(3):60-80.

National Marine Fisheries Service (NMFS). 2016. Guidelines for preparing stock assessment reports pursuant to the 1994 amendments to the Marine Mammal Protection Act. 23 p. Available online: https://www.fisheries.noaa.gov/national/marine-mammal-protection/guidelines-assessing-marine-mammal-stocks . Accessed June 2018.

O'Corry-Crowe, G. M., R. S. Suydam, A. Rosenberg, K. J. Frost, and A. E. Dizon. 1997. Phylogeography, population structure and dispersal patterns of the beluga whale *Delphinapterus leucas* in the western Nearctic revealed by mitochondrial DNA. Mol. Ecol. 6:955-970.

O'Corry-Crowe G., A. R. Mahoney, R. Suydam, L. Quakenbush A. Whiting, L. Lowry, and L. Harwood. 2016. Genetic profiling links changing sea-ice to shifting beluga whale migration patterns. Biol. Lett. 12:20160404. DOI: dx.doi.org/10.1098/rsbl.2016.0404 .

Quakenbush, L. 2003. Summer movements of beluga whales captured in the Kvichak River in May 2002 and 2003. Alaska Beluga Whale Committee Report 03-03. 15 p.

Shelden, K. E. W., K. T. Goetz, D. J. Rugh, D. G. Calkins, B. A. Mahoney, and R. C. Hobbs. 2015. Spatio-temporal changes in beluga whale, *Delphinapterus leucas*, distribution: results from aerial surveys (1977-2014), opportunistic sightings (1975-2014), and satellite tagging (1999-2003) in Cook Inlet, Alaska. Mar. Fish. Rev. 77(2):1-31 + appendices. DOI: dx.doi.org/10.7755/MFR.77.2.1 .

Suydam, R. S. 2009. Age, growth, reproduction, and movements of beluga whales (*Delphinapterus leucas*) from the eastern Chukchi Sea. Ph.D. Dissertation, University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA.

Wade, P. R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 p.