Alaska Marine Mammal Stock Assessments, ~~2020~~2021

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PREFACE

On 30 April 1994, Public Law 103-238 was enacted allowing significant changes to provisions within the Marine Mammal Protection Act (MMPA). Interactions between marine mammals and commercial fisheries are addressed under three new sections. This new regime replaced the interim exemption that had regulated fisheries-related incidental takes since 1988. Section 117, Stock Assessments, required the establishment of three regional scientific review groups to advise and report on the status of marine mammal stocks within Alaska waters, along the Pacific Coast (including Hawaii), and along the Atlantic Coast (including the Gulf of Mexico). This report provides information on the marine mammal stocks of Alaska under the jurisdiction of the National Marine Fisheries Service.

Each stock assessment includes, when available, a description of the stock's geographic range; a minimum population estimate; current population trends; current and maximum net productivity rates; optimum sustainable population levels and allowable removal levels; estimates of annual human-caused mortality and serious injury through interactions with commercial, recreational, and subsistence fisheries, takes by subsistence hunters, and other human-caused events (e.g., entanglement in marine debris, ship strikes); and habitat concerns. The commercial fishery interaction data will be used to evaluate the progress of each fishery towards achieving the MMPA's goal of zero fishery-related mortality and serious injury of marine mammals.

The Stock Assessment Reports should be considered working documents, as they are updated as new information becomes available. The Alaska Stock Assessment Reports were originally developed in 1995 (Small and DeMaster 1995). Revisions have been published for the following years: 1996 (Hill et al. 1997), 1998 (Hill and DeMaster 1998), 1999 (Hill and DeMaster 1999), 2000 (Ferrero et al. 2000), 2001 (Angliss et al. 2001), 2002 (Angliss and Lodge 2002), 2003 (Angliss and Lodge 2004), 2005 (Angliss and Outlaw 2005), 2006 (Angliss and Outlaw 2007), 2007 (Angliss and Outlaw 2008), 2008 (Angliss and Allen 2009), 2009 (Allen and Angliss 2010), 2010 (Allen and Angliss 2011), 2011 (Allen and Angliss 2012), 2012 (Allen and Angliss 2013), 2013 (Allen and Angliss 2014), 2014 (Allen and Angliss 2015), 2015 (Muto et al. 2016), 2016 (Muto et al. 2017), 2017 (Muto et al. 2018), 2018 (Muto et al. 2019), ~~and~~ 2019 (Muto et al. 2020), and 2020 (Muto et al. in press). Each Stock Assessment Report is designed to stand alone and is updated as new information becomes available. The MMPA requires Stock Assessment Reports to be reviewed annually for stocks designated as strategic, annually for stocks where there is significant new information available, and at least once every 3 years for all other stocks. NMFS reviewed new information for ~~28~~19 stocks (including all of the strategic stocks) in the Alaska Region in ~~2019-2020~~2020-2021 and revised ~~23~~5 Stock Assessment Reports under NMFS' jurisdiction: ~~all 15~~4 strategic stocks (~~Western U.S. Steller sea lions;~~ Eastern Pacific northern fur seals~~;~~, ~~bearded seals; ringed seals;~~ Cook Inlet beluga whales~~;~~, ~~AT1 Transient killer whales;~~ Southeast Alaska~~, Gulf of Alaska, and Bering Sea stocks of~~ harbor porpoise~~;~~, ~~sperm whales; Western North Pacific and Central North Pacific stocks of humpback whales; fin whales; North Pacific right whales;~~ and Western Arctic bowhead whales) and ~~8~~1 non-strategic stock~~s~~ (~~spotted seals; ribbon seals; Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay stocks of beluga whales; and Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and West Coast Transient stocks of killer whales~~Alaska Dall's porpoise). The Stock Assessment Reports for all of the Alaska stocks, however, are included in ~~this~~the final document to provide a complete reference. Those sections of each Stock Assessment Report containing ~~significant~~substantial changes in 2021 are listed in Appendix 1. The authors solicit any new information or comments which would improve future Stock Assessment Reports.

New abundance estimates were calculated for the following Alaska stocks in the ~~2020~~2021 Stock Assessment Reports. For explanations of why estimates have changed, see the individual report for each stock:

- ~~Western U.S. Steller sea lions: The updated best model estimated count in 2019, derived from aerial photographic and land-based surveys in 2018 and 2019, is 52,932 sea lions. This is a decrease from the previous estimate of 53,624. The model estimated count is not a total population abundance estimate because the count has not been corrected for animals at sea during the surveys or for pups that are born before or die after the surveys.~~
- Eastern Pacific northern fur seals: The updated best abundance estimate, derived from counts on Sea Lion Rock in 2014, St. Paul and St. George Islands in 2014, 2016, and 2018, and Bogoslof Island in 2015 and 2019, is ~~608,143~~626,618 northern fur seals. This is an ~~decrease~~increase from the previous estimate of ~~620,660~~608,143.
- ~~Eastern Chukchi Sea beluga whales: The updated best abundance estimate, derived from aerial surveys in summer 2017 in the Beaufort Sea (in an area and time period in which the Beaufort Sea and Eastern Chukchi Sea stocks do not overlap, as determined from satellite tag data), is 13,305 beluga whales. This is a decrease from the previous estimate of 20,752, derived from aerial surveys of the northeastern Chukchi and Alaska Beaufort seas in 2012.~~
- ~~Eastern Bering Sea beluga whales: The updated best abundance estimate, derived from aerial surveys in 2017, is 9,242 beluga whales. This is an increase from the previous estimate of 6,994.~~
- ~~Bristol Bay beluga whales: The updated best abundance estimate, derived from aerial surveys in 2016, is 2,040 beluga whales. This is an increase from the previous estimate of 1,926.~~

- ~~Cook Inlet beluga whales: The updated best estimate of abundance in 2018, derived using a new analytical method on aerial survey data from 2014, 2016, and 2018, is 279 beluga whales. This is a decrease from the previous estimate of 327.~~
- ~~West Coast Transient killer whales: The updated best estimate of abundance in 2018, derived from an analysis of photo-identification data from 1958 to 2018 for a subset of whales in British Columbia waters, is 349 killer whales. This is an increase from the previous estimate of 243, derived for a subset of whales in the inside waters of Southeast Alaska, British Columbia, and northern Washington.~~
- Southeast Alaska harbor porpoise: The updated best estimate of abundance (uncorrected for animals missed on the trackline), derived from a vessel survey in 2019, is 1,302 harbor porpoise. This estimate is not statistically different from the previous (uncorrected) estimate of 975 in 2010-2012. However, the estimates for both 2010-2012 and 2019 are for the inland waters of Southeast Alaska, which is only a portion of the range of this stock.
- Alaska Dall's porpoise: An abundance estimate for Dall's porpoise in the northwestern Gulf of Alaska, derived from a vessel survey in 2015, is 13,110 porpoise. However, this estimate is for only a small portion of the stock's range and is not considered a reliable estimate for the entire stock.
- ~~Bering Sea harbor porpoise: An abundance estimate for harbor porpoise in the eastern Bering Sea, derived from vessel surveys in association with pollock stock assessment surveys in 2008, is 5,713 harbor porpoise. However, this estimate is for only a small portion of the range of this stock and, because the survey data are more than 8 years old, the minimum population estimate (N_{MIN}) is now considered unknown and the potential biological removal (PBR) is considered undetermined.~~

The U.S. Fish and Wildlife Service (USFWS) has management authority for polar bears, sea otters, and walruses. Copies of the stock assessments for these species are included in Appendix 4 of this document for your convenience.

Ideas and comments from the Alaska Scientific Review Group (SRG) have significantly improved this document from its draft form. The authors wish to express their gratitude for the thorough reviews and helpful guidance provided by the Alaska Scientific Review Group members: John Citta, Beth Concepcion, Thomas Doniol-Valcroze, Mike Miller, Greg O'Corry-Crowe (Co-Chair in 2019-~~2020~~2021), Lorrie Rea, Megan Peterson Williams (Co-Chair in 2019-~~2020~~2021), Eric Regehr, and Kate Stafford. We would also like to acknowledge the contributions from the NMFS Alaska Regional Office and the Communications Program of the Alaska Fisheries Science Center.

The information contained within the individual Stock Assessment Reports ~~stems~~is from a variety of sources. Where feasible, we have attempted to use only published material. When citing information contained in this document, authors are reminded to cite the original publications, when possible.

CONTENTS*

*NMFS Stock Assessment Reports and Appendices revised in ~~2020~~2021 are in boldface.

Revised ~~12/30/2020~~7/8/2021

NORTHERN FUR SEAL (*Callorhinus ursinus*): Eastern Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern fur seals occur from southern California north to the Bering Sea (Fig. 1) and west to the Sea of Okhotsk and Honshu Island, Japan. During the summer breeding season, most of the worldwide population is found on the Pribilof Islands (St. Paul Island and St. George Island) in the southern Bering Sea, with the remaining animals on rookeries in Russia, on Bogoslof Island in the southern Bering Sea, on San Miguel Island off southern California (Lander and Kajimura 1982, NMFS 1993), and on the Farallon Islands off central California. Non-breeding northern fur seals may occasionally haul out on land at other sites in Alaska, British Columbia, and on islets along the west coast of the United States (Fiscus 1983).

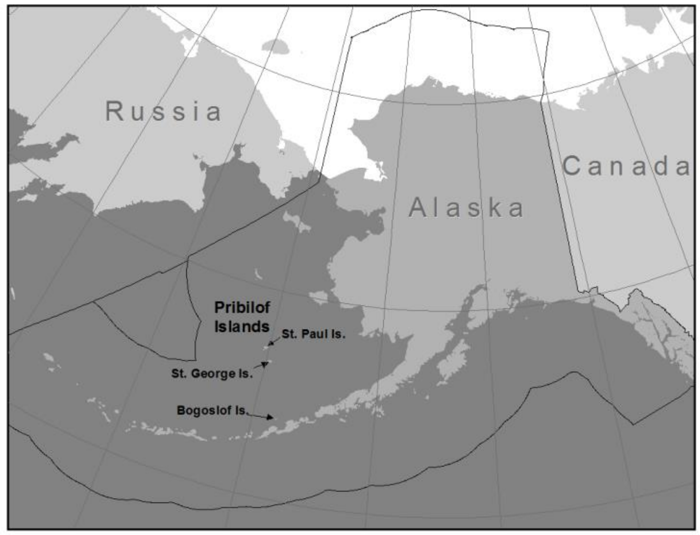

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area). Eastern Pacific northern fur seal breeding colonies in U.S. waters are located on the three named islands. The U.S. Exclusive Economic Zone is delineated by a black line.

During the reproductive season, adult males usually are on shore during the 4-month period from May to August, although some may be present until November (well after giving up their territories). Adult females are ashore during a 6-month period (June-November). Following their respective times ashore, Alaska northern fur seals of both genders then move south and remain at sea until the next breeding season (Roppel 1984). Adult females and pups from the Pribilof Islands move through the Aleutian Islands into the North Pacific Ocean, often to the waters offshore of Oregon and California (Ream et al. 2005). Adult males generally move only as far south as the Gulf of Alaska in the eastern North Pacific (Kajimura 1984) and the Kuril Islands in the western North Pacific (Loughlin et al. 1999). In Alaska, pups are born during summer months and leave the rookeries in the fall, on average around mid-November but ranging from late October to early December. Alaska northern fur seal pups generally remain at sea for 22 months (Kenyon and Wilke 1953) before returning to land, usually at their rookery of birth but with considerable interchange of individuals between rookeries.

Two separate stocks of northern fur seals, an Eastern Pacific stock and a California stock, are recognized within U.S. waters based on the distribution and population response factors of the Dizon et al. (1992) phylogeographic approach, which considers four types of data: 1) Distribution: continuous during non-breeding season and discontinuous during the breeding season, high natal site fidelity (DeLong 1982, Baker et al. 1995); 2) Population response: substantial differences in population dynamics between the Pribilof Islands and San Miguel Island (DeLong 1982, DeLong and Antonelis 1991, NMFS 1993); 3) Phenotypic differentiation: unknown; and 4) Genotypic differentiation: little evidence of genetic differentiation among breeding islands (Ream 2002, Dickerson et al. 2010). The California stock is reported in the Stock Assessment Reports for the U.S. Pacific Region.

This stock assessment report assesses the abundance and Native subsistence harvest of Eastern Pacific northern fur seals at the breeding colonies in U.S. waters; human-caused mortality and serious injury other than subsistence harvest is estimated only for the portion of the stock's range within U.S. waters (i.e., the U.S. Exclusive Economic Zone), because relevant data are generally not available for the broader range of the stock.

POPULATION SIZE

The population estimate for the Eastern Pacific stock of northern fur seals is calculated as the estimated number of pups born at rookeries in the eastern Bering Sea multiplied by a series of expansion factors determined from a life table analysis to estimate the number of yearlings, 2-year-olds, 3-year-olds, and animals 4 or more years old (Lander 1981). The resulting population estimate is equal to the pup production estimate multiplied by 4.47. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. There is no coefficient of variation (CV) for the expansion factor. Pup production is estimated at all islands using a mark-recapture method, or "shear-sampling" (Chapman and Johnson 1968, York and Kozloff 1987, Towell et al. 2006), with the exception of estimates conducted at Bogoslof Island through 1995, where the smaller population size in those years allowed direct counting of pups. As the majority of pups are born on St. Paul and St. George Islands, pup surveys are conducted biennially on these islands. Pup production estimates are available less frequently on Sea Lion Rock (adjacent to St. Paul Island) and Bogoslof Island (Table 1). Annual variation in female reproductive rates is reflected in the respective pup production estimates. Because the estimation of stock population size relies on these estimates of pup production, means of recent pup production estimates are used to account for variability in the reproductive rates over time. The most recent estimate for the number of northern fur seals in the Eastern Pacific stock, based on pup production estimates on Sea Lion Rock (2014), on St. Paul and St. George Islands (mean of 2014, 2016, and 2018), and on Bogoslof Island (mean of 2015 and 2019), is ~~608,143~~626,618 northern fur seals (4.47 × ~~136,050~~140,183).

Table 1. Estimates and/or counts of northern fur seal pups born on the Pribilof Islands and Bogoslof Island. Standard errors for pup estimates at rookery locations and the CV for total pup production estimates are provided in parentheses (direct counts do not have standard errors). The " symbol indicates that no new data are available for that year and, thus, the most recent prior estimate/count was used in determining total annual estimates.

	Rookery location				
Year	**St. Paul**	**Sea Lion Rock**	**St. George**	**Bogoslof**	**Total**
1994	192,104 (8,180)	12,891 (989)	22,244 (410)	1,472 (N/A)	228,711 (0.036)
1995	"	"	"	1,272 (N/A)	228,511 (0.036)
1996	170,125 (21,244)	"	27,385 (294)		211,673 (0.10)
1997	"	"	"	5,096 (33)	215,497 (0.099)
1998	179,149 (6,193)	"	22,090 (222)		219,226 (0.029)
2000	158,736 (17,284)	"	20,176 (271)	"	196,899 (0.089)
2002	145,716 (1,629)	8,262 (191)	17,593 (527)	"	176,667 (0.01)
2004	122,825 (1,290)	"	16,876 (239)	"	153,059 (0.01)
2005	"	"	"	12,631 (335)	160,594 (0.01)
2006	109, 961 (1,520)	"	17,072 (144)	"	147,900 (0.011)
2007	"	"	"	17,574 (843)	152,867 (0.011)
2008	102,674 (1,084)	6,741 (80)	18,160 (288)	"	145,149 (0.009)
2010	94,502 (1,259)	"	17,973 (323)	"	136,790 (0.011)
2011	"	"	"	22,905 (921.5)	142,121 (0.011)
2012	96,828 (1,260)	"	16,184 (155)	"	142,658 (0.011)
2014	91,737 (769)	5,250 (293)	18,937 (308)	"	138,829 (0.009)
2015	"	"	"	27,750 (228)	143,674 (0.006)

	Rookery location				
Year	**St. Paul**	**Sea Lion Rock**	**St. George**	**Bogoslof**	**Total**
2016	80,641 (717)	“	20,490 (460)	“	134,131 (0.007)
2018	75,719 (1,008)	“	21,625 (345)	“	130,344 (0.009)
2019	“	“	“	36,015 (1,098)	141,609 (0.011)

Minimum Population Estimate

A CV(N) that incorporates the variance of the correction factor is not available. Consistent with a recommendation of the Alaska Scientific Review Group (SRG) in October 1997 (DeMaster 1998) and recommendations contained in Wade and Angliss (1997), a default CV(N) of 0.2 is used in the calculation of the minimum population estimate (N_{MIN}) for this stock. N_{MIN} is calculated using Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of ~~608,143~~626,618 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock is ~~514,738~~530,376 northern fur seals.

Current Population Trend

Estimates of the size of the Alaska population of northern fur seals increased to approximately 1.25 million in 1974. The population began to decrease in the mid-1970s, with pup production declining at a rate of 6.5-7.8% per year into the 1980s (York 1987). By 1983, the total stock estimate was 877,000 northern fur seals (Briggs and Fowler 1984). Annual pup production on St. Paul Island remained stable between 1981 and 1996 (Fig. 2; York and Fowler 1992). There has been a decline in pup production on St. Paul Island since the mid-1990s. Pup production at St. George Island had a less pronounced period of stabilization, beginning in the late-1980s, that was similarly followed by a decline. However, pup production stabilized again on St. George Island beginning around 2002 (Fig. 3). From 1998 to 2018, pup production declined 4.09% per year (SE = 0.34%; P < 0.01) on St. Paul Island and showed no significant trend (SE = 0.58%; P = 0.59) on St. George Island. The estimated pup production in 2018 was below the 1919 level (Bower 1920) on both St. Paul and St. George Islands. Northern fur seal pup production at Bogoslof Island has grown at an exponential rate since the 1990s (Towell and Ream 2012) (Fig. 4). Despite continued growth at Bogoslof Island, recent estimates of pup production indicate that the rate of increase may be slowing. ~~Between 1997 and 2015, pup production at Bogoslof Island increased 10.1% per year.~~Since the first pups were observed on Bogoslof Island in 1980, pup production has increased at an annual rate of 30.0% (SE = 2.41) but has slowed to an annual rate of 9.2% (SE = 0.91) since 1997. Temporary increases in the overall stock size are observed when opportunistic estimates are conducted at Bogoslof, but declines at the larger Pribilof colony (specifically St. Paul) continue to drive the overall stock estimate down over time. ~~The current~~Recent (20-year and 10-year) trends in pup production ~~was~~were fit using agTrend (Johnson and Fritz 2014). Estimated pup production for the Eastern Pacific stock has been declining at ~~1.93~~1.80% (95% CI: ~~-2.67~~ -2.36 to ~~-1.24~~ -1.19) per year from ~~1998~~1999 to ~~2018~~2019 (Fig. 5) but only at 0.55% (95% CI: -2.11 to 1.06; not significantly different from 0) per year from 2009 to 2019 (Fig. 6).

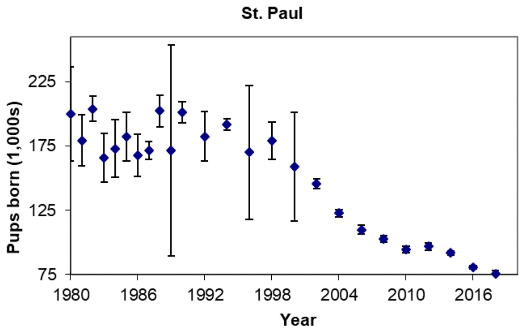

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, 1980-2018.

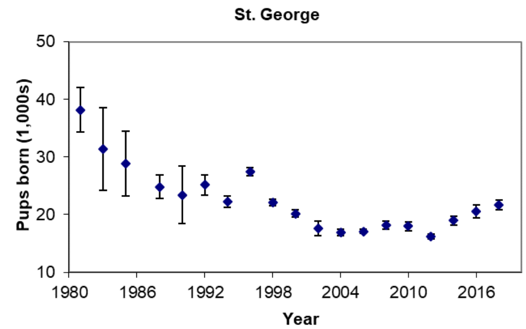

Figure 3. Estimated number of northern fur seal pups born on St. George Island, 1980-2018.

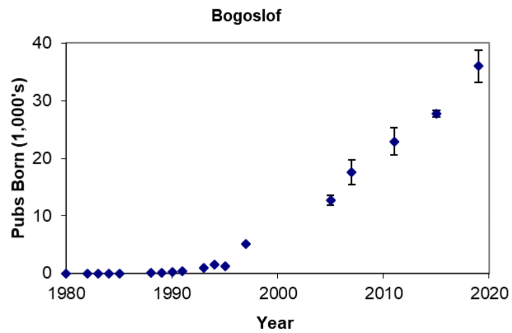

Figure 4. Estimated number of northern fur seal pups born on Bogoslof Island, ~~1980-2015~~1980-2019.

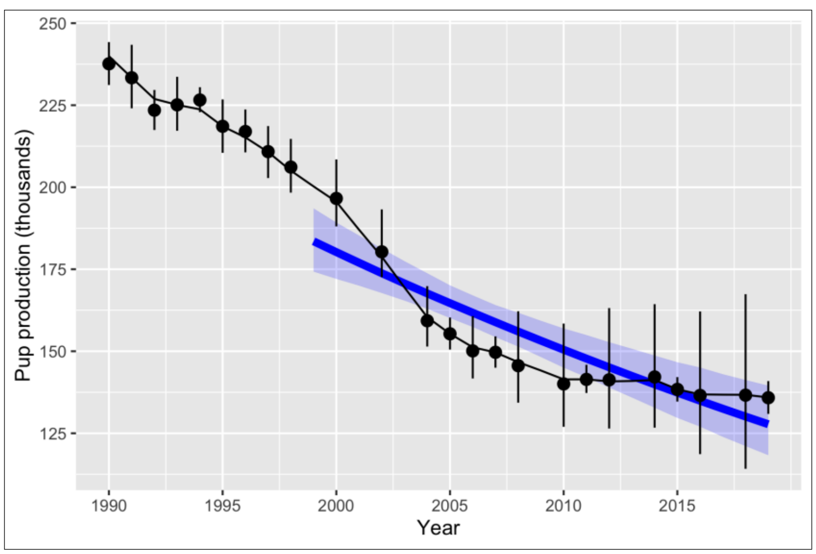

Figure 5. Estimated pup production for the Eastern Pacific stock, 1990-~~2018~~2019, from agTrend (dots), 95% credible interval (bars), agTrend temporal interpolation fit (black line), ~~1998-2018~~1999-2019 average decline (blue line), and 95% credible interval for the fitted average decline in each year (light blue shading).

