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Alaska Marine Mammal Stock Assessments, 2023

N. C. Young, A. A. Brower, M. M. Muto, J. C. Freed, R. P. Angliss, N. A. Friday, B. D. Birkemeier, P. L. Boveng, B. M. Brost, M. F. Cameron, J. L. Crance, S. P. Dahle, B. S. Fadely, M. C. Ferguson, K. T. Goetz, J. M. London, E. M. Oleson, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini

December 2024

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Alaska Fisheries Science Center

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Cover photo: Steller sea lion territorial male surrounded by adult females and pups at Cape St. Stephens rookery on Kiska Island in June 2015. Image credit: NOAA Fisheries, U.S. MMPA/ESA Permit 22289.

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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 in most years since then, and are available online at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region. 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 24 existing stocks (including all of the strategic stocks) in the Alaska Region for the 2023 Stock Assessment Report cycle and updated information or developed new reports for 5 stocks contained in 5 Stock Assessment Reports under NMFS' jurisdiction: 3 strategic stocks (Western stock of Steller sea lions, Eastern North Pacific stock of North Pacific right whales, and Western Arctic stock of bowhead whales) and 2 non-strategic stocks (Eastern stock of Steller sea lions and Sato's beaked whales stock). The Stock Assessment Reports for all of the Alaska stocks, however, are included in the final document to provide a complete reference. Those sections of each Stock Assessment Report containing substantial changes in 2023 are listed in Appendix 1. The authors solicit any new information or comments which would improve future Stock Assessment Reports.

In the 2023 Stock Assessment Reports, a new stock was added for Sato's beaked whale, which is a newly recognized species.

New abundance estimates were calculated for the following Alaska stocks in the 2023 Stock Assessment Reports. For explanations of why estimates have changed, see the individual report for each stock:

- Western Steller sea lions: The updated best model estimated count, derived from aerial photographic and land-based surveys in 2021 and 2022, is 49,837 sea lions. This is a decrease from the previous estimate of 52,932. 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. New mixing between the Eastern and Western stocks in areas of northern Southeast Alaska are accounted for by adjusting the minimum abundance, mortality and serious injury, and PBR calculations.
- Eastern Steller sea lions: The updated best model estimated count, derived from aerial photographic and land-based surveys in 2015-2022, is 36,308 sea lions. This is a decrease from the previous estimate of 43,201. 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. New mixing between the Eastern and Western stocks in areas of northern Southeast Alaska are accounted for by adjusting the minimum abundance, mortality and serious injury, and PBR calculations.
- Western Arctic bowhead whales: The updated best estimate of abundance, derived from an inverse-variance weighted average of abundance estimates derived from ice-based counts and aerial line-transect surveys in 2019, is 15,229 bowhead whales. This is an increase from the previous estimate of 14,025, which was derived from the 2019 ice-based estimate alone. All three of these estimates are considered to be underestimates and not a true decline in abundance. During the ice-based survey, the ice conditions and the bowhead whale migration route were atypical, and any whales that did not migrate past Point Barrow were excluded from the survey design. The study area for the aerial survey did not encompass the entire known range of the stock during the survey period, and a small statistical bias has not been accounted for in the resulting abundance estimate.

The U.S. Fish and Wildlife Service (USFWS) has management authority for polar bears, sea otters, and walruses. The stock assessments for these species are published separately by USFWS and are available online at https://www.fws.gov/library/collections/marine-mammal-stock-assessment-reports.

Ideas and comments from the Alaska Scientific Review Group 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, Donna Hauser, Nicole Wojciechowski, Greg O'Corry-Crowe (Co-Chair in 2019-2024), Lorrie Rea, Megan Williams (Co-Chair in 2019-2024), Eric Regehr, Kate Stafford, and Lori Quakenbush. 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 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.

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Revised 5/10/2024

STELLER SEA LION (*Eumetopias jubatus*): Western Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

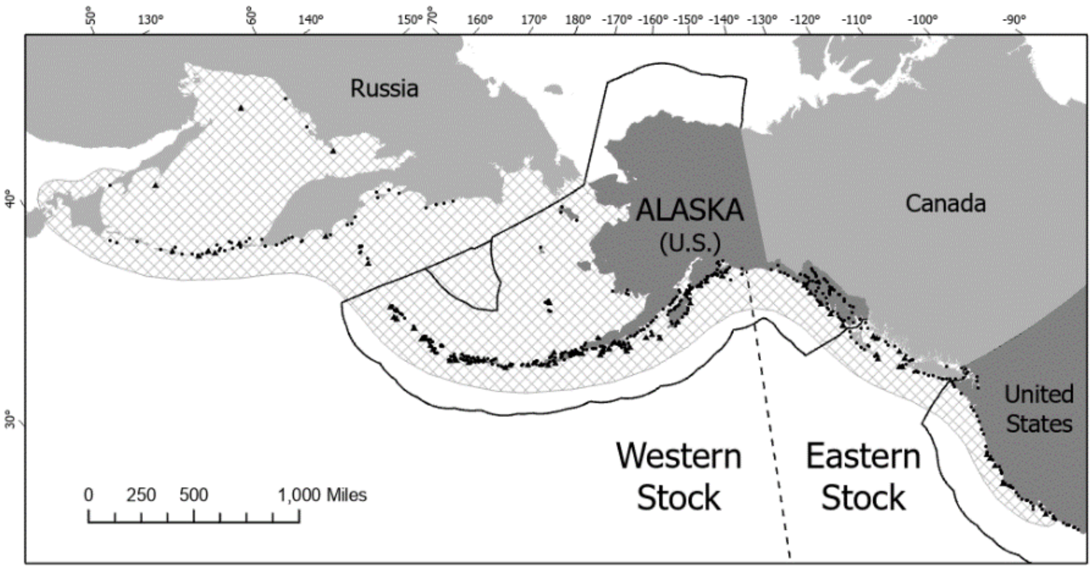

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005, Olesiuk 2018). A black dashed line (144°W) indicates the stock boundary (Loughlin 1997) and a black line delineates the U.S. Exclusive Economic Zone.

Steller sea lions range along the North Pacific Rim from northern Japan to California (Loughlin et al. 1984) (Fig. 1). Outside of the breeding season (late May to July), large numbers of individuals, especially juveniles and males, disperse widely, probably to access seasonally important prey resources (Jemison et al. 2018). This results in marked seasonal patterns of abundance in some parts of the range and potential for intermixing of animals that were born in different regions (Sease and York 2003; Baker et al. 2005; Jemison et al. 2013, 2018; Hastings et al. 2020). The Western stock is transboundary, extending west from Cape Suckling in the Gulf of Alaska into Asia. During the breeding season, Steller sea lions, especially adult females, typically return to their natal rookery or a nearby breeding rookery to breed and pup (Raum-Suryan et al. 2002, Hastings et al. 2017).

Loughlin (1997) considered the following information when classifying stock structure based on the phylogeographic approach of Dizon et al. (1992): 1) Distributional data: geographic distribution continuous, yet a high degree of natal site fidelity and low (<10%) exchange rate of breeding animals among rookeries; 2) Population response data: substantial differences in population dynamics (York et al. 1996); 3) Phenotypic data: differences in pup mass (Merrick et al. 1995, Loughlin 1997); and 4) Genotypic data: substantial differences in mitochondrial DNA (Bickham et al. 1996). Based on this information, two stocks of Steller sea lions were recognized: the Eastern stock, which includes animals born east of Cape Suckling, Alaska (144°W), and the Western stock, which includes animals born at and west of Cape Suckling (Loughlin 1997; Fig. 1). These stocks are equivalent to the eastern and western distinct population segments (DPSs) identified under the Endangered Species Act (62 FR 24345, 62 FR 30772).

All genetic analyses (Baker et al. 2005; Harlin-Cognato et al. 2006; Hoffman et al. 2006, 2009; O'Corry-Crowe et al. 2006) confirm a strong separation between Western and Eastern stocks, and O'Corry-Crowe et al. (2006) identified structure at the level of different oceanic regions within the Aleutian Islands. There may be sufficient morphological differentiation to support elevating the two recognized stocks to subspecies (Phillips et al. 2009), although a review by Berta and Churchill (2012) characterized the status of these subspecies assignments as "tentative" and requiring further attention before their status can be determined. Work by Phillips et al. (2011) addressed the effect of climate change, in the form of glacial events, on the evolution of Steller sea lions and reported that the effective population size at the time of the event determines the impact of change on the population. The results suggested that during historic glacial periods, dispersal events were correlated with historically low effective population sizes, whereas range fragmentation type events were correlated with larger effective population sizes. This work again reinforced the separation of the Western and Eastern stocks by noting that ancient population subdivision likely led to the sequestering of most mitochondrial DNA (mtDNA) haplotypes as stock or subspecies-specific (Phillips et al. 2011).

Observations of marked sea lions indicate there is regular movement of Steller sea lions across the stock boundary, especially by juveniles and males outside the breeding season (Jemison et al. 2013, 2018; Hastings et al. 2020). During the breeding season, an equal number of male and female Western stock Steller sea lions have been observed in the Eastern stock area, while Eastern stock sea lions observed moving west have been almost exclusively males (Jemison et al. 2013, 2018; Hastings et al. 2020). Mixing of mostly breeding females occurred between Prince William Sound and northern Southeast Alaska, beginning in the 1990s (Gelatt et al. 2007; Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Rehberg et al. 2018). In 1998 a single Steller sea lion pup was observed on Graves Rock just north of Cross Sound in Southeast Alaska, and within 15 years (2013) pup counts increased to 551 (DeMaster 2014). Movements of animals marked as pups in both stocks corroborate the extensive genetic research findings for a strong separation between the two currently recognized stocks (Jemison et al. 2013, 2018). Mitochondrial and microsatellite analysis of pup tissue samples collected at Graves Rock in 2002 revealed that approximately 70% of the pups had mtDNA haplotypes that were consistent with those found in the Western stock (Gelatt et al. 2007). Similarly, a rookery to the south on the White Sisters Islands, where pups were first noted in 1990, was also sampled in 2002 and approximately 45% of those pups had Western stock haplotypes (O'Corry-Crowe et al. 2014). Hastings et al. (2020) estimated that a minimum of 38% and 13% of animals in the North Outer Coast-Glacier Bay and Lynn Canal-Frederick Sound regions in northern Southeast Alaska, respectively, carry genetic information unique to the Western stock. Collectively, this information demonstrates that these two most recently established rookeries in northern Southeast Alaska were partially to predominantly established by Western stock females (Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Rehberg et al. 2018; Hastings et al. 2020).

While movements of animals marked as pups in both stocks support these genetic results (Jemison et al. 2013, 2018; Hastings et al. 2020), overall the observations of marked Steller sea lion movements corroborate the extensive genetic research findings for a strong separation between the two currently recognized stocks. O'Corry-Crowe et al. (2014) concluded that the results of their study of the genetic characteristics of pups born on these new rookeries "demonstrates that resource limitation may trigger an exodus of breeding animals from declining populations, with substantial impacts on distribution and patterns of genetic variation." Jemison et al. (2018) also found that movement of Prince William Sound females east to these rookeries was negatively correlated with density: the population's declines prior to the early 2000s likely spurred these animals to move east in search of better foraging opportunities. This movement also revealed that this event is rare because colonists dispersed across an evolutionary boundary, suggesting that the causative factors behind recent declines are unusual or of larger magnitude than normally occur (O'Corry-Crowe et al. 2014).

Thus, although recent colonization events in the northern part of the Eastern stock area indicate movement of Western stock sea lions (especially adult females) into this area, the mixed part of the range remains geographically distinct (Jemison et al. 2013, 2018), and the discreteness between the Eastern and Western stocks remains. Hybridization among subspecies and species along a contact zone such as a stock boundary is not unexpected as the ability to interbreed is an ancestral condition, whereas reproductive isolation would be considered a recently derived condition. The level of differentiation indicates long-term reproductive isolation resulting from four glacial refugia events 60,000 to 180,000 years before present (Harlin-Cognato et al. 2006). The fundamental concept overlying this distinctiveness is the collection of morphological, ecological, behavioral, and genetic evidence for stock differences initially described by Bickham et al. (1996) and Loughlin (1997) and supported by Baker et al. (2005), Harlin-Cognato et al. (2006), Hoffman et al. (2006, 2009), O'Corry-Crowe et al. (2006), Phillips et al. (2009, 2011), and Hastings et al. (2020). As stated by NMFS and the U.S. Fish and Wildlife Service (USFWS) in a 1996 response to a previous comment regarding their joint DPS policy (61 FR 4722), "The Services do not consider it appropriate to require absolute reproductive isolation as a prerequisite to recognizing a distinct population segment" or stock.

In Asia, Steller sea lions seasonally inhabit coastal waters of Japan during the non-breeding season and breeding rookeries are only located in Russia (Burkanov and Loughlin 2005). Analyses of genetic data differ in their interpretation of an Asian stock separate from the Western stock of Steller sea lions. Based on analysis of mitochondrial DNA, Baker et al. (2005) found evidence of a genetic split in Russia between Kamchatka and the Commander Islands, with the latter being included as part of the Western stock with Alaska sea lions. However, Hoffman et al. (2006) did not support a stock split based on their analysis of nuclear microsatellite markers indicating high rates of male gene flow. Further, Berta and Churchill (2012) concluded that a putative Asian stock is "not substantiated by microsatellite data since the Asian stock groups with the Western stock." In the 2008 Steller sea lion Recovery Plan (NMFS 2008), sea lions that breed in Asia are considered part of the Western stock.

POPULATION SIZE

The Western stock of Steller sea lions decreased from 220,000 to 265,000 animals in the late 1970s to less than 50,000 in 2000 (Loughlin et al. 1984, Loughlin and York 2000, Burkanov and Loughlin 2005). Since 2003, the abundance of the Western stock has increased, but there has been considerable regional variation in trend (Sease and Gudmundson 2002; Burkanov and Loughlin 2005; Fritz et al. 2013, 2016). Abundance surveys to count Steller sea lions are conducted in late June through mid-July starting approximately 10 days after the mean pup birth dates in the survey area (4-14 June) after approximately 95% of all pups are born (Pitcher et al. 2001, Kuhn et al. 2017). Modeled counts and trends are reported for the Western stock in Russia and Alaska. The geographic range in Alaska is composed of six regions (eastern, central, and western Gulf of Alaska and eastern, central, and western Aleutian Islands); the boundaries of which were identified based on metapopulation analysis of survey count data collected from 1976 to 1994 (York et al. 1996).

An updated agTrend model (R package; Johnson and Fritz 2014, Gaos et al. 2021) was used to estimate counts and trends by augmenting missing counts. The updated agTrend model uses the penalized spline model to reduce variance for years where missing data is interpolated (Gaos et al. 2021). This model improves upon the previous method, which used a random walk time series model (Johnson and Fritz 2014), providing more precise estimates. Non-pup counts do not account for animals at sea and therefore cannot be used as an abundance estimate. Pup counts are considered a census (i.e., total pup production) however, these counts do not account for pups that are born, or die, after the surveys.

Demographic multipliers (e.g., pup production multiplied by 4.5) and corrections for proportions of each age-sex class that are hauled out during the day in the breeding season (when aerial surveys are conducted) have been proposed as methods to estimate total population size from pup and/or non-pup counts (Calkins and Pitcher 1982, Higgins et al. 1988, Milette and Trites 2003, Maniscalco et al. 2006). There are several factors which make using demographic multipliers problematic, including the lack of more recent vital (survival and reproductive) rate information, the lack of vital rate information for the western and central Aleutian Islands, the large variability in abundance trends across the range (see Current Population Trend section below and Pitcher et al. 2007), and the large uncertainties related to reproductive status and foraging conditions that affect proportions hauled out (see review in Holmes et al. 2007).

The most recent comprehensive aerial photographic and land-based surveys of Western Steller sea lions in Alaska were conducted during the 2021 (Southeast Alaska and Gulf of Alaska east of Shumagin Islands) and 2022 (Aleutian Islands west of Shumagin Islands) breeding seasons (Sweeney et al. 2022, 2023). The Western Steller sea lion pup and non-pup model-predicted count estimates in Alaska (U.S. range of the stock) in 2022 were 11,987 (95% credible interval of 11,291-12,703) and 37,333 (34,274-40,245), respectively.

Methods used to survey Steller sea lions in Russia differ from those used in Alaska, with more use of skiff surveys and cliff counts for non-pups and ground counts for pups (Burkanov 2020). Since 2016, the use of uncrewed aircraft systems (drones) has allowed more survey effort to collect aerial imagery, similar to survey methods used for the Alaska range (Burkanov 2020). Counts and trends for non-pups and pups were modeled using agTrend for the six regions in Russia (Commander Islands, East Kamchatka, Kuril Islands, northern part of Sea of Okhotsk, Sakhalin Island, and western Bering Sea) that compose the Steller sea lion geographic range along the entire Asian coast, because the species is absent in Japan during the breeding season (Fig. 2). In 2022, the non-pup modeled count estimate was 17,342 (95% credible interval of 13,944-21,354) and for pups 6,032 (95% credible interval of 5,555-6,541).

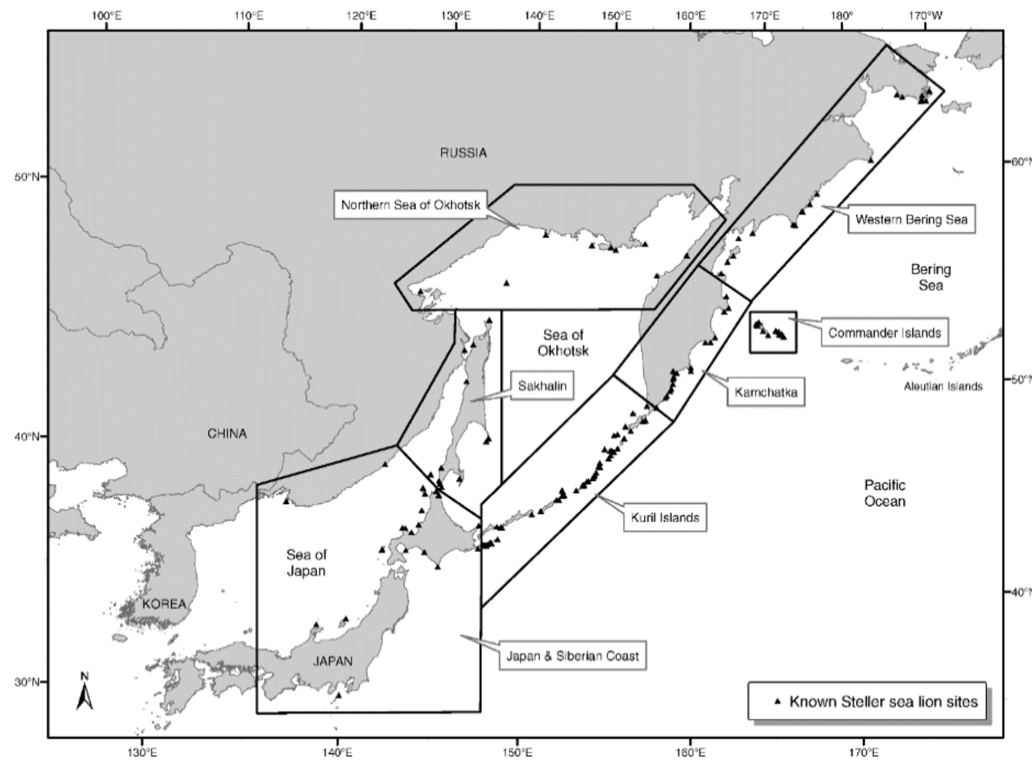

Figure 2. Steller sea lion survey regions along the Asian coast (Burkanov and Loughlin 2005).

Minimum Population Estimate

Steller sea lion non-pups from the Western stock occur in Southeast Alaska, east of the stock boundary line (O'Corry-Crowe et al. 2006; Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Hastings et al. 2020). Hastings et al. (2020) reported 7-8% of non-pups that occurred in Southeast Alaska in the summer were born in the Western stock area. They principally occurred in the north outer coast (identified as population mixing zone "F," Table 1; Fig. 3) and Glacier Bay (G), and at lower proportions in Lynn Canal (H), Frederick Sound (E), and the Central Outer Coast (D). Using the Hastings et al. (2020) proportions for Western stock non-pups in Southeast Alaska allows for apportionment of modeled counts to the corresponding stock by adjusting the N_{MIN} to help account for movement between stocks.

AgTrend modeled non-pup predicted counts by site were aggregated into the population mixing zones and the Western stock proportion was applied to calculate the number of Western stock non-pups in Southeast Alaska (Table 1; Hastings et al. 2020). This total number of Western stock non-pups in Southeast Alaska (517) was added to the estimated total number of Western stock pups and non-pups. As discussed above, the current population size (N) is unknown as there is no method for deriving abundance estimates from agTrend modeled counts and modeled counts are considered "minimum" estimates of population size. Pup counts are considered a census (i.e., total pup production) however, these counts do not account for pups that are born, or die, after the surveys.

While there are conflicting interpretations around the distinction of an Asian stock separate from the Western stock, NMFS' Steller sea lion Recovery Plan for the management and recovery of the Western stock includes all of Russia as a part of the Western stock. Therefore, we report the minimum population estimate for the entire Western stock of Steller sea lions in 2022 was 73,211 (summing: 17,342 non-pups and 6,032 pups in Russia, 37,333 non-pups and 11,987 pups in Alaska, and 517 Western stock non-pups in the Eastern stock area). The NMIN for the U.S. portion of the Western stock was 49,837 (summing: 37,333 non-pups, 11,987 pups, and 517 Western stock non-pups in the Eastern stock area).

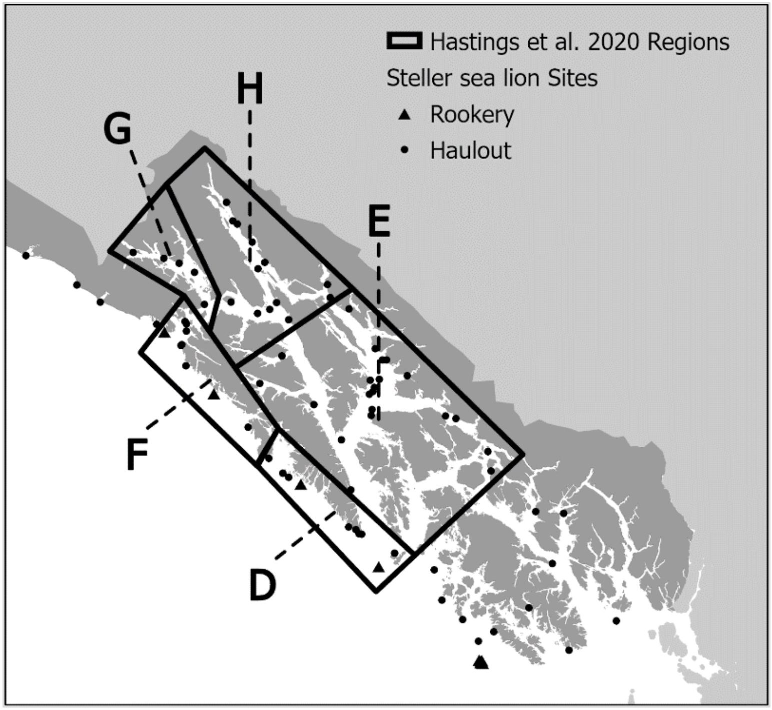

Figure 3. Hastings et al. (2020) mixing zones where non-pups born in the western stock area were reported to inhabit in different proportions, with most in the North Outer Coast (F) and Glacier Bay (G), and at lower proportions in Lynn Canal (H), Frederick Sound (E), and the Central Outer Coast (D) (Table 1).

Table 1. Steller sea lion non-pup apportionment to stock using the Hastings et al. (2020) proportions of Western stock non-pups in Southeast Alaska. Proportions were applied to agTrend modeled predicted counts to estimate the number of western- and eastern- born non-pups in the Hastings et al. (2020) population mixing zones.

Southeast Alaska Area	Population Mixing Zone	Western Stock Non-Pup Proportion	Modeled Non-Pup Count	Western Stock Non-Pup Count	Eastern Stock Non-Pup Count
Central Outer Coast	D	0.022	3,131	69	3,062
Frederick Sound	E	0.012	1,850	22	1,828
North Outer Coast	F	0.082	3,826	314	3,512
Glacier Bay	G	0.073	1,423	104	1,319
Lynn Canal	H	0.014	578	8	570
Remaining Southeast Alaska	I, B, C	-	6,298	-	6,298
TOTAL			17,106	517	16,589

Current Population Trend

The first reported trend counts (sums of counts at consistently surveyed, large sites used to examine population trends) of Steller sea lions in Alaska were made in 1956-1960. Those counts indicated that there were at least 140,000 (no correction factor applied) sea lions in the Gulf of Alaska and Aleutian Islands (Merrick et al. 1987). Subsequent surveys indicated a major population decrease, first detected in the eastern Aleutian Islands in the mid-1970s (Braham et al. 1980). Counts from 1976 to 1979 totaled about 110,000 sea lions (no correction factor applied). The decline appears to have spread eastward to Kodiak Island during the late 1970s and early 1980s, and then westward to the central and western Aleutian Islands during the early and mid-1980s (Merrick et al. 1987, Byrd 1989). During the late 1980s, counts in Alaska overall declined at approximately 15% per year (NMFS 2008), which prompted the listing (in 1990) of the species as threatened range-wide under the Endangered Species Act (ESA). Continued declines in counts of Western Steller sea lions in Alaska in the 1990s (Sease et al. 2001) led NMFS to change the ESA listing status of the Western stock to endangered in 1997 (NMFS 2008). Surveys in Alaska in 2002 were the first to note an increase in counts, which suggested that the overall decline of Western Steller sea lions stopped in the early 2000s (Sease and Gudmundson 2002).

Using the updated agTrend model, we used count data from 1973 to 2022 for pups and 1978 to 2022 for non-pups to estimate trends for the Western stock in Alaska, east and west of Samalga Pass, and the six central, western, and eastern Gulf of Alaska and Aleutian Island regions (Table 2). Model results indicated that pup and non-pup counts of Western stock Steller sea lions in Alaska were at their lowest levels in 2002. Within the last 15-year period (2007 to 2022), pup and non-pup counts increased at 0.50% y^{-1} and 1.05% y^{-1}, respectively (Table 2; Fig. 4; Sweeney et al. 2023). There are regional differences in trend across the range in Alaska, with positive or plateaued trends in the Gulf of Alaska and the eastern Aleutian Islands region, including the eastern Bering Sea (east of Samalga Pass, ~170°W), and generally negative or plateaued trends to the west of Samalga Pass, in the central and western Aleutian Islands (Table 2; Figs. 5 and 6).

Table 2. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in counts of Western Steller sea lion pups and non-pups (adults and juveniles) in Alaska, by regional areas. The rates reported for the Western stock in Alaska; east and west of Samalga Pass; eastern, central, and western Gulf of Alaska; and eastern, central, and western Aleutian Islands were calculated for the period from 2007 to 2022 (Sweeney et al. 2022, 2023).

Region	**Latitude Range**	**Pups**				**Non-pups**		
		Trend	**-95%**	**+95%**		**Trend**	**-95%**	**+95%**
Western stock in Alaska	144°W-172°E	0.50	0.04	0.96		1.05	0.46	1.69
East of Samalga Pass	144°-170°W	1.35	0.84	1.91		1.52	0.82	2.20
Eastern Gulf of Alaska	144°-150°W	0.81	-0.53	2.13		-0.21	-2.25	1.81
Central Gulf of Alaska	150°-158°W	2.32	1.18	3.43		3.74	2.80	4.73
Western Gulf of Alaska	158°-163°W	1.36	0.46	2.28		1.22	0.08	2.45
Eastern Aleutian Islands	163°-170°W	0.73	-0.31	1.75		1.09	-0.27	2.46
West of Samalga Pass	170°W-172°E	-2.17	-2.94	-1.41		-0.70	-2.04	0.72
Central Aleutian Islands	170°W-177°E	-2.01	-2.85	-1.21		-0.20	-1.56	1.36
Western Aleutian Islands	172°-177°E	-4.10	-5.09	-3.07		-5.78	-8.02	-3.44

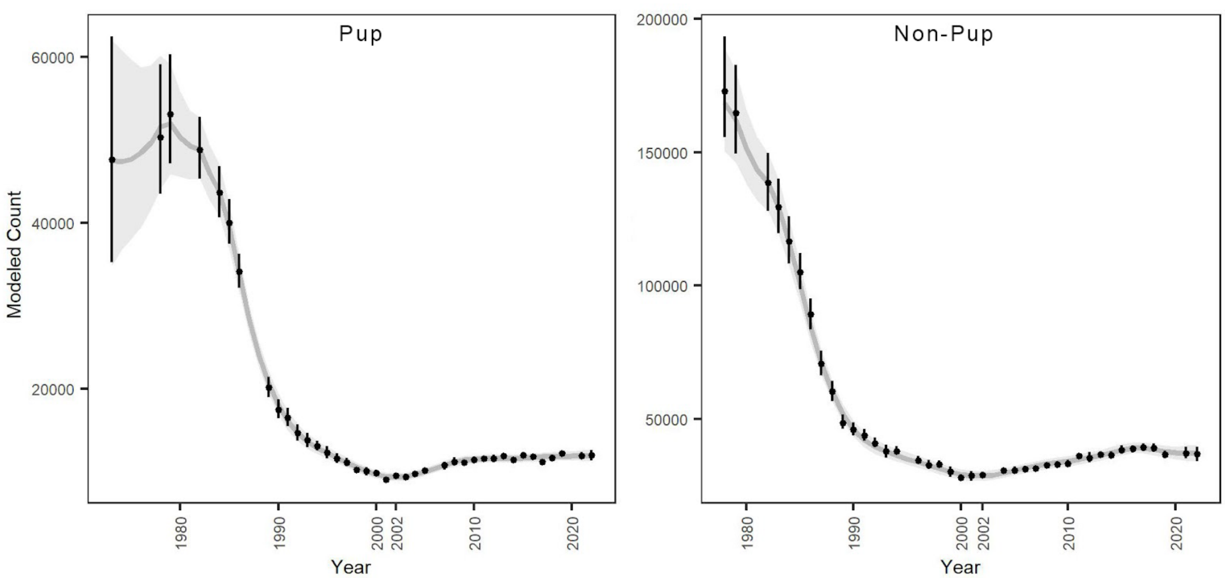

Figure 4. Realized and predicted counts of Western Steller sea lion pups (left) and non-pups (right) in Alaska, from 1973 for pups and 1978 for non-pups to 2022. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the dark gray line surrounded by the lighter gray 95% credible interval.

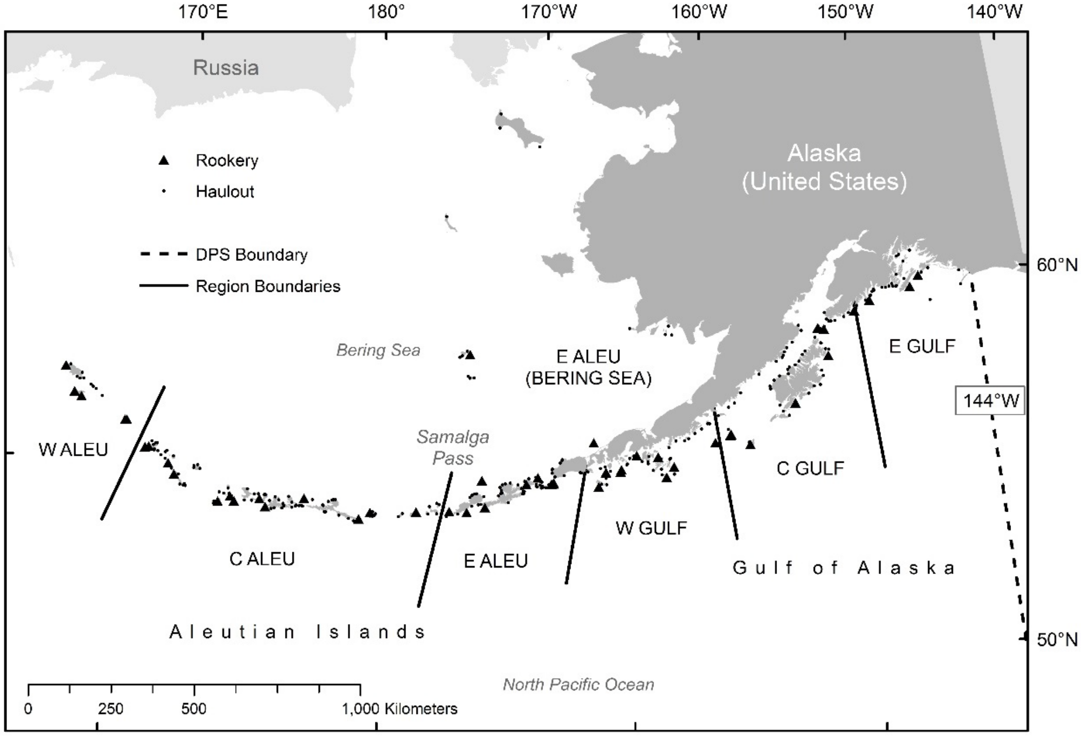

Figure 5. Regions of Alaska used for Western Steller sea lion population trend estimation. E GULF, C GULF, and W GULF are eastern, central, and western Gulf of Alaska regions, respectively. E ALEU, C ALEU, and W ALEU are eastern, central, and western Aleutian Islands regions, respectively (AFSC-MML-Alaska Ecosystems Program 2016).

In 2021, U.S. survey effort was focused in the Gulf of Alaska (Sweeney et al. 2022). Between 2015 and 2017, pup counts declined in the eastern (-33%) and central (-18%) Gulf of Alaska, counter to the continuous increases observed in both regions since 2002 (Sweeney et al. 2017). These declines may have been due to changes in availability of prey associated with warm ocean temperatures that occurred in the northern Gulf of Alaska from 2014 to 2016 (Bond et al. 2015, Peterson et al. 2016, von Biela et al. 2019, Yang et al. 2019, Suryan et al. 2021). There was also a movement of approximately 1,000 non-pups from the eastern to the central Gulf of Alaska regions, although the combined non-pup count in these two regions remained relatively stable between 2015 and 2017 (western Gulf of Alaska did not appear to change; Sweeney et al. 2017). In 2019, pup counts rebounded to 2015 levels; however, there was a decline in non-pup counts in the eastern, central, and western Gulf of Alaska regions (Sweeney et al. 2019). The eastern Gulf of Alaska region remained low in 2021, and the central Gulf of Alaska increased to 2010 levels. The western Gulf of Alaska showed the first signs of decline in 2021 after increasing since the early 2000s (Sweeney et al. 2022).

In 2022, survey effort was focused on the Aleutian Islands (Sweeney et al. 2023). From 2007 to 2022, pups declined west of Samalga Pass, especially in the western Aleutian Islands region, where non-pups have also continued to decline. The central Aleutian Island region plateaued; however, the eastern portion of this region, which was largely contributing to increases in counts in this region, has not been surveyed since 2016 or 2018. The eastern Aleutian Islands region, an area that had shown signs of recovery and was increasing since the early 2000s, has now plateaued for both pups and non-pups.

Describing population trends in Russia, Burkanov and Loughlin (2005) estimated the Russian Steller sea lion population (pups and non-pups) declined approximately 52% from the 1970s to the 1990s. Johnson (2018) estimated the non-pup count in Russia declined 1.3% y^{-1} between 2002 and 2017. The most recent agTrend estimate between 2007 and 2022 for non-pups was 1.04% y^{-1} (Table 3). However, just as in the U.S. portion of the Western stock, there were significant regional differences in population trend throughout Russia (Table 3; Fig. 7; Burkanov 2020). The decline in non-pup counts continued in the Kurils which, traditionally, represents the largest area in terms of non-pup counts (Burkanov and Loughlin 2005). The growth was attributed to a significant increase in the Sakhalin region (Table 3; Fig. 7). Pup production continued to decline in three of five areas where breeding occurs in Russia (Kuril

Islands, the Commander Islands, and the northern part of the Sea of Okhotsk), while pup production continued to grow in the Sakhalin Region (Tuleny Island) and became equally important for the Asian population of Kurils.

Table 3. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in non-pup counts for the Asian (Russia) portion of the Western stock of Steller sea lions and by region, from 2007 to 2022 (Johnson 2018, Gaos et al. 2021). See Figure 2 for regions.

Region	**Trend**	**-95%**	**+95%**
Asian portion of Western stock (Russia)	1.04	-0.73	3.24
Commander Islands (CI)	-0.30	-4.43	3.87
Kamchatka (KAM)	2.98	-3.02	9.49
Kuril (KUR)	-2.15	-4.16	0.26
Northern Sea of Okhotsk (NPSO)	1.01	-1.66	3.89
Sakhalin (SAK)	5.51	1.81	10.67
Western Bering Sea (WBS)	0.63	-12.26	14.43

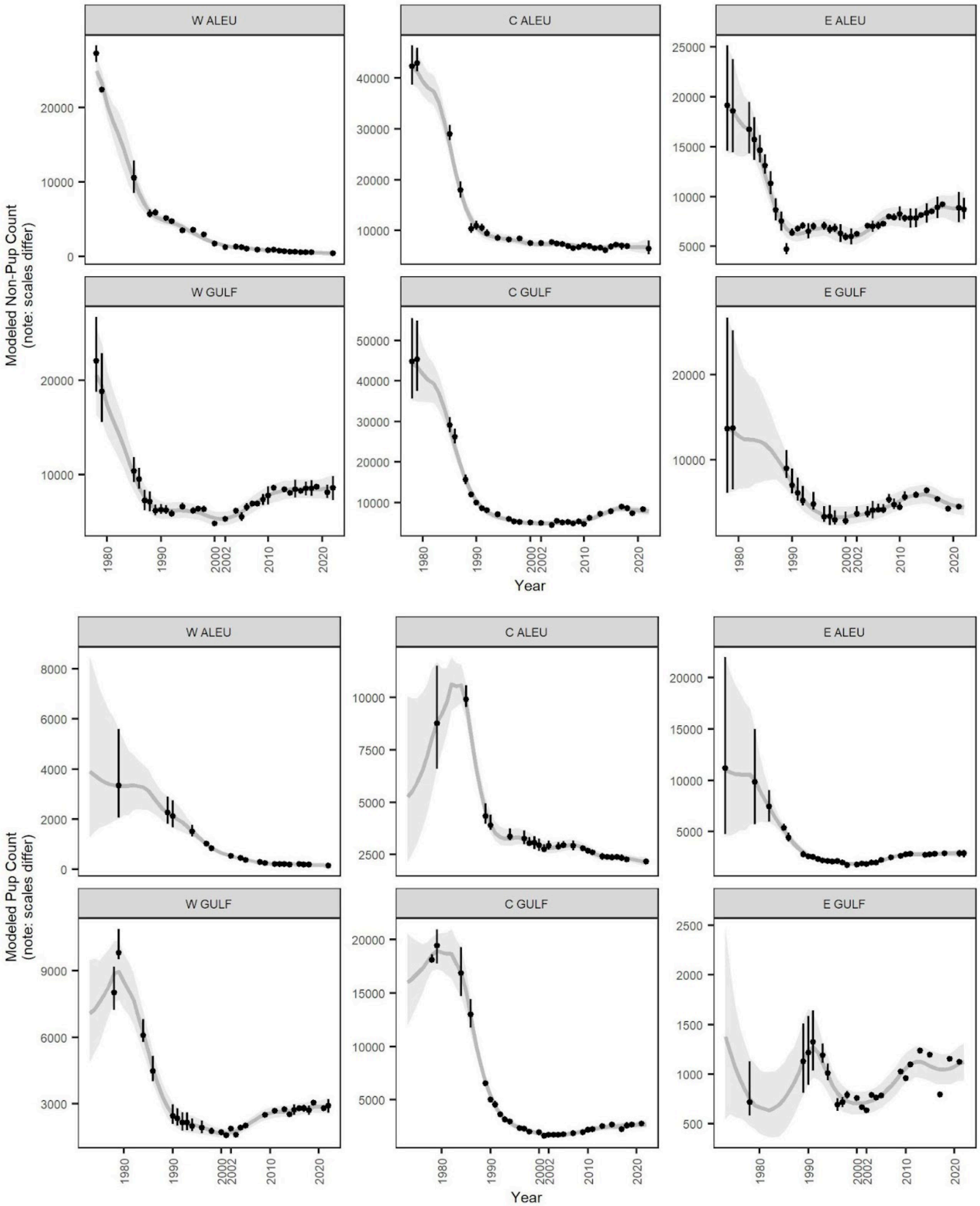

Figure 6. Realized and predicted counts of Steller sea lion pups (top) and non-pups (bottom) in the six regions that compose the Western stock in Alaska, 1973 for pups and 1978 for non-pups to 2022. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the dark gray line surrounded by the lighter gray 95% credible interval (Sweeney et al. 2023).

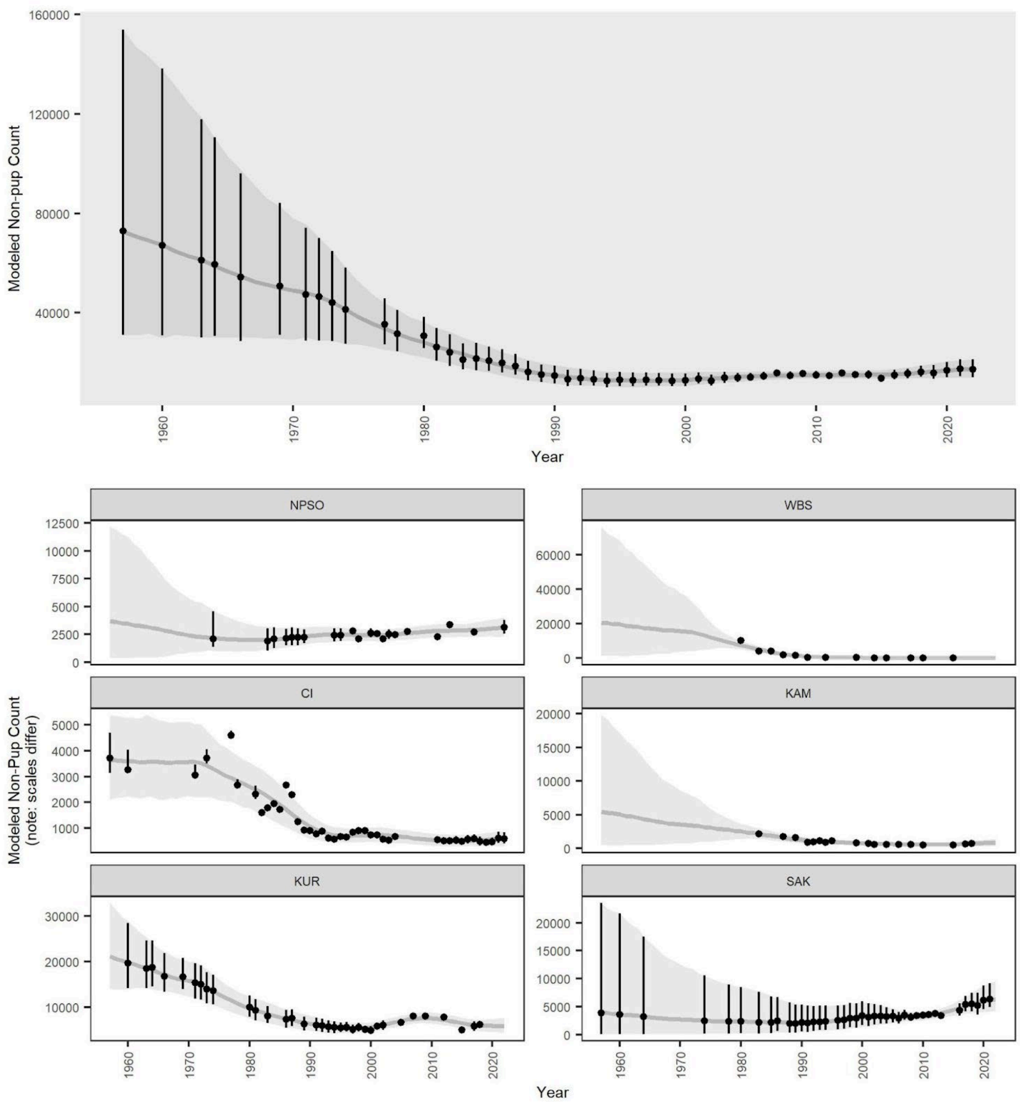

Figure 7. Realized and predicted counts of Russian Steller sea lion non-pups (above) and by region (below), 1957-2022. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the dark gray line surrounded by the lighter gray 95% credible interval. See Table 3 and Figure 2 for regions.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the maximum net productivity rate (R_{MAX}) for Steller sea lions. Until additional data become available, the default pinniped maximum theoretical net productivity rate of 12% will be used for this stock (NMFS 2023).

POTENTIAL BIOLOGICAL REMOVAL

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 default value for stocks listed as endangered under the ESA (NMFS 2023). Thus, for the Western stock of Steller sea lions (including Russia), PBR is 439 sea lions (73,211 × 0.06 × 0.1). The PBR for the U.S. portion of the Western stock of Steller sea lions is 299 sea lions (49,837 × 0.06 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury (SI), and non-serious injury (NSI) reported for NMFS-managed Alaska marine mammals between 2017 and 2021 is listed, by marine mammal stock, in Freed et al.

(2023); however, only the mortality and serious injury (M/SI) data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused M/SI for the U.S. portion of the Western Steller sea lion stock between 2017 and 2021 is 267 sea lions: 39 in U.S. commercial fisheries, 0.004 in Alaska subsistence fisheries, 0.2 in Alaska salmon hatcheries, 1.9 in unknown (commercial, recreational, or Alaska subsistence) fisheries, 6.6 in marine debris, 0.8 due to illegal shooting, and 218 in the Alaska Native subsistence harvest. The number of human-caused M/SI of Western Steller sea lions in the Asian portion of the range is unknown.

The most recent data on Steller sea lion interactions with state-managed fisheries in Alaska are from the Southeast Alaska salmon drift gillnet fishery in 2012 and 2013 (Manly 2015), a fishery in which the majority of the Steller sea lions taken are likely to be from the Eastern stock, although sea lions carrying Western genetic material could be as high as 38% (Hastings et al. 2020). Counts of annual illegal gunshot mortality in the Copper River Delta should be considered minimums as they are based solely on aerial carcass surveys from 2017 to 2019, no data are available for 2020-2021, a cause of death for all carcasses found was not determined, and it is not likely that all carcasses are detected. Disturbance of Steller sea lion haulouts and rookeries can potentially cause disruption of reproduction, stampeding, or increased exposure to predation by marine predators (NMFS 2008; see also NMFS 1990, 1997). Effects of disturbance are highly variable and difficult to predict. Data are not available to estimate potential impacts from non-monitored activities, including disturbance near rookeries without 3-nmi no-entry buffer zones. Potential threats most likely to result in direct human-caused M/SI of this stock include subsistence harvest, incidental take, illegal shooting, disturbance at rookeries that could cause stampedes, and entanglement in fishing gear and marine debris.

Fisheries Information

Commercial fisheries

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2024).

Based on historical reports and their geographic range, Steller sea lion M/SI could occur in several fishing gear types, including trawl, gillnet, longline, and hook and line fisheries. However, observer data are limited. Of these fisheries, only trawl fisheries are regularly observed, and gillnet fisheries have had limited observations in select areas over short time frames and with modest observer coverage. Consequently, there are little to no data on Steller sea lion M/SI in non-trawl fisheries. Therefore, the potential for fisheries-caused M/SI may be greater than is reflected in existing observer data.

Between 2017 and 2021, M/SI of Western Steller sea lions was observed or recorded via electronic monitoring in 8 of the federally-managed commercial fisheries in Alaska that are monitored for incidental M/SI by fisheries observers: Bering Sea/Aleutian Islands Atka mackerel trawl, Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands Pacific cod trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod longline, Gulf of Alaska flatfish trawl, Gulf of Alaska pollock trawl, and Gulf of Alaska sablefish longline fisheries, resulting in a mean annual M/SI rate of 24 sea lions (Table 4; Breiwick 2013; MML, unpubl. data).

AMMOP observers monitored the Alaska State-managed Prince William Sound salmon drift gillnet fishery in 1990 and 1991, recording two incidental mortalities in 1991, extrapolated to 29 (95% CI: 1-108) for the entire fishery (Wynne et al. 1992; Table 4). No incidental M/SI was observed during 1990 for this fishery (Wynne et al. 1991), resulting in a mean annual M/SI rate of 15 sea lions for 1990 and 1991. It is not known whether this incidental M/SI rate is representative of the current rate in this fishery; between 2017 and 2021, only one Steller sea lion mortality, reported to the NMFS Alaska Region marine mammal stranding network, was attributed to the Prince William Sound salmon drift gillnet fishery (Freed et al. 2023).

The minimum estimated mean annual M/SI rate in U.S. commercial fisheries between 2017 and 2021 is 39 Steller sea lions from this stock (Table 4). All U.S. commercial fishery-related reports of M/SI of this stock came from U.S. commercial fishery observer or electronic monitoring data. No observers have been assigned to several fisheries that are known to interact with this stock, thus, the estimated M/SI is likely an underestimate of the actual level.

Commercial fishery-related serious injuries averted (i.e., human intervention or self-release lessened the severity of the initial serious injury, leaving the animal with only non-serious or no injuries) and non-serious injuries are not included in the total estimate of annual human-caused M/SI that is compared to PBR, but are used to develop the List of Fisheries under Section 118 of the Marine Mammal Protection Act and inform management (e.g., take reduction planning and negligible impact determinations). No serious injuries of Western Steller sea lions were averted in U.S. commercial fishery interactions between 2017 and 2021. Additionally, there were no U.S. commercial fisheries with only non-serious injuries of western Steller sea lions between 2017 and 2021.

Table 4. Summary of incidental M/SI of Western stock Steller sea lions in U.S. waters due to U.S. commercial fisheries between 2017 and 2021 (or the most recent data available) and calculation of the mean annual M/SI rate (Wynne et al. 1991, 1992; Breiwick 2013; MML, unpubl. data). The "Observed mortality" column does not include M/SI in unsampled hauls unless there were no observed M/SI in sampled hauls in that fishery that year. N/A indicates that data are not available. Methods for calculating percent observer coverage are described in Appendix 3 of the Alaska Stock Assessment Reports. Mean annual estimates are rounded but the total estimate is based on unrounded estimates.

Fishery name	Years	Data type	Percent observer coverage	Observed M/SI	Estimated M/SI (CV)	Mean estimated annual M/SI
Bering Sea/Aleutian Is. Atka mackerel trawl	2017 2018 2019 2020 2021	obs data	100 100 100 100 99	1 5 0 0 1	1 (0.06) 5.1 (0.08) 0 0 1 (0.04)	1.4 (CV = 0.06)
Bering Sea/Aleutian Is. flatfish trawl	2017 2018 2019 2020 2021	obs data	100 100 100 100 99	13 8 12 14 17	13 (0.01) 8.0 (0.02) 12.1 (0.02) 14.1 (0.02) 17.2 (0.03)	13 (CV = 0.01)
Bering Sea/Aleutian Is. Pacific cod trawl	2017 2018 2019 2020 2021	obs data	68 73 67 71 58	1 1 0 0 0	1 (0) 1 (0) 0 0 0	0.40 (CV = 0)
Bering Sea/Aleutian Is. pollock trawl	2017 2018 2019 2020 2021	obs data	99 99 98 91 77	6 7 4 10 5	6.1 (0.05) 7.1 (0.05) 4 (0.02) 11.2 (0.13) 6.5 (0.22)	7.0 (CV = 0.06)
Bering Sea/Aleutian Is. Pacific cod longline	2017 2018 2019 2020 2021	obs data	58 55 52 52 55	1 0 0 0 0	1.6 (0.61) 0 0 0 0	0.32 (CV = 0.61)
Gulf of Alaska flatfish trawl	2017 2018 2019 2020 2021	obs data	56 35 39 38 82	0 0 2[a] 0 0	0 0 2 0 0	0.40 (CV = N/A)
Gulf of Alaska pollock trawl	2017 2018 2019 2020 2021	obs data	19 21 23 10 13	0 0 0 1[b] 0	0 0 0 1 0	0.20 (CV = N/A)
Gulf of Alaska sablefish longline	2017 2018 2019 2020 2021	obs data	10 9 12 7 11	0 0 2 0 0	0 0 9.4 (0.79) 0 0	1.9 (CV = 0.79)

Fishery name	Years	Data type	Percent observer coverage	Observed M/SI	Estimated M/SI (CV)	Mean estimated annual M/SI
Prince William Sound salmon drift gillnet	1990 1991	obs data	4 5	0 2	0 29.0	15 (CV = 1.0)
Minimum total estimated annual mortality						39 (CV = 0.37)

[a] Two animals were killed in unsampled hauls and represent a minimum estimate of M/SI in this fishery in this year.
[b] One mortality was detected via electronic monitoring while the fishery was operating on an exempted fishing permit. This mortality represents a minimum estimate of M/SI in this fishery in this year.

Non-commercial and unknown fisheries

Reports to the NMFS Alaska Region marine mammal stranding network and the Alaska Department of Fish and Game (ADF&G) of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear are another source of M/SI data (Table 5; Freed et al. 2023). Steller sea lions from parts of the Western stock are known to regularly occur in parts of Southeast Alaska (Jemison et al. 2013, 2018; NMFS 2013), and higher rates of entanglement of Steller sea lions have been observed in this area (e.g., Raum-Suryan et al. 2009). From 2017 to 2021, one mortality was reported in an Alaska subsistence halibut longline fishery, resulting in a mean annual M/SI rate of 0.004 western Steller sea lions in Alaska subsistence fisheries. Other fishery-related M/SI included a mean of 0.2 sea lions in salmon hatchery nets and 1.9. in unknown (commercial, recreational, or Alaska subsistence) fishing gear (Table 5). These M/SI estimates result from actual counts 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 two Steller sea lions in the Eastern and Western stock mixing area of Southeast Alaska that were initially considered seriously injured due to hooking by unknown salmon hook and line gear (one in 2017 and one in 2018) were disentangled or dehooked and released, or presumed to have self released, with non-serious injuries (Freed et al. 2023). None of these serious injuries averted were included in the estimate of the average annual M/SI rate for 2017 to 2021.

Table 5. Summary of Western stock Steller sea lion M/SI in U.S. waters, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and Alaska Department of Fish and Game between 2017 and 2021 (Freed et al. 2023). In areas of Southeast Alaska where the western (wSSL) and eastern (eSSL) populations mix, the mean annual M/SI of both stocks (wSSL + eSSL) was multiplied by the mixing zone-specific proportion of western non-pups (Table 1; Hastings et al. 2020) to produce estimates for the Western stock (wSSL only).

Cause of injury				2017	2018	2019	2020	2021	Mean annual M/SI	
									wSSL + eSSL	wSSL only
Southeast Alaska – Mixing Zone D										
Hooked by Alaska subsistence halibut longline gear				0	0	0	0	1	0.2	0.004
Hooked by salmon hook and line gear*				4	0	1	1	3	1.8	0.040
Hooked by unknown hook and line gear*				0	1	0	0	0	0.2	0.004
Entangled in Southeast Alaska salmon hatchery pen				0	0	0	1	0	0.2	0.004
Entangled in unknown fishery gear*				0	0	1	0	0	0.2	0.004
Entangled in marine debris				3	3	2	0	0	1.6	0.035
Illegally shot				0	0	1	0	0	0.2	0.004

Southeast Alaska – Mixing Zone E										
Hooked by halibut hook and line gear*				0	1	0	0	0	0.2	0.002
Hooked by salmon hook and line gear*				4	0	1	0	0	1.0	0.012
Entangled in marine debris				3	2	1	0	0	1.2	0.014
Southeast Alaska – Mixing Zone F										
Hooked or entangled by salmon hook and line gear*				8	8	4	0	6	5.2	0.426
Hooked by unknown hook and line gear*				2	1	2	0	0	1.0	0.082
Entangled in unknown fishery gear*				0	0	0	1	0	0.2	0.016
Entangled in marine debris				2	8	1	0	3	2.8	0.230
Dependent pup of animal seriously injured by marine debris				0	1	0	0	0	0.2	0.016
Southeast Alaska – Mixing Zone G										
Hooked by salmon hook and line gear*				1	1	2	0	0	0.8	0.058
Entangled in marine debris				3	3	0	0	0	1.2	0.088
Southeast Alaska – Mixing Zone H										
Hooked by salmon hook and line gear*				3	0	1	1	1	1.2	0.017
Entangled in marine debris				3	2	1	0	1	1.4	0.020
All Other Areas in Western Stock Range										
Entangled in Kodiak salmon hatchery seine net				0	1	0	0	0	-	0.2
Hooked by salmon hook and line gear*				1	1	1	0	0	-	0.6
Hooked by unknown hook and line gear*				0	0	0	0	2	-	0.4
Entangled in unknown trawl gear				0	0	0	1	0	-	0.2
Entangled in marine debris				3	5	2	8	13	-	6.2
Illegally shot				0	0	3	1	0	-	0.8
Total in commercial fisheries										0
Total in Alaska subsistence fisheries										0.004
Total in salmon hatchery nets										0.2
*Total in unknown (commercial, recreational, or Alaska subsistence) fisheries										1.9
Total in marine debris (including dependent pup(s) of animal(s) seriously injured or killed by marine debris)										6.6
Total due to illegal shooting)										0.8

In summary, the minimum mean annual M/SI rate for all fisheries in the U.S. between 2017 and 2021, is 41 Western Steller sea lions based on observer data and stranding data for: U.S. commercial fisheries (39 sea lions), Alaska subsistence fisheries (0.004 sea lions), salmon hatchery nets (0.2 sea lions), and unknown (commercial, recreational, or Alaska subsistence) fisheries (1.9 sea lions).

Alaska Native Subsistence/Harvest Information

NMFS has 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. NMFS also has an agreement with the Aleut Marine Mammal Commission (2006) for the conservation and management of all marine mammal subsistence species, with particular focus on Steller sea lions and harbor seals. These co-management agreements promote full and equal participation by Alaska Natives in decisions affecting the subsistence management of Steller sea lions (to the maximum extent allowed by law) as a tool for conserving Steller sea lion populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed May 2024).

Information on the subsistence harvest of Steller sea lions comes via four sources: the Alaska Department of Fish and Game (ADF&G), the Ecosystem Conservation Office of the Aleut Community of St. Paul Island, the Kayumixtax Eco-Office of the Traditional Council of St. George Island, and the Aleut Marine Mammal Commission. The ADF&G conducted systematic interviews with hunters and users of marine mammals in approximately 2,100 households in about 60 coastal communities within the geographic range of the Steller sea lion in Alaska (Wolfe et al. 2005, 2006, 2008, 2009a, 2009b). The interviews were conducted once per year in the winter (January to March) and covered hunter activities for the previous calendar year. As of 2009, annual statewide data on community subsistence harvests are no longer being consistently collected. Data are being collected periodically in subareas. Data were collected on the Alaska Native harvest of Western stock Steller sea lions for seven communities on Kodiak Island in 2011 and for 15 communities in Southcentral Alaska in 2014. The Alaska Native Harbor Seal Commission (ANHSC) and ADF&G estimated a total of 20 adult sea lions were harvested on Kodiak Island in 2011, with a 95% confidence range between 15 and 28 animals (Wolfe et al. 2012), and 7.8 sea lions (CI = 6-15.3) were harvested in Southcentral Alaska in 2014, with adults comprising 84% of the harvest (ANHSC 2015). These estimates do not represent a comprehensive statewide estimate. In addition, different surveys have produced different harvest estimates; for example, the ANHSC survey produced an estimate of 0 Steller sea lions harvest in the community of Tatitlek for 2014 (ANHSC 2015), while the ADF&G comprehensive survey that year produced an estimate of 10.3 for that community that year (Fall and Zimpelman 2016). The best available statewide subsistence harvest estimates for a 5-year period are those from 2004 to 2008. Thus, the most recent 5 years of data available from the ADF&G (2004-2008) will be used for calculating an annual M/SI estimate for all areas except St. Paul, St. George, Atka, and Akutan Islands (Wolfe et al. 2005, 2006, 2008, 2009a, 2009b) (Table 6). Current harvest data are being collected on St. Paul (Tribal Government of St. Paul Island, unpubl. data), St. George (Traditional Council of St. George Island, unpubl. data), and Atka and Akutan Islands (Aleut Marine Mammal Commission, unpubl. data) (Table 6). Since the cessation of ADF&G monitoring, there is an incomplete understanding of harvest levels statewide.