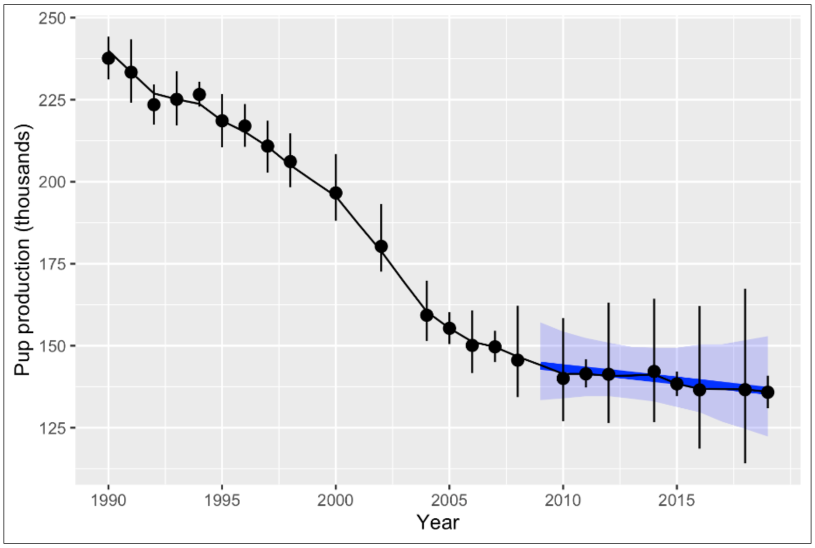

Figure 6. Estimated pup production for the Eastern Pacific stock, 1990-2019, from agTrend (dots), 95% credible interval (bars), agTrend temporal interpolation fit (black line), 2009-2019 average decline (blue line), and 95% credible interval for the fitted average decline in each year (light blue shading).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Pelagic sealing led to a decrease in the fur seal population; however, a moratorium on fur seal harvesting and termination of pelagic sealing resulted in a steady increase in the northern fur seal population from 1912 to 1924. During this period, the rate of population growth was approximately 8.6% (SE = 1.47) per year (A. York, NMFS-AFSC-MML (retired), unpubl. data), the maximum recorded for this species. This growth rate is similar and slightly higher than the 8.1% rate of increase (approximate SE = 1.29) estimated by Gerrodette et al. (1985). Though not as high as growth rates estimated for other fur seal species, the 8.6% rate of increase is considered a reliable estimate of the maximum net productivity rate (R_{MAX}) given the extremely low density of the population in the early 1900s.

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum estimated 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 0.5, the value for depleted stocks under the Marine Mammal Protection Act (MMPA) (NMFS 2016). Thus, for the Eastern Pacific stock, PBR is ~~11,067~~11,403 northern fur seals (~~514,738~~530,376 × 0.043 × 0.5).

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 ~~2014~~2015 and ~~2018~~2019 is listed, by marine mammal stock, in ~~Young et al. (2020)~~Freed et al. (in prep.); 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 the Eastern Pacific stock between ~~2014~~2015 and ~~2018~~2019 is ~~387~~373 northern fur seals: ~~3.4~~3.5 in U.S. commercial fisheries (2.7 from observer data and 0.8 from stranding data), 2.4 in unknown (commercial, recreational, or subsistence) fisheries, 7~~.8~~ in marine debris, ~~0.6~~0.4 due to other causes (car strike, dog attack~~, oil/tar~~), and ~~373~~360 in the Alaska Native subsistence harvest. These mortality and serious injury data do not reflect the total potential threat of entanglement, since additional northern fur seals initially considered seriously injured due to entanglement in fishing gear or marine debris were disentangled and released with non-serious injuries between ~~2014~~2015 and ~~2018~~2019 (see details in the text and in ~~Young et al. 2020~~Freed et al. in prep.). Assignment of mortality and serious injury to both the Eastern Pacific and California stocks of northern fur seals, when events occur in the area and time of year where the two stocks overlap (off the U.S. west coast in December through May), may result in overestimating stock specific mortality and serious injury. Additional potential threats most likely to result in direct human-caused mortality or serious injury of this stock include the increased potential for oil spills due to an increase in vessel traffic in Alaska waters (with changes in sea-ice coverage).

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 ~~December 2020~~July 2021).

Based on historical reports and the stock's geographic range, northern fur seal mortality and serious injury is known to occur in several fishing gear types, including trawl, gillnet, and longline fisheries. However, observer data are limited. Both trawl and longline fisheries are regularly observed, but this occurs at different levels dependent upon the target species and location. Observation is as high as 100% in some trawl fisheries, but it is less than 50% in other trawl and longline fisheries that also have the potential to overlap with northern fur seals. Further, drift gillnet and set gillnet fisheries in Alaska are not currently observed. Therefore, the potential for fisheries-caused mortality and serious injury may be greater than is reflected in existing observer data.

Between ~~2014~~2015 and ~~2018~~2019, incidental mortality and serious injury of northern fur seals was observed in one of the federally-managed U.S. commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl fishery (Table 2; Breiwick 2013; MML, unpubl. data). The minimum estimated mean annual mortality and serious injury rate in this fishery between ~~2014~~2015 and ~~2018~~2019 is ~~0.8~~2.7 northern fur seals.

Observer programs for Alaska State-managed commercial fisheries have not documented any mortality or serious injury of northern fur seals.

Table 2. Summary of observed incidental mortality and serious injury of Eastern Pacific northern fur seals due to U.S. commercial fisheries between ~~2014~~2015 and ~~2018~~2019 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 3 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality (CV)	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	~~2014~~ 2015 2016 2017 2018 2019	obs data	~~100~~ 100 99 100 100 100	~~1~~ 0 0 1 2 10	~~1 (0.04)~~ 0 0 1 (0.03) 2 (0.03) 10 (0.05)	~~0.8~~2.7 (CV = ~~0.02~~0.04)
Minimum total estimated annual mortality						~~0.8~~2.7 (CV = ~~0.02~~0.04)

Entanglements of northern fur seals have been observed on St. Paul, St. George, and Bogoslof Islands. Since 2011, there has been an increased effort to include entanglement reports in the NMFS Alaska Region marine mammal stranding database. A summary of entanglements in fishing gear reported between ~~2014~~2015 and ~~2018~~2019 is provided in Table 3 (~~Young et al. 2020~~Freed et al. in prep.). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and are minimums because not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined. ~~Three northern fur seals entangled in commercial Bering Sea/Aleutian Islands halibut longline gear and six~~One dead and three seriously injured northern fur seals entangled in commercial Bering Sea/Aleutian Islands trawl gear were reported to the NMFS Alaska Region marine mammal stranding network between ~~2014~~2015 and ~~2018~~2019, resulting in a minimum mean annual mortality and serious injury rate~~s~~ of ~~0.6 and 1.2~~0.8 northern fur seals~~, respectively,~~ in ~~these~~commercial trawl fisheries (Table 3; ~~Young et al. 2020~~Freed et al. in prep.).

In addition, ~~A total of seven~~16 northern fur seals initially considered to be seriously injured due to entanglement in commercial ~~Bering Sea/Aleutian Islands trawl gear (one in 2014),~~ Bering Sea/Aleutian Islands trawl gear (~~one~~1 in 2015 and 3 in 2016), unidentified trawl gear (~~three in 2016~~9 in 2019), ~~and~~ unidentified net (~~one~~1 each in 2016 and 2017), and unidentified hook and line gear (1 in 2019) were disentangled and released with non-serious injuries (~~Young et al. 2020~~Freed et al. in prep.)~~,~~; therefore, they were not included in the mean annual mortality and serious injury rate for ~~2014~~2015 to ~~2018~~2019.

The total mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between ~~2014~~2015 and ~~2018~~2019 is ~~3.4~~3.5 northern fur seals (~~0.8~~2.7 from observer data + ~~2.6~~0.8 from stranding data).

The minimum mean annual mortality and serious injury rate due to entanglements in Bering Sea/Aleutian Islands gillnet (~~0.4~~0.2), Bering Sea/Aleutian Islands unidentified fishing gear (0.2), trawl gear (1.2), and ~~unidentified fishing net (0.2)~~hook and line gear (0.2) in Alaska waters between ~~2014~~2015 and ~~2018~~2019 totaled ~~0.8~~1.8 northern fur seals (Table 3; ~~Young et al. 2020~~Freed et al. in prep.). These entanglements cannot be assigned to a specific fishery, and it is unknown whether commercial, recreational, or subsistence fisheries are the source of the fishing debris.

The Eastern Pacific northern fur seal stock can occur off the west coast of the continental U.S. in winter/spring; therefore, any mortality or serious injury of northern fur seals reported off the coasts of Washington, Oregon, or California during December through May is assigned to both the Eastern Pacific and California stocks~~ of northern fur seals~~ (as noted in Table 3). Reports to the NMFS West Coast Region marine mammal stranding network between ~~2014~~2015 and ~~2018~~2019 resulted in a minimum mean annual mortality and serious injury rate~~s~~ of ~~one~~0.6 northern fur seals entangled in trawl gear ~~and 0.2 entangled in unidentified fishing net~~ from unknown (commercial, recreational, or subsistence) fisheries off the U.S. west coast in December through May, which was assigned to both stocks of northern fur seals (Table 3; ~~Young et al. 2020~~Freed et al. in prep.). ~~These~~This mortality and serious injury estimate~~s~~ results from an actual count of verified human-caused deaths and serious injuries and ~~are~~is a minimum~~s~~ because not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined.

Table 3. Summary of mortality and serious injury of Eastern Pacific northern fur seals, by year and type, reported to the NMFS Alaska Region and NMFS West Coast Region marine mammal stranding networks, the NMFS Southwest Fisheries Science Center (SWFSC), and the Alaska Department of Fish and Game (ADF&G) between ~~2014~~2015 and ~~2018~~2019 (~~Young et al. 2020~~Freed et al. in prep.). Animals that were disentangled and released with non-serious injuries have been excluded from this table.

Cause of injury	~~2014~~	2015	2016	2017	2018	2019	Mean annual mortality
~~Entangled in commercial Bering Sea/Aleutian Is. halibut longline gear~~	~~3~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.6~~
Entangled in commercial Bering Sea/Aleutian Is. trawl gear	~~6~~	1	1	1	1	0	~~2~~0.8
Entangled in Bering Sea/Aleutian Is. gillnet gear*	~~0~~	1	0	0	0	0	0.2
Entangled in Bering Sea/Aleutian Is. unidentified fishing gear*	~~0~~	1	0	0	0	0	0.2
~~Entangled in gillnet*~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
~~Entangled in unidentified net*~~	~~1 + 1[a]~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2 + 0.2[a]~~
Entangled in trawl gear*	~~2[a]~~	0	0	3[a]	0	6	~~1[a]~~ 1.2 + 0.6[a]
Entangled in hook and line gear*		0	0	0	0	1	0.2
Entangled in marine debris	~~11~~	0	9	13	6	7	7~~.8~~
Struck by car	~~0~~	1	0	0	0	0	0.2
Dog attack	~~0~~	0	1[a]	0	0	0	0.2[a]
~~Oil/tar~~	~~1[a]~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2[a]~~
Total in commercial fisheries							~~2.6~~0.8
*Total in unknown (commercial, recreational, or subsistence) fisheries							~~2~~1.8 + 0.6[a]
Total in marine debris							7~~.8~~
Total due to other causes (car strike, dog attack~~, oil/tar~~)							~~0.6~~0.2 + 0.2[a]

[a]The mortality or serious injury occurred off the coast of Washington, Oregon, or California in December through May and was assigned to both the Eastern Pacific and California stocks of northern fur seals.

Alaska Native Subsistence/Harvest Information

NMFS signed agreements with the Tribal Government of St. Paul Island (2000) and the Traditional Council of St. George Island (2001) to co-manage Steller sea lions and northern fur seals. These co-management agreements promote full and equal participation by Alaska Natives in decisions affecting the subsistence management of northern fur seals (to the maximum extent allowed by law) as a tool for conserving northern fur seal populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed ~~December 2020~~July 2021). Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, ~~with a 3-year take range~~ based on ~~historical local needs~~the regulations in 50 CFR 216, subpart F. ~~Typically, only~~The regulations authorize the taking of juvenile males ~~are taken in the~~for subsistence ~~harvest~~uses, which results in a much smaller impact on population growth than a harvest that includes females. However, accidental ~~harvesting~~mortality of females does occur during subsistence activities and is authorized in the new regulations. The accidental ~~harvest~~mortality of female northern fur seals between ~~2014~~2015 and ~~2018~~2019 included ~~four~~seven females on St. Paul Island: ~~(Melovidov et al. 2014) and one on St. George Island (Kashevarof 2014) in 2014,~~ two ~~on St. Paul~~ in 2015 (Lestenkof et al. 2015), ~~and~~ one ~~on St. Paul~~ in 2016 (Melovidov et al. 2017a), one in 2018 (Lestenkof et al. 2019), and three in 2019 (Lestenkof et al. 2020). The harvest of male northern fur seal pups began on St. George Island ~~between 2014 and 2018, beginning with the inaugural pup harvest~~ in 2014~~,~~ and on St. Paul Island in 2019. The harvest of male pups between 2015 and 2019 included ~~54 pups in 2014 (Testa 2016),~~ 57 pups on St. George Island in 2015 (Meyer 2016), 46 in 2016 (Meyer 2017), 51 in 2017 (Meyer 2018), ~~and~~ 26 in 2018 (Meyer 2019), and 32 in 2019 (Meyer 2020) and 111 pups on St. Paul Island in 2019 (Lestenkof et al. 2020). Between ~~2014~~2015 and ~~2018~~2019, the average annual subsistence harvest of northern fur seals on the Pribilof Islands was ~~373~~360 fur seals (Table 4).

Table 4. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands (including the number of juvenile males, pups, and females) between ~~2014~~2015 and ~~2018~~2019.

Year	St. Paul	St. George	Total harvested
~~2014~~	~~266[a]~~	~~158[b, c]~~	~~424~~
2015	314~~[d]~~[a]	118~~[e]~~[b], ~~[f]~~[c]	432
2016	309~~[g]~~[d]	83~~[h]~~[e], ~~[i]~~[f]	392
2017	217~~[j]~~[g]	89~~[k]~~[h], ~~[l]~~[i]	306
2018	225~~[m]~~[j]	88~~[n]~~[k], ~~[o]~~[l]	313
2019	296[m]	59[n, o]	355
Mean annual harvest			~~373~~360

~~[a]Melovidov et al. (2014); [b]Kashevarof (2014); [c]Testa (2016);~~ ~~[d]~~[a]Lestenkof et al. (2015); ~~[e]~~[b]Kashevarof (2016)~~,~~; ~~[f]~~[c]Meyer (2016); ~~[g]~~[d]Melovidov et al. (2017a); ~~[h]~~[e]Testa (2018); ~~[i]~~[f]Meyer (2017); ~~[j]~~[g]~~NMFS, unpubl. data~~Melovidov et al. (2017b); ~~[k]~~[h]Lekanof (2017); ~~[l]~~[i]Meyer (2018); ~~[m]~~[j]Lestenkof et al. (2019);~~,~~ ~~[n]~~[k]Malavansky (2019a); ~~[o]~~[l]Meyer (2019); [m]Lestenkof et al. (2020); [n]Malavansky (2019b); [o]Meyer (2020).

Other Mortality

Intentional killing of northern fur seals by commercial fishermen, sport fishermen, and others may occur, but the magnitude of that mortality is unknown.

Because the Eastern Pacific and California stocks of northern fur seals overlap off the west coast of the continental U.S. during December through May, non-fishery mortality and serious injury reported off the coast of Washington, Oregon, or California during that time is assigned to both stocks (see details in Table 3). Reports to the NMFS Alaska Region and West Coast Region marine mammal stranding networks, NMFS SWFSC, and ADF&G between ~~2014~~2015 and ~~2018~~2019 resulted in mean annual mortality and serious injury rates of 7~~.8~~ northern fur seals due to entanglement in marine debris in Alaska waters~~,~~ and 0.2 due to a car strike on St. Paul Island (assigned to the Eastern Pacific stock)~~,~~ and 0.2 ~~each~~ due to a dog attack ~~and oil/tar~~ in California (assigned to both stocks) (Table 3; ~~Young et al. 2020~~Freed et al. in prep.). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and are minimums because not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined.

An additional 29 northern fur seals that were initially considered seriously injured due to entanglement in marine debris (~~four in 2014, six~~6 in 2015, ~~six~~6 in 2016, ~~four~~4 in 2017, ~~and~~ 9 in 2018 (including one assigned to both stocks), and 4 in 2019) were disentangled and released with non-serious injuries (~~Young et al. 2020~~Freed et al. in prep.); therefore, these animals were not included in the mean annual mortality and serious injury rate for ~~2014~~2015 to ~~2018~~2019.

STATUS OF STOCK

Based on currently available data, the minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (~~3.4~~3.5 northern fur seals) is less than 10% of the calculated PBR (10% of PBR = ~~1,107~~1,140 northern fur seals) 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 (~~387~~373 northern fur seals) does not exceed the PBR (~~11,067~~11,403) for this stock. The PBR calculation assumes mortality is evenly distributed across males, females, and each age class; but that is not the case with the subsistence harvest, which accounts for most of the known direct human-caused mortality. The subsistence harvest is almost entirely sub-adult males and male pups and, therefore, has a relatively low impact on the population due to the disproportionate importance of females to the population. Thus, non-breeding male-biased mortality up to the maximum levels authorized for subsistence use does not represent a significant risk to the Eastern Pacific northern fur seal stock. The northern fur seal was designated as depleted under the MMPA in 1988 because population levels had declined to less than 50% of levels observed in the late 1950s (1.8 million animals; 53 FR 17888, 18 May 1988). The Eastern Pacific stock of northern fur seals is classified as a strategic stock because it is designated as depleted under the MMPA.

There are key uncertainties in the assessment of the Eastern Pacific stock of northern fur seals. The abundance estimate is based on pup counts multiplied by a constant; this constant was based on northern fur seal demographic information which is now quite dated and it is unknown whether the constant is still optimum for this population. Because an estimate of variance cannot be determined, the N_{MIN} calculation uses a default CV of 0.2. At this time, the cause of the decline of this stock is unknown. Estimates of human-caused mortality and serious injury from stranding data are underestimates because not all animals strand nor are all stranded animals found, reported, or have the cause of death determined.

HABITAT CONCERNS

A number of natural and human-related factors have been suggested as contributing to the continued decline in abundance of the Eastern Pacific stock of northern fur seals, including environmental perturbation, disease, predation, contaminants, indirect effects of commercial fishing, incidental take, poaching, and the effects of human presence and development at or near fur seal rookeries (NMFS 2007). The concentration of fur seals on the breeding islands and in the surrounding waters of the Bering Sea during summer, and their broad pelagic distribution across the North Pacific Ocean over the winter, complicates the understanding of these factors and the ability to implement effective management strategies. However, the population trends at the Pribilof Islands are of significant concern, with declines in stock abundance continuing to be driven by the declines on St. Paul Island rookeries (Fig. 2); pup production at St. George Island has stabilized (Fig~~s.~~ ~~2 and~~ 3). The Pribilof Island communities, particularly St. Paul, have developed a fishery-based economy since the cessation of the commercial fur harvest in 1985. Harbor development and expansion from 1985 to present, and the economic growth resulting from the now well-established fisheries, has increased the potential exposure of fur seals to construction activities, vessel and vehicle traffic, seafood and municipal waste discharge, and human presence. Management measures are in place to help ameliorate some of these threats around the fur seal breeding and resting sites (e.g., regulatory closures that prohibit unauthorized human access beyond posted fur seal breeding and resting sites from 1 June to 15 October each year, establishment of Aircraft Advisory Zones and Requested Aircraft Flight Paths, and new subsistence use regulations).

Northern fur seals from each island, and even from central breeding areas within each island, may also experience dissimilar exposure to varying environmental and foraging conditions across the Bering Sea; northern fur seals from different central breeding areas consistently use different foraging habitat (Robson et al. 2004, Sterling and Ream 2004, Call et al. 2008, Kuhn et al. 2014). Climate change could alter the abundance, distribution, and makeup of available prey for northern fur seals in the Bering Sea as a result of reduced sea ice and warming temperatures. These changes could differentially impact the survival and reproduction of individuals and breeding aggregations on the three islands; however, the exact mechanisms are unknown and there are no clear management actions that could be taken to address the impacts on northern fur seals.

Commercial fisheries target fur seal prey and prey that compete with fur seals in both the Bering Sea and the North Pacific Ocean. Northern fur seals predominantly prey on walleye pollock over the Bering Sea shelf, and progressively greater proportions of oceanic fish and squid are consumed when they forage over the slope and in off-shelf waters (Zeppelin and Ream 2006). Comparison of ingested prey sizes based on scat and spew analysis indicates an overlap between sizes of pollock consumed by Pribilof Island northern fur seals and those caught by the commercial trawl fishery, suggesting possible competition between fur seals and commercial fisheries for pollock (Gudmundson et al. 2006). In contrast to northern fur seals from the Pribilof Islands, Bogoslof Island northern fur seals forage in the deeper water of the Bering Sea Basin and their diet is comprised primarily of off-shelf species (northern smoothtongue, squid, myctophids) as well as juvenile walleye pollock (Zeppelin and Orr 2010, Kuhn et al. 2014). Our understanding of the consequences of commercial fisheries removals on northern fur seal survival and productivity is highly uncertain.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980). 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, and Beaufort Sea (Mackenzie River Delta) (Hazard 1988, O'Corry-Crowe et al. 2018) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985).

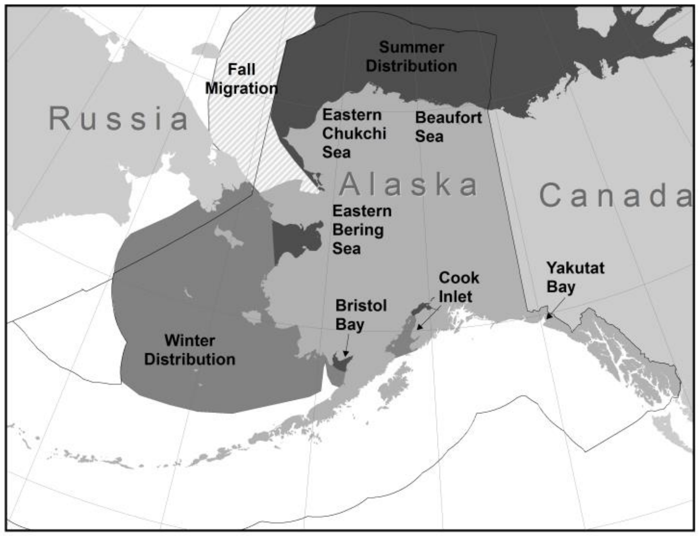

Figure 1. Approximate distribution for all five beluga whale stocks. The Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay beluga whale stocks summer in the Beaufort Sea (Beaufort Sea and Eastern Chukchi Sea stocks) and Bering Sea (Eastern Bering Sea and Bristol Bay stocks); they overwinter in the Bering Sea. The Bristol Bay and Cook Inlet beluga whale stocks show only small seasonal shifts in distribution, remaining in Bristol Bay and Cook Inlet, respectively, throughout the year. 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.

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach, which considers four types of data: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990); 2) Population response data: distinct population trends among regions occupied in summering areas (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 (O'Corry-Crowe et al. 2018). 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.

Data from satellite transmitters attached to beluga whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea~~, and Bristol Bay~~ stocks identify 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).

The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering 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 eastern Beaufort Sea where they remain in the summer and fall, returning to the Bering Sea in late fall. Eastern Chukchi Sea beluga whales depart the Bering Sea in late spring and early summer, migrate through the Chukchi Sea and into the western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. 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 (Suydam 2009, Hauser et al. 2014, Citta et al. 2017, Lowry et al. 2019). Beluga whales tagged in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Goetz et al. 2012a; Shelden et al. 2015, 2018; Lowry et al. 2019) remained in those areas throughout the year, showing only small seasonal shifts in distribution.

~~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 summering areas (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 (O'Corry-Crowe et al. 2018). 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~~summer months, Cook Inlet beluga whales are often concentrated near river mouths (Shelden et al. 2015) and are found seasonally in distinct areas (Susitna River delta, Chickaloon Bay, Turnagain Arm, and Knik Arm), where they aggregate in large groups of both sexes and all age classes as they rear calves and feed (McGuire et al. 2020a). The fall-winter-spring distribution of this stock is not fully understood; however, there is evidence that most whales in this population inhabit upper Cook Inlet year-round but small groups also enter bays and rivers in the lower inlet such as Tuxedni Bay and Kenai River (Lammers et al. 2013, Castellote et al. 2015, Shelden et al. 2015). From 1999 to 2002, satellite tags were attached to a total of 18 Cook Inlet beluga whales to determine their movement patterns (Goetz et al. 2012a; Shelden et al. 2015, 2018). All tag~~ged~~ ~~beluga whales~~ ~~remained~~locations occurred within Cook Inlet, primarily in the upper inlet north of East and West Foreland~~s~~, with some whales briefly ~~trips to~~entering the lower inlet in the fall and then returning to the upper inlet (Shelden et al. 2015, 2018).

A review of all marine mammal surveys and anecdotal sightings in the northern Gulf of Alaska between 1936 and 2000 found only 28 beluga whale sightings, indicating that very few beluga whale sightings occurred in the Gulf of Alaska outside Cook Inlet (Laidre et al. 2000). Yakutat Bay is the only area in the Gulf of Alaska outside of Cook Inlet where multiple beluga whale sightings have occurred (Laidre et al. 2000, Lucey et al. 2015, O'Corry-Crowe et al. 2015). Based on genetic analyses, traditional ecological knowledge, and observations by fishermen and others, the Yakutat Bay beluga whales likely represent a small, resident group (fewer than 20 whales) that has been observed year round and is reproductively separated from Cook Inlet (Lucey et al. 2015, O'Corry-Crowe et al. 2015). Furthermore, this group in Yakutat Bay appears to be showing signs of inbreeding and low diversity due to their isolation and small numbers (O'Corry-Crowe et al. 2015). Although the beluga whales in Yakutat Bay are not included in the Cook Inlet Distinct Population Segment (DPS) of beluga whales under the Endangered Species Act (ESA), they are considered part of the depleted Cook Inlet stock under the Marine Mammal Protection Act (MMPA) (50 CFR 216.15; 75 FR 12498, 16 March 2010) because insufficient information was available to identify Yakutat Bay beluga whales as a separate population when Cook Inlet beluga whales were designated as depleted under the MMPA. Thus, Yakutat Bay beluga whales remain part of the Cook Inlet stock, are designated as depleted, and are provided the same protections as the Cook Inlet stock, including hunting regulations/restrictions.

This stock assessment report assesses the abundance and human-caused mortality and serious injury of Cook Inlet beluga whales throughout the stock's entire geographic range.

POPULATION SIZE

Aerial surveys during June documented the distribution and abundance of Cook Inlet beluga whales and were conducted by NMFS each year from 1994 to 2012 (Rugh et al. 2000, 2005; Shelden et al. 2013), after which NMFS began biennial surveys in 2014 (Shelden et al. 2019) (Fig. 2). NMFS changed to a biennial survey schedule after analysis showed there would be little reduction in the ability to detect a trend given the current growth rate of the population (Hobbs 2013).

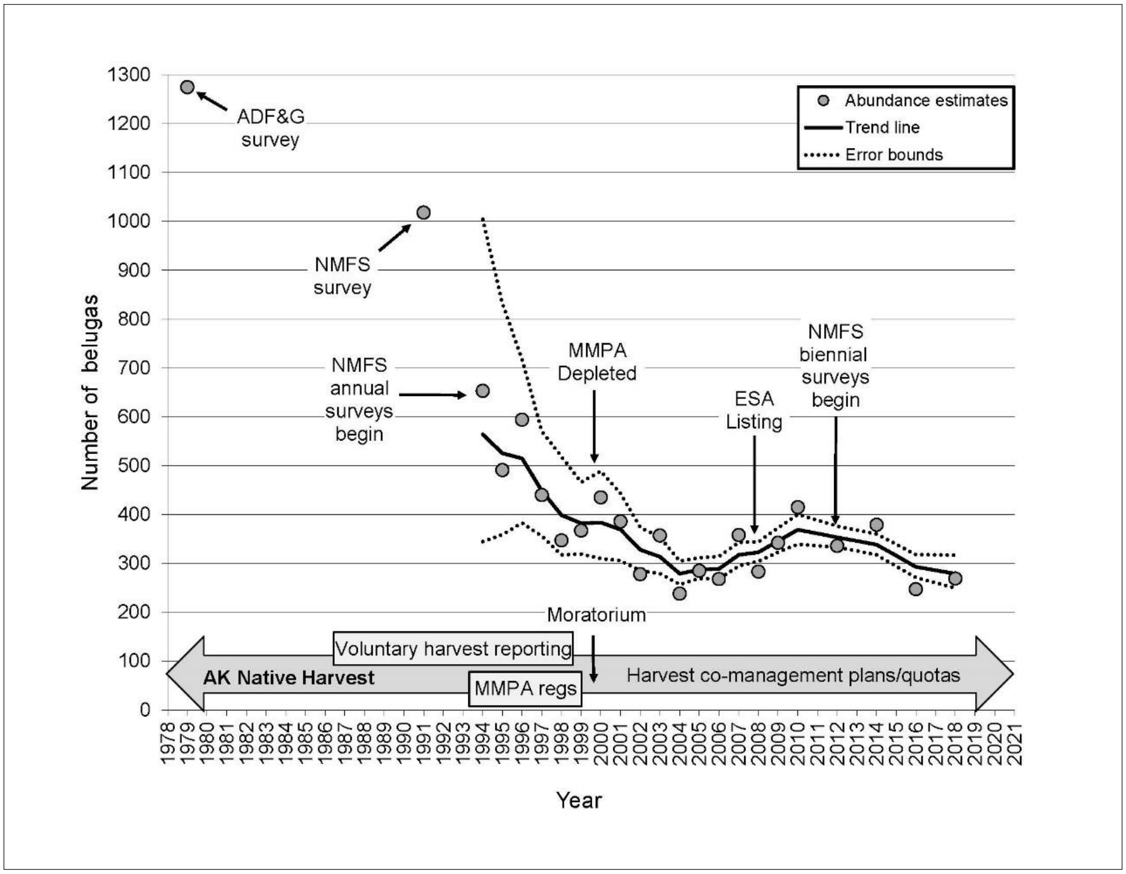

Figure 2. Annual abundance estimates (circles) of beluga whales in Cook Inlet, Alaska, 1979-2018 (Calkins 1989, Hobbs et al. 2015a, Shelden et al. 2015, Shelden and Mahoney 2016, Wade et al. 2019). The solid line from 1994 to 2018 is a weighted moving average of the abundance estimates that represents the smoothed trend of the population through time. Dashed lines above and below the solid line are 95% probability intervals around the smoothed trend line. Changes to harvest reporting are shown along the x-axis and indicate periods when Alaska Native hunting households provided data to the Alaska Department of Fish and Game, Alaska Beluga Whale Committee, Cook Inlet Marine Mammal Council, and NMFS and when MMPA harvest reporting regulations and co-management plans were adopted.

The survey covers all coastal areas and all river mouths and deltas in Cook Inlet in early June. The surveys are designed with the intention of detecting all substantially-sized beluga whale groups in the upper inlet. When beluga whale groups are detected, the group sizes are estimated by visual counts by observers or from video data recorded of the groups. The group-size estimates are summed across all detected groups to calculate an abundance estimate from each day's survey. Daily estimates from all survey days considered acceptable are combined to form an annual estimate of abundance for the population.

The method used for estimating group size from video data requires estimating multiple correction factors for visibility bias (Hobbs et al. 2000, 2015a). Following the June 2016 abundance survey, a major revision was made to the methods used to estimate group sizes from the survey data (Boyd et al. 2019). ~~A~~The new method was developed using a Bayesian statistical approach to group-size estimation; this new method was then applied to the 2004-2016 time series (Boyd et al. 2019). Wade et al. (2019) applied the same methodology to the 2018 survey data to estimate abundance for the 2018 survey. The new approach was designed to address the same four types of bias in the group-size estimation process as previous methods: 1) availability bias due to diving behavior; 2) proximity bias due to individuals concealed by another individual in the video data; 3) perception bias due to individuals not detected because of small image size in the video data; and 4) individual observer bias in visual estimates of group size (see Boyd et al. 2019 for a complete description of methods). The main advantages to the change in group-size estimation methods are as follows: (a) the Bayesian methods allow the variance in the parameter estimates to be fully propagated through the analysis (unlike the previous methods)~~,~~ and also allow~~s~~ for specification of distributions for some parameters, rather than just single values, to more completely consider uncertainty in the analyses; (b) for estimating the visibility bias correction factors (availability, proximity bias, and perception), the important assumption was added that the true group size was the same for all video passes of the same group (this assumption was not previously used in the analysis); (c) for availability bias, a prior distribution is specified for mean dive time for a beluga whale group; previously this was fixed at the single value of 24.1 seconds; and (d) for perception bias, the analysis now simultaneously estimates two distributions as part of the integrated analysis: 1) detection probability as a function of image size, and 2) the distribution of image sizes for all individuals; previously, this was done as a separate ad hoc analysis (Wade et al. 2019).

In addition to the new group-size estimation method, the revised abundance method controls for possible strong positive and negative outliers on single days (Wade et al. 2019). Strong negative outliers (days with very low abundance) can potentially happen when some groups are not seen. Strong positive outliers (days with very high abundance) can potentially happen when the whales occur in one or more very large groups, and the video group-size estimation process becomes difficult, with ~~wide probability intervals~~large sampling and model error leading to large scatter between survey days. Previously (i.e., Hobbs et al. 2015a), the annual estimate of abundance was calculated as the average of three or more days, excluding a day's estimate if it was less than approximately 60% of the highest day. However, it is not possible to objectively determine if one specific estimate was low because a group was missed (in which case the estimate should be dropped) or if it was low because of sampling and model error as part of the estimation process (in which case it should not be dropped). ~~Now~~Therefore, the annual abundance is calculated as the median of all the daily abundance estimates, using all days with an acceptable survey day, defined objectively by weather/sighting conditions and spatial coverage. Using the median lessens the influence of strong positive and negative outliers.

The point estimate of abundance for 2018, based on the median of all acceptable daily estimates in 2018, is 269 beluga whales (coefficient of variation (CV) = 0.103~~,~~; 95% probability interval (PI): 227 to 333). The best estimate of current abundance is based on a weighted average from the last three annual abundance estimates (2014, 2016, and 2018), giving more weight to the more recent estimates. From that weighted average, the best estimate of abundance for the Cook Inlet beluga whale population in 2018 is 279 (CV = 0.061~~,~~; 95% PI: 250 to 317) (Wade et al. 2019).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) is calculated as the 20th percentile of the best abundance estimate, according to the potential biological removal (PBR) guidelines (NMFS 2016a). In this case, N_{MIN} is calculated as the 20th percentile of the posterior distribution of the best estimate of abundance in 2018, which is 267 (Wade et al. 2019). Therefore, N_{MIN} for the Cook Inlet beluga whale stock is 267 beluga whales.

Current Population Trend

The annual abundance estimates for 1994 to 2018 are shown in Figure 2, along with a weighted moving average to show the smoothed trend over time. The population declined substantially during the period of unregulated hunting, with the peak hunting mortality reported in 1996 (123 whales) and the last year of substantial hunting mortality in 1998 (42 whales). Although only five whales were reported killed from hunting from 1999 to 2005, the population continued to decline until about 2004. The population showed an increase from 2005 to 2010 but has apparently declined since 2010. During the most recent 10-year time period (2008-2018), the estimated exponential trend in the abundance estimates is a decline of 2.3% per year (95% PI: -4.1% to -0.6%), with a 99.7% probability of a decline~~,~~ and a 93.0% probability of a decline that is more than 1% per year (Wade et al. 2019).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Cook Inlet beluga whale stock. Until additional data become available, the default cetacean maximum theoretical net productivity rate of 4% will be used for this stock (NMFS 2016a).

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 (NMFS 2016a). Using the N_{MIN} of 267 beluga whales, the calculated PBR for this stock is 0.53 beluga whales (267 × 0.02 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between ~~2014~~2015 and ~~2018~~2019 is listed, by marine mammal stock, in ~~Young et al. (2020)~~Freed et al. (in prep.); 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 confirmed between ~~2014~~2015 and ~~2018~~2019. There are no observers in Cook Inlet fisheries, so the mean annual mortality and serious injury in commercial fisheries is unknown, although likely low, given that an observer program conducted in Cook Inlet in 1999-2000 did not observe mortality or serious injury of beluga whales (Manly 2006). Other potential threats most likely to result in direct human-caused mortality or serious injury of this stock include ship strikes.

Fisheries Information

Information 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 ~~December 2020~~July 2021).

Based on historical reports, Cook Inlet beluga whale mortality and serious injury has occurred in the Cook Inlet salmon set gillnet and drift gillnet fisheries. Because these fisheries are not currently observed, the potential for fisheries-caused mortality and serious injury may be greater than is reflected in existing observer data.

Alaska Native Subsistence/Harvest Information

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

Following a significant decline in Cook Inlet beluga whale abundance estimates between 1994 and 1998, the Cook Inlet hunters voluntarily stopped hunting in 1999 and the Federal government took actions to conserve, protect, and prevent further declines in the abundance of these whales. Public Laws 106-31 (1999) and 106-553 (2000) established a moratorium on Cook Inlet beluga whale harvests unless such taking occurs pursuant to a cooperative agreement between NMFS and affected Alaska Native organizations. A cooperative agreement, also referred to as a co-management agreement, was not signed in 1999 and 2004. In December 2000, an administrative hearing was held to create interim harvest regulations for 2001 through 2004 (69 FR 17973, 6 April 2004). Three Cook Inlet beluga whales were killed under this interim harvest plan (2001-~~2004~~2003). In August 2004, an administrative hearing was held to create a long-term harvest plan, which allowed up to eight whales to be harvested between 2005 and 2009 (NMFS 2008). Two whales were harvested in 2005 and no whales were harvested in 2006. The long-term harvest plan was signed in 2008 and established a harvest level for a 5-year period, based on the average abundance in the previous 5-year period and the growth rate during the previous 10-year period (NMFS 2008). A harvest is not allowed if the previous 5-year average abundance ~~is~~was less than 350 beluga whales. Under the long-term harvest plan, the 5-year average abundance during the first review period (2003-2007) was 336 whales and, therefore, a harvest was not allowed during the subsequent 5-year period (2008-2012) (73 FR 60976, 15 October 2008). The average abundance of Cook Inlet beluga whales remained below 350 whales during the second review period (2008-2012); therefore, a harvest was not allowed for the subsequent 5-year period (2013-2017). NMFS changed to a biennial survey schedule after 2012, therefore, the 5-year average abundance is now based on either two or three surveys in a 5-year period. Hobbs (2013) showed that biennial rather than annual surveys may lead to higher variation in allowable harvest levels, but it is not expected to change the probability of recovery while using the algorithm that determines the allowable harvest level. The average abundance for a third review period (2013-2017), using the 2014 and 2016 estimates, is still below 350 whales (Wade et al. 2019), so a harvest is not allowed for the subsequent 5-year period (2018-2022).

Other Mortality

Reports from the NMFS Alaska Region marine mammal stranding network provide ~~additional~~ information on beluga whale mortality. Mortality related to live stranding events, where a beluga whale group strands as the tide recedes, has been regularly observed in upper Cook Inlet (Table 1). ~~Improved r~~Reports include the number of live stranded beluga whales, as well as floating and beachcast carcasses (NMFS 2016b; McGuire et al. 2020b; ~~https://www.fisheries.noaa.gov/resource/document/alaska-region-marine-mammal-stranding-summary~~ https://www.fisheries.noaa.gov/resource/document/alaska-region-marine-mammal-annual-stranding-reports, accessed ~~December 2020~~July 2021). Most beluga whales involved in live stranding events survive, although some associated deaths may not be observed if whales die later from ~~live-stranding~~ related injuries (Vos and Shelden 2005, Burek-Huntington et al. 2015). Between ~~2014~~2015 and ~~2018~~2019, there were reports of approximately ~~79~~three beluga whales involved in ~~three~~two known live stranding events ~~plus one suspected live stranding event with two associated deaths~~ (Table 1; NMFS 2016b; McGuire et al. 2020b; NMFS, unpubl. data). ~~A~~The beluga whale calf that stranded alive in 2017 was sent to the Alaska SeaLife Center for rehabilitation; ~~and then~~after rehabilitation, NMFS determined the animal could not survive on its own if returned to the wild, so it was transferred to SeaWorld in San Antonio, Texas, in 2018. ~~In 2014, necropsy results from two whales found in Turnagain Arm suggested that a live stranding event contributed to their deaths as both had aspirated mud and water. No live stranding events were reported prior to the discovery of these dead whales, suggesting that not all live stranding events are observed (Table 1). Most live strandings occur in Knik Arm and Turnagain Arm, which are shallow and have large tidal ranges (Turnagain Arm has the largest tidal range in the U.S., with a mean of 30 ft), strong currents, and extensive mudflats.~~

Long-term photo-identification data from approximately 420 individual beluga whales identified between 2005 and 2017 were compared with stranding data from 95 dead beluga whales to identify patterns of mortality with respect to age, sex, geographic range, and cause of death and to estimate minimum mortality rates (McGuire et al. 2020b). Reported mortality was greatest for adults of reproductive age, followed by calves, with fewer subadults and no adults older than 49 years in the stranding data set. Live stranding was the predominant assigned cause of death but represented only approximately 33% of deaths with known cause. Annual mortality from all causes estimated from reported carcasses relative to total population size averaged 2.2% (SE = 0.36%) (McGuire et al. 2020b).

Table 1. Cook Inlet beluga whale strandings investigated by NMFS between ~~2014~~2015 and ~~2018~~2019 (NMFS 2016b; McGuire et al. 2020b; NMFS, unpubl. data). These numbers include non human-caused strandings.

Year	Floating and beachcast carcasses	Number of beluga whales per live stranding event (number of associated known or suspected resulting deaths)
~~2014~~	~~11~~	~~unknown[a] (2), 76+ (0)~~
2015	3	2 (0)
2016	8	0
2017	12	1~~[b]~~[*]
2018	7	0
2019	13	0
Total	~~41~~43	~~79+ (2)~~3 (0)

~~[a] A live stranding was not observed but was suspected based on necropsy results from two beluga whales found in Turnagain Arm (NMFS 2016b).~~
~~[b]~~[*] ~~A~~The beluga whale calf that stranded alive in 2017 was sent to the Alaska SeaLife Center for rehabilitation and then transferred to SeaWorld in San Antonio, Texas, in 2018. It is considered a permanent removal from the wild population.

Another source of beluga whale mortality in Cook Inlet is predation by transient-type (mammal-eating) killer whales. Killer whale sightings were not well documented and were likely rare in the upper inlet prior to the mid-1980s. From 1982 through 2018, NMFS received 31 reports of killer whale sightings in upper Cook Inlet (north of East and West Foreland~~s~~). Up to 12 beluga whale deaths, inlet-wide, were suspected to be a direct result of killer whale predation (NMFS 2016b). The last confirmed killer whale predation of a Cook Inlet beluga whale occurred in 2008 in Turnagain Arm. From ~~2014~~2015 through ~~2018~~2019, NMFS received two separate killer whale sighting reports (both in 2015) in upper Cook Inlet, but there were no reports of predation attempts. Transient killer whale vocalizations have been detected on acoustic moorings in upper Cook Inlet (Castellote et al. 2016a) but only once in a 5-year period (Castellote et al. 2016b).

Between 1998 and 2013, 38 necropsies were performed on beluga whale carcasses (23% of the 164 known stranded carcasses) (Burek-Huntington et al. 2015). The sample included adults (n = 25), juveniles (n = 6), calves (n = 3), and aborted fetuses (n = 4). When possible, a primary cause of death was noted along with contributing factors. Cause of death was unknown for 29% of the necropsied carcasses. Other causes of death were attributed to various types of trauma (18%), caused by confirmed and suspected killer whale predation, blunt force, choking on a starry flounder, and entanglement in a setnet (although this individual was in poor health and it could not be determined if it died before or after entanglement); perinatal mortality (13%); live mass stranding (13%); live single stranding (11%); malnutrition (8%); or disease (8%). Several animals had mild to moderate pneumonia, kidney disease, and/or stomach ulcers that likely contributed to their deaths.

~~A photo-identification study (Kaplan et al. 2009) did not find any instances where Cook Inlet beluga whales appeared to have been entangled in, or to have otherwise interacted with, fishing gear. However, in 2010, a beluga whale with a rope entangled around its girth was observed and photographed from May through August. Based on how frequently this whale was seen between 2010 and 2013, and the abrupt cessation of sightings post-2013, it is assumed this whale died. It is also possible that it lost the rope and was no longer recognized in subsequent sightings; however, natural marks (i.e., marks other than the rope) were quite distinct on this whale, and it seems likely that it would still have been recognizable if it had been photographed without the rope (McGuire et al. 2018).~~Individual beluga whales photographed from 2005 to 2017, along with stranding records, were examined to determine prevalence of scars indicative of anthropogenic trauma (McGuire et al. 2020c). Scars were classified by likely source (e.g., entanglements, vessel strikes, puncture wounds, and research). Of 78 whales examined, 7 had signs of trauma confirmed or possibly from entanglement in rope or lines; 6 had signs of trauma that were possibly from entanglement or from a vessel collision; 3 had signs of trauma possibly from a vessel collision or a predation attack; 4 had signs of possible puncture scars consistent with bullets, arrows, or harpoons; and 2 had signs of trauma consistent with a vessel collision. The authors concluded the sample did not allow them to reliably infer the rate of anthropogenic trauma at the population level, but the study does provide evidence of the types and level of trauma experienced by a subset of the population.

STATUS OF STOCK

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

There are key uncertainties in the assessment of the Cook Inlet stock of beluga whales. The stock decline is well documented. While the early decline was likely due to unrestricted subsistence harvesting, it is unknown what has prevented recovery of this stock, because subsistence harvest has not been allowed since 2007~~,~~ and the mortality and serious injury in commercial fisheries is likely low. PBR is designed to allow stocks to recover to, or remain above, the maximum net productivity level (Wade 1998). An underlying assumption in the application of the PBR equation is that marine mammal stocks exhibit certain dynamics. Specifically, it is assumed that a depleted stock will naturally grow toward Optimum Sustainable Population and that some surplus growth could be removed while still allowing recovery. However, the Cook Inlet beluga whale population is far below historical levels and yet, for unknown reasons, is not increasing. If the Cook Inlet beluga whale population was increasing at an expected rate of approximately 2 to 4%, it would currently be adding, on average, about 7 to 13 whales per year to the population. ~~Although there is c~~Currently, ~~no known~~there is not a subsistence harvest and direct human-caused mortality ~~(e.g., from~~due to fisheries bycatch, ~~harvest, ship~~vessel strikes, or other sources has not been definitively determined~~)~~, although McGuire et al. (2020c) documented beluga whales with scars due to vessel strikes and entanglements in ropes and lines, indicating these sources are a potential cause of injury or mortality. However, even if the PBR level (~one whale every 2 years) was taken, it is clear this would have little consequence on the overall population trend given the unexplained lack of increase by 7 to 13 whales per year. Stranding data from Cook Inlet have shown that an average of approximately 10 beluga whales died per year between 1998 and 2013 (Burek-Huntington et al. 2015) due to non-human-related or unknown causes, but total mortality in the population is unknown without information on the carcass recovery rate. Individuals die from natural causes even in a growing population; for example, if the average survival rate was a relatively high 0.95, there would still be approximately 14 (0.05×279) deaths expected each year; therefore, it is hard to conclude anything definitive from an average of 10 observed deaths per year.