The mean annual subsistence harvest from this stock for all areas except St. Paul, St. George, Atka, and Akutan Islands between 2004 and 2008 (172) combined with the mean annual harvest for St. Paul (31), St. George (0.6), Atka (10), and Akutan (4) Islands between 2017 and 2021 is 218 western Steller sea lions (Table 6).

Other Mortality

Reports to the NMFS Alaska Region marine mammal stranding network of Steller sea lions entangled in marine debris or with injuries caused by other types of human interaction are another source of M/SI data. These M/SI 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. Between 2017 and 2021, reports to the stranding network resulted in mean annual M/SI rates of 0.8 Western Steller sea lions illegally shot (most of which were observed during surveys of the Copper River Delta), 6.6 entangled in marine debris, and 0.016 dependent pups of an animal seriously injured by marine debris (Table 5; Freed et al. 2023).

An additional six Steller sea lions in the Eastern and Western stock mixing area of Southeast Alaska that were initially considered seriously injured in marine debris (four in 2017, one in 2018, and one in 2019) were disentangled or dehooked and released, or presumed to have self released, with non-serious injuries (Freed et al. 2023). None of these serious injuries averted were included in the estimate of the average annual M/SI rate for 2017 to 2021.

Table 6. Summary of the Alaska Native subsistence harvest data for Western stock Steller sea lions. As of 2009, data on community subsistence harvests are no longer being consistently collected. Therefore, the most recent 5 years of data (2004 to 2008) will be used for calculating an annual M/SI estimate for all areas except St. Paul, St. George, Atka, and Akutan Islands. Data from St. Paul, St. George, Atka, and Akutan Islands are still being collected and the most data available will be used. Mean annual harvest is calculated across only the years where data are available. N/A indicates that data are not available. No data are available for struck and lost animals at Akutan Island in 2020 and 2021.

	All areas except St. Paul, St. George, Atka, and Akutan Islands			St. Paul Island	St. George Island	Atka Island	Akutan Island
Year	**Number harvested**	**Number struck and lost**	**Total**	**Number harvested + Number struck and lost**	**Number harvested + Number struck and lost**	**Number harvested + Number struck and lost**	**Number harvested + Number struck and lost**
2004	136.8	49.1	185.9[a]				
2005	153.2	27.6	180.8[b]				
2006	114.3	33.1	147.4[c]				
2007	165.7	45.2	210.9[d]				
2008	114.7	21.6	136.3[e]				
2017	N/A	N/A	N/A	30[f]	0[g]	N/A	N/A
2018	N/A	N/A	N/A	28[f]	1[g]	6[h]	N/A
2019	N/A	N/A	N/A	33[f]	1[g]	6[h]	N/A
2020	N/A	N/A	N/A	33[f]	0[g]	20[h]	3[h]
2021	N/A	N/A	N/A	N/A	1[g]	7[h]	5[h]
Mean annual harvest	137	35	172	31	0.6	10	4

[a] Wolfe et al. (2005); [b] Wolfe et al. (2006); [c] Wolfe et al. (2008); [d] Wolfe et al. (2009a); [e] Wolfe et al. (2009b); [f] Tribal Government of St. Paul Island, unpubl. data; [g] Traditional Council of St. George Island, unpubl. data; [h] Aleut Marine Mammal Commission, unpubl. data.

STATUS OF STOCK

The minimum estimated mean annual U.S. commercial fishery-related M/SI rate (39 sea lions) is more than 10% of the PBR for the U.S. portion of the range (10% of PBR = 30) and, therefore, cannot be considered insignificant and approaching a zero M/SI rate. Based on available data, the minimum estimated mean annual level of human-caused M/SI (267 sea lions) in the U.S. is below both the U.S. PBR level (299) and the range-wide PBR level (439) for this stock. The Western stock of Steller sea lions is currently listed as endangered under the ESA and, therefore, designated as depleted under the MMPA. As a result, the stock is classified as a strategic stock. The population previously declined for unknown reasons that are not explained by the documented level of direct human-caused M/SI. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Western stock of Steller sea lions. Some genetic studies support the separation of Steller sea lions in western Alaska from those in Russia. Information on human-caused M/SI is currently only available for the U.S. portion of the stock's range. The population abundance is based on counts of visible animals; the calculated N_{MIN} and PBR levels are conservative because there are no data available to correct for animals not visible during the visual surveys. There are multiple nearshore commercial fisheries operating within the stock's range that are not observed; thus, there is likely to be unreported fishery-related M/SI of Steller sea lions. Estimates of human-caused M/SI from stranding data are underestimated because not all animals strand nor are all stranded animals found, reported, or have the cause of death determined. Several factors may have been important drivers of the decline of the stock. However, there is uncertainty about threats currently impeding their recovery, particularly in the Aleutian Islands.

OTHER FACTORS THAT MAY BE CAUSING A DECLINE OR IMPEDING RECOVERY

Many factors have been suggested as causes of the steep decline in abundance of Western Steller sea lions observed in the 1980s, including competitive effects of fishing, environmental change, disease, contaminants, killer whale predation, incidental take, and illegal and legal shooting (Atkinson et al. 2008, NMFS 2008). A number of management actions have been implemented since 1990 to promote the recovery of the Western stock of Steller sea lions, including 3-nmi no-entry zones around rookeries, prohibition of shooting at or near sea lions, and regulation of fisheries for sea lion prey species (e.g., walleye pollock, Pacific cod, and Atka mackerel; see reviews by Fritz et al. 1995, McBeath 2004, Atkinson et al. 2008, NMFS 2008). Additionally, potentially deleterious events, such as harmful algal blooms (Lefebvre et al. 2016) and disease transmission across the Arctic (VanWormer et al. 2019) that have been associated with warming waters, could lead to potentially negative population-level impacts on Steller sea lions. Metal and contaminant exposure remains a focus of ongoing investigation. Total mercury concentrations measured in hair samples collected from pups in the western-central Aleutian Islands are the highest measured for this species and at levels that in other species cause neurological and reproductive effects (Rea et al. 2013, 2020), and organochlorine burdens were detected in tissue samples from across the range but were highest in pups sampled from the Aleutian Islands (Beckmen et al. 2016, Keogh et al. 2020).

The area of greatest (continued) decline in the U.S. remains in the western Aleutian Islands (west of Samalga Pass). Pacific cod and Atka mackerel are two of the primary prey species of Steller sea lions in the central and western Aleutian Islands (Sinclair et al. 2013, Tollit et al. 2017). In the eastern Aleutian Islands region where Steller sea lion numbers are increasing, Rand et al. (2019) reported dense and consistent aggregations of Atka mackerel. However, in the western Aleutian Islands region, this important prey species was more spread out over a larger area during the non-breeding (i.e., "winter") season (Fritz et al. 2019, Rand et al. 2019). Prey availability over winter is thought to be a key factor in energy budgets of Steller sea lions, especially for pregnant females and especially those supporting a pup and/or juvenile (NMFS 2010, Boyd 2000, Malavaer 2002, Winship et al. 2002, Williams 2005). This could result in increases in energy expenditures by Steller sea lions associated with finding and capturing prey, as evident by increased frequency and duration of foraging trips observed in juvenile Steller sea lions in this region (Lander et al. 2010). Prey species (e.g., Atka mackerel, Pacific cod, and walleye pollock) are likely to have lower overall abundance, less predictable spatial distributions, and altered demographics in fished versus unfished habitats (Hsieh et al. 2006, Barbeaux et al. 2013, Fritz et al. 2019). In 2011, the Pacific cod and Atka mackerel fisheries were closed and then re-opened in 2014. In the western Aleutian Islands region, modeled realized counts exhibited stability from 2014 to 2016 (and potentially an increase in pup counts), followed by continued declines since 2016 (Sweeney et al. 2016, 2017, 2018). Fritz et al. (2019) suggested that if nutrition is a driver of the decline, then it appears that other factors (than diet diversity, species mix, and energy density) may be acting. The literature does not prove (or disprove) a correlation between fisheries, sea lion population trends, and prey availability in the Aleutian Islands, and this hypothesis is an important area of investigation for Steller sea lions, especially in the Aleutian Islands.

The Pacific marine heatwave that occurred from 2014 to 2016, and subsequent warm waters in the north Pacific, especially the Gulf of Alaska, has been linked to large declines in productivity and impacts on groundfish populations (von Biela et al. 2019, Yang et al. 2019, Suryan et al. 2021), including survival of adult female Steller sea lions in Southeast Alaska, Prince William Sound, and Chiswell Island (Hastings et al. 2023). In fact, the concomitant decline in pup productivity in the eastern and central Gulf of Alaska regions observed from 2015 and 2017 may be related to the reduction of available prey in the area (Sweeney et al. 2017). In 2019, pup production in these regions rebounded to 2015 levels; however, there was a decline in non-pups that spanned all the Gulf of Alaska regions (Sweeney et al. 2019). These declines are concerning given that prior to 2017, these regions were showing relatively consistent and steady increases in counts (Sweeney et al. 2019). As Alaska waters, especially the Gulf of Alaska, continue to warm, it seems evident from NMFS' Steller sea lion surveys that this could continue to impact the Western stock of Steller sea lions in the U.S. It is also possible that changes in foraging ability could affect Steller sea lion movements between and within the stocks (Jemison et al. 2018).

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STELLER SEA LION (*Eumetopias jubatus*): Eastern Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

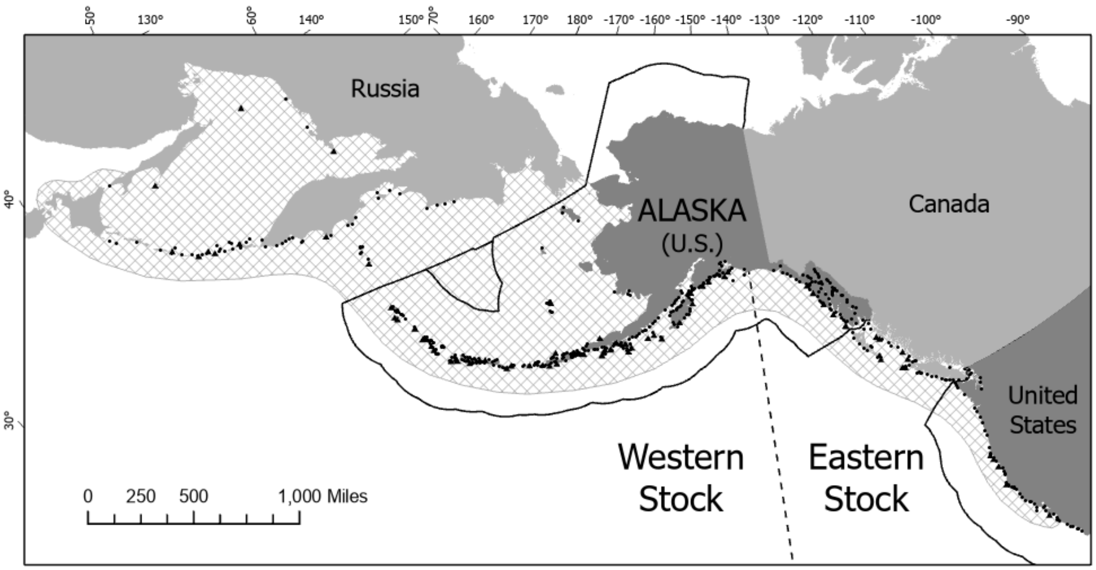

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005; Olesiuk 2018). A black dashed line (144°W) indicates the stock boundary (Loughlin 1997) and a black line delineates the U.S. Exclusive Economic Zone.

Steller sea lions range along the North Pacific Rim from northern Japan to California (Loughlin et al. 1984) (Fig. 1). Large numbers of individuals disperse widely outside of the breeding season (late May to July), probably to access seasonally important prey resources. This results in marked seasonal patterns of abundance in some parts of the range and potential for intermixing in foraging areas of animals that were born in different areas (Sease and York 2003). There is an exchange of sea lions across the stock boundary (144°W; dashed line in Fig. 1), especially due to the wide-ranging seasonal movements of juveniles and adult males (Baker et al. 2005; Jemison et al. 2013, 2018; Hastings et al. 2020). The Eastern stock is transboundary, extending from southeast Alaska, south through Canada, and down the west coast of the U.S. into California. During the breeding season, Steller sea lions, especially adult females, typically return to their natal rookery or a nearby breeding rookery to breed and pup (Raum-Suryan et al. 2002, Hastings et al. 2017). However, mixing of mostly breeding females from Prince William Sound (Western stock) to Southeast Alaska began in the 1990s and two new, mixed-stock rookeries were established (Gelatt et al. 2007; Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014).

Loughlin (1997) considered the following information when classifying stock structure based on the phylogeographic approach of Dizon et al. (1992): 1) Distributional data: geographic distribution continuous, yet a high degree of natal site fidelity and low (<10%) exchange rate of breeding animals among rookeries; 2) Population response data: substantial differences in population dynamics (York et al. 1996); 3) Phenotypic data: differences in pup mass (Merrick et al. 1995, Loughlin 1997); and 4) Genotypic data: substantial differences in mitochondrial DNA (Bickham et al. 1996). Based on this information, two stocks of Steller sea lions were recognized: the Eastern stock, which includes animals born east of Cape Suckling, Alaska (144°W), and the Western stock, which includes animals born at and west of Cape Suckling (Loughlin 1997; Fig. 1). These stocks are equivalent to the eastern and western distinct population segments (DPSs) identified under the Endangered Species Act (62 FR 24345, 62 FR 30772).

All genetic analyses (Baker et al. 2005; Harlin-Cognato et al. 2006; Hoffman et al. 2006, 2009; O'Corry-Crowe et al. 2006) confirm a strong separation between Western and Eastern stocks, and there may be sufficient morphological differentiation to support elevating the two recognized stocks to subspecies (Phillips et al. 2009), although a review by Berta and Churchill (2012) characterized the status of these subspecies assignments as "tentative" and requiring further attention before their status can be determined. Work by Phillips et al. (2011) addressed the effect of climate change, in the form of glacial events, on the evolution of Steller sea lions and reported that the effective population size at the time of the event determines the impact of change on the population. The results suggested that during historic glacial periods, dispersal events were correlated with historically low effective population sizes, whereas range fragmentation type events were correlated with larger effective population sizes. This work again reinforced the separation of the Western and Eastern stocks by noting that ancient population subdivision likely led to the sequestering of most mtDNA haplotypes as stock or subspecies-specific (Phillips et al. 2011).

Observations of marked sea lions indicate there is regular movement of Steller sea lions across the stock boundary outside the breeding season, especially by juveniles and males (Jemison et al. 2013, 2018; Hastings et al. 2020). During the breeding season, an equal proportion of male and female Western stock Steller sea lions have been observed in the Eastern stock area, while Eastern stock sea lions observed moving west have been almost exclusively male (Jemison et al. 2013, 2018; Hastings et al. 2020). In 1998 a single Steller sea lion pup was observed on Graves Rock just north of Cross Sound in Southeast Alaska, and within 15 years (2013) pup counts had increased to 551 (DeMaster 2014). Mitochondrial and microsatellite analysis of pup tissue samples collected in 2002 revealed that approximately 70% of the pups had mtDNA haplotypes that were consistent with those found in the western stock (Gelatt et al. 2007). Similarly, a rookery to the south on the White Sisters Islands, where pups were first noted in 1990, was also sampled in 2002 and approximately 45% of those pups had western stock haplotypes (O'Corry-Crowe et al. 2014). Collectively, this information demonstrates that these two most recently established rookeries in northern Southeast Alaska have been partially to predominantly established by western stock females (Jemison et al. 2013, 2018; Rehberg et al. 2018).

While movements of animals marked as pups in both stocks support these genetic results (Jemison et al. 2013, 2018; Hastings et al. 2020), overall the observations of marked Steller sea lion movements corroborate the extensive genetic research findings for a strong separation between the two currently recognized stocks. O'Corry-Crowe et al. (2014) concluded that the results of their study of the genetic characteristics of pups born on these new rookeries "demonstrates that resource limitation may trigger an exodus of breeding animals from declining populations, with substantial impacts on distribution and patterns of genetic variation. It also revealed that this event is rare because colonists dispersed across an evolutionary boundary, suggesting that the causative factors behind recent declines are unusual or of larger magnitude than normally occur."

Thus, although recent colonization events in the northern part of the Eastern stock area indicate movement of Western stock Steller sea lions (especially adult females) into this area, the mixed part of the range remains geographically distinct (Jemison et al. 2013), and the overall discreteness of the Eastern from the Western stock remains distinct. Hybridization among subspecies and species along a contact zone such as now occurs near the stock boundary is not unexpected, as the ability to interbreed is a primitive condition whereas reproductive isolation would be derived. The level of differentiation indicates long-term reproductive isolation resulting from four glacial refugia events 60,000 to 180,000 years before present (BP) (Harlin-Cognato et al. 2006). The fundamental concept overlying this distinctiveness is the collection of morphological, ecological, behavioral, and genetic evidence for stock differences initially described by Bickham et al. (1996) and Loughlin (1997) and supported by Baker et al. (2005), Harlin-Cognato et al. (2006), Hoffman et al. (2006, 2009), O'Corry-Crowe et al. (2006), Phillips et al. (2009, 2011), and Hastings et al. (2020). As stated by NMFS and the U.S. Fish and Wildlife Service (USFWS) in a 1996 response to a previous comment regarding their joint "DPS" policy (61 FR 4722), "The Services do not consider it appropriate to require absolute reproductive isolation as a prerequisite to recognizing a distinct population segment" or stock.

POPULATION SIZE

The Eastern stock of Steller sea lions has historically bred on rookeries located in Southeast Alaska, British Columbia (Canada), Oregon, and California. However, within the last several years a new rookery has become established on the outer Washington coast at the Carroll Island and Sea Lion Rock complex (Stocking and Wiles 2021). Abundance surveys to count Steller sea lions are conducted in late June through mid-July starting approximately 10 days after the mean pup birth dates in the survey area (4-14 June) after approximately 95% of all pups are born (Pitcher et al. 2001, Kuhn et al. 2017). Researchers collaborated on a range-wide Eastern stock survey in 2021. The dates of the most recent aerial photographic and land-based surveys of eastern Steller sea lions have varied by region. Southeast Alaska was last surveyed in June and July 2021 (Sweeney et al. 2022), while counts used in population analyses for the contiguous U.S. are from 2015-2022 surveys in Washington (NMFS and Washington Department of Fish and Wildlife, unpubl. data), Oregon (Oregon Department of Fish and Game, unpubl. data), and California (NMFS, unpubl. data). Counts from British Columbia are from the 2013 survey (Olesiuk 2018). Counts from subsequent surveys in Canada in 2015 and 2021 were not yet publicly available to include in this report.

An updated agTrend model (R package; Johnson and Fritz 2014, Gaos et al. 2021) was used to estimate counts and trends by augmenting missing counts. The updated agTrend model uses the penalized spline model to reduce variance for years where missing data is interpolated (Gaos et al. 2021). This model improves upon the previous method, which used a random walk-time series model (Johnson and Fritz 2014), providing more precise estimates. Non-pup counts do not account for animals at sea and therefore cannot be used as an abundance estimate. Pup counts are considered a census (i.e., total pup production), however, these counts do not account for pups that are born, or die, after the surveys.

Demographic multipliers (e.g., pup production multiplied by 4.5) and corrections for proportions of each age-sex class that are hauled out during the day in the breeding season (when aerial surveys are conducted) have been proposed as methods to estimate total population size from pup and/or non-pup counts (Calkins and Pitcher 1982, Higgins et al. 1988, Milette and Trites 2003, Maniscalco et al. 2006). There are several factors that make using demographic multipliers problematic, including the large variability in abundance trends across the range of the species and the fact that such correction factors have been calculated for the Western stock and not the Eastern.

The 2022 estimated total Eastern stock (including Canada) pup count was 31,289 (95% credible interval of 21,264-44,298). The 2022 estimated total Eastern stock non-pup count was 66,150 (95% credible interval of 49,688-84,914). These are count estimates and cannot be used as an abundance estimate as they do not account for animals at sea.

Minimum Population Estimate

Steller sea lion non-pups from the Western stock occur in Southeast Alaska, east of the stock boundary (O'Corry-Crowe et al. 2006; Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Hastings et al. 2020). Hastings et al. (2020) reported 7-8% of non-pups that occurred in Southeast Alaska in the summer were born in the Western stock area. They principally occurred in the north outer coast (identified as population mixing zone "F," Table 1; Fig. 2) and Glacier Bay (G), and at lower proportions in Lynn Canal (H), Frederick Sound (E), and the Central Outer Coast (D). Using the Hastings et al. (2020) proportions for Western stock non-pups in Southeast Alaska allows for apportionment of modeled counts to the corresponding stock by adjusting the minimum population estimate (N_{MIN}) to help account for movement between stocks.

AgTrend modeled non-pup predicted counts by site were aggregated into the population mixing zones, and the Western stock proportion was applied to calculate the number of Western stock non-pups in Southeast Alaska (Table 1; Hastings et al. 2020). This total number of Western stock non-pups in Southeast Alaska was subtracted from the total Eastern stock count of pups and non-pups. As discussed above, the current population size (N) is unknown as there is no method for deriving abundance estimates from agTrend modeled counts and modeled counts are considered "minimum" estimates of population size. Pup counts are considered a census (i.e., total pup production) however, these counts do not account for pups that are born, or die, after the surveys.

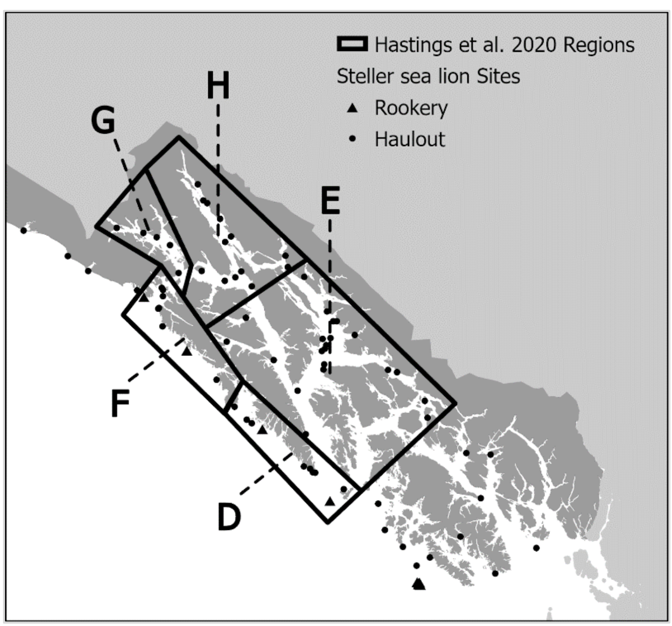

Figure 2. Hastings et al. (2020) mixing zones where non-pups born in the western stock area were reported to inhabit in different proportions, with most in the North Outer Coast (F) and Glacier Bay (G), and at lower proportions in Lynn Canal (H), Frederick Sound (E), and the Central Outer Coast (D) (Table 1).

As the most recent counts from Canada are almost a decade old and analyses have not been conducted to adjust the counts to account for potential abundance changes that may have occurred since the 2013 survey (NMFS 2023), we report only the N_{MIN} estimate for the U.S. portion of the Eastern Steller sea lion stock (excluding Canada and Western stock non-pups): 36,308 (summing 26,158 non-pups and 10,667 pup, and subtracting 517 Western stock non-pups in the Eastern stock area).

Table 1. Steller sea lion non-pup apportionment to stock using the Hastings et al. (2020) proportions of Western stock non-pups in Southeast Alaska. Proportions were applied to agTrend modeled predicted counts to estimate the number of western- and eastern-born non-pups in the Hastings et al. (2020) population mixing zones.

Southeast Alaska Area	Population Mixing Zone	Western Stock Non-Pup Proportion	Modeled Non-Pup Count	Western Stock Non-Pup Count	Eastern Stock Non-Pup Count
Central Outer Coast	D	0.022	3,131	69	3,062
Frederick Sound	E	0.012	1,850	22	1,828
North Outer Coast	F	0.082	3,826	314	3,512
Glacier Bay	G	0.073	1,423	104	1,319
Lynn Canal	H	0.014	578	8	570
Remaining Southeast Alaska	I, B, C	-	6,298	-	6,298
TOTAL			17,106	517	16,589

Current Population Trend

Using the updated agTrend model, count data from 1971 to 2022 were modeled to estimate annual trends from 1992 to 2022 (30-year period). The transboundary Eastern stock of Steller sea lion pups increased 5.08% per year (95% credible intervals of 4.30-6.08%) between 1992 and 2022 (Table 2, Figs. 3 and 4). Non-pups increased an estimated 3.54% per year during the same time period (95% credible intervals of 2.83-4.36%: Table 2). The Eastern stock increase has been driven by growth in pup counts in all regions, including the new rookery in Washington (NMFS 2013; NMFS unpubl. data; Stocking and Wiles 2021).

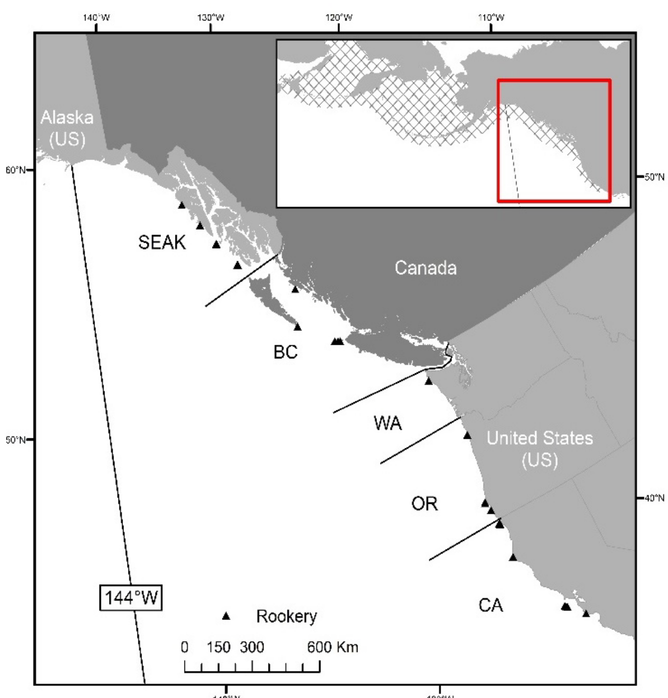

Figure 3. The Eastern Steller sea lion rookery sites by region: Southeast Alaska (SEAK), British Columbia, Canada (BC), Washington State (WA), Oregon State (OR), and California State (CA).

Table 2. Trends (annual rates of change expressed as % per year with 95% credible interval) of Eastern Steller sea lion non-pups (adults and juveniles) and pups, by region and total population (Johnson and Fritz 2014, Gaos et al. 2021, Sweeney et al. 2022). California, Oregon, Washington, and Southeast Alaska trends are for the 1992-2022 time period, British Columbia trends are for 1992-2013.

	Non-Pup				Pup		
Region	**Trend**	**-95%**	**+95%**		**Trend**	**-95%**	**+95%**
California, U.S.	1.66	0.55	2.68		2.94	2.39	3.55
Oregon, U.S.	1.61	0.78	2.41		3.79	3.31	4.25
Washington, U.S.*	5.69	3.99	7.36		16.17	5.58	26.78
British Columbia, Canada	4.93	4.07	5.83		8.03	7.23	8.82
Southeast Alaska, U.S.	2.08	1.56	2.60		2.51	2.27	2.76
Total Eastern Stock	3.54	2.83	4.36		5.08	4.30	6.08

* NMFS had not observed Steller sea lion pups born on known sites in Washington until a new rookery was established on the outer Washington coast (at the Carroll Island and Sea Lion Rock complex).

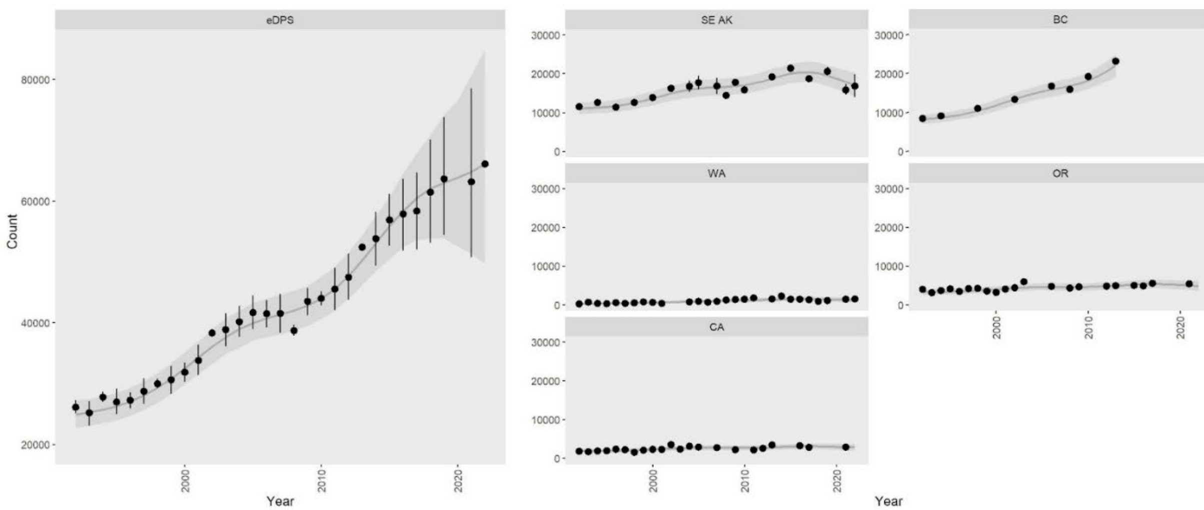

Figure 4. Estimated counts (modeled with agTrend) of Steller sea lion non-pups (adults and juveniles) for the Eastern stock and the five regions: Southeast Alaska (SEAK), British Columbia, Canada (BC), Washington (WA), Oregon (OR), and California (CA) for 1992-2022 (Gaos et al. 2021, Sweeney et al. 2021).

While the Eastern stock of Steller sea lions has been increasing in most regions from 1990 to 2022, the most significant continued growth has been observed in British Columbia, Canada (Fig. 4). The Southeast Alaska region was increasing from 1990 to 2017 but has appeared to level out since 2017. An abrupt decline of adult female Steller sea lion survival occurred in Southeast Alaska, Prince William Sound, and Chiswell Island during and following the severe North Pacific marine heatwave of 2014-2017 (Hastings et al. 2023). Southeast Alaska and British Columbia comprise almost 87% of the total Eastern stock count. Non-pups in Oregon and Washington have been increasing since 1990, though at a lower rate. Non-pup counts in California ranged between 4,000 and 6,000 with no apparent trend from 1927 to 1947 and then subsequently declined. At Año Nuevo Island off central California, a steady decline in abundance began in 1970 and there was an 85% reduction in the breeding population by 1987 (Le Boeuf et al. 1991). Non-pup counts increased slightly from 1989 to 2022, ranging from approximately 2,000 to 3,200.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the maximum net productivity rate (R_{MAX}) for Steller sea lions. Until additional data become available, the maximum theoretical net productivity rate for pinnipeds of 12% will be used for this stock (NMFS 2023).

POTENTIAL BIOLOGICAL REMOVAL

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. On 4 December

2013, the Eastern DPS of Steller sea lions was removed from the list of threatened species under the Endangered Species Act (ESA; 78 FR 66140, 4 November 2013). NMFS' decision to delist this population was based on the information presented in the Status Review (NMFS 2013), the factors for delisting in section 4(a)(1) of the ESA, the biological and threats-based recovery criteria in the 2008 Recovery Plan (NMFS 2008), the continuing efforts to protect the species, and information received during public comment and peer review. NMFS' consideration of this information led to a determination that the Eastern DPS has recovered and no longer meets the definition of a threatened species under the ESA. As noted within the humpback whale ESA listing final rule (81 FR 62259, 8 September 2016), in the case of a species or stock that achieved its depleted status solely on the basis of its ESA status, such as the Eastern stock of Steller sea lions, the species or stock would cease to qualify as depleted under the terms of the definition set forth in Marine Mammal Protection Act (MMPA) Section 3(1) if the species or stock is no longer listed as threatened or endangered. Therefore, NMFS considers this stock not to be depleted and the recovery factor is 1.0 (recovery factor for a stock of unknown status that is known to be increasing). As discussed above, a range-wide count estimate is available, but the most recent counts from Canada are almost a decade old and analyses have not been conducted to adjust the counts to account for potential abundance changes that may have occurred since the 2013 survey, so only the N_{MIN} estimate for the U.S. portion of the Eastern Steller sea lion stock (excluding Canada and Western stock non-pups) is reported. Thus, we calculate PBR for only the U.S. portion of the Eastern stock. The PBR for the U.S. portion of the Eastern stock of Steller sea lions is 2,178 (36,308 × 0.06 × 1.0). Excluding Western stock non-pups reduced the PBR by 32 sea lions.

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 2017 and 2021 is listed, by marine mammal stock, in Freed et al. (2023); however, only the mortality and serious injury (M/SI) data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused M/SI for the U.S. portion of the Eastern Steller sea lion stock between 2017 and 2021 is 92.3 sea lions: 20.5 in U.S. commercial fisheries, 2.3 in Washington tribal treaty fisheries, 0.4 in Alaska subsistence fisheries, 0.2 in Southeast Alaska salmon hatchery pens, 15.1 in unknown (commercial, recreational, Washington tribal, or Alaska subsistence) fisheries, 15.6 in marine debris, 27.2 due to other causes (illegally shot, and euthanized under NMFS-authorized MMPA section 120(f) permit), and 11 in the Alaska Native subsistence harvest (from the 2005 to 2008 and 2012 data, which are the most recent data available). The number of human-caused mortalities and serious injuries of Eastern Steller sea lions in Canada is unknown. Additional potential threats most likely to result in direct human-caused mortality or serious injury of this stock include incidental take in unmonitored fisheries, unreported entanglement in marine debris, and disturbance at rookeries that could cause stampedes.

Fisheries Information

Commercial fisheries

Information for federally-managed and state-managed U.S. commercial fisheries is available in Appendix 3 of the Alaska Stock Assessment Reports (for fisheries in Alaska waters) and Appendix 1 of the U.S. Pacific Stock Assessment Reports (for fisheries in Washington, Oregon, and California waters) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2024).

Between 2017 and 2021, incidental mortality of an eastern Steller sea lion was observed in one of the federally-managed U.S. commercial fisheries in Alaska that are monitored for incidental M/SI by fisheries observers: the Gulf of Alaska sablefish longline fishery in 2017 (Table 3; Breiwick 2013; MML, unpubl. data). In addition, one mortality of an Eastern Steller sea lion was reported in this fishery via a Marine Mammal Authorization Program (MMAP) fisherman self-report in 2020. Because there were no observed mortalities or serious injuries of this stock in the Gulf of Alaska sablefish longline fishery in 2020, the MMAP-reported mortality is considered to be a minimum estimate for the stock in the fishery for 2020 (Table 4; Freed et al. 2023).

Mortality and serious injury of Eastern Steller sea lions was also observed or recorded via electronic monitoring in six of the federally-managed U.S. commercial fisheries monitored by U.S. West Coast groundfish fisheries observers in 2015-2019 (the most recent years for which bycatch estimates are available): the Washington/Oregon/California (WA/OR/CA) groundfish bottom trawl (catch shares), WA/OR/CA groundfish bottom and midwater trawl (catch shares with electronic monitoring), WA/OR/CA groundfish midwater trawl (at-sea hake catcher-processor sector), WA/OR/CA groundfish midwater trawl (at-sea hake mothership catcher vessel sector), WA/OR/CA sablefish hook and line (limited entry), and California halibut bottom trawl (open access) fisheries (Table 3; Jannot et al. 2022).

Table 3. Summary of incidental M/SI of Eastern stock Steller sea lions due to observed or electronically monitored U.S. commercial fisheries between 2017 and 2021 (or the most recent data available) and calculation of the mean annual M/SI rate for Alaska fisheries (Breiwick 2013; MML, unpubl. data) and WA/OR/CA fisheries (Jannot et al. 2022).

Fishery name	Years	Data type	Percent observer coverage	Observed M/SI	Estimated M/SI	Mean estimated annual M/SI
Gulf of Alaska sablefish longline	2017 2018 2019 2020 2021	obs data	10 9 12 7 11	1 0 0 0 0	15 0 0 0 0	3.0 (CV = 0.97)
WA/OR/CA groundfish (bottom trawl - catch shares)	2015 2016 2017 2018 2019	obs data	100 100 100 100 100	8[a] 0 1[a] 0[a] 0	8[a] 0 1[a] 0[a] 0	1.8
WA/OR/CA groundfish (bottom and midwater trawl – catch shares with electronic monitoring)	2015 2016 2017 2018 2019	electronic monitoring data	100 100 100 100 100	0 0 1 0[a] 1	0 0 1 0[a] 1	0.4
WA/OR/CA groundfish (midwater trawl - at-sea hake catcher-processor sector)	2015 2016 2017 2018 2019	obs data	100 100 100 100 100	0 21 1 4 0	0 21 1 4 0	5.2
WA/OR/CA groundfish (midwater trawl - at-sea hake mothership catcher vessel sector)	2015 2016 2017 2018 2019	obs data	100 100 100 100 99	0 2 8 8 0	0 2 8 8 0	3.6
WA/OR/CA sablefish (hook and line - limited entry)	2015 2016 2017 2018 2019	obs data	42 33 37 46 39	0 2 0 0 0	0.2 2.3 0.4 0.3 0.3	0.7 (CV = 0.37)
California halibut (bottom trawl - open access)	2015 2016 2017 2018 2019	obs data	33 31 26 26 27	3 3 1 0[b] 4	6.8 6.8 5.2 0 9.4	5.6 (CV = 0.17)
Minimum total estimated annual mortality						20.3 (CV = 0.15)

[a]Jannot et al. (2022) misreport this value; the value in this table is correct.
[b]Following publication of Jannot et al.(2022), genetic species identification confirmed that the observed mortality in this fishery in 2018 was a California sea lion, not a Steller sea lion.

Commercial fishery-related serious injuries averted (i.e., human intervention or self-release lessened the severity of the initial serious injury, leaving the animal with only non-serious or no injuries) and non-serious injuries are not included in the total estimate of annual human-caused M/SI that is compared to PBR, but are used to develop the LOF under Section 118 of the MMPA and inform management (e.g., take reduction planning and negligible impact determinations). No serious injuries were averted in U.S. commercial fishery interactions between 2017 and 2021. Additionally, there were no U.S. commercial fisheries with only non-serious injuries of Eastern Steller sea lions between 2017 and 2021.

The minimum estimated mean annual M/SI rate incidental to U.S. commercial fisheries between 2017 and 2021 is 20.5 Eastern Steller sea lions, based on observer, electronic monitoring, and MMAP data (Tables 3 and 4). Due to limited observer program coverage, no data exist on the mortality of marine mammals incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to take Steller sea lions). As a result, the number of Steller sea lions taken in Canadian waters is not known.

Non-commercial, tribal, and unknown fisheries

Entanglement in marine debris and interactions with fisheries are a contributing factor in Steller sea lion injury and mortality (Allyn and Scordino 2020, Raum-Suryan and Suryan 2022). Reports to the NMFS West Coast Region and Alaska Region stranding networks and the Alaska Department of Fish and Game (ADF&G) of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear provide additional information on fishery-related M/SI (Table 4; Freed et al. 2023). In addition, NMFS receives reports from the Northwest Indian Fisheries Commission of Steller sea lions taken in association with Washington tribal treaty fisheries (Table 4; NWIFC unpubl. data, Freed et al. 2023).

The minimum mean annual M/SI rate due to all non-commercial, tribal, and unknown fishery interactions reported between 2017 and 2021 is 16.8 eastern Steller sea lions: 2.3 in association with Washington tribal treaty fisheries + 0.4 in Alaska subsistence fisheries + 0.2 in the Southeast Alaska salmon hatchery pens + 15.1 in unknown (commercial, recreational, Washington tribal, or Alaska subsistence) fisheries (Table 4; Freed et al. 2023). These M/SI estimates 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.

An additional two Steller sea lions in the Eastern and Western stock mixing area of Southeast Alaska that were initially considered seriously injured due to hooking by unknown salmon hook and line gear (one in 2017 and one in 2018) were disentangled and released, or were presumed to have self-released, with non-serious injuries (Freed et al. 2023). None of these serious injuries averted were included in the average annual M/SI rate for 2017 to 2021.

Table 4. Summary of Eastern stock Steller sea lion M/SI in U.S. waters, by year and type, reported to the NMFS Alaska Region marine mammal stranding network, Northwest Indian Fisheries Commission, and ADF&G, and by fishermen self-reports, between 2017 and 2021 (Freed et al. 2023). Sea lions euthanized in response to their predation on endangered salmon and steelhead stocks in the Columbia River under an MMPA section 120(f) permit are also included in this table. In areas of Southeast Alaska where the Western (wSSL) and Eastern (eSSL) populations mix, the mean annual mortality of both stocks (wSSL + eSSL) was multiplied by the mixing zone-specific proportion of Western stock non-pups (Table 1; Hastings et al. 2020) and subtracted from the total to produce estimates for the Eastern stock (eSSL only).

Cause of injury					**2017**	**2018**	**2019**	**2020**	**2021**	**Mean annual M/SI**	
										wSSL + eSSL	eSSL only
Southeast Alaska – Mixing Zone D											
Hooked by Alaska subsistence halibut longline gear					0	0	0	0	1	0.2	0.2
Hooked by salmon hook and line gear*					4	0	1	1	3	1.8	1.8
Hooked by unknown hook and line gear*					0	1	0	0	0	0.2	0.2
Entangled in Southeast Alaska salmon hatchery pen					0	0	0	1	0	0.2	0.2
Entangled in unknown fishery gear*					0	0	1	0	0	0.2	0.2
Entangled in marine debris					3	3	2	0	0	1.6	1.6
Illegally shot					0	0	1	0	0	0.2	0.2
Southeast Alaska – Mixing Zone E											
Hooked by halibut hook and line gear*					0	1	0	0	0	0.2	0.2
Hooked by salmon hook and line gear*					4	0	1	0	0	1.0	1.0
Entangled in marine debris					3	2	1	0	0	1.2	1.2
Southeast Alaska – Mixing Zone F											
Hooked or entangled by salmon hook and line gear*					8	8	4	0	6	5.2	4.8
Hooked by unknown hook and line gear*					2	1	2	0	0	1.0	0.9
Entangled in unknown fishery gear*					0	0	0	1	0	0.2	0.2
Entangled in marine debris					2	8	1	0	3	2.8	2.6
Dependent pup of animal seriously injured by marine debris					0	1	0	0	0	0.2	0.2
Southeast Alaska – Mixing Zone G											
Hooked by salmon hook and line gear*					1	1	2	0	0	0.8	0.7
Entangled in marine debris					3	3	0	0	0	1.2	1.1

Southeast Alaska – Mixing Zone H											
Hooked by salmon hook and line gear*					3	0	1	1	1	1.2	1.2
Entangled in marine debris					3	2	1	0	1	1.4	1.4
All Other Areas in Eastern Stock Range											
Hooked by AK Gulf of Alaska sablefish longline gear					0	0	0	1[a]	0	-	0.2
Hooked by Alaska subsistence halibut longline gear					1	0	0	0	0	-	0.2
Hooked by salmon hook and line gear*					5	1	2	1	3	-	2.4
Washington tribal treaty salmon hook and line fishery[b]							0	5	0	-	1.7[c]
Washington tribal treaty salmon set gillnet fishery[b]							1	0	0	-	0.3[c]
Washington tribal treaty sablefish longline fishery[b]							1	0	0	-	0.3[c]
Hooked by unknown hook and line gear*					0	1	1	0	1	-	0.6
Entangled in unknown trawl gear*					1	0	0	0	0	-	0.2
Entangled in unidentified fishing gear*					0	1	3	0	0	-	0.8
Entangled in marine debris					15	11	8	0	2	-	7.2
Dependent pup of animal seriously injured by marine debris					0	2	0	0	0	-	0.4
Illegally shot					1	2	8	9	5	-	5.0
Euthanized under NMFS-authorized MMPA section 120(f) permit								6	38	-	22[d]
Total in commercial fisheries											0.2
Total in Washington tribal fisheries											2.3
Total in Alaska subsistence fisheries											0.4
Total in Southeast Alaska salmon hatchery pen											0.2
*Total in unknown (commercial, recreational, Washington tribal, or Alaska subsistence) fisheries											15.1
Total in marine debris (including dependent pup(s) of animal(s) seriously injured or killed by marine debris)											15.6
Total due to other sources (illegally shot, euthanized under NMFS-authorized MMPA section 120(f) permit)											27.2

[a] Marine Mammal Authorization Program (MMAP) fisherman self report.

[b] Interactions reported by the NWIFC lack details on whether each interaction involved bycatch or lethal removal to prevent interference with fishing gear and/or catch. For purposes of this stock assessment report, these animals are considered to have been incidentally killed in association with Washington tribal treaty fishing operations.

[c] A 3-year average (using 2019-2021 data) was calculated for this category because data were not received from the NWIFC in 2017-2018.

[d] A 2-year average (using 2020-2021 data) was calculated for this category because intentional lethal take of eastern Steller sea lions on the waters of the Columbia River and its tributaries under MMPA Section 120(f) was not authorized prior to 2020.

All fisheries

In summary, the minimum estimated mean annual M/SI rate incidental to all fisheries in U.S. waters between 2017 and 2021 is 38.5 Eastern stock Steller sea lions: 20.5 in U.S. commercial fisheries + 2.3 in Washington tribal treaty fisheries + 0.4 in Alaska subsistence fisheries + 0.2 in Southeast Alaska salmon hatchery pens + 15.1 in unknown (commercial, recreational, Washington tribal, or Alaska subsistence) fisheries.

Alaska Native Subsistence/Harvest Information

Information on the subsistence harvest of Steller sea lions is provided by the ADF&G. The ADF&G conducted systematic interviews with hunters and users of marine mammals in approximately 2,100 households in about 60 coastal communities within the geographic range of the Steller sea lion in Alaska in 2005-2008 (Wolfe et al. 2006, 2008, 2009a, 2009b). The interviews were conducted once per year in the winter (January to March) and covered hunter activities for the previous calendar year. Approximately 16 of the interviewed communities lie within the range of the Eastern stock. As of 2009, annual statewide data on community subsistence harvests are no longer being consistently collected. Data are being collected periodically in subareas. Between 2010 and 2017, monitoring occurred only in 2012 (Wolfe et al. 2013), when one animal was landed and eight animals were struck and lost. Therefore, the most recent 5 years of data (2005 to 2008 and 2012) will be used for calculating an annual M/SI estimate. The average number of animals harvested plus struck and lost is 11 animals per year during this 5-year period (Table 5). Since the cessation of ADF&G monitoring, there is an incomplete understanding of harvest levels statewide.

An unknown number of Steller sea lions from this stock are harvested by subsistence hunters in Canada. The magnitude of the Canadian subsistence harvest is believed to be small (Fisheries and Oceans Canada 2010). Alaska Native subsistence hunters have initiated discussions with Canadian hunters to quantify their respective subsistence harvests, and to identify any effect these harvests may have on management of the stock.

Table 5. Summary of the Alaska Native subsistence harvest data for Eastern stock Steller sea lions from 2005 to 2008 and in 2012. As of 2009, data on community subsistence harvests are no longer being consistently collected at a statewide level. Therefore, the most recent 5 years of data (2005 to 2008 and 2012) will be used for calculating an annual M/SI estimate.

Year	Number harvested	Number struck and lost	Estimated total number taken
2005	0	19	19[a]
2006	2.5	10.1	12.6[b]
2007	0	6.1	6.1[c]
2008	1.7	8.0	9.7[d]
2012	1	8	9[e]
Mean annual take (2005-2008 and 2012)	1.0	10	11

[a]Wolfe et al. (2006); [b]Wolfe et al. (2008); [c]Wolfe et al. (2009a); [d]Wolfe et al. (2009b); [e]Wolfe et al. (2013).

Other Mortality

Steller sea lions were killed in British Columbia during commercial salmon farming operations. Preliminary figures from the British Columbia Aquaculture Predator Control Program indicated a mean annual mortality of 45.8 Steller sea lions from the Eastern stock from 1999 to 2003 (Olesiuk 2004). Starting in 2004, aquaculture facilities were no longer permitted to shoot Steller sea lions (P. Olesiuk, Pacific Biological Station, BC, Canada, pers. comm.). However, Fisheries and Oceans Canada (2010) summarized that "illegal and undocumented killing of Steller Sea Lions is likely to occur in B.C." and reported "[s]everal cases of illegal kills have been documented (Fisheries and Oceans Canada, unpubl. data), and mortality may also occur outside of the legal parameters assigned to permit holders (e.g., for predator control or subsistence harvest)" but "…data on these activities are currently lacking."

Illegal shooting of Steller sea lions in U.S. waters was thought to be a potentially significant source of mortality prior to the listing of Steller sea lions as threatened under the ESA in 1990. Steller sea lion M/SI caused by gunshot wounds is reported to the NMFS Alaska Region and the NMFS West Coast Region stranding networks. Between 2017 and 2021, 26 animals with gunshot wounds within the range of the Eastern stock (including one in the population mixing zone in Southeast Alaska) were reported to the NMFS West Coast Region and Alaska Region stranding networks, resulting in a minimum mean annual M/SI rate of 5.2 Eastern Steller sea lions illegally shot from this stock (Table 4; Freed et al. 2023). The Steller sea lions reported to the NMFS Alaska Region stranding network were considered to be illegal shootings, not animals that were struck and lost during Alaska Native subsistence hunting.

Other non-fishery human-caused M/SI of Steller sea lions reported to the NMFS Alaska Region stranding network between 2017 and 2021 (and the resulting minimum mean annual M/SI rates) were due to entanglement in marine debris (15), dependent pups of animals seriously injured by marine debris (0.6), and euthanized (22) in response to their predation on endangered salmon and steelhead stocks in the Columbia River as authorized under a NMFS MMPA section 120(f) permit (Table 4; Freed et al. 2023). These estimates result from an actual count of verified human-caused deaths and serious injuries and are minimums because not all animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined (via necropsy by trained personnel), and human-related stranding data are not available for British Columbia.

An additional six Steller sea lions in the Eastern and Western stock mixing area of Southeast Alaska that were initially considered seriously injured in marine debris (four in 2017, one in 2018, and one in 2019) were disentangled and released, or were presumed to have self-released, with non-serious injuries (Freed et al. 2023). None of these serious injuries averted were included in the average annual M/SI rate for 2017 to 2021.

STATUS OF STOCK

Based on currently available data, the minimum estimated mean annual U.S. commercial fishery-related M/SI rate for this stock (20.5 sea lions) is less than 10% of the U.S. PBR (10% of PBR = 218) and, therefore, can be considered to be insignificant and approaching a zero M/SI rate. For the U.S. portion of the Eastern stock, the minimum estimated mean annual level of U.S. human-caused M/SI (92.3 sea lions) does not exceed the U.S. PBR (2,178) for this stock. The Eastern stock of Steller sea lions is not listed under the ESA and is not considered depleted under the MMPA. This stock is not classified as strategic. Because the counts of Eastern stock Steller sea lions have steadily increased over a 30+ year period, this stock is likely within its Optimum Sustainable Population (OSP); however, no determination of its status relative to OSP has been made.

There are key uncertainties in the assessment of the Eastern stock of Steller sea lions. The population is based on counts of visible animals; the calculated N_{MIN} and PBR levels, reported only for the U.S. portion of the stock, are conservative because there are no data available to correct for animals not visible during the visual surveys. Information on human-caused M/SI is currently only available for the U.S. portion of the stock's range. There are multiple nearshore commercial fisheries operating within the stock's range that are not observed; thus, there is likely to be unreported fishery-related M/SI of Steller sea lions. Estimates of human-caused M/SI from stranding data are negatively biased because not all animals strand nor are all stranded animals found, reported, or have the cause of death determined.

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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).

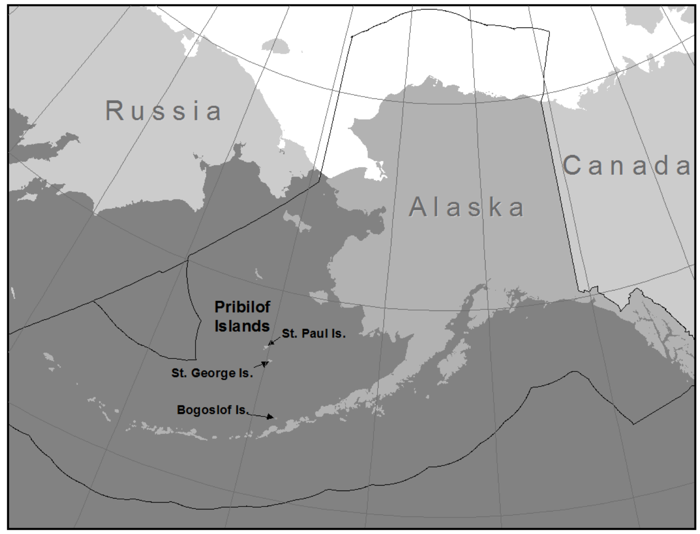

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area). Eastern Pacific northern fur seal breeding colonies in U.S. waters are located on the three named islands. The U.S. Exclusive Economic Zone is delineated by a black line.

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, Loughlin et al. 1994). 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 626,618 northern fur seals (4.47 × 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)	138,609 (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 626,618 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock is 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. Since the first pups were observed on Bogoslof Island in 1980, pup production 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. Recent (20-year and 10-year) trends in pup production were fit using agTrend (Johnson and Fritz 2014). Estimated pup production for the Eastern Pacific stock has been declining at 1.80% (95% CI: -2.36 to -1.19) per year from 1999 to 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).

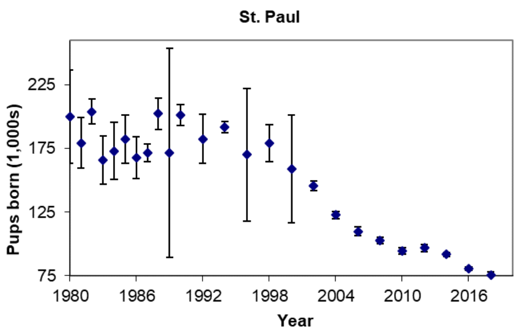

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, 1980-2018.

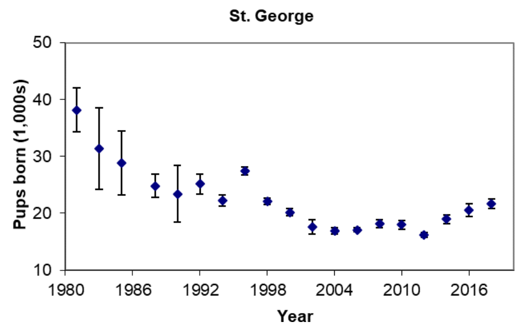

Figure 3. Estimated number of northern fur seal pups born on St. George Island, 1980-2018.

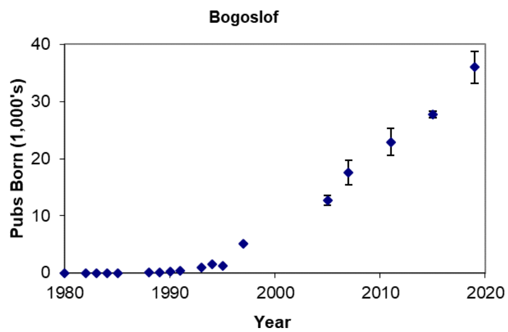

Figure 4. Estimated number of northern fur seal pups born on Bogoslof Island, 1980-2019.

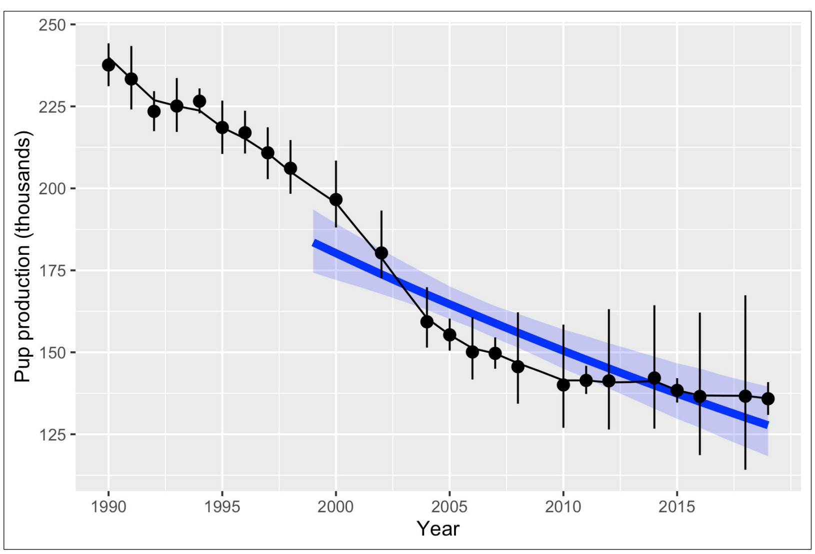

Figure 5. Estimated pup production for the Eastern Pacific stock, 1990-2019, from agTrend (dots), 95% credible interval (bars), agTrend temporal interpolation fit (black line), 1999-2019 average decline (blue line; 1.8%), and 95% credible interval for the fitted average decline in each year (light blue shading).