HABITAT CONCERNS

~~Critical habitat designated for the Cook Inlet DPS of beluga whales under the ESA includes two geographic areas of marine habitat in Cook Inlet that comprise 7,800 km² (3,013 mi²), excluding waters of the Port of Alaska (76 FR 20180, 11 April 2011).~~ Based on available information, beluga whales remain within ~~the~~Cook ~~i~~Inlet year-round. Review of beluga whale presence data from aerial surveys, satellite tagging, protected species observers, citizen scientists, and opportunistic sightings collected in Cook Inlet from the late 1970s to 2018 shows their range has contracted remarkably since the 1970s (Shelden et al. 2019). Almost the entire population is found in northern Cook Inlet from late spring through the summer and into the fall. This differs markedly from surveys in the 1970s when beluga whales were found in, or would disperse to, lower Cook Inlet by midsummer. Since 2008, on average, 83% of the total population occupied the Susitna Delta (Beluga to Little Susitna rivers) in early June during the aerial survey period, compared to roughly 50% in the past (1978-1979, 1993-1997, 1998-2008). The 2009 to 2014 distribution was estimated to be only 25% of the range observed in 1978 and 1979 (Shelden et al. 2015). 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. 2015). During surveys in the 1970s, large numbers of whales were scattered throughout the lower inlet in August (Shelden et al. 2015). This was not the case in 2001, when counts in the upper inlet in August were similar to those reported in June and July (Rugh et al. 2004). In August, only 2 of 10 tagged whales spent time in offshore waters and the lower inlet (Shelden et al. 2015). The number of whales observed in the upper inlet during the August calf index surveys, conducted from 2005 to 2012, was similar to the June surveys (Hobbs et al. 2015a), suggesting the contraction in range continued through the summer. While surveys were not conducted in September during the 1970s and 1980s, aerial surveys in 1993 showed some dispersal into lower inlet waters by late September (Shelden et al. 2015). However, surveys in September and October of 2001 resulted in counts that were similar to June (Rugh et al. 2004). With the exception of three whales that spent brief periods of time in the lower inlet during September and/or October, most whales transmitting locations in 1999, 2000, 2001, and 2002 remained in the upper inlet north of East and West Foreland~~s~~ (Shelden et al. 2015, 2018). Counts during aerial surveys in September 2008 were also similar to June (Shelden et al. 2015).

Goetz et al. (2012b) modeled habitat preferences using NMFS' 1994-2008 June abundance survey data. In large areas, such as the Susitna Delta and Knik Arm, there was a high probability that beluga whales were in larger group sizes. Beluga whale presence also increased closer to rivers with Chinook salmon (*Oncorhynchus tshawytscha*) runs, such as the Susitna River. Chinook salmon runs have been decreasing in many Alaska Rivers since 2007, including the Susitna River (https://www.adfg.alaska.gov/index.cfm?adfg=chinookinitiative.main, accessed ~~December 2020~~July 2021). The Susitna Delta also supports two major spawning migrations of a small, schooling eulachon (*Thaleichthys pacificus*) in May and June (Goetz et al. 2012b).

The population appears to be consolidated into habitat in the upper-most reaches of Cook Inlet for much longer periods of time, in habitat that is most likely to be noisy (e.g., Moore et al. 2000, Lowry et al. 2006, Hobbs et al. 2015b, Kendall and Cornick 2015, Norman et al. 2015). An assessment of noise sources in Cook Inlet (Castellote et al. 2019) indicates that anthropogenic noise occurring in some of the most important habitat ~~(i.e., Area 1 critical habitat: 76 FR 20180, 11 April 2011)~~ has the potential to mask beluga whale communication and hearing, and the potential reduction of communication and echolocation range is considerable. It is unknown ~~W~~whether this contracted distribution is a result of changing habitat (Moore et al. 2000), prey concentration, or predator avoidance (Shelden et al. 2003) or can simply be explained as the contraction of a reduced population into small areas of preferred habitat (Goetz et al. 2007, 2012b)~~ is unknown~~.

The Cook Inlet Beluga Whale Recovery Plan (NMFS 2016b) identifies potential threats: 1) high concern: catastrophic events (e.g., natural disasters, spills, mass strandings), cumulative effects of multiple stressors, and noise; 2) medium concern: disease agents (e.g., pathogens, parasites, and harmful algal blooms), habitat loss or degradation, reduction in prey, and unauthorized take; and 3) low concern: pollution, predation, and subsistence harvest. 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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HARBOR PORPOISE (*Phocoena phocoena*): Southeast Alaska Stock

NOTE – ~~December 2015~~July 2021: In areas outside of Alaska, studies of harbor porpoise distribution have indicated that ~~stock~~population structure is likely more fine-scaled than is reflected in the Alaska Stock Assessment Reports (SARs). ~~No data are available to define stock structure for harbor porpoise on a finer scale in Alaska. However, based on comparisons with other regions, it is likely that several regional and sub-regional populations exist. Should new information on harbor porpoise stocks become available, the harbor porpoise Stock Assessment Reports will be updated.~~Data to evaluate population structure for harbor porpoise in Southeast Alaska have been collected and are currently being analyzed. Should the analysis identify different population structure than is currently reflected in the Alaska SARs, we will consider how best to revise stock designations in a future SAR following NMFS Procedure "Reviewing and Designating Stocks and Issuing Stock Assessment Reports under the Marine Mammal Protection Act" (NMFS 2019).

STOCK DEFINITION AND GEOGRAPHIC RANGE

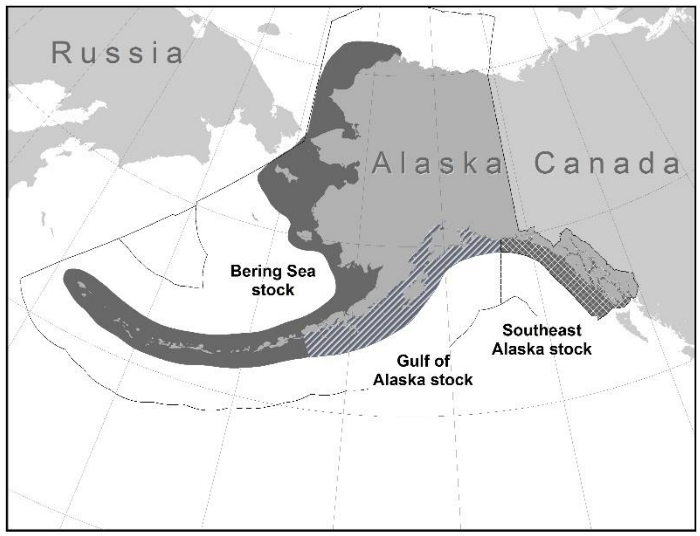
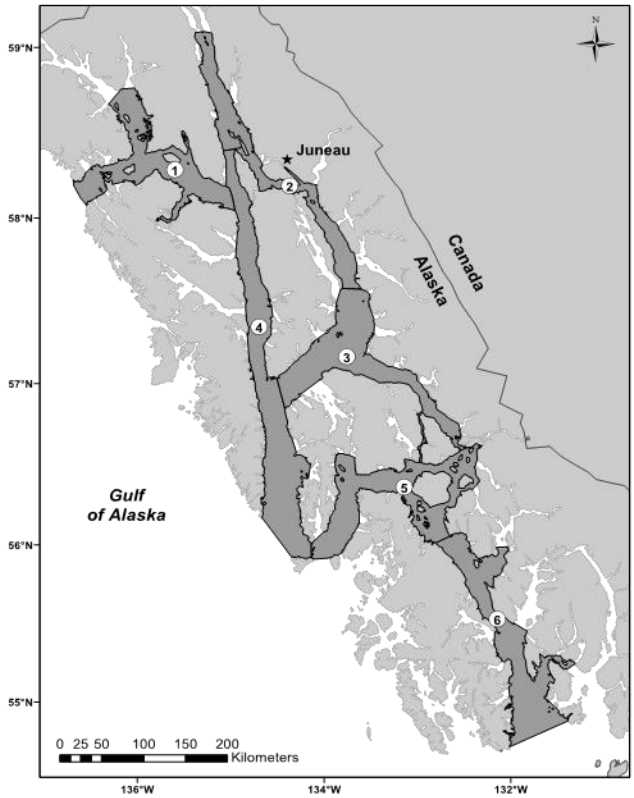


Figure 1. Approximate distribution of harbor porpoise in Alaska waters. The U.S. Exclusive Economic Zone is delineated by a black line.

In the eastern North Pacific Ocean, harbor porpoise range from Point Barrow and offshore areas of the Chukchi Sea, along the Alaska coast, and down the west coast of North America to Point Conception, California (Gaskin 1984, Christman and Aerts 2015). Harbor porpoise primarily frequent the coastal waters of the Gulf of Alaska and Southeast Alaska (Dahlheim et al. 2000, 2009), typically occurring in waters less than 100 m deep; however, occasionally they occur in deeper waters (Hobbs and Waite 2010). Within the inland waters of Southeast Alaska, harbor porpoise distribution is clumped with the greatest densities observed in the Glacier Bay/Icy Strait region, ~~and~~ near Zarembo and Wrangell Islands, and the adjacent waters of Sumner Strait (Dahlheim et al. 2009, 2015). The average density of harbor porpoise in Alaska appears to be less than that reported off the west coast of the continental U.S., although areas of high densities do occur in inland waters off Southeast Alaska (Glacier Bay and ~~the adjacent waters of~~ Icy Strait), Yakutat Bay, the Copper River Delta, Sitkalidak Strait (Dahlheim et al. 2000, 2009, 2015; Hobbs and Waite 2010), and lower Cook Inlet (Shelden et al. 2014).

Stock discreteness in the eastern North Pacific was analyzed using mitochondrial DNA from samples collected along the west coast (Rosel 1992), including one sample from Alaska. Two distinct mitochondrial DNA groupings or clades were found. One clade is present in California, Washington, British Columbia, and the single sample from Alaska (no samples were available from Oregon), while the other is found only in California and Washington. ~~Although~~Despite these two clades ~~are not geographically distinct by~~overlapping in latitude, the results ~~may indicate~~suggest a low mixing rate for harbor porpoise along the west coast of North America. Investigation of pollutant loads in harbor porpoise ranging from California to the Canadian border also suggests restricted harbor porpoise movements (Calambokidis and Barlow 1991); these results are reinforced by a similar study in the northwest Atlantic (Westgate and Tolley 1999). Further genetic testing of the same samples mentioned above, along with ~~a few~~eight additional samples ~~including eight more~~ from Alaska, ~~found~~revealed differences between some of the four areas investigated, California, Washington, British Columbia, and Alaska, but inference was limited by small sample size (Rosel et al. 1995). Those results ~~demonstrate~~revealed that harbor porpoise along the west coast of North America are not panmictic and that movement is sufficiently restricted to result in genetic differences between regions (Walton 1997). This is consistent with low movement suggested by genetic analysis of harbor porpoise specimens from the North Atlantic (Rosel et al. 1999). In a genetic analysis of small-scale population structure of eastern North Pacific harbor porpoise, Chivers et al. (2002) included 30 samples from Alaska, 16 of which were from the Copper River Delta, 5 from Barrow, 5 from Southeast Alaska, and 1 sample each from St. Paul, Adak, Kodiak, and Kenai. Unfortunately, no conclusions could be drawn about the genetic structure of harbor porpoise within Alaska because of the insufficient number of samples from each region. Accordingly, harbor porpoise stock structure in Alaska is defined by geographic areas.

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint it is prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). Based on the above information, three harbor porpoise stocks in Alaska are currently specified, recognizing that the boundaries of these three stocks are identified primarily based upon geography or perceived areas of low porpoise ~~low~~ density: 1) the Southeast Alaska stock - occurring from Dixon Entrance to Cape Suckling, including offshore, coastal, and inland waters (Fig. 1), 2) the Gulf of Alaska stock - occurring from Cape Suckling to Unimak Pass, and 3) the Bering Sea stock - occurring throughout the Aleutian Islands and all waters west and north of Unimak Pass. There have been no analyses to assess the validity of these stock designations and research to assess substructure is ongoing only within a portion of the Southeast Alaska stock. Preliminary results from ~~the~~an analysis of environmental DNA (eDNA) samples suggest~~ed~~ significant genetic differentiation between harbor porpoise concentrations ~~found~~ in Glacier Bay/Icy Strait (northern region) and around Zarembo/Wrangell Islands (southern region) (Parsons et al. 2018). Dahlheim et al. (2015) proposed that harbor porpoise in these regions potentially represent different subpopulations based on analogy with other west coast harbor porpoise populations, because of differences in trends in abundance of porpoise between the northern and southern regions and because of ~~the two concentrations, and~~ a possible hiatus in distribution between these two areas. Because eDNA samples were only obtained in ~~only~~ one area ~~in~~of the northern and southern regions ~~and one area in the southern region~~as of 2016 (Parsons et al. 2018), ~~further sampling is~~additional samples are needed to better understand harbor porpoise substructure within Southeast Alaska, ~~including~~as well as ~~the~~ connectivity of subpopulations in inland, ~~waters and those in adjacent~~ coastal, and offshore waters of Alaska. NMFS will consider whether concentrations of harbor porpoise in Glacier Bay/Icy Strait and around Zarembo/Wrangell Islands should be considered "prospective stocks" in a future Stock Assessment Report. Incidental takes from commercial fisheries within ~~a small~~the southern region, ~~(~~e.g., Wrangell and Zarembo Islands area (Manly 2015), are of concern because of the potential impact on undefined localized stocks of harbor porpoise.



~~**Figure 2.** Survey strata defined for line-transect survey effort allocation in Southeast Alaska (as illustrated in Fig. 1 of Dahlheim et al. 2015). The northern region (Areas 1, 2, and 4) includes Cross Sound, Icy Strait, Glacier Bay, Lynn Canal, Stephens Passage, and Chatham Strait; the southern region (Areas 3, 5, and 6) includes Frederick Sound, Sumner Strait, Wrangell and Zarembo Islands, and Clarence Strait as far south as Ketchikan.~~

This stock assessment report primarily provides an assessment of Southeast Alaska harbor porpoise in the inland waters of Southeast Alaska, which represents a portion of the stock's geographic range, because current estimates of abundance are only available for this region. The stock was previously assessed across its entire range based on stock-wide estimates of abundance from surveys conducted in the 1990s (Hobbs and Waite 2010), but these estimates are now outdated. Human-caused mortality and serious injury is estimated for the stock's entire range, as well as for a specific subarea in the inland waters of Southeast Alaska; however, these are likely underestimates because the majority of the salmon and herring fisheries operating within the range of this stock are not observed.

POPULATION SIZE

Information on harbor porpoise abundance ~~and relative abundance~~ has been collected for coastal and ~~inside~~inland waters of Southeast Alaska by the Alaska Fisheries Science Center's Marine Mammal Laboratory (MML) using both aerial and shipboard surveys. Aerial surveys of this stock were conducted in June and July 1997 and resulted in an ~~observed~~ abundance estimate of ~~3,766 harbor porpoise (CV = 0.16) (Hobbs and Waite 2010); the surveys included a subset of smaller bays and inlets. Correction factors for observer perception bias and porpoise availability at the surface were used to develop an estimated corrected abundance of~~ 11,146 harbor porpoise ~~(3,766 × 2.96; CV = 0.24)~~ in the coastal and ~~inside~~inland waters of Southeast Alaska (Hobbs and Waite 2010).

~~Relative a~~Abundance of harbor porpoise was computed from shipboard line-transect surveys carried out in the inland waters of Southeast Alaska in the summers of 1991-1993, 2005-2006, and 2010-2012 (Dahlheim et al. 2015). Because these surveys only covered a portion of the inland waters and not the entire range of this stock, they were not used to compute the size of the stock~~-specific estimates of abundance~~. ~~Relative a~~Abundance was found to vary across the 22-year survey period~~. Abundance estimated in~~ with the estimate for 1991-1993 (N = 1,076; 95% CI = 910-1,272) ~~was~~being higher than the ~~estimate~~one obtained for 2006-2007 (N = 604; 95% CI = 468-780) but comparable to the estimate for 2010-2012 (N = 975; 95% CI = 857-1,109; Dahlheim et al. 2015). There ~~is~~was insufficient information to estimate the probability of detection on the trackline (g~~(~~[0~~)~~]) ~~from the ship~~for these surveys~~ in Southeast Alaska~~; therefore, the abundance estimates above assume ~~the~~a detection probability of ~~detection directly on the trackline to be unity (g(0) =~~ 1 (perfect detection). This assumption is typically violated in harbor porpoise surveys because observers tend to miss animals on the survey trackline.~~ Therefore, the abundances provided by Dahlheim et al. (2015) were corrected using an estimate of g(0) from ship surveys for harbor porpoise off the U.S. east coast (g[0] = 0.72, CV = 0.083: Palka 1995) because the methods used in these surveys (e.g., size of vessels, number of observers) more closely resembled the methods employed in the Southeast Alaska surveys. Estimates corrected for g(0) are N(1991-1993) = 1,494 (95% CI = 1,130-1,974), N(2006-2007) = 839 (95% CI = 494-1,184), and N(2010-2012) = 1,354 (95% CI = 753-1,197).~~

~~Using the 2010 to 2012 survey data for the inland waters of Southeast Alaska, Dahlheim et al. (2015) calculated abundance estimates for the concentrations of harbor porpoise in the northern (Areas 1, 2, and 4) and southern (Areas 3, 5, and 6) regions of the inland waters (Fig. 2). The resulting g(0)-corrected abundance estimates are 553 harbor porpoise (CV = 0.13) in the northern inland waters (including Cross Sound, Icy Strait, Glacier Bay, Lynn Canal, Stephens Passage, and Chatham Strait) and 801 harbor porpoise (CV = 0.15) in the southern inland waters (including Frederick Sound, Sumner Strait, Wrangell and Zarembo Islands, and Clarence Strait as far south as Ketchikan).~~

A line-transect vessel survey was ~~carried out~~conducted in the inland waters of Southeast Alaska in July/August 2019 using a combination of line-transect and strip-transect methods (Fig. 2) (Zerbini et al. in prep.) and ~~data analysis is underway to compute new estimates of harbor porpoise abundance in this area~~harbor porpoise abundance was estimated at 1,302 porpoise (coefficient of variation (CV) = 0.21; 95% CI = 831-1,965). These surveys also assumed that detection probability on the trackline was perfect (i.e., g[0] = 1); work is underway on a corrected estimate with a calculated value for g(0). Preliminary results based on eDNA analysis show genetic differentiation between harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska, however, the geographic delineation between these regions is not yet known and separate subpopulations or stocks are currently not recognized (but see the NOTE above). An estimate of abundance, based on the 2019 survey, of 332 harbor porpoise (CV = 0.37; 95% CI = 125-616) was computed for the region composed of the Alaska Department of Fish and Game (ADF&G) Districts 6, 7, and 8, where the salmon drift gillnet fishery was observed in 2012 and 2013 and mortality and serious injury was estimated (Manly 2015).

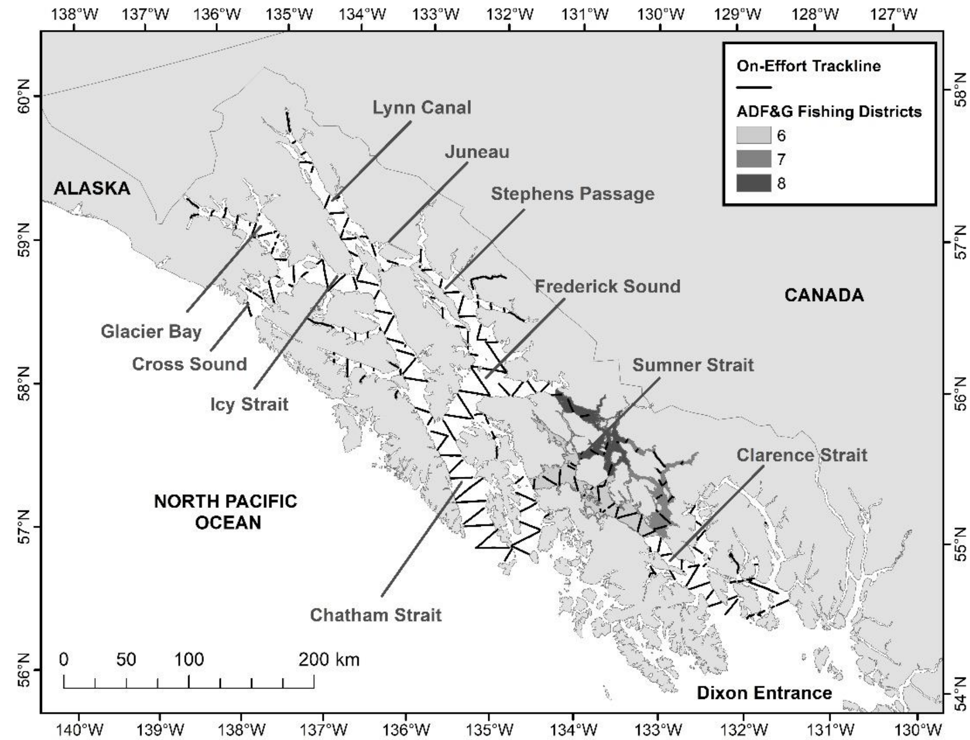


Figure 2. Harbor porpoise survey of the inland waters of Southeast Alaska in 2019. ADF&G Districts 6, 7, and 8 are indicated by gray shading.

Minimum Population Estimate

For the Southeast Alaska stock of harbor porpoise, the minimum population estimate (N_{MIN}) for the ~~2010-2012~~2019 ~~shipboard~~vessel survey~~s~~ is ~~1,224~~1,057 porpoise calculated ~~using Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): N_{MIN} = N/exp(0.842×[ln(1+[CV(N)]^2)]^{½}), where N = 1,354 (assumes g(0) = 0.72) and CV = 0.12~~as the 20th percentile of the distribution of abundance estimates computed using bootstrap. Since this abundance estimate represents some portion of the total number of animals in the stock and is not corrected for animals missed on the trackline, using this estimate to calculate N_{MIN} results in a negatively-biased N_{MIN} for the stock. ~~Although harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska have not been determined to be subpopulations or stocks, PBR calculations for these areas may provide a frame of reference for comparison to harbor porpoise mortality and serious injury in the portion of the Southeast Alaska salmon drift gillnet fishery that was monitored in 2012 and 2013. The pooled 2010 to 2012 abundance estimates of 553 (CV = 0.13; assumes g(0) = 0.72) for the northern region and 801 (CV = 0.15; assumes g(0) = 0.72) for the southern region results in N_{MINs} of 496 and 707, respectively. Alaska Department of Fish and Game~~ N_{MIN} for the area that overlaps ~~(~~ADF&G~~)~~ Districts 6, 7, and 8~~, where the Southeast Alaska salmon drift gillnet fishery was observed in 2012 and 2013 (Manly 2015), partially overlap porpoise survey areas (Areas 5 and 6: Dahlheim et al. 2015)~~ in the southern region of the inland waters was computed as 224 individuals using the same method described above.

Current Population Trend

An analysis of the line-transect vessel survey data collected throughout the inland waters of Southeast Alaska between 1991 and 2010 suggested high probabilities of a population decline ranging from 2 to 4% per year for the whole study area and highlighted a potentially important conservation issue (Zerbini et al. 2011). However, when data from 2011 and 2012 were added to this analysis, the population decline was no longer significant (Dahlheim et al. 2015). It is unclear why a negative trend in harbor porpoise numbers was detected in inland waters of Southeast Alaska between 1991 and 2010 and reversed thereafter (Dahlheim et al. 2015). Regionally, abundance was relatively constant in the northern region of the inland waters of Southeast Alaska throughout the survey period, while declines and subsequent increases were documented in the southern region (Dahlheim et al. 2015). The estimate of abundance computed in 2019 is not statistically different from the estimate computed for Southeast Alaska inland waters in 2010-2012.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Southeast Alaska stock of harbor porpoise. Until additional data become available, the cetacean maximum theoretical net productivity rate of 4% will be used (NMFS 2016).

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 0.5, the value for cetacean stocks with unknown population status (NMFS 2016). Using the N_{MIN} of ~~1,224~~1,057 (based on the ~~2010 to 2012~~2019 abundance estimate for harbor porpoise in the inland waters of Southeast Alaska), PBR is ~~12~~11 harbor porpoise (~~1,224~~1,057 × 0.02 × 0.5) for this area.

Computing a ~~N_{MINs} and~~ PBR~~s~~ for harbor porpoise in the ~~northern and southern regions of the inland waters of Southeast Alaska may provide a frame of reference for the observed mortality and serious injury of harbor porpoise in the~~area where a portion of the Southeast Alaska salmon drift gillnet fishery ~~that~~ was monitored in 2012 and 2013 may provide a frame of reference for the observed mortality and serious injury of harbor porpoise in that area. Based on the ~~pooled 2010 to 2012~~2019 abundance estimate~~s~~ and corresponding N_{MIN}~~s~~, ~~the~~ PBR ~~calculations~~ for the ~~northern and southern regions of the inland waters of Southeast Alaska are 5.0 (N = 553; CV = 0.13; N_{MIN} = 496) and 7.1 (N = 801; CV = 0.15; N_{MIN} = 707)~~area overlapping ADF&G Districts 6, 7, and 8 is 2.2 harbor porpoise (224 × 0.02 × 0.5)~~, respectively~~.

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 ~~2014~~2015 and ~~2018~~2019 is listed, by marine mammal stock, in ~~Young et al. (2020)~~Freed et al. (in prep.); 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 Southeast Alaska harbor porpoise between ~~2014~~2015 and ~~2018~~2019 is 34 porpoise in U.S. commercial fisheries (22 estimated from observer data collected in Yakutat in 2007-2008; 12 estimated from observer data collected in ADF&G Districts 6, 7, and 8 in the inland waters of Southeast Alaska in 2012-2013; and 0.2 estimated from a Marine Mammal Authorization Program (MMAP) fisherman self-report in the coastal waters of Southeast Alaska in 2019); however, this estimate is considered a minimum because ~~not all of~~the majority of the salmon and herring fisheries (salmon and herring gillnet and purse seine and salmon hook and line) operating within the range of this stock ~~have been~~are not observed. The ~~P~~potential threat~~s~~ most likely to result in direct human-caused mortality or serious injury of this stock ~~include~~is entanglement in fishing gear. There are no other known causes of human-caused mortality and serious injury for this stock.

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 ~~December 2020~~July 2021).

No mortality or serious injury of harbor porpoise from the Southeast Alaska stock was observed incidental to federally-managed U.S. commercial fisheries in Alaska between ~~2014~~2015 and ~~2018~~2019.

In 2007 and 2008, the Alaska Marine Mammal Observer Program (AMMOP) placed observers in four regions where the state-managed Yakutat salmon set gillnet fishery operates (Manly 2009). These regions included the Alsek River area, the Situk area, the Yakutat Bay area, and the Kaliakh River and Tsiu River areas. Based on a total of four mortalities and serious injuries observed during these 2 years, the estimated mean annual mortality and serious injury rate in the Yakutat salmon set gillnet fishery was 22 harbor porpoise (Table 1). Although these observer data are dated, they are considered the best available data on mortality and serious injury levels in ~~these~~this fisher~~ies~~y.

In 2012 and 2013, the AMMOP placed observers on independent vessels in the state-managed Southeast Alaska salmon drift gillnet fishery in ADF&G Management Districts 6, 7, and 8 to assess mortality and serious injury of marine mammals (Manly 2015). These Management Districts cover areas of Frederick Sound, Sumner

Strait, Clarence Strait, and Anita Bay which include, but are not limited to, areas around and adjacent to Petersburg and Wrangell and Zarembo Islands. No mortality or serious injury of harbor porpoise was observed in 2012. However, ~~I~~in 2013, four harbor porpoise were observed entangled and released: two were determined to be seriously injured and two were determined not to be ~~not~~ seriously injured. Based on the two observed serious injuries, 23 serious injuries were estimated for Districts 6, 7, and 8 in 2013, resulting in an estimated mean annual mortality and serious injury rate of 12 harbor porpoise in 2012 and 2013 (Table 1). Since these three districts represent only a portion of the overall fishing effort in this fishery, this is a minimum estimate of mortality and serious injury for the fishery.

Table 1. Summary of observed incidental mortality and serious injury of Southeast Alaska harbor porpoise due to U.S. commercial fisheries between ~~2014~~2015 and ~~2018~~2019 (~~or the most recent data available~~estimated from data collected in 2007-2008 and 2012-2013) and calculation of the mean annual mortality and serious injury rate (Manly 2009, 2015). Methods for calculating percent observer coverage are described in Appendix 3 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Yakutat salmon set gillnet	2007 2008	obs data	5.3 7.6	1 3	16.1 27.5	22 (CV = 0.54)
Southeast Alaska salmon drift gillnet (Districts 6, 7, and 8)	2012 2013	obs data	6.4 6.6	0 2	0 23	12 (CV = 1.0)
Minimum total estimated annual mortality						34 (CV = 0.77)

Mortality of one harbor porpoise due to entanglement in a commercial Southeast Alaska salmon cost recovery drift gillnet in the coastal waters of Southeast Alaska was reported in an MMAP fisherman self-report in 2019 (Table 2; Freed et al. in prep.), resulting in a minimum mean annual mortality and serious injury rate of 0.2 harbor porpoise in this fishery between 2015 and 2019. This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and is a minimum because not all entangled animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

Table 2. Summary of Southeast Alaska harbor porpoise mortality and serious injury, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and in MMAP fisherman self-reports between 2015 and 2019 (Freed et al. in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	2015	2016	2017	2018	2019	Mean annual mortality
Entangled in commercial Southeast Alaska salmon cost recovery drift gillnet	0	0	0	0	1*	0.2
Total in commercial fisheries						0.2

*MMAP fisherman self-report.

~~A complete estimate of the total mortality and serious injury incidental to U.S. commercial fisheries is not available for this stock because not all of the salmon and herring fisheries operating within the range of this stock have been observed.~~ Based on observed mortality and serious injury in two commercial fisheries in 2007-2008 and 2012-2013 (Table 1) and an MMAP fisherman self-report in 2019 (Table 2), the minimum estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between ~~2014~~2015 and ~~2018~~2019 is 34 harbor porpoise from observed fisheries (22 in Yakutat and 12 in the inland waters of Southeast Alaska) and 0.2 from an MMAP fisherman self-report in the coastal waters of Southeast Alaska. This is likely an underestimate because the majority of the salmon and herring fisheries (salmon and herring gillnet and purse seine and salmon hook and line) operating within the range of this stock are not observed and not all entangled animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined. Thus, given the known occurrence of fisheries-caused mortality and serious injury of harbor porpoise in gillnet fisheries in Alaska and the lack of thorough and/or recent observation, the total fisheries-caused mortality and serious injury of this stock is likely greater than is reported here.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska have not been reported to take from this stock of harbor porpoise.

STATUS OF STOCK

Southeast Alaska harbor porpoise are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. The minimum ~~estimated~~ mean annual level of human-caused mortality and serious injury estimated for the entire range of Southeast Alaska harbor porpoise (34 porpoise, based on data collected from observer programs in Yakutat (22 porpoise) and ADF&G Districts 6, 7, and 8 in the inland waters of Southeast Alaska (12 porpoise) and from an MMAP fisherman self-report in the coastal waters of Southeast Alaska (0.2 porpoise)) exceeds the calculated PBR (~~12~~11 porpoise), which means this stock is strategic. The minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate (34 porpoise) is more than 10% of the calculated PBR (10% of PBR = ~~1.2~~1.1 porpoise), so it is not considered insignificant and approaching a zero mortality and serious injury rate. However, the calculated PBR is ~~likely~~ biased low for the entire stock because it is based on an estimate~~s~~ from the ~~2010 to 2012~~2019 survey~~s~~ of only a portion (the ~~inside~~inland waters of Southeast Alaska) of the range of this stock as currently designated, whereas the estimate of mortality and serious injury is for the stock's entire range, although the majority of the salmon and herring fisheries operating within the range of this stock are not observed. For comparison, the mean annual estimate of mortality and serious injury for ADF&G Districts 6, 7, and 8 is 12 harbor porpoise compared to the PBR of 2.2 harbor porpoise calculated for this area from the 2019 abundance estimate. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

There are key uncertainties in the assessment of the Southeast Alaska stock of harbor porpoise. This stock likely comprises multiple, smaller stocks based on analogy with harbor porpoise populations that have been the focus of specific studies on stock structure. Preliminary results based on eDNA analysis show genetic differentiation between harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska; however, the geographic delineation between these regions is not known and separate subpopulations or stocks are currently not recognized (but see NOTE above). ~~Concentrations of harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska are identified, and~~ ~~N_{MINs}~~ ~~and PBR levels are calculated for these areas.~~ The trend in abundance of harbor porpoise in these regions is unclear; an early decline appears to have reversed in recent years. Several commercial fisheries overlap with the range of this stock and are not observed or have not been observed in a long time; thus, the estimate of commercial fishery mortality and serious injury is expected to be a minimum estimate. Estimates of human-caused mortality and serious injury from stranding data and fisherman self-reports are underestimates because not all animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

HABITAT CONCERNS

Harbor porpoise are mostly found in nearshore areas and inland waters, including bays, tidal areas, and river mouths (Dahlheim et al. 2000, 2009, 2015; Hobbs and Waite 2010). As a result, harbor porpoise are vulnerable to physical modifications of nearshore habitats resulting from urban and industrial development (including waste management and nonpoint source runoff) and activities such as construction of docks and other over-water structures, filling of shallow areas, dredging, and noise (Linnenschmidt et al. 2013).

Algal toxins are a growing concern in Alaska marine food webs, in particular the neurotoxins domoic acid and saxitoxin. While saxitoxin was not detected in harbor porpoise samples collected in Alaska, domoic acid was found in 40% (2 of 5) of the samples and, notably, in maternal transfer to a fetus (Lefebvre et al. 2016).

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DALL'S PORPOISE (*Phocoenoides dalli*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dall's porpoise are widely distributed across the entire North Pacific Ocean (Fig. 1). They are found over the continental shelf adjacent to the slope and over deep (2,500+ m) oceanic waters (Hall 1979). They have been sighted throughout the North Pacific as far north as 65°N (Buckland et al. 1993) and as far south as 28°N in the eastern North Pacific (Leatherwood and Fielding 1974). The only apparent distribution gaps in Alaska waters are upper Cook Inlet and the shallow eastern flats of the Bering Sea. ~~Throughout most of the eastern North Pacific they~~Dall's porpoise are present during all months of the year throughout most of the eastern North Pacific, although there may be seasonal onshore-offshore movements along the west coast of the continental U.S. (Loeb 1972, Leatherwood and Fielding 1974) ~~and winter movements of populations out of areas with ice such as Prince William Sound (Hall 1979)~~.

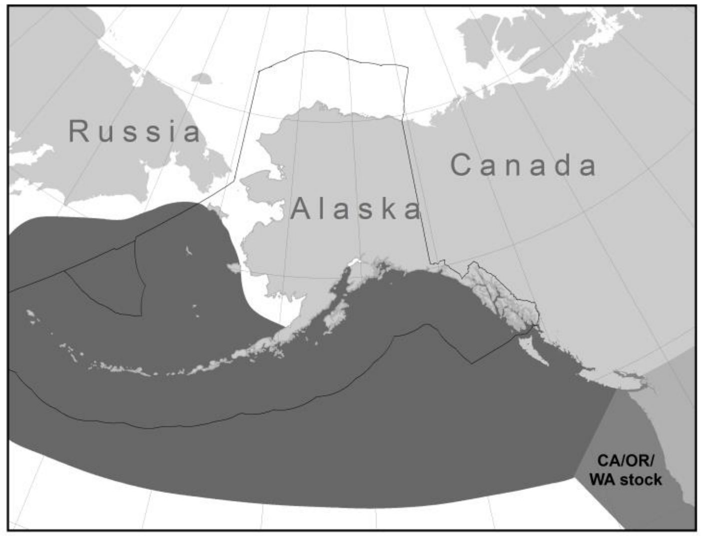

Figure 1. Approximate distribution of Dall's porpoise in the eastern North Pacific Ocean (dark shaded area). The Alaska stock is defined as the portion of the distribution in Alaska waters. The U.S. Exclusive Economic Zone is delineated by ~~the solid~~a black line.

Surveys on the eastern Bering Sea shelf and slope to the 1,000 m isobath in 1999, 2000, 2002, 2004, 2008, and 2010 provided information about the distribution and relative abundance of Dall's porpoise in that area (Moore et al. 2002; Friday et al. 2012, 2013). Dall's porpoise were sighted on the shelf and slope in waters deeper than 100 m in 2002, 2008, and 2010 with greater densities at the shelf break than in shallower waters (Friday et al. 2013). A 2012 vessel survey conducted between 30 and 62°N in the North Pacific Ocean and the Bering Sea between June and August reported sightings across a wide range of water depths and temperatures with concentrations found near Aleutian passes in water depths less than 1,000 m (Suzuki et al. 2016). During the 2011 Chukchi Acoustic, Oceanographic, and Zooplankton (CHAOZ) vessel survey, Dall's porpoise were sighted in the Bering Strait and along the Aleutian Chain (BOEM 2011). ~~Ship~~

Vessel surveys in the northeast Gulf of Alaska in 2013 and 2015 recorded Dall's porpoise throughout the study area, including the continental shelf, the slope, offshore waters, and around seamounts. Higher densities were observed on the shelf and slope (Rone et al. 2017). Vessel surveys for Dall's porpoise conducted in Prince William Sound (PWS) from 2007 to 2015 found that animals shifted their distribution and habitat preferences seasonally (Moran et al. 2018). Dall's porpoise were distributed throughout PWS in summer, the passages in fall, and eastern PWS in winter and spring. Additionally, Dall's porpoise were found in deeper water in summer (mean ± 1 SD: 242 ± 132 m) and shallower water in spring (104 ± 93.4 m) (Moran et al. 2018).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach, which considers four types of data: 1) Distributional data: geographic distribution continuous; 2) Population response data: differential timing of reproduction between the Bering Sea and western North Pacific; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. The stock structure of eastern North Pacific Dall's porpoise is not adequately understood at this time; however, ~~based on patterns of stock differentiation in the western North Pacific, where they have been more intensively studied,~~ it is expected that separate stocks will emerge when data become available (Perrin and Brownell 1994). Based primarily on the population response data (Jones et al. 1986) and ~~preliminary~~ genetic analyses (Winans and Jones 1988), a delineation between Bering Sea and western North Pacific stocks has been recognized. However, similar data are not available for the eastern North

Pacific; thus, one stock of Dall's porpoise is currently recognized in Alaska waters. Dall's porpoise along the west coast of the continental U.S. from California to Washington comprise a separate stock and are reported in the Stock Assessment Reports for the U.S. Pacific Region.

This stock assessment report currently assesses the abundance of Alaska Dall's porpoise only in the northwestern Gulf of Alaska, which is a small portion of the stock's geographic range; however, there is information on Dall's porpoise abundance (now considered outdated) in other areas of the stock's range (e.g., the Bering Sea and Southeast Alaska). Human-caused mortality and serious injury is estimated throughout the stock's entire range; however, it is likely an underestimate because there is no current observer coverage for the salmon and herring fisheries operating within the range of this stock.

POPULATION SIZE

Data collected from vessel surveys, ~~performed~~ by both U.S. fishery observers (collected opportunistically during fishing trips) and U.S. researchers from 1987 to 1991, were analyzed to provide population estimates of Dall's porpoise throughout the North Pacific and the Bering Sea (Hobbs and Lerczak 1993). The quality of data used in analyses was determined by the procedures recommended by Boucher and Boaz (1989). Survey effort was not ~~well~~uniformly distributed ~~throughout~~within the U.S. Exclusive Economic Zone (EEZ) ~~in~~around Alaska and, as a result, Bristol Bay and the northern Bering Sea received little survey effort. Between 1987 and 1991, ~~O~~only three sightings were reported ~~between 1987 and 1991~~ in ~~this area~~the northern Bering Sea ~~by~~ (Hobbs and Lerczak ~~(~~1993), resulting in an estimate of 9,000 porpoise (coefficient of variation (CV) = 0.91) in that area. Hobbs and Lerczak (1993) reported 302,000 (CV = 0.11) Dall's porpoise ~~I~~in the U.S. EEZ north and south of the Aleutian Islands~~,~~ ~~Hobbs and Lerczak (1993) reported an estimated abundance of 302,000 porpoise (CV = 0.11), whereas,~~ and 106,000 (CV = 0.20) ~~for~~in the U.S. EEZ in the Gulf of Alaska~~ EEZ, they reported 106,000 (CV = 0.20)~~. Combining these ~~three~~ estimates (9,000 + 302,000 + 106,000) results in a total abundance estimate of 417,000 (CV = 0.097) for the Alaska stock of Dall's porpoise. Turnock and Quinn (1991) estimated ~~that~~a five-fold positive bias in abundance estimates of Dall's porpoise~~ are inflated by as much as five times~~ because of vessel attraction behavior. Therefore, a corrected population estimate from 1987 ~~-~~to 1991 ~~is~~could be as low as 83,400 (417,000 × 0.2) for this stock. Because these surveys are more than 8 years old, ~~there are no reliable~~this abundance estimate~~s~~ for the ~~entire~~ Alaska stock of Dall's porpoise is no longer considered reliable.

Sighting surveys for cetaceans were conducted opportunistically during NMFS pollock stock assessment surveys in 1999, 2000, 2002, 2004, 2008, and 2010 on the eastern Bering Sea shelf (Moore et al. 2002; Friday et al. 2012, 2013). The entire study area of the survey, which corresponded to only a fraction of the range of the Alaska stock, was fully covered in three of those years (2002, 2008, and 2010). Dall's porpoise ~~estimates were calculated for each of these surveys (Friday et al. 2013). The~~ abundance estimates were 35,303 ~~porpoise~~ (CV = 0.53) in 2002, 14,543 (CV = 0.32) in 2008, and 11,143 (CV = 0.32) in 2010 (Friday et al. 2013). Although the 2010 estimate is the lowest of the three years, it is not statistically different from the 2002 and 2008 estimates (Friday et al. 2013).

Abundance estimates for Dall's porpoise in inland waters of Southeast Alaska were calculated from 19 line-transect vessel surveys from 1991 to 2012 (Jefferson et al. 2019). Abundance across the whole period was estimated at 5,381 (CV = 0.25), 2,680 (CV = 0.20), and 1,637 (CV = 0.23) in the spring, summer, and fall, respectively (Jefferson et al. 2019).

Vessel surveys were carried out in and around a Navy Maritime Activity/Training Area in the northwestern Gulf of Alaska to document abundance and density of cetaceans in 2013 and 2015 (Rone et al. 2017). The surveys covered different, but partially overlapping, areas in the two years and estimated Dall's porpoise abundance as 15,432 (CV = 0.28) in 2013 and 13,110 (CV = 0.22) in 2015.

Estimates of abundance ~~for~~from the NMFS pollock stock assessment surveys in the Bering Sea, the 1991-2012 vessel surveys in Southeast Alaska, and the 2013/2015 vessel surveys in the Gulf of Alaska did not cover the whole range of the stock and were not corrected for responsive movement (vessel attraction), animals missed on the trackline (perception bias), or for animals submerged when the ~~ship~~vessel passed (availability bias).~~ These estimates are also uncorrected for potential biases from responsive movements (ship attraction), which is known to result in severe positive bias when calculating abundance of Dall's porpoise (Turnock and Quinn 1991). Therefore, these estimates are not used as minimum population estimates.~~

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is ~~calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997):~~ ~~$N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. However, because the abundance estimate for the entire stock is based on data older than 8 years, the~~ ~~N_{MIN}~~ ~~is considered~~

~~unknown~~assumed to correspond to the point estimate of the 2015 vessel-based abundance computed by Rone et al. (2017) in the Gulf of Alaska (N = 13,110; CV = 0.22). The study area of this survey corresponds to a small fraction of the range of the stock and, despite the caveats noted in the previous section, it is reasonable to assume the stock size is equal to or greater than that estimate.

Current Population Trend

There is no reliable information on trends in abundance for the Alaska stock of Dall's porpoise.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Alaska stock of Dall's porpoise. Until additional data become available, the cetacean maximum theoretical net productivity rate of 4% will be used (~~Wade and Angliss 1997~~NMFS 2016). However, based on life-history analyses by Ferrero and Walker (1999), Dall's porpoise reproductive strategy is not consistent with the delphinid pattern on which the default maximum theoretical net productivity rate for cetaceans is based. In contrast to the delphinids, Dall's porpoise mature earlier and reproduce annually (Ferrero and Walker 1999), which suggests that a higher R_{MAX} may be warranted.

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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. ~~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 this stock is considered undetermined.~~ The recovery factor (F_R) for this stock is 0.5, the value for cetacean stocks with unknown population status (NMFS 2016). Using the N_{MIN} of 13,110 (based on the 2015 abundance estimate for Dall's porpoise in the Gulf of Alaska), PBR is 131 Dall's porpoise (13,110 × 0.02 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals ~~in 2012-2016~~between 2015 and 2019 is listed, by marine mammal stock, in ~~Helker et al. (in press)~~Freed et al. (in prep.); 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 the Alaska stock of Dall's porpoise ~~in 2012-2016~~between 2015 and 2019 is ~~38~~37 ~~Dall's~~ porpoise: 37 in U.S. commercial fisheries (~~37~~estimated from observer data collected in 1990 and 2012-2013 ~~and 0.6 from fisherman self-reports~~) and 0.2 in unknown (commercial, recreational, or subsistence) fisheries. This estimate is considered a minimum because ~~not all of~~there is no current observer coverage for the salmon and herring fisheries (salmon and herring gillnet and purse seine and salmon hook and line) operating within the range of this stock ~~have been observed~~. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include entanglement in fishing gear.