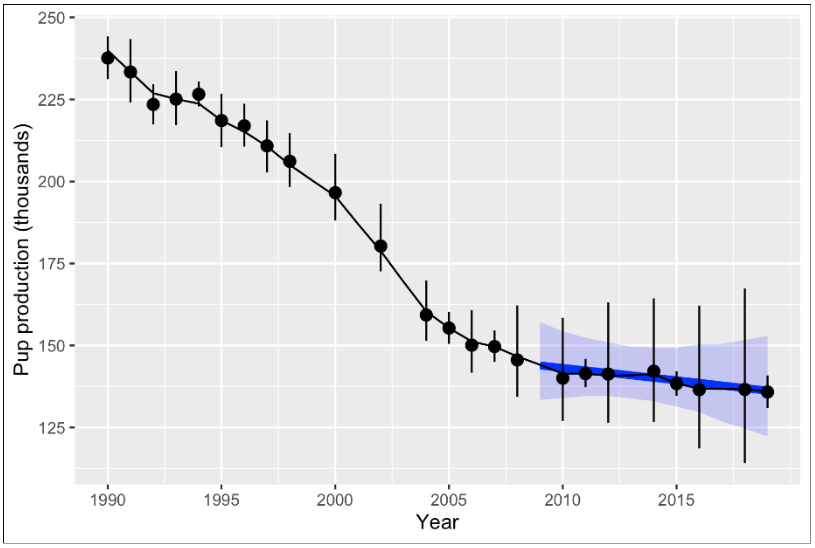

Figure 6. Estimated pup production for the Eastern Pacific stock, 1990-2019, from agTrend (dots), 95% credible interval (bars), agTrend temporal interpolation fit (black line), 2009-2019 average decline (blue line; 0.55%), and 95% credible interval for the fitted average decline in each year (light blue 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 11,403 northern fur seals (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 2015 and 2019 is listed, by marine mammal stock, in Freed et al. (2021); 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 2015 and 2019 is 373 northern fur seals: 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 in marine debris, 0.4 due to other causes (car strike, dog attack), and 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 2015 and 2019 (see details in the text and in Freed et al. 2021). 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 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 2015 and 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 2015 and 2019 is 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 2015 and 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	2015	obs data	100	0	0	2.7 (CV = 0.04)
	2016		99	0	0	
	2017		100	1	1 (0.03)	
	2018		100	2	2 (0.03)	
	2019		100	10	10 (0.05)	
Minimum total estimated annual mortality						2.7 (CV = 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 2015 and 2019 is provided in Table 3 (Freed et al. 2021). 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. 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 2015 and 2019, resulting in a minimum mean annual mortality and serious injury rate of 0.8 northern fur seals in commercial trawl fisheries (Table 3; Freed et al. 2021).

In addition, 16 northern fur seals initially considered to be seriously injured due to entanglement in commercial Bering Sea/Aleutian Islands trawl gear (1 in 2015 and 3 in 2016), unidentified trawl gear (9 in 2019), unidentified net (1 each in 2016 and 2017), and unidentified hook and line gear (1 in 2019) were disentangled and released with non-serious injuries (Freed et al. 2021); therefore, they were not included in the mean annual mortality and serious injury rate for 2015 to 2019.

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

The minimum mean annual mortality and serious injury rate due to entanglements in Bering Sea/Aleutian Islands gillnet (0.2), Bering Sea/Aleutian Islands unidentified fishing gear (0.2), trawl gear (1.2), and hook and line gear (0.2) in Alaska waters between 2015 and 2019 totaled 1.8 northern fur seals (Table 3; Freed et al. 2021). 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 (as noted in Table 3). Reports to the NMFS West Coast Region marine mammal stranding network between 2015 and 2019 resulted in a minimum mean annual mortality and serious injury rate of 0.6 northern fur seals entangled in trawl gear 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; Freed et al. 2021). 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 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 2015 and 2019 (Freed et al. 2021). Animals that were disentangled and released with non-serious injuries have been excluded from this table.

Cause of injury	2015	2016	2017	2018	2019	Mean annual mortality
Entangled in commercial Bering Sea/Aleutian Is. trawl gear	1	1	1	1	0	0.8
Entangled in Bering Sea/Aleutian Is. gillnet gear*	1	0	0	0	0	0.2
Entangled in Bering Sea/Aleutian Is. unidentified fishing gear*	1	0	0	0	0	0.2
Entangled in trawl gear*	0	0	3[a]	0	6	1.2 + 0.6[a]
Entangled in hook and line gear*	0	0	0	0	1	0.2
Entangled in marine debris	0	9	13	6	7	7
Struck by car	1	0	0	0	0	0.2
Dog attack	0	1[a]	0	0	0	0.2[a]
Total in commercial fisheries						0.8
*Total in unknown (commercial, recreational, or subsistence) fisheries						1.8 + 0.6[a]
Total in marine debris						7
Total due to other causes (car strike, dog attack)						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 2021). Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, based on the regulations in 50 CFR 216, subpart F. The regulations authorize the taking of juvenile males for subsistence uses, which results in a much smaller impact on population growth than a harvest that includes females. However, accidental mortality of females does occur during subsistence activities and is authorized in the new regulations. The accidental mortality of female northern fur seals between 2015 and 2019 included seven females on St. Paul Island: two in 2015 (Lestenkof et al. 2015), one 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 in 2014 and on St. Paul Island in 2019. The harvest of male pups between

2015 and 2019 included 57 pups on St. George Island in 2015 (Meyer 2016), 46 in 2016 (Meyer 2017), 51 in 2017 (Meyer 2018), 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 2015 and 2019, the average annual subsistence harvest of northern fur seals on the Pribilof Islands was 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 2015 and 2019.

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

[a]Lestenkof et al. (2015); [b]Kashevarof (2016); [c]Meyer (2016); [d]Melovidov et al. (2017a); [e]Testa (2018); [f]Meyer (2017); [g]Melovidov et al. (2017b); [h]Lekanof (2017); [i]Meyer (2018); [j]Lestenkof et al. (2019); [k]Malavansky (2019a); [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 2015 and 2019 resulted in mean annual mortality and serious injury rates of 7 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 due to a dog attack in California (assigned to both stocks) (Table 3; Freed et al. 2021). 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 (6 in 2015, 6 in 2016, 4 in 2017, 9 in 2018 (including one assigned to both stocks), and 4 in 2019) were disentangled and released with non-serious injuries (Freed et al. 2021); therefore, these animals were not included in the mean annual mortality and serious injury rate for 2015 to 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 (3.5 northern fur seals) is less than 10% of the calculated PBR (10% of PBR = 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 (373 northern fur seals) does not exceed the PBR (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. 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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HARBOR SEAL (*Phoca vitulina richardii*)

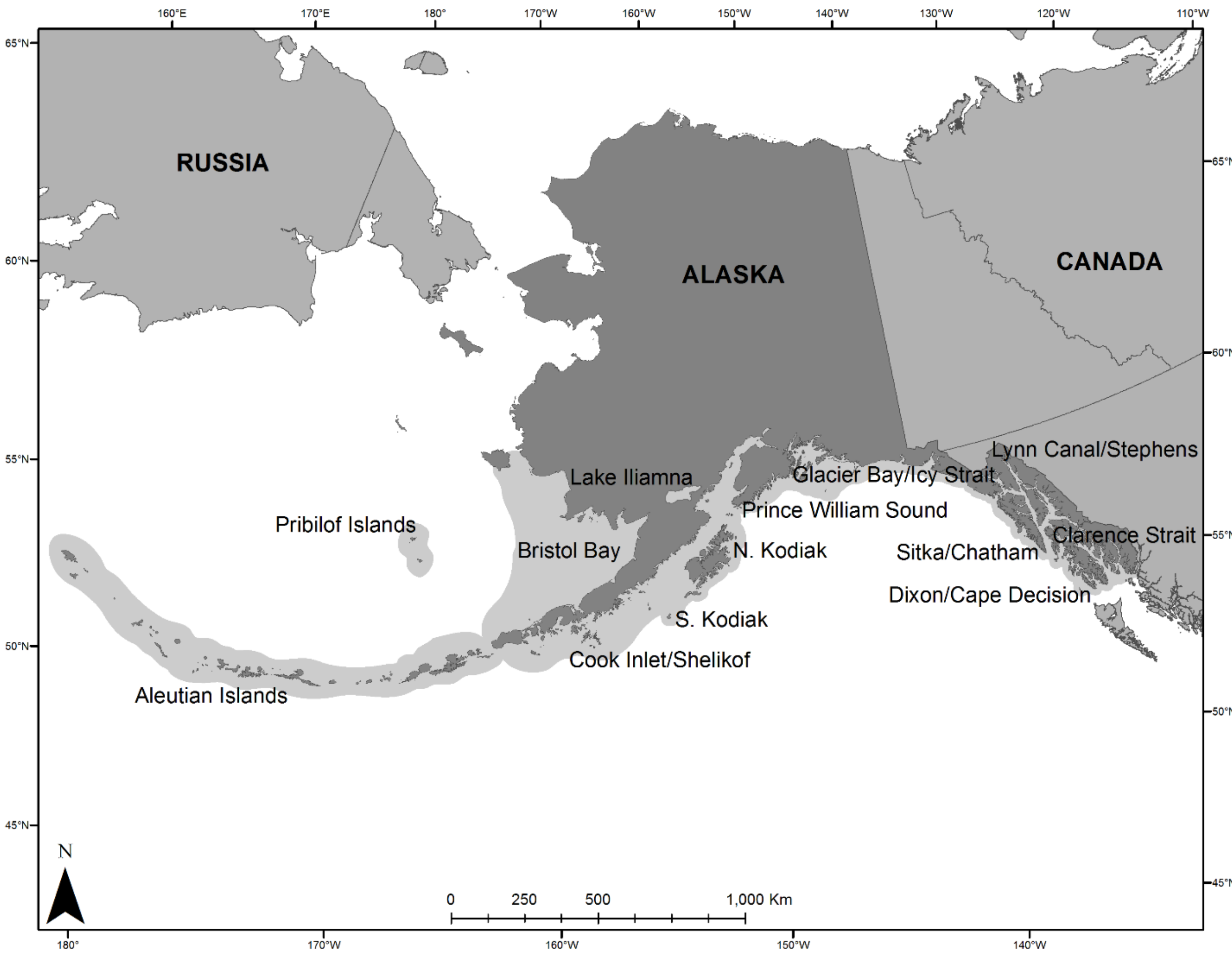

Figure 1. Approximate extent of harbor seals in Alaska waters (shaded coastline area).

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944; Fisher 1952; Bigg 1969, 1981; Hastings et al. 2004). The results of past and recent satellite-tagging studies in Southeast Alaska, Prince William Sound, Kodiak Island, and Cook Inlet are also consistent with the conclusion that harbor seals are non-migratory (Swain et al. 1996, Lowry et al. 2001, Small et al. 2003, Boveng et al. 2012). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Lowry et al. 2001, Small et al. 2003, Womble 2012, Womble and Gende 2013). Strong fidelity of individuals for haul-out sites during the breeding season has been documented in several populations (Härkönen and Harding 2001), including some regions in Alaska such as Kodiak Island, Prince William Sound, Glacier Bay/Icy Strait, and Cook Inlet (Pitcher and McAllister 1981, Small et al. 2005, Boveng et al. 2012, Womble 2012, Womble and Gende 2013).

Westlake and O'Corry-Crowe's (2002) analysis of genetic information from 881 samples across 181 sites revealed population subdivisions on a scale of 600-820 km. These results suggest that genetic differences within

Alaska, and most likely over their entire North Pacific range, increase with increasing geographic distance. New information revealed substantial genetic differences indicating that female dispersal occurs at region specific spatial scales of 150-540 km. This research identified 12 demographically independent clusters within the range of Alaska harbor seals; however, significant geographic areas within the Alaska harbor seal range remain unsampled (O'Corry-Crowe et al. 2003).

In 2010, NMFS and their co-management partners, the Alaska Native Harbor Seal Commission, identified 12 separate stocks of harbor seals based largely on genetic structure; this represented a significant increase in the number of harbor seal stocks from the three stocks (Bering Sea, Gulf of Alaska, Southeast Alaska) previously recognized. Given the genetic samples were not obtained continuously throughout the range, a total evidence approach was used to consider additional factors such as population trends, observed harbor seal movements, and traditional Alaska Native use areas in the final designation of stock boundaries. The 12 stocks of harbor seals currently identified in Alaska are 1) the Aleutian Islands stock – occurring along the entire Aleutian chain from Attu Island to Ugamak Island; 2) the Pribilof Islands stock – occurring on Saint Paul and Saint George Islands, as well as on Otter and Walrus Islands; 3) the Bristol Bay stock – ranging from Nunivak Island south to the west coast of Unimak Island and extending inland to Kvichak Bay and Lake Iliamna; 4) the North Kodiak stock – ranging from approximately Middle Cape on the west coast of Kodiak Island northeast to West Amatuli Island and south to Marmot and Spruce Islands; 5) the South Kodiak stock – ranging from Middle Cape on the west coast of Kodiak Island southwest to Chirikof Island and east along the south coast of Kodiak Island to Spruce Island, including the Trinity Islands, Tugidak Island, Sitkinak Island, Sundstrom Island, Aiaktalik Island, Geese Islands, Two Headed Island, Sitkalidak Island, Ugak Island, and Long Island; 6) the Prince William Sound stock – ranging from Elizabeth Island off the southwest tip of the Kenai Peninsula to Cape Fairweather, including Prince William Sound, the Copper River Delta, Icy Bay, and Yakutat Bay; 7) the Cook Inlet/Shelikof Strait stock – ranging from the southwest tip of Unimak Island east along the southern coast of the Alaska Peninsula to Elizabeth Island off the southwest tip of the Kenai Peninsula, including Cook Inlet, Knik Arm, and Turnagain Arm; 8) the Glacier Bay/Icy Strait stock – ranging from Cape Fairweather southeast to Column Point, extending inland to Glacier Bay, Icy Strait, and from Hanus Reef south to Tenakee Inlet; 9) the Lynn Canal/Stephens Passage stock – ranging north along the east and north coast of Admiralty Island from the north end of Kupreanof Island through Lynn Canal, including Taku Inlet, Tracy Arm, and Endicott Arm; 10) the Sitka/Chatham Strait stock – ranging from Cape Bingham south to Cape Ommaney, extending inland to Table Bay on the west side of Kuiu Island and north through Chatham Strait to Cube Point off the west coast of Admiralty Island, and as far east as Cape Bendel on the northeast tip of Kupreanof Island; 11) the Dixon/Cape Decision stock – ranging from Cape Decision on the southeast side of Kuiu Island north to Point Barrie on Kupreanof Island and extending south from Port Protection to Cape Chacon along the west coast of Prince of Wales Island and west to Cape Muzon on Dall Island, including Coronation Island, Forrester Island, and all the islands off the west coast of Prince of Wales Island; and 12) the Clarence Strait stock – ranging along the east coast of Prince of Wales Island from Cape Chacon north through Clarence Strait to Point Baker and along the east coast of Mitkof and Kupreanof Islands north to Bay Point, including Ernest Sound, Behm Canal, and Pearse Canal (Fig. 1). Individual stock distributions can be seen in Figures 2a-l.

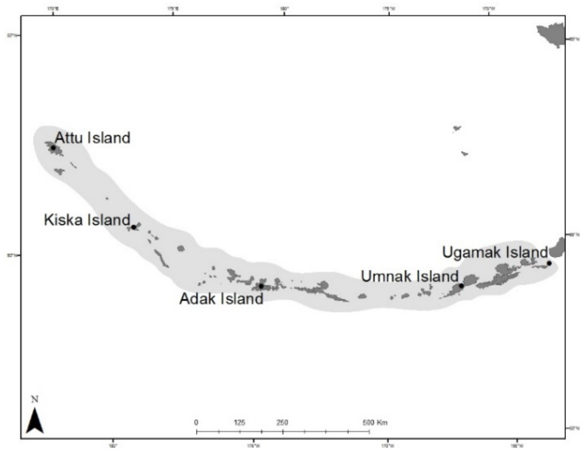

Figure 2a. Approximate extent of Aleutian Islands harbor seal stock (shaded area).

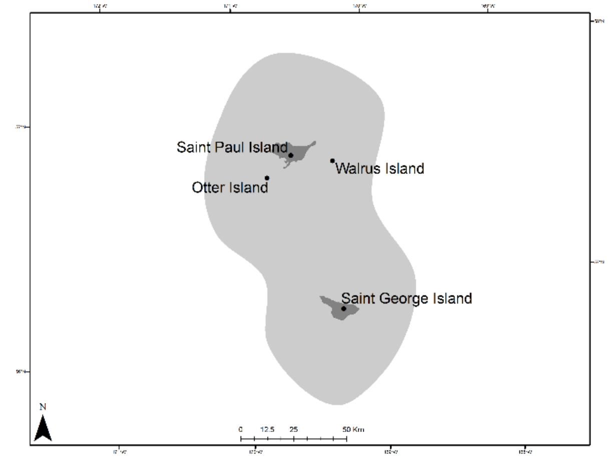

Figure 2b. Approximate extent of Pribilof Islands harbor seal stock (shaded area).

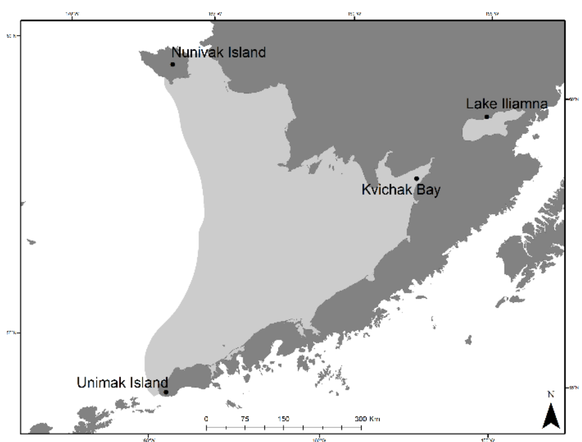

Figure 2c. Approximate extent of Bristol Bay harbor seal stock (shaded area).

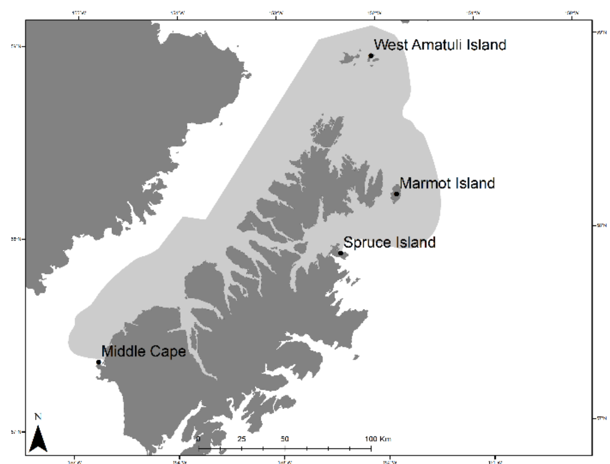

Figure 2d. Approximate extent of North Kodiak harbor seal stock (shaded area).

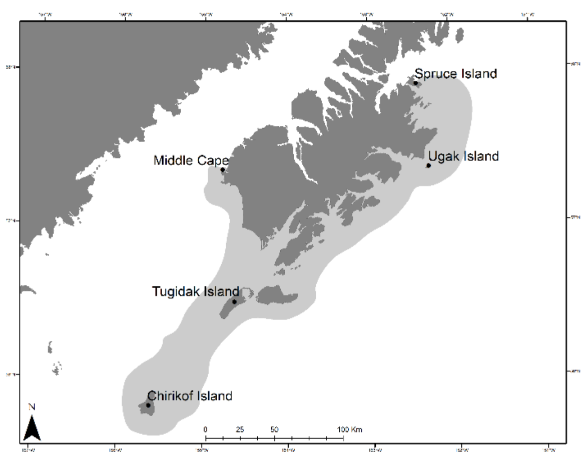

Figure 2e. Approximate extent of South Kodiak harbor seal stock (shaded area).

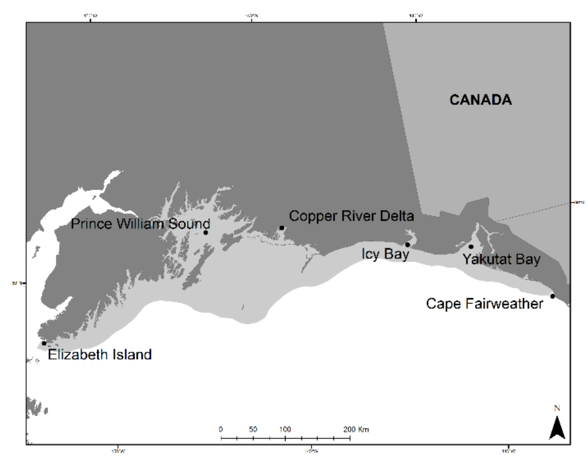

Figure 2f. Approximate extent of Prince William Sound harbor seal stock (shaded area).

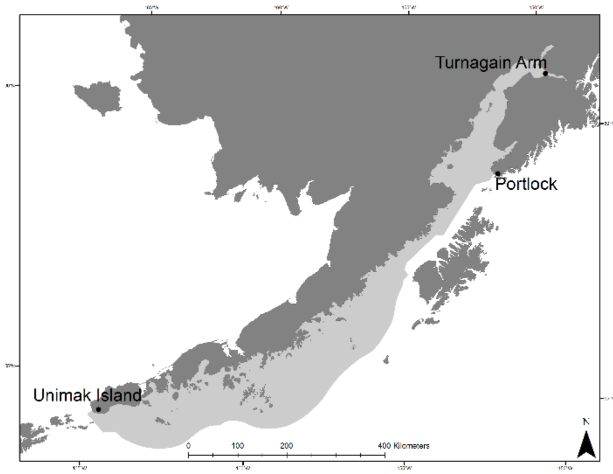

Figure 2g. Approximate extent of Cook Inlet/Shelikof Strait harbor seal stock (shaded area).

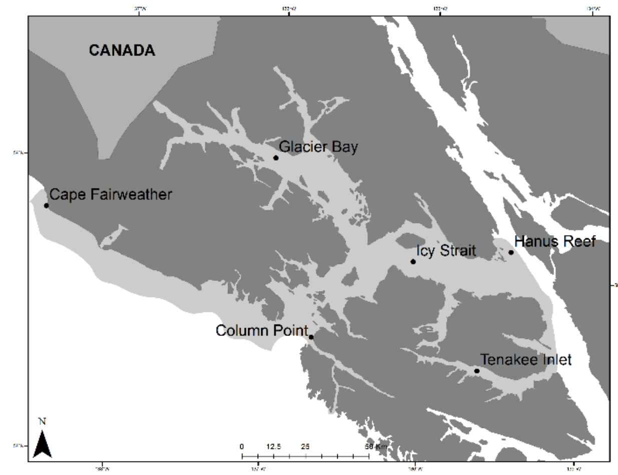

Figure 2h. Approximate extent of Glacier Bay/Icy Strait harbor seal stock (shaded area).

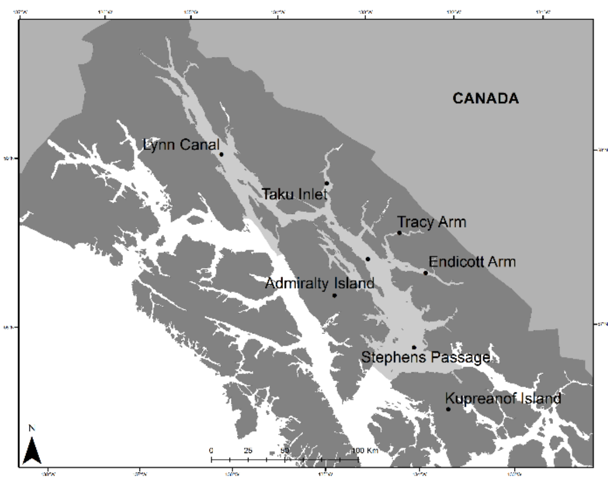

Figure 2i. Approximate extent of Lynn Canal/Stephens Passage harbor seal stock (shaded area).

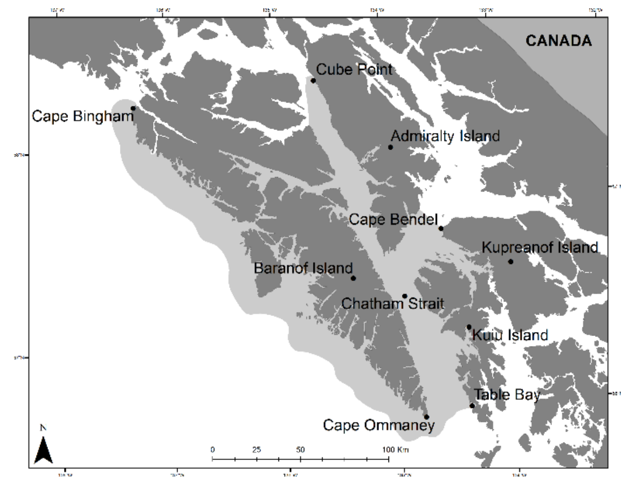

Figure 2j. Approximate extent of Sitka/Chatham Strait harbor seal stock (shaded area).

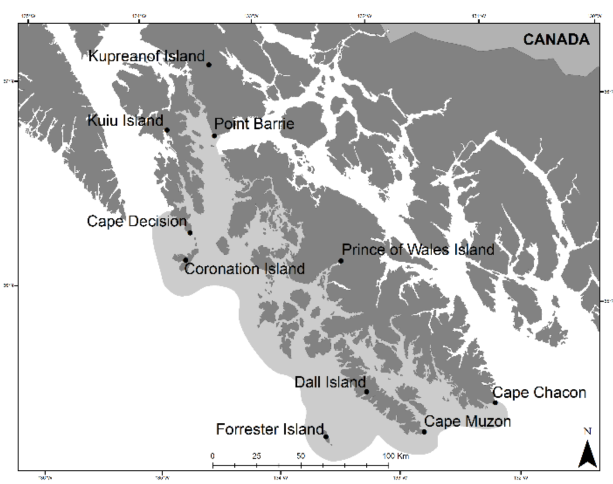

Figure 2k. Approximate extent of Dixon/Cape Decision harbor seal stock (shaded area).

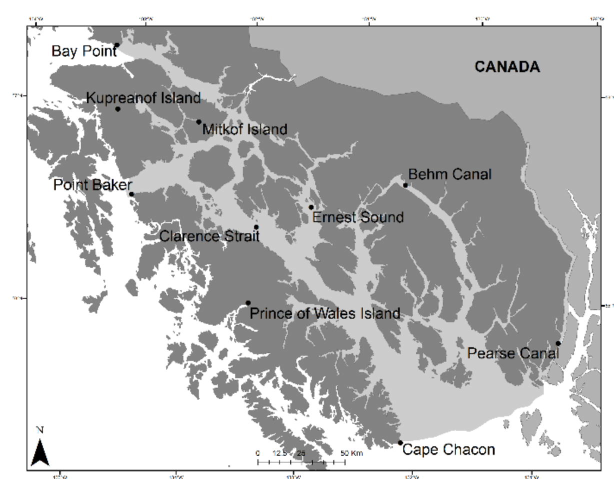

Figure 2l. Approximate extent of Clarence Strait harbor seal stock (shaded area).

POPULATION SIZE

Local or regional trends in harbor seal numbers have been monitored at various time intervals since the 1970s, revealing diverse spatial patterns in apparent population trends. Where declines have been observed, they seem, generally, to have been strongest in the late 1970s or early 1980s to the 1990s. For example, counts of harbor seals declined by about 80% at Tugidak Island in the 1970s and 1980s (Pitcher 1990), and numbers at Nanvak Bay in northern Bristol Bay also declined at about the same time (Jemison et al. 2006). In Prince William Sound, harbor seal numbers declined by about 63% overall between 1984 and 1997, including a 40% decline prior to the *Exxon Valdez* oil spill that occurred in 1989 (Frost et al. 1999, Ver Hoef and Frost 2003). Harbor seal counts in Glacier Bay National Park, where the majority of seals haul out on floating ice calved from glaciers, declined by roughly 60% between 1992 and 2001 and continued to decline through 2008 (Mathews and Pendleton 2006, Womble et al. 2010). At Aialik Bay, a site in Kenai Fjords National Park where harbor seals also haul out on ice calved from a glacier, harbor seal numbers declined by 93% from 1979 to 2009 (Hoover-Miller et al. 2011). In the Aleutian Islands, counts declined by 67% between the early 1980s and 1999, with declines of about 86% in the western Aleutians (Small et al. 2008). Although there is evidence for recent stabilization or even partial recovery of harbor seal numbers in some areas of long-term harbor seal decline, such as Tugidak Island and Nanvak Bay (Jemison et al. 2006), most have not made substantial recoveries toward historical abundances. These areas of localized declines in harbor seals contrast strongly with other large regions of Alaska where harbor seal numbers have remained stable or increased over the same period: trend monitoring regions around Ketchikan and the Kodiak area increased significantly in the 1980s and 1990s and regions around Sitka and Bristol Bay were stable (Small et al. 2003). Differences in trend across the various regions of Alaska suggest some level of independent population dynamics (O'Corry-Crowe et al. 2003, O'Corry-Crowe 2012).

The Alaska Fisheries Science Center's Marine Mammal Laboratory (MML) routinely conducts aerial surveys of harbor seals across their entire range in Alaska. Prior to 2008, Alaska was divided into five survey regions, with one region surveyed per year. In 2010, the survey sites were prioritized based on the newly defined harbor seal stock divisions, and annual aerial surveys attempt to sample the full geographic range of harbor seals in Alaska. These surveys focus, annually, on sites that make up a significant portion of each stock's population or have timely conservation interest. Sites with fewer seals are intended to be flown every 5 to 7 years. Reduced funding since 2015 has limited the scope of surveys, and efforts have been focused in regions of specific conservation interest (e.g., the Aleutian Islands).

Count data from surveys were analyzed with Bayesian hierarchical models, where true abundance per site per year was modeled with a Poisson distribution. Only a fraction of the animals could be observed, so counted seals were modeled with a binomial distribution, given the true number and a haul-out probability. The haul-out probability was modeled from bio-logging data on individual seals, using Bayesian beta regression, that accounted for date, time of day, and tide, which were also known for the counted data. The observed count data were thus adjusted for haul out by the hierarchical model. All models accounted for temporal autocorrelation, by site for count models and by seal for haul-out models, but the temporal autocorrelation parameters were pooled within stock. Models were fit with Markov chain Monte Carlo (MCMC) methods. Abundance estimates for sites were aggregated into estimates by stock, with variability in the estimates provided by the variation in the MCMC chains.

Abundance Estimates and Minimum Population Estimates

The current statewide abundance estimate for Alaska harbor seals is 243,938 (Boveng et al. 2019), based on aerial survey data collected from 1996 to 2018 (Boveng et al. 2019). See Table 1 for abundance estimates of the 12 stocks of harbor seals in Alaska. The minimum population estimate (N_{MIN}) for 11 of the 12 stocks of harbor seals in Alaska is calculated as the lower bound of the 80% credible interval obtained from the posterior distribution of abundance estimates. This approach is consistent with the definition of potential biological removal (PBR) in the current guidelines (NMFS 2016). The abundance estimate and N_{MIN} for the remaining stock, the Pribilof Islands stock, is simply the number counted in the most recent survey (2018) of this very small group.

Table 1. Abundance and 8-year trend (number of seals per year) estimates, by stock, for harbor seals in Alaska, along with respective estimates of standard error. The probability of decrease represents the proportion of the posterior probability distribution for the 8-year trend that fell below a value of 0 seals per year. N_{MIN} is the lower bound of the 80% credible interval obtained from the posterior distribution of the abundance estimates The Pribilof Islands stock abundance estimate (*) is simply the count of seals ashore during the survey and does not include a correction for seals in the water.

Stock	Year of last survey	Abundance estimate	SE	8-year trend estimate	SE	Probability of decrease	N_{MIN}
Aleutian Islands	2018	5,588	274	-131	86	0.932	5,366
Pribilof Islands	2018	229*	n/a	n/a	n/a	n/a	229
Bristol Bay	2017	44,781	7,278	1,127	1,196	0.218	38,254
North Kodiak	2017	8,677	1,335	53	236	0.409	7,609
South Kodiak	2017	26,448	5,282	1,234	1,062	0.076	22,351
Prince William Sound	2015	44,756	3,391	-200	555	0.648	41,776
Cook Inlet/Shelikof Strait	2018	28,411	1,839	-111	333	0.609	26,907
Glacier Bay/Icy Strait	2017	7,455	894	-216	147	0.904	6,680
Lynn Canal/Stephens Passage	2016	13,388	1,876	-114	262	0.73	11,867
Sitka/Chatham Strait	2015	13,289	1,734	71	277	0.41	11,883
Dixon/Cape Decision	2015	23,478	2,501	142	450	0.382	21,453
Clarence Strait	2015	27,659	3,030	138	485	0.413	24,854

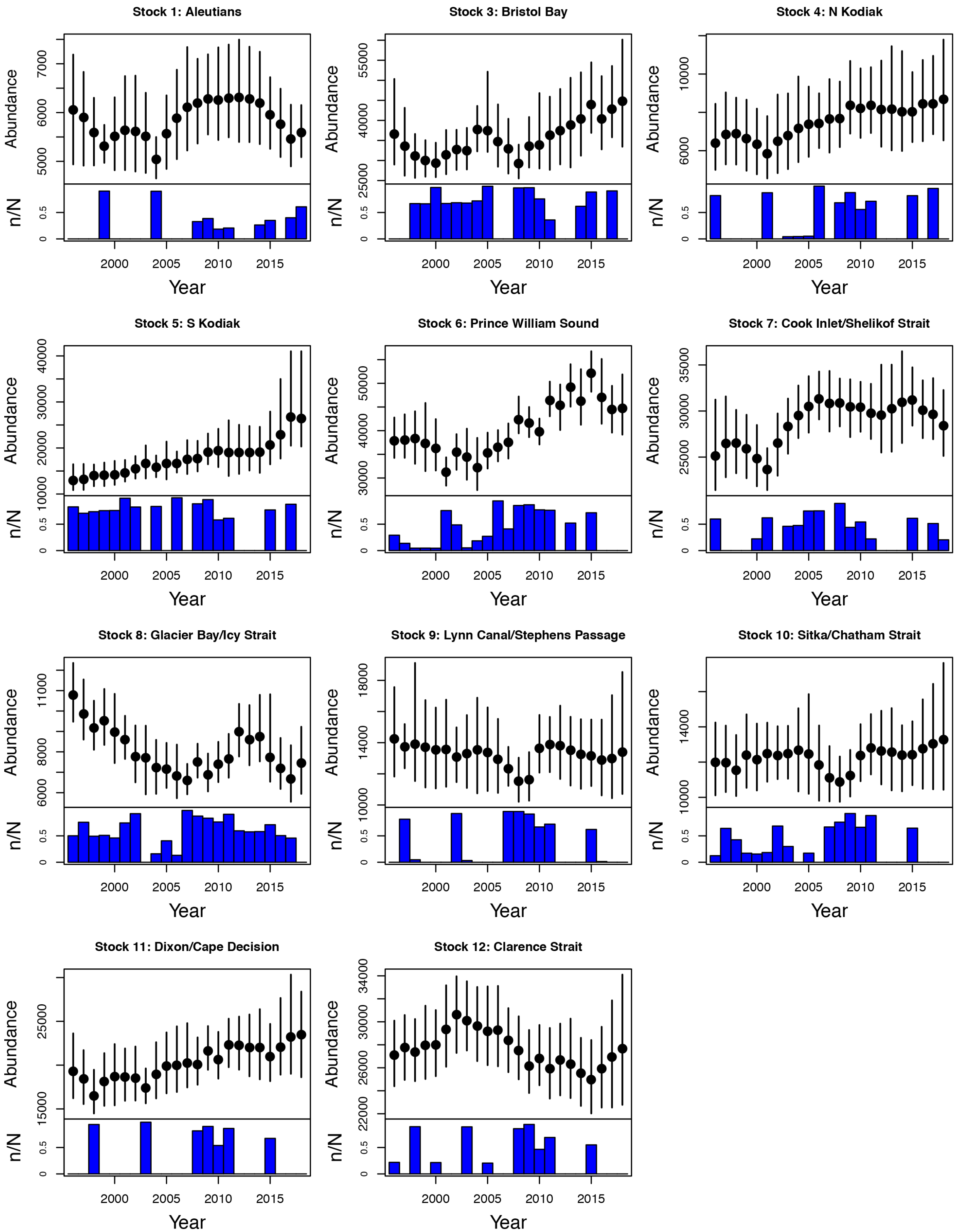

Figure 3. Annual abundance estimates (black dots) of harbor seals in Alaska for all stocks except the Pribilof Islands stock. Black lines represent the 95% credible interval. Blue bars provide a measure of survey effort and indicate the proportion of the estimated abundance likely surveyed each year.

Current Population Trend

Aerial surveys of harbor seal haul-out sites throughout Alaska have been conducted annually and provide information on trends in abundance. The most current estimates of trend (Table 1) were estimated as the means of the slopes of 1,000 simple linear regressions over the most recent eight annual estimates in each of the 1,000 MCMC samples from the posterior distributions for abundance. Thus, they are in units of seals per year, rather than the typical annual percent growth rate. There is no appropriate method for converting these estimates of trend to annual percent growth rate. As a reflection of uncertainty in trend estimates, the proportion of the posterior distribution for each stock's trend that lies below the value of 0 is used as an estimate of the probability that a stock is currently decreasing (Table 1). This allows a probabilistic determination of the qualitative trend status: a value greater than 0.5 means the evidence suggests that the stock is decreasing; a value less than 0.5 means the stock is increasing. For the estimation of trend, an 8-year time interval was used. Eight years is considered to be the approximate threshold of reliability for Marine Mammal Protection Act (MMPA) stock assessment data. One caveat of this approach is that, due to the skewness inherent in the posterior distribution, it is possible for a stock to exhibit a positive trend while also having a probability of decrease greater than 0.5. The following summarizes historical and recent information on the population trend for each of the 12 stocks.

Aleutian Islands: A partial estimate of harbor seal abundance in the Aleutian Islands was determined from skiff surveys of 106 islands from 1977 to 1982 (8,601 seals). Small et al. (2008) compared counts from the same islands during a 1999 aerial survey (2,859 seals). Counts decreased at a majority of the islands. Islands with greater than 100 seals decreased by 70%. The overall estimates showed a 67% decline during the approximate 20-year period (Small et al. 2008). Starting in 2005, the stock abundance estimates show annual increases with a peak abundance of approximately 6,500 in 2010. Since 2010, there is an apparent decline. The current estimate of the 8-year population trend in the Aleutian Islands is -131 seals per year, with a probability that the stock is decreasing of 0.932 (Table 1). Note the survey effort (as represented by n/N in Figure 3) has been consistently below 50% for the Aleutians. This stock represents the most challenging region (due to size, logistics, and weather) in Alaska for aerial surveys. Limited funds and availability of suitable aircraft have prevented greater survey coverage.

Pribilof Islands: Counts of harbor seals in the Pribilof Islands ranged from 250 to 1,224 in the 1970s. Counts in the 1980s and 1990s ranged between 119 and 232 harbor seals. Prior to July 2010, the most recent count was 202 seals in 1995. In July 2010, approximately 185 adults and 27 pups were observed on Otter Island for a maximum count of 212 harbor seals. Counts from 2010 (all ages) are nearly identical to the 1995 counts (212 vs. 202), but 2010 pup numbers were slightly less (27 vs. 42). July 2015 was the first year that counts were conducted on both Otter Island and St. George Island, resulting in a total count of 235 seals (all ages). In 2018, the Aleut Community of St. Paul and MML collaborated on a comprehensive survey of harbor seals in the Pribilof Islands using small unoccupied aircraft. The survey was conducted on the islands of Otter, St. Paul, and St. George in early September, resulting in a total of 229 seals counted across all islands (Boveng et al. 2019). For all other stocks in Alaska, the abundance and trend estimates account for the proportion of seals likely in the water during the survey. This is not done for the Pribilof Island stock because counts have typically been more opportunistic and information on environmental covariates is less standardized. It is also possible the isolated and unique nature of the habitat could lead to very different haul-out behaviors that are unknown without conducting a behavioral study. Analysis of the nearest two stocks (Aleutian Islands and Bristol Bay) estimated standardized correction factors of 1.5 and 3.0. Using the mean correction factor of 2.25 would result in approximately 515 harbor seals in the Pribilof Island region. The current population trend in the Pribilof Islands is unknown.

Bristol Bay: At Nanvak Bay, the largest haul-out location in northern Bristol Bay, harbor seals declined in abundance from 1975 to 1990 and increased from 1990 to 2000 (Jemison et al. 2006). Land-based harbor seal counts at Nanvak Bay from 1990 to 2000 increased at 9.2% per year during the pupping period and 2.1% per year during the molting period (Jemison et al. 2006). After a period of growth in the 1980s, the population in Iliamna Lake appears to be relatively stable at around 400 individuals. A population viability analysis assessing the risk of quasi-extinction in Iliamna Lake, defined as any reduction to 50 animals or below in the next 100 years, ranged from 1% to 3%, depending on the prior scenario (Boveng et al. 2018). The current 8-year estimate of the population trend in the Bristol Bay stock is +1,127 seals per year, with a probability that the stock is decreasing of 0.218 (Table 1).

North Kodiak: The current 8-year estimate of the North Kodiak population trend is +53 seals per year, with a probability that the stock is decreasing of 0.409 (Table 1). The North Kodiak stock appears to have levelled off since 2010 at approximately 8,000 seals.

South Kodiak: A significant portion of the harbor seal population within the South Kodiak stock is located at and around Tugidak Island off the southwest coast of Kodiak Island. Sharp declines in the number of seals present on Tugidak were observed between 1976 and 1998. The highest rate of decline was 21% per year between 1976 and 1979 (Pitcher 1990). While the number of seals on Tugidak has stabilized and shown some evidence of increase since the decline, the population in 2000 remained reduced by 80% compared to the levels in the 1970s (Jemison et al. 2006). The South Kodiak stock has shown a consistent, increasing trend since the low levels in the mid-1990s, with an even more noticeable increase in recent years. The current 8-year estimate of the South Kodiak population trend is +1,234 seals per year, with a probability that the stock is decreasing of 0.076 (Table 1).

Prince William Sound: The Prince William Sound stock includes harbor seals both within and adjacent to Prince William Sound proper. Within Prince William Sound proper, harbor seals declined in abundance by 63% between 1984 and 1997 (Frost et al. 1999). In Aialik Bay, adjacent to Prince William Sound proper, there has been a decline in pup production by 4.6% annually from 40 down to 32 pups born from 1994 to 2009 (Hoover-Miller et al. 2011). The current 8-year estimate of the Prince William Sound population trend is -200 seals per year, with a probability that the stock is decreasing of 0.648 (Table 1). There has been limited survey effort outside of glacial habitats in recent years and, thus, the most recent abundance estimates have larger credible intervals.

Cook Inlet/Shelikof Strait: A multi-year study of seasonal movements and abundance of harbor seals in Cook Inlet was conducted between 2004 and 2007. This study involved multiple aerial surveys throughout the year, and the data indicated a stable population of harbor seals during the August molting period (Boveng et al. 2011). Aerial surveys along the Alaska Peninsula present greater logistical challenges and have therefore been conducted less frequently. The current 8-year estimate of the Cook Inlet/Shelikof Strait population trend is -111 seals per year, with a probability that the stock is decreasing of 0.609 (Table 1).

Glacier Bay/Icy Strait: The Glacier Bay/Icy Strait stock showed a negative population trend estimate for harbor seals from 1992 to 2008 in June and August for glacial (-7.7%/yr; -8.2%/yr) and terrestrial sites (-12.4%/yr, August only) (Womble et al. 2010). Trend estimates by Mathews and Pendleton (2006) were similarly negative for both glacial and terrestrial sites. Long-term monitoring of harbor seals on glacial ice has occurred in Glacier Bay since the 1970s (Mathews and Pendleton 2006) and has shown this area to support one of the largest breeding aggregations in Alaska (Steveler 1979, Calambokidis et al. 1987). After a dramatic retreat of Muir Glacier (more than 7 km), in the East Arm of Glacier Bay, between 1973 and 1986 and the subsequent grounding and cessation of calving in 1993, floating glacial ice was greatly reduced as a haul-out substrate for harbor seals and ultimately resulted in the abandonment of upper Muir Inlet by harbor seals (Calambokidis et al. 1987, Hall et al. 1995, Mathews 1995). Prior to 1993, seal counts were up to 1,347 in the East Arm of Glacier Bay; 2008 counts were fewer than 200 (Streveler 1979, Molnia 2007). The current 8-year estimate of the Glacier Bay/Icy Strait population trend is -216 seals per year, with a probability that the stock is decreasing of 0.904 (Table 1). The majority of survey effort in recent years has been conducted by the National Park Service and focused, mostly, on glacial ice habitats. Limited surveys have been conducted in the Icy Strait portion of the stock.

Lynn Canal/Stephens Passage: The current 8-year estimate of the Lynn Canal/Stephens Passage population trend is -114 seals per year, with a probability that the stock is decreasing of 0.73 (Table 1). Outside of efforts in 2007 to 2011 and 2015, there has been limited survey effort for this stock and, thus, the recent estimates of abundance include large credible intervals.

Sitka/Chatham Strait: The current 8-year estimate of the Sitka/Chatham Strait population trend is +71 seals per year, with a probability that the stock is decreasing of 0.41 (Table 1). Outside of efforts in 2007 to 2011 and 2015, there has been limited survey effort for this stock and, thus, the recent estimates of abundance include large credible intervals.

Dixon/Cape Decision: The current 8-year estimate of the Dixon/Cape Decision population trend is +142 seals per year, with a probability that the stock is decreasing of 0.382 (Table 1). Outside of efforts in 2007 to 2011 and 2015, there has been limited survey effort for this stock and, thus, the recent estimates of abundance include large credible intervals.

Clarence Strait: The current 8-year estimate of the Clarence Strait population trend is +138 seals per year, with a probability that the stock is decreasing of 0.413 (Table 1). Outside of efforts in 2007 to 2011 and 2015, there has been limited survey effort for this stock and, thus, the recent estimates of abundance include large credible intervals.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reliable rates of maximum net productivity have not been estimated directly from the 12 stocks of harbor seals identified in Alaska. Based on monitoring in Washington State from 1978 to 1999, Jeffries et al. (2003) estimated R_{MAX} to be 12.6% and 18.5% for harbor seals of the inland and coastal stocks, respectively. Harbor seals have been protected in British Columbia since 1970, and the monitored portion of that population responded with an annual rate of increase of approximately 12.5% through the late 1980s (Olesiuk et al. 1990), although a more recent evaluation suggested that 11.5% may be a more appropriate figure (Fisheries and Oceans Canada 2010). These empirical estimates of R_{MAX} indicate that the continued use of the pinniped maximum theoretical net productivity rate of 12% is appropriate for the Alaska stocks (NMFS 2016).

POTENTIAL BIOLOGICAL REMOVAL

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. Marine mammal stocks such as the harbor seal stocks in Alaska that are taken by subsistence hunting may be given F_R values up to 1.0, provided they are "known to be increasing" or "not known to be decreasing" and "there have not been recent increases in the levels of takes" (NMFS 2016). For harbor seals in Alaska, these guidelines were followed by assigning all harbor seal stocks an initial, default recovery factor of 0.5. The default value was adjusted up to 0.7 if the estimated probability of decrease was less than 0.3. The value was adjusted down to 0.3 if the estimated probability of decrease was greater than 0.7. This provides a simple, balanced approach for providing a recovery factor consistent with current guidelines while incorporating results from novel statistical methods. Table 2 summarizes the PBR levels for each stock of harbor seals in Alaska based on N_{MIN} estimates, an R_{MAX} of 12%, and F_R values.

Table 2. PBR calculations by stock for harbor seals in Alaska. The N_{MIN} values are determined from the 20th percentile of the posterior distribution for stock-level abundance estimates, except for the Pribilof Islands. A default value of 0.5 was used as the recovery factor. Based on evaluation of the trend estimates and probability of decrease, the recovery factor for some stocks was increased to 0.7. For other stocks, the recovery factor was decreased to 0.3.

Stock	N_{MIN}	R_{MAX}	Recovery Factor (F_R) (default value = 0.5)	PBR
Aleutian Islands	5,366	0.12	0.3	97
Pribilof Islands	229	0.12	0.5	7
Bristol Bay	38,254	0.12	0.7	1,607
North Kodiak	7,609	0.12	0.5	228
South Kodiak	22,351	0.12	0.7	939
Prince William Sound	41,776	0.12	0.5	1,253
Cook Inlet/Shelikof Strait	26,907	0.12	0.5	807
Glacier Bay/Icy Strait	6,680	0.12	0.3	120
Lynn Canal/Stephens Passage	11,867	0.12	0.3	214
Sitka/Chatham Strait	11,883	0.12	0.5	356
Dixon/Cape Decision	21,453	0.12	0.5	644
Clarence Strait	24,854	0.12	0.5	746

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 2013 and 2017 is listed, by marine mammal stock, in Delean et al. (2020);

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 all harbor seal stocks between 2013 and 2017 is 1,135 harbor seals: 32 in U.S. commercial fisheries, 0.4 in unknown (commercial, recreational, or subsistence) fisheries, 3.7 due to other causes (illegal shooting, entanglement in ADF&G research trawl gear), and 1,099 in the Alaska Native subsistence harvest. Human-caused mortality and serious injury information for individual harbor seal stocks is listed in the Status of Stock section for each stock. Additional potential threats most likely to result in direct human-caused mortality or serious injury for all stocks of harbor seals include unmonitored subsistence harvests, incidental takes in unmonitored fisheries, and illegal shooting. Disturbance by cruise vessels is an additional threat for harbor seal stocks that occur in glacial fjords (Jansen et al. 2010, 2015; Matthews et al. 2016).

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 in Appendices 3-6 of the Alaska Stock Assessment Reports.

Observer programs have documented mortality and serious injury of harbor seals in the Bering Sea/Aleutian Islands Atka mackerel trawl, Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands rockfish trawl, Bering Sea/Aleutian Islands Pacific cod pot, Gulf of Alaska flatfish trawl, and Gulf of Alaska halibut longline fisheries between 2013 and 2017 (Breiwick 2013; MML, unpubl. data) (Table 3).

Although a reliable estimate of the overall mortality and serious injury rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in salmon gillnet fisheries known to interact with several of these stocks, for the purposes of stock assessment, mean annual mortality and serious injury rates are assigned to the following harbor seal stocks based on the location of takes in observed fisheries between 2013 and 2017 (Table 3): Aleutian Islands stock: 0.2 from the Bering Sea/Aleutian Islands Atka mackerel trawl fishery + 0.2 from the Bering Sea/Aleutian Islands rockfish trawl fishery; Bristol Bay stock: 0.8 from the Bering Sea/Aleutian Islands flatfish trawl fishery + 0.2 from the Bering Sea/Aleutian Islands pollock trawl fishery + 2.8 from the Bering Sea/Aleutian Islands Pacific cod pot fishery; North Kodiak stock: 0.3 from the Gulf of Alaska flatfish trawl fishery; South Kodiak stock: 1.0 from the Gulf of Alaska flatfish trawl fishery; Cook Inlet/Shelikof Strait stock: 0.7 from the Gulf of Alaska flatfish trawl fishery + 1.8 from the Gulf of Alaska halibut longline fishery.

Table 3. Summary of incidental mortality and serious injury of harbor seals in Alaska due to U.S. commercial fisheries between 2013 and 2017 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data).

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. Atka mackerel trawl	2013 2014 2015 2016 2017	obs	99 100 100 98 100	0 0 0 1[AI] 0	0 0 0 1.1[AI] 0	0.2[AI] (CV = 0.25)
Bering Sea/Aleutian Is. flatfish trawl	2013 2014 2015 2016 2017	obs data	100 100 100 99 100	0 1[BB] 0 0 3[BB]	0 1[BB] 0 0 3[BB]	0.8[BB] (CV = 0.02)
Bering Sea/Aleutian Is. pollock trawl	2013 2014 2015 2017 2017	obs data	98 98 99 99 99	0 1[BB] 0 0 0	0 1.0[BB] 0 0 0	0.2[BB] (CV = 0.14)

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. rockfish trawl	2013	obs data	100	0	0	0.2^{AI} (CV = 0.05)
	2014		100	1^{AI}	1^{AI}	
	2015		100	0	0	
	2016		100	0	0	
	2017		100	0	0	
Bering Sea/Aleutian Is. Pacific cod pot	2013	obs data	18	0	0	2.4^{BB} ($+0.4^{BB}$)[c] (CV = 0.78)
	2014		21	2^{BB} ($+2^{BB}$)[a]	12^{BB} ($+2^{BB}$)[b]	
	2015		27	0	0	
	2016		21	0	0	
	2017		13	0	0	
Gulf of Alaska flatfish trawl	2013	obs data	46	2^{SK}	5.2^{SK}	$1.0^{SK} + 0.3^{NK} + 0.7^{CI}$ (CV = 0.34)[d]
	2014		47	0	0	
	2015		54	0	0	
	2016		39	0	0	
	2017		56	$1^{NK} + 2^{CI}$	$1.7^{NK} + 3.3^{CI}$	
Gulf of Alaska halibut longline	2013	obs data	4.2	0	0	1.8^{CI} (CV = 0.95)
	2014		11	0	0	
	2015		9.4	1^{CI}	9.1^{CI}	
	2016		9.5	0	0	
	2017		4.6	0	0	
Minimum total estimated annual mortality						$0.4^{AI} + 3.8^{BB} + 0.3^{NK} + 1.0^{SK} + 2.5^{CI}$ (CV = 0.34)[e]

[a]Total mortality and serious injury observed in 2014: 2 harbor seals in sampled hauls + 2 harbor seals in unsampled hauls.
[b]Total estimate of mortality and serious injury in 2014: 12 harbor seals (extrapolated estimate from 2 harbor seals observed in sampled hauls) + 2 harbor seals (2 harbor seals observed in unsampled hauls).
[c]Mean annual mortality and serious injury for fishery: 2.4 harbor seals (mean of extrapolated estimates from sampled hauls) + 0.4 harbor seals (mean of number observed in unsampled hauls).
[d]This CV is for the mean estimated annual mortality for all harbor seal stocks taken in the fishery.
[e]This CV is for the sum of the mean estimated annual mortality for all stocks.

Harbor seal stock identifications for observed mortality, estimated mortality, and mean estimated annual mortality:
^{AI}Aleutian Islands stock
^{BB}Bristol Bay stock
^{NK}North Kodiak stock
^{SK}South Kodiak stock
^{CI}Cook Inlet/Shelikof Strait stock

Observer programs in Alaska State-managed salmon set gillnet and salmon drift gillnet fisheries have documented harbor seal mortality and serious injury (Table 4). The Prince William Sound salmon drift gillnet fishery is known to interact with harbor seals, although the most recent observer data available for this fishery are from 1990 and 1991 (Wynne et al. 1991, 1992). The minimum estimated average annual mortality and serious injury rate (24 seals) in this fishery will be applied to the Prince William Sound stock of harbor seals. Although the observer data are dated, they are considered the best available data on mortality and serious injury levels in this fishery.

Observers reported a South Kodiak harbor seal mortality in a federally-managed U.S. commercial Gulf of Alaska pot fishery in 2014; however, there was not enough information in the record to assign the event to a specific fishery. Therefore, the observed mortality is used to calculate a mean annual mortality and serious injury rate of 0.2 South Kodiak harbor seals in commercial Gulf of Alaska pot fisheries between 2013 and 2017 (Delean et al. 2020; Table 5).

Table 4. Summary of incidental mortality and serious injury of harbor seals in Alaska due to U.S. commercial salmon drift and set gillnet fisheries in 1990 and 1991 and calculation of the mean annual mortality and serious injury rate based on the most recent observer program data available (Wynne et al. 1991, 1992).

Fishery name	**Years**	**Data type**	**Percent observer coverage**	**Observed mortality**	**Estimated mortality**	**Mean estimated annual mortality**
Prince William Sound salmon drift gillnet	1990 1991	obs data	4 5	2 1	36 12	24 (CV = 0.50)
Minimum total estimated annual mortality						24 (CV = 0.50)

Reports to the NMFS Alaska Region stranding network of harbor seals entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data (Delean et al. 2020). Between 2013 and 2017, there were two reports of Cook Inlet/Shelikof Strait harbor seal mortality and serious injury due to entanglements in fishing gear, including one in a Cook Inlet salmon set gillnet in 2014 and one in an unidentified net in 2017, resulting in a mean annual mortality and serious injury rate of 0.4 harbor seals from this stock due to interactions with unknown (commercial, recreational, or subsistence) fisheries (Table 5).

Table 5. Summary of harbor seal mortality and serious injury, by year, type, and harbor seal stock, reported to the NMFS Alaska Region marine mammal stranding network between 2013 and 2017 (Delean et al. 2020).

Cause of injury	**2013**	**2014**	**2015**	**2016**	**2017**	**Mean annual mortality**
Gulf of Alaska commercial pot fishery	0	1[SK]	0	0	0	0.2[SK]
Entangled in Cook Inlet salmon set gillnet*	0	1[CI]	0	0	0	0.2[CI]
Entangled in unidentified net*	0	0	0	0	1[CI]	0.2[CI]
Illegally shot[a]	-	-	1[PW]	3[PW]	3[PW]	2.3[PW]
Illegally shot	0	0	0	6[BB]	0	1.2[BB]
Entangled in ADF&G research trawl gear	0	1[NK]	0	0	0	0.2[NK]
Total in commercial fisheries *Total in unknown (commercial, recreational, or subsistence) fisheries Total due to other causes (illegally shot, research fisheries)						0.2[SK] 0.4[CI] 2.3[PW] + 1.2[BB] + 0.2[NK]

[a]Dedicated effort to survey the Copper River Delta for stranded marine mammals began in 2015 in response to a high number of reported strandings, some of which were later determined to be human-caused (illegally shot). Dedicated surveys were also conducted in 2016 and 2017. Because similar data are not available for 2013 and 2014, the data were averaged over the 3 years of survey effort for a more informed estimate of mean annual mortality.

Harbor seal stock identifications for observed mortality and mean annual mortality:
[BB]Bristol Bay stock
[NK]North Kodiak stock
[SK]South Kodiak stock
[CI]Cook Inlet/Shelikof Strait stock
[PW]Prince William Sound stock

Alaska Native Subsistence/Harvest Information

The Alaska Native subsistence harvest of harbor seals has been estimated by the Alaska Native Harbor Seal Commission (ANHSC) and the Alaska Department of Fish and Game (ADF&G). Information from the ADF&G indicates the average harvest levels for the 12 stocks of harbor seals identified in Alaska from 2004 to 2008, including struck and lost animals (Table 6: average annual harvest column). Data on community subsistence harvests were collected for Kodiak Island, Prince William Sound, and Southeast Alaska in 2011 and 2012, Prince William Sound and Cook Inlet/Shelikof Strait in 2014, and Bristol Bay in 2017 (Table 6: annual harvest columns). The remaining stocks do not have updated community subsistence data, therefore, the most recent 5-years of harvest data (2004-2008) will be used for these stocks.

Table 6. Summary of the subsistence harvest data for all 12 harbor seal stocks in Alaska, 2004-2008, 2011-2012, 2014, and 2017. Data are from Wolfe et al. (2005, 2006, 2008, 2009a, 2009b, 2012, 2013); NMFS, unpubl. data.

Stock	Minimum annual harvest 2004-2008	Maximum annual harvest 2004-2008	Average annual harvest 2004-2008	Annual harvest 2011 or 2012	Annual harvest 2014	Annual harvest 2017
Aleutian Islands	50	146	90	N/A	N/A	N/A
Pribilof Islands	0	0	0	N/A	N/A	N/A
Bristol Bay[a]	82	188	141	N/A	N/A	15[b]
North Kodiak	66	260	131	37	N/A	N/A
South Kodiak	46	126	78	126	N/A	N/A
Prince William Sound	325	600	439	255[c]	387	N/A
Cook Inlet/Shelikof Strait	177	288	233	N/A	104	N/A
Glacier Bay/Icy Strait	22	108	52	104	N/A	N/A
Lynn Canal/Stephens Passage	17	60	30	50	N/A	N/A
Sitka/Chatham Strait	97	314	222	77	N/A	N/A
Dixon/Cape Decision	100	203	157	69	N/A	N/A
Clarence Strait	71	208	164	40	N/A	N/A

[a]Seals taken in summer on shore in Bristol Bay could be either harbor seals or spotted seals. Absent specific identification, we have listed the species as reported to the ADF&G. NMFS will work with the organizations that work with harbor seals to determine how to apportion the harvest in this area between the two species.
[b]This is a minimum estimate because it includes subsistence harvest data from only one community (Clark's Point) and does not include the number of struck and lost animals.
[c]This is a minimum estimate because it includes subsistence harvest data from only one community (Yakutat).

Other Mortality

Reports to the NMFS Alaska Region stranding network of harbor seals entangled in marine debris or with injuries caused by other types of human interaction are another source of mortality and serious injury data (Delean et al. 2020). 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. From 2013 to 2017, reports to the NMFS Alaska Region stranding network resulted in mean annual mortality and serious injury rates of 2.3 Prince William Sound harbor seals illegally shot in the Copper River Delta (3-year average), 1.2 Bristol Bay harbor seals illegally shot, and 0.2 North Kodiak harbor seals entangled in ADF&G research trawl gear. Gunshot mortality of an additional five harbor seals was reported to the NMFS Alaska Region between 2013 and 2017, including two Cook Inlet/Shelikof Strait harbor seals (one each in 2013 and 2014) and three Prince William Sound harbor seals (two in 2014 and one in 2015). However, these events are not included in the estimate of the mean annual mortality and serious injury rate for 2013 to 2017 because it could not be confirmed that the deaths were due to illegal shooting and were not already accounted for in the estimate of animals struck and lost in the Alaska Native subsistence harvest.

STATUS OF STOCK

No harbor seal stocks in Alaska are designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act, and the minimum estimate of the mean annual level of human-caused mortality and serious injury does not exceed PBR for any of the stocks; therefore, none of the stocks are strategic. At present, mean annual mortality and serious injury rates incidental to U.S. commercial fisheries that are less than 10% of PBR can be considered insignificant and approaching a zero mortality and serious injury rate. Reliable estimates of the mean annual rates of mortality and serious injury incidental to U.S. commercial fisheries are unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rates due to U.S. commercial fishing are insignificant. The status of all 12 stocks of harbor seals identified in Alaska relative to their Optimum Sustainable Population is unknown.

There are key uncertainties in the assessment of the abundance and trend of harbor seals in Alaska. The population abundance is based on counts of visible animals and adjusted to account for seals in the water based on haul-out behavior data obtained from bio-logging studies. These deployments are confined to a small portion of the geographic range and only a portion of the recognized stocks. Additionally, many of these deployments rely on bio-loggers attached to seal hair with adhesive. These tags fall off during the annual molt. Since the surveys are typically conducted during the molt period, there is some additional uncertainty due to reduced sample size. Reduced funding and limited availability of suitable aircraft has prevented regular surveys that properly sample the full expanse of harbor seal distribution in Alaska. Instead, resources are prioritized to areas of special conservation or management concern. This means some stocks or portions of stocks are not surveyed annually and, consequently, uncertainty is increased for those areas.

In addition to uncertainties related to assessment, evaluation and documentation of human-caused mortality could be improved. There are multiple nearshore commercial fisheries which are not observed; thus, there is likely to be unreported fishery-related mortality and serious injury of harbor seals. 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.

Aleutian Islands: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 9.7 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0.4 (commercial fisheries) + 90 (harvest) + 0 (other fisheries + other mortality and serious injury) = 90) is not known to exceed the PBR (97). The Aleutian Islands stock of harbor seals is not classified as a strategic stock.

Pribilof Islands: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 0.7 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0 + 0 + 0 = 0) is not known to exceed the PBR (7). The Pribilof Islands stock of harbor seals is not classified as a strategic stock.

Bristol Bay: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 161 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (3.8 + 15 + 1.2 = 20) is not known to exceed the PBR (1,607). The Bristol Bay stock of harbor seals is not classified as a strategic stock.

North Kodiak: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 23 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0.3 + 37 + 0.2 = 38) is not known to exceed the PBR (228). The North Kodiak stock of harbor seals is not classified as a strategic stock.

South Kodiak: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 94 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (1.2 + 126 + 0 = 127) is not known to exceed the PBR (939). The South Kodiak stock of harbor seals is not classified as a strategic stock.

Prince William Sound: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 125 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (24 + 387 + 2.3 = 413) is not known to exceed the PBR (1,253). The Prince William Sound stock of harbor seals is not classified as a strategic stock.

Cook Inlet/Shelikof Strait: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 81 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (2.5 + 104 + 0.4 = 107) is not known to exceed the PBR (807). The Cook Inlet/Shelikof Strait stock of harbor seals is not classified as a strategic stock.

Glacier Bay/Icy Strait: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 12 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0 + 104 + 0 = 104) is not known to exceed the PBR (120). The Glacier Bay/Icy Strait stock of harbor seals is not classified as a strategic stock.

Lynn Canal/Stephens Passage: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 21 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0 + 50 + 0 = 50) is not known to exceed the PBR (214). The Lynn Canal/Stephens Passage stock of harbor seals is not classified as a strategic stock.

Sitka/Chatham Strait: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 36 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0 + 77 + 0 = 77) is not known to exceed the PBR (356). The Sitka/Chatham Strait stock of harbor seals is not classified as a strategic stock.

Dixon/Cape Decision: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 64 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0 + 69 + 0 = 69) is not known to exceed the PBR (644). The Dixon/Cape Decision stock of harbor seals is not classified as a strategic stock.

Clarence Strait: At present, U.S. commercial fishery-related mean annual mortality and serious injury rates less than 75 animals (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. A reliable estimate of the mean annual rate of mortality and serious injury incidental to U.S. commercial fisheries is unavailable. Therefore, it is unknown whether the mean annual mortality and serious injury rate due to U.S. commercial fishing is insignificant. Based on the best scientific information available, the minimum estimated mean annual level of human-caused mortality and serious injury (0 + 40 + 0 = 40) is not known to exceed the PBR (746). The Clarence Strait stock of harbor seals is not classified as a strategic stock.

HABITAT CONCERNS

Glacial fjords in Alaska are critical for harbor seal whelping, nursing, and molting. Several of these areas have experienced a ten-fold increase in tour ship visitation since the 1980s. This increase in the presence of tour vessels has resulted in additional levels of disturbance to pups and adults (Jansen et al. 2015, Matthews et al. 2016). The level of serious injury or mortality resulting from increased disturbance is not known.

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SPOTTED SEAL (*Phoca largha*): Bering Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Spotted seals are distributed along the continental shelf of the Bering, Chukchi, and Beaufort seas, and the Sea of Okhotsk south to the western Sea of Japan and northern Yellow Sea (Fig. 1). Eight main areas of spotted seal breeding have been reported (Shaughnessy and Fay 1977). On the basis of small samples and preliminary analyses of genetic composition, potential geographic barriers, and significance of breeding groups, Boveng et al. (2009) grouped those breeding areas into three Distinct Population Segments (DPSs): the Bering DPS, which includes breeding areas in the Bering Sea and portions of the East Siberian, Chukchi, and Beaufort seas that may be occupied outside the breeding period; the Okhotsk DPS; and the Southern DPS, which includes spotted seals breeding in the Yellow Sea and Peter the Great Bay in the Sea of Japan. The Bering stock of spotted seals is defined as the Bering DPS. This stock assessment considers only the portion of the stock found within U.S. waters bounded by the U.S. Exclusive Economic Zone (EEZ; Fig. 1), because the relevant stock assessment data on abundance and human-caused mortality and serious injury are generally not available for the broader range of the stock or even for waters adjacent to the U.S. EEZ.

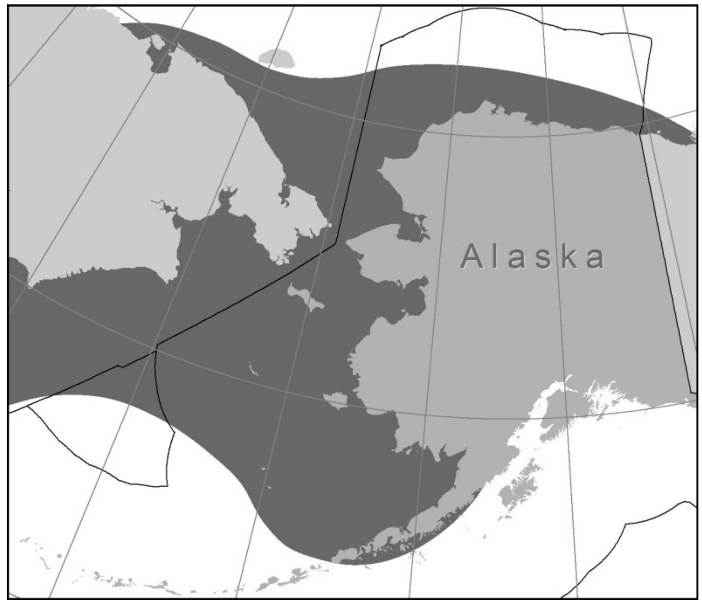

Figure 1. Approximate distribution of spotted seals in the Bering stock (dark shaded area), which is defined as the Bering DPS. This stock assessment considers only the portion of the stock occurring within U.S. waters (i.e., the U.S. Exclusive Economic Zone delineated by a black line).

The distribution of spotted seals is seasonally related to specific life-history events that can be broadly divided into two periods: late-fall through spring, when whelping, nursing, breeding, and molting occur in association with the presence of sea ice on which the seals haul out, and summer through fall when seasonal sea ice has melted and most spotted seals use land for hauling out (Boveng et al. 2009, Citta et al. 2018). Satellite-tagging studies showed that seals tagged in the northeastern Chukchi Sea moved south in October and passed through the Bering Strait in November. Seals overwintered in the Bering Sea along the ice edge and made east-west movements along the edge (Lowry et al. 1998). During spring they tend to prefer small floes (i.e., <20 m in diameter), and inhabit mainly the southern margin of the ice in areas where water depth does not exceed 200 m, and move to coastal habitats after molting and the retreat of the sea ice (Fay 1974, Shaughnessy and Fay 1977, Lowry et al. 2000, Simpkins et al. 2003). In summer and fall, spotted seals use coastal haul-out sites regularly (Frost et al. 1993, Lowry et al. 1998) and may be found as far north as 69-72°N in the Chukchi and Beaufort seas (Porsild 1945, Shaughnessy and Fay 1977). To the south, along the west coast of Alaska, spotted seals are known to occur around the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands. Spotted seals are closely related to, and often mistaken for, Pacific harbor seals (*Phoca vitulina richardii*). The two species are often seen together and are partially sympatric, as their ranges overlap in the southern part of the Bering Sea (Quakenbush 1988). Yet, spotted seals breed earlier and are less social during the breeding season, and only spotted seals are strongly associated with pack ice (Shaughnessy and Fay 1977). These and other ecological, behavioral, genetic, and morphological differences support their recognition as two separate species (Quakenbush 1988, O'Corry-Crowe and Westlake 1997, Berta and Churchill 2012).

POPULATION SIZE

In the spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire ice-covered portions of the Bering Sea (Moreland et al. 2013). Conn et al. (2014), using a sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of 461,625 spotted seals (95% CI: 388,732-560,348) in those waters. Although this is a preliminary abundance estimate it is also the best available and it is a reasonable estimate for the entire portion of the Bering spotted seal stock in U.S. waters because relatively few spotted seals are expected north of the Bering Strait during the surveys.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for a stock is usually calculated using Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$, which approximates the 20th percentile of a distribution that is assumed to be log-normal. However, the abundance estimate based on Conn et al. (2014) was calculated using a Bayesian hierarchical framework, so we used the 20th percentile of the posterior distribution of abundance estimates as a more direct estimator of N_{MIN} than Equation 1 to provide an N_{MIN} of 423,237 spotted seals in the U.S. Bering Sea in the spring.

Current Population Trend

Reliable data on trends in population abundance for the Bering stock of spotted seals or the portion of the stock within U.S. waters are not available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Bering stock of spotted seals or for any portion of the stock within U.S. waters. Until additional data become available, the default pinniped maximum theoretical net productivity rate of 12% will be used for this stock (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 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2016). Using the N_{MIN} based on Conn et al. (2014) for spotted seals in the U.S. portion of the stock, the PBR is 25,394 seals (423,237 × 0.06 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 portion of the Bering spotted seal stock in U.S. waters between 2014 and 2018 is 5,254 seals: 1 in U.S. commercial fisheries, 0.4 incidental to Marine Mammal Protection Act (MMPA)-authorized research, and 5,253 in the Alaska Native subsistence harvest (average statewide harvest, including struck and lost animals, in 2015, based on a recently published analysis (Nelson et al. 2019) that is higher and likely more accurate than previous estimates but also revealed stable or decreasing trends in harvest numbers; see below). However, the total mortality and serious injury due to commercial fisheries is unknown because some of the reported harbor seal takes in U.S. commercial fisheries may actually have been spotted seals (since it is virtually impossible to distinguish between these two species without genetic analysis), and there have been no observer programs in nearshore Bristol Bay fisheries that are known to interact with spotted seals. 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).

Between 2014 and 2018, incidental mortality and serious injury of spotted seals in U.S. waters occurred 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 1; Breiwick 2013; MML, unpubl. data). This resulted in a minimum estimated mean annual mortality and serious injury rate of one spotted seal incidental to U.S. commercial fisheries between 2014 and 2018, based exclusively on observer data.

Mortality and serious injury of harbor seals incidental to U.S. commercial fisheries occurred between 2014 and 2018 and, because it is virtually impossible to distinguish between harbor seals and spotted seals without genetic analysis, some of the reported harbor seal takes may actually have been spotted seals. Further, there have been no observer programs on nearshore Bristol Bay fisheries that are known to interact with spotted seals, making the total mortality and serious injury due to fisheries unknown.

Table 1. Summary of incidental mortality and serious injury of Bering spotted seals in U.S. waters due to U.S. commercial fisheries between 2014 and 2018 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	obs data	100 100 99 100 100	0 2 1 2 0	0 2 (0.03) 1 (0.05) 2 (0.03) 0	1 (CV = 0.02)
Minimum total estimated annual mortality						1 (CV = 0.02)

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Ice Seal Committee (ISC; 2006) to co-manage Alaska ice seal populations. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of ice seals (to the maximum extent allowed by law) as a tool for conserving ice seal populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

Spotted seals are an important resource for Alaska Native subsistence hunters. Approximately 64 coastal communities in Alaska, from Bristol Bay to the Beaufort Sea, harvest ice seals (ISC 2019). The ISC, as co-managers with NMFS, recognizes the importance of harvest information and has collected it since 2008. Annual household survey results compiled in a statewide harvest report include historical ice seal harvest information from 1960 to 2017 (Quakenbush et al. 2009, ISC 2019). To estimate the recent subsistence harvest of ice seals, Nelson et al. (2019) used ice seal harvest survey data collected from 1992 to 2014 for 41 of 55 communities that regularly hunt ice seals, as well as the per capita removal estimates (based on the 2015 human population) from the surveyed communities, to estimate the average regional and statewide subsistence harvest (Table 2). The best statewide estimate of the average number of spotted seals harvested in 2015, including struck and lost animals, is 5,253 seals (Nelson et al. 2019). The authors also found stable or decreasing trends in the annual numbers of ice seals harvested (Nelson et al. 2019).

Table 2. Average regional and statewide subsistence harvest (including struck and lost animals) of Bering spotted seals in 2015 (Nelson et al. 2019). See Figure 1 in Nelson et al. (2019) for a list of the communities in each region.

Region	Average harvest (including struck and lost animals)
North Slope Borough	89
Maniilaq	507
Kawerak	3,175
Association of Village Council Presidents	1,205
Bristol Bay Native Association	277
Statewide total	5,253

Other Mortality

Mortality and serious injury may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2014 and 2018, there were two reports of mortality incidental to research on the Bering stock of spotted seals (one each in 2014 and 2016), resulting in a mean annual mortality and serious injury rate of 0.4 spotted seals from this stock (Table 3; Young et al. 2020).

In 2011, NMFS and the U.S. Fish and Wildlife Service declared an Unusual Mortality Event (UME) for pinnipeds in the Bering and Chukchi seas, due to the unusual number of sick or dead seals and walruses discovered with skin lesions, bald patches, and other symptoms. The UME occurred from 1 May 2011 to 31 December 2016 and primarily affected ice seals, including ringed seals, bearded seals, ribbon seals, and spotted seals. The investigation concluded that the skin and hair symptoms were signs of a molt abnormality; however, no infectious disease agent or environmental cause for the UME symptoms and mortality was identified (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). Patchy baldness and delayed molt, however, continue to be observed in limited numbers (<20 per year) of harvested and beachcast ringed seals, bearded seals, ribbon seals, and spotted seals in Alaska.

Since 1 June 2018, elevated numbers of ice seal strandings have occurred in the Bering and Chukchi seas in Alaska and NMFS declared a UME for bearded seals, ringed seals, and spotted seals from 1 June 2018 to present in the Bering and Chukchi seas (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). As of 31 July 2020, 298 ice seal strandings of all age classes have been reported, including 88 bearded seals, 72 ringed seals, 49 spotted seals, and 89 unidentified seals. A subset of seals has been sampled for genetics and harmful algal bloom exposure and a few have had histopathology samples collected.

Table 3. Summary of mortality and serious injury of Bering spotted seals in U.S. waters, by year and type, reported to the NMFS Office of Protected Resources between 2014 and 2018 (Young et al. 2020).

Cause of injury	2014	2015	2016	2017	2018	Mean annual mortality
Incidental to MMPA-authorized research	1	0	1	0	0	0.4
Total incidental to MMPA-authorized research						0.4

STATUS OF STOCK

The Bering spotted seal stock is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act (ESA). NMFS completed a comprehensive status review of the spotted seal under the ESA in 2009 (Boveng et al. 2009) and concluded that listing the Bering DPS of spotted seals, which corresponds to the Bering stock of spotted seals, was not warranted at that time (73 FR 51615, 20 October 2009). The Bering stock of spotted seals is not considered a strategic stock. The best estimate of the mean annual level of human-caused mortality and serious injury in the portion of the stock in U.S. waters is 5,254 spotted seals, which is less than the PBR (25,394 seals). The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (one seal) is less than 10% of the PBR (10% of PBR = 2,539) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Bering stock of spotted seals. The 2012 Bering Sea abundance estimate by Conn et al. (2014) was calculated using only a sub-sample of the survey data and may be biased. Further, the sample size available for genetics analysis was small so there could be additional stock structure within the Bering stock. Nearshore commercial fisheries are not observed, and fishery-related mortality and serious injury in these fisheries could occur undetected. Based on the best available information, spotted seals are likely to be moderately sensitive to climate change.

HABITAT CONCERNS

The main concern about the conservation status of spotted seals is long-term habitat loss and modification resulting from climate change (Boveng et al. 2009). Laidre et al. (2008) concluded that on a worldwide basis spotted seals were likely to be moderately sensitive to climate change, based on an analysis of various life-history features that could be affected by climate. Climate models consistently project substantial reductions in both the extent and timing of sea ice within the range of spotted seals in Alaska waters; however, the sea ice in the Bering Sea is expected to continue forming annually in winter for the foreseeable future. Spotted seals are associated with sea ice during the periods of reproduction and molting. The presence of sea ice is considered a requirement for whelping and nursing young, providing a platform out of the water to facilitate these life-history events. Similarly, the molt is believed to be promoted by elevated skin temperatures that, in polar regions, can only be achieved when seals haul out of the water. There will likely be more frequent years in which ice coverage is reduced, resulting in a decline in the long-term average ice extent, but Bering Sea spotted seals will likely continue to encounter sufficient ice to support adequate vital rates. Even if sea ice were to vanish completely from the Bering Sea, there may be prospects for spotted seals to adjust their breeding grounds to follow the northward shift of the annual ice front into the Chukchi Sea.

A second major concern, driven primarily by the production of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may affect spotted seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The nature and timing of such impacts are extremely uncertain. As described in Boveng et al. (2009), changes in spotted seal prey, anticipated in response to ocean warming and loss of sea ice, have the potential for negative impacts, but the possibilities are complex. Ecosystem responses may have very long lags as they propagate through trophic webs. Because of spotted seals' apparent dietary flexibility, this threat should be of less immediate concern than the direct effects of sea-ice degradation.

Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait), such as disturbance from vessel traffic and the potential for oil spills.

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BEARDED SEAL (*Erignathus barbatus nauticus*): Beringia Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bearded seals are a boreoarctic species with a circumpolar distribution (Fedoseev 1965; Johnson et al. 1966; Burns 1967, 1981; Burns and Frost 1979; Smith 1981; Kelly 1988). Their normal range extends from the Arctic Ocean (85°N) south to Sakhalin Island (45°N) in the Pacific Ocean and south to Hudson Bay (55°N) in the Atlantic Ocean (Allen 1880, Ognev 1935, King 1983). Bearded seals inhabit the seasonally ice-covered seas of the Northern Hemisphere, where they whelp and rear their pups and molt their coats on the ice in the spring and early summer. Bearded seals feed primarily on benthic organisms, including epifaunal and infaunal invertebrates, and demersal fishes and are closely linked to areas where the seafloor is shallow (less than 200 m).

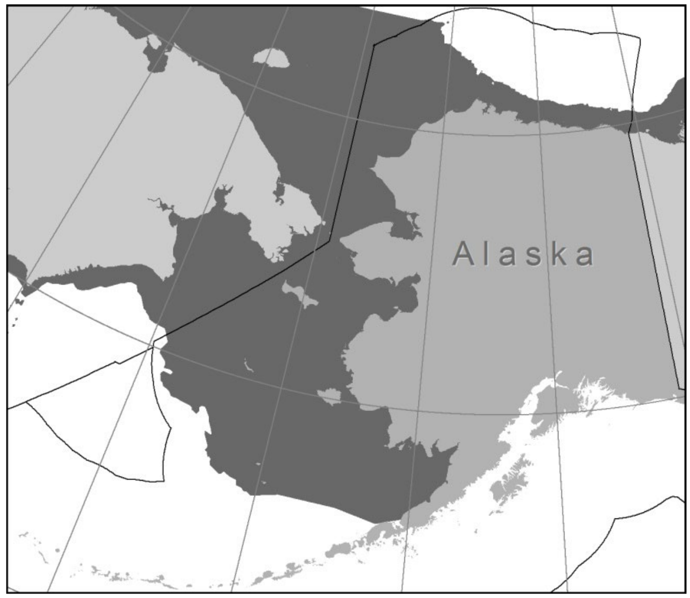

Figure 1. The Beringia bearded seal stock is defined as the Beringia DPS of the *E. B. nauticus* subspecies (dark shaded area). This stock assessment considers only the portion of the stock occurring in U.S. waters (i.e., the U.S. Exclusive Economic Zone delineated by a black line).

Two subspecies have been described: *Erignathus barbatus barbatus* from the Laptev Sea, Barents Sea, North Atlantic Ocean, and Hudson Bay (Rice 1998); and *E. b. nauticus* from the remaining portions of the Arctic Ocean, the Bering Sea, and the Sea of Okhotsk (Ognev 1935, Scheffer 1958, Manning 1974, Heptner et al. 1976). The geographic distributions of these subspecies are not separated by conspicuous gaps, and there are regions of intergrading generally described as somewhere along the northern Russian and central Canadian coasts. NMFS defined longitude 145°E as the Eurasian delineation between the two subspecies and 130°W in western Canada as the North American delineation between the two subspecies (Cameron et al. 2010; 77 FR 76740, 28 December 2012). Based on evidence for discreteness and ecological uniqueness of bearded seals in the Sea of Okhotsk, under the Endangered Species Act (ESA) the *E. b. nauticus* subspecies was further divided into an Okhotsk Distinct Population Segment (DPS) and a Beringia DPS (77 FR 76740), so named because the continental shelf waters of the Bering, Chukchi, Beaufort, and East Siberian seas that are the bearded seals' range in this region overlie much of the land bridge that was exposed during the last glaciation, which has been referred to as Beringia. This stock is defined as the Beringia DPS; however, this stock assessment considers only the portion of the Beringia stock found within U.S. waters bounded by the U.S. Exclusive Economic Zone (EEZ; Fig. 1), because the relevant stock assessment data on abundance and human-caused mortality and serious injury are generally not available for the broader range of the stock or even for waters adjacent to the U.S. EEZ.

Spring surveys conducted in 1999 and 2000 along the Alaska coast indicate that bearded seals are typically more abundant 20-100 nautical miles (nmi) from shore than within 20 nmi from shore, except for high concentrations nearshore to the south of Kivalina (Bengtson et al. 2000, 2005; Simpkins et al. 2003). Many seals that winter in the Bering Sea move north through the Bering Strait from late April through June and spend the summer in the Chukchi Sea (Burns 1967, 1981). Bearded seal sounds (produced by adult males) have been recorded nearly year-round (peak occurrence in December-June, when sea-ice concentrations were >50%) at multiple locations in the Bering, Chukchi, and Beaufort seas, and calling behavior is closely related to the presence of sea ice (MacIntyre et al. 2013, 2015; Jimbo et al. 2019). The overall summer distribution is quite broad, with seals rarely hauled out on land, and some seals, mostly juveniles, may not follow the ice northward but remain near the coasts of the Bering and Chukchi seas (Burns 1967, 1981; Heptner et al. 1976; Nelson 1981; Cameron et al. 2018). As the ice forms again in the fall and winter, most seals move south with the advancing ice edge through the Bering Strait into the Bering Sea where they spend the winter (Burns and Frost 1979; Frost et al. 2005, 2008; Cameron and Boveng 2007, 2009; Breed et al. 2018; Cameron et al. 2018). This southward migration is less noticeable and predictable than the northward movements in late spring and early summer (Burns and Frost 1979, Burns 1981, Kelly 1988). During winter, the central and northern parts of the Bering Sea shelf have the highest densities of bearded seals (Fay 1974, Heptner et al. 1976, Burns and Frost 1979, Braham et al. 1981, Burns 1981, Nelson et al. 1984, Citta et al. 2018). In late winter and early spring, bearded seals are widely, but not uniformly, distributed in the broken, drifting pack ice ranging from the Chukchi Sea to the ice front in the Bering Sea. In these areas, they tend to avoid the coasts and areas of fast ice (Burns 1967, Burns and Frost 1979).

POPULATION SIZE

Although a reliable population estimate for the entire stock is not available, survey methods have been developed and applied to substantial portions of the stock's range in U.S. waters. In the spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire ice-covered portions of the Bering Sea (Moreland et al. 2013). Conn et al. (2014), using a sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of 301,836 bearded seals (95% CI: 238,195-371,147) in those waters. Researchers expect to provide a population estimate for the entire U.S. portion of the bearded seal stock once the final Bering Sea results are combined with the results from spring surveys of the Chukchi Sea (conducted in 2016) and Beaufort Sea (planned for 2021).

Minimum Population Estimate

A minimum population estimate (N_{MIN}) for the entire U.S. portion of the stock cannot be determined because reliable abundance estimates are not yet available for the Chukchi and Beaufort seas. Using the 2012 Bering Sea density estimate by Conn et al. (2014), however, we are able to calculate an N_{MIN} of 273,676 bearded seals in the U.S. Bering Sea. The N_{MIN} for a stock is usually calculated using Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$, which approximates the 20th percentile of a distribution that is assumed to be log-normal. However, the abundance estimate based on Conn et al. (2014) was calculated using a Bayesian hierarchical framework, so we used the 20th percentile of the posterior distribution of abundance estimates as a more direct estimator of N_{MIN} than Equation 1. This N_{MIN} is negatively biased as an estimator of the Beringia bearded seal stock, and even the U.S. portion of the stock, because the estimate is based solely on the Bering Sea and, therefore, doesn't include the many bearded seals that inhabit the Chukchi and Beaufort seas (e.g., Bengtson et al. 2005, Laidre et al. 2015).

Current Population Trend

Reliable data on trends in population abundance for the Beringia stock of bearded seals or the portion of the stock within U.S. waters are not available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Beringia stock of bearded seals or any portion of the stock within U.S. waters. Until additional data become available, the default pinniped maximum theoretical net productivity rate of 12% will be used for this stock (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 pinniped stocks listed as threatened under the ESA (NMFS 2016). Using the negatively biased N_{MIN} for bearded seals in the U.S. portion of the Beringia stock, PBR is 8,210 seals (273,676 × 0.06 × 0.5). This PBR is negatively biased because of its dependence on the negatively biased N_{MIN} estimate.

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 portion of the Beringia bearded seal stock in U.S. waters between 2014 and 2018 is 6,709 seals: 1.8 in U.S. commercial fisheries, 6,707 in the Alaska Native subsistence harvest (average statewide harvest, including struck and lost animals, in 2015, based on a recently published analysis (Nelson et al. 2019) that is higher and likely more accurate than previous estimates but also revealed stable or decreasing trends in harvest numbers; see below), and 0.4 due to Marine Mammal Protection Act (MMPA)-authorized research-related permanent removals from the population. 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).

Between 2014 and 2018, incidental mortality and serious injury of bearded seals in U.S. waters occurred in two 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 pollock trawl and Bering Sea/Aleutian Islands flatfish trawl fisheries (Table 1; Breiwick 2013; MML, unpubl. data). The minimum estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2014 and 2018 is 1.8 bearded seals, based exclusively on observer data.

Table 1. Summary of incidental mortality and serious injury of Beringia bearded seals in U.S. waters due to U.S. commercial fisheries between 2014 and 2018 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. pollock trawl	2014 2015 2016 2017 2018	obs data	98 99 99 99 99	1 0 0 1 0	1.0 (0.14) 0 0 1.0 (0.1) 0	0.4 (CV = 0.09)
Bering Sea/Aleutian Is. pollock trawl	2016	obs data	99	1*	N/A	0.2 (CV = N/A)
Bering Sea/Aleutian Is. flatfish trawl	2014 2015 2016 2017 2018	obs data	100 100 99 100 100	1 2 1 1 1	1 (0.05) 2 (0.03) 1 (0.05) 1 (0.04) 1 (0.05)	1.2 (CV = 0.02)
Minimum total estimated annual mortality						1.8 (CV = 0.03)

*This seal was discovered during a vessel offload. Because it could not be associated with a haul number, it was not included in the bycatch estimate for the fishery.

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Ice Seal Committee (ISC; 2006) to co-manage Alaska ice seal populations. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of ice seals (to the maximum extent allowed by law) as a tool for conserving ice seal populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

Bearded seals are an important resource for Alaska Native subsistence hunters. Approximately 64 coastal communities in Alaska, from Bristol Bay to the Beaufort Sea, harvest ice seals (ISC 2019). The ISC, as co-managers with NMFS, recognizes the importance of harvest information and has collected it since 2008. Annual household survey results compiled in a statewide harvest report include historical ice seal harvest information from 1960 to 2017 (Quakenbush et al. 2011, ISC 2019).To estimate the recent subsistence harvest of ice seals, Nelson et al. (2019) used ice seal harvest survey data collected from 1992 to 2014 for 41 of 55 communities that regularly hunt ice seals, as well as the per capita removal estimates (based on the 2015 human population) from the surveyed communities, to estimate the average regional and statewide subsistence harvest (Table 2). The best statewide estimate of the average number of bearded seals harvested in 2015, including struck and lost animals, is 6,707 seals (Nelson et al. 2019). The authors also found stable or decreasing trends in the annual numbers of ice seals harvested (Nelson et al. 2019).

Table 2. Average regional and statewide subsistence harvest (including struck and lost animals) of Beringia bearded seals in 2015 (Nelson et al. 2019). See Figure 1 in Nelson et al. (2019) for a list of the communities in each region.

Region	Average harvest (including struck and lost animals)
North Slope Borough	1,031
Maniilaq	1,038
Kawerak	3,248
Association of Village Council Presidents	1,360
Bristol Bay Native Association	30
Statewide total	6,707

Other Mortality

Permanent removals from the population may occasionally occur during marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2014 and 2018, two research-related permanent removals (one seal each in 2014 and 2015) were reported for the Beringia stock of bearded seals (Young et al. 2020; Table 3), resulting in a mean annual rate of 0.4 bearded seals.

In 2011, NMFS and the U.S. Fish and Wildlife Service declared an Unusual Mortality Event (UME) for pinnipeds in the Bering and Chukchi seas, due to the unusual number of sick or dead seals and walruses discovered with skin lesions, bald patches, and other symptoms. The UME occurred from 1 May 2011 to 31 December 2016 and primarily affected ice seals, including ringed seals, bearded seals, ribbon seals, and spotted seals. The investigation concluded that the skin and hair symptoms were signs of a molt abnormality; however, no infectious disease agent or environmental cause for the UME symptoms and mortality was identified (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). Patchy baldness and delayed molt, however, continue to be observed in limited numbers (<20 per year) of harvested and beachcast ringed seals, bearded seals, ribbon seals, and spotted seals in Alaska.

Since 1 June 2018, elevated numbers of ice seal strandings have occurred in the Bering and Chukchi seas in Alaska and NMFS declared a UME for bearded seals, ringed seals, and spotted seals from 1 June 2018 to present in the Bering and Chukchi seas (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). As of 31 July 2020, 298 ice seal strandings of all age classes have been reported, including 88 bearded seals, 72 ringed seals, 49 spotted seals, and 89 unidentified seals. A subset of seals has been sampled for genetics and harmful algal bloom exposure and a few have had histopathology samples collected.

Table 3. Summary of mortality and serious injury of Beringia bearded seals, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and NMFS Office of Protected Resources between 2014 and 2018 (Young et al. 2020).

Cause of Injury	2014	2015	2016	2017	2018	Mean annual mortality
MMPA-authorized research-related permanent removals	1	1	0	0	0	0.4
Total MMPA-authorized research-related permanent removals						0.4

STATUS OF STOCK

On 28 December 2012, NMFS listed the Beringia DPS bearded seal (*E. b. nauticus*), which corresponds to the Beringia stock of bearded seals, as threatened under the ESA (77 FR 76740). The primary concern for this population is the ongoing and projected loss of sea-ice cover resulting from climate change, which is expected to pose a significant threat to the persistence of these seals in the foreseeable future (based on projections through the end of the 21st century: Cameron et al. 2010). Because of its threatened status under the ESA, this stock is designated as depleted under the MMPA and is classified as a strategic stock. The best estimate of the mean annual level of human-caused mortality and serious injury in the portion of the stock in U.S. waters is 6,709 bearded seals, which is less than the negatively biased PBR of 8,210 seals. The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (1.8 seals) is less than 10% of the PBR (10% of PBR = 821) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Beringia stock of bearded seals. Abundance and mortality and serious injury estimates are not available for the vast majority of the stock's range. Within U.S. waters, where abundance estimates are being developed and data are currently available on mortality and serious injury in commercial fisheries and the Alaska Native subsistence harvest, key abundance estimates for the Beaufort and Chukchi seas are not yet available. The negatively biased N_{MIN} used here, based on a 2012 Bering Sea density estimate from Conn et al. (2014), was calculated using only a sub-sample of the data and may be biased as an estimate for the U.S. waters of the Bering Sea. Also, it represents just a portion of the population of bearded seals in U.S. waters and is, therefore, not very reliable for comparison with mortality and serious injury numbers for the entire U.S. portion of the stock. Based on the best available information, bearded seals are likely to be highly sensitive to climate change.

HABITAT CONCERNS

The main concern about the conservation status of bearded seals is long-term habitat loss and modification resulting from climate change (77 FR 76740, 28 December 2012). Laidre et al. (2008) concluded that on a worldwide basis bearded seals were likely to be highly sensitive to climate change, based on an analysis of various life-history features that could be affected by climate. Climate models consistently project substantial reductions in both the extent and timing of sea ice within the range of bearded seals in Alaska waters (Cameron et al. 2010). Bearded seals are closely associated with sea ice, particularly during the periods of reproduction and molting. The presence of sea ice is considered a requirement for whelping and nursing young. Similarly, the molt is believed to be promoted by elevated skin temperatures that, in polar regions, can only be achieved when seals haul out of the water. If suitable ice cover is absent from shallow feeding areas during times of peak whelping and nursing (April/May) or molting (May/June and sometimes through August), bearded seals would be forced to seek either sea-ice habitat over deeper waters (perhaps with poor access to food) or onshore haul-out sites (perhaps with increased risks of disturbance, predation, and competition). Both scenarios would require bearded seals to adapt to novel (i.e., potentially suboptimal) conditions and to exploit habitats to which they may not be well adapted, likely compromising their reproduction and survival rates.

A second major concern, driven primarily by the production of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may affect bearded seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The nature and timing of such impacts are extremely uncertain. As discussed in Cameron et al. (2010), changes in bearded seal prey, anticipated in response to ocean warming and loss of sea ice, have the potential for negative impacts, but the possibilities are complex. Ecosystem responses may have very long lags as they propagate through trophic webs. Because of bearded seals' apparent dietary flexibility, this threat may be of less immediate concern than the threats from sea-ice degradation.

Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait), such as disturbance from vessel traffic and the potential for oil spills.

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RINGED SEAL (*Pusa hispida hispida*): Arctic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Ringed seals (*Pusa hispida*) have a circumpolar distribution and are found in all seasonally ice-covered seas of the Northern Hemisphere as well as in certain freshwater lakes (King 1983). Most taxonomists currently recognize five subspecies of ringed seals: *P. h. hispida* in the Arctic Ocean and Bering Sea; *P. h. ochotensis* in the Sea of Okhotsk and northern Sea of Japan; *P. h. botnica* in the northern Baltic Sea; *P. h. lagodensis* in Lake Ladoga, Russia; and *P. h. saimensis* in Lake Saimaa, Finland. Morphologically, the Baltic and Okhotsk subspecies are fairly well differentiated from the Arctic subspecies (Ognev 1935, Müller-Wille 1969, Rice 1998) and the Ladoga and Saimaa subspecies differ significantly from each other and from the Baltic subspecies (Müller-Wille 1969, Hyvärinen and Nieminen 1990, Amano et al. 2002). Genetic analyses support isolation of the lake-inhabiting populations (Palo 2003, Palo et al. 2003, Valtonen et al. 2012). Lack of differentiation between the Baltic and the Arctic subspecies may reflect recurrent gene flow (Martinez-Bakker et al. 2013) but is more likely due to retention of high diversity within the relatively large effective population size of the Baltic subspecies since separation from the Arctic subspecies (Nyman et al. 2014). Widespread mixing within the Arctic subspecies is the likely explanation for its high diversity and apparent lack of population structure (Palo et al. 2001, Davis et al. 2008, Kelly et al. 2009, Martinez-Bakker et al. 2013). Differences in body size, morphology, growth rates, and/or diet between Arctic ringed seals in shorefast versus pack ice have been taken as evidence of separate breeding populations in some locations (McLaren 1958, Fedoseev 1975, Finley et al. 1983). This has not been thoroughly examined, however, and the taxonomic status and population structure of the Arctic subspecies remain unresolved (Berta and Churchill 2012). The stock, therefore, may be as large as the entire *P. h. hispida* subspecies range. This stock assessment considers only the portion of the stock found within U.S. waters bounded by the U.S. Exclusive Economic Zone (EEZ; Fig. 1), because the relevant stock assessment data on abundance and human-caused mortality and serious injury are generally not available for the broader range of the stock or even for waters adjacent to the U.S. EEZ.

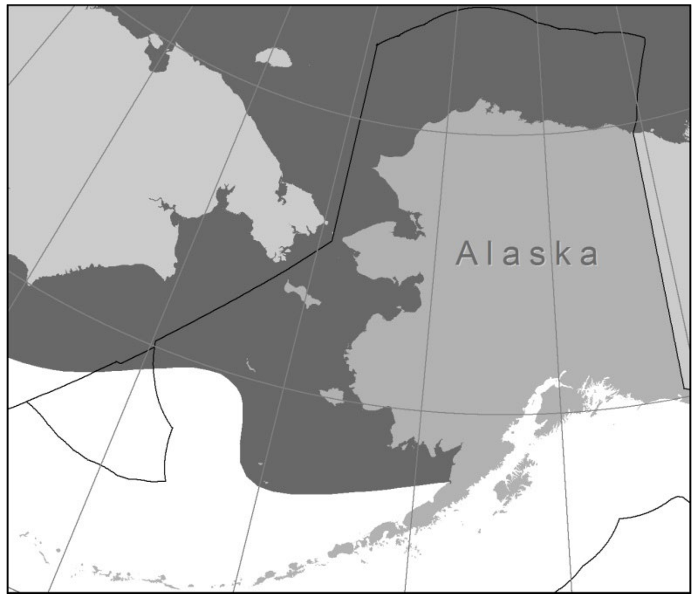

Figure 1. The Arctic ringed seal stock is defined as the population of the Arctic subspecies (*P. h. hispida*). This stock assessment considers only the portion of the stock occurring in U.S. waters (i.e., the U.S. Exclusive Economic Zone delineated by a black line). The dark shaded area shows the approximate winter distribution of the Arctic ringed seal stock around Alaska.

Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying both shorefast and pack ice (Kelly 1988). They remain with the ice most of the year and use it as a platform for pupping and nursing in late winter to early spring, for molting in late spring to early summer, and for resting at other times of the year. Arctic ringed seals rarely come ashore in the Arctic, although they have been observed during summer months resting on land in the White Sea (Lukin et al. 2006) and, recently, in a fjord system in Svalbard (Lydersen et al. 2017). In Alaska waters, during winter and early spring when sea ice is at its maximal extent, ringed seals are abundant in the northern Bering Sea, Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort seas. They occur as far south as Bristol Bay in years of extensive ice coverage but generally are not abundant south of Norton Sound except in nearshore areas (Frost 1985). However, surveys conducted in the Bering Sea in the spring of 2012 and 2013 documented numerous ringed seals in both nearshore and offshore habitat extending south of Norton Sound (79 FR 73010, 9 December 2014). Although details of their seasonal movements have not been adequately documented, most ringed seals that winter in the Bering, Chukchi, and Beaufort seas are thought to migrate north in the spring as the seasonal ice melts and retreats (Burns 1970, Kelly et al. 2010b) and spend summers in the pack ice of the northern Chukchi and Beaufort seas, as well as on nearshore ice remnants in the Beaufort Sea (Frost 1985, Kelly et al. 2010b). During summer, ringed seals range hundreds to thousands of kilometers to forage along ice edges or in highly productive open-water areas (Harwood and Stirling 1992, Freitas et al. 2008, Kelly et al. 2010b, Harwood et al. 2015). With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted. Seals that have summered in the Beaufort Sea are thought to move west and south with the advancing ice pack, with many seals dispersing throughout the Chukchi and Bering seas while some remain in the Beaufort Sea (Frost and Lowry 1984, Crawford et al. 2012, Harwood et al. 2012). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly et al. 2010b).

POPULATION SIZE

Although a reliable population estimate for the entire stock is not available, survey methods have been developed and applied to substantial portions of the stock's range in U.S. waters. In the spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire ice-covered portions of the Bering Sea (Moreland et al. 2013). Conn et al. (2014), using a sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of 171,418 ringed seals (95% CI: 141,588-201,090). This estimate did not account for availability bias due to seals in the water at the time of the surveys and did not include ringed seals in the shorefast ice zone, which were surveyed using a different trackline design that will require a separate analysis. Thus, the actual number of ringed seals in the U.S. portion of the Bering Sea is likely much higher, perhaps by a factor of two or more. Researchers expect to provide a population estimate, corrected for availability bias, for the entire U.S. portion of the ringed seal stock once the final Bering Sea results are combined with the results from spring surveys of the Chukchi Sea (conducted in 2016) and Beaufort Sea (planned for 2020).

Minimum Population Estimate

A minimum population estimate (N_{MIN}) for the entire U.S. portion of the stock cannot be determined because reliable abundance estimates are not yet available for the Chukchi and Beaufort seas. Using the 2012 Bering Sea density estimate by Conn et al. (2014), however, we are able to calculate an N_{MIN} of 158,507 ringed seals in the U.S. Bering Sea. The N_{MIN} for a stock is usually calculated using Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$, which approximates the 20th percentile of a distribution that is assumed to be log-normal. However, the abundance estimate based on Conn et al. (2014) was calculated using a Bayesian hierarchical framework, so we used the 20th percentile of the posterior distribution of abundance estimates as a more direct estimator of N_{MIN} than Equation 1. This N_{MIN} is negatively biased as an estimator of the Arctic ringed seal stock, and even the U.S. portion of the stock, because the estimate is based solely on the Bering Sea and, therefore, doesn't include the many ringed seals that inhabit the Chukchi and Beaufort seas (e.g., Kelly et al. 2010a, Laidre et al. 2015) and because the Conn et al. (2014) study did not adjust densities for seals in the water (not detectable by the surveys).

Current Population Trend

Reliable data on trends in population abundance for the Arctic stock of ringed seals or the portion of the stock within U.S. waters are not available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Arctic stock of ringed seals or any portion of the stock within U.S. waters. Until additional data become available, the default pinniped maximum theoretical net productivity rate of 12% will be used for this stock (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 pinniped stocks listed as threatened under the Endangered Species Act (ESA) (NMFS 2016). Using the negatively biased N_{MIN} for ringed seals in the U.S. portion of the Arctic stock, PBR is 4,755 seals (158,507 × 0.06 × 0.5). This PBR is negatively biased because of its dependence on the negatively biased N_{MIN} estimate.

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 portion of the Arctic ringed seal stock in U.S. waters between 2014 and 2018 is 6,459 seals: 5 in U.S. commercial fisheries, 6,454 in the Alaska Native subsistence harvest (average statewide harvest, including struck and lost animals, in 2015, based on a recently published analysis (Nelson et al. 2019) that is higher and likely more accurate than previous estimates but also revealed stable or decreasing trends in harvest numbers; see below), 0.2 in marine debris, and 0.2 incidental to Marine Mammal Protection Act (MMPA)-authorized research. 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).

Between 2014 and 2018, incidental mortality and serious injury of ringed seals in U.S. waters was reported in two 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 and Bering Sea/Aleutian Islands pollock trawl fisheries (Table 1; Breiwick 2013; MML, unpubl. data). Based on observer data from 2014 to 2018, the minimum average annual rate of mortality and serious injury incidental to U.S. commercial fishing operations is 4.8 ringed seals.

One ringed seal mortality resulting from entanglement in unidentified commercial gear in U.S. waters was reported to the NMFS Alaska Region marine mammal stranding network in 2017 (Young et al. 2020), resulting in a mean annual mortality and serious injury rate of 0.2 ringed seals between 2014 and 2018 (Table 3). 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 nor are all stranded animals found, reported, or have the cause of death determined.

Table 1. Summary of incidental mortality and serious injury of Arctic ringed seals in U.S. waters due to U.S. commercial fisheries between 2014 and 2018 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	obs data	100 100 99 100 100	0 1 0 8 14	0 1 (0.05) 0 8.0 (0.01) 14 (0.02)	4.6 (CV = 0.01)
Bering Sea/Aleutian Is. pollock trawl	2017	obs data	100	1[a]	N/A	0.2 (CV = N/A)
Minimum total estimated annual mortality						4.8 (CV = 0.01)

[a]This seal was discovered during a vessel offload. Because it could not be associated with a haul number, it was not included in the bycatch estimate for the fishery.

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Ice Seal Committee (ISC; 2006) to co-manage Alaska ice seal populations. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of ice seals (to the maximum extent allowed by law) as a tool for conserving ice seal populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

Ringed seals are an important resource for Alaska Native subsistence hunters. Approximately 64 coastal communities in Alaska, from Bristol Bay to the Beaufort Sea, harvest ice seals (ISC 2019). The ISC, as co-managers with NMFS, recognizes the importance of harvest information and has collected it since 2008. Annual household survey results compiled in a statewide harvest report include historical ice seal harvest information from 1960 to 2017 (Quakenbush et al. 2011, ISC 2019). To estimate the recent subsistence harvest of ice seals, Nelson et al. (2019) used ice seal harvest survey data collected from 1992 to 2014 for 41 of 55 communities that regularly hunt ice seals, as well as the per capita removal estimates (based on the 2015 human population) from the surveyed communities, to estimate the average regional and statewide subsistence harvest (Table 2). The best statewide estimate of the average number of ringed seals harvested in 2015, including struck and lost animals, is 6,454 seals (Nelson et al. 2019). The authors also found stable or decreasing trends in the annual numbers of ice seals harvested (Nelson et al. 2019).

Table 2. Average regional and statewide subsistence harvest (including struck and lost animals) of Arctic ringed seals in 2015 (Nelson et al. 2019). See Figure 1 in Nelson et al. (2019) for a list of the communities in each region.

Region	**Average harvest (including struck and lost animals)**
North Slope Borough	1,146
Maniilaq	493
Kawerak	2,287
Association of Village Council Presidents	2,484
Bristol Bay Native Association	44
Statewide total	6,454

Other Mortality

Reports to the NMFS Alaska Region marine mammal stranding network of ringed seals entangled in marine debris or with injuries caused by other types of human interaction are another source of mortality and serious injury data. 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. One ringed seal mortality due to entanglement in marine debris in U.S. waters was reported in 2017, resulting in a mean annual mortality and serious injury rate of 0.2 ringed seals between 2014 and 2018 (Table 3; Young et al. 2020).

Ringed seal mortality due to gunshot wounds reported to the NMFS Alaska Region stranding network (Young et al. 2020) is presumed to be animals struck and lost in the Alaska Native subsistence hunt and, therefore, is not included in the mean annual mortality and serious injury rate for 2014 to 2018.

Mortality and serious injury may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2014 and 2018, there was one report, in 2016, of a mortality incidental to research on the Arctic stock of ringed seals (Table 3; Young et al. 2020), resulting in a mean annual mortality and serious injury rate of 0.2 ringed seals.

In 2011, NMFS and the U.S. Fish and Wildlife Service declared an Unusual Mortality Event (UME) for pinnipeds in the Bering and Chukchi seas, due to the unusual number of sick or dead seals and walruses discovered with skin lesions, bald patches, and other symptoms. The UME occurred from 1 May 2011 to 31 December 2016 and primarily affected ice seals, including ringed seals, bearded seals, ribbon seals, and spotted seals. The investigation concluded that the skin and hair symptoms were signs of a molt abnormality; however, no infectious disease agent or environmental cause for the UME symptoms and mortality was identified (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). Patchy baldness and delayed molt, however, continue to be observed in limited numbers (<20 per year) of harvested and beachcast ringed seals, bearded seals, ribbon seals, and spotted seals in Alaska.

Since 1 June 2018, elevated numbers of ice seal strandings have occurred in the Bering and Chukchi seas in Alaska and NMFS declared a UME for bearded seals, ringed seals, and spotted seals from 1 June 2018 to present in the Bering and Chukchi seas (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). As of 31 July 2020, 298 ice seal strandings of all age classes have been reported, including 88 bearded seals, 72 ringed seals, 49 spotted seals, and 89 unidentified seals. A subset of seals has been sampled for genetics and harmful algal bloom exposure and a few have had histopathology samples collected.

Table 3. Summary of Arctic ringed seal mortality and serious injury in U.S. waters, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and NMFS Office of Protected Resources between 2014 and 2018 (Young et al. 2020). Animals that were disentangled and released with non-serious injuries have been excluded from this table.

Cause of injury	2014	2015	2016	2017	2018	Mean annual mortality
Entangled in unidentified commercial gear	0	0	0	1	0	0.2
Entangled in marine debris	0	0	0	1	0	0.2
Incidental to MMPA-authorized research	0	0	1	0	0	0.2
Total in commercial fisheries						0.2
Total in marine debris						0.2
Total incidental to MMPA-authorized research						0.2

STATUS OF STOCK

On 28 December 2012, NMFS listed the Arctic ringed seal subspecies (*P. h. hispida*), which corresponds to the Arctic stock of ringed seals, as threatened under the ESA (77 FR 76706). The primary concern for this population is the ongoing and anticipated loss of sea ice and snow cover resulting from climate change, which is expected to pose a significant threat to the persistence of these seals in the foreseeable future (based on projections through the end of the 21st century; Kelly et al. 2010a). Because of its threatened status under the ESA, this stock is designated as depleted under the MMPA and is classified as a strategic stock. The best estimate of the mean annual level of human-caused mortality and serious injury in the U.S. waters portion of the stock is 6,459 ringed seals, which is greater than the negatively biased PBR of 4,755 seals. However, because this exceedance of PBR stems from an unrealistically low N_{MIN}, it should not be taken as indicative of a risk to this stock. The PBR was obtained from an N_{MIN} that is known to be an extreme underestimate of the abundance in the U.S. waters of the Bering Sea, which in turn is just a portion of the Arctic ringed seal stock in U.S. waters, and the best estimate of human-caused mortality and serious injury is for the entire U.S. portion of the stock, including, for example, Alaska Native subsistence takes in the Chukchi and Beaufort seas. Previous estimates from the U.S. waters of the Chukchi Sea (Bengtson et al. 2005) and results from a recent (2016) NOAA survey of those waters indicate that there are several hundreds of thousands of ringed seals in that region that are not included in N_{MIN} because the former results are outdated and the latter have not yet been published. Furthermore, ringed seals are known to remain abundant in the U.S. waters of the Beaufort Sea (which are also not included in N_{MIN}) based, for example, on hunter reports to the ISC and NOAA test surveys conducted in 2019. NMFS believes with high confidence that the number of ringed seals in Alaska waters greatly exceeds the number of individuals that would be required for the current take to balance the PBR (i.e., N_{MIN} × Mortality and Serious Injury / PBR = 215,310 individuals). Therefore, the apparent exceedance of PBR in this case reflects inadequacy in the abundance estimates, rather than an indication of excessive take. The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (5 seals) is less than 10% of the negatively biased PBR (10% of PBR = 476) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Arctic stock of ringed seals. Abundance and mortality and serious injury estimates are not available for the vast majority of the stock's range. Within U.S. waters, where abundance estimates are being developed and data are currently available on mortality and serious injury in commercial fisheries and the Alaska Native subsistence harvest, key abundance estimates for the Beaufort and Chukchi seas are not yet available. The negatively biased N_{MIN} used here, based on a 2012 Bering Sea density estimate from Conn et al. (2014), was calculated using only a sub-sample of the data and is likely to be an underestimate for the U.S. waters of the Bering Sea because of availability bias. Also, it represents just a portion of the population of ringed seals in U.S. waters and is, therefore, not very reliable for comparison with mortality and serious injury numbers for the entire U.S. portion of the stock. Based on the best available information, ringed seals are likely to be highly sensitive to climate change.

HABITAT CONCERNS

The main concern about the conservation status of ringed seals is long-term habitat loss and modification resulting from climate change (77 FR 76706, 28 December 2012). Laidre et al. (2008) concluded that on a worldwide basis ringed seals were likely to be highly sensitive to climate change based on an analysis of various life-history features that could be affected by climate.

Climate models consistently project substantial reductions in sea ice and on-ice snow depths (Kelly et al. 2010a, Hezel et al. 2012). Ringed seals excavate subnivean lairs (snow caves) in drifts over their breathing holes in the ice, in which they rest, give birth, and nurse their pups for 5-9 weeks during late winter and spring (Chapskii 1940, McLaren 1958, Smith and Stirling 1975). Substantial data indicate high pup mortality due to hypothermia and predation as a consequence of inadequate snow cover (e.g., Kumlien 1879, Lukin and Potelov 1978, Lydersen and Smith 1989, Smith and Lydersen 1991, Hammill and Smith 1991, Stirling and Smith 2004). Decreases in ice, and especially on-ice snow depths, are expected to lead to increased juvenile mortality from premature weaning, hypothermia, and predation (Kelly et al. 2010a). Changes in the ringed seal's habitat will be rapid relative to their generation time and, thereby, will limit adaptive responses (Kelly et al. 2010a).

A second major concern, driven primarily by the production of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may affect ringed seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The nature and timing of such impacts are extremely uncertain. As discussed by Kelly et al. (2010a), changes in ringed seal prey, anticipated in response to ocean warming and loss of sea ice, have the potential for negative impacts, but the possibilities are complex. Ecosystem responses may have very long lags as they propagate through trophic webs. Because of ringed seals' apparent dietary flexibility, this threat may be of less immediate concern than the threats from sea-ice degradation.

Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait), such as disturbance from vessel traffic and the potential for oil spills.

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RIBBON SEAL (*Histriophoca fasciata*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Ribbon seals inhabit the North Pacific Ocean and adjacent parts of the Arctic Ocean. In Alaska waters, ribbon seals range from the North Pacific Ocean and Bering Sea into the Chukchi and western Beaufort seas (Fig. 1). Ribbon seals are very rarely seen on shorefast ice or land. From late March to early May, ribbon seals inhabit the Bering Sea ice front (Burns 1970, 1981; Braham et al. 1984). They are most abundant in the northern part of the ice front in the central and western parts of the Bering Sea (Burns 1970, Burns et al. 1981). As the ice recedes in May to mid-July, the seals move farther north in the Bering Sea, where they haul out on the receding ice edge and remnant ice (Burns 1970, 1981; Burns et al. 1981). As the ice melts, seals become more concentrated, with at least part of the Bering Sea population moving to the Bering Strait and the southern part of the Chukchi Sea. Ten ribbon seals satellite tagged in the spring of 2005 near the eastern coast of Kamchatka spent the summer and fall throughout the Bering Sea (Boveng et al. 2013). However, of 72 ribbon seals satellite tagged in the central Bering Sea from 2007 to 2010, 21 seals (29%) moved to the Bering Strait, Chukchi Sea, or Arctic Basin as the ice retreated northward, while the other 51 tagged seals did not pass north of the Bering Strait (Boveng et al. 2013). Passive acoustic sampling detected ribbon seal calls in August to early/mid-November in the Chukchi Sea and on the Chukchi Plateau (Moore et al. 2012, Hannay et al. 2013, Jones et al. 2014, Frouin-Mouy et al. 2019), as well as in the western Beaufort Sea in September to early November (Frouin-Mouy et al. 2019), similarly indicating presence of some ribbon seals north of the Bering Strait during summer and fall. The 72 seals tagged in the central Bering Sea and the 10 seals tagged near Kamchatka dispersed widely, occupying coastal areas as well as the middle of the Bering Sea, both on and off the continental shelf (Boveng et al. 2013).

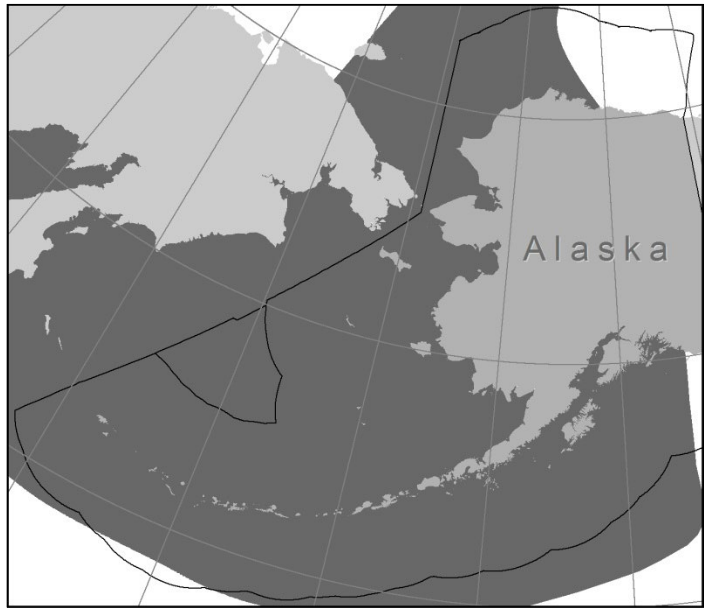

Figure 1. The ribbon seal stock is defined as the *Histriophoca fasciata* species (dark shaded areas depict the combined summer and winter distribution). This stock assessment considers only the portion of the stock occurring in U.S. waters (i.e., the U.S. Exclusive Economic Zone delineated by a black line).