Fisheries Information

Information ~~(including observer programs, observer coverage, and observed incidental takes of marine mammals)~~ for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is ~~presented~~available in Appendi~~ces~~x 3 ~~-6~~ 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 July 2021).

Based on historical reports and the stock's geographic range, Dall's porpoise mortality and serious injury is known to occur in gillnet fisheries and, to a lesser extent, in trawl and purse seine fisheries. While trawl fisheries have relatively high levels of observation, gillnet and purse seine fisheries do not. There has only been limited observation of gillnet fisheries in discrete years, and mortality and serious injury of Dall's porpoise was documented only in the Southeast Alaska salmon drift gillnet fishery in 2012 and 2013 and the Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery in 1990. Given the known occurrence of fishery-caused mortality and serious injury of Dall's porpoise in gillnet fisheries in Alaska and the lack of thorough and/or recent observation, the potential for fisheries-caused mortality and serious injury may be greater than is reflected in existing observer data.

No mortality or serious injury of the Alaska stock of Dall's porpoise was observed incidental to federally-managed U.S. commercial fisheries ~~in 2012-2016~~between 2015 and 2019 ~~(Breiwick 2013; MML, unpubl. data)~~.

The state-managed Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery was monitored by Alaska Marine Mammal Observer Program (AMMOP) observers in 1990 (Wynne et al. 1991). One Dall's porpoise mortality was observed, which extrapolated to an annual (total) incidental mortality and serious injury rate of 28 Dall's porpoise (Table 1). Although these observer data are dated, they are considered the best available data on mortality and serious injury levels in this fishery.

In 2012 and 2013, the AMMOP placed observers on independent vessels in the state-managed Southeast Alaska salmon drift gillnet fishery to assess mortality and serious injury of marine mammals. Areas around and adjacent to Wrangell and Zarembo Islands (ADF&G Districts 6, 7, and 8) were observed during the 2012-2013 program (Manly 2015). In 2012, one Dall's porpoise was seriously injured. Based on the one observed serious injury, 18 serious injuries were estimated for Districts 6, 7, and 8 in 2012. No mortality or serious injury was observed in 2013, resulting in an estimated mean annual mortality and serious injury rate of 9 Dall's porpoise in 2012-2013 (Table 1). Since these three districts represent only a portion of the overall fishing effort in this fishery, we expect this to be a minimum estimate of mortality for the fishery. Note that the AMMOP has not observed the Southeast Alaska salmon drift gillnet fishery in the other districts; additionally, NMFS has not observed several other gillnet fisheries that are known to interact with this stock~~,~~; therefore, the total estimated mortality and serious injury is unavailable. Combining the estimates from the Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery (28) and the Southeast Alaska salmon drift gillnet fishery (9) results in a~~n~~ minimum estimated ~~average~~mean annual mortality and serious injury rate of 37 Dall's porpoise from this stock.

Table 1. Summary of observed incidental mortality and serious injury of the Alaska stock of Dall's porpoise due to U.S. commercial fisheries ~~in 2012-2016~~ between 2015 and 2019 (~~or the most recent data available~~estimated from data collected in 1990 and 2012-2013) and calculation of the mean annual mortality and serious injury rate (Wynne et al. 1991; Breiwick 2013; Manly 2015; 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
Southeast Alaska salmon drift gillnet (Districts 6, 7, 8)	2012 2013	obs data	6.4 6.6	1 0	18 0	9 (CV = 1.0)
Alaska Peninsula/Aleutian Is. salmon drift gillnet	1990	obs data	4	1	28	28 (CV = 0.585)
Minimum total estimated annual mortality						37 (CV = 0.505)

Mortality ~~and serious injury~~ of one Dall's porpoise due to entanglement~~s~~ in ~~Prince William Sound commercial salmon drift gillnet (1 in 2013), Southeast Alaska commercial salmon drift gillnet (1 in 2014 in District 15C), and Kodiak Island commercial salmon purse seine gear (1 in 2013)~~unknown (commercial, recreational, or subsistence) pot gear was reported ~~by~~in a Marine Mammal Authorization Program (MMAP) fisherman self-report~~s~~ ~~in 2012-2016~~in 2019 (Table 2; ~~Helker et al. in press~~Freed et al. in prep.), resulting in a minimum mean annual mortality and serious injury rate of 0.2 Dall's porpoise between 2015 and 2019.~~ Because observer data are not available for these fisheries, this mortality and serious injury is used to calculate mean annual mortality and serious injury rates of 0.2 Dall's porpoise for each of these fisheries (Table 2).~~ There were no Dall's porpoise entanglements reported to the Alaska Region marine mammal stranding network between 2015 and 2019. ~~These m~~Mortality and serious injury estimates from stranding data and fisherman self-reports result from an actual count of verified human-caused deaths and serious injuries and are minimums because not all entangled animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

Table 2. Summary of Alaska Dall's porpoise mortality and serious injury, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and ~~by~~in ~~Marine Mammal Authorization Program (~~MMAP~~)~~ fisherman self-reports ~~in 2012-2016~~between 2015 and 2019 (~~Helker et al. in press~~Freed et al. in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	~~2012~~	~~2013~~	~~2014~~	2015	2016	2017	2018	2019	Mean annual mortality
~~Entangled in Prince William Sound commercial salmon drift gillnet~~	~~0~~	~~1[a]~~	~~0~~	~~0~~	~~0~~				~~0.2~~
~~Entangled in Southeast Alaska commercial salmon drift gillnet (District 15C)~~	~~0~~	~~0~~	~~1[a]~~	~~0~~	~~0~~				~~0.2~~
~~Entangled in Kodiak Island commercial salmon purse seine gear~~	~~0~~	~~1[a]~~	~~0~~	~~0~~	~~0~~				~~0.2~~
Entangled in unknown pot gear*				0	0	0	0	1[a]	0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries									~~0.6~~0.2

[a]MMAP fisherman self-report.

~~A complete estimate of the total mortality and serious injury incidental to U.S. commercial fisheries is unavailable for this stock because not all of the salmon and herring fisheries operating within the range of this stock have been observed.~~ Based on observed mortality and serious injury in two commercial fisheries in 1990 and 2012-2013 (Table 1)~~ and by MMAP fisherman self-reports (Table 2)~~, the minimum estimated mean annual mortality and serious injury rate incidental to commercial fisheries ~~in 2012-2016~~between 2015 and 2019 is ~~38~~37 Dall's porpoise from this stock. This is likely an underestimate because there is no current observer coverage for the salmon and herring fisheries (salmon and herring gillnet and purse seine and salmon hook and line) operating within the range of this stock and not all entangled animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

Alaska Native Subsistence/Harvest Information

There are no reports of subsistence take of Dall's porpoise in Alaska.

STATUS OF STOCK

Dall's porpoise are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. ~~The minimum abundance estimate for this stock is unknown because the most recent abundance estimate is more than 8 years old and so the PBR level is considered undetermined.~~The minimum estimated mean annual level of human-caused mortality and serious injury for this stock (37 porpoise) is less than the calculated PBR (131 porpoise). The Alaska stock of Dall's porpoise is not classified as strategic. ~~Because the PBR is undetermined and fisheries observer coverage is limited and aged, it is unknown if t~~The minimum estimated ~~of the~~ mean annual mortality and serious injury rate (~~38~~37 porpoise) in U.S. commercial fisheries is more than 10% of the calculated PBR (10% of PBR = 13 porpoise), so it ~~can be~~is not considered insignificant and approaching a zero mortality and serious injury rate. However, the calculated PBR is likely biased low for the entire stock because it is based on an estimate from a 2015 survey of only a small portion of the stock's range, whereas the estimate of mortality and serious injury is for the stock's entire range, although there is no current observer coverage for the salmon and herring fisheries operating within the range of this stock. ~~The Alaska stock of Dall's porpoise is not classified as a strategic stock.~~ Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Alaska stock of Dall's porpoise. The most recent surveys of the entire range of this stock were more than 8 years ago, ~~so~~and the ~~related~~ abundance estimates ~~are not~~ used to calculate an N_{MIN} and ~~the~~ PBR level is ~~undetermined~~based on a survey that covered only a small portion of the stock's range and was not corrected for various biases. There is no information on population trend. Several commercial fisheries overlap with the range of this stock and are not observed or have not been observed in a long time; thus, the estimate of commercial fishery mortality and serious injury is expected to be a minimum estimate. Estimates of human-caused mortality and serious injury from stranding data and fisherman self-reports are underestimates because not all animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

HABITAT CONCERNS

~~While the majority of~~ Dall's porpoise are ~~found throughout~~widely distributed in the North Pacific, ~~there are also significant numbers found in~~ranging from shallow continental shelf ~~break~~waters (Friday et al. 2013) ~~and~~to deepe~~r~~ central North Pacific waters (Ohizumi et al. 2003) and deep nearshore ~~areas~~waters (Jefferson 1988, 2008). Thus, they are ~~subject~~vulnerable to a variety of habitat impacts, including physical modifications from urban and industrial development (including waste management and non-point source runoff). ~~Of particular concern are nearshore areas, bays, channels, and inlets where some Dall's porpoise are vulnerable to physical modifications of nearshore habitats and noise~~Additionally, nearshore habitats are also subject to increased construction of docks and other overwater structures, filling of shallow areas, and dredging and noise (Linnenschmidt et al. 2013). Algal toxins are a growing concern in Alaska marine food webs, in particular the neurotoxins domoic acid and saxitoxin. While saxitoxin was not detected in harbor porpoise samples collected in Alaska, domoic acid was found in 40% (2 of 5) of the samples and, notably, in maternal transfer to a fetus (Lefebvre et al. 2016). Climate change and changes to sea-ice coverage may be opening up new habitats for marine mammals~~, or resulting in shifts in habitat, as evident by an increase in the number of reported sightings of Dall's porpoise in the Chukchi Sea~~ (Funk et al. 2010, 2011). Shipping and noise from oil and gas activities may also be a habitat concern for Dall's porpoise, particularly in the Chukchi Sea.

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BOWHEAD WHALE (*Balaena mysticetus*): Western Arctic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984, Moore and Reeves 1993). For management purposes, four stocks of bowhead whales are recognized worldwide by the International Whaling Commission (IWC 2010). Small stocks, comprising only a few hundred individuals, occur in the Sea of Okhotsk and the offshore waters of Spitsbergen (Zeh et al. 1993, Shelden and Rugh 1995, Wiig et al. 2009, Shpak et al. 2014, Boertmann et al. 2015). Bowhead whales occur in western Greenland (Hudson Bay and Foxe Basin) and eastern Canada (Baffin Bay and Davis Strait), and evidence suggests that these should be considered one stock based on genetics (Postma et al. 2006, Bachmann et al. 2010, Heide-Jørgensen et al. 2010, Wiig et al. 2010), aerial surveys (Cosens et al. 2006), and tagging data (Dueck et al. 2006; Heide-Jørgensen et al. 2006; IWC 2010, 2011). This stock, previously thought to include only a few hundred animals, may number over a thousand (Heide-Jørgensen et al. 2006, Wiig et al. 2011), and perhaps over 6,000 (IWC 2008, Doniol-Valcroze et al. 2015, Frasier et al. 2015). The only stock found within U.S. waters is the Western Arctic stock (Fig. 1), also known as the Bering-Chukchi-Beaufort stock (Rugh et al. 2003) or Bering Sea stock (Burns et al. 1993). The IWC Scientific Committee concluded, in several reviews of the extensive genetic and satellite telemetry data, that the weight-of-evidence is most consistent with one bowhead whale stock that migrates throughout waters of northern and western Alaska and northeastern Russia (IWC 2008, 2018).

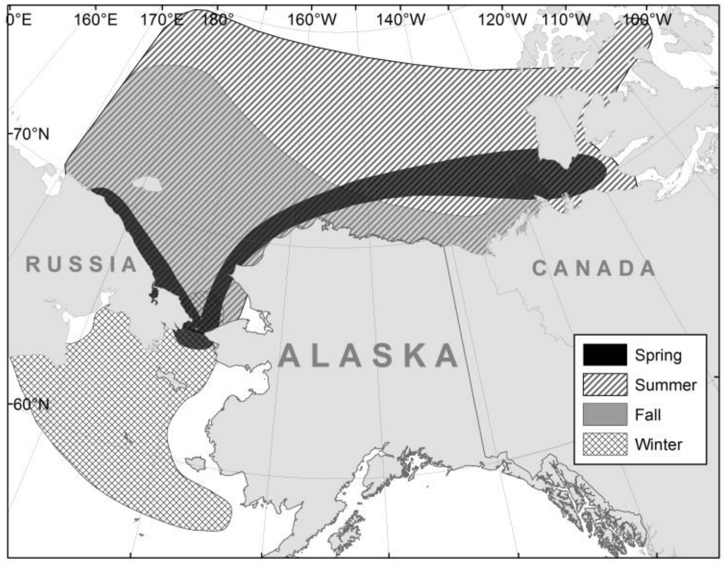

Figure 1. Annual range of the Western Arctic stock of bowhead whales by season from satellite tracking data, 2006-2017 (map based on Quakenbush et al. (2018): Fig. 2).

The majority of the Western Arctic stock migrates annually from wintering areas in the northern Bering and southern Chukchi seas (December to April), through the Chukchi Sea and Beaufort Sea in the spring (April through May), to the eastern Beaufort Sea (Fig. 1) where they spend much of the late spring and summer (May through September). During late summer and autumn (September through December), this stock migrates back to the Chukchi Sea and then to the Bering Sea (Fig. 1) to overwinter (Braham et al. 1980; Moore and Reeves 1993; Quakenbush et al. 2010a, 2018; Citta et al. 2015). During winter and spring, bowhead whales are closely associated with sea ice (Moore and Reeves 1993, Quakenbush et al. 2010a, Citta et al. 2015, Druckenmiller et al. 2018). The bowhead whale spring migration follows fractures in the sea ice along the coast to Point Barrow, generally in the shear zone between the shorefast ice and the mobile pack ice, then continues offshore on a direct path to the Cape Bathurst polynya (Citta et al. 2015). In most years, during summer, a large proportion of the population is in the relatively ice-free waters of Amundsen Gulf in the eastern Beaufort Sea (Citta et al. 2015), an area often exposed to industrial activity related to petroleum exploration (e.g., Richardson et al. 1987, Davies 1997). However, summer aerial surveys conducted in the western Beaufort Sea during July and August of 2012-2017 have had relatively high sighting rates of bowhead whales, including cows with calves and feeding animals (Clarke et al. 2018a, 2018b), suggesting interannual variability in bowhead whale summer distribution. Additionally, data from a satellite-tagging study conducted between 2006 and 2018 indicated that, although most tagged whales began to leave the Canadian Beaufort Sea in September, the timing of their westward migration across the Beaufort Sea was highly variable; furthermore, all tagged whales observed in summer and fall in Beaufort and Chukchi waters near Point Barrow were known to have returned from Canada (Quakenbush and Citta 2019). Timing of the onset of the westward migration across the Beaufort Sea is associated with oceanographic conditions in the eastern Beaufort Sea

(Citta et al. 2018, Clarke et al. 2018b). During the autumn migration, bowhead whales generally inhabit shelf waters across the Beaufort Sea (Citta et al. 2015). The autumn migration across the Chukchi Sea is more dispersed (Clarke et al. 2016); here, bowhead whales generally prefer cold, saline waters that are mostly of Bering Sea origin (Citta et al. 2018). During winter in the Bering Sea, bowhead whales often use areas covered by nearly 100% sea ice, even when polynyas are available (Quakenbush et al. 2010a, Citta et al. 2015).

Evidence from stomach contents and habitat associations suggests that Western Arctic bowhead whales feed on concentrations of zooplankton throughout their range. Likely or confirmed feeding areas include Amundsen Gulf and the eastern Beaufort Sea; the central and western Beaufort Sea; the Chukchi shelf break, especially Herald Valley and the Central Channel; and the coast of Chukotka between Wrangel Island and Bering Strait (Lowry et al. 2004; Ashjian et al. 2010; Clarke and Ferguson 2010; Quakenbush et al. 2010a, 2010b; Okkonen et al. 2011; Fish et al. 2013; Citta et al. 2015, 2018; Clarke et al. 2017; Harwood et al. 2017; Olnes et al. 2020). Citta et al. (2015) identified six core use areas for Western Arctic bowhead whales based on bowhead whale satellite telemetry, oceanography, sea ice, and winds. During spring in the Cape Bathurst polyna, whales are found in water <75 m deep where calanoid copepods ~~are~~ ascend~~ing~~ after diapause. In summer and into fall, bowhead whales inhabit shelf waters in the Beaufort Sea, including the Tuktoyaktuk shelf and areas farther west, where episodic wind-driven upwelling and high river discharge results in high densities of zooplankton (Citta et al. 2015, Harwood et al. 2017, Okkonen et al. 2018, Clarke et al. 2018b). During summer and fall, Western Arctic bowhead whales may congregate on the shallow shelf east of Point Barrow, where variable wind dynamics promote large aggregations of zooplankton onto the shelf (Ashjian et al. 2010, Okkonen et al. 2011, Citta et al. 2015). In winter, dive behavior suggests that bowhead whales feed in shelf waters of the Bering Sea, from Bering Strait south through Anadyr Strait, and near the seafloor in the Gulf of Anadyr (Citta et al. 2012, 2015). Of four bowhead whales harvested in November (two in 2012) and December (two in 2010) near St. Lawrence Island, in the northern Bering Sea, three had been feeding (Sheffield and George 2013). Results from mercury and stable isotope analysis are consistent with year-round foraging and seasonal migration of bowhead whales (Pomerleau et al. 2018).

Clarke et al. (2015) ~~evaluated biologically important areas (BIAs) for bowhead whales in the U.S. Arctic region and~~ identified nine ~~BIAs~~important areas for bowhead whales in the U.S. Arctic based on ~~satellite telemetry and~~ aerial survey data and satellite telemetry. ~~The f~~Four are reproductive ~~BIAs encompass~~ areas where the majority of bowhead whales identified as calves were observed each season. ~~The t~~Three are feeding ~~BIAs were~~ areas located in the western Beaufort Sea. In most years, the krill trap area (Ashjian et al. 2010) from Smith Bay to Point Barrow is the most consistent feeding area for bowhead whales from August to October (Clarke et al. 2015). In other areas of the western Beaufort Sea, bowhead whales may feed in ephemeral prey patches on the continental shelf, out to approximately the 50 m isobath, in September and October. These ephemeral foraging areas are also evident in satellite telemetry data (Quakenbush and Citta 2019, Olnes et al. 2020).

This stock assessment report assesses the abundance and Native subsistence harvest of Western Arctic bowhead whales throughout the stock's entire geographic range. Human-caused mortality and serious injury, other than Native subsistence harvest, is estimated for the portion of the range within U.S. waters (i.e., the U.S. Exclusive Economic Zone) because relevant data are generally not available for the broader range of the stock. However, some pot gear entanglements and rope scars first detected in U.S. waters may have been caused by Russian pot fisheries (Citta et al. 2014).

POPULATION SIZE

All stocks of bowhead whales were severely depleted during intense commercial whaling, starting in the early 16th century near Labrador, Canada (Ross 1993), and spreading to the Bering Sea in the mid-19th century (Braham 1984, Bockstoce and Burns 1993, Bockstoce et al. 2007). Woodby and Botkin (1993) summarized previous efforts to estimate bowhead whale population size prior to the onset of commercial whaling. They reported a minimum worldwide population estimate of 50,000, with 10,400 to 23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). Brandon and Wade (2006) used Bayesian model averaging to estimate that the Western Arctic stock consisted of 10,960 bowhead whales (9,190 to 13,950; 5th and 95th percentiles, respectively) in 1848 at the start of commercial whaling.

The recently adopted Aboriginal Whaling Scheme (IWC 2018) requires that abundance estimates be conducted every 10 years as input into the Strike Limit Algorithm (SLA) that the IWC approved for estimating a safe strike limit for aboriginal subsistence hunting. Ice-based visual and acoustic counts have been conducted since 1978 (Krogman et al. 1989; Table 1). These counts have been corrected for whales missed due to distance offshore since the mid-1980s, using acoustic methods described in (Clark et al. 1994). Correction factors were estimated for whales missed during a watch (due to visibility, number of observers, and offshore distance) and when no watch was in effect (through interpolations from sampled periods) (Zeh et al. 1993, Givens et al. 2016). The spring ice-based estimates of abundance have not been corrected for a small portion of the population that may not migrate past Point Barrow during the period when counts are made. According to Melnikov and Zeh (2007), 470 bowhead whales (95% CI: 332-665) likely migrated to Chukotka instead of Barrow in spring 2000 and 2001.

Table 1. Summary of abundance estimates for the Western Arctic stock of bowhead whales. The historical estimates were made by back-projecting using a simple recruitment model. All other estimates were developed by corrected ice-based census counts. Historical estimates are from Woodby and Botkin (1993); 1978-2001 estimates are from George et al. (2004) and Zeh and Punt (2005). The 2011 estimate is reported in Givens et al. (2016).

Year	Abundance range or estimate (CV)	Year	Abundance estimate (CV)
Historical	10,400-23,000	1985	5,762 (0.253)
End of commercial whaling	1,000-3,000	1986	8,917 (0.215)
1978	4,765 (0.305)	1987	5,298 (0.327)
1980	3,885 (0.343)	1988	6,928 (0.120)
1981	4,467 (0.273)	1993	8,167 (0.017)
1982	7,395 (0.281)	2001	10,545 (0.128)
1983	6,573 (0.345)	2011	16,820 (0.052)

Bowhead whales were identified from aerial photographs taken in 1985 and 1986, and again in 2003 and 2004, and the results were used in a sight-resight analysis (Table 2). These population estimates and their associated error are comparable to the estimates obtained from the combined ice-based visual and acoustic counts (Raftery and Zeh 1998, Schweder et al. 2009, Koski et al. 2010). An aerial photographic survey was conducted near Point Barrow concurrently with the ice-based spring census in 2011, which, in addition to an abundance estimate based on sight-resight data, also provided a revised survival estimate for the population (Givens et al. 2018) (Table 2). However, because the 2011 ice-based estimate had a lower coefficient of variation (CV), the

Table 2. Summary of abundance estimates for the Western Arctic stock of bowhead whales from aerial sight-resight surveys. Estimates are reported in da Silva et al. 2000, 2007 (1986 estimate), Koski et al. 2010 (2004 estimate), and Givens et al. 2018 (2011 estimate). LB = lower bound of 95% confidence interval.

Year	Abundance range or estimate (CV)	Survival estimate (LB)
1986	4,719 - 7,331	0.985 (0.958)
2004	12,631 (0.2442)	
2011	27,133 (0.217)	0.996 (0.976)

IWC Scientific Committee considered this estimate the most appropriate for management and use in the SLA (IWC 2018). This estimate is more than 8 years old and is outdated for use in stock assessments; however, because this population is increasing, this is still considered a valid minimum population estimate (NMFS 2016).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for the Western Arctic stock is calculated from Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 2011 population estimate (N) from the ice-based survey of 16,820 and its associated CV(N) of 0.052 (Table 1), N_{MIN} for this stock of bowhead whales is 16,100 whales. The 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) recommend that N_{MIN} be considered unknown if the abundance estimate is more than 8 years old, unless there is compelling evidence that the stock has not declined since the last estimate. Because this population is increasing, this is still considered a valid minimum population estimate.