This stock is defined as the *Histriophoca fasciata* species; however, this stock assessment considers only the portion of the stock found within U.S. waters bounded by the U.S. Exclusive Economic Zone (EEZ; Fig. 1), because the relevant stock assessment data on abundance and human-caused mortality and serious injury are generally not available for the broader range of the stock or even for waters adjacent to the U.S. EEZ.

POPULATION SIZE

In the spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire ice-covered portions of the Bering Sea and Sea of Okhotsk (Moreland et al. 2013). Conn et al. (2014), using a sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of 184,697 ribbon seals (95% CI: 139,617-240,225) in those waters. Although this is a preliminary abundance estimate, it is also the best available and it is a reasonable estimate for the entire portion of the stock in U.S. waters because relatively few ribbon seals are expected north of the Bering Strait during the surveys. When the final analyses for the Bering Sea and Sea of Okhotsk are complete, they will provide the first range-wide estimates of ribbon seal abundance.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for a stock is usually calculated using Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$, which approximates the 20th percentile of a distribution that is assumed to be log-normal. However, the abundance estimate based on Conn et al. (2014) was calculated using a Bayesian hierarchical framework, so we used the 20th percentile of the posterior distribution of abundance estimates as a more direct estimator of N_{MIN} than Equation 1 to provide an N_{MIN} of 163,086 ribbon seals in the U.S. Bering Sea in the spring.

Current Population Trend

Reliable data on trends in population abundance for the ribbon seal stock or for the portion of the stock within U.S. waters are not available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the ribbon seal stock or for any portion of the stock within U.S. waters. Until additional data become available, the default pinniped maximum theoretical net productivity rate of 12% will be used for this stock (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 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2016). Using the N_{MIN} based on Conn et al. (2014) for ribbon seals in the U.S. portion of the stock, the PBR is 9,785 seals (163,086 × 0.06 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 portion of the ribbon seal stock in U.S. waters between 2014 and 2018 is 163 seals: 0.9 in U.S. commercial fisheries and 162 in the Alaska Native subsistence harvest (average statewide harvest, including struck and lost animals, in 2015, based on a recently published analysis (Nelson et al. 2019) that is higher and likely more accurate than previous estimates but also revealed stable or decreasing trends in harvest numbers; see below). 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).

Between 2014 and 2018, incidental mortality and serious injury of ribbon seals in U.S. waters occurred in four 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, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod trawl, and Bering Sea/Aleutian Islands rockfish trawl fisheries (Table 1; Breiwick 2013; MML, unpubl. data). The minimum estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2014 and 2018 is 0.9 ribbon seals, based exclusively on observer data.

Table 1. Summary of incidental mortality and serious injury of ribbon seals in U.S. waters due to U.S. commercial fisheries between 2014 and 2018 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	obs data	100 100 99 100 100	1 0 0 0 0	1 (0.04) 0 0 0 0	0.2 (CV = 0.04)
Bering Sea/Aleutian Is. pollock trawl	2014 2015 2016 2017 2018	obs data	98 99 99 99 99	0 0 1 0 0	0 0 1.0 (0.13) 0 0	0.2 (CV = 0.13)
Bering Sea/Aleutian Is. Pacific cod trawl	2014 2015 2016 2017 2018	obs data	80 72 68 68 73	1 0 0 0 0	1.3 (0.49) 0 0 0 0	0.3 (CV = 0.49)
Bering Sea/Aleutian Is. rockfish trawl	2014 2015 2016 2017 2018	obs data	100 100 100 100 100	1 0 0 0 0	1 (0) 0 0 0 0	0.2 (CV = 0)
Minimum total estimated annual mortality						0.9 (CV = 0.15)

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Ice Seal Committee (ISC; 2006) to co-manage Alaska ice seal populations. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of ice seals (to the maximum extent allowed by law) as a tool for conserving ice seal populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

Ribbon seals are an important resource for Alaska Native subsistence hunters. Approximately 64 coastal communities in Alaska, from Bristol Bay to the Beaufort Sea, harvest ice seals (ISC 2019). The ISC, as co-managers with NMFS, recognizes the importance of harvest information and has collected it since 2008. Annual household survey results compiled in a statewide harvest report include historical ice seal harvest information from 1960 to 2017 (Quakenbush and Citta 2008, ISC 2019). To estimate the recent subsistence harvest of ice seals, Nelson et al. (2019) used ice seal harvest survey data collected from 1992 to 2014 for 41 of 55 communities that regularly hunt ice seals, as well as the per capita removal estimates (based on the 2015 human population) from the surveyed communities, to estimate the average regional and statewide subsistence harvest (Table 2). The best statewide estimate of the average number of ribbon seals harvested in 2015, including struck and lost animals, is 162 seals (Nelson et al. 2019). The authors also found stable or decreasing trends in the annual numbers of ice seals harvested (Nelson et al. 2019).

Table 2. Average regional and statewide subsistence harvest (including struck and lost animals) of ribbon seals in 2015 (Nelson et al. 2019). See Figure 1 in Nelson et al. (2019) for a list of the communities in each region.

Region	**Average harvest (including struck and lost animals)**
North Slope Borough	0
Maniilaq	9
Kawerak	130
Association of Village Council Presidents	23
Bristol Bay Native Association	0
Statewide total	162

Other Mortality

In 2011, NMFS and the U.S. Fish and Wildlife Service declared an Unusual Mortality Event (UME) for pinnipeds in the Bering and Chukchi seas, due to the unusual number of sick or dead seals and walruses discovered with skin lesions, bald patches, and other symptoms. The UME occurred from 1 May 2011 to 31 December 2016 and primarily affected ice seals, including ringed seals, bearded seals, ribbon seals, and spotted seals. The investigation concluded that the skin and hair symptoms were signs of a molt abnormality; however, no infectious disease agent or environmental cause for the UME symptoms and mortality was identified (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). Patchy baldness and delayed molt, however, continue to be observed in limited numbers (<20 per year) of harvested and beachcast ringed seals, bearded seals, ribbon seals, and spotted seals in Alaska.

Since 1 June 2018, elevated numbers of ice seal strandings have occurred in the Bering and Chukchi seas in Alaska and NMFS declared a UME for bearded seals, ringed seals, and spotted seals from 1 June 2018 to present in the Bering and Chukchi seas (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). As of 31 July 2020, 298 ice seal strandings of all age classes have been reported, including 88 bearded seals, 72 ringed seals, 49 spotted seals, and 89 unidentified seals. Although the UME was not declared for ribbon seals, some of the unidentified carcasses could have been ribbon seals that were too decomposed to be identified. A subset of seals has been sampled for genetics and harmful algal bloom exposure and a few have had histopathology samples collected.

STATUS OF STOCK

Ribbon seals are not designated as depleted under the Marine Mammal Protection Act (MMPA) or listed as threatened or endangered under the Endangered Species Act (ESA). NMFS completed a comprehensive status review of ribbon seals under the ESA in 2013 (Boveng et al. 2013) and concluded that listing ribbon seals was not warranted at that time (78 FR 41371, 10 July 2013). The ribbon seal stock is not considered a strategic stock. The best estimate of the mean annual level of human-caused mortality and serious injury in the portion of the stock in U.S. waters is 163 ribbon seals, which is less than the PBR (9,785 seals). The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (0.9 seals) is less than 10% of the PBR (10% of PBR = 979) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the ribbon seal stock. The N_{MIN} used here, based on a 2012 Bering Sea density estimate from Conn et al. (2014) was calculated using only a sub-sample of the survey data and may be biased. Based on the best available information, ribbon seals are likely to be moderately sensitive to climate change.

HABITAT CONCERNS

The main concern about the conservation status of ribbon seals is long-term habitat loss and modification resulting from climate change (Boveng et al. 2013). Laidre et al. (2008) concluded that on a worldwide basis ribbon seals were likely to be moderately sensitive to climate change, based on an analysis of various life-history features that could be affected by climate. Climate models consistently project substantial reductions in both the extent and timing of sea ice within the range of ribbon seals in Alaska waters; however, the sea ice in the Bering Sea is expected to continue forming annually in winter for the foreseeable future. Ribbon seals are closely associated with sea ice, particularly during the periods of reproduction and molting. The presence of sea ice is considered a requirement for whelping and nursing young, providing a platform out of the water to facilitate these life-history events. Similarly, the molt is believed to be promoted by elevated skin temperatures that, in polar regions, can only be achieved when seals haul out of the water. There will likely be more frequent years in which ice coverage is reduced, resulting in a decline in the long-term average ice extent; however, ribbon seals will likely continue to encounter sufficient ice to support adequate vital rates.

A second major concern, driven primarily by the production of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may affect ribbon seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The nature and timing of such impacts are extremely uncertain. As described in Boveng et al. (2013), changes in ribbon seal prey, anticipated in response to ocean warming and loss of sea ice, have the potential for negative impacts, but the possibilities are complex. Ecosystem responses may have very long lags as they propagate through trophic webs. Because of ribbon seals' apparent dietary flexibility, this threat may be of less immediate concern than the threats from sea-ice degradation.

Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait), such as disturbance from vessel traffic and the potential for oil spills.

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BELUGA WHALE (*Delphinapterus leucas*): Beaufort Sea Stock

NOTE – April 2022: NMFS is evaluating whether scientific issues raised by co-management partners in November 2021 concerning the Eastern Bering Sea beluga whale Stock Assessment Report may also be applicable to the Beaufort Sea beluga whale Stock Assessment Report. Any resulting changes will be reflected in a future Stock Assessment Report.

STOCK DEFINITION AND GEOGRAPHIC RANGE

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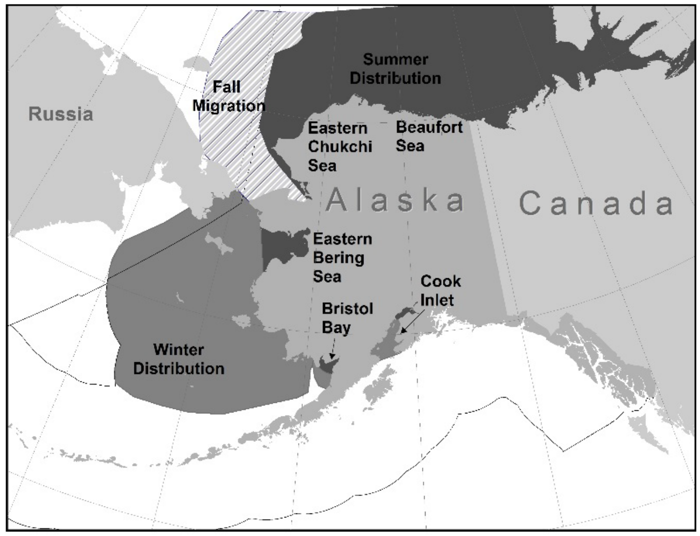

Figure 1. Approximate distribution for all five beluga whale stocks. The Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay beluga whale stocks summer in the Beaufort Sea (Beaufort Sea and Eastern Chukchi Sea stocks) and Bering Sea (Eastern Bering Sea and Bristol Bay stocks); they 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.

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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. 2012; Shelden et al. 2015, 2018; Lowry et al. 2019) remain 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, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 1).

POPULATION SIZE

The sources of information to estimate abundance for beluga whales in waters of northern Alaska and western Canada have included both opportunistic and systematic observations. Duval (1993) reported an estimate of 21,000 beluga whales for the Beaufort Sea stock, similar to that reported by Seaman et al. (1985). The most recent aerial survey conducted in July 1992 resulted in an estimate of 19,629 beluga whales (CV = 0.229) in the eastern Beaufort Sea (Harwood et al. 1996). To account for availability bias, a correction factor (CF), which was not data-based, has been recommended for the Beaufort Sea beluga whale stock (Duval 1993), resulting in a population estimate of 39,258 whales (19,629 × 2). A coefficient of variation (CV) for the CF is not available; however, this CF was considered negatively biased by the Alaska Scientific Review Group (SRG) considering that aerial survey CFs for this stock were estimated between 2.5 and 3.27 (Frost and Lowry 1995). Additionally, the 1992 surveys did not encompass the entire summer range of Beaufort Sea beluga whales (Richard et al. 2001), thus, are negatively biased.

During summer 2019, the governments of the United States and Canada supported independent aerial line-transect surveys in the eastern Beaufort Sea to conduct an abundance survey for bowhead whales. Those data are also being analyzed to derive abundance estimates for the Beaufort Sea stock of beluga whales.

Minimum Population Estimate

For the Beaufort Sea beluga whale stock, the minimum population estimate (N_{MIN}) is calculated according to 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 39,258 whales and an associated CV(N) of 0.229, N_{MIN} for this stock would be 32,453 whales. However, because the survey data are more than 8 years old, it is not considered a reliable minimum population estimate for calculating a PBR and N_{MIN} is considered unknown.

Current Population Trend

The current population trend of the Beaufort Sea stock of beluga whales is unknown. Aerial surveys seaward of the Mackenzie River Delta between 1982-1985 and 2007-2009 indicate that the stock in that area is at least stable or increasing (Harwood and Kingsley 2013).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Beaufort Sea 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 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 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2016). 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.

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 Beaufort Sea beluga whales between 2014 and 2018 is 104 beluga whales: 29 in subsistence takes by Alaska Natives and 75 in subsistence takes by Canadian Inuvialuit.

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).

There were no reports of mortality or serious injury of this stock incidental to U.S. commercial fisheries or subsistence fisheries in Alaska between 2014 and 2018.

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Alaska Beluga Whale Committee (ABWC; 2000) to co-manage western Alaska beluga whale populations in the Bering Sea (including Bristol Bay), Chukchi Sea, and Beaufort Sea. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of beluga whales (to the maximum extent allowed by law) as a tool for conserving beluga whale populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

The subsistence take of Beaufort Sea beluga whales within U.S. waters is reported by the ABWC. The most recent Alaska Native subsistence harvest estimates for the Beaufort Sea beluga whale stock are provided in Table 1 (ABWC, unpubl. data, 2020). The annual subsistence take by Alaska Native hunters averaged 29 Beaufort Sea beluga whales landed between 2014 and 2018. It should be noted that beluga whales harvested at Utqiaġvik (formerly Barrow) in spring are assumed to be from the Beaufort Sea stock, while those harvested in summer are assumed to be from the Eastern Chukchi Sea stock.

Table 1. Summary of Beaufort Sea beluga whales landed by Alaska Native subsistence hunters between 2014 and 2018 (ABWC, unpubl. data, 2020). These are minimum estimates of the total number of beluga whales taken, because not all landed whales and struck and lost whales are consistently reported.

Year	Number landed	Number struck and lost	Total (landed + struck and lost)
2014	24	7	31
2015	43	1	44
2016	43	no data	43
2017	10	no data	10
2018	13	4	17
Mean annual number (landed + struck and lost)			29

Canadian Inuvialuit Subsistence/Harvest Information

The subsistence take of beluga whales within the Canadian waters of the Beaufort Sea is reported by the Fisheries Joint Management Committee (FJMC). The data are collected through on-site harvest monitoring conducted by the FJMC at Inuvialuit communities in the Mackenzie River Delta, Northwest Territories. The Canadian Inuvialuit subsistence harvest estimates for the Beaufort Sea beluga whale stock between 2014 and 2018 are provided in Table 2 (FJMC Beluga Monitor Program, FJMC, Inuvik, NT, Canada). Given these data, the annual subsistence take in Canada averaged 75 beluga whales between 2014 and 2018.

Thus, the estimated mean annual subsistence take of Beaufort Sea beluga whales in U.S. and Canadian waters between 2014 and 2018 is 104 whales (29 + 75).

Table 2. Summary of Beaufort Sea beluga whales harvested by Canadian Inuvialuit subsistence hunters between 2014 and 2018 (FJMC, unpubl. data). N/A indicates that data are not available.

Year	Number landed	Number struck and lost	Total (landed + struck and lost)
2014	104	2	106
2015*	75	1	76
2016	48	1	49
2017	66	N/A	66
2018	76	2	78
Mean annual number taken (landed + struck and lost)			75

*The number of beluga whales landed in 2015 was changed from 82 to 75 whales (resulting in a change in the total harvest from 83 to 76 whales) based on updated harvest information from the FJMC (FJMC, unpubl. data).

STATUS OF STOCK

No fishery-related mortality or serious injury has been reported for the Beaufort Sea stock of beluga whales between 2014 and 2018; therefore, the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries 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 for this stock is 104 beluga whales. Beaufort Sea beluga whales are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. Therefore, the Beaufort Sea beluga whale stock is classified as a non-strategic stock. At this time, it is not possible to assess the status of this stock relative to its Optimum Sustainable Population.

There are key uncertainties in the assessment of the Beaufort Sea stock of beluga whales. The most recently analyzed surveys were conducted more than 8 years ago and did not cover the entire population; given the lack of information on population trend, the abundance estimates are not used to calculate an N_{MIN} and the PBR level is undetermined.

HABITAT CONCERNS

Evidence indicates that the arctic climate is changing rapidly and significantly, and one result of this change is a reduction in the extent and duration of sea ice in some regions (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, are sensitive to changes in arctic weather, sea-surface temperatures, and sea-ice extent, and the concomitant effect on prey availability. There are indications that decreases in seasonal sea ice have influenced beluga whale phenology; however, Beaufort Sea beluga whales did not show a statistically significant change in the timing of their southward migration in response to changes in sea ice (Hauser et al. 2017). An offshore shift in distribution of Beaufort Sea beluga whales between an earlier sample in 1982-1985 and a later sample in 2007-2009 was attributed either to increased habitat due to more open water or potential response to industrial activity (Harwood and Kingsley 2013). Decreases in seasonal sea ice may also increase the risk of killer whale predation (O'Corry-Crowe et al. 2016). There are insufficient data to make reliable predictions of the effects of arctic climate change on beluga whales; however, Laidre et al. (2008) and Heide-Jørgensen et al. (2010) concluded that on a worldwide basis beluga whales were likely to be less sensitive to climate change than other arctic cetaceans because of their wide distribution and flexible behavior. Increased human activity in the Arctic, including increased oil and gas exploration and development and increased nearshore development, has the potential to impact beluga whale habitat (Moore et al. 2000, Lowry et al. 2006). However, predicting the type and magnitude of these impacts is difficult.

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

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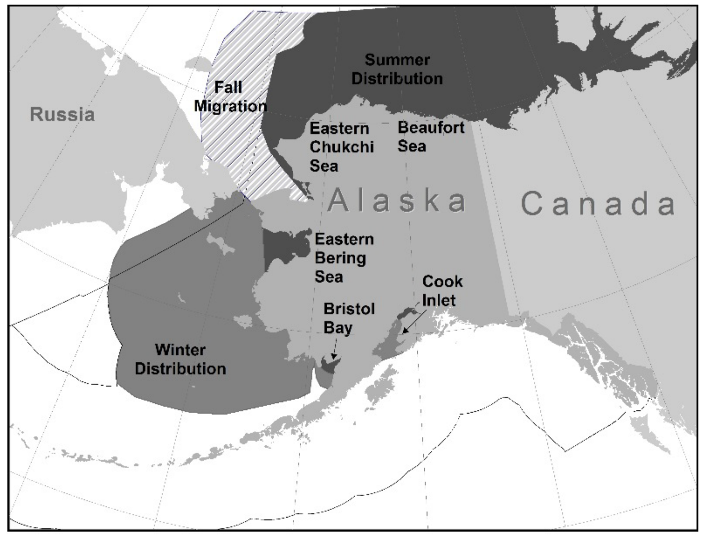

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The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering and Beaufort seas. Beaufort Sea beluga whales depart the Bering Sea in early spring, migrate through the Chukchi Sea and into the Canadian waters of the Beaufort 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. 2012; Shelden et al. 2015, 2018; Lowry et al. 2019) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

At least some of the Eastern Chukchi Sea beluga whales move along coastal areas in late June and animals are sighted in the area until about mid-July (Frost and Lowry 1990, Frost et al. 1993, Suydam et al. 2001). Data from satellite tags attached to Eastern Chukchi Sea beluga whales captured in Kasegaluk Lagoon during the summer showed these whales traveled 1,100 km north of the Alaska coastline, into the Canadian Beaufort Sea within 3 months (Suydam et al. 2001, Hauser et al. 2014). These movements indicated overlap in distribution with the Beaufort Sea beluga whale stock during late summer. Satellite-telemetry data from 24 whales tagged from 1998 to 2007 suggest variation in movement patterns for different age and/or sex classes during July to September (Suydam et al. 2005, Hauser et al. 2014). Compared to tagged adult females, tagged adult males used deeper waters and remained there for the summer. All beluga whales that moved into the Arctic Ocean (north of 75°N) were males, and males traveled through 90% pack ice to reach deeper waters in the Beaufort Sea and Arctic Ocean (79-80°N) by late July/early August. In September, males occupied the southern Canada Basin and Beaufort Sea shelf and slope, maintaining a small core area over Barrow Canyon and a larger core area over the eastern Canada Basin slope. In October, the male distribution shifted south and west, with one core area extending over the Beaufort Sea slope into Barrow Canyon and another over Herald Shoal in the Chukchi Sea. Adult females ranged from just offshore of the Kasegaluk Lagoon system to Barrow Canyon in July. In August, the distribution of females was limited to Barrow Canyon and the adjacent western Beaufort Sea shelf and slope. In September, the female distribution expanded to include the southern Canada Basin, before shifting south and west in October to the Chukchi Sea and western Beaufort Sea (Hauser et al. 2014). In late autumn, only six tags continued to transmit and those whales migrated south through the eastern Bering Strait into the northern Bering Sea, remaining north of Saint Lawrence Island during the winter (Hauser et al. 2014, Citta et al. 2017). A whale tagged in the eastern Chukchi Sea in 2007 overwintered in the waters north of Saint Lawrence Island during 2007/2008, then moved towards King Island in April and May before moving north through the Bering Strait in late May and early June (Suydam 2009).

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

POPULATION SIZE

Frost et al. (1993) estimated the minimum size of the Eastern Chukchi Sea beluga whale stock at 1,200 whales, based on whale counts from aerial surveys conducted from 1989 to 1991. Survey effort was concentrated sea side of the 170-km long Kasegaluk Lagoon, an area known to be regularly used by beluga whales during the open-water season. The offshore areas that these beluga whales are known to frequent were not surveyed. Therefore, the targeted surveys provided only a minimum count. If this count is corrected using radio-telemetry data for the proportion of whales that were diving and thus not visible at the surface (2.62: Frost and Lowry 1995), and for the proportion of newborns and yearlings not observed due to small size and dark coloration (1.18: Brodie 1971), the total corrected abundance estimate for the Eastern Chukchi Sea stock is 3,710 whales (1,200 × 2.62 × 1.18).

During 25 June to 6 July 1998, aerial surveys were conducted in the eastern Chukchi Sea (DeMaster et al. 1998). The maximum single day count (1,172 whales) was derived from a photographic count of a large aggregation near Icy Cape (1,018 whales), plus whales counted along an ice edge transect (154 whales). This count is an underestimate, because it was clear to the observers that many more whales were present along and in the ice than they were able to count and only a small portion of the ice edge habitat was surveyed. Furthermore, only one of five beluga whales equipped with satellite tags a few days earlier remained within the survey area when the peak count occurred (DeMaster et al. 1998). It is not possible to estimate abundance from the 1998 survey. Not only were a large number of whales unavailable for counting, but the large Icy Cape aggregation was in shallow, clear water (DeMaster et al. 1998) and a correction factor (to account for missed whales) does not exist for beluga whales encountered in such conditions.

In July 2002, aerial surveys were conducted again in the eastern Chukchi Sea (Lowry and Frost 2002). Those surveys resulted in a peak count of 582 whales. A correction factor for whales that were not visible for this count is not available. Offshore sightings during this survey combined with satellite-tag data collected in 2001 (Lowry and Frost 2001, 2002) indicate that nearshore surveys for beluga whales will only result in partial counts for this stock.

A new strategy for deriving a population abundance estimate for the Eastern Chukchi Sea stock of beluga whales was based on summer aerial survey data from the Beaufort Sea, after the stock had migrated through the eastern Chukchi Sea. Analyses of satellite telemetry data from beluga whales belonging to the Eastern Chukchi Sea and Beaufort Sea stocks (Hauser et al. 2014) identified an area in the Beaufort Sea (140°W to 157°W) and period (19 July-20 August) when the two stocks did not overlap (Lowry et al. 2017). These aerial surveys were conducted as part of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project in the northeastern Chukchi and Alaska Beaufort seas from 19 July to 20 August 2012-2017 (Clarke et al. 2018). A geographically stratified line-transect analysis that was based on the assumption that the Beaufort Sea and Eastern Chukchi Sea stocks are geographically segregated from mid-July through August (Hauser et al. 2014) resulted in the following population estimates of the Eastern Chukchi Sea beluga whales in the study area for each year from 2012 to 2017, respectively: 7,355 (CV=0.47), 6,813 (CV=0.47), 16,598 (CV=0.49), 6,456 (CV=0.48), 6,965 (CV=0.49) and 13,305 (CV=0.51) (Givens et al. 2019). These estimates incorporate a correction factor of 1.85 (Lowry et al. 2017) for whales that were submerged and, therefore, not visible to the aerial observers. These estimates do not account for whales that might have been outside the project area during the survey period.

The assumption that Eastern Chukchi Sea beluga whales are isolated from Beaufort Sea beluga whales is possibly flawed based on three lines of evidence: the assumption of a lack of overlap within the Alaska Beaufort Sea from late July to late August is based on satellite-tag data that are dated (few beluga whales from either stock have been tagged in the last decade); the assumed distribution of all Eastern Chukchi Sea and Beaufort Sea beluga whales in July and August cannot be determined from tags that were deployed at the same time and in locations that were too far apart for the tagged whales to overlap in July and August (all Eastern Chukchi Sea beluga whales were tagged near Point Lay in July and all Beaufort Sea beluga whales were tagged in the Mackenzie Delta mainly in July and in August, although numbers in these areas indicate the stocks were more wide-spread at this time); and genetic evidence from harvested beluga whales indicates that Beaufort Sea beluga whales are sometimes found in the Chukchi Sea in late July (O'Corry-Crowe et al. 2018). However, the Givens et al. (2019) abundance estimate reflects the best available data for Eastern Chukchi Sea beluga whales at this time.

Minimum Population Estimate

For the Eastern Chukchi Sea beluga whale stock, the minimum population estimate (N_{MIN}) is calculated according to 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 2017 population estimate of 13,305 and the associated coefficient of variation (CV) of 0.51, N_{MIN} for this stock is 8,875 whales; however, this N_{MIN} may be positively biased due to possible overlap between the Eastern Chukchi Sea and Beaufort Sea stocks of beluga whales during the survey in late July to late August.

Current Population Trend

There is no statistically significant trend in the abundance of the Eastern Chukchi Sea beluga whale stock inside the ASAMM study area from 19 July to 20 August in 2012-2017 (Givens et al. 2019). However, the interannual variation among the abundance estimates and the estimated CVs are both large.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Eastern Chukchi Sea 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 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 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2016). Therefore, the PBR for this stock is 178 beluga whales (8,875 × 0.02 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused mortality and serious injury for Eastern Chukchi Sea beluga whales between 2014 and 2018 is 56 beluga whales in subsistence takes by Alaska Natives. Potential threats most likely to result in direct human-caused mortality and serious injury of this stock include entanglement in fishing gear.

Fisheries Information

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed December 2020).

In the nearshore waters of the southeastern Chukchi Sea, substantial efforts occur in gillnet (mostly set nets) and personal-use fisheries. Although a potential source of mortality, there have been no reported beluga whale takes as a result of these fisheries and such incidental takes could be counted as subsistence harvest.

There were no reports of mortality or serious injury of this stock incidental to U.S. commercial fisheries or subsistence fisheries in Alaska between 2014 and 2018.

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Alaska Beluga Whale Committee (ABWC; 2000) to co-manage western Alaska beluga whale populations in the Bering Sea (including Bristol Bay), Chukchi Sea, and Beaufort Sea. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of beluga whales (to the maximum extent allowed by law) as a tool for conserving beluga whale populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

The subsistence take of Eastern Chukchi Sea beluga whales is reported by the ABWC. The most recent subsistence harvest estimates for the Eastern Chukchi Sea stock are provided in Table 1 (ABWC, unpubl. data, 2020). The annual subsistence take by Alaska Native hunters averaged 56 Eastern Chukchi Sea beluga whales landed between 2014 and 2018. It should be noted that beluga whales harvested at Utqiaġvik (formerly Barrow) in spring are assumed to be from the Beaufort Sea stock, while those harvested in summer are assumed to be from the Eastern Chukchi Sea stock.

Table 1. Summary of Eastern Chukchi Sea beluga whales landed by Alaska Native subsistence hunters between 2014 and 2018 (ABWC, unpubl. data, 2020). It should be noted that these harvest levels include takes from Kotzebue Sound (10 in 2014, 1 in 2015, 9 in 2016, 2 in 2017, and 15 in 2018; no data are available for struck and lost animals in Kotzebue Sound) which are likely from a population that is genetically distinct from the Eastern Chukchi Sea beluga whale stock. These are minimum estimates of the total number of beluga whales taken, because not all landed whales and struck and lost whales are consistently reported.

Year	Number landed	Number struck and lost	Total (landed + struck and lost)
2014	60	no data	60
2015	72	4	76
2016	23	0	23
2017	40	2	42
2018	80	0	80
Mean annual number (landed + struck and lost)			56

STATUS OF STOCK

No fishery-related mortality or serious injury has been reported for the Eastern Chukchi Sea stock of beluga whales between 2014 and 2018; therefore, the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries 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 beluga whales) is less than the PBR (178 whales). Eastern Chukchi Sea beluga whales are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. Therefore, the Eastern Chukchi Sea stock of beluga whales is not classified as a strategic stock. The historical level and overall population trend is unknown and, given the uncertainty of the data, we are unable at this time to assess the status of this stock relative to its Optimum Sustainable Population. Recent data indicate no statistically significant trend from 2012 to 2017 (Givens et al. 2019).

There are key uncertainties in the assessment of the Eastern Chukchi Sea stock of beluga whales. The proportion of the stock within the ASAMM study area during the survey period used in the Lowry et al. (2017) and Givens et al. (2019) abundance analyses is unknown. The assumption that the Eastern Chukchi Sea and Beaufort Sea stocks are geographically segregated during the July-August time period used in Lowry et al.'s (2017) and Givens et al.'s (2019) abundance estimates is based on a relatively limited number of whales tagged between 1993 and 2007. Beaufort Sea beluga whales are found in Kotzebue (Chukchi Sea) in July of some years, indicating that the two stocks may overlap in July. This may result in a positive bias in the estimate of abundance for the Eastern Chukchi Sea stock. Coastal subsistence fisheries can occasionally cause incidental mortality or serious injury of a beluga whale; these incidental takes used for subsistence purposes are not always reported to the ABWC as a fishery interaction and may be included in the subsistence harvest reports for the stock.

HABITAT CONCERNS

Evidence indicates that the arctic climate is changing rapidly and significantly, and one result of this change is a reduction in the extent and duration of sea ice in some regions (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, are sensitive to changes in arctic weather, sea-surface temperatures, and sea-ice extent, and the concomitant effect on prey availability. There are indications that decreases in seasonal sea ice have influenced beluga whale phenology. Eastern Chukchi Sea beluga whales tagged between 2004 and 2012 were distributed farther north and east in September-November than those tagged between 1993 and 2002 (Hauser et al. 2017). Further, the median date at which tagged whales departed the Beaufort and Chukchi seas during their southbound migrations was 14-33 days later overall in 2004-2012 versus 1993-2002 (Hauser et al. 2017). Decreases in seasonal sea ice may also increase the risk of killer whale predation (O'Corry-Crowe et al. 2016).

There are insufficient data to make reliable predictions of the effects of arctic climate change on beluga whales; however, Laidre et al. (2008) and Heide-Jørgensen et al. (2010) concluded that on a worldwide basis beluga whales were likely to be less sensitive to climate change than other arctic cetaceans because of their wide distribution and flexible behavior. Stafford et al. (2016) found that dive behavior of Eastern Chukchi Sea beluga whales was correlated to wind speed and direction. When winds were from the WSW, whales made shallow dives likely exploiting the front developed by the Alaska Coastal Current between the coast and the deep Arctic basin. Strong winds from the ENE resulted in deeper, longer dives (Stafford et al. 2016). East winds are increasing in the Arctic (Pickart et al. 2009), thus, beluga whales may be spending more time diving at greater depths. Increased human activity in the Arctic, including increased oil and gas exploration and development and increased nearshore development, has the potential to impact beluga whale habitat (Moore et al. 2000, Lowry et al. 2006). However, predicting the type and magnitude of these impacts is difficult.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

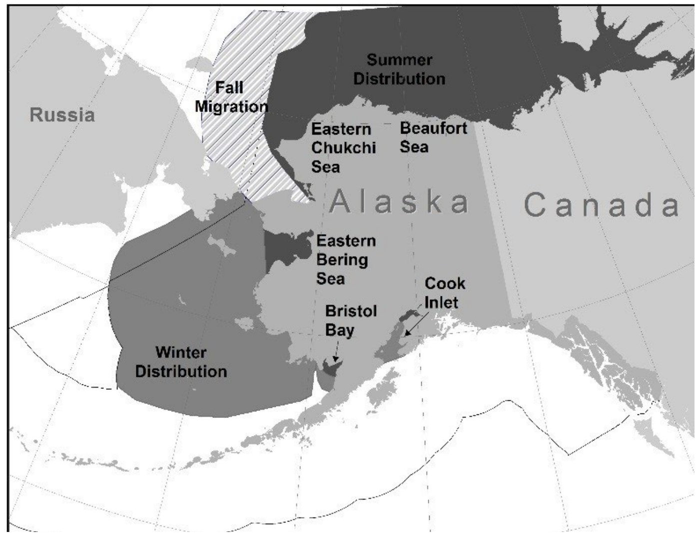

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration. The U.S. Exclusive Economic Zone is delineated by a black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

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

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

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

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

POPULATION SIZE

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

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

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

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

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

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) used for this stock is 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2023). Thus, the PBR for the Eastern Bering Sea stock is 267 beluga whales (11,112 × 0.024 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

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

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

Fisheries Information

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

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

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

Alaska Native Subsistence/Harvest Information

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

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

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

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

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

STATUS OF STOCK

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

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

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

HABITAT CONCERNS

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

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

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

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BELUGA WHALE (*Delphinapterus leucas*): Bristol Bay Stock

NOTE – April 2022: NMFS is evaluating whether scientific issues raised by co-management partners in November 2021 concerning the Eastern Bering Sea beluga whale Stock Assessment Report may also be applicable to the Bristol Bay beluga whale Stock Assessment Report. Any resulting changes will be reflected in a future Stock Assessment Report.

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). Data from satellite transmitters attached to beluga whales from the Beaufort Sea, Eastern Chukchi Sea, 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 (Suydam 2009, Citta et al. 2017, Lowry et al. 2019).

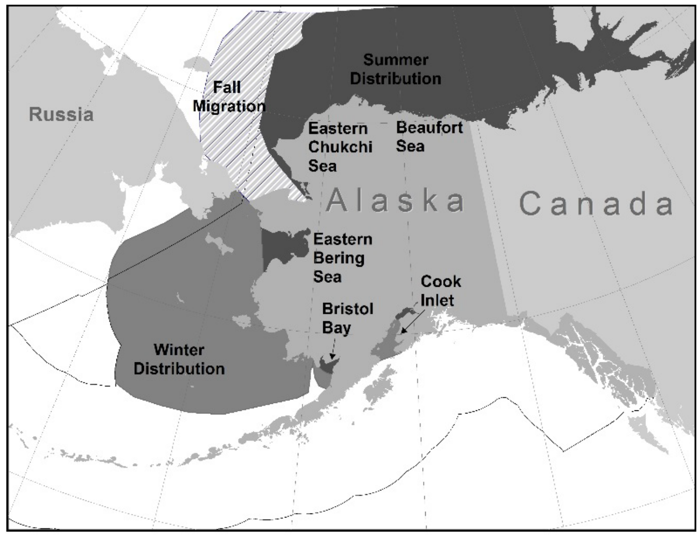

Figure 1. Approximate distribution for all five beluga whale stocks. The Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay beluga whale stocks summer in the Beaufort Sea (Beaufort Sea and Eastern Chukchi Sea stocks) and Bering Sea (Eastern Bering Sea and Bristol Bay stocks); they 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.

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

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 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. 2012; Shelden et al. 2015, 2018; Lowry et al. 2019) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

Summer movement patterns of Bristol Bay beluga whales were determined from satellite-linked tags deployed on 10 animals in the Kvichak River in 2002 and 2003 and 22 whales in the Nushagak River from 2006 to 2011 (Citta et al. 2016). Those whales used the shallow upper portions of Kvichak and Nushagak bays between May and August (Quakenbush 2003) and remained in the nearshore waters of Bristol Bay throughout September and October (Quakenbush and Citta 2006). Data from two beluga whales whose tags transmitted into December and January showed they were in Nushagak and Kvichak bays, suggesting that some beluga whales do not leave the nearshore waters of Bristol Bay during the winter (Citta et al. 2017). Tags attached to whales in 2012, 2013, 2014, and 2016 confirmed these movement observations (NMFS and Alaska SeaLife Center, unpubl. data; https://www.fisheries.noaa.gov/resource/document/2014-cook-inlet-beluga-whale-science-conference-presentations, accessed December 2020).

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

POPULATION SIZE

The sources of information to estimate abundance for beluga whales in the waters of western and northern Alaska have included both opportunistic and systematic observations. Frost and Lowry (1990) compiled data collected from aerial surveys conducted in Bristol Bay between 1978 and 1987 that were specifically designed to estimate the beluga whale population. Surveys focused on areas where beluga whales had been found to aggregate during the summer. Frost and Lowry (1990) reported an estimate of 1,000-1,500 whales for Bristol Bay, similar to that reported by Seaman et al. (1985). In 1994, the abundance was estimated at 1,555 beluga whales (Lowry and Frost 1998). That estimate was based on a maximum count of 503 whales, which was corrected using radio-telemetry data for the proportion of whales that were diving and thus not visible at the surface (2.62: Frost and Lowry 1995) and for the proportion of newborns and yearlings not observed due to their small size and dark coloration (1.18: Brodie 1971). The Alaska Department of Fish and Game and the Alaska Beluga Whale Committee (ABWC) conducted aerial beluga whale surveys in Bristol Bay in 1999, 2000, 2004, 2005, and 2016, with average counts of 444, 421, 609, 637, and 660 whales, respectively (Lowry et al. 2008, Lowry et al. 2019). The data from the 2004 and 2005 surveys result in an average count of 623 (coefficient of variation (CV) = 0.25) and, using the correction values above, a population estimate of 1,926 beluga whales (623 × 2.62 × 1.18). Using the count from the 2016 surveys and the correction values that have been applied in the past yields an estimated abundance of 2,040 beluga whales (CV = 0.26) in 2016 (660 × 2.62 × 1.18).

The Bristol Bay stock of beluga whales is genetically distinct. Citta et al. (2018) used a POPAN Jolly-Seber model to estimate abundance using genetic mark-recapture methods. Of the 516 individual whales identified from skin biopsies collected between 2002 and 2011, 75 beluga whales were identified (recaptured) in separate years, resulting in an estimate of 1,928 beluga whales (95% CI: 1,611-2,337), not including calves, which were not sampled (Citta et al. 2018).

Minimum Population Estimate

The survey technique used for estimating the abundance of beluga whales in this stock is a direct count which incorporates correction factors for submerged whales and calves. The abundance estimate is thought to be conservative because no correction was made for whales that were at the surface but were missed by the observers (Lowry and Frost 1998). The minimum population estimate (N_{MIN}) for the Bristol Bay beluga whale stock is calculated according to 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) from the 2016 surveys of 2,040 and the CV of 0.26, N_{MIN} for the Bristol Bay stock is 1,645 beluga whales.

Current Population Trend

After a period of growth observed during surveys conducted from 1993 to 2005 where the population increased by 65% (Lowry et al. 2008), the estimate obtained from a survey conducted in 2016 was similar to those in 2004 and 2005 (Citta et al. 2019). Citta et al. (2019) concluded that population growth has now slowed or ceased entirely.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The estimated rate of increase in beluga whale abundance in Bristol Bay from 1993 to 2005 was 4.8% per year (95% CI: 2.1%-7.5%: Lowry et al. 2008); however, because this estimate has a large CV, the default cetacean maximum net productivity rate (R_{MAX}) of 4% (NMFS 2016) will be used for this stock. It is not clear why the stock increased at this rate between 1993 and 2005, but possibilities include recovery from research kills in the 1960s, a reduction in subsistence harvests, and a delayed response to increases in salmon stocks (Lowry et al. 2008). Genetic mark-recapture estimates that include whales sampled between 2002 and 2011 and the most recent aerial estimate from 2016 suggest the population growth previously observed has slowed or ceased (Citta et al. 2019, Lowry et al. 2019).

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 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2016, Lowry et al. 2019). Using the N_{MIN} of 1,645, calculated from the 2016 aerial survey estimate of 2,040 (CV = 0.26), PBR for this stock is 33 beluga whales (1,645 × 0.02 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 Bristol Bay beluga whales between 2014 and 2018 is 19 beluga whales: 19 in subsistence takes by Alaska Natives (including one take in a subsistence salmon set gillnet fishery), and 0.2 incidental to Marine Mammal Protection Act (MMPA)-authorized research. Estimates of mortality and serious injury incidental to Bristol Bay fisheries are likely to be underestimated because observers have never monitored the Bristol Bay commercial salmon set gillnet and drift gillnet fisheries, there is substantial participation in the subsistence salmon gillnet fishery in Bristol Bay but no established protocol for reporting incidental takes in non-commercial fisheries to NMFS, and beluga whales taken incidental to personal-use or commercial salmon fisheries may be used by Alaska Natives for subsistence purposes and may be reported as subsistence takes. 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 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).

No beluga whale mortality or serious injury was observed incidental to U.S. commercial fisheries in Alaska between 2014 and 2018.

The Bristol Bay commercial salmon set gillnet and drift gillnet fisheries combined had 2,841 active permits listed in the NMFS 2019 LOF (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed December 2020). These fisheries are known to have caused mortality of Bristol Bay beluga whales (Frost et al. 1984). However, complete data on incidental takes of this stock are not available because there have never been observer programs in these commercial fisheries, and there is no reporting requirement for takes in personal-use fisheries.

It should be noted that in western Alaska, beluga whales taken incidental to personal-use or commercial salmon fisheries may be used by Alaska Natives for subsistence purposes and may be included in the subsistence harvest data reported below. For example, one beluga whale that entangled in a Bristol Bay subsistence salmon set gillnet in 2014 was known to be used for subsistence purposes and is included in the subsistence harvest data for 2014-2018 (Table 1; ABWC, unpubl. data; Young et al. 2020).

The minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2014 and 2018 is zero beluga whales from this stock; however, a reliable estimate of the mortality rate incidental to U.S. commercial fisheries is not available because most coastal commercial fisheries that overlap with this stock have never been observed.

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the ABWC (2000) to co-manage western Alaska beluga whale populations in the Bering Sea (including Bristol Bay), Chukchi Sea, and Beaufort Sea. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of beluga whales (to the maximum extent allowed by law) as a tool for conserving beluga whale populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

The subsistence take of Bristol Bay beluga whales is reported by the ABWC. The most recent subsistence harvest estimates for the Bristol Bay stock are provided in Table 1 (ABWC, unpubl. data, 2020). The annual subsistence take by Alaska Native hunters averaged 19 Bristol Bay beluga whales landed between 2014 and 2018.

Table 1. Summary of Bristol Bay beluga whales landed by Alaska Native subsistence hunters between 2014 and 2018 (ABWC, unpubl. data, 2020). These are minimum estimates of the total number of beluga whales taken, because not all landed whales and struck and lost whales are consistently reported.

Year	Number landed	Number struck and lost	Total (landed + struck and lost)
2014	27	0	27
2015	22	2	24
2016	19	1	20
2017	10	no data	10
2018	11	2	13
Mean annual number (landed + struck and lost)			19

Other Mortality

Mortality and serious injury may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. In 2016 there was a report of one beluga whale mortality incidental to research on the Bristol Bay stock (Table 2; Young et al. 2020), resulting in a mean annual mortality and serious injury rate of 0.2 beluga whales from this stock between 2014 and 2018.

Table 2. Summary of Bristol Bay beluga whale mortality and serious injury, by year and type, reported to the NMFS Office of Protected Resources between 2014 and 2018 (Young et al. 2020). Beluga whales with non-serious injuries were excluded.

Cause of Injury	2014	2015	2016	2017	2018	Mean annual mortality
Incidental to MMPA-authorized research	0	0	1	0	0	0.2
Total incidental to MMPA-authorized research						0.2

STATUS OF STOCK

No fishery-related mortality or serious injury has been reported for the Bristol Bay beluga whale stock between 2014 to 2018; therefore, the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries can be considered insignificant and approaching a zero mortality and serious injury rate. Bristol Bay beluga whales are not designated as depleted under the MMPA or listed as threatened or endangered under the

Endangered Species Act. Because the minimum estimate of the mean annual human-caused mortality and serious injury rate (19 beluga whales) is less than the PBR (33), the Bristol Bay stock of beluga whales is not classified as a strategic stock. However, as noted previously, the estimate of fisheries-related mortality and serious injury is likely underestimated.

There are key uncertainties in the assessment of the Bristol Bay stock of beluga whales. The abundance is based on count data that are corrected for the proportion of whales that are diving and the proportion of newborns and yearlings not observed because of their size and coloration; however, the counts are not corrected for whales which are at the surface but missed by the observers. Although the apparent population rate of increase was quite high from 1993 to 2005, which may indicate that the population was depleted and reduced human-related mortality and serious injury allowed an increase, most coastal commercial fisheries that overlap with this stock have never been observed. Therefore, the mortality and serious injury of Bristol Bay beluga whales in commercial fisheries could be underestimated. Coastal subsistence fisheries for salmon will occasionally cause incidental mortality or serious injury of a beluga whale; these incidental takes used for subsistence purposes may not always be reported to the ABWC for inclusion in the subsistence harvest estimates for this stock.

HABITAT CONCERNS

Evidence indicates that climate is changing significantly in the Bristol Bay region. One result of the change is a reduction in the extent and duration of sea ice in the winter (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in Bristol Bay. Ice-associated animals, such as the beluga whale, are sensitive to changes in weather, sea-surface temperatures, and sea-ice extent, and the concomitant effect on prey availability. Decreases in seasonal sea ice may also increase the risk of killer whale predation (O'Corry-Crowe et al. 2016). There are insufficient data to make reliable predictions of the effects of climate change on beluga whales; however, Laidre et al. (2008) and Heide-Jørgensen et al. (2010) concluded that on a worldwide basis beluga whales were likely to be less sensitive to climate change in general than other arctic cetaceans because of their wide distribution and flexible behavior. However, local changes in distribution and seasonal behavior are likely to occur (Hauser et al. 2017). Increased human activity in the Bristol Bay region, including increased oil and gas exploration and development and increased nearshore development and mining activities near large tributaries, has the potential to impact habitat for beluga whales (Lowry et al. 2006, Norman et al. 2015). However, predicting the type and magnitude of these impacts is difficult.

In all cases, increased human activities in or near coastal areas of Bristol Bay will increase anthropogenic noise in the water, which has been shown to have negative impacts on cetacean feeding and communication (Norman et al. 2015, Small et al. 2017). Studies of beluga whales in Bristol Bay found that some individuals have "sensitive hearing that approaches the lower levels of noise within their habitat" (Mooney et al. 2018). This may be a result of living in an acoustically quiet environment, which allows for a large dynamic range of hearing. However, if the ambient noise were to increase due to increased anthropogenic activities, masking of calls may occur. This is a particular concern for cow/calf pairs because calves have been shown to vocalize at lower amplitudes than their mothers (Vergara 2019). If ambient or anthropogenic noise levels increase, cow/calf pairs may lose the ability to communicate effectively. Additionally, masking can reduce the range of acoustic detection of prey and communication in cooperative feeding.

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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).

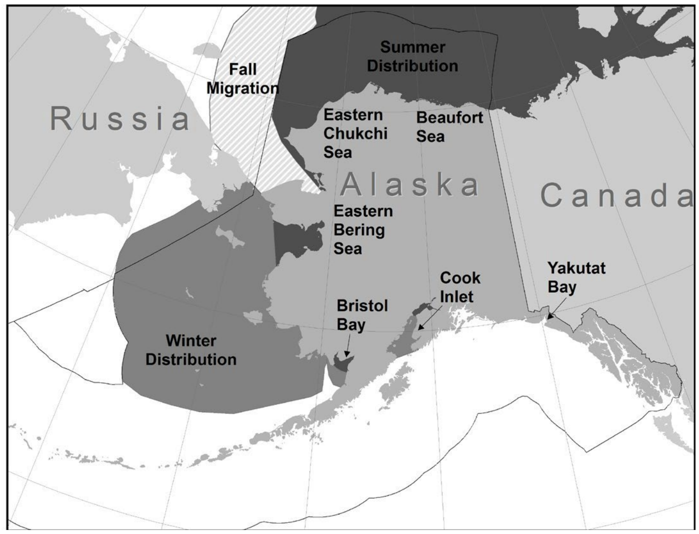

Figure 1. Approximate distribution for all five beluga whale stocks. The Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay beluga whale stocks summer in the Beaufort Sea (Beaufort Sea and Eastern Chukchi Sea stocks) and Bering Sea (Eastern Bering Sea and Bristol Bay stocks); they 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 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.

During 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 locations occurred within Cook Inlet, primarily in the upper inlet north of East and West Foreland, with some whales briefly 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).

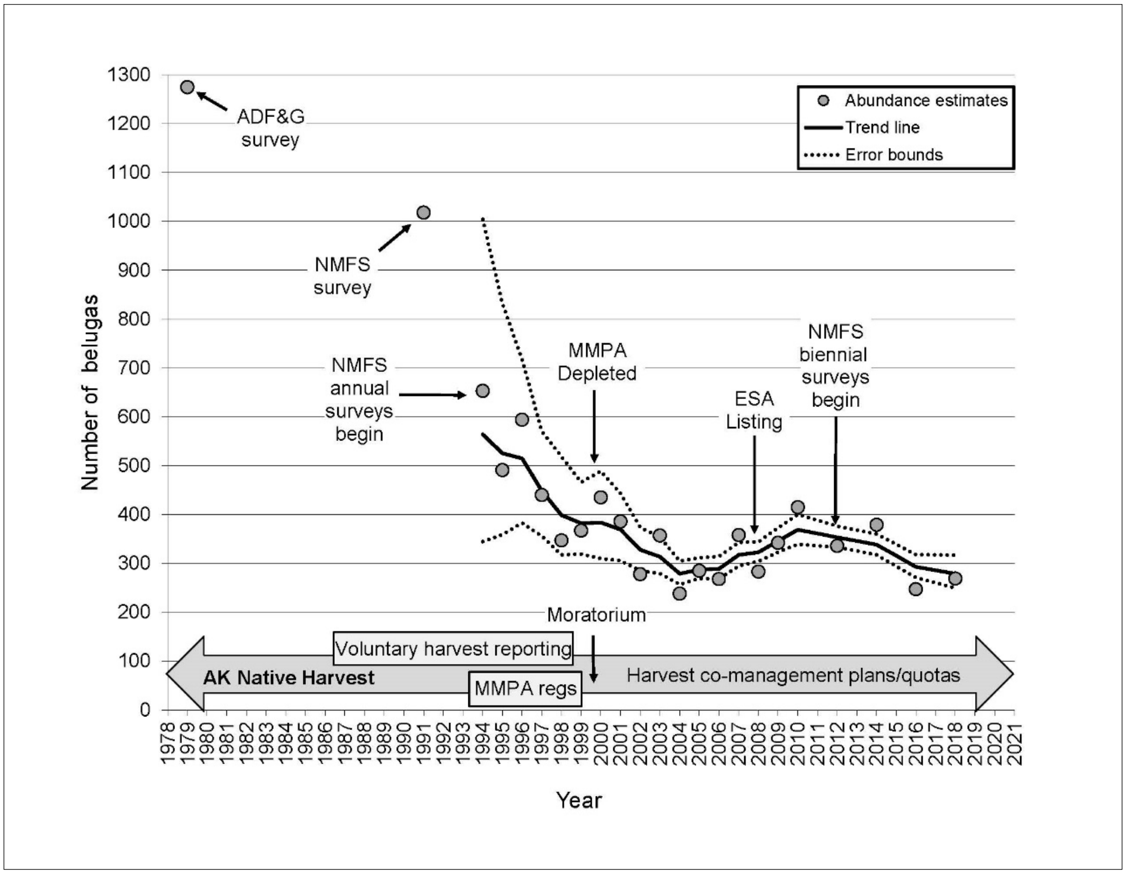

Figure 2. Annual abundance estimates (circles) of beluga whales in Cook Inlet, Alaska, 1979-2018 (Calkins 1989, Hobbs et al. 2015a, Shelden et al. 2015, Shelden and Mahoney 2016, Wade et al. 2019). The solid line from 1994 to 2018 is a weighted moving average of the abundance estimates that represents 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). 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 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 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). 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 2015 and 2019 is listed, by marine mammal stock, in Freed et al. (2021); 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 2015 and 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 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 (2001-2003). 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 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 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). 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-annual-stranding-reports, accessed December 2021). Most beluga whales involved in live stranding events survive, although some associated deaths may not be observed if whales die later from related injuries (Vos and Shelden 2005, Burek-Huntington et al.

2015). Between 2015 and 2019, there were reports of approximately three beluga whales involved in two known live stranding events (Table 1; NMFS 2016b; McGuire et al. 2020b; NMFS, unpubl. data). The beluga whale calf that stranded alive in 2017 was sent to the Alaska SeaLife Center for rehabilitation; 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.

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 2015 and 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)
2015	3	2 (0)
2016	8	0
2017	12	1*
2018	7	0
2019	13	0
Total	43	3 (0)

*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). 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 2015 through 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.

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); therefore, 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. Currently, there is not a subsistence harvest and direct human-caused mortality due to fisheries bycatch, 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

Based on available information, beluga whales remain within Cook 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 (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 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 has the potential to mask beluga whale communication and hearing, and the potential reduction of communication and echolocation range is considerable. It is unknown 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).

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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NARWHAL (*Monodon monoceros*): Unidentified Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Narwhals are found year-round north of 60°N, primarily in the waters of the Canadian Arctic, Hudson Bay, Baffin Bay, Davis Strait, West Greenland, East Greenland, and the waters around Svalbard, Franz Josef Land, and Novaya Zemyla (Gjertz 1991, Jefferson et al. 2012, Higdon and Ferguson 2014) While large aggregations are found in eastern Arctic waters, they rarely occur in the western Arctic, namely the East Siberian, Bering, Chukchi, and Beaufort seas (COSEWIC 2004) (Fig. 1). The three recognized narwhal populations are based on geographic separation: Baffin Bay, Hudson Bay, and East Greenland (DFO 1998a, 1998b; COSEWIC 2004). The Baffin Bay population summers in the waters along West Greenland and the Canadian High Arctic and overwinters in Baffin Bay and Davis Strait (Koski and Davis 1994, Dietz et al. 2001, Heide-Jørgensen et al. 2003). Narwhals from the northwest Hudson Bay population are thought to overwinter in eastern Hudson Strait (Richard 1991). The East Greenland population is believed to winter in the pack ice between eastern Greenland and Svalbard (Dietz et al. 1994). A poorly described population inhabits the waters around Svalbard, Franz Josef Land, and Novaya Zemyla (Gjertz 1991, Lydersen et al. 2007). The amount of interchange between these populations is unknown. Populations are defined for management purposes, and these designated populations may actually consist of several populations (COSEWIC 2004). Population definition based on molecular genetic studies of narwhals remains unresolved at this time due to extremely low genetic variability within and among management stocks (Palsbøll et al. 1997; de March et al. 2001, 2003).

Figure 1. Potential distribution of narwhals in arctic waters based on extralimital sightings and strandings (George and Suydam, unpubl. ms.; Reeves and Tracey 1980; COSEWIC 2004).

Local observations and traditional ecological knowledge are the primary source for any data on narwhals in Alaska waters, dating back to the 1800s (Bee and Hall 1956; Geist et al. 1960; Noongwook et al. 2007; George and Suydam, unpubl. ms.). The earliest record dates back to 1874, with most occasional sightings occurring around the area east of Point Barrow (Scammon 1874, Ray and Murdoch 1885, Turner 1886, Nelson and True 1887, Murdoch 1898, MacFarlane 1905, Dufresne 1946, Anderson 1947, Bee and Hall 1956, Geist et al. 1960). Narwhal occurrences are reported in Bee and Hall (1956) from Point Barrow to the Colville River Delta. Ljungblad et al. (1983) reported a sighting of two male narwhals northwest of King Island in the Bering Sea, during a systematic scientific survey. Sightings have occurred in Russian waters of the northern Chukchi Sea (Yablokov and Bel'kovich 1968, Reeves and Tracey 1980). George and Suydam (unpubl. ms.) summarized observations from Alaska Native hunters during eight sightings of narwhals in the Chukchi and Beaufort seas between 1989 and 2008. Of these records, seven sightings were live animals totaling 11-12 individuals; one record was of a beachcast narwhal tusk at Cape Sabine. Four of the seven live narwhal sightings consisted of mixed groups of belugas and narwhals (George and Suydam, unpubl. ms.).

Several narwhal specimens collected in Alaska have been documented. Murie (1936) reported a single tusk that was found on a sandbar at Cape Chibukak, St. Lawrence Island. Huey (1952) reported on a specimen collected near Cape Halkett, Harrison Bay, at the mouth of the Colville River, in the Beaufort Sea. Three additional specimen records from various locations were documented in Geist et al. (1960): one specimen was found on the beach of Kiwalik Bay (Kotzebue Sound), another was initially sighted alive at the mouth of the Caribou River in Nelson Lagoon (Alaska Peninsula) but later died, and a third specimen was a tusk found on a beach near Wainwright, on the Chukchi Sea.

It is believed that these incidental narwhal records that occurred in the Beaufort, Chukchi, and Bering seas and Bristol Bay are whales from the Baffin Bay population, which are known to move into the Canadian Arctic Archipelago and as far north and west as ice conditions will permit (COSEWIC 2004). However, there is no evidence or method to confirm this. There are insufficient data to apply the phylogeographic approach to stock structure (Dizon et al. 1992) for narwhals.

POPULATION SIZE

Reliable estimates of abundance for narwhals in Alaska are currently unavailable.

Minimum Population Estimate

At this time, it is not possible to produce a reliable minimum population estimate (N_{MIN}) for this stock, as current estimates of abundance are unavailable.

Current Population Trend

At present, reliable data on trends in population abundance are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for narwhals in Alaska. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the 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 these stocks is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). However, in the absence of a reliable estimate of a minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

There are no U.S. commercial fisheries operating within the normal range of narwhals in Alaska. There are no observer program records of narwhal mortality or serious injury incidental to commercial fisheries in Alaska. The estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries is zero.

Subsistence/Native Harvest Information

There is no known subsistence harvest of narwhals by Alaska Natives.

STATUS OF STOCK

Narwhals are not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. Reliable estimates of the minimum population, population trend, PBR, and status of the stock relative to its Optimum Sustainable Population are currently not available. There are no federal or state commercial fisheries operating in the marine waters of the Arctic, and there are no reports of mortality or serious injury of narwhals in Alaska, therefore, the mean annual mortality and serious injury rate is considered insignificant and approaching zero. The estimated annual rate of human-caused mortality and serious injury is believed to be zero for this stock. Thus, the Unidentified stock of narwhals in Alaska is not classified as strategic.

HABITAT CONCERNS

Narwhals tend to prefer heavy ice cover in the winter and animals studied in Baffin Bay chose areas associated with high concentrations of Greenland halibut, which correspond to the coldest bottom temperatures (Laidre et al. 2004b; Laidre and Heide-Jørgensen 2005b, 2011). Narwhals wintering in Hudson Strait are also found in ice-covered areas of deep water, but the maximum depths are much shallower than the areas used by narwhals in Baffin Bay (Laidre et al. 2003, 2004a). As the Arctic warms through climate change, ice cover will be thinner, form later, melt earlier, and be less predictable. A warming Arctic will also see changes in ocean currents which create conditions that support concentrations of winter narwhal prey species, such as Greenland halibut. This may result in a shift in distribution of narwhals and their prey, requiring changes in migration timing, as well as destinations

(Kovaks and Lydersen 2008; Laidre et al. 2008, 2010, 2015). An increased risk of ice entrapment is associated with the changes in sea-ice formation, because seasonal cues for the timing of freeze up have changed and because later freezing may result in large expanses of open water freezing at one time (Heide-Jørgensen et al. 2002, Heide-Jørgensen and Laidre 2004, Laidre and Heide-Jørgensen 2005a, Laidre et al. 2012).

In addition to changing sea ice, narwhals are threatened by a number of changes associated with warming of the Arctic, including increased shipping and development, which adds noise; risk of pollution and ship strikes; risk of predation by killer whales (*Orcinus orca*) (Laidre et al. 2006); shifts in prey abundance and distribution; and exposure to novel diseases (Laidre et al. 2015).

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KILLER WHALE (*Orcinus orca*): Eastern North Pacific Alaska Resident Stock

NOTE – NMFS has genetic information on killer whales in Alaska that indicates the current stock structure of killer whales in Alaska needs to be reassessed (Parsons et al. 2013). NMFS is evaluating this genetic information, along with all other available data that inform stock structure (e.g., movements, tagging data, social association patterns, call types, etc.; see Martien et al. 2019). Should the evaluation identify a 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

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported occurring in tropical waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade 2006). Seasonal and year-round occurrence of killer whales has been noted along the entire Alaska coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Killer whales from these areas have been labeled as "resident," "transient," or "offshore" type killer whales (Bigg et al. 1990, Ford et al. 2000, Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of recognizable individuals in photographs, movements of whales and pods between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994, Black et al. 1997, Dahlheim and White 2010).

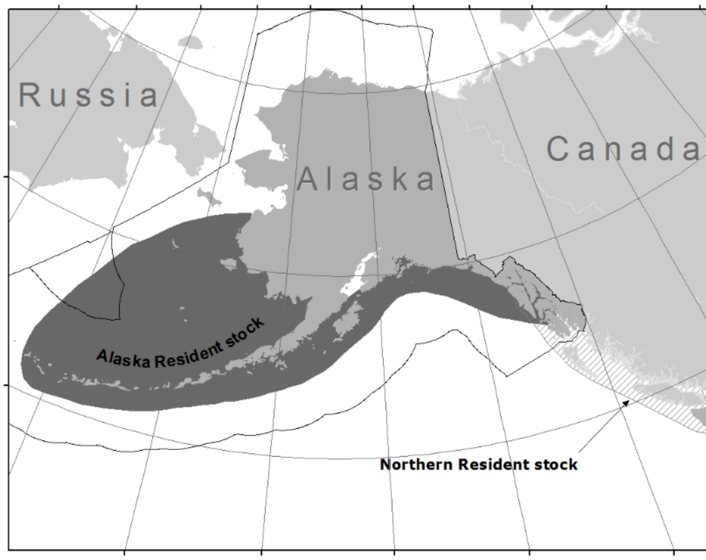

Figure 1. Approximate distribution of resident killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

Several studies provide evidence that the resident, offshore, and transient ecotypes are genetically distinct in both mtDNA and nuclear DNA. Genetic differences have also been found between populations within the transient and resident ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). A global genetic study of killer whales using the entire mitochondrial genome found that some killer whale ecotypes represent deeply divergent evolutionary lineages and warrant elevation to species or subspecies status (Morin et al. 2010). In particular, estimates from mitogenome sequence data indicate that transient killer whales diverged from all other killer whale lineages approximately 700,000 years ago. Some researchers now refer to transient-type killer whales as Bigg's killer whales (e.g., Ford 2011, Riesch et al. 2012), in tribute to the late Dr. Michael Bigg.

Based on data regarding association patterns (Matkin et al. 2010), acoustics (Ford 1989, 1991; Yurk et al. 2002; Matkin et al. 2007), movements (Matkin et al. 2010), and genetic differences (Hoelzel and Dover 1991; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000), eight killer whale stocks are now recognized within the Pacific U.S. Exclusive Economic Zone: 1) the Alaska Resident stock - occurring from Southeast Alaska to the Aleutian Islands and Bering Sea (Fig. 1), 2) the Northern Resident stock - occurring from Washington State through part of Southeast Alaska, 3) the Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from Southeast Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast Transient stock - occurring from California through Southeast Alaska, 7) the Offshore stock - occurring from California through Alaska, and 8) the Hawaiian stock. Transient killer whales in Canadian waters are considered part of the West Coast Transient stock. The Southern Resident, Offshore, and Hawaiian stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

The Alaska Resident stock includes killer whales from Southeast Alaska to the Aleutian Islands and Bering Sea.

Gulf of Alaska

Long-term photo-identification studies by the North Gulf Oceanic Society (NGOS) and collaborators have provided minimum counts for resident killer whales belonging to the Alaska Resident stock in Prince William Sound, Kenai Fjords, Kodiak, and Southeast Alaska (e.g., Matkin et al. 1999, 2014). For the time period 2005-2012, this resulted in a minimum count of 121 whales for Southeast Alaska and 751 whales for Prince William Sound, Kodiak, and Kenai Fjords (Table 1). NGOS has updated the counts for many of the pods seen most frequently in more recent years and has documented the most recent count for those pods on their website (https://www.whalesalaska.org/salmon-specialist-residents, accessed May 2023); most pods have continued to increase in size. Those updated counts result in revised minimum counts of 137 whales for Southeast Alaska and 784 whales for Prince William Sound, Kodiak, and Kenai Fjords, for a total of 921 for the Gulf of Alaska for the years 2005-2019 (years in parentheses in Table 1 represent the most recent year a count is available for each pod).

Aleutian Islands and Bering Sea

Beginning in 2001, dedicated killer whale studies were initiated by the NMFS Marine Mammal Laboratory (MML) in Alaska waters, including the Aleutian Islands and Bering Sea (e.g., Fearnbach et al. 2012, 2014; Zerbini et al. 2007), and by the NGOS in the eastern Aleutians. For the first 3 years (2001-2003), MML conducted killer whale line-transect surveys in July and August. These surveys covered an area from approximately Resurrection Bay in the Kenai Fjords area to the central Aleutians. The surveys covered an area from shore to 30-45 nautical miles offshore, with randomly located transects in a zigzag pattern. A total of 9,053 km of tracklines were surveyed between the Kenai Peninsula (~150°W) and Amchitka Pass (~179ºW). A total of 41 on-effort sightings of killer whales were recorded, with an additional 16 sightings off-effort. Estimated abundance of resident killer whales from these surveys was 991 (CV = 0.52), with a 95% confidence interval of 380-2,585 (Zerbini et al. 2007). However, the first four strata of that survey overlap with the NGOS photo-identification study areas around Kodiak and Kenai Fjords. The estimated abundance for strata 1-4 was 208 (Zerbini et al. 2007: Table 4). Subtracting 208 from 991 leaves a line-transect abundance estimate of 783 for the areas from Kodiak to the west.

Identification photographs were collected on those and subsequent MML biopsy and tagging surveys from 2001 to 2010 and on NGOS surveys (2001-2005). These two data sets were matched and reconciled, with Fearnbach et al. (2014: Table 2, areas 4-8) reporting a total of 999 distinct individuals for the Aleutian Islands and Bering Sea from 2001 to 2010.

The line-transect surveys provide an "instantaneous" (across ~40 days) estimate of the number of resident killer whales in the survey area. It should be noted that the photographic catalog encompasses a larger area, including some data from areas such as Prince William Sound and the Bering Sea that were outside the line-transect survey area. Additionally, the number of whales in the photographic catalog is a documentation of all whales seen in the area over the time period of the catalog; movements of some individual whales have been documented between the line-transect survey area and locations outside the survey area. Accordingly, a larger number of resident killer whales may use the line-transect survey area at some point over the 3 years than would necessarily be found at one time in the survey area in July and August in a particular year.

Using essentially the same combined dataset of photographs from MML and NGOS, Fearnbach (2014) used photographic mark-recapture methods to estimate abundance of resident killer whales in the coastal waters (typically within 30 km from the shore or continental shelf edge) around the central and eastern Aleutians (~160°W to 180°), and extending northwards up the Bering Sea shelf edge to the Pribilof Islands (~57°N). The yearly estimates ranged from 732 (95% highest density probability intervals = 493-1,561) to 2,260 individuals (95% highest density probability intervals = 1,255-4,112) using this area annually during summer sampling periods from 2001 to 2010. These estimates refer to the number of whales using (rather than necessarily resident in) these coastal waters during an annual May-September sampling period. Of these, the highest estimate is thought to be the best representation of summer abundance in this region, as it was obtained in the year (2002) when there was the greatest extent of survey effort (Fearnbach 2014).

In summary, for resident type killer whales in the areas west of Kodiak, primarily the Aleutian Islands and Bering Sea, there is a line-transect estimate of 783 (CV = 0.52) for the years 2001-2003 (Zerbini et al. 2007: Table 4, strata 5-16), mark-recapture estimates ranging from 732 to 2,260, with the highest estimate of 2,260 (CV = 0.32) occurring in the year 2002 (Fearnbach 2012), and a minimum count of unique identified individual whales of 999 whales for the years 2001-2010 (Fearnbach et al. 2014: Table 2, areas 4-8). These estimates are relatively consistent with one another. For the sake of consistency across areas, the minimum count of unique identified individuals (999) will be used for the Aleutian Islands and Bering Sea area.

Total for Alaska

The number of unique identified individual whales in the Gulf of Alaska is 921, with the estimates for different pods occurring in different years, ranging from 2005 to 2019 (Table 1). The only available number of unique identified individuals for the Aleutian Islands and Bering Sea is 999, for the years 2001 to 2010. Combining those two counts results in a total for Alaska of 1,920 resident killer whales (Table 1).

Minimum Population Estimate

For the Gulf of Alaska, a minimum count of photographically identified whales for Prince William Sound, Kodiak, Kenai Fjords, and Southeast Alaska results in a total of 921 whales for the years 2005-2019 (the years in parentheses in Table 1 represent the most recent years a count is available for each pod). Although some of the counts are fairly old, nearly all pods that have been recently counted have continued to increase, suggesting this number can still represent a conservative estimate of the minimum number of resident killer whales in the Gulf of Alaska. Therefore, we use this estimate even though parts of it are older than 8 years because there is reasonable assurance the population has not declined in the Gulf of Alaska.

For the Aleutian Islands and Bering Sea, the minimum count of photographically identified whales is 999 for the years 2001 to 2010. This is a minimum count over a 10-year period, so some identified whales could have died by the end of the study in 2010. However, there are two reasons to suggest this number can be used as a minimum abundance estimate. First, the great majority of whales in this study were only seen in one year, meaning that capture probability was relatively low, suggesting there are a large number of distinctive whales that have never been identified. This is supported by annual mark-recapture estimates for a portion of the area that are much higher than the number of identified individuals in each year (Fearnbach 2012). Second, Fearnbach (2012) used photo identification data to estimate that the proportion of the population that was distinctive was, on average, 0.67, with annual estimates ranging from 0.59 to 0.73. Therefore, the number of identified whales represents only about two-thirds of the total population, meaning that number should be re-scaled by ~1.5 to account for whales (mainly younger animals) that are not sufficiently marked to be distinctive and thus are unable to be re-identified. Therefore, we use this estimate as a minimum abundance for the Aleutians and Bering Sea even though it is older than 8 years, because there is reasonable assurance the true abundance of resident killer whales is much greater than the number counted.

Therefore, the minimum population estimate (N_{MIN}) for resident-type killer whales in Alaska is 1,920, based on adding 921 identified individuals from the Gulf of Alaska with 999 identified individuals from the Aleutian Islands and Bering Sea.

Current Population Trend

Data from Matkin et al. (2003, 2014) indicate that the component of the Alaska Resident stock that summers in the Prince William Sound and Kenai Fjords area is increasing. With the exception of AB pod, which declined drastically after the *Exxon Valdez* oil spill and has not yet recovered, the component of the Alaska Resident stock in the Prince William Sound and Kenai Fjords area increased 3.2% (95% CI = 1.94 to 4.36%) per year from 1990 to 2005 (Matkin et al. 2008); the 10 pods seen most frequently increased by 3.4% per year from 1984 to 2005, with evidence of continued increase through 2010 by 7 of those pods (Matkin et al. 2014). At present, reliable data on trends in population abundance for the entire Alaska Resident stock of killer whales are unavailable, due to a lack of trend data from the Aleutian Islands and Bering Sea.

Table 1. Numbers of animals in each pod of killer whales belonging to the Alaska Resident stock of killer whales.

Pod ID	2005-2012 estimate (and source)	2005-2019 estimate
Southeast Alaska		Source: NGOS website https://www.whalesalaska.org/salmon-specialist-residents
AF22	33 (Matkin et al. 2013)	33 (2012)
AF5	46 (Matkin et al. 2013)	45 (2012)
AG	42 (Matkin et al. 2013)	59 (2017)
AZ	Not seen since prior to 1997	
Total, Southeast Alaska	**121 (excluding AZ)**	**137 (excluding AZ)**
Prince William Sound	**Matkin et al. 2013**	**NGOS website https://www.whalesalaska.org/salmon-specialist-residents**
AA1	8	8 (2005-2012)
AA30	24	24 (2005-2012)
AB	20	20 (2014)
AB25	19	25 (2018)
AD05	22	11 (2015)
AD08		9 (2019)
AD11		6 (2018)
AD16	9	12 (2017)
AE	17	19 (2019)
AH01	9	9 (2005-2012)
AH20	12	12 (2005-2012)
AI	8	8 (2019)
AJ (AJ+AJ8)	57	64 (2018-2019)
AK (AK2+AK6)	19	24 (2019)
AL	23	23 (2005-2012)
AN10	36	36 (2005-2012)
AN20	30	30 (2005-2012)
AS2	31	31 (2005-2012)
AS30	19	19 (2005-2012)
AW	27	27 (2005-2012)
AX01	33	33 (2005-2012)
AX27	26	26 (2005-2012)
AX32	18	18 (2005-2012)
AX40	16	16 (2005-2012)
AX48	23	31 (2015)
AY	21	23 (2015)
Unassigned to pods	220	220 (2005-2012)
Total, Prince William Sound/ Kenai Fjord/ Kodiak	**751**	**784**
Western Alaska	**2001-2010 MML/NGOS total unique IDs (Fearnbach et al. 2014)**	**2001-2010 MML/NGOS total unique IDs (Fearnbach et al. 2014)**
Unassigned to pods (MML)	999	999
Total, Western Alaska	**999**	**999**
Total, all areas	**1,871**	**1,920**

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Studies of resident killer whale pods in the Pacific Northwest resulted in estimated population growth rates of 2.92% and 2.54% from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993) and 3.3% from 1984 to 2002 (Matkin et al. 2003). Until additional stock-specific data become available, the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% is used for this stock (NMFS 2023).

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 2023). Thus, for the Eastern North Pacific Alaska Resident killer whale stock, PBR = 19 whales (1,920 × 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 between 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused mortality and serious injury for Alaska Resident killer whales between 2016 and 2020 is 1.3 killer whales: 1.1 in commercial fisheries and 0.2 in unknown (commercial, recreational, or subsistence) fisheries. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include oil spills, vessel strikes, and interactions with fisheries.

Fisheries Information

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

Between 2016 and 2020, mortality and serious injury of killer whales occurred in two of the federally-regulated U.S. commercial fisheries that are monitored for incidental mortality and serious injury of marine mammals by fishery observers: the Bering Sea/Aleutian Islands flatfish trawl and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Table 2; Breiwick 2013; MML, unpubl. data).

Fishery observers have collected tissue samples from many of the killer whales that were killed incidental to U.S. commercial fisheries. Genetic analyses of samples from seven killer whales collected between 1999 and 2004 confirmed that Alaska Resident killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands flatfish trawl fishery (n = 3) and Bering Sea/Aleutian Islands Pacific cod longline fishery (n = 1) and that Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands pollock trawl fishery (n = 3) (M. Dahlheim, NMFS-AFSC-MML, pers. comm., 20 February 2013). Given the overlap in the range of transient and resident stocks in Alaska waters, unless genetic samples can be collected from animals injured or killed by gear or the vessel's propeller, the events are assigned to both the transient and resident killer whale stocks occurring in the area. Thus, an estimated mean annual mortality and serious injury rate of 0.4 killer whales in the Bering Sea/Aleutian Islands flatfish trawl fishery between 2016 and 2020 is assigned to both the Alaska Resident and Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stocks of killer whales. A mean annual mortality and serious injury rate of 0.4 killer whales in the Bering Sea/Aleutian Islands flatfish trawl fishery and 0.3 in the Bering Sea/Aleutian Islands Pacific cod longline fishery between 2016 and 2020 is assigned to the Alaska Resident stock (Table 2; Breiwick 2013; MML, unpubl. data).

Typically, if mortality or serious injury occurs incidental to U.S. commercial fishing, it is due to interactions with the fishing gear. However, reports indicate that observed killer whale mortality incidental to the Bering Sea/Aleutian Islands trawl fisheries often occurs due to contact with the vessel's propeller (e.g., the 2016 serious injury in the Bering Sea/Aleutian Islands flatfish trawl fishery). Fisheries observers report that large groups of killer whales in the Bering Sea follow vessels for days at a time, actively consuming the processing waste (NMFS-AFSC, Fishery Observer Program, unpubl. data). On some vessels, the waste is discharged in the vicinity of the vessel's propeller (NMFS, unpubl. data); consumption of the processing waste in the vicinity of the propeller may be the cause of the propeller-caused mortalities of killer whales in the trawl fisheries.

Table 2. Summary of incidental mortality and serious injury of Alaska Resident killer whales due to U.S. commercial fisheries in 2016-2020 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	2016	obs data	99	1[a]	1 (0)	0.8 (CV = 0.02)
	2017		100	0	0	
	2018		100	1[a]	1 (0.05)	
	2019		100	0	0	
	2020		100	2	2 (0.02)	
Bering Sea/Aleutian Is. Pacific cod longline	2016	obs data	57	1	1.7 (0.64)	0.3 (CV = 0.64)
	2017		58			
	2018		55			
	2019		52			
	2020		53			
Minimum total estimated annual mortality						1.1 (CV = 0.19)

[a]The mortality or serious injury was assigned to the Eastern North Pacific Alaska Resident and Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stocks of killer whales because the stock is unknown and these two stocks overlap in the area where the event occurred..

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2016 and 2020, based on observer data, is 1.1 Alaska Resident killer whales, (Table 2).

Reports from the NMFS Alaska Region stranding network of killer whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data. There was one report of a killer whale seriously injured by entanglement in pot gear in Icy Strait in 2016, resulting in a mean annual mortality and serious injury rate of 0.2 killer whales in unknown (commercial, recreational, or subsistence) Southeast Alaska pot fisheries between 2016 and 2020 (Table 3; Freed et al. 2022). Because the stock is unknown, this serious injury was assigned to the three killer whale stocks that occur in the area: the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, and West Coast Transient stocks. 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 nor are all stranded animals found or reported.

Table 3. Summary of mortality and serious injury of Alaska Resident killer whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2016 and 2020 (Freed et al. 2022).

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality
Entangled in Southeast Alaska pot gear*	1[a]	0	0	0	0	0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.2

[a]This serious injury was assigned to the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, and West Coast Transient stocks of killer whales because the stock is unknown and these three stocks overlap in the area where the event occurred.

Subsistence/Native Harvest Information

There are no reports of a subsistence harvest of killer whales in Alaska.

Other Mortality

During the 1992 killer whale surveys conducted in the Bering Sea and western Gulf of Alaska, 9 of 182 (4.9%) individual whales in 7 of the 12 (58%) pods encountered had evidence of bullet wounds (Dahlheim and Waite

1993). The relationship between wounding due to shooting and survival is unknown. In Prince William Sound, the pod responsible for most of the fishery interactions experienced a high level of mortality: between 1986 and 1991, 22 whales out of a pod of 37 (59%) disappeared (Matkin et al. 1994). The cause of death for these whales is unknown, but it may be related to gunshot wounds or effects of the *Exxon Valdez* oil spill (Dahlheim and Matkin 1994). It is unknown who was responsible for shooting at the killer whales.

There have been no obvious bullet wounds observed on killer whales during surveys in the Bering Sea and western Gulf of Alaska (J. Durban, NMFS-SWFSC, pers. comm.). However, researchers have reported that killer whale pods in certain areas exhibit vessel avoidance behavior, which may indicate that shootings occur in some places.

Other Issues

Killer whales are known to depredate longline catches in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003, 2006; Sigler et al. 2003) and in the Gulf of Alaska (Sigler et al. 2003, Perez 2006). In addition, there have been many reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (Perez 2006). More recently, Peterson and Hanselman (2017) estimated that killer whales reduce commercial sablefish fishery catch rates by approximately 45% to 70%. Resident killer whales are most likely to be involved in such fishery interactions since these whales are known to be fish eaters.

STATUS OF STOCK

The Eastern North Pacific Alaska Resident stock of killer whales is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. The minimum abundance estimate for the Alaska Resident stock is likely underestimated because researchers continue to encounter new whales in the Gulf of Alaska and in western Alaska waters. Because the population estimate is likely to be conservative, the PBR is also conservative.

Based on currently available data, a minimum estimate of the mean annual mortality and serious injury rate due to U.S. commercial fisheries (1.1 killer whales) is less than 10% of the PBR (10% of PBR = 1.9) and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate. A minimum estimate of the total annual level of human-caused mortality and serious injury (1.3 killer whales) is not known to exceed the PBR (19). Therefore, the Eastern North Pacific Alaska Resident stock of killer whales is not classified as a strategic stock. 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 Alaska Resident stock of killer whales. Some of the pods have not been photographically identified since 2005-2012 and the population estimate and PBR are likely conservative because researchers continue to encounter new whales.

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KILLER WHALE (*Orcinus orca*): Eastern North Pacific Northern Resident Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

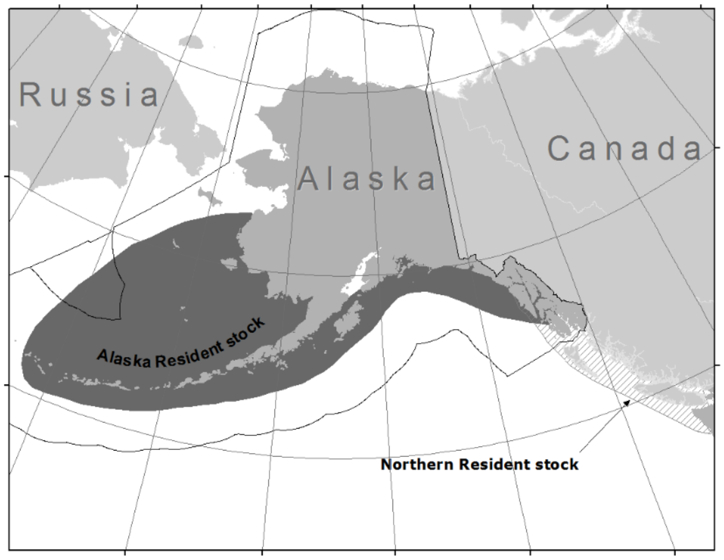

Figure 1. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade 2006). Killer whales are found throughout the North Pacific Ocean. Along the west coast of North America, seasonal and year-round occurrence of killer whales has been noted along the entire Alaska coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Killer whales from these areas have been labeled as "resident," "transient," and "offshore" type killer whales (Bigg et al. 1990, Ford et al. 2000, Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994, Black et al. 1997, Dahlheim and White 2010).

Several studies provide evidence that the resident, offshore, and transient ecotypes are genetically distinct in both mtDNA and nuclear DNA (Hoelzel and Dover 1991; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Genetic differences have also been found between populations within the transient and resident ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). A global genetic study of killer whales using the entire mitochondrial genome found that some killer whale ecotypes represent deeply divergent evolutionary lineages and warrant elevation to species or subspecies status (Morin et al. 2010). In particular, estimates from mitogenome sequence data indicate that transient killer whales diverged from all other killer whale lineages approximately 700,000 years ago. In light of these differences, the Society for Marine Mammalogy's Committee on Taxonomy currently recognizes the resident and transient North Pacific ecotypes as un-named *Orcinus orca* subspecies (Committee on Taxonomy 2018). In recognition of its status as an un-named subspecies or species, some researchers now refer to transient-type killer whales as Bigg's killer whales (e.g., Ford 2011, Riesch et al. 2012), in tribute to the late Dr. Michael Bigg.

Acoustic data (Ford 1989, 1991; Yurk et al. 2002), association data (Bigg et al. 1990; Ford et al. 1994, 2000; Dahlheim et al. 1997; Matkin et al. 1999), and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) confirm that Southern Residents, Northern Residents, and Alaska Residents are discrete populations. The Southern Resident population is found in summer primarily in waters of Washington State and southern British Columbia and has never been seen to associate with other resident stocks. The Eastern North Pacific Northern Resident stock is a transboundary stock and includes killer whales that frequent British Columbia, Canada, and Southeast Alaska (Dahlheim et al. 1997, Ford et al. 2000). They have been seen infrequently in Washington State waters. Members of the Northern Resident population have been documented in Southeast Alaska; however, they have not been seen to intermix with Alaska Residents (Fig. 1).

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. Exclusive Economic Zone: 1) the Alaska Resident stock - occurring from Southeast Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of Southeast Alaska (Fig. 1), 3) the Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia but also in coastal waters from Southeast Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast Transient stock - occurring from California through Southeast Alaska, 7) the Offshore stock - occurring from California through Alaska, and 8) the Hawaiian stock. Transient killer whales in Canadian waters are considered part of the West Coast Transient stock. The Hawaiian and Offshore stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

Photo-identification studies since 1970 (e.g., Ford et al. 2000) have attempted to catalogue every individual belonging to the Eastern North Pacific Northern Resident population. The Canadian government published a recent summary of abundance and trends for the population (Fisheries and Oceans Canada 2019). The abundance numbers reported in that document are based on the most recent census data. They report the population was approximately 122 when first censused in 1974, and the number known to be alive in a specified year has grown over the years as the photo-identification catalogue has been updated. Note that the number reported from the Northern Resident catalogue is calculated slightly differently than the number reported in the Southern Resident catalogue; for Northern Residents, it represents the number of whales known to be alive at any time during the year, even if known or suspected to have died later in the calendar year (Fisheries and Oceans Canada 2018).

Although the majority of Northern Resident killer whales are photographed each year, it is not always possible to locate every matrilineal group during each field season, and there can remain some uncertainty about the status of missing individuals until their death is confirmed in subsequent years. For this reason, the census reports a minimum and a maximum population size, as well as a "best" number derived from the best estimates of the year of birth and year of death of individuals. For 2018, the total best population size was estimated at 302 individuals (range = 302 to 310).

Minimum Population Estimate

The technique used for estimating abundance of Northern Resident killer whales is a direct count of individually identifiable animals known to be alive in a specified year. Because this population has been studied for such a long time, each individual is well documented and, except for births, no new individuals are expected to be discovered. For populations with a statistical estimate of the overall population size (i.e., N_{BEST}) and its associated precision (i.e., coefficient of variation CV(N)), the minimum population estimate can be substantially lower than the best estimate of abundance. This is not the case here, as the minimum population estimate of 302 whales reported in Fisheries and Oceans Canada (2019) can serve as a minimum count of the population.

Thus, the minimum population estimate (N_{MIN}) for the Northern Resident stock of killer whales is 302 whales, which includes whales found in Canadian waters (see PBR Guidelines (NMFS 2016) regarding the status of migratory transboundary stocks). Information on the percentage of time animals typically encountered in Canadian waters spend in U.S. waters is unquantified.

Current Population Trend

Trends for this population have been recently summarized and contrasted with trends for the Southern Resident population (Fisheries and Oceans Canada 2018). From the mid-1970s to the 1990s, the Northern Resident killer whale population increased at an annual rate of 2.6% (i.e., from 122 whales in 1974 to 218 in 1997). A decline was reported from 1998 to 2001 at a rate of 7% per year. The increased mortality that drove this decline coincided with a period of reduced range-wide Chinook salmon abundance, their primary prey (Ford et al. 2010). Then, after 2001, the growth was positive again with the population increasing at an average rate of 2.9% per year from 2002 to 2014. At the end of the 2015 field season, 290 whales were catalogued alive for the 2014 assessment.

This represents an average annual increase of 2.2% over the 40-year time series (Towers et al. 2015). However, annual Northern Resident killer whale population growth rates have slowed over the past five census years, from 5.1% in 2014 to -0.3% in 2018 (Fisheries and Oceans Canada 2019).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

As summarized in the previous paragraph, studies of Northern Resident killer whale pods in British Columbia and Washington waters resulted in estimated population growth rates of 2.6% from 1974 to 1997 and 2.9% from 2002 to 2014 (Towers et al. 2015), separated by a short period of decline from 1998 to 2001. The period from 2002 to 2014 was a period of maximum growth for this population when it grew at an average rate of 2.9% per year. Therefore, the maximum net productivity rate (R_{MAX}) is estimated to be 2.9% (Towers et al. 2015).

POTENTIAL BIOLOGICAL REMOVAL

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 cetacean stocks with unknown population status (NMFS 2016). Thus, for the Eastern North Pacific Northern Resident killer whale stock, PBR = 2.2 animals (302 × 0.0145 × 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 2013 and 2017 is listed, by marine mammal stock, in Delean et al. (2020); 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 Northern Resident killer whales between 2013 and 2017 is 0.2 killer whales in unknown (commercial, recreational, or subsistence) fisheries. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include oil spills, vessel strikes, and interactions with fisheries.

Fisheries Information

Information on U.S. commercial fisheries in Alaska waters (including observer programs, observer coverage, and observed incidental takes of marine mammals) is presented in Appendices 3-6 of the Alaska Stock Assessment Reports.

Incidental mortality or serious injury of Northern Resident killer whales has not been observed in federally-managed or state-managed U.S. commercial fisheries which operate within the range of this stock; however, the state-managed fisheries are not observed or have not been observed in a long time.

Reports from the NMFS Alaska Region stranding network of killer whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data. There was one report of a killer whale entangled in pot gear in Icy Strait in 2016, resulting in a mean annual mortality and serious injury rate of 0.2 killer whales in unknown (commercial, recreational, or subsistence) Southeast Alaska pot fisheries between 2013 and 2017 (Table 1; Delean et al. 2020). Because the killer whale stock identification is unknown, this mortality and serious injury was assigned to the three killer whale stocks that occur in the area: the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, and West Coast Transient stocks. 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 nor are all stranded animals found or reported.

All Canadian longline fisheries (including halibut, rockfish, dogfish, sablefish, jig for lingcod, and troll for lingcod and Chinook salmon) are monitored by observers or video. However, only groundfish trawl fisheries have observer or electronic monitoring in Canada, whereas, trawl fisheries for krill, scallop, and shrimp have no observer coverage and salmon net fisheries are not observed (T. Doniol-Valcroze, pers. comm., Department of Fisheries and Oceans, BC, Canada, 14 May 2019). The interaction of Alaska resident killer whales with the sablefish longline fishery accounts for a large proportion of the commercial fishing/killer whale interactions in Alaska waters. Such interactions have not been reported in Canadian waters where sablefish are taken via a pot fishery; however, Northern Resident killer whale interactions with Pacific halibut longline and salmon troll fisheries in British Columbia have been reported (Ford 2014). Reports of killer whale interactions with gillnets in Canadian waters include one killer whale that contacted a salmon gillnet in 1994 but did not entangle (Guenther et al. 1995) and one killer whale (Northern Resident I103) that entangled in a gillnet in 2014 but was quickly released (Fisheries and Oceans Canada 2018).

Table 1. Summary of mortality and serious injury of Northern Resident killer whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2013 and 2017 (Delean et al. 2020).

Cause of injury	2013	2014	2015	2016	2017	Mean annual mortality
Entangled in Southeast Alaska pot gear*	0	0	0	1[a]	0	0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.2

[a]This mortality and serious injury was assigned to the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, and West Coast Transient stocks of killer whales since the stock is unknown and these three stocks overlap in the area where the event occurred.

Subsistence/Native Harvest Information

Killer whales are not harvested for subsistence in Alaska.

Other Mortality

Collisions of killer whales with vessels occur occasionally. One ship-strike mortality of a Northern Resident killer whale (C21) in Prince Rupert, BC, was reported in 2006 (Williams and O'Hara 2010). The shooting of killer whales in Canadian waters has been a concern in the past. Since 1974, however, fresh bullet wounds are rarely, if ever, seen on whales in British Columbia and Washington (Ford et al. 2000, Fisheries and Oceans Canada 2018).

Other Issues

Killer whales are known to depredate longline catches in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003, 2006; Sigler et al. 2003) and in the Gulf of Alaska (Sigler et al. 2003, Perez 2006). In Canada, Northern Resident killer whales have been reported to depredate fish from both commercial salmon trollers and recreational sportfishermen, as well as Pacific halibut longliners (Ford 2014). Most reports occur in the northern half of the coast, especially Dixon Entrance, and early in the season (April to June), although some are scattered throughout the summer (J. Ford, pers. comm., Department of Fisheries and Oceans, BC, Canada, 3 December 2012).

STATUS OF STOCK

The Northern Resident killer whale stock is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. In 2001, the Committee on the Status of Endangered Wildlife in Canada designated Northern Resident killer whales in British Columbia as threatened and listed in Schedule 1 of the Species at Risk Act (SARA) for Canada. Resident killer whales in British Columbia are considered to be at risk based on their small population size, low reproductive rate, and the existence of a variety of anthropogenic threats that have the potential to prevent recovery or to cause further declines (Fisheries and Oceans Canada 2008). Monitoring of fisheries in BC over the past decade has been quite extensive and likely at the same level as in U.S. waters. One serious injury from an entanglement in unidentified pot gear was reported in Alaska waters in 2016 and a Northern Resident killer whale entangled in a gillnet in British Columbia waters in 2014 but was quickly released. Northern Resident killer whale interactions with longline and troll fisheries in British Columbia waters have also been reported.

Based on currently available data, the minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate is zero, which does not exceed 10% of the PBR (10% of PBR = 0.22) and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate. The minimum estimated mean annual level of human-caused mortality and serious injury (0.2) is not known to exceed the PBR (2.2). Therefore, the Eastern North Pacific Northern Resident stock of killer whales is not classified as a strategic stock. Status of this stock relative to its Optimum Sustainable Population size has not been quantified.

There are few other uncertainties in the assessment of the Northern Resident stock of killer whales. Individual whales can be counted annually and the stock increased at an average rate of 2.9% per year from 2002 to 2014, although the growth rate has slowed in the last five census years.

HABITAT CONCERNS

Ford et al. (2005) showed that a sharp drop in coast-wide Chinook salmon abundance during the late 1990s was correlated with a significant decline in resident killer whale survival. They noted that the whales' preference for

Chinook salmon is likely due to this species' relatively large size, high lipid content and, unlike other salmonids, its year-round presence in the whales' range. They further note that resident killer whales may be especially dependent on Chinook during winter, when this species is the primary salmonid available in coastal waters, and the whales may be subject to nutritional stress leading to increased mortality if the quantity and/or quality of this prey resource declines.

Environmental contaminants and vessel traffic, particularly increased whale-watching activity, are other potential concerns for this stock (Fisheries and Oceans Canada 2018).

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KILLER WHALE (*Orcinus orca*): Eastern North Pacific
Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock

NOTE – NMFS has preliminary genetic information on killer whales in Alaska which indicates that the current stock structure of killer whales in Alaska needs to be reassessed. NMFS is evaluating the new genetic information. In the interim, new information on killer whale mortality levels is provided within this report. A complete revision of the killer whale stock assessments will be postponed until the stock structure evaluation is completed and any new stocks are identified.

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade 2006). Killer whales are found throughout the North Pacific Ocean. Along the west coast of North America, seasonal and year-round occurrence of killer whales has been noted along the entire Alaska coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Killer whales from these areas have been labeled as "resident," "transient," and "offshore" type killer whales (Bigg et al. 1990, Ford et al. 2000, Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994, Black et al. 1997, Dahlheim and White 2010).

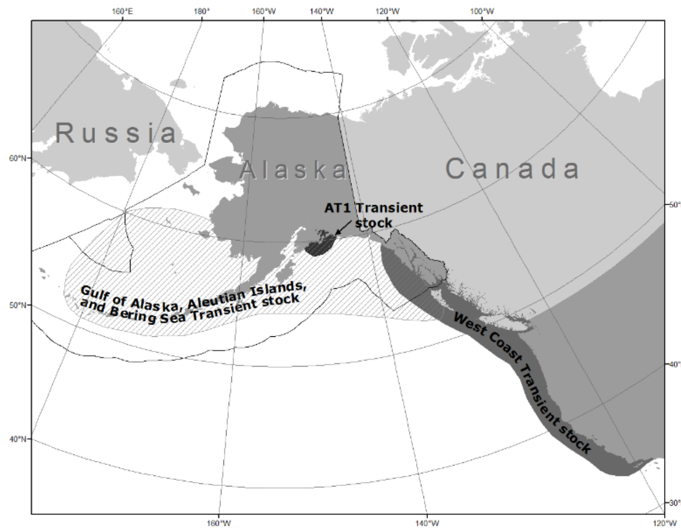

Figure 1. Approximate distribution of transient killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

Several studies provide evidence that the resident, offshore, and transient ecotypes are genetically distinct in both mtDNA and nuclear DNA (Hoelzel and Dover 1991; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Genetic differences have also been found between populations within the transient and resident ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). A global genetic study of killer whales using the entire mitochondrial genome found that some killer whale ecotypes represent deeply divergent evolutionary lineages and warrant elevation to species or subspecies status (Morin et al. 2010). In particular, estimates from mitogenome sequence data indicate that transient killer whales diverged from all other killer whale lineages approximately 700,000 years ago. In light of these differences, the Society for Marine Mammalogy's Committee on Taxonomy currently recognizes the resident and transient North Pacific ecotypes as un-named *Orcinus orca* subspecies (Committee on Taxonomy 2019). In recognition of its status as an un-named subspecies or species, some researchers now refer to transient-type killer whales as Bigg's killer whales (e.g., Ford 2011, Riesch et al. 2012), in tribute to the late Dr. Michael Bigg.

The first studies of transient killer whales in Alaska were conducted in Southeast Alaska and in the Gulf of Alaska (from Prince William Sound, through the Kenai Fjords, and around Kodiak Island). In the Gulf of Alaska, Matkin et al. (1999) described two genetically distinct populations of transients which were never found in association with one another, the so-called "Gulf of Alaska" transients and "AT1" transients. In the past, neither of these populations were known to associate with the population of transient killer whales that ranged from California to Southeast Alaska, which are described as the West Coast Transient stock. Gulf of Alaska transients are documented throughout the Gulf of Alaska, including occasional sightings in Prince William Sound. AT1 transients have been seen only in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with Gulf of Alaska transients. In addition, 14 out of 217 transients on the outer coast of Southeast Alaska and British Columbia were identified as Gulf of Alaska transients and in one encounter they were observed mixing with West Coast transients (Matkin et al. 2012, Ford et al. 2013). Transients within the Gulf of Alaska population have been found to have two mtDNA haplotypes, neither of which is found in the West Coast or AT1 populations. Members of the AT1 population share a single mtDNA haplotype. Transient killer whales from the West Coast population have been found to share a single mtDNA haplotype that is not found in the other populations. Additionally, all three populations have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found as well; Saulitis et al. (2005) described acoustic differences between Gulf of Alaska transients and AT1 transients. For these reasons, the Gulf of Alaska transients are considered part of a population that is discrete from the AT1 population, and both of these populations are considered discrete from the West Coast transients.

Transient-type killer whales from the Aleutian Islands and Bering Sea are currently considered to be part of a single population that includes Gulf of Alaska transients; however, recent genetic analyses suggest substructure within the region. Biopsy samples from the eastern Aleutians and the south side of the west end of the Alaska Peninsula have produced the same haplotypes as killer whales in the northern Gulf of Alaska; however, nuclear DNA analysis strongly suggests they belong to a separate population (Parsons et al. 2013). The geographic distribution of mtDNA haplotypes revealed samples from the central Aleutian Islands and Bering Sea with haplotypes not found in Gulf of Alaska transients, suggesting additional population structure in western Alaska. Killer whales observed in the northern Bering Sea and north and east to the western Beaufort Sea have characteristics of transient-type whales, but little is known about these whales (Braham and Dahlheim 1982, George and Suydam 1998). AT1 haplotype whales are also present west of the Aleutian Islands and into the Bering Sea; however, nuclear DNA analysis indicates these animals are not part of the AT1 transient population in the Gulf of Alaska (Parsons et al. 2013).

In summary, within the transient ecotype, association data (Ford et al. 1994, Ford and Ellis 1999, Matkin et al. 1999), acoustic data (Ford and Ellis 1999, Saulitis et al. 2005), and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) confirm that at least three communities of transient whales exist and represent three discrete populations: 1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, 2) AT1 transients, and 3) West Coast transients.

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. Exclusive Economic Zone: 1) the Alaska Resident stock - occurring from Southeast Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of Southeast Alaska, 3) the Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from Southeast Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea (Fig. 1), 5) the AT1 Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast Transient stock - occurring from California through Southeast Alaska, 7) the Offshore stock - occurring from California through Alaska, and 8) the Hawaiian stock. Transient killer whales in Canadian waters are considered part of the West Coast Transient stock. The Hawaiian and Offshore stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

In January 2004, the North Gulf Oceanic Society (NGOS) and the Marine Mammal Laboratory (MML) held a joint workshop to match identification photographs of transient killer whales from this population. That analysis of photographic data resulted in the following minimum counts for transient killer whales belonging to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock. In the Gulf of Alaska (east of the Shumagin Islands), 82 whales were identified by NGOS, including whales from Matkin et al. (1999) as well as whales identified in subsequent years (but not including whales identified as part of the AT1 population). MML identified

43 whales and 11 matches were found between the NGOS and MML catalogues. Since that time an additional 22 whales have been added to the NGOS catalogue (Matkin et al. 2013). Therefore, a total of 136 transients (104 + 43 - 11) have been identified in the Gulf of Alaska. In the Aleutian Islands (west of and including the Shumagin Islands) and Bering Sea, the combined NGOS/MML catalogue (NGOS/MML 2012) now contains 451 individually identifiable whales (not counting unmarked calves and not counting two Gulf of Alaska transient whales that have been photographed in that region). Combining the Aleutian Islands and Bering Sea count (451) with the Gulf of Alaska count (136), a total count of 587 individual whales have been identified in catalogues of this stock.

MML conducted killer whale line-transect surveys for 3 years in July and August in 2001-2003. These surveys covered an area from approximately Resurrection Bay in the Kenai Fjords to the central Aleutians. The surveys covered an area from shore to 30-45 nautical miles offshore, with randomly located transects in a zigzag pattern. Estimated transient killer whale abundance from these surveys, using post-encounter estimates of group size, was 249 (CV = 0.50), with a 95% confidence interval of 99-628 (Zerbini et al. 2007).

Mark-recapture methods were used to estimate the number of transient killer whales using the coastal waters from the central Gulf of Alaska to the central Aleutian Islands, using photographs collected during the three line-transect surveys (Zerbini et al. 2007), along with photographs collected from a variety of additional surveys during the same time period (Durban et al. 2010). A total of 154 individuals were identified from 6,489 photographs collected between July 2001 and August 2003. A Bayesian mixture model estimated seven distinct clusters (95% Probability Interval = 7-10) of individuals that were differentially covered by 14 boat-based surveys exhibiting varying degrees of association in space and time, leading to a total estimate of 345 whales (95% Probability Interval = 255-487). This estimate is higher than the line-transect estimate for at least two reasons. First, the line-transect estimate provides an "instantaneous" (across ~40 days) estimate of the average number of transient killer whales in the survey area, whereas the mark-recapture methods provide an estimate of the total number of whales to use the survey area over the 3 years, which is known to be greater due to the long distance movements documented by satellite tags (J. Durban, Southwest Fisheries Science Center, pers. comm.). Second, the mark-recapture estimate included photographic data from a broader seasonal time period and, therefore, includes transient killer whales documented in the False Pass/Unimak Island area in spring where they aggregate to prey on gray whales on migration (Matkin et al. 2007). Many of these whales have not been seen in that region in the summer. However, mark recapture estimates do not include most of the Bering Sea and Pribilof Islands.

It should be noted that the photographic catalogue encompasses a larger area, including some data from areas such as the Bering Sea and Pribilof Islands that were outside the line-transect survey area. The photo catalogue also encompasses a much longer time period (through 2012). Additionally, the number of whales in the photographic catalogue is a documentation of all whales seen in the area over the time period of the catalogue; movements of some individual whales have been documented between the line-transect survey area and locations outside the survey area. Accordingly, a larger number of transient killer whales may use the line-transect survey area at some point over the 3 years than would necessarily be found at one time in the survey area in July and August in a particular year.

Minimum Population Estimate

A total count of 587 individual whales have been identified in the photograph catalogues from the Gulf of Alaska (Matkin et al. 2013) and from western Alaska (NGOS/MML 2012). The photograph catalogue estimate of transient killer whales is a direct count of individually identifiable animals. However, the number of catalogued whales does not necessarily represent the number of live animals. Some animals may have died, but whales cannot be presumed dead if not resighted because long periods of time between sightings are common for some transient animals. The catalogue for the western area used data only from 2001-2012, decreasing the potential bias from using whales that may have died prior to the end of the time period. However, given that researchers continue to identify new whales and the entire range has not been surveyed, the estimate of abundance based on the number of uniquely identified individuals catalogued is likely conservative.

Thus, the minimum population estimate (N_{MIN}) for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales is 587 animals based on the count of individuals using photo-identification.

Current Population Trend

Matkin et al. (2012) analyzed photographic data collected since 1984 and determined Gulf of Alaska transients in the northern Gulf of Alaska have had stable numbers. At present, reliable data on trends in population abundance for the Aleutian Islands and Bering Sea portion of this stock of killer whales are not available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales. Between 2012 and 2018, Towers et al. (2019) observed a mean annual growth rate of 4.1% for a population subset of transient killer whales in Canadian coastal waters, which was higher than the mean annual growth rate of 2.7% documented by Ford et al. (2013) between 2006 and 2011 for a sub-population of inner-coast transient killer whales that contained most of the same individuals. However, until additional data become available for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales, the default cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% will be used for this stock (NMFS 2016).

POTENTIAL BIOLOGICAL REMOVAL

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 is $N_{MIN} \times 0.5R_{Max} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status (NMFS 2016). Thus, for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale stock, PBR is 5.9 animals (587 × 0.02 × 0.5). Although only a few individuals have been observed in Canadian waters, the proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whales between 2014 and 2018 is 0.8 killer whales in U.S. commercial fisheries. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include oil spills, vessel strikes, and interactions with fisheries.

Fisheries Information

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); however, only the mortality and serious injury data are included in the Stock Assessment Reports.

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).

Two of the federally-regulated U.S. commercial fisheries, monitored for incidental mortality and serious injury of marine mammals by fishery observers, incurred serious injury and mortality of killer whales of unknown stock between 2014 and 2018: the Bering Sea/Aleutian Islands flatfish trawl and Bering Sea/Aleutian Islands Greenland turbot longline fisheries (Table 1; Breiwick 2013; MML, unpubl. data).

Fishery observers have collected tissue samples from many of the killer whales that were killed incidental to U.S. commercial fisheries. Genetic analyses of samples from seven killer whales collected between 1999 and 2004 have confirmed that Alaska Resident killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands flatfish trawl (n = 3) and Bering Sea/Aleutian Islands Pacific cod longline fisheries (n = 1) and that Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands pollock trawl fishery (n = 3) (M. Dahlheim, NMFS-AFSC-MML (retired), pers. comm., 20 February 2013). Given the overlap in the range of transient and resident stocks in Alaska waters, unless genetic samples can be collected from animals injured or killed by gear or the ship's propeller, these events are assigned to both the transient and resident stock occurring in that area. Thus, the estimated mean annual mortality and serious injury rate of 0.6 killer whales between 2014 and 2018 will be assigned to both the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and Alaska Resident stocks of killer whales (Table 1).

Typically, if mortality or serious injury occurs incidental to U.S. commercial fishing, it is due to interactions with the fishing gear. However, reports indicate that observed killer whale mortality incidental to Bering Sea/Aleutian Islands trawl fisheries often occurs due to contact with the ship's propeller (e.g., the 2016 mortality in the Bering Sea/Aleutian Islands flatfish trawl fishery).

Table 1. Summary of incidental mortality and serious injury of Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whales due to U.S. commercial fisheries between 2014 and 2018 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. N/A indicates that data are not available.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality (CV)	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl[a]	2014 2015 2016 2017 2018	obs data	100 100 99 100 100	0 0 1 0 1	0 0 1 (0.05) 0 1 (0.05)	0.4 (CV = 0.03)
Bering Sea/Aleutian Is. Greenland turbot longline[a]	2014 2015 2016 2017 2018	obs data	56 52 60 56 62	0 0 (+1)[b] 0 0 0	0 0 (+1)[c] 0 0 0	0 (+0.2)[d] (CV = N/A)
Minimum total estimated annual mortality						0.6 (CV = 0.03)

[a]Mortality and serious injury in this fishery was assigned to both the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and Alaska Resident stocks of killer whales, since stock is unknown and the two stocks occur within the area of operation of the fishery.
[b]Total mortality and serious injury observed in 2015: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[c]Total estimate of mortality and serious injury in 2015: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 1 whale (1 whale observed in an unsampled haul).
[d]Mean annual mortality and serious injury for fishery: 0 whales (mean of extrapolated estimates from sampled hauls) + 0.2 whales (mean of number observed in unsampled hauls).

Reports to NMFS Region marine mammal stranding networks of killer whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data. A killer whale mortality in commercial California Dungeness crab pot gear in 2015 reported to the NMFS West Coast Region stranding network was genetically identified as a transient ecotype. Because the whale could not be assigned to a specific stock, the mean annual mortality and serious injury rate of 0.2 killer whales in this fishery between 2014 and 2018 was assigned to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and West Coast Transient killer whale stocks; it was not assigned to the AT1 Transient killer whale stock because none of the whales in this population are missing (Table 2; Young et al. 2020).

Table 2. Summary of mortality and serious injury of Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whales, by year and type, reported to the NMFS West Coast Region marine mammal stranding network between 2014 and 2018 (Young et al. 2020).

Cause of Injury	2014	2015	2016	2017	2018	Mean annual mortality
Entangled in commercial CA Dungeness crab pot gear	0	1[a]	0	0	0	0.2
Total in commercial fisheries						0.2

[a]This whale was genetically identified as a transient ecotype but could not be assigned to a specific stock; therefore, the mortality was assigned to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and West Coast Transient killer whale stocks.

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2014 and 2018 is 0.8 Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whales, based on observer data (0.6) and stranding data (0.2) (Tables 1 and 2).

Alaska Subsistence/Native Harvest Information

Killer whales are not harvested for subsistence in Alaska.

Other Mortality

Collisions with vessels are an occasional source of mortality or serious injury of killer whales. For example, a killer whale struck the propeller of a vessel in the Bering Sea/Aleutian Islands flatfish trawl fishery in 2016 (Table 1; Young et al. 2020).

Other Issues

Killer whales are known to depredate longline catches in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003, 2006; Sigler et al. 2003) and in the Gulf of Alaska (Sigler et al. 2003, Perez 2006). In addition, there have been many reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (Perez 2006). More recently, Peterson and Hanselman (2017) estimated that killer whales reduce commercial sablefish fishery catch rates by approximately 45% to 70%. However, resident killer whales are most likely to be involved in such fishery interactions since these whales are known to be fish eaters.

STATUS OF STOCK

The Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. Based on currently available data, a minimum estimate of the mean annual mortality and serious injury rate due to U.S. commercial fisheries (0.8 whales) is greater than 10% of the PBR (10% of PBR = 0.6) and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. A minimum estimate of the total annual level of human-caused mortality and serious injury (0.8 whales) is less than the PBR (5.9). Therefore, the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales is not classified as a strategic stock. 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 Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales. The estimate of abundance, based on the number of uniquely identified individuals, is likely conservative because researchers continue to identify new whales and there has not been a comprehensive survey in recent years to allow an updated line-transect or mark-recapture estimate.

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KILLER WHALE (*Orcinus orca*): AT1 Transient Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade 2006). Killer whales are found throughout the North Pacific Ocean. Along the west coast of North America, seasonal and year-round occurrence of killer whales has been noted along the entire Alaska coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Killer whales from these areas have been labeled as "resident," "transient," and "offshore" type killer whales (Bigg et al. 1990, Ford et al. 2000, Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994, Black et al. 1997, Dahlheim and White 2010).

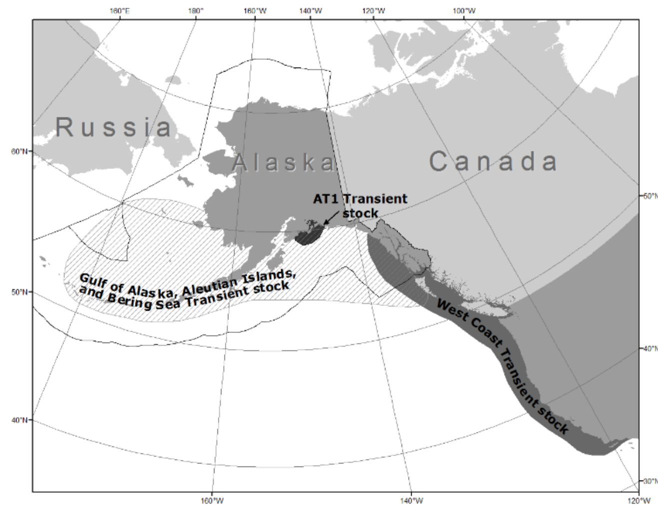

Figure 1. Approximate distribution of transient killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

Several studies provide evidence that the resident, offshore, and transient ecotypes are genetically distinct in both mtDNA and nuclear DNA (Hoelzel and Dover 1991; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Genetic differences have also been found between populations within the transient and resident ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). A global genetic study of killer whales using the entire mitochondrial genome found that some killer whale ecotypes represent deeply divergent evolutionary lineages and warrant elevation to species or subspecies status (Morin et al. 2010). In particular, estimates from mitogenome sequence data indicate that transient killer whales diverged from all other killer whale lineages approximately 700,000 years ago. In light of these differences, the Society for Marine Mammalogy's Committee on Taxonomy currently recognizes the resident and transient North Pacific ecotypes as un-named *Orcinus orca* subspecies (Committee on Taxonomy 2019). In recognition of its status as an un-named subspecies or species, some researchers now refer to transient-type killer whales as Bigg's killer whales (e.g., Ford 2011, Riesch et al. 2012), in tribute to the late Dr. Michael Bigg.

The first studies of transient killer whales in Alaska were conducted in Southeast Alaska and in the Gulf of Alaska (from Prince William Sound, through the Kenai Fjords, and around Kodiak Island). In the Gulf of Alaska, Matkin et al. (1999) described two genetically distinct populations of transients which were never found in association with one another, the so-called "Gulf of Alaska" transients and "AT1" transients. In the past, neither of these populations were known to associate with the population of transient killer whales that ranged from California to Southeast Alaska, which are described as the West Coast Transient stock. Gulf of Alaska transients are documented throughout the Gulf of Alaska, including occasional sightings in Prince William Sound. AT1 transients have been seen only in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with Gulf of Alaska transients. In addition, 14 out of 217 transients on the outer coast of Southeast Alaska and British Columbia were identified as Gulf of Alaska transients and in one encounter they were observed mixing with West Coast transients (Matkin et al. 2012, Ford et al. 2013). Transients within the Gulf of Alaska population have been found to have two mtDNA haplotypes, neither of which is found in the West Coast or AT1 populations. Members of the AT1 population share a single mtDNA haplotype. Transient killer whales from the West Coast population have been found to share a single mtDNA haplotype that is not found in the other populations. Additionally, all three populations have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found as well; Saulitis et al. (2005) described acoustic differences between Gulf of Alaska transients and AT1 transients. For these reasons, the Gulf of Alaska transients are considered part of a population that is discrete from the AT1 population, and both of these populations are considered discrete from the West Coast transients.

Transient-type killer whales from the Aleutian Islands and Bering Sea are currently considered to be part of a single population that includes Gulf of Alaska transients; however, recent genetic analyses suggest substructure within the region. Biopsy samples from the eastern Aleutians and the south side of the west end of the Alaska Peninsula have produced the same haplotypes as killer whales in the northern Gulf of Alaska; however, nuclear DNA analysis strongly suggests they belong to a separate population (Parsons et al. 2013). The geographic distribution of mtDNA haplotypes revealed samples from the central Aleutian Islands and Bering Sea with haplotypes not found in Gulf of Alaska transients, suggesting additional population structure in western Alaska. Killer whales observed in the northern Bering Sea and north and east to the western Beaufort Sea have characteristics of transient-type whales, but little is known about these whales (Braham and Dahlheim 1982, George and Suydam 1998). AT1 haplotype whales are also present west of the Aleutian Islands and into the Bering Sea; however, nuclear DNA analysis indicates these animals are not part of the AT1 transient population in the Gulf of Alaska (Parsons et al. 2013).

In summary, within the transient ecotype, association data (Ford et al. 1994, Ford and Ellis 1999, Matkin et al. 1999), acoustic data (Ford and Ellis 1999, Saulitis et al. 2005), and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) confirm that at least three communities of transient whales exist and represent three discrete populations: 1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, 2) AT1 transients, and 3) West Coast transients.

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. Exclusive Economic Zone: 1) the Alaska Resident stock - occurring from Southeast Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of Southeast Alaska, 3) the Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from Southeast Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords (Fig. 1), 6) the West Coast Transient stock - occurring from California through Southeast Alaska, 7) the Offshore stock - occurring from California through Alaska, and 8) the Hawaiian stock. Transient killer whales in Canadian waters are considered part of the West Coast Transient stock. The Hawaiian and Offshore stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

AT1 killer whales were first identified as a separate, cohesive group in 1984, when 22 transient-type whales were documented in Prince William Sound (Leatherwood et al. 1984, Heise et al. 1991), although individual whales from the group had been photographed as early as 1978 (von Ziegesar et al. 1986). Once the North Gulf Oceanic Society (NGOS) began consistent annual research effort in Prince William Sound, AT1 killer whales were resighted frequently. In fact, AT1 killer whales were found to be some of the most frequently sighted killer whales in Prince William Sound (Matkin et al. 1993, 1994, 1999). Gulf of Alaska transients are seen less frequently in Prince William Sound, with periods of several years or more between resightings.