Current Population Trend

Based on concurrent passive acoustic and ice-based visual surveys, Givens et al. (2013) reported that the Western Arctic stock of bowhead whales increased at a rate of 3.7% (95% CI = 2.9-4.6%) from 1978 to 2011, during which time abundance tripled from approximately 5,000 to approximately 16,820 whales (Givens et al. 2016) (Fig. 2). Schweder et al. (2009) estimated the yearly growth rate to be 3.2% (95% CI = 0.5-4.8%) between 1984 and 2003 using a sight-resight analysis of aerial photographs.

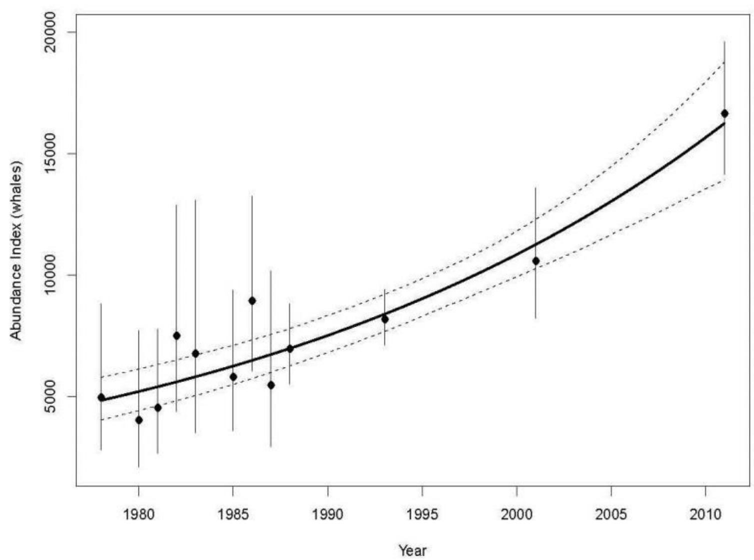

Figure 2. Abundance estimates (points with confidence interval lines) and trend (black line with confidence range) for the Western Arctic stock of bowhead whales, 1978-2011 (Givens et al. 2013), as computed from ice-based counts and acoustic data collected during bowhead whale spring migrations past Point Barrow, Alaska.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The current estimate for the rate of increase for the Western Arctic stock of bowhead whales (3.7%: 95% CI = 2.9-4.6%) should not be used as an estimate of the maximum net productivity rate (R_{MAX}) because the population is currently being harvested and the population has been estimated to be at a substantial fraction of its carrying capacity (Brandon and Wade 2006); therefore, this stock may not be growing at its maximum rate. Thus, ~~T~~the cetacean maximum theoretical net productivity rate of 4% will be used for the Western Arctic stock of bowhead whales (NMFS 2016).

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 has been set at 0.5 rather than the default value of 0.1 for endangered species because population levels are increasing in the presence of a known take (NMFS 2016). Thus, PBR is 161 whales (16,100 × 0.02 × 0.5). The calculation of a PBR level for the Western Arctic bowhead whale stock is required by the MMPA even though the subsistence harvest quota is established under the authority of the IWC based on an extensively tested SLA (IWC 2003). The quota is based on subsistence need or the ability of the bowhead whale population to sustain a harvest, whichever is smaller. The IWC bowhead whale quota takes precedence over the PBR estimate for the purpose of managing the Alaska Native subsistence harvest from this stock. ~~From 2013 to 2018, the IWC established a block quota of 336 landed bowhead whales. Because some whales are struck and lost, the IWC set a strike limit of 67 (plus up to 15 previously unused strikes) per year.~~In 2018, the IWC revised the bowhead whale subsistence quota (IWC 2018 Schedule amendment). Under the revisions, the total block quota for 2019 to 2025 is 392 whales, with no more than 67 strikes per year, except that any unused portion of a strike quota from the three prior quota blocks can be carried forward and added to the strike quotas of subsequent years, provided that no more than 50% of the annual strike limit is added to the strike quota for any one year (IWC 2018 Schedule amendment, section 13(b)1). ~~In recent years, an arrangement~~A bilateral agreement between the United States and the Russian Federation ensures that the total quota of bowhead whales struck will not exceed the limits set by the IWC. Under this bilateral arrangement, the Chukotka Natives in Russia may use no more than seven strikes~~,~~ and Alaska Natives may use no more than ~~75~~93 strikes per year. ~~The total block quota for 2019 to 2025 is 392 whales, with no more than 67 strikes per year, except that any unused portion of a strike quota from the three prior quota blocks can be carried forward and added to the strike quotas of subsequent years, provided that no more than 50% of the annual strike limit is added to the strike quota for any one year.~~

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 ~~2014~~2015 and ~~2018~~2019 is listed, by marine mammal stock, in ~~Young et al. (2020)~~Freed et al. (in prep.); 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 Western Arctic bowhead whales between ~~2014~~2015 and ~~2018~~2019 is ~~56~~52 whales: 0.2 in U.S. commercial fisheries, 0.6 in unknown (commercial, recreational, or subsistence) fisheries ~~(Table 3)~~, ~~and 56~~50 in subsistence takes by Natives of Alaska (51 whales (~~number~~ landed ~~+~~plus struck and lost mortality) minus 0.6 whales seriously injured in fisheries interactions prior to harvest), and 0.8 in subsistence takes by Natives of Russia (number landed~~,~~; struck and lost not reported). Potential threats most likely to result in direct human-caused mortality or serious injury of individuals in this stock include entanglement in fishing gear and ship strikes due to increased vessel traffic (from increased commercial shipping in the Chukchi and Beaufort seas) ~~(Smith and Stephenson 2013)~~.

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 ~~December 2020~~July 2021).

Based on historical reports and the stock's geographic range, the only documented fisheries-caused bowhead whale mortality and serious injury has been from entanglement in pot fishery gear. Given the minimal range overlap of bowhead whales and active pot fisheries, the levels of these interactions may be low; however, the levels are unknown even for observed fisheries. While some finfish pot and crab pot fisheries have onboard observers, the observers are unlikely to observe interactions unless an animal is anchored in gear. In most cases, large whale interactions occur while the pots are left untended to fish or "soak" and the whale swims away with gear attached. Because an observer generally cannot determine if a missing pot was lost due to whale entanglement, mortality and serious injury events are seldom reported in these fisheries. Therefore, the potential for fisheries-caused mortality and serious injury may be greater than is reflected in existing observer data. Additionally, bowhead whales may become entangled in derelict pot gear and such interactions would also not be reflected in observer data. A northward shift of fish stocks and fisheries due to climate change (Morley et al. 2018) will also increase the risk of bowhead whale interactions with fishing gear.

~~While t~~There are no observer program records of bowhead whale mortality or serious injury incidental to U.S. commercial fisheries in Alaska; however, there have been reports of bowhead whale mortality and serious injury due to entanglement in fishing gear (Table 3). Because no U.S. commercial fisheries occur in the Beaufort or Chukchi seas, bowhead whale mortality or injury that can be associated with U.S. commercial fisheries is currently attributed to interactions with fisheries in the Bering Sea. Citta et al. (2014) found that the distribution of satellite-tagged bowhead whales in the Bering Sea spatially, but not temporally, overlapped areas where commercial pot fisheries occurred and noted the potential risk of entanglement in lost gear. ~~Approximately 12% of the bowhead whales taken in the subsistence hunt between 1990 and 2012 showed evidence of entanglement in line or net (Philo et al. 1993).~~ George et al. (2017) ~~examined 904 records of~~analyzed scarring data for bowhead whales harvested between 1990 and 2012 to estimate the frequency of line entanglement. ~~Of these, 514 records were examined for at least one of the three types of scars indicating injuries from line entanglement wounds (514 records examined), attacks by killer whales (377 records examined), or ship strikes (and/or propeller injuries) (504 records examined). Their best estimate of the occurrence of entanglement scars was a~~Approximately 12.2% of the harvested whales examined for signs of entanglement (59/485~~;~~) had scar patterns that were identified as definite entanglement injuries (29 ~~records~~whales with possible entanglement scars were excluded ~~from the analysis~~) ~~with the cause most likely~~

~~from fishing/crab pot gear in the Bering Sea~~. Most of the entanglement ~~injuries~~scars occurred on the peduncle, and entanglement scars were rar~~ely observed~~ on smaller subadult and juvenile whales (body length <10 m), possibly because young whales are less likely to survive entanglements ~~(George et al. 2017)~~ and have ~~presumably~~ had fewer years during which to acquire entanglement scars (George et al. 2017). The authors suspected the entanglement scars were largely the result of interactions with commercial pot gear (including derelict gear) in the Bering Sea. A review of the photo-identification catalogue from 1985 to 2011 found the probability of scarring due to entanglement ~~at~~was about 2.2% per year (95% CI: 1.1-3.3%), with 12.4% of living bowhead whales photographed in 2011 showing evidence of entanglement (George et al. 2019).

~~One dead bowhead whale was found floating in Kotzebue Sound in early July 2010, entangled in crab pot gear similar to that used by commercial crabbers in the Bering Sea (Suydam et al. 2011), and one entangled bowhead whale was photographed during the 2011 spring aerial photographic survey of bowhead whales near Point Barrow (Mocklin et al. 2012) but it was not considered to be seriously injured.~~Between 2015 and 2019, there were four reports of bowhead whale mortality or serious injury caused by interactions with fishing gear (Table 3). In July 2015, a dead adult female bowhead whale drifting near Saint Lawrence Island in the Bering Strait was entangled in commercial crab fishing gear (Sheffield and Savoonga Whaling Captains Association 2015, Suydam et al. 2016, Freed et al. in prep.)~~, which included lines, two floats, and an attached color coded/numbered permit tag for the 2012/2013 winter commercial blue king crab fishery located in Saint Matthew Island waters of the northern Bering Sea (Sheffield and Savoonga Whaling Captains Association 2015)~~, resulting in a mean annual mortality and serious injury rate of 0.2 whales in commercial fisheries between 2015 and 2019 (Table 3). ~~Two~~Three of the bowhead whales taken in the Alaska Native subsistence hunt in 2017 were seriously injured prior to harvest due to entanglement in pot gear suspected (but not confirmed) to be from Bering Sea commercial pot fisheries (~~Young et al. 2020~~Rolland et al. 2019, Freed et al. in prep.)~~ and a third whale taken during the subsistence hunt on 5 May 2017 was reported as "lethargic" and was later found to have 84 m of 19-mm rope attached to the baleen rack, left pectoral flipper, and peduncle, penetrating up to 10 cm through the epidermis (Rolland et al. 2019)~~, resulting in a mean annual mortality and serious injury rate of 0.6 bowhead whales in unknown (commercial, recreational, or subsistence) fisheries between 2015 and 2019 (Table 3).~~; however,~~ ~~b~~Because these three whales are also included in the Alaska Native subsistence harvest for 2017 (Table 4), ~~they are not listed in Table 3~~the mean annual mortality and serious injury rate for these three events (0.6 whales) will be subtracted from the mean annual subsistence harvest for 2015-2019 to prevent double counting.

Thus, the minimum estimated average annual mortality and serious injury rate in U.S. commercial fisheries between ~~2014~~2015 and ~~2018~~2019 is 0.2 bowhead whales and the rate in unknown (commercial, recreational, or subsistence) fisheries is 0.6 (Table 3; ~~Young et al. 2020~~Freed et al. in prep.), although, the actual rates ~~is~~are currently unknown. ~~This~~These mortality and serious injury estimates result~~s~~ from ~~an~~ actual counts of verified human-caused deaths and serious injuries and ~~is a~~are minimums because not all entangled animals are found, reported, or have the cause of death determined.

Table 3. Summary of mortality and serious injury of Western Arctic bowhead whales, by year and type, reported ~~to the NMFS Alaska Region marine mammal stranding network~~ between ~~2014~~2015 and ~~2018~~2019 (~~Young et al. 2020~~NMFS Alaska Region marine mammal stranding network, Sheffield and Savoonga Whaling Captains Association 2015, Suydam et al. 2016, Rolland et al. 2019, Freed et al. in prep.).

Cause of injury	~~2014~~	2015	2016	2017	2018	2019	Mean annual mortality
Entangled in commercial Bering Sea/Aleutian Is. ~~commercial blue king~~ crab pot gear	~~0~~	1	0	0	0	0	0.2
Entangled in Bering Sea/Aleutian Is. pot gear*		0	0	3	0	0	0.6
Total in commercial fisheries							0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries							0.6

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Alaska Eskimo Whaling Commission (in 1998, as last amended in 2019) to protect the bowhead whale and the Eskimo culture. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of marine mammals (to the maximum extent allowed by law) as a tool for conserving marine mammal populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed ~~December 2020~~July 2021).

Alaska Natives have been taking bowhead whales for subsistence purposes for at least 2,000 years (Marquette and Bockstoce 1980, Stoker and Krupnik 1993). Subsistence takes have been regulated by a quota system under the authority of the IWC since 1977. Alaska Native subsistence hunters, primarily from 11 Alaska communities, take approximately 0.1-0.5% of the Western Arctic bowhead whale stock per annum (Philo et al. 1993, Suydam et al. 2011). Under this quota, the number of bowhead whales landed by Alaska Natives between 1974 and ~~2018~~2019 ranged from 8 to 55 whales per year (Suydam and George 2012; Suydam et al. 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020; George and Suydam 2014). The maximum number of strikes per year is set by a quota which is determined by subsistence needs and bowhead whale abundance and trend estimates (Stoker and Krupnik 1993) (see the Potential Biological Removal section). Suydam and George (2012) summarized Alaska subsistence harvests of bowhead whales from 1974 to 2011 and reported a total of 1,149 whales landed by hunters from 12 villages, with Utqiaġvik (formerly Barrow) landing the most whales (n = 590) and Shaktoolik landing only one. Alaska Natives landed ~~221~~213 bowhead whales between ~~2014~~2015 and ~~2018~~2019 and ~~52~~42 of the ~~65~~56 whales that were struck and lost were determined to have died or had a poor chance of survival, resulting in an average annual take of ~~55~~51 whales (Table 4); however, because a mean annual 0.6 whales were determined to have been seriously injured in fishery interactions prior to harvest, the total subsistence harvest by Alaska Natives between 2015 and 2019 is 50 whales. Unlike the NMFS process for determining serious injuries (described in NMFS 2012), the~~se~~ estimates of struck and lost mortality in the subsistence harvest are based on the Whaling Captains' assessment of the likelihood of survival (see criteria described in Suydam et al. 1995). The number of whales landed at each village varies greatly from year to year, as success is influenced by village size and ice and weather conditions. The efficiency of the hunt (the percent of whales struck that are retrieved) has increased since the implementation of the bowhead whale quota in 1978. In 1978, the efficiency was about 50%. In ~~2018~~2019, ~~47~~30 of ~~68~~36 whales struck were landed, resulting in an efficiency of ~~69~~83% and the mean efficiency for ~~2008~~2009 to ~~2017~~2018 was 77% (Suydam et al. ~~2019~~2020).

Canadian and Russian Natives also take whales from this stock. No catches of Western Arctic bowhead whales were reported by Canadian hunters between ~~2014~~2015 and ~~2018~~2019; however, two bowhead whales were landed in Russia in 2016 (Ilyashenko and Zharikov 2017), one in 2017 (Zharikov 2018), ~~and~~ none in 2018 (Zharikov et al. 2019), and one in 2019 (Zharikov et al. 2020), resulting in an average annual take of ~~0.6~~0.8 (landed) whales by Russian Natives between 2015 and 2019.

The total average annual subsistence take ~~for~~from ~~2014~~2015 to ~~2018~~2019 is ~~56~~51 bowhead whales: ~~, which includes the number~~50 whales by Alaska Natives (51 landed ~~(~~plus ~~the~~ struck and lost mortality (Table 4) minus 0.6 seriously injured in fisheries interactions prior to harvest (Table 3)) ~~by Alaska Natives~~ and 0.8 whales by ~~and the number~~ Russian Natives (landed; ~~(~~struck and lost not reported)~~ by Russian Natives~~.

Table 4. Summary of the Alaska Native subsistence harvest of Western Arctic bowhead whales between ~~2014~~2015 and ~~2018~~2019.

Year	Landed	Struck and lost	Struck and lost mortality	Total (landed + struck and lost mortality)
~~2014[a]~~	~~38~~	~~15~~	~~12~~	~~50~~
2015[~~b~~a]	39	10	6	45
2016[~~c~~b]	47	12	12	59
2017[~~d~~c]	50	7	5	55

Year	Landed	Struck and lost	Struck and lost mortality	Total (landed + struck and lost mortality)
2018~~[e]~~[d]	47	21	17	64
2019[e]	30	6	2	32
Mean annual number taken (landed + struck and lost mortality)				~~55~~51

~~[a]Suydam et al. (2015);~~ ~~[b]~~[a]Suydam et al. (2016); ~~[c]~~[b]Suydam et al. (2017); ~~[d]~~[c]Suydam et al. (2018); ~~[e]~~[d]Suydam et al. (2019); [e]Suydam et al. (2020).

Other Mortality

Pelagic commercial whaling for bowhead whales was conducted from 1849 to 1914 in the Bering, Chukchi, and Beaufort seas (Bockstoce et al. 2007). During the first two decades of the fishery (1850-1870), over 60% of the estimated pre-whaling population was killed, and effort remained high into the 20th century (Braham 1984). Woodby and Botkin (1993) estimated that the pelagic whaling industry harvested 18,684 whales from this stock. From 1848 to 1919, shore-based whaling operations (including landings as well as struck and lost estimates from the U.S., Canada, and Russia) took an additional 1,527 whales (Woodby and Botkin 1993). An unknown percentage of the whales taken by the shore-based operations were harvested for subsistence purposes. Historical harvest estimates likely underestimate the actual harvest as a result of under-reporting of the Soviet catches (Yablokov 1994) and incomplete reporting of struck and lost whales.

Transient killer whales are known to prey on bowhead whales. In a study of marks on bowhead whales taken in the subsistence harvest between spring 1976 and fall 1992, 4.1% to 7.9% had scars indicating that they had survived attacks by killer whales (George et al. 1994). Of 377 complete records for killer whale scars collected from 1990 to 2012, 29 whales (7.9%) had scarring “rake marks” consistent with killer whale injuries and another 10 had possible injuries (George et al. 2017). A higher rate of killer whale rake mark scars occurred from 2002 to 2012 than in the previous decade. George et al. (2017) noted this may be due to better reporting and/or sampling bias, an increase in killer whale population size, an increase in occurrence of killer whales at high latitudes (Clarke et al. 2013), or a longer open water period offering more opportunities to attack bowhead whales. The Aerial Surveys of Arctic Marine Mammals (ASAMM) project photo-documented bowhead whale carcasses that had injuries consistent with killer whale predation in 2010 (one carcass), 2012 (two~~ carcasses~~), 2013 (~~two~~three), 2015 (~~two~~three), 2016 (~~three~~four), ~~and~~ 2017 (one), 2018 (four), and 2019 (six) ~~and three of these carcasses (one each in 2013, 2015, and 2017) were likely calves or yearlings~~ (Willoughby et al. ~~2018~~2020a, 2020b).

With increasing ship traffic and oil and gas exploration and development activities in the Chukchi and Beaufort seas, ship strikes may pose a greater risk to bowhead whales. Currently, ship-strike injuries on bowhead whales in Alaska are thought to be uncommon (George et al. 2017, 2019). Only 10 whales harvested between 1990 and 2012 (approximately 2% of the records examined) showed clear evidence of scarring from ship propellers (George et al. 2017), while only seven whales from the photo-identification catalogue from 1985 to 2011 (1% of the sample) had evidence of ship-inflicted scars (George et al. 2019). One carcass observed in 2019 during the ASAMM surveys had blubber sections with straight wound edges and was likely struck by a vessel (Willoughby et al. 2020b).

STATUS OF STOCK

Based on currently available data, the minimum estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries (0.2 whales) is not known to exceed 10% of the PBR (10% of PBR = 16) 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 (~~56~~52 whales) is not known to exceed the PBR (161) nor the IWC annual maximum strike limit (67 + up to ~~15~~33 previously unused strikes). The Western Arctic bowhead whale stock has been increasing; the estimate of 16,820 whales from 2011 is between 31% and 168% of the pre-exploitation abundance of 10,000 to 55,000 whales estimated by Brandon and Wade (2004, 2006). However, the stock is classified as ~~a~~ strategic ~~stock~~ because the bowhead whale is listed as endangered under the U.S. Endangered Species Act and is, therefore, also designated as depleted under the MMPA.

There are key uncertainties in the assessment of the Western Arctic stock of bowhead whales. The current abundance estimate is calculated using data from 2011; however, the N_{MIN} is still considered a valid minimum population estimate because the population is increasing (NMFS 2016). Although there are few records of bowhead whales being killed or seriously injured incidental to commercial fishing, about 12.2% of harvested bowhead whales examined for scarring (59/485 records) had scars indicating line entanglement wounds (George et al. 2017) and the southern range of the population overlaps with commercial pot fisheries (Citta et al. 2014). The stock may be particularly sensitive to anthropogenic sound; under some circumstances, the stock changes either distribution or calling behavior in response to levels of anthropogenic sounds that are slightly above ambient (Blackwell et al. 2015). The reduction in sea ice may lead to increased predation of bowhead whales by killer whales.

HABITAT CONCERNS

Vessel traffic in arctic waters is increasing, largely due to an increase in commercial shipping facilitated by the lack of sea ice (Smith and Stephenson 2013, Reeves et al. 2014, George et al. 2020). This increase in vessel traffic could result in an increased number of vessel collisions with bowhead whales (Huntington et al. 2015). Oil and gas development in the Arctic imposes risks of various forms of pollution, including oil spills, in bowhead whale habitat, and the technology for effectively recovering spilled oil in icy conditions is lacking (Wilkinson et al. 2017).

Also of concern is noise produced by seismic surveys and vessel traffic resulting from shipping and offshore energy exploration, development, and production operations. Evidence indicates that bowhead whales are sensitive to noise from offshore drilling platforms and seismic survey operations (Richardson and Malme 1993, Richardson 1995, Davies 1997, Robertson et al. 2013, Blackwell et al. 2017). Bowhead whales often avoid sound sources associated with active drilling (Schick and Urban 2000) and seismic operations (Miller et al. 1999). Exposure to seismic operations resulted in subtle changes to dive, surfacing, and respiration behaviors (Robertson et al. 2013). Source levels, time of year, and whale behavior (migrating, feeding, etc.) all affect the extent of displacement or changes in behavior (e.g., Richardson et al. 1986, 1999; Ljungblad et al. 1988; Miller et al. 2005; Harris et al. 2007; MMS 2008; Funk et al. 2010) and impacts on bowhead calling rates (Greene et al. 1998; Blackwell et al. 2013, 2015).