AT1 killer whales have never been seen in association with sympatric resident killer whale pods or with Gulf of Alaska transients (Matkin et al. 1999, 2012) and appear to have a more limited range than other transients. Their approximately 200-mile known range includes only Prince William Sound and Kenai Fjords and adjacent offshore waters (Matkin et al. 1999, 2012).

POPULATION SIZE

Using photographic-identification, all 22 individuals in the AT1 Transient population were censused for the first time in 1984 (Leatherwood et al. 1984). All 22 AT1 killer whales were seen annually or biannually from 1984 to 1988 (Matkin et al. 1999, 2003). The *Exxon Valdez* oil spill occurred in spring of 1989. Nine individuals from the AT1 group have been missing since 1990 (last seen in 1989), and two have been missing since 1992 (last seen in 1990 and 1991). Three of the missing AT1 killer whales (AT5, AT7, and AT8) were seen near the leaking *Exxon Valdez* shortly after the spill (Matkin et al. 1993, 1994, 2008). Two whales were found dead, stranded in 1989 and 1990, both genetically assigned to the AT1 population and one visually recognized as AT19, one of the missing nine whales (Matkin et al. 1994, 2008; Heise et al. 2003). The second unidentified whale was most likely one of the other missing AT1 whales. Additional mortalities of four older males include whales AT1 found stranded in 2000, AT13 and AT17 missing in 2002 (one of which was thought to be the carcass from the AT1 population that was found in 2002), and AT14 missing in 2003. A stranded whale found in 2003, genetically assigned to the AT1 population, was probably AT14 but could also have been AT13 (Matkin et al. 2008). No births have occurred in this population since 1984 and none of the missing whales have been seen since 2003 and are presumed dead. There is an extremely small probability (0.4%) that AT1 killer whales that are missing for 3 years or more are still alive (Matkin et al. 2008). No AT1 killer whale missing for at least 4 years has ever been resighted, and all 15 missing whales are presumed dead (Matkin et al. 2008). In 2019, photographs of the seven remaining AT1 killer whales were confirmed by researchers from the NGOS (http://www.whalesalaska.org, accessed December 2020); birth year is estimated for whales born before 1983, as described in Matkin et al. (1999): AT2 (female, born ≤1969), AT3 (male, born 1984), AT4 (female, born ≤1974), AT6 (male, born 1976), AT9 (female, born ≤1965), AT10 (male, born 1980), and AT18 (female, born ≤1974). Therefore, the population estimate as of the summer of 2019 remains at seven whales (NGOS; C. Matkin, NGOS, pers. comm., 17 October 2019). There has been no recruitment in this population since 1984 (Matkin et al. 2012).

Minimum Population Estimate

The abundance estimate of killer whales is a direct count of individually identifiable animals. Only 11 whales were seen between 1990 and 1999. Since then, four of those whales have not been seen for four or more consecutive years, so the minimum population estimate (N_{MIN}) is seven whales (Matkin et al. 2008; NGOS; C. Matkin, NGOS, pers. comm., 17 October 2019). Fourteen years of annual effort have failed to discover any whales that had not been seen previously, so there is no reason to believe there are additional whales in the population. Therefore, this N_{MIN} is the total population size.

Current Population Trend

The population counts have declined from a level of 22 whales in 1989 to the 7 whales that have been resighted since 2003, a decline of 68%. Most of the mortality apparently occurred in 1989 and 1990.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the AT1 Transient stock of killer whales. Between 2012 and 2018, Towers et al. (2019) observed a mean annual growth rate of 4.1% for a population subset of transient killer whales in Canadian coastal waters, which was higher than the mean annual growth rate of 2.7% documented by Ford et al. (2013) between 2006 and 2011 for a subpopulation of inner-coast transient killer whales that contained most of the same individuals. The current net productivity rate for the AT1 Transient stock of killer whales is 0, given that there has been no recruitment into the stock since 1984. Until additional stock-specific data become available, the default cetacean maximum theoretical net productivity rate of 4% will be used for this stock (NMFS 2016).

POTENTIAL BIOLOGICAL REMOVAL

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, as the stock is considered depleted under the Marine Mammal Protection Act (MMPA) and there has been no recruitment into the stock since 1984. Thus, for the AT1 Transient killer whale stock, PBR is 0.01 whales (7 × 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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); however, only the mortality and serious injury data are included in the Stock Assessment Reports. No human-caused mortality or serious injury of AT1 Transient killer whales was reported between 2014 and 2018. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include ship strikes and oil spills (most of the mortality in this stock occurred in 1989 and 1990, following the *Exxon Valdez* oil spill).

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).

The known range of the AT1 Transient stock is limited to waters of Prince William Sound and Kenai Fjords. There are no federally-managed commercial fisheries in this area. Incidental mortality or serious injury of AT1 killer whales has not been reported in state-managed commercial fisheries which operate within the range of this stock, such as the Prince William Sound salmon set and drift gillnet fisheries and various herring fisheries, or in several subsistence fisheries (salmon, halibut, non-salmon finfish, and shellfish) which also occur within this area; however, the state-managed fisheries are not observed or have not been observed in a long time. Transient killer whales have entangled in pot fishery gear in other areas (Young et al. 2020) and entanglement in this type of gear may be a risk for the AT1 Transient stock of killer whales.

Alaska Native Subsistence/Harvest Information

Killer whales are not harvested for subsistence in Alaska.

Other Mortality

Collisions with vessels are an occasional source of mortality or serious injury of killer whales. For example, a killer whale struck the propeller of a vessel in the Bering Sea/Aleutian Islands flatfish trawl fishery in 2016 (Young et al. 2020); however, this mortality did not involve a whale from the AT1 Transient stock. There has been no known mortality or serious injury of AT1 killer whales due to vessel collisions. Most of the mortality occurred from 1989 to 1990 following the *Exxon Valdez* oil spill.

STATUS OF STOCK

The AT1 Transient stock of killer whales is below its Optimum Sustainable Population (OSP) and designated as depleted under the MMPA (69 FR 31321, 3 June 2004); therefore, it is classified as a strategic stock. The AT1 Transient stock is not listed as threatened or endangered under the Endangered Species Act. Based on currently available data, the minimum estimated mean annual mortality and serious injury rate due to U.S. commercial fisheries (0) does not exceed 10% of the PBR (10% of PBR = 0.001) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. At least 11 animals were alive in 1998, but it appears that only 7 individuals remain alive. The AT1 killer whale group has been reduced to 32% (7/22) of its 1984 level. Since no births have occurred in the past 30 years, it is unlikely that this stock will recover.

There are few uncertainties in the assessment of the AT1 Transient stock of killer whales. Individual whales can be counted annually and the stock has been declining slowly since a dramatic reduction in the stock occurred immediately after the *Exxon Valdez* oil spill. PBR is designed to allow stocks to recover to, or remain above, the maximum net productivity level (MNPL) (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 OSP and that some surplus growth could be removed while still allowing recovery. However, the AT1 Transient killer whale population is at a very small population size, and small populations can have different dynamics than larger populations from Allee effects and stochastic dynamics. Although there is currently no known direct human-caused mortality or serious injury, given the small number of animals in the population, any human-caused mortality or serious injury is likely to have a serious population-level impact.

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KILLER WHALE (*Orcinus orca*): West Coast Transient Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade 2006). Killer whales are found throughout the North Pacific Ocean. Along the west coast of North America, seasonal and year-round occurrence of killer whales has been noted along the entire Alaska coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Killer whales from these areas have been labeled as "resident," "transient," and "offshore" type killer whales (Bigg et al. 1990, Ford et al. 2000, Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994, Black et al. 1997, Dahlheim and White 2010).

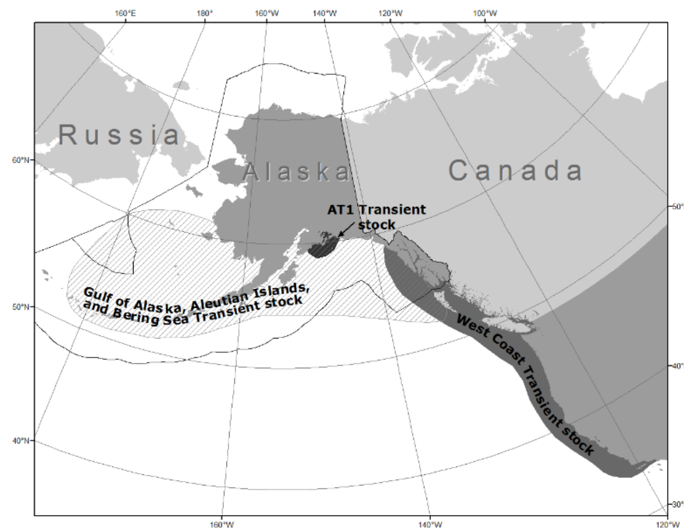

Figure 1. Approximate distribution of transient killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

Several studies provide evidence that the resident, offshore, and transient ecotypes are genetically distinct in both mtDNA and nuclear DNA (Hoelzel and Dover 1991; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Genetic differences have also been found between populations within the transient and resident ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). A global genetic study of killer whales using the entire mitochondrial genome found that some killer whale ecotypes represent deeply divergent evolutionary lineages and warrant elevation to species or subspecies status (Morin et al. 2010). In particular, estimates from mitogenome sequence data indicate that transient killer whales diverged from all other killer whale lineages approximately 700,000 years ago. In light of these differences, the Society for Marine Mammalogy's Committee on Taxonomy currently recognizes the resident and transient North Pacific ecotypes as un-named *Orcinus orca* subspecies (Committee on Taxonomy 2019). In recognition of its status as an un-named subspecies or species, some researchers now refer to transient-type killer whales as Bigg's killer whales (e.g., Ford 2011, Riesch et al. 2012), in tribute to the late Dr. Michael Bigg.

The first studies of transient killer whales in Alaska were conducted in Southeast Alaska and in the Gulf of Alaska (from Prince William Sound, through the Kenai Fjords, and around Kodiak Island). In the Gulf of Alaska, Matkin et al. (1999) described two genetically distinct populations of transients which were never found in association with one another, the so-called "Gulf of Alaska" transients and "AT1" transients. In the past, neither of these populations were known to associate with the population of transient killer whales that ranged from California to Southeast Alaska, which are described as the West Coast Transient stock. Gulf of Alaska transients are documented throughout the Gulf of Alaska, including occasional sightings in Prince William Sound. AT1 transients have been seen only in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with Gulf of Alaska transients. In addition, 14 out of 217 transients on the outer coast of Southeast Alaska and British Columbia were identified as Gulf of Alaska transients and in one encounter they were observed mixing with West Coast transients (Matkin et al. 2012, Ford et al. 2013). Transients within the Gulf of Alaska population have been found to have two mtDNA haplotypes, neither of which is found in the West Coast or AT1 populations. Members of the AT1 population share a single mtDNA haplotype. Transient killer whales from the West Coast population have been found to share a single mtDNA haplotype that is not found in the other populations. Additionally, all three populations have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found as well; Saulitis et al. (2005) described acoustic differences between Gulf of Alaska transients and AT1 transients. For these reasons, the Gulf of Alaska transients are considered part of a population that is discrete from the AT1 population, and both of these populations are considered discrete from the West Coast transients.

Transient-type killer whales from the Aleutian Islands and Bering Sea are currently considered to be part of a single population that includes Gulf of Alaska transients; however, recent genetic analyses suggest substructure within the region. Biopsy samples from the eastern Aleutians and the south side of the west end of the Alaska Peninsula have produced the same haplotypes as killer whales in the northern Gulf of Alaska; however, nuclear DNA analysis strongly suggests they belong to a separate population (Parsons et al. 2013). The geographic distribution of mtDNA haplotypes revealed samples from the central Aleutian Islands and Bering Sea with haplotypes not found in Gulf of Alaska transients, suggesting additional population structure in western Alaska. Killer whales observed in the northern Bering Sea and north and east to the western Beaufort Sea have characteristics of transient-type whales, but little is known about these whales (Braham and Dahlheim 1982, George and Suydam 1998). AT1 haplotype whales are also present west of the Aleutian Islands and into the Bering Sea; however, nuclear DNA analysis indicates these animals are not part of the AT1 transient population in the Gulf of Alaska (Parsons et al. 2013).

In summary, within the transient ecotype, association data (Ford et al. 1994, Ford and Ellis 1999, Matkin et al. 1999), acoustic data (Ford and Ellis 1999, Saulitis et al. 2005), and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) confirm that at least three communities of transient whales exist and represent three discrete populations: 1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, 2) AT1 transients, and 3) West Coast transients.

Most of the transient killer whales photographed in the inland waters of Southeast Alaska share the West Coast Transient haplotype and have been seen in association with British Columbia/Washington State transients. Transients most often seen off California also share the West Coast Transient (WCT) haplotype and have been observed in association with transients in Washington and British Columbia. The West Coast Transient stock is therefore considered to include transient killer whales from California through Southeast Alaska. However, it should be noted that Fisheries and Oceans Canada no longer includes whales from California in their assessment of the "West Coast Transient (WCT) Population" (Fisheries and Oceans Canada 2007). They noted that 100 or so transient killer whales identified off the central coast of California (Black et al. 1997) were in the past considered to be an extension of this population because of acoustical similarities and occasional mixing with WCT individuals in BC waters (Ford and Ellis 1999), but that a recent reassessment indicated that the available evidence was insufficient to warrant inclusion of those whales in the WCT population (Fisheries and Oceans Canada 2010). Canadian researchers have now identified 46 individual whales in British Columbia that are known from California (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013). They also noted that the Gulf of Alaska transients are seen occasionally within the range of WCTs (in Southeast Alaska and off British Columbia) but have only been observed to travel in association with WCTs on one occasion (Fisheries and Oceans Canada 2007, Matkin et al. 2012). For the purposes of this stock assessment report, the West Coast Transient stock continues to include animals that occur in California, Oregon, Washington, British Columbia, and Southeast Alaska. Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. Exclusive Economic Zone: 1) the Alaska Resident stock - occurring from Southeast Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of Southeast Alaska, 3) the Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from Southeast Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1

Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast Transient stock - occurring from California through Southeast Alaska (Fig. 1), 7) the Offshore stock - occurring from California through Alaska, and 8) the Hawaiian stock. Transient killer whales in Canadian waters are considered part of the West Coast Transient stock. The Hawaiian and Offshore stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

The West Coast Transient stock is a trans-boundary stock, including killer whales from British Columbia. Preliminary analysis of photographic data resulted in the following minimum counts for transient killer whales belonging to the West Coast Transient stock. Towers et al. (2019) used a 61-year archive of photo-identification data (1958-2018) to assess the portion of the West Coast Transient stock that inhabits Canadian coastal waters and, therefore, was most likely to be impacted by human activity in Canada. Because there is evidence that this population may be composed of discrete population clusters (Parsons et al. 2013, Sharpe et al. 2017), they used a set of criteria to ensure that their analysis represented the animals that were the most regularly and recently documented in Canadian waters. Using only mature individuals, the criteria included the number of encounters, the cumulative number of years documented, and the time since the last encounter. Examination of these data produced a population subset of 349 individuals, including 206 mature individuals plus 143 individuals who were offspring and other inferred maternally related kin. Given that this number was limited to the population likely to be impacted by human activity in British Columbia, and that the California transient numbers have not been updated since the publication of the catalogue in 1997 (Black et al. 1997), the total number of transient killer whales reported above should be considered a minimum count for the West Coast Transient stock.

Minimum Population Estimate

The abundance estimate of killer whales is an analysis of individually identifiable animals. However, the number of catalogued whales does not necessarily represent the number of live animals. Some whales may have died, but they cannot be presumed dead if not resighted because long periods of time between sightings are common for some transient whales. The connection of the “outer coast” whales with the West Coast transient population of inshore waters is not well established, and the photographic catalogue from California has not been updated in 23 years. Estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) that include the outer coast whales are not currently available. Thus, the minimum population estimate (N_{MIN}) of 349 whales for the West Coast Transient stock of killer whales is derived from the recent catalogue for West Coast transient population whales from the inside waters of British Columbia (Towers et al. 2019), which focuses on whales found in Canadian waters (see PBR Guidelines regarding the status of migratory trans-boundary stocks, NMFS 2016). Information on the percentage of time whales typically encountered in Canadian waters spend in U.S. waters is unknown. However, as noted above, this minimum population estimate is considered conservative. This approach is consistent with previous recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

Recent analyses of the inshore West Coast Transient population indicate that this segment grew rapidly from the mid-1970s to mid-1990s as a result of a combination of high birth rate and survival, as well as greater immigration of animals into the nearshore study area (Fisheries and Oceans Canada 2009). The rapid growth of the West Coast Transient population in the mid-1970s to mid-1990s coincided with a dramatic increase in the abundance of the whales’ primary prey, harbor seals, in nearshore waters. Population growth began slowing in the mid-1990s but has increased in recent years (Fisheries and Oceans Canada 2009, Towers et al. 2019). Given that population estimates are based on photo identification of individuals and considered minimum estimates, no reliable estimate of trend is available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the West Coast Transient stock of killer whales. Analyses by Fisheries and Oceans Canada (2009) estimated a rate of increase of about 6% per year in this population from 1975 to 2006; however, this included recruitment of non-calf whales into the population, at least in the first half of the time period, interpreted as either a movement of some whales into nearshore waters from elsewhere or a result of better spatial sampling coverage. The population increased at a rate of approximately 2% for the second half of the time period, when recruitment of new individuals was nearly exclusively from new-born individuals (Fisheries and Oceans Canada 2009). Between 2012 and 2018, Towers et al.

(2019) observed a mean annual growth rate of 4.1% for a population subset in Canadian coastal waters, which was higher than the mean annual growth rate of 2.7% documented by Ford et al. (2013) between 2006 and 2011 for a sub-population of inner-coast transient killer whales that contained most of the same individuals. This rate was also higher than Ford et al.'s (2007) mean annual growth rate of 2% estimated for the same population between 1991 and 2006. However, until additional data become available for the West Coast Transient stock of killer whales, the default cetacean maximum theoretical net productivity rate of 4% will be used for this stock (NMFS 2016).

POTENTIAL BIOLOGICAL REMOVAL

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). Thus, for the West Coast Transient killer whale stock, PBR is 3.5 whales (349 × 0.02 × 0.5). The proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 West Coast Transient stock of killer whales between 2014 and 2018 is 0.4 killer whales: 0.2 in U.S. commercial fisheries and 0.2 in unknown (commercial, recreational, or subsistence) fisheries. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include oil spills, vessel strikes, and interactions with fisheries.

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).

NMFS observers monitored the California swordfish drift gillnet fishery from 1990 to 2017 (Carretta et al. 2019). The one killer whale mortality observed in this fishery, in 1995, was genetically identified as a transient ecotype. Bycatch estimates for 2013-2017, based on a bycatch model, result in a minimum mean annual mortality and serious injury rate of zero killer whales for this stock (Carretta et al. 2019).

Reports to NMFS Region marine mammal stranding networks of killer whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data. A killer whale mortality in commercial California Dungeness crab pot gear in 2015 reported to the NMFS West Coast Region marine mammal stranding network was genetically identified as a transient ecotype. Because the whale could not be assigned to a specific stock, the mean annual mortality and serious injury rate of 0.2 killer whales between 2014 and 2018 was assigned to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and the West Coast Transient killer whale stocks; it was not assigned to the AT1 Transient killer whale stock because none of the whales in this population are missing (Table 1; Young et al. 2020). An additional whale, photographically identified as a member of the West Coast Transient stock of killer whales, entangled in and self-released from commercial California Dungeness crab pot gear in 2016; however, this was considered to be a non-serious injury (Young et al. 2020). There was also a report to the NMFS Alaska Region marine mammal stranding network of a killer whale entangled in pot gear in Icy Strait in 2016, resulting in a mean annual mortality and serious injury rate of 0.2 killer whales in unknown (commercial, recreational, or subsistence) Southeast Alaska pot fishery gear between 2014 and 2018 (Table 1; Young et al. 2020). Because the stock identification is unknown, this mortality and serious injury was assigned to the three killer whale stocks that occur in the area: the Alaska Resident, Northern Resident, and West Coast Transient stocks. 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 or reported.

The minimum estimated mean annual mortality and serious injury rate incidental to fisheries between 2014 and 2018 is 0.4 killer whales: 0.2 in U.S. commercial fisheries and 0.2 in unknown (commercial, recreational, or subsistence) fisheries.

Table 1. Summary of mortality and serious injury of West Coast Transient killer whales, by year and type, reported to the NMFS Alaska Region and NMFS West Coast Region marine mammal stranding networks between 2014 and 2018 (Young et al. 2020).

Cause of Injury	2014	2015	2016	2017	2018	Mean annual mortality
Entangled in commercial CA Dungeness crab pot gear	0	1[a]	0	0	0	0.2
Entangled in Southeast Alaska pot gear*	0	0	1[b]	0	0	0.2
Total in commercial fisheries						0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.2

[a]This whale was genetically identified as a transient ecotype but could not be assigned to a specific stock; therefore, the mortality was assigned to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and the West Coast Transient killer whale stocks.
[b]The stock identification of this whale is unknown; therefore, this mortality was assigned to the three killer whale stocks in the area: the Alaska Resident, Northern Resident, and West Coast Transient killer whale stocks.

All Canadian longline fisheries (including halibut, rockfish, dogfish, sablefish, jig for lingcod, and troll for lingcod and Chinook salmon) are monitored by observers or video. However, only groundfish trawl fisheries have observer or electronic monitoring in Canada, whereas, trawl fisheries for krill, scallop, and shrimp have no observer coverage and salmon net fisheries are not observed (T. Doniol-Valcroze, pers. comm., Department of Fisheries and Oceans, BC, Canada, 14 May 2019). The interaction of Alaska Resident killer whales with the sablefish longline fishery accounts for a large proportion of the commercial fishing/killer whale interactions in Alaska waters. However, transient killer whales typically are not involved in these interactions. Such interactions have not been reported in Canadian waters where sablefish are taken via a pot fishery; however, Northern Resident killer whale interactions with Pacific halibut longline and salmon troll fisheries in British Columbia have been reported (Ford 2014). Reports of killer whale interactions with gillnets in Canadian waters include one killer whale that contacted a salmon gillnet in 1994 but did not entangle (Guenther et al. 1995) and one killer whale (Northern Resident I103) that entangled in a gillnet in 2014 but was quickly released (Fisheries and Oceans Canada 2018).

Alaska Native Subsistence/Harvest Information

Killer whales are not harvested for subsistence in Alaska.

Other Mortality

The shooting of killer whales in Canadian waters has been a concern in the past. Since 1974, however, fresh bullet wounds are rarely, if ever, seen on whales in British Columbia and Washington (Ford et al. 2000, Fisheries and Oceans Canada 2018). In fact, the likelihood of shooting incidents involving transient killer whales is thought to be minimal since commercial fishermen are most likely to observe transients feeding on seals or sea lions instead of interacting with their fishing gear (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

Collisions with vessels are an occasional source of mortality or serious injury of killer whales. For example, a killer whale struck the propeller of a vessel in the Bering Sea/Aleutian Islands flatfish trawl fishery in 2016. Stock identification of this whale is unknown; however, this fishery is outside of the known range of the West Coast Transient stock. There has been no known mortality or serious injury of West Coast Transient killer whales due to vessel collisions.

STATUS OF STOCK

The West Coast Transient killer whale stock is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. In 2001, the Committee on the Status of Endangered Wildlife in Canada designated West Coast Transient killer whales in British Columbia as threatened under the Species at Risk Act (SARA) for Canada. Human-caused mortality may have been underestimated, primarily due to a lack of information on Canadian fisheries, and the minimum abundance estimate is considered conservative (because researchers continue to encounter new whales and provisionally classified whales from Southeast Alaska and off the coast of California were not included), resulting in a conservative PBR estimate. Based on currently available data, the minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate (0.2) does not exceed 10% of the PBR (10% of PBR = 0.3) and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate. The minimum estimated mean annual level of human-caused mortality and serious injury (0.4) is not known to exceed the PBR (3.5). Therefore, the West Coast Transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population size are currently unknown.

There are key uncertainties in the assessment of the West Coast Transient stock of killer whales. The current population estimate is for a subset of whales that inhabits Canadian coastal waters and this subset has increased at an average rate of 4.1% per year from 2012 to 2018. However, an updated abundance estimate and growth rate is not available for the entire stock.

HABITAT CONCERNS

Analyses of blubber biopsies collected from mammal-eating transient killer whales and fish-eating resident killer whales in Canadian waters between 1993 and 1996 revealed that transient killer whales and Southern Resident killer whales had surprisingly high levels of persistent PCB contamination; the particularly high levels of contamination found in transient killer whales most likely reflected their higher trophic level (Ross et al. 2000). Due to these high levels of contamination, transient and Southern Resident killer whales in Canadian waters were considered to be at risk for toxic effects (Ross et al. 2000).

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Revised 12/30/2018

PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The Pacific white-sided dolphin is found throughout the temperate North Pacific Ocean, north of the coasts of Japan and Baja California, Mexico. In the eastern North Pacific, the species occurs from the southern Gulf of California, north to the Gulf of Alaska, west to Amchitka in the Aleutian Islands, and is sometimes encountered in the southern Bering Sea. The species is common both on the high seas and along the continental margins, and animals are known to enter the inshore passes of Alaska, British Columbia, and Washington (Ferrero and Walker 1996).

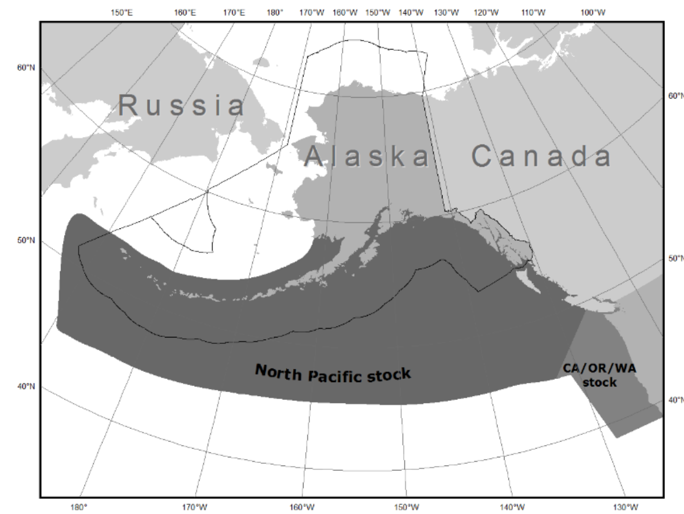

Figure 1. Approximate distribution of Pacific white-sided dolphins in the eastern North Pacific (dark shaded areas). The U.S. Exclusive Economic Zone is delineated by the solid black line.

The following information was considered in classifying Pacific white-sided dolphin stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution is continuous; 2) Population response data: unknown; 3) Phenotypic data: two morphological forms are recognized (Walker et al. 1986, Chivers et al. 1993); and 4) Genotypic data: preliminary genetic analyses on 116 Pacific white-sided dolphins collected in four areas (Baja California, the U.S. west coast, British Columbia/Southeast Alaska, and offshore) do not support phylogeographic partitioning, although they are sufficiently differentiated to be treated as separate management units (Lux et al. 1997). This limited information is not sufficient to define stock structure throughout the North Pacific beyond the generalization that a northern form occurs north of about 33°N from southern California along the coast to Alaska and a southern form ranges from about 36°N southward along the coasts of California and Baja California, while the core of the population ranges across the North Pacific to Japan at latitudes south of 45°N. Data are lacking to determine whether this latter group might include animals from one or both of the coastal forms. Although the genetic data are unclear, management issues support the designation of two stocks; because the California and Oregon thresher shark/swordfish drift gillnet fishery (operating between 33°N and approximately 47°N) and, to a lesser extent, the groundfish and salmon fisheries in Alaska are known to interact with Pacific white-sided dolphins, two management stocks are recognized: 1) the California/Oregon/Washington stock, and 2) the North Pacific stock (Fig. 1). The California/Oregon/Washington stock is reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

The most complete population abundance estimate for Pacific white-sided dolphins was calculated from line-transect analyses applied to the 1987-1990 marine mammal sighting survey data across the North Pacific from 25°N and into the Bering Sea (Buckland et al. 1993). The Buckland et al. (1993) abundance estimate, 931,000 dolphins (CV = 0.90), more closely reflects a range-wide estimate rather than one that can be applied to either of the two management stocks off the west coast of North America. Furthermore, Buckland et al. (1993) suggested that Pacific white-sided dolphins show strong vessel attraction but that a correction factor was not available to apply to the estimate. While the Buckland et al. (1993) abundance estimate is not considered appropriate to apply to the management stock in Alaska waters, the portion of the estimate derived from sightings north of 45°N in the Gulf of Alaska can be used as the population estimate for this area (26,880). For comparison, Hobbs and Lerczak (1993) estimated 15,200 Pacific white-sided dolphins (95% CI: 868-265,000) in the Gulf of Alaska. This estimate is based on a single sighting of 20 animals and so should not be used as an abundance estimate. Small cetacean aerial surveys in the Gulf of Alaska during 1997 sighted one group of 164 Pacific white-sided dolphins off Dixon entrance, while similar surveys in Bristol Bay in 1999 made 18 sightings (188 individuals with possible repeat sightings) off Port Moller (MML, unpubl. data).

Minimum Population Estimate

Historically, the minimum population estimate (N_{MIN}) for this stock was 26,880 dolphins, based on the sum of abundance estimates for four separate 5° × 5° blocks north of 45°N (1,970 + 6,427 + 6,101 + 12,382 = 26,880) from surveys conducted during 1987-1990, reported in Buckland et al. (1993). This was considered a minimum estimate because the abundance of animals in a fifth 5° × 5° block (53,885), which straddled the boundary of the two coastal management stocks, was not included in the estimate for the North Pacific stock and because much of the potential habitat for this stock was not surveyed between 1987 and 1990. However, because the abundance estimate is more than 8 years old, N_{MIN} is considered unknown.

Current Population Trend

There is no reliable information on trends in abundance for this stock of Pacific white-sided dolphins.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the North Pacific stock of Pacific white-sided dolphins. Life-history analyses by Ferrero and Walker (1996) suggest a reproductive strategy consistent with the delphinid pattern on which the 4% cetacean maximum theoretical net productivity rate was based. Thus, the cetacean maximum theoretical net productivity rate of 4% will be used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

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 of unknown status (Wade and Angliss 1997). However, the 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. In addition, there is no corroborating evidence from recent surveys in Alaska that provide abundance estimates for a portion of the stock's range or any indication of the current status of this stock. Therefore, the PBR for this stock is considered undetermined.

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 is listed, by marine mammal stock, in Helker et al. (in press); 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 North Pacific stock of Pacific white-sided dolphins in 2012-2016 is zero; however, this estimate is considered a minimum because not all of the salmon and herring fisheries 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

Between 1978 and 1991, mortality and serious injury of thousands of Pacific white-sided dolphins occurred annually incidental to high-seas fisheries for salmon and squid. However, these fisheries were closed in 1991 and no other large-scale fisheries have operated in the central North Pacific since 1991.

Information (including observer programs, observer coverage, and observed incidental takes of marine mammals) for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is presented in Appendices 3-6 of the Alaska Stock Assessment Reports.

No mortality or serious injury of Pacific white-sided dolphins was observed incidental to U.S. federal commercial fisheries in Alaska in 2012-2016 (Breiwick 2013; MML, unpubl. data). However, 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.

Alaska Native Subsistence/Harvest Information

There are no reports of subsistence takes of Pacific white-sided dolphins in Alaska.

Other Mortality

From 2012 to 2016, no human-caused mortality or serious injury of Pacific white-sided dolphins was reported to the NMFS Alaska Region stranding network (Helker et al. in press).

STATUS OF STOCK

Pacific white-sided dolphins are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. The North Pacific stock of Pacific white-sided dolphins is not classified as a strategic stock. The abundance estimate for this stock is unknown because the existing estimate is more than 8 years old and so the PBR level is considered undetermined. Because the PBR is undetermined and fisheries observer coverage is limited, it is unknown if the minimum estimate of the mean annual mortality and serious injury rate (zero) in U.S. commercial fisheries can be considered insignificant and approaching zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the North Pacific stock of Pacific white-sided dolphins. The most recent surveys were more than 8 years ago and, given the lack of information on population trend, the abundance estimates are not used to calculate an N_{MIN} and the PBR level is undetermined. 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.

HABITAT CONCERNS

While the majority of Pacific white-sided dolphins are found throughout the North Pacific, there are also significant numbers found in shelf break and deeper nearshore areas. Thus, they are subject to a variety of habitat impacts. Of particular concern are nearshore areas, bays, channels, and inlets where some Pacific white-sided dolphins are vulnerable to physical modifications of nearshore habitats, resulting from urban and industrial development (including waste management and nonpoint source runoff), and noise (Linnenschmidt et al. 2013, Waite and Shelden 2018).

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HARBOR PORPOISE (*Phocoena phocoena*): Southeast Alaska Stocks: Northern Southeast Alaska Inland Waters, Southern Southeast Alaska Inland Waters, Yakutat/Southeast Alaska Offshore Waters

STOCK DEFINITION AND GEOGRAPHIC RANGE

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, near Wrangell and Zarembo Islands, and in 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 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).

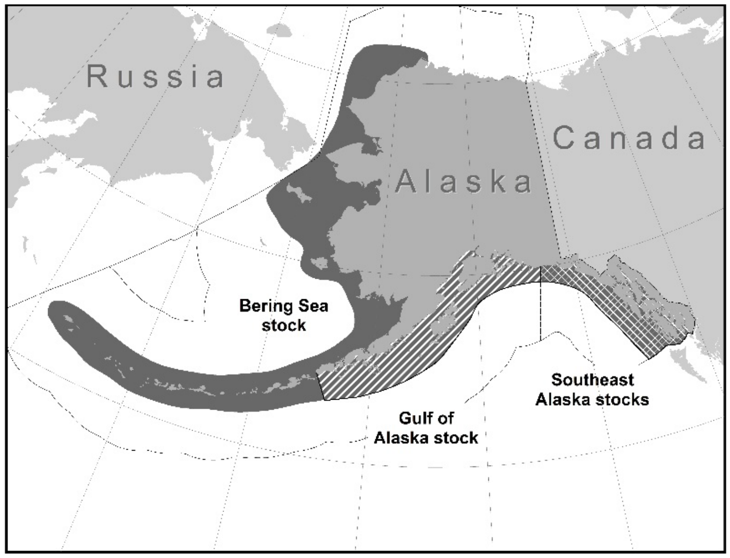

Figure 1. Approximate distribution of harbor porpoise in Alaska waters. See Figure 2 for boundaries of the three stocks in Southeast Alaska. The U.S. Exclusive Economic Zone is delineated by a black line.

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. Despite these two clades overlapping in latitude, the results 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 eight additional samples from Alaska, 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 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 was 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 were previously specified, recognizing that the boundaries were identified primarily based upon geography or perceived areas of low porpoise density: 1) the Southeast Alaska stock - occurring from Dixon Entrance to Cape Suckling, including offshore, coastal, and inland waters, 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 (Fig. 1). 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.

Dahlheim et al. (2015) proposed that harbor porpoise in the northern and southern inland waters of Southeast Alaska potentially represented different populations due to differences in trends in abundance between the two regions. In addition, there is a possible hiatus in distribution between the two higher-density areas of Frederick Sound and Wrangell/Zarembo, which suggests the range of harbor porpoise from those two regions does not overlap; in fact, many of the passages between these areas have shoal or constricted areas that might serve as physical barriers to movements of harbor porpoise (Zerbini et al. 2022a, 2022b). Results from analyses of environmental DNA (eDNA) from three areas in Southeast Alaska (Glacier Bay and Icy Strait, Keku Strait, and Wrangell and Zarembo Islands) suggested significant genetic differentiation between Wrangell and Zarembo Islands and the two other areas (Parsons et al. 2018), supporting the existence of two different populations within Southeast Alaska inland waters. Connectivity of harbor porpoise in these two regions with those in Gulf of Alaska waters offshore of Southeast Alaska and in the region around Yakutat is poorly understood.

Multiple lines of evidence (molecular genetics, density discontinuities) led NMFS to delineate six stocks of harbor porpoise along the coasts of California, Oregon, and Washington. The same lines of evidence, along with additional evidence from trends in abundance, led NMFS to delineate two Demographically Independent Populations and one unit within the Southeast Alaska harbor porpoise stock (Zerbini et al. 2022a), which is now divided into three stocks: 1) the Northern Southeast Alaska (N-SEAK) Inland Waters stock, which includes Cross Sound, Glacier Bay, Icy Strait, Chatham Strait, Frederick Sound, Stephens Passage, Lynn Canal, and adjacent inlets; 2) the Southern Southeast Alaska (S-SEAK) Inland Waters stock, which encompasses Sumner Strait, including areas around Wrangell and Zarembo Islands, Clarence Strait, and adjacent inlets and channels within the inland waters of Southeast Alaska north-northeast of Dixon Entrance; and 3) the Yakutat/Southeast Alaska (Y-SEAK) Offshore Waters stock, which includes offshore habitats in the Gulf of Alaska west of the Southeast Alaska inland waters and the areas around Yakutat Bay (Fig. 2). There is limited information to assess how harbor porpoise in the Y-SEAK Offshore Waters stock relate to animals in inland waters, but it is likely, based on what is known about harbor porpoise stock structure in other areas, that the Y-SEAK Offshore Waters stock includes more than one Demographically Independent Population. Therefore, refinement of the stock structure of Y-SEAK/Offshore Waters stock in future years is likely as new information becomes available in the future (Zerbini et al. 2022a).

POPULATION SIZE

Information on harbor porpoise abundance was collected for coastal and inland waters of Southeast Alaska by the Alaska Fisheries Science Center's Marine Mammal Laboratory (MML), using both aerial and shipboard surveys between 1991 and 2012 (Hobbs and Waite 2010, Dahlheim et al. 2015). Estimates of abundance provided by these surveys are more than 10 years old and are no longer considered reliable as a measure of current abundance and there is no basis for adjusting the abundance estimates to account for potential changes that may have occurred since the last survey (see Current Population Trend section below). Further information on these surveys is available in previous stock assessment reports for Southeast Alaska harbor porpoise (e.g., Muto et al. 2021).

Northern and Southern Southeast Alaska Inland Waters Stocks

A line-transect vessel survey was 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. 2022b). Using the methods of Barlow (2015), an estimate of g(0) = 0.53 (CV = 0.11, 95% CI = 0.43-0.65) was computed for both inland waters stocks from apparent densities in different survey conditions. This parameter corrects for the fraction of animals missed directly on the survey transect line. Estimates of abundance for the N-SEAK and S-SEAK Inland Waters stocks are, respectively, 1,619 (CV = 0.26, 95% CI = 944-2,529) and 890 (CV = 0.37, 95% CI = 385-1,708) harbor porpoise.

Yakutat/Southeast Alaska Offshore Waters Stock

A current estimate of abundance is not available for the Y-SEAK Offshore Waters stock.

Minimum Population Estimate

Northern and Southern Southeast Alaska Inland Waters Stocks

The minimum population estimates (N_{MINs}) for the harbor porpoise stocks in Southeast Alaska inland waters, based on the 2019 vessel survey, were calculated as the 20th percentile of the distribution of the g(0)-corrected abundance estimates computed using bootstrap methods. The N_{MINs} for the N-SEAK and S-SEAK Inland Waters stocks are, respectively, 1,250 and 610 harbor porpoise.

Yakutat/Southeast Alaska Offshore Waters Stock

A current minimum population estimate is not available for the Y-SEAK Offshore Waters stock.

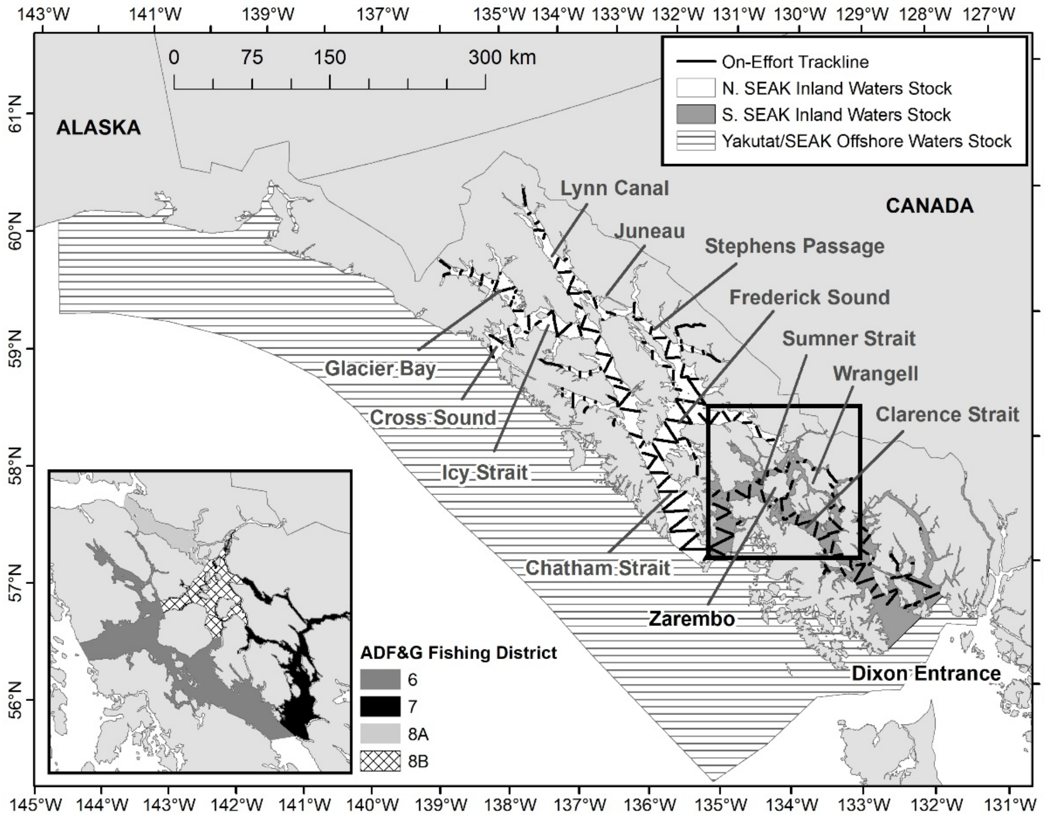

Figure 2. Boundaries for the three newly identified Southeast Alaska harbor porpoise stocks. The on-effort trackline for the 2019 harbor porpoise survey of the inland waters of Southeast Alaska is also shown. Alaska Department of Fish and Game Management Districts 6, 7, and 8 are indicated by gray shading and cross-hatching. The two sub-areas comprising District 8 are differentiated because the N-SEAK Inland Waters stock occurs in sub-area 8A and the S-SEAK Inland Waters stock occurs in sub-area 8B (Zerbini et al. 2022a).

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). 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).

Current estimates of trend in abundance are not available for any of the Southeast Alaska harbor porpoise stocks.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for any of the Southeast Alaska stocks of harbor porpoise. Until additional data become available, the cetacean maximum theoretical net productivity rate of 4% will be used (NMFS 2023).

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 the three Southeast Alaska stocks of harbor porpoise is 0.5, the default value for cetacean stocks with unknown population status (NMFS 2023).

Northern and Southern Southeast Alaska Inland Waters Stocks

PBRs for the N-SEAK and the S-SEAK Inland Waters stocks are 13 (1,250 x 0.02 x 0.5) and 6.1 (610 x 0.02 x 0.5) porpoise, respectively.

Yakutat/Southeast Alaska Offshore Waters Stock

Because there is no current estimate of N_{MIN}, the PBR for this stock is considered undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused mortality and serious injury for Southeast Alaska harbor porpoise between 2016 and 2020, by stock, is: 1) N-SEAK Inland Waters stock = 5.6 porpoise in U.S. commercial fisheries (estimated from observer data collected in 2012-2013); 2) S-SEAK Inland Waters stock = 7.4 porpoise in U.S. commercial fisheries (estimated from observer data collected in 2012-2013); and 3) Y-SEAK Offshore Waters stock = 22.2 porpoise in U.S. commercial fisheries (22 estimated from observer data collected in 2007-2008 and 0.2 estimated from a Marine Mammal Authorization Program (MMAP) fisherman self-report in the coastal waters of Southeast Alaska in 2019).

The estimates of mortality and serious injury provided above are considered minimums 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 these stocks are not observed. The potential threat most likely to result in direct human-caused mortality or serious injury of these stocks is entanglement in fishing gear. There are no other known causes of human-caused mortality and serious injury for these stocks.

Fisheries Information

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

Northern and Southern Southeast Alaska Inland Waters Stocks

No mortality or serious injury of harbor porpoise from the N-SEAK or S-SEAK Inland Waters stocks was observed incidental to federally-managed U.S. commercial fisheries in Alaska between 2016 and 2020. In 2012 and 2013, the Alaska Marine Mammal Observer Program (AMMOP) placed observers on independent vessels in the state-managed Southeast Alaska salmon drift gillnet fishery in Alaska Department of Fish and Game (ADF&G) Management Districts 6, 7, and 8 to assess mortality and serious injury of marine mammals (Manly 2015). Specifically, the program observed sub-areas 6A, 6B, 7A, 8A, and 8B within Districts 6, 7, and 8; sub-areas are referenced herein only if relevant to identifying specific harbor porpoise interactions or assigning interactions to a stock. 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, in 2013, four harbor porpoise were observed entangled and released.

A previous estimate of harbor porpoise mortality and serious injury from these observed interactions was 23 harbor porpoise for 2012-2013 (an average of 12 individuals per year) (Manly 2015). That estimate is revised here because of an error in the assignment of injury severity for two of the bycaught individuals. Upon review of the data, it was determined that one of the two porpoise that were caught in sub-area 8A and reported to have serious injuries (Manly 2015) should have been classified as having a non-serious injury (Helker et al. 2015), and the porpoise caught in sub-area 6A and classified as having a non-serious injury (Manly 2015) was in fact seriously injured (Helker et al. 2015). These corrections required a review of the estimated bycatch in these sub-areas. Following the same methods used by Manly (2015), mortality and serious injury in sub-areas 6A and 8A were estimated, respectively, as 14.8 (CV = 1.0) and 11.2 (CV = 0.7) porpoise. Total mortality and serious injury estimated for the observed sub-areas of Districts 6, 7, and 8 was estimated at 26 porpoise (CV = 0.5) for 2012-2013, which results in a mean annual mortality and serious injury rate of 13 porpoise.

Total annual mortality and serious injury was then divided between the inland waters stocks based on the locations of the observed mortalities and serious injuries. As shown in Figure 2, sub-area 8A occurs within the range of the N-SEAK Inland Waters stock, thus the estimated mortality and serious injury in sub-area 8A was assigned to the N-SEAK Inland Waters stocks; similarly, sub-areas 6A, 6B, 7A, and 8B overlap with the range of the S-SEAK Inland Waters stock and thus the estimated mortality and serious injury in sub-area 6A was assigned to the S-SEAK Inland Waters stock. Based on the revised estimates, the mean annual mortality and serious injury rate for the N-SEAK and S-SEAK Inland Waters stocks is estimated to be 5.6 and 7.4 porpoise, respectively (Table 1). It is important to note that these are minimum estimates of mortality and serious injury for these stocks in the Southeast Alaska salmon drift gillnet fishery because they only apply to the sub-areas in which the fishery was observed (ADF&G sub-areas 6A, 6B, 7A, 8A and 8B), not to other districts where the salmon driftnet fishery is known to operate (e.g., Lynn Canal, Taku/Snettisham, and Tree Point) but was not observed. In addition, there are no estimates of mortality and serious injuries for fisheries other than the salmon drift gillnet fishery.

Yakutat/Southeast Alaska Offshore Waters Stock

No mortality or serious injury of harbor porpoise from any of the Southeast Alaska stocks was observed incidental to federally-managed U.S. commercial fisheries in Alaska between 2016 and 2020. In 2007 and 2008, the 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 for this stock in this fishery.

Mortality of one harbor porpoise in the Y-SEAK Offshore Waters stock due to entanglement in a commercial Southeast Alaska salmon cost recovery drift gillnet was reported in an MMPA fisherman self-report in 2019 (Table 2; Freed et al. 2022), resulting in a minimum mean annual mortality and serious injury rate of 0.2 harbor porpoise for this stock in this fishery between 2016 and 2020. 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.

Fisheries Summary

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 2016 and 2020, by stock, is: 1) N-SEAK Inland Waters stock = 5.6 harbor porpoise from observed fisheries, 2) S-SEAK Inland Waters stock = 7.4 harbor porpoise from observed fisheries; and 3) Y-SEAK Offshore Waters stock = 22 harbor porpoise from observed fisheries and 0.2 from an MMAP fisherman self-report. These are likely underestimates 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 these stocks 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 these stocks is likely greater than is reported here.

Table 1. Summary of incidental mortality and serious injury of Southeast Alaska harbor porpoise due to U.S. commercial fisheries, by stock, between 2016 and 2020 (estimated from data collected in 2007-2008 and 2012-2013) and the mean annual mortality and serious injury rate (Manly 2009, 2015; see text for information on re-analysis of estimates from Manly 2015). Observer coverage levels shown for the Southeast Alaska salmon drift gillnet fishery are specific to individual observed ADF&G sub-areas and do not represent the level of coverage of the entire Southeast Alaska salmon drift gillnet fishery.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Northern Southeast Alaska Inland Waters stock						
Southeast Alaska salmon drift gillnet (ADF&G sub-area 8A)	2012 2013	obs data	6.9 8.9	0 1	0 11.2	5.6 (CV = 0.7)
Southern Southeast Alaska Inland Waters stock						
Southeast Alaska salmon drift gillnet (ADF&G sub-area 6A)	2012 2013	obs data	7.3 6.7	0 1	0 14.8	7.4 (CV = 1.0)
Yakutat/Southeast Alaska Offshore Waters stock						
Yakutat salmon set gillnet	2007 2008	obs data	5.3 7.6	1 3	16.1 27.5	22 (CV = 0.54)
Minimum total estimated annual mortality N-SEAK Inland Waters stock S-SEAK Inland Waters stock Y-SEAK Offshore Waters stock						 5.6 (CV = 0.7) 7.4 (CV = 1.0) 22 (CV = 0.54)

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 2016 and 2020 (Freed et al. 2022). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury		2016	2017	2018	2019	2020	Mean annual mortality
Yakutat/Southeast Alaska Offshore Waters stock							
Entangled in commercial Southeast Alaska salmon cost recovery drift gillnet		0	0	0	1*	0	0.2
Total in commercial fisheries Y-SEAK Offshore Waters stock							0.2

*MMAP fisherman self-report.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska have not been reported to take from these stocks of harbor porpoise.

STATUS OF STOCK

None of the stocks of Southeast Alaska harbor porpoise are designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act.

<u>Northern and Southern Southeast Alaska Inland Waters Stocks</u>

The minimum mean annual level of human-caused mortality and serious injury estimated for the N-SEAK Inland Waters stock (5.6 porpoise, based on data collected from an observer program in ADF&G sub-area 8A) does not exceed the calculated PBR (13); therefore, the stock is not strategic. However, because only a portion of the Southeast Alaska salmon drift gillnet fishery was monitored by AMMOP, it is possible that the actual level of human-caused mortality and serious injury is underestimated, and NMFS is evaluating the feasibility of observing the fishery throughout the stock's range. The minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate (5.6 porpoise) is more than 10% of the calculated PBR (10% of PBR = 1.3 porpoise), so it is not considered insignificant and approaching a zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

The minimum mean annual level of human-caused mortality and serious injury estimated for the S-SEAK Inland Waters stock (7.4 porpoise, based on data collected from an observer program in ADF&G sub-areas 6A, 6B, 7A, and 8B) exceeds the calculated PBR (6.1); therefore, the stock is strategic. The minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate (7.4 porpoise) is more than 10% of the calculated PBR (10% of PBR = 0.6 porpoise), so it is not considered insignificant and approaching a zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

Yakutat/Southeast Alaska Offshore Waters Stock

The current abundance for this stock is unknown because the existing estimate is more than 10 years old and, based on available data, cannot be corrected to account for potential changes in abundance since the last survey. Without an estimate of N_{MIN}, the PBR level is considered undetermined. Because the PBR is undetermined, it is unknown if the minimum estimate of the mean annual mortality and serious injury rate (22.2 porpoise) in U.S. commercial fisheries can be considered insignificant and approaching a zero mortality and serious injury rate. NMFS considers this stock not strategic at this time because the PBR level is undetermined and a comparison between the level of mortality and serious injury and a PBR level is thus not possible. However, based on information about the range of harbor porpoise stocks in other areas, the Y-SEAK Offshore stock is likely to comprise multiple stocks, and if this is the case, a mortality and serious injury level of 22.2 harbor porpoise from a portion of the total area of this stock is likely to be of concern. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

Uncertainties

There are key uncertainties in the assessment of the Southeast Alaska stocks of harbor porpoise. It is unclear whether there is connectivity between the N-SEAK and S-SEAK Inland Waters stocks and the Y-SEAK Offshore Waters stock. Trends in abundance of harbor porpoise in these regions are unclear; an early decline in inland waters appears to have reversed in recent years. Several commercial fisheries overlap with the range of these stocks and have not been observed since at least 2013; thus, the estimates of commercial fishery mortality and serious injury are expected to be minimum estimates. 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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Revised 12/30/2020

HARBOR PORPOISE (*Phocoena phocoena*): Gulf of Alaska Stock

NOTE – December 2015: In areas outside of Alaska, studies of harbor porpoise distribution have indicated that stock structure is likely more fine-scaled than is reflected in the Alaska Stock Assessment Reports. 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.

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the eastern North Pacific Ocean, the harbor porpoise ranges 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). 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 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; Castellote et al. 2015), and lower Cook Inlet (Shelden et al. 2014).

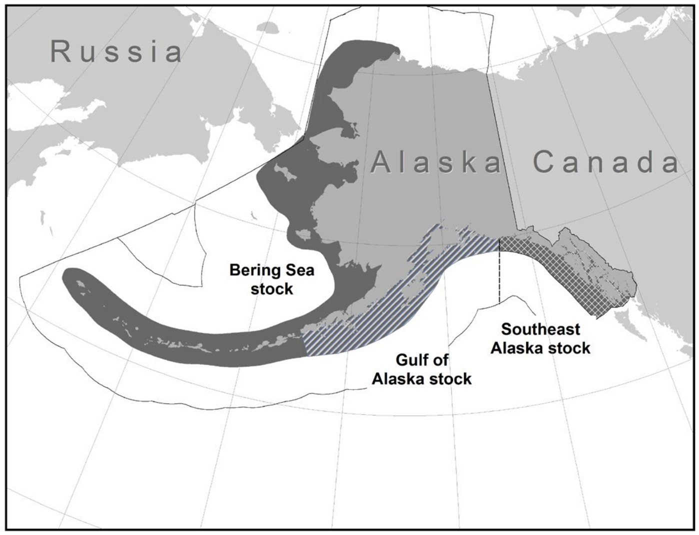

Figure 1. Approximate distribution of harbor porpoise in Alaska waters. The U.S. Exclusive Economic Zone is delineated by a black line.

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 these two clades are not geographically distinct by latitude, the results may indicate 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 additional samples including eight more from Alaska, found 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 that harbor porpoise along the west coast of North America are not panmictic and that movement is sufficiently restricted to result in genetic differences (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 inferred primarily based upon geography or perceived areas of low porpoise density: 1) the Southeast Alaska stock - occurring from Dixon Entrance to Cape Suckling, including inland waters, 2) the Gulf of Alaska stock - occurring from Cape Suckling to Unimak Pass (Fig. 1), and 3) the Bering Sea stock - occurring throughout the Aleutian Islands and all waters 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 the Southeast Alaska stock (see the Southeast Alaska harbor porpoise Stock Assessment Report and Parsons et al. 2018).

POPULATION SIZE

In June and July of 1998 and 1999, an aerial survey covered the waters of the western Gulf of Alaska from Cape Suckling to Unimak Island, offshore to the 1,000 fathom depth contour. Two types of corrections were needed for these aerial surveys: one to correct for animals available but not counted because they were not detected by the observers (perception bias) and another to correct for porpoise that were submerged and not available at the surface (availability bias). The 1998 survey resulted in an abundance estimate for the Gulf of Alaska harbor porpoise stock of 10,489 porpoise (coefficient of variation (CV) = 0.12) (Hobbs and Waite 2010), which includes a correction factor (1.372; CV = 0.07) for perception bias. Laake et al. (1997) estimated the availability bias correction factor for aerial surveys of harbor porpoise in Puget Sound to be 2.96 (CV = 0.18); the use of this correction factor is preferred to other published correction factors (e.g., Barlow et al. 1988, Calambokidis et al. 1993) because it is an empirical estimate of availability bias. Hobbs and Waite (2010) applied the Laake et al. (1997) correction factor to the 1998 estimate, resulting in a corrected abundance of 31,046 porpoise (10,489 × 2.96 = 31,046; CV = 0.21) for the Gulf of Alaska stock.

This latest estimate of abundance (31,046) is considerably higher than the estimate reported in the 1999 stock assessment (8,271; CV = 0.31), which was based on surveys conducted in 1991-1993. This disparity largely stems from changes in the area covered by the two surveys and differences in harbor porpoise density encountered in areas added to, or dropped from, the 1998 survey relative to the 1991 to 1993 surveys. The survey area in 1998 (119,183 km^2) was greater than the area covered in the combined portions of the 1991, 1992, and 1993 surveys (106,600 km^2). The 1998 survey included selected bays, channels, and inlets in Prince William Sound, the outer Kenai Peninsula, the south side of the Alaska Peninsula, and the Kodiak Archipelago, whereas, the earlier survey included only open water areas. Several of the bays and inlets covered by the 1998 survey had higher harbor porpoise densities than were observed in the open waters. In addition, the 1998 estimate provided by Hobbs and Waite (2010) empirically estimates the perception bias and uses this in addition to the correction factor for availability bias. Finally, the 1998 estimate extrapolates available densities to estimate the number of porpoise which would likely be found in unsurveyed inlets within the study area. For these reasons, the 1998 survey result is probably more representative of the size of the Gulf of Alaska harbor porpoise stock.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock 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 31,046 in 1998 and its associated CV of 0.21, N_{MIN} for the Gulf of Alaska stock of harbor porpoise is 26,064. However, because the survey data are now more than 8 years old, N_{MIN} is considered unknown for this stock.

Current Population Trend

There is no reliable information on trends in abundance for the Gulf of Alaska stock of harbor porpoise because survey methods and results are not comparable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Gulf of 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). 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.

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 Gulf of Alaska harbor porpoise between 2014 and 2018 is 72 porpoise: 72 in U.S. commercial fisheries and 0.2 in unknown (commercial, recreational, or subsistence) fisheries; however, this estimate is considered a minimum because of the absence of observer placements in all of the salmon and herring fisheries operating within the range of this stock. 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 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).

No incidental mortality or serious injury of Gulf of Alaska harbor porpoise was observed in U.S. federal commercial fisheries between 2014 and 2018. Alaska Marine Mammal Observer Program (AMMOP) observers monitoring the State of Alaska-managed Prince William Sound salmon drift gillnet fishery in 1990 and 1991 recorded 1 mortality in 1990 and 3 in 1991, which extrapolated to 8 (95% CI: 1-23) and 32 (95% CI: 3-103) for the entire fishery, resulting in a mean annual mortality and serious injury rate of 20 porpoise (CV = 0.60) when averaged over 1990 and 1991 (Table 1; Wynne et al. 1991, 1992). The Prince William Sound salmon drift gillnet fishery has not been observed since 1991 and no additional data are available for this fishery.