Global climate model projections for the next 50 to 100 years consistently show pronounced warming over the Arctic, accelerated sea-ice loss, and continued permafrost degradation (USGS 2011, IPCC 2013, Jeffries et al. 2015). Within the Arctic, some of the largest changes are projected to occur in the Bering, Beaufort, and Chukchi seas (Chapman and Walsh 2007, Walsh 2008). Ice-associated animals, including the bowhead whale, may be sensitive to changes in arctic weather, sea surface temperatures, sea-ice extent, and the concomitant effect on prey availability. Based on an analysis of various life-history features, Laidre et al. (2008) concluded that, on a worldwide basis, bowhead whales were likely to be moderately sensitive to climate change. Using statistical models, Chambault et al. (2018) found that bowhead whales in Baffin Bay, Greenland, targeted a narrow range of temperatures (-0.5 to 2°~~-~~C) and may be exposed to thermal stress as a result of warming temperatures. However, ~~thermal stress resulting from increased sea surface temperatures has not been observed in~~ the Western Arctic stock of bowhead whales commonly feeds in waters ranging from 4° to 6°C near Tuktoyaktuk (Citta et al. 2021); a bowhead was sighted in the relatively warm waters of the Gulf of Maine during summer 2012, 2014, and 2017 (Accardo et al. 2018); and bowheads in the Sea of Okhotsk are found in waters with sea surface temperatures up to 16.5°C (Shpak and Paramonov 2018). Therefore, it is possible that bowhead whales' selection of cooler waters in some regions could be primarily due to prey availability as opposed to thermal stress. ~~On the contrary~~Additionally, landed Western Arctic bowhead whales had better body condition during years of light ice cover (George et al. 2006). In addition, a positive correlation between body condition of Western Arctic bowhead whales and summer sea-ice loss has been observed over the last 2.5 decades in the Pacific Arctic (George et al. 2015). Ice-free areas along the shelf break are thought to create increased upwelling and likely more feeding opportunities for foraging whales. The movement and foraging behavior of bowhead whales is becoming more variable as feeding areas are altered in response to retreating sea ice. Additionally, Hannay et al. (2013) found that a large fraction of bowhead whale acoustic detections in the northeast Chukchi Sea occurred just in advance of the progression of sea ice formation during the fall migration, suggesting that an increase in ice-free days may lead to a delayed migration out of the Chukchi Sea during fall. Sheffield and George (2013) presented evidence that the occurrence of fish has become more prevalent in the diets of Western Arctic bowhead whales near Utqiaġvik in the autumn. However, there are insufficient data to make reliable projections about whether arctic climate change will result in negative (thermal stress, habitat loss) or positive (prey abundance) effects on this population.

Ocean acidification, driven primarily by the production of carbon dioxide (CO_2) emissions into the atmosphere, is also a concern due to potential effects on prey. Because their primary prey are small crustaceans (especially calanoid copepods, euphausiids, gammarid and hyperid amphipods, and mysids that have exoskeletons composed of chitin and calcium carbonate), bowhead whale survival and recruitment may be impacted by increased ocean acidification (Lowry et al. 2004). The nature and timing of impacts to bowhead whales from ocean acidification are extremely uncertain and will depend partially on the whales' ability to switch to alternate prey species. Ecosystem responses may have very long lags as they propagate through trophic webs.

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Appendix 1. Summary of substantial changes to the text and/or values in the ~~2020~~2021 stock assessments (last revised ~~12/30/2020~~7/8/2021). An 'X' indicates sections where the information presented has been updated since the ~~2019~~2020 stock assessments were released. Stock Assessment Reports for those stocks in boldface were updated in ~~2020~~2021.

Stock	Stock definition	Population size	PBR	Fishery mortality	Subsistence mortality	Status
Steller sea lion (Western U.S.)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Steller sea lion (Eastern U.S.)						
Northern fur seal (Eastern Pacific)		**X**	**X**	**X**	**X**	**X**
Harbor seal (Aleutian Islands)						
Harbor seal (Pribilof Islands)						
Harbor seal (Bristol Bay)						
Harbor seal (North Kodiak)						
Harbor seal (South Kodiak)						
Harbor seal (Prince William Sound)						
Harbor seal (Cook Inlet/Shelikof Strait)						
Harbor seal (Glacier Bay/Icy Strait)						
Harbor seal (Lynn Canal/Stephens Passage)						
Harbor seal (Sitka/Chatham Strait)						
Harbor seal (Dixon/Cape Decision)						
Harbor seal (Clarence Strait)						
Spotted seal (Bering)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Bearded seal (Beringia)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Ringed seal (Arctic)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Ribbon seal	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Beluga whale (Beaufort Sea)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Beluga whale (Eastern Chukchi Sea)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Beluga whale (Eastern Bering Sea)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Beluga whale (Bristol Bay)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Beluga whale (Cook Inlet)	**X**	~~**X**~~	~~**X**~~	~~**X**~~	~~**X**~~	**X**
Narwhal (Unidentified)						
Killer whale (ENP Alaska Resident)						
Killer whale (ENP Northern Resident)						
Killer whale (ENP Gulf of Alaska, Aleutian Islands, and Bering Sea Transient)	~~X~~		~~X~~	~~X~~	~~X~~	~~X~~
Killer whale (AT1 Transient)	~~X~~	~~X~~		~~X~~	~~X~~	
Killer whale (West Coast Transient)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
Pacific white-sided dolphin (North Pacific)						
Harbor porpoise (Southeast Alaska)	**X**	**X**	X	**X**		X
Harbor porpoise (Gulf of Alaska)	~~X~~			~~X~~		
Harbor porpoise (Bering Sea)	~~X~~	~~X~~		~~X~~		~~X~~
Dall's porpoise (Alaska)	X	X	X	X		X
Sperm whale (North Pacific)				~~X~~		~~X~~
Baird's beaked whale (Alaska)						
Cuvier's beaked whale (Alaska)						
Stejneger's beaked whale (Alaska)						
Humpback whale (Western North Pacific)				~~X~~	~~X~~	~~X~~
Humpback whale (Central North Pacific)	~~X~~			~~X~~	~~X~~	~~X~~
Fin whale (Northeast Pacific)				~~X~~		~~X~~
Minke whale (Alaska)						
North Pacific right whale (Eastern North Pacific)	~~X~~	~~X~~	~~X~~	~~X~~		
Bowhead whale (Western Arctic)	~~**X**~~		**X**	**X**	**X**	**X**

Appendix 2. Stock summary table (last revised ~~12/30/2020~~7/8/2021). N/A indicates data are unknown. UNDET (undetermined) PBR indicates data are available to calculate a PBR level but a determination has been made that calculating a PBR level using those data is inappropriate (see Stock Assessment Report (SAR) for details). N_{EST} is the AFSC Marine Mammal Laboratory's best estimate of the size of the population; Strategic status: S = Strategic, NS = Not Strategic.~~ NOTE: This summary table has been reformatted/revised to be consistent with the summary tables in the U.S. Pacific and Atlantic SARs.~~

Species	Stock name	SAR updated	N_{EST}	CV N_{EST}	N_{MIN}	R_{MAX}	F_R	PBR	Total annual mortality/ serious injury	Annual U.S. commercial fishery mortality/ serious injury	Annual Native subsistence mortality	Strategic status	SAR last revised	Last survey year(s) for estimating abundance	Comments
Steller sea lion	Western U.S.	~~Y~~N	52,932		52,932	0.12	0.1	318	254	37	209	S	2019	2018-2019	N_{EST} is best estimate of counts, which have not been corrected for animals at sea during abundance surveys.
Steller sea lion	Eastern U.S.	N	43,201		43,201	0.12	1.0	2,592	112	24	11	NS	2019	2017	N_{EST} is best estimate of counts, which have not been corrected for animals at sea during abundance surveys.
Northern fur seal	Eastern Pacific	Y	~~608,143~~ 626,618	0.2	~~514,738~~ 530,376	0.086	0.5	~~11,067~~ 11,403	~~387~~373	~~3.4~~3.5	~~373~~360	S	~~2019~~ 2020	~~2014-2018~~ 2014-2019	Survey years = Sea Lion Rock - 2014; St. Paul and St. George Is. - 2014, 2016, 2018; Bogoslof Is. - 2015, 2019.
Harbor seal	Aleutian Islands	N	5,588		5,366	0.12	0.3	97	90	0.4	90	NS	2019	2018	
Harbor seal	Pribilof Islands	N	229		229	0.12	0.5	7	0	0	0	NS	2019	2018	N_{EST} is best estimate of counts, which have not been corrected for animals at sea during abundance surveys.

Species	Stock name	SAR updated	N_{EST}	CV N_{EST}	N_{MIN}	R_{MAX}	F_R	PBR	Total annual mortality/ serious injury	Annual U.S. commercial fishery mortality/ serious injury	Annual Native subsistence mortality	Strategic status	SAR last revised	Last survey year(s) for estimating abundance	Comments
Harbor seal	Bristol Bay	N	44,781		38,254	0.12	0.7	1,607	20	3.8	15	NS	2019	2017	
Harbor seal	North Kodiak	N	8,677		7,609	0.12	0.5	228	38	0.3	37	NS	2019	2017	
Harbor seal	South Kodiak	N	26,448		22,351	0.12	0.7	939	127	1.2	126	NS	2019	2017	
Harbor seal	Prince William Sound	N	44,756		41,776	0.12	0.5	1,253	413	24	387	NS	2019	2015	
Harbor seal	Cook Inlet/Shelikof Strait	N	28,411		26,907	0.12	0.5	807	107	2.5	104	NS	2019	2018	
Harbor seal	Glacier Bay/Icy Strait	N	7,455		6,680	0.12	0.3	120	104	0	104	NS	2019	2017	
Harbor seal	Lynn Canal/Stephens Passage	N	13,388		11,867	0.12	0.3	214	50	0	50	NS	2019	2016	
Harbor seal	Sitka/Chatham Strait	N	13,289		11,883	0.12	0.5	356	77	0	77	NS	2019	2015	
Harbor seal	Dixon/Cape Decision	N	23,478		21,453	0.12	0.5	644	69	0	69	NS	2019	2015	
Harbor seal	Clarence Strait	N	27,659		24,854	0.12	0.5	746	40	0	40	NS	2019	2015	
Spotted seal	Bering	~~Y~~N	461,625		423,237	0.12	1.0	25,394	5,254	1	5,253	NS	2017	2012-2013	
Bearded seal	Beringia	~~Y~~N				0.12	0.5		6,709	1.8	6,707	S	2019	2012-2013	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.
Ringed seal	Arctic	~~Y~~N				0.12	0.5		6,459	5	6,454	S	2019	2012-2013	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.

Species	Stock name	SAR updated	N_{EST}	CV N_{EST}	N_{MIN}	R_{MAX}	F_R	PBR	Total annual mortality/ serious injury	Annual U.S. commercial fishery mortality/ serious injury	Annual Native subsistence mortality	Strategic status	SAR last revised	Last survey year(s) for estimating abundance	Comments
Ribbon seal		~~Y~~N	184,697		163,086	0.12	1.0	9,785	163	0.9	162	NS	2018	2012-2013	
Beluga whale	Beaufort Sea	~~Y~~N	39,258	0.229	N/A	0.04	1.0	UNDET	104	0	104	NS	2017	1992	
Beluga whale	Eastern Chukchi Sea	~~Y~~N	13,305	0.51	8,875	0.04	1.0	178	56	0	56	NS	2017	2017	
Beluga whale	Eastern Bering Sea	~~Y~~N	9,242	0.12	8,357	0.04	1.0	167	217		217	S	2017	2017	
Beluga whale	Bristol Bay	~~Y~~N	2,040	0.26	1,645	0.04	1.0	33	19		19	NS	2017	2016	
Beluga whale	Cook Inlet	Y	279	0.061	267	0.04	0.1		0	0	0	S	~~2019~~ 2020	2014-2018	Survey years = 2014, 2016, and 2018. PBR has been calculated, however, important caveats exist; see SAR text for details.
Narwhal	Unidentified	N	N/A		N/A	0.04	0.5	N/A	0	0	0	NS	2016		
Killer whale	Eastern North Pacific Alaska Resident	N	2,347	N/A	2,347	0.04	0.5	24	1	1	0	NS	2016	2012	N_{EST} is based on counts of individuals identified from photo-ID catalogues.
Killer whale	Eastern North Pacific Northern Resident (British Columbia)	N	302	N/A	302	0.029	0.5	2.2	0.2	0	0	NS	2019	2018	N_{EST} is based on counts of individuals identified from photo-ID catalogues.
Killer whale	Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient	~~Y~~N	587	N/A	587	0.04	0.5	5.9	0.8	0.8	0	NS	2016	2012	N_{EST} is based on counts of individuals identified from photo-ID catalogues.

Species	Stock name	SAR updated	N_{EST}	CV N_{EST}	N_{MIN}	R_{MAX}	F_R	PBR	Total annual mortality/ serious injury	Annual U.S. commercial fishery mortality/ serious injury	Annual Native subsistence mortality	Strategic status	SAR last revised	Last survey year(s) for estimating abundance	Comments
Killer whale	AT1 Transient	~~Y~~N	7	N/A	7	0.04	0.1		0	0	0	S	2019	2019	N_{EST} is based on counts of individuals identified from photo-ID catalogues. PBR has been calculated, however, important caveats exist; see SAR text for details.
Killer whale	West Coast Transient	~~Y~~N	349	N/A	349	0.04	0.5	3.5	0.4	0.2	0	NS	2013	2018	N_{EST} is based on counts of individuals identified from photo-ID catalogues in an analysis of a subset of data from 1958 to 2018.
Pacific white-sided dolphin	North Pacific	N	26,880	N/A	N/A	0.04	0.5	UNDET	0	0	0	NS	2018	1990	
Harbor porpoise	Southeast Alaska	Y				0.04	0.5		34	34	0	S	~~2019~~ 2020	~~2010-2012~~ 2019	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.
Harbor porpoise	Gulf of Alaska	~~Y~~N	31,046	0.21	N/A	0.04	0.5	UNDET	72	72	0	S	2019	1998	
Harbor porpoise	Bering Sea	~~Y~~N			N/A	0.04	0.5	UNDET	0.4	0	0	S	2019	2008	N_{EST} has been calculated, however, important caveats exist; see SAR text for details.

Species	Stock name	SAR updated	N_{EST}	CV N_{EST}	N_{MIN}	R_{MAX}	F_R	PBR	Total annual mortality/ serious injury	Annual U.S. commercial fishery mortality/ serious injury	Annual Native subsistence mortality	Strategic status	SAR last revised	Last survey year(s) for estimating abundance	Comments
Dall's porpoise	Alaska	~~N~~Y	~~83,400~~	~~0.097~~	~~N/A~~	0.04	~~1.0~~0.5	~~UNDET~~	~~38~~37	~~38~~37	0	NS	2018	~~1991~~ 2015	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.
Sperm whale	North Pacific	~~Y~~N				0.04	0.1		3.5	3.3	0	S	2019	2015	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.
Baird's beaked whale	Alaska	N	N/A		N/A	0.04	0.5	N/A	0	0	0	NS	2013		
Cuvier's beaked whale	Alaska	N	N/A		N/A	0.04	0.5	N/A	0	0	0	NS	2013		
Stejneger's beaked whale	Alaska	N	N/A		N/A	0.04	0.5	N/A	0	0	0	NS	2013		
Humpback whale	Western North Pacific	~~Y~~N	1,107	0.300	865	0.07	0.1	3.0	2.8	0.9	0	S	2019	2004-2006	
Humpback whale	Central North Pacific - entire stock	~~Y~~N	10,103	0.300	7,891	0.07	0.3	83	26	9.8	0	S	2019	2004-2006	
Fin whale	Northeast Pacific	~~Y~~N				0.04	0.1		0.6	0	0	S	2019	2013	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.
Minke whale	Alaska	N	N/A		N/A	0.04	0.5	N/A	0	0	0	NS	2018		

Species	Stock name	SAR updated	N_{EST}	CV N_{EST}	N_{MIN}	R_{MAX}	F_R	PBR	Total annual mortality/ serious injury	Annual U.S. commercial fishery mortality/ serious injury	Annual Native subsistence mortality	Strategic status	SAR last revised	Last survey year(s) for estimating abundance	Comments
North Pacific right whale	Eastern North Pacific	~~Y~~N	31	0.226	26	0.04	0.1		0	0	0	S	2019	2008	PBR has been calculated, however, important caveats exist; see SAR text for details.
Bowhead whale	Western Arctic	Y	16,820	0.052	16,100	0.04	0.5	161	~~56~~52	0.2	~~56~~51	S	~~2019~~ 2020	2011	

Appendix 3. Percent observer coverage in Alaska commercial fisheries 1990-~~2018~~2019 (last revised ~~12/30/2020~~7/8/2021).

Fishery name[a]	Method for calculating observer coverage[b]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gulf of Alaska (GOA) groundfish trawl	% of observed biomass	55	38	41	37	33	44	37	33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GOA flatfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	39.2	35.8	36.8	40.5	35.9	40.6	76.9	29.2	24.2	31	28	22	26	31	42	46	47	54	39	56	~~34~~35	39
GOA Pacific cod trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.6	16.4	13.5	20.3	23.2	27.0	82.5	21.4	22.8	25	24	38	31	41	25	10	12	13	13	11	~~25~~28	28
GOA pollock trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	37.5	31.7	27.5	17.6	26.0	31.4	96.1	24.2	26.5	27	34	43			27	15	14	23	27	19	~~21~~20	23
GOA rockfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	51.4	49.8	50.2	51.0	37.2	48.4	74.1	51.4	49.1	88	87	91			95	95	96	93	98	98	~~95~~94	95
GOA longline	% of observed biomass	21	15	13	13	8	18	16	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GOA Pacific cod longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.8	5.7	6.1	4.9	11.4	12.6	21.4	3.7	10.2	45	32	43	29	30	13	29	31	36	30	~~40~~39	~~29~~28	33
GOA halibut longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	51.3	47.1	51.1	43.0	41.4	9.6	36.4	6.5	2.8	N/A	N/A	N/A		2.3	0.6	4.2	11	~~9.4~~2.5	~~9.5~~2.3	~~4.6~~1.1	~~6.4~~1.7	1.9
GOA rockfish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0	1.4	0.2	1.3	4.9	2.5	0	0	3.1	N/A	N/A	83			0	0	3.2	~~10~~5	~~6.7~~4.4	~~12~~5.6	0	0.8
GOA sablefish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.9	14.0	15.2	12.4	13.7	9.4	37.7	10.4	11.2	37	35	38	15	14	14	14	19	~~20~~18	~~14~~12	~~12~~10	~~9.8~~8.6	11
GOA finfish pots	% of observed biomass	13	9	9	7	7	7	5	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GOA Pacific cod pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.7	5.7	7.0	5.8	7.0	4.0	40.6	3.8	2.9	14	18	13			9.6	8.4	8.7	14	8.3	2.9	8.8	7.6
Bering Sea/Aleutian Islands (BSAI) finfish pots	% of observed biomass	43	36	34	41	27	20	17	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Fishery name[a]	Method for calculating observer coverage[b]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BSAI Pacific cod pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14.6	16.2	8.5	14.7	12.1	12.4	33.1	14.4	12.4	30	23	29	21	20	19	18	21	27	21	13	21	16
BS sablefish pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	42.1	44.1	62.6	38.7	40.6	21.4	72.5	44.3	35.3	N/A	N/A	N/A			39	13	11	9	23	19	33	11
AI sablefish pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	50.3	68.2	60.6	69.4	47.5	51.2	64.4	18.7	N/A	N/A	N/A			40	0	0	86	88	33	55	23
BSAI groundfish trawl	% of observed biomass	74	53	63	66	64	67	66	64	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BSAI Atka mackerel trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	65.0	77.2	86.3	82.4	98.3	95.4	96.6	97.8	96.7	94	100	99	100	99	100	99	100	100	98	100	100	100
BSAI flatfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	59.4	66.3	64.5	57.6	58.4	63.9	68.2	68.3	67.8	72	100	100	99	99	100	100	100	100	99	100	100	100
BSAI Pacific cod trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	55.3	50.6	51.7	57.8	47.4	49.9	75.1	52.8	46.8	52	56	64	66	60	68	80	80	72	68	68	73	67
BSAI pollock trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	66.9	75.2	76.2	79.0	80.0	82.2	92.8	77.3	73.0	85	85	86	86	98	98	98	98	99	99	99	99	98
BSAI rockfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	85.4	85.6	85.1	65.3	79.9	82.6	94.1	71.0	80.6	88	98	99	99	99	100	100	100	100	100	100	100	100
BSAI longline	% of observed biomass	80	54	35	30	27	28	29	33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BSAI Greenland turbot longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	31.6	30.8	52.8	33.5	37.3	40.9	39.3	33.7	36.2	64	74	74	59	59	57	52	56	52	60	56	62	56
BSAI Pacific cod longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	34.4	31.8	35.2	29.5	29.6	29.8	25.7	24.6	26.3	63	63	61	64	57	51	66	64	62	57	58	55	52
BSAI halibut longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.9	48.4	55.3	67.2	57.4	20.3	44.5	27.9	26.4	N/A	N/A	N/A		16	1.8	13	11	~~13~~3.9	~~10~~2.5	~~6.9~~1.4	~~8.2~~2.7	2
BSAI rockfish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	41.5	21.4	53.0	26.9	36.0	74.9	37.9	36.3	46.8	88	N/A	100			34	49	100	~~70~~71	53	0	~~83~~82	73

Fishery name[a]	Method for calculating observer coverage[b]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BSAI sablefish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.5	28.4	24.4	18.9	30.3	10.4	50.9	19.3	11.2	48	49	56			27	42	35	34	~~22~~23	~~6.9~~5.6	7.7	8.4
Prince William Sound salmon drift gillnet	% of estimated sets observed	4	5	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Prince William Sound salmon set gillnet	% of estimated sets observed	3	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Alaska Peninsula/Aleutian Islands salmon drift gillnet (South Unimak area only)	% of estimated sets observed	4	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Cook Inlet salmon drift gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	1.6	3.6	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Cook Inlet salmon set gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	0.16-1.1	0.34-2.7	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Kodiak Island salmon set gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	6.0	not obs.	not obs.	4.9	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Yakutat salmon set gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	5.3	7.6	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Southeast Alaska salmon drift gillnet (Districts 6, 7, and 8)	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	6.4	6.6	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.

[a]From 1990 to 1997, most federally-regulated commercial fisheries in Alaska were named using gear type and fishing location. In 2003, the naming convention changed to define fisheries based on gear type, fishing location, and target fish species. Bycatch data collected from 1998 to present are analyzed using these fishery definitions. The use of "N/A" for either pooled or separated fisheries indicates that we do not have effort data for a particular fishery for that year.

[b]Observer coverage in the groundfish fisheries (trawl, longline, and pots) was determined by the percentage of ~~tons caught which were~~the total catch that was observed. ~~Observer coverage in the groundfish fisheries is assigned according to vessel length; where vessels greater than 125 feet have 100% coverage, vessels 60-125 feet have 30% coverage, and vessels less than 60 feet are not observed. Observer coverage in the groundfish fisheries varies by statistical area; the pooled percent coverage for all areas is provided here.~~ Observer coverage in the drift gillnet fisheries was calculated as the percentage of the estimated sets that were observed. Observer coverage in the set gillnet fishery was calculated as the percentage of estimated setnet hours (determined by number of permit holders and the available fishing time) that were observed.

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