In 1999 and 2000, AMMOP observers were placed on state-managed Cook Inlet salmon set and drift gillnet vessels. One harbor porpoise mortality was observed in 2000 in the Cook Inlet salmon drift gillnet fishery (Manly 2006). This single mortality extrapolates to an estimated mortality and serious injury rate of 31 porpoise for that year and an average of 16 porpoise per year when averaged over the 2 years of observer data (Table 1).

In 2002 and 2005, AMMOP observers were placed on state-managed Kodiak Island set gillnet vessels. Harbor porpoise mortality observed in this fishery (two each in both 2002 and 2005) (Manly 2007) extrapolates to an estimated mean annual mortality and serious injury rate of 36 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 fisheries.

Table 1. Summary of incidental mortality and serious injury of Gulf of Alaska harbor porpoise due to state-managed fisheries from 1990 through 2005 and calculation of the mean annual mortality and serious injury rate (Wynne et al. 1991, 1992; Manly 2006, 2007). 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
Prince William Sound salmon drift gillnet	1990 1991	obs data	4 5	1 3	8 32	20 (CV = 0.60)
Cook Inlet salmon drift gillnet	1999 2000	obs data	1.6 3.6	0 1	0 31	16 (CV = 1.00)
Cook Inlet salmon set gillnet	1999 2000	obs data	0.16-1.1 0.34-2.7	0 0	0 0	0
Kodiak Island salmon set gillnet	2002 2005	obs data	6.0 4.9	2 2	32 39	36 (CV = 0.68)
Minimum total estimated annual mortality						72 (CV = 0.44)

Reports to the NMFS Alaska Region marine mammal stranding network of marine mammals with fishing gear attached or with injuries caused by interactions with fishing gear are another source of mortality data. A harbor porpoise mortality, due to entanglement in unidentified fishing net near Homer, Alaska, was reported in 2014, resulting in a minimum mean annual mortality and serious injury rate of 0.2 harbor porpoise from this stock in unknown (commercial, recreational, or subsistence) fisheries between 2014 and 2018 (Table 2; Young et al. 2020). 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 nor are all stranded animals found, reported, or have the cause of death determined.

Table 2. Summary of incidental mortality and serious injury of Gulf of Alaska harbor porpoise, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2014 and 2018 (Young et al. 2020).

Cause of Injury	**2014**	**2015**	**2016**	**2017**	**2018**	**Mean annual mortality**
Entangled in unidentified net*	1	0	0	0	0	0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.2

A complete estimate of the total mortality and serious injury incidental to U.S. commercial fisheries is unavailable for this stock because of the absence of an observer program for all of the salmon and herring fisheries operating within the range of this stock. Based on observed mortality and serious injury in four commercial fisheries (Table 1) and a report to the NMFS Alaska Region stranding network (Table 2), the minimum estimated mean annual mortality and serious injury rate incidental to all fisheries between 2014 and 2018 is 72 harbor porpoise from this stock (72 in U.S. commercial fisheries + 0.2 in unknown fisheries).

Alaska Native Subsistence/Harvest Information

Porpoise in the Gulf of Alaska were hunted by prehistoric societies from Kodiak Island and areas around Cook Inlet and Prince William Sound (Shelden et al. 2014). Subsistence hunters have not been reported to harvest from this stock of harbor porpoise since the early 1900s (Shelden et al. 2014).

STATUS OF STOCK

Gulf of 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 abundance estimate for this stock is unknown because the existing estimate is more than 8 years old and so the PBR level is considered undetermined. Because the PBR is undetermined and fisheries observer coverage is limited and aged, it is unknown if the minimum estimate of the mean annual mortality and serious injury rate (72 porpoise) in U.S. commercial fisheries can be considered insignificant and approaching a zero mortality and serious injury rate. NMFS considers this stock strategic because the level of mortality and serious injury would likely exceed the PBR level if we had accurate information on stock structure, a newer abundance estimate, and complete fisheries observer coverage. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Gulf of 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. The most recent surveys were more than 8 years ago and, given the lack of information on population trend, the abundance estimates are not used to calculate an N_{MIN} and the PBR level is undetermined. 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, bays, tidal areas, and river mouths (Dahlheim et al. 2000, 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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HARBOR PORPOISE (*Phocoena phocoena*): Bering Sea Stock

NOTE – December 2015: In areas outside of Alaska, studies of harbor porpoise distribution have indicated that stock structure is likely more fine-scaled than is reflected in the Alaska Stock Assessment Reports. 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.

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the eastern North Pacific Ocean, the harbor porpoise ranges 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). 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 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).

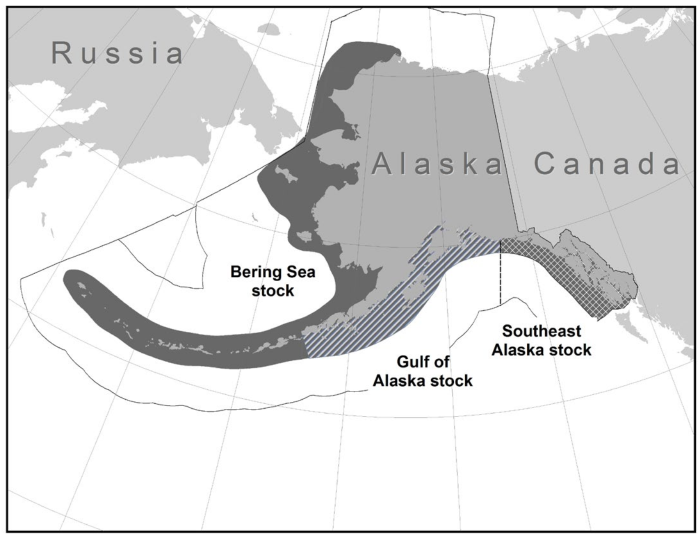

Figure 1. Approximate distribution of harbor porpoise in Alaska waters. The U.S. Exclusive Economic Zone is delineated by a black line.

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 these two clades are not geographically distinct by latitude, the results may indicate 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 additional samples including eight more from Alaska, found 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 that harbor porpoise along the west coast of North America are not panmictic and that movement is sufficiently restricted to result in genetic differences (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 inferred primarily based upon geography or perceived areas of low porpoise density: 1) the Southeast Alaska stock - occurring from Dixon Entrance to Cape Suckling, including inland waters, 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 north of Unimak Pass (Fig. 1). There have been no analyses to assess the validity of these stock designations and research to assess substructure is ongoing only within the Southeast Alaska stock (see the Southeast Alaska harbor porpoise Stock Assessment Report and Parsons et al. 2018).

Harbor porpoise have been sighted during seismic surveys of the Chukchi Sea conducted in the nearshore and offshore waters by the oil and gas industry between July and November from 2006 to 2014 (Funk et al. 2010, 2011; Reiser et al. 2011; Aerts et al. 2013; Christman and Aerts 2015). Harbor porpoise were the third most frequently sighted cetacean species in the Chukchi Sea, after gray and bowhead whales, with most sightings occurring during the September to October monitoring period (Funk et al. 2011, Reiser et al. 2011, Christman and Aerts 2015). Over the 2006 to 2010 industry-sponsored monitoring period, six sightings of 11 harbor porpoise were reported in the Beaufort Sea, suggesting harbor porpoise regularly occur in both the Chukchi and Beaufort seas (Funk et al. 2011).

POPULATION SIZE

In June and July of 1999, an aerial survey covered the waters of Bristol Bay. Two types of corrections were needed for these aerial surveys: one to correct for animals available but not counted because they were missed by the observer (perception bias) and another to correct for porpoise that were submerged and not available at the surface (availability bias). The 1999 survey resulted in an observed abundance estimate for the Bering Sea harbor porpoise stock of 16,289 (coefficient of variation (CV) = 0.13: Hobbs and Waite 2010), which includes the perception bias correction factor (1.337; CV = 0.06) obtained during the survey using an independent belly window observer. Laake et al. (1997) estimated the availability bias correction factor for aerial surveys of harbor porpoise in Puget Sound to be 2.96 (CV = 0.18); the use of this correction factor is preferred to other published correction factors (e.g., Barlow et al. 1988, Calambokidis et al. 1993) because it is an empirical estimate of availability bias. Applying the Laake et al. (1997) correction factor, the corrected abundance estimate is 48,215 porpoise (16,289 × 2.96 = 48,215; CV = 0.22). The estimate for 1999 can be considered conservative for that time period, as the surveyed areas did not include known harbor porpoise range along the Aleutian Island chain, near the Pribilof Islands, or in the waters north of Cape Newenham (approximately 59°N).

Shipboard visual line-transect surveys for cetaceans were conducted on the eastern Bering Sea shelf in association with pollock stock assessment surveys in June and July of 1999, 2000, 2002, 2004, 2008, and 2010 (Moore et al. 2002; Friday et al. 2012, 2013). The entire range of the survey was completed in three of those years (2002, 2008, and 2010) and harbor porpoise abundance estimates were calculated for each of these surveys as 1,971 porpoise (CV = 0.46) for 2002, 4,056 (CV = 0.40) for 2008, and 833 (CV = 0.66) for 2010 (Friday et al. 2013). The abundance estimates provided above assume the probability of detection directly on the trackline to be unity (g(0) = 1). This assumption is typically violated in harbor porpoise surveys because observers tend to miss animals on the survey trackline. Because no estimate of g(0) was computed for the Bering Sea survey in Friday et al. (2013), their abundance estimates were corrected using an averaged estimate of g(0) (weighted by the inverse of the CV) from ship surveys for harbor porpoise in other areas off the U.S. coast (g[0] = 0.71, CV = 0.052: Barlow 1988; Palka 1995, 2000). Using this value for g(0), corrected abundance estimates for harbor porpoise in the Bering Sea are 2,276 porpoise (CV = 0.46) for 2002, 5,713 (CV = 0.40) for 2008, and 1,173 (CV = 0.66) for 2010. The 2008 ship survey estimate is used below to calculate N_{MIN} because the spatial coverage during the year of the most recent estimate (2010) was limited due to poor weather conditions and missed many habitats where harbor porpoise are known to occur in the Bering Sea (e.g., Fig. 7 in Friday et al. 2013).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock 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 2008 ship survey partial population estimate (N) of 5,713 and its associated CV of 0.40, N_{MIN} for the Bering Sea stock of harbor porpoise is 4,130. However, this is an underestimate for the entire stock because it is based on a survey that covered only a small portion of the stock's range. Because the survey data are more than 8 years old, N_{MIN} is considered unknown.

Current Population Trend

There is no reliable information on trends in abundance for the Bering Sea stock of harbor porpoise.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for this stock of harbor porpoise. Until additional data become available, the default 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). 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.

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 Bering Sea harbor porpoise between 2014 and 2018 is 0.4 porpoise in subsistence fisheries; however, this estimate is considered a minimum because most of the fisheries likely to interact with this stock of harbor porpoise have never been monitored. 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 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).

Harbor porpoise mortality and serious injury is known to occur in gillnet (both drift gillnet and set gillnet) and trawl fisheries. While much of the trawl fleet has observer coverage, there are several gillnet fisheries in the Bering Sea that do not. Given the occurrence of fishery-caused mortality and serious injury of harbor porpoise in other gillnet fisheries in Alaska, it is likely that gillnet fisheries within the range of this stock also incur mortality and serious injury of harbor porpoise.

No mortality or serious injury of Bering Sea harbor porpoise was observed incidental to U.S. federal commercial fisheries between 2014 and 2018. However, a complete estimate of the total mortality and serious injury rate incidental to U.S. commercial fisheries is not available for this stock because of the absence of an observer program for all of the salmon and herring fisheries operating within the range of the stock.

Reports to the NMFS Alaska Region marine mammal stranding network of harbor porpoise entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data (Table 1; Young et al. 2020). In 2018, two harbor porpoise entanglements were reported in the Kuskokwim, Yukon, Norton Sound, Kotzebue subsistence salmon gillnet fishery, resulting in a minimum mean annual mortality and serious injury rate of 0.4 Bering Sea harbor porpoise in this subsistence fishery between 2014 and 2018 (Table 1; Young et al. 2020). 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 nor are all stranded animals found, reported, or have the cause of death determined.

Table 1. Summary of incidental mortality and serious injury of Bering Sea harbor porpoise, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2014 and 2018 (Young et al. 2020).

Cause of injury	2014	2015	2016	2017	2018	Mean annual mortality
Entangled in Kuskokwim, Yukon, Norton Sound, Kotzebue subsistence salmon gillnet	0	0	0	0	2	0.4
Total in subsistence fisheries						0.4

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska have not been reported to hunt from this stock of harbor porpoise; however, when porpoise are caught incidental to subsistence or commercial fisheries, subsistence hunters may claim the carcass for subsistence use (R. Suydam, North Slope Borough, pers. comm.).

STATUS OF STOCK

Bering Sea 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 population estimate for this stock is an underestimate for the entire stock because it is based on a survey that covered only a small portion of the stock's range. Because the existing estimates are more than 8 years old, N_{MIN} is unknown and the PBR level is undetermined. Because the PBR is undetermined and most of the fisheries likely to interact with this stock have never been observed, it is unknown if the minimum estimate of the mean annual mortality and serious injury rate (0.4 porpoise from stranding data) in U.S. commercial fisheries can be considered insignificant and approaching a zero mortality and serious injury rate. NMFS considers this stock strategic because the level of mortality and serious injury would likely exceed the PBR level for this stock if we had accurate information on stock structure, a newer abundance estimate, and complete observer coverage. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Bering Sea 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. The most recent surveys were more than 8 years ago and covered only a small portion of the stock's range, so N_{MIN} is unknown and the PBR level is undetermined. Several commercial fisheries overlap with the range of this stock and most have never been observed; thus, the estimate of commercial fishery mortality and serious injury is expected to be a minimum estimate. Coastal subsistence fisheries will occasionally cause incidental mortality or serious injury of a harbor porpoise; tracking these subsistence takes is challenging because there is no reporting mechanism. 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

Harbor porpoise are found over the shelf waters of the southeastern Bering Sea (Dahlheim et al. 2000, Hobbs and Waite 2010). In the nearshore waters of this region, 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). Climate change and changes to sea-ice coverage may be opening up new habitats, or resulting in shifts in distribution, as evident by an increase in the number of reported sightings of harbor 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 harbor porpoise, particularly in the Chukchi Sea.

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. 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).

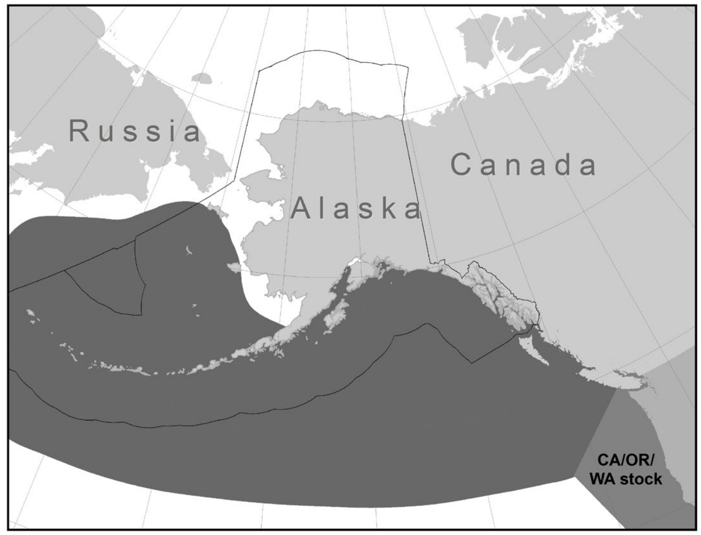

Figure 1. Approximate distribution of Dall's porpoise in the eastern North Pacific Ocean (dark shaded area). The Alaska stock is defined as the portion of the distribution in Alaska waters. The U.S. Exclusive Economic Zone is delineated by a black line.

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).

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, 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 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, 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 uniformly distributed within the U.S. Exclusive Economic Zone (EEZ) around Alaska and, as a result, Bristol Bay and the northern Bering Sea received little survey effort. Between 1987 and 1991, only three sightings were reported in the northern Bering Sea (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 in the U.S. EEZ north and south of the Aleutian Islands and 106,000 (CV = 0.20) in the U.S. EEZ in the Gulf of Alaska. Combining these 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 a five-fold positive bias in abundance estimates of Dall's porpoise because of vessel attraction behavior. Therefore, a corrected population estimate from 1987 to 1991 could be as low as 83,400 (417,000 × 0.2) for this stock. Because these surveys are more than 8 years old, this abundance estimate for the 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 abundance estimates were 35,303 (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 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 vessel passed (availability bias).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is 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 (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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 between 2015 and 2019 is listed, by marine mammal stock, in Freed et al. (2021); 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 between 2015 and 2019 is 37 porpoise: 37 in U.S. commercial fisheries (estimated from observer data collected in 1990 and 2012-2013) and 0.2 in unknown (commercial, recreational, or subsistence) fisheries. This estimate is considered a minimum 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. 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 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 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 between 2015 and 2019.

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 minimum estimated 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 between 2015 and 2019 (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 of one Dall's porpoise due to entanglement in unknown (commercial, recreational, or subsistence) pot gear was reported in a Marine Mammal Authorization Program (MMAP) fisherman self-report in 2019 (Table 2; Freed et al. 2021), resulting in a minimum mean annual mortality and serious injury rate of 0.2 Dall's porpoise between 2015 and 2019. There were no Dall's porpoise entanglements reported to the Alaska Region marine mammal stranding network between 2015 and 2019. 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 in MMAP fisherman self-reports between 2015 and 2019 (Freed et al. 2021). 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 unknown pot gear*	0	0	0	0	1[a]	0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.2

[a]MMAP fisherman self-report.

Based on observed mortality and serious injury in two commercial fisheries in 1990 and 2012-2013 (Table 1), the minimum estimated mean annual mortality and serious injury rate incidental to commercial fisheries between 2015 and 2019 is 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 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. The minimum estimated mean annual mortality and serious injury rate (37 porpoise) in U.S. commercial fisheries is more than 10% of the calculated PBR (10% of PBR = 13 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 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. 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, and the abundance estimate used to calculate an N_{MIN} and PBR level is 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

Dall's porpoise are widely distributed in the North Pacific, ranging from shallow continental shelf waters (Friday et al. 2013) to deep central North Pacific waters (Ohizumi et al. 2003) and deep nearshore waters (Jefferson 1988, 2008). Thus, they are vulnerable to a variety of habitat impacts, including physical modifications from urban and industrial development (including waste management and non-point source runoff). 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).

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SPERM WHALE (*Physeter macrocephalus*): North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The sperm whale is one of the most widely distributed marine mammal species, perhaps exceeded in its global range only by the killer whale and humpback whale (Rice 1989). In the North Pacific Ocean, sperm whales were depleted by extensive commercial whaling over a period of more than a hundred years, and the species was the primary target of illegal Soviet whaling in the second half of the 20th century (Ivashchenko et al. 2013, 2014). Systematic illegal catches were also made on a large scale by Japan in both the North Pacific and Antarctic in at least the late 1960s (Ivashchenko and Clapham 2015, Clapham and Ivashchenko 2016).

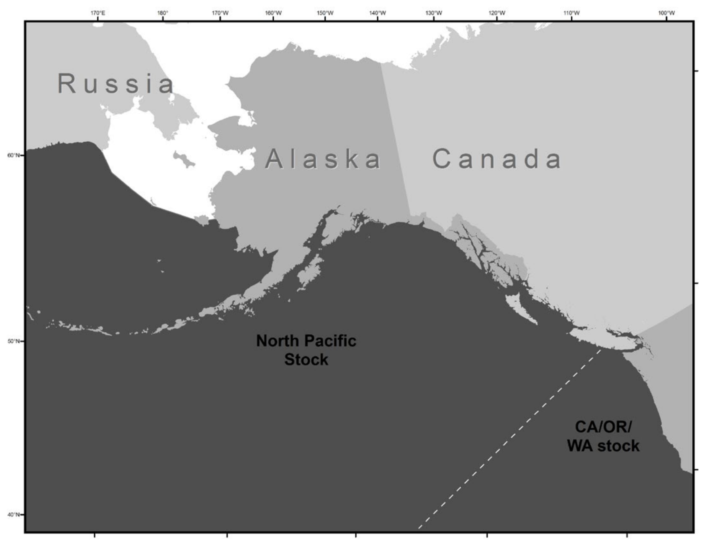

Figure 1. The approximate distribution of sperm whales in the North Pacific Ocean includes deep waters south of 62°N to the equator.

Sperm whales feed primarily on medium-sized to large-sized squids but also consume substantial quantities of large demersal and mesopelagic sharks, skates, and fishes (Rice 1989). In the North Pacific, sperm whales are distributed widely (Fig. 1). Although females and young sperm whales were thought to remain in tropical and temperate waters year-round, Mizroch and Rice (2006) and Ivashchenko et al. (2014) showed that there were extensive catches of female sperm whales above 50°N; Soviet catches of females were made as far north as Olyutorsky Bay (62°N) in the western Bering Sea, as well as in the western Aleutian Islands. Mizroch and Rice (2013) also showed movements by females into the Gulf of Alaska and western Aleutians. During summer, males are found in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Kasuya and Miyashita 1988, Mizroch and Rice 2013, Ivashchenko et al. 2014). Sighting surveys conducted by the Alaska Fisheries Science Center's Marine Mammal Laboratory (MML) in the summer months between 2001 and 2010 found sperm whales to be the most frequently sighted large cetacean in the coastal waters around the central and western Aleutian Islands (MML, unpubl. data). Acoustic surveys, from fixed autonomous hydrophones, detected the presence of sperm whales year-round in the Gulf of Alaska, although they appear to be approximately two times as common in summer than in winter (Mellinger et al. 2004). This seasonality of detections is consistent with the hypothesis that sperm whales generally move to higher latitudes in summer and to lower latitudes in winter (Whitehead and Arnbom 1987).

Discovery tags implanted in sperm whales in the 1960s could, when recovered from a dead whale, provide useful information on historical movements. Mizroch and Rice (2013) examined 261 Discovery tag recoveries from the days of commercial whaling and found extensive movements from U.S. and Canadian coastal waters into the Gulf of Alaska and Bering Sea/Aleutian Islands region. The U.S. tagged 176 sperm whales from 1962 to 1969 off southern California and northern Baja California (Mizroch and Rice 2013). Seven of those tagged whales were recovered in locations ranging from offshore California, Oregon, and British Columbia to the western Gulf of Alaska. A male sperm whale tagged by Canadian researchers moved from near Vancouver Island, British Columbia, to the Aleutian Islands near Adak. A whale tagged by Soviet researchers moved from coastal Michoacán, mainland Mexico, to a location about 1,300 km offshore of Washington State. Similar extensive movements have also been demonstrated by satellite-tagging studies (Straley et al. 2014). Three adult males satellite tagged off southeastern Alaska moved far south: one to coastal Baja California, one into the north-central Gulf of California, and the third to a location near the Mexico-Guatemala border (Straley et al. 2014).

Mizroch and Rice (2013) analyzed whaling data and found that males and females historically concentrated seasonally along oceanic frontal zones, for example, in the subtropical frontal zone (approximately 28-34°N) and the subarctic frontal zones (approximately 40-43°N). Males also concentrated seasonally near the Aleutian Islands and along the Bering Sea shelf edge. More current research suggests sperm whales are likely relatively nomadic, with movements linked to geographical and temporal variations in the abundance of pelagic squids (Mizroch and Rice 2013). The authors also found no indication from Discovery tag or whaling data to indicate apparent divisions between separate demes or stocks within the North Pacific (Mizroch and Rice 2013). Analysis of Soviet catch data by Ivashchenko et al. (2014) showed broad agreement with these results, although they identified a sharp division at Amchitka Pass in the Aleutians, with mature males to the east and males and family groups to the west. There were four main areas of concentration in the Soviet catches: a large pelagic area (30-50°N) in the eastern North Pacific, including the Gulf of Alaska and western coast of North America; the northeastern and southwestern central North Pacific; and the southern Kuril Islands. Some of the catch distribution was similar to that of 19th-century Yankee whaling catches plotted by Townsend (1935), notably in the "Japan Ground" (in the pelagic western Pacific) and the "Coast of Japan Ground." Many females were caught in Olyutorsky Bay (western Bering Sea) and around the Commander Islands.

More recently, an International Whaling Commission (IWC)-sponsored survey operated by the Government of Japan recorded 284 sightings of sperm whales across the entire North Pacific between 2010 and 2016, but an abundance estimate was not calculated (IWC 2017).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: no apparent discontinuities based on Discovery tag data; 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: genetic studies indicate the possibility of a "somewhat" discrete U.S. coastal stock (Mesnick et al. 2011). For management purposes, the IWC recognizes two management units of sperm whales in the North Pacific (eastern and western). However, the IWC has not reviewed its sperm whale stock boundaries in recent years (Donovan 1991). For management purposes, three stocks of sperm whales are currently recognized in U.S. waters: 1) Alaska (North Pacific stock) (Fig. 1); 2) California/Washington/Oregon; and 3) Hawaii. Mizroch and Rice (2013) suggest that this should be reviewed and updated to reflect additional data, but there is insufficient information to propose a reasonable alternative structure. The California/Oregon/Washington and Hawaii sperm whale stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

Current and historical abundance estimates of sperm whales in the North Pacific are based on limited data and are considered unreliable; caution should be exercised in interpreting published estimates. Further, sperm whales are far-ranging and exhibit sex segregation and stock overlap that together make population size estimation difficult. The existing estimates are caveated and do not cover consistent areas, making comparisons difficult. The abundance of sperm whales in the North Pacific was estimated to be 1,260,000 prior to exploitation, which by the late 1970s was thought to have been reduced to 930,000 whales (Rice 1989). Confidence intervals for these estimates do not exist. These estimates include whales from the California/Oregon/Washington stock, for which a separate abundance estimate is available (see the Stock Assessment Reports for the U.S. Pacific Region). Estimates for a large area of the eastern temperate North Pacific were produced from line-transect and acoustic survey data by Barlow and Taylor (2005); the acoustic data produced an estimate of 32,100 sperm whales (coefficient of variation (CV) = 0.36). However, no more recent estimate exists for other areas, including for the central or western North Pacific.

Kato and Miyashita (1998) reported 102,112 sperm whales (CV = 0.155) in the western North Pacific, with the caveat that their estimate is likely positively biased. From surveys in the Gulf of Alaska in 2009 and 2015, Rone et al. (2017) estimated 129 (CV = 0.44) and 345 sperm whales (CV = 0.43) in each year, respectively. These estimates are for a small area that was unlikely to include females and juveniles and they do not account for animals missed on the trackline; therefore, they are not considered reliable estimates.

As the data used in estimating the abundance of sperm whales in the entire North Pacific are more than 8 years old, a reliable estimate of abundance for the entire North Pacific stock is considered unavailable.

Minimum Population Estimate

A minimum population estimate (N_{MIN}) for this stock can be calculated according to 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 estimate (N) of 345 from surveys in the Gulf of Alaska in 2015 (Rone et al. 2017), and the associated CV(N) of 0.43, results in an N_{MIN} of 244 sperm whales. However, this is an underestimate for the entire stock because it is based on surveys of a small portion of the stock's extensive range and it does not account for animals missed on the trackline or for females and juveniles in tropical and subtropical waters.

Current Population Trend

There is no reliable information on trends in abundance for this stock (Braham 1992).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) is defined as the product of the minimum population estimate (N_{MIN}), 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 classified as endangered (NMFS 2016). Using the estimate of 345 (CV = 0.43) from surveys in the Gulf of Alaska in 2015 (Rone et al. 2017), and the associated N_{MIN} of 244, PBR is calculated to be 0.5 sperm whales (244 × 0.02 × 0.1). However, because the N_{MIN} is for only a small portion of the stock's range and does not account for females and juveniles in tropical and subtropical waters, the calculated PBR is not a reliable index for the entire stock.

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); however, only the mortality and serious injury data are included in the Stock Assessment Reports. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2012). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorate values used for large whale reports with incomplete information, is reported in Young et al. (2020). A minimum estimate of the mean annual level of human-caused mortality and serious injury for North Pacific sperm whales between 2014 and 2018 is 3.5 whales: 3.3 in U.S. commercial fisheries and 0.2 due to ship strikes. Sperm whales have been observed depredating both halibut and sablefish longline fisheries in the Gulf of Alaska and this is particularly common in sablefish longline fisheries in the central and eastern Gulf of Alaska; this depredation can lead to mortality or serious injury if hooking or entanglement occurs. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include entanglement in fishing gear and ship strikes due to increased vessel traffic (from increased shipping in higher latitudes).

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).

Between 2014 and 2018, mortality and serious injury of sperm whales was observed in the Bering Sea/Aleutian Islands halibut longline fishery (one serious injury in 2015, prorated at 0.75), the Aleutian Islands sablefish pot fishery (one mortality in 2018), and the Gulf of Alaska sablefish longline fishery (one serious injury in 2016, prorated at 0.75). The mortality and serious injury was extrapolated to fishery-wide estimates when possible, resulting in a minimum estimated mean annual mortality and serious injury rate of 3.3 sperm whales in U.S. commercial fisheries between 2014 and 2018 (Table 1; Breiwick 2013; MML, unpubl. data).

Table 1. Summary of incidental mortality and serious injury of North Pacific sperm whales due to U.S. commercial fisheries between 2014 and 2018 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. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2012). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorate values used for large whale reports with incomplete information, is reported in Young et al. (2020).

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality (CV)	Mean estimated annual mortality
Bering Sea/Aleutian Is. halibut longline	2014 2015 2016 2017 2018	obs data	11 13 10 6.9 8.2	0 0.75 0 0 0	0 10 (0.98) 0 0 0	2.0 (CV=0.98)
Aleutian Is. sablefish pot	2014 2015 2016 2017 2018	obs data	0 86 88 33 55	0 0 0 0 0 (+1)[a]	0 0 0 0 0 (+1)[b]	0 (+0.2)[c] (CV = N/A)
Gulf of Alaska sablefish longline	2014 2015 2016 2017 2018	obs data	19 20 14 12 9.8	0 0 0.75 0 0	0 0 5.7 (0.93) 0 0	1.1 (CV = 0.93)
Minimum total estimated annual mortality						3.3 (CV = 0.71)

[a]Total mortality and serious injury observed in 2018: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[b]Total estimate of mortality and serious injury in 2018: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 1 whale (1 whale observed in an unsampled haul).
[c]Mean annual mortality and serious injury for fishery: 0 whales (mean of extrapolated estimate from 0 whales observed in sampled hauls) + 0.2 whales (mean of number observed in unsampled hauls).

Alaska Native Subsistence/Harvest Information

Sperm whales have never been reported to be taken by subsistence hunters (Rice 1989).

Other Mortality

Sperm whales were the dominant species killed by the commercial whaling industry as it developed in the North Pacific in the years after World War II (Mizroch and Rice 2006, Ivashchenko et al. 2014). Between 1946 and 1967, most of the sperm whales were caught in waters near Japan and in the Bering Sea/Aleutian Islands region. The Bering Sea/Aleutian Islands catches were dominated by males. After 1967, whalers moved out of the Bering Sea/Aleutian Islands region and began to catch even larger numbers of sperm whales farther south in the North Pacific between 30° and 50°N latitude (Mizroch and Rice 2006: Figs. 7-9). The reported catch of sperm whales taken by commercial whalers operating in the North Pacific between 1912 and 2006 equaled 261,148 sperm whales, of which, 259,120 were taken between 1946 and 1987 (Allison 2012). This value underestimates the actual kill in the North Pacific as a result of under-reporting by U.S.S.R. and Japanese pelagic whaling operations. Berzin (2008) described extreme under-reporting and misreporting of Soviet sperm whale catches from the mid-1960s into the early 1970s, including enormous (and under-reported) whaling pressure on female sperm whales in the latter years of whaling. More recently, Ivashchenko et al. (2013, 2014) estimate that 157,680 sperm whales were killed by the U.S.S.R. in the North Pacific between 1948 and 1979, of which, 25,175 were unreported; the Soviets also extensively misreported the sex and length of catches. In addition, it is known that Japanese land-based whaling operations also misreported the number and sex of sperm whale catches during the post-World War II era (Kasuya 1999), and other studies indicate that falsifications also occurred on a large scale in the Japanese pelagic fishery (Cooke et al. 1983, Ivashchenko and Clapham 2015). The last year that the U.S.S.R. reported catches of sperm whales was in 1979 and the last year that Japan reported substantial catches was in 1987, but Japanese whalers reported catches of 48 sperm whales between 2000 and 2009 (IWC, BIWS catch data, October 2010 version, unpubl.). Although the Soviet data on catches of this species in the North Pacific have now been largely corrected (Ivashchenko et al. 2013), the North Pacific sperm whale data in the IWC's Catch Database (Allison 2012) are known to be incorrect (i.e., too low) because of falsified catch information from both the Japanese coastal and pelagic fisheries (Kasuya 1999, Ivashchenko and Clapham 2015).

Reports to the NMFS Alaska Region marine mammal stranding network are another source of information on sperm whale mortality and serious injury (Table 2; Young et al. 2020). One sperm whale mortality due to a ship strike was reported in 2017, resulting in a mean annual mortality and serious injury rate of 0.2 sperm whales due to ship strikes between 2014 and 2018.

Table 2. Summary of mortality and serious injury of North Pacific sperm whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2014 and 2018 (Young et al. 2020).

Cause of Injury	2014	2015	2016	2017	2018	Mean annual mortality
Ship strike	0	0	0	1	0	0.2
Total due to ship strikes						0.2

Other Issues

NMFS observers aboard longline vessels targeting both sablefish and halibut have documented sperm whales feeding off longline gear in the Gulf of Alaska (Hill and Mitchell 1998, Hill et al. 1999, Perez 2006, Sigler et al. 2008). Fishery observers recorded several instances between 1995 and 1997 in which sperm whales were deterred by fishermen (i.e., throwing seal bombs in the water).

Annual longline surveys have been recording sperm whale depredation on catch since 1998 (Hanselman et al. 2008). Sperm whale depredation in the sablefish longline fishery is widespread in the central and eastern Gulf of Alaska but rarely observed in the Bering Sea; interaction rates are increasing significantly in the East Yakutat/Southeast Alaska and Central Gulf management areas (Hanselman et al. 2018). More recent research suggests that sperm whales impacted catch rates at a more significant rate than earlier studies suggested (Straley et al. 2005, Sigler et al. 2008), and sperm whales are estimated to reduce commercial fishery and NMFS annual longline survey catch rates by approximately 15% - 26% (Peterson and Hanselman 2017, Hanselman et al. 2018).

STATUS OF STOCK

Sperm whales are listed as endangered under the Endangered Species Act of 1973 and, therefore, designated as depleted under the MMPA. As a result, this stock is classified as a strategic stock. However, on the basis of total abundance, current distribution, and regulatory measures that are in place, it is unlikely that this stock is in danger of extinction (Braham 1992). Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population are not available. A minimum estimate of the mean annual level of human-caused mortality and serious injury is 3.5 whales. The minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate (3.3 whales) is more than 10% of the PBR (10% of PBR = 0.05) calculated from the 2015 abundance estimate (Rone et al. 2017) for a small portion of the stock's range. However, because the calculated PBR level is based on an N_{MIN} which is known to be an underestimate of the abundance of the population, the PBR level is considered unreliable.

There are key uncertainties in the assessment of the North Pacific stock of sperm whales. There is little current information about the broad-scale distribution of sperm whales in Alaska waters, and there is no current abundance estimate, N_{MIN}, PBR level, or trend in abundance for the entire stock.

HABITAT CONCERNS

Potential habitat concerns for this stock include elevated levels of sound from anthropogenic sources (e.g., shipping, military exercises), possible changes in prey distribution and quality with climate change, entanglement in fishing gear, ship strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes), and oil and gas activities.

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BAIRD'S BEAKED WHALE (*Berardius bairdii*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

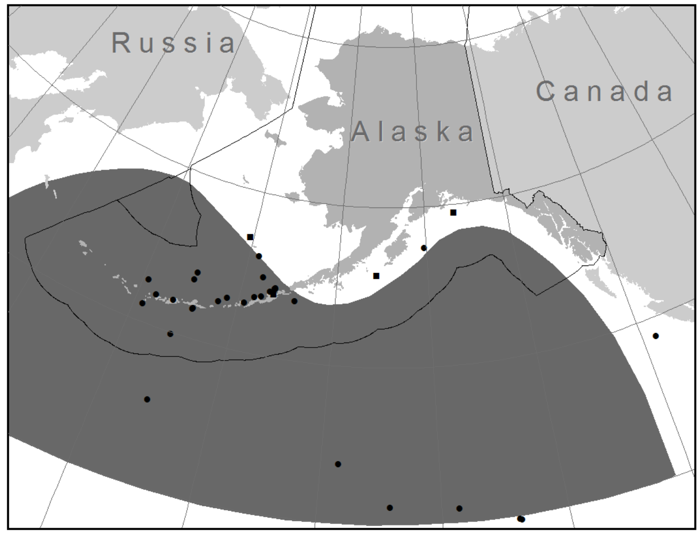

Figure 1. Approximate distribution of Baird's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted. (Forney and Brownell 1996, Moore et al. 2002, NMFS unpublished data). Note: Distribution updated based on Kasuya 2002.

Baird's beaked, or giant bottlenose, whale inhabits the North Pacific Ocean and adjacent seas (Bering Sea, Okhotsk Sea, Sea of Japan, and the Sea of Cortez in the southern Gulf of California, Mexico), with the best-known populations occurring in the coastal waters around Japan (Balcomb 1989) and the Commander Islands (Fedutin et al. 2012). Within the North Pacific Ocean, Baird's beaked whales have been sighted in virtually all areas north of 30°N in deep waters over the continental shelf, particularly in regions with submarine escarpments and seamounts (Ohsumi 1983, Kasuya and Ohsumi 1984, Kasuya 2002). The range of the species extends north from Cape Navarin (62° N) and the central Sea of Okhotsk (57° N) to St. Matthew Island, the Pribilof Islands in the Bering Sea, and the northern Gulf of Alaska (Rice 1986, Rice 1998, Kasuya 2002) (Fig. 1). An apparent break in distribution occurs in the eastern Gulf of Alaska, but from the mid-Gulf to the Aleutian Islands and in the southern Bering Sea there are numerous sighting records (Kasuya and Ohsumi 1984, Forney and Brownell 1996, Moore et al. 2002). In the Sea of Okhotsk and the Bering Sea, Baird's beaked whales arrive in April-May, are numerous during the summer, and decrease in October (Tomilin 1957, Kasuya 2002). Observations during 2007-2011 in the western Bering Sea were made in all months except winter (December to March) around the Commander Islands, with encounters peaking in April-June and to a lesser extent in August-November (Fedutin et al. 2012). During winter months, they are rarely found in offshore waters and their winter distribution is unknown (Kasuya 2002). However, acoustic detections of Baird's beaked whales from November through January (and no detections in July-October) in the northern Gulf of Alaska suggest that this region may be wintering habitat for some Baird's beaked whales (Baumann-Pickering et al. 2012b). There were no detections of this species from early June to late August 2010 off Kiska Island (Baumann-Pickering et al. 2012a). They are the most commonly seen beaked whales within their range, perhaps because they are relatively large and gregarious, traveling in schools of a few to several dozen, making them more noticeable to observers than other beaked whale species. Baird's beaked whales are migratory, arriving in continental slope waters during summer and fall months when surface water temperatures are the highest (Dohl et al. 1983, Kasuya 1986). Photo-identification analysis of animals sighted between 2007-2011 revealed resightings of some individuals around the Commander Islands and confirmed associations of individuals over several years in this species (Fedutin et al. 2012).

There are insufficient data to apply the phylogeographic approach to stock structure (Dizon et al. 1992) for Baird's beaked whale. Therefore, Baird's beaked whale stocks are defined as the two non-contiguous areas within Pacific U. S. waters where they are found: 1) Alaska and 2) California/Oregon/Washington. These two stocks were defined in this manner because of: 1) the large distance between the two areas in conjunction with the lack of any information about whether animals move between the two areas, 2) the somewhat different oceanographic habitats found in the two areas, and 3) the different fisheries that operate within portions of those two areas, with bycatch of Baird's beaked whales only reported from the California/Oregon thresher shark and swordfish drift gillnet fishery. The California/Oregon/Washington Baird's beaked whale stock is reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

At this time, it is not possible to produce a reliable minimum population estimate (N_{MIN}) for this stock, as current estimates of abundance are unavailable.

Current Population Trend

No reliable estimates of abundance are available for this stock; therefore, reliable data on trends in population abundance are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for the Alaska stock of Baird's beaked whale. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the 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 these stocks is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). However, in the absence of a reliable estimate of minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality.*" Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fisheries Information

Twenty-two different commercial fisheries operating within the potential range of the Alaska stock of Baird's beaked whale were monitored for incidental take by fisheries observers from 2007-2011 (see 76 FR 73912, final List of Fisheries for 2012) . There were no serious injuries or mortalities of Baird's beaked whales incidental to observed commercial fisheries reported between 2007-2011 (Breiwick 2013). The estimated annual mortality rate incidental to commercial fisheries is zero.

Subsistence/Native Harvest Information

There is no known subsistence harvest of Baird's beaked whales by Alaska Natives.

Other Mortality

Between 1925 and 1987, 618 Baird's beaked whales were reported taken throughout the North Pacific (International Whaling Commission, BWIS catch data, February 2003 version, unpublished). The annual quota of Baird's beaked whales for small-type whaling in Japan was 62 from 1999-2004, which increased temporarily to 66 from 2005-2010 and will remain a permanent increase (Kasuya 2011). Due to the unknown stock structure and migratory patterns in the North Pacific, it is unclear whether these animals belong to the Alaska stock of Baird's beaked whales.

STATUS OF STOCK

Baird's beaked whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are currently not available. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. However, the estimated annual rate of human-caused mortality and serious injury seems minimal for this stock. Thus, the Alaska stock of Baird's beaked whale is not classified as strategic.

Habitat concerns

Disturbance by anthropogenic noise is an increasing habitat concern for most species of beaked whales, particularly in areas of oil and gas activities or where shipping or military activities are high. Shipping noise and the use of military sonars have been found to alter dive behavior and movements, as well as vocal activity in some species of beaked whales (Aguilar de Soto et al. 2006, McCarthy et al. 2011, Tyack et al. 2011). Little is known about the effects of noise on beaked whales in Alaska. Ingestion of marine debris, particularly plastics, is a concern; plastic is occasionally found in the stomach contents of stranded beaked whales, including Baird's beaked whales (Smithsonian Institution, Cetacean Distributional Database, accessed 04 June 2012).

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Revised 5/15/2013

CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of Cuvier's beaked, or goosebeak, whale (Fig. 1) is known primarily from strandings, which indicate that it is the most widespread of the beaked whales and is distributed in all oceans and most seas except in the high polar waters (Moore 1963). In the Pacific, they range north to the northern Gulf of Alaska, the Aleutian Islands, and the Commander Islands (Rice 1986, 1998). In the northeastern Pacific from Alaska to Baja California, no obvious pattern of seasonality to strandings has been identified (Mitchell 1968). Strandings of Cuvier's beaked whales are the most numerous of all beaked whales, indicating that they are probably not as rare as originally thought (Heyning 1989). Observations reveal that the blow is low, diffuse, and directed forward (Backus and Schevill 1961, Norris and Prescott 1961), making sightings more difficult, and there is some evidence that they avoid vessels by diving (Heyning 1989). Relatively few (4 total) acoustic detections of Cuvier's beaked whales were recorded off Kiska Island (1 in summer) and in the offshore Gulf of Alaska (3 total detections, 1 in October and 2 in January; Baumann-Pickering et al. 2012a, 2012b).

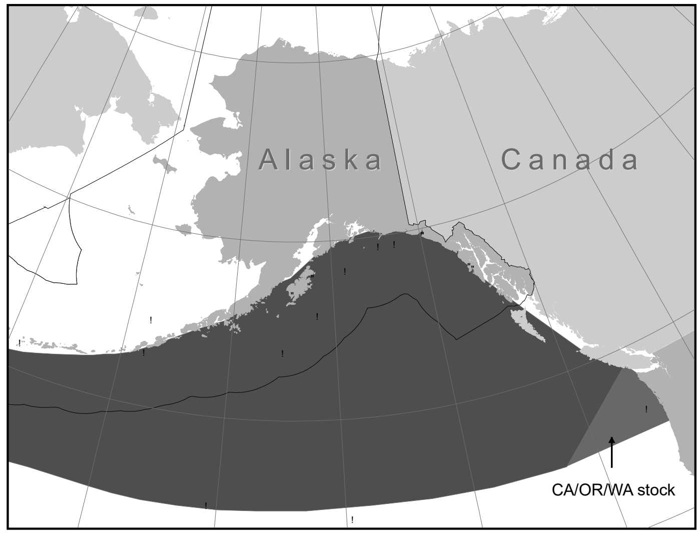

Figure 1. Approximate distribution of Cuvier's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted (Forney and Brownell 1996, NMFS unpublished data).

Mitchell (1968) examined skulls of stranded whales for geographical differences and thought that there was probably one panmictic population in the northeastern Pacific. Otherwise, there are insufficient data to apply the phylogeographic approach to stock structure (Dizon et al. 1992) for the Cuvier's beaked whale. Therefore, Cuvier's beaked whale stocks are defined as the three non-contiguous areas within Pacific U. S. waters where they are found: 1) Alaska, 2) California/Oregon/Washington, and 3) Hawaii. These three stocks were defined in this way because of: 1) the large distance between the areas in conjunction with the lack of any information about whether animals move between the three areas, 2) the different oceanographic habitats found in the three areas, and 3) the different fisheries that operate within portions of those three areas, with bycatch of Cuvier's beaked whales only reported from the California/Oregon thresher shark and swordfish drift gillnet fishery. The California/Oregon/Washington and Hawaiian Baird's beaked whale stocks are reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

At this time, it is not possible to produce a reliable minimum population estimate (N_{MIN}) for this stock, as current estimates of abundance are unavailable.

Current Population Trend

No reliable estimates of abundance are available for this stock; therefore, reliable data on trends in population abundance are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for the Alaska stock of Cuvier's beaked whale. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the 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 (Wade and Angliss 1997). However, in the absence of a reliable estimate of minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fisheries Information

Twenty-two different commercial fisheries operating within the potential range of the Alaska stock of Cuvier's beaked whale were monitored for incidental take by fishery observers from 2007-2011 (see 76 FR 73912, final List of Fisheries for 2012) . There were no serious injuries or mortalities of Cuvier's beaked whales incidental to observed commercial fisheries reported between 2007-2011 (Breiwick 2013). The estimated annual mortality rate incidental to commercial fisheries is zero.

Subsistence/Native Harvest Information

There is no known subsistence harvest of Cuvier's beaked whales.

Other Mortality

Unknown levels of injuries and mortality of Cuvier's beaked whales may occur as a result of anthropogenic noise, such as military sonars (U.S. Dept. of Commerce and Secretary of the Navy 2001) or other commercial and scientific activities producing high-energy sound. The use of active sonar from military vessels has been implicated or coincident with mass strandings of beaked whales (Cox et al. 2006, Frantzis 1998, Martel 2002, Jepson et al. 2003, Simmonds and Lopez-Jurado 1991, U.S. Dept. of Commerce and Secretary of the Navy 2001), and all atypical single and mixed-species mass strandings involved Cuvier's beaked whales (D'Amico et al. 2009). There is concern regarding the potential effects of underwater sounds from seismic operations on beaked whales, although investigations of causation of atypical strandings of Cuvier's beaked whales and nearby seismic air gun operations have been inconclusive (Gentry 2002, Gordon et al. 2003/2004, Malakoff 2002). Changes in dive behavior, particularly a quick ascent from deep dives, in response to sound exposure may result in injuries related to bubble growth during decompression (Cox et al. 2006, Tyack et al. 2011, Hooker et al. 2011). Such injuries or mortality would rarely be documented due to the remote nature of many of these activities and the low probability that an injured or dead beaked whale would strand. No estimates of potential mortality or serious injury are available for Cuvier's beaked whales in Alaska waters.

STATUS OF STOCK

Cuvier's beaked whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are currently not available. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. However, the estimated annual rate of human-caused mortality and serious injury seems minimal for this stock. Thus, the Alaska stock of Cuvier's beaked whale is not classified as strategic.

Habitat concerns

Disturbance by anthropogenic noise is an increasing habitat concern for most species of beaked whales, particularly in areas of oil and gas activities or where shipping or military activities are high. Shipping noise may disrupt the behavior of Cuvier's beaked whales (Aguilar de Soto et al. 2006), and the use of military sonars has been found to alter dive behavior and movements, as well as vocal activity in some species of beaked whales (McCarthy et al. 2011, Tyack et al. 2011). Moore and Barlow (2013) report impacts of anthropogenic sound and ecosystem change as the most plausible hypotheses for declining abundance of *Ziphius* and *Mesoplodon* spp. in the California Current large marine ecosystem. Little is known about the effects of noise or ecosystem change on beaked whales in Alaska, and the lack of abundance estimates hinder the detection of any population trends. Ingestion of marine debris, particularly plastics, is a concern; plastic is occasionally found in the stomach contents of stranded beaked whales, including Cuvier's beaked whales. (Smithsonian Institution, Cetacean Distributional Database, accessed 04 June 2012).

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Revised 2/11/2013

STEJNEGER'S BEAKED WHALE (*Mesoplodon stejnegeri*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Stejneger's, or Bering Sea, beaked whale is rarely seen at sea, and its distribution generally has been inferred from stranded specimens (Loughlin and Perez 1985, Mead 1989, Walker and Hanson 1999). It is endemic to the cold-temperate waters of the North Pacific Ocean, Sea of Japan, and deep waters of the southwest Bering Sea (Fig. 1). The range of Stejneger's beaked whale extends along the coast of North America from Cardiff, California, north through the Gulf of Alaska to the Aleutian Islands, into the Bering Sea to the Pribilof Islands and Commander Islands, and, off Asia, south to Akita Beach on Noto Peninsula, Honshu, in the Sea of Japan (Loughlin and Perez 1985). Near the central Aleutian Islands, groups of 3-15 Stejneger's beaked whales have been sighted on a number of occasions (Rice 1986). The species is not known to enter the Arctic Ocean and is the only species of *Mesoplodon* known to occur in Alaska waters. The distribution of *M. stejnegeri* in the North Pacific corresponds closely, in occupying the same cold-temperate niche and position, to that of *M. bidens* in the North Atlantic. It lies principally between 50°and 60°N and extends only to about 45°N in the eastern Pacific, but to about 40°N in the western Pacific (Moore 1963, 1966). Acoustic signals believed to be produced by Stejneger's beaked whales (based on frequency characteristics, interpulse interval and geographic location, Baumann-Pickering et al. 2012a) were recorded 2-5 times a week in July off Kiska Island and almost weekly from July 2011 to February 2012 in the northern Gulf of Alaska (Baumann-Pickering et al. 2012b).

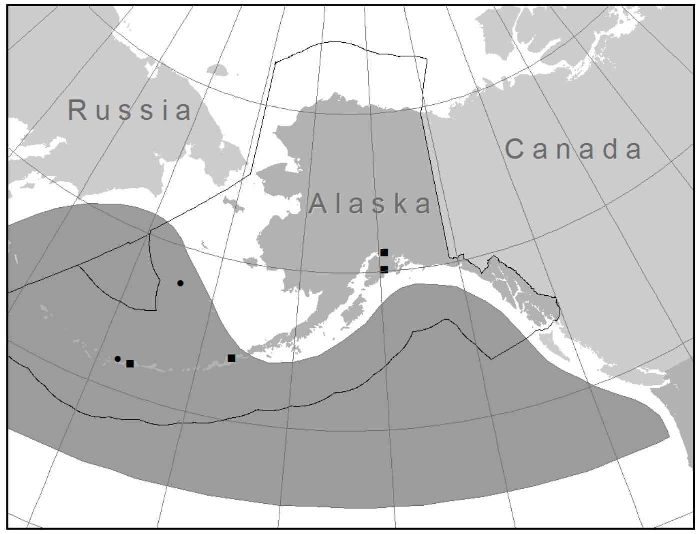

Figure 1. Approximate distribution of Stejneger's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted (Walker and Hanson 1999, NMFS unpublished data).

There are insufficient data to apply the phylogeographic approach to stock structure (Dizon et al. 1992) for Stejneger's beaked whale. The Alaska Stejneger's beaked whale stock is recognized separately from *Mesoplodon* spp. off California, Oregon, and Washington because of: 1) the distribution of Stejneger's beaked whale and the different oceanographic habitats found in the two areas, 2) the large distance between the two non-contiguous areas of U.S. waters in conjunction with the lack of any information about whether animals move between the two areas, and 3) the different fisheries that operate within portions of those two areas, with bycatch of *Mesoplodon* spp. only reported from the California/Oregon thresher shark and swordfish drift gillnet fishery. The California/Oregon/Washington stock of all *Mesoplodon* spp. and a *Mesoplodon densirostris* stock in Hawaiian waters are reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

At this time, it is not possible to produce a reliable minimum population estimate (N_{MIN}) for this stock, as current estimates of abundance are unavailable.

Current Population Trend

No reliable estimates of abundance are available for this stock; therefore, reliable data on trends in population abundance are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for the Alaska stock of Stejneger's beaked whale. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the 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 (Wade and Angliss 1997). However, in the absence of a reliable estimate of minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality.*" Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fisheries Information

Twenty-two different commercial fisheries operating within the potential range of the Alaska stock of Cuvier's beaked whale were monitored for incidental take by fishery observers from 2007-2011 (see 76 FR 73912, final List of Fisheries for 2012) . There were no serious injuries or mortalities of Stejneger's beaked whales incidental to observed commercial fisheries reported between 2007-2011 (Breiwick 2013). The estimated annual mortality rate incidental to commercial fisheries is zero.

Subsistence/Native Harvest Information

There is no known subsistence harvest of Stejneger's beaked whales.

STATUS OF STOCK

Stejneger's beaked whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are currently not available. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. However, the estimated annual rate of human-caused mortality and serious injury seems minimal for this stock. Thus, the Alaska stock of Stejneger's beaked whale is not classified as strategic.

Habitat concerns

Disturbance by anthropogenic noise is an increasing habitat concern for most species of beaked whales, particularly in areas of oil and gas activities or where shipping or military activities are high. Shipping noise and the use of military sonars have been found to alter dive behavior and movements, as well as vocal activity in some species of beaked whales (Aguilar de Soto et al. 2006, McCarthy et al. 2011, Tyack et al. 2011). Moore and Barlow (2013) report impacts of anthropogenic sound and ecosystem change as the most plausible hypotheses for declining abundance of *Ziphius* and *Mesoplodon* spp., including *M. stejnegeri*, in the California Current large marine ecosystem. Little is known about the effects of noise on beaked whales in Alaska. Ingestion of marine debris, particularly plastics, is a concern; plastic is occasionally found in the stomach contents of stranded beaked whales, including Stejneger's beaked whales. (Smithsonian Institution, Cetacean Distributional Database, accessed 04 June 2012).

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SATO'S BEAKED WHALE (*Berardius minimus*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

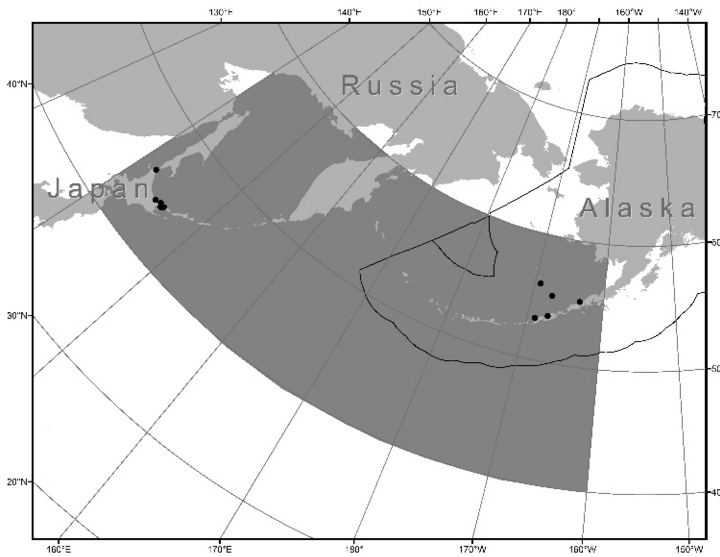

Figure 1. Approximate distribution of Sato's beaked whales in the western and central North Pacific (shaded area). Strandings (black dots) are also depicted (Kitamura et al. 2013, Morin et al. 2017, Yamada et al. 2019). This stock assessment considers only the portion of the stock occurring in U.S. waters (i.e., the U.S. Exclusive Economic Zone delineated by a black line).

Sato's beaked whale, or black beaked whale, is a newly described species which inhabits the western and central North Pacific (Fig. 1; Morin et al. 2017, Yamada et al. 2019, Brownell 2020, Fedutin et al. 2020). Reports from Japanese whalers of a "black" beaked whale smaller than the more common Baird's beaked whale and measurements from stranded animals suggested the existence of a separate species (Yamada et al. 2019). Strong genetic differences confirmed it to be distinct from the partly sympatric Baird's beaked whale (Kitamura et al. 2013, Morin et al. 2017, Yamada et al. 2019, Fedutin et al. 2020).

Although the existence of a smaller form of beaked whale off Japan has been suggested for years (Brownell and Kasuya 2021), the first confirmed observation of living Sato's beaked whales was made in 2021 (Fedutin et al. 2022). Twenty-three encounters were made off the west coast of Kunashir Island (the southernmost Kuril Island) from May to June 2021. The species identification was confirmed from one biopsy sample, and fourteen individuals in groups of 4-5 animals were identified from photographs. In 2023, three groups consisting of at least nine total Sato's beaked whales were documented by photographs collected by unmanned aerial vehicles in the Abashiri Submarine Canyon, Hokkaido, Japan (Kobayashi et al. 2023).

Our current information on geographic range comes from relatively few stranded or incidentally caught animals. From skull characteristics and genetics, specimens have been identified in northern Hokkaido, Japan; Sakhalin and Kunshir Islands, Russia; Unalaska Island, Bering Sea; and the Alaska Peninsula, U.S. (Morin et al. 2017, Fedutin et al. 2020). Because our knowledge of distribution is based on relatively few strandings, distribution is uncertain but appears to include waters between 40°N and 60°N, and 140°E and 160°W (Yamada et al. 2019).

This transboundary stock is defined as the *Berardius minimus* species.

POPULATION SIZE

Reliable estimates of population abundance are not available for this stock.

Minimum Population Estimate

It is not possible to produce a reliable minimum population estimate (N_{MIN}) for this stock, as estimates of abundance are not available.

Current Population Trend

There are no data on trends in population abundance for the Sato's beaked whale stock or for the portion of the stock within U.S. waters.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Sato's beaked whale stock or for any portion of the stock within U.S. waters. Until additional data become available, the default cetacean maximum theoretical net productivity rate of 4% will be used for this stock (NMFS 2023).

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 2023). However, in the absence of a reliable estimate of minimum abundance, the PBR for this stock is unknown.

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 2017 and 2021 is listed, by marine mammal stock, in Freed et al. (2023); however, only the mortality and serious injury data are included in the Stock Assessment Reports. No human-caused mortality or serious injury of Sato's beaked whales was reported between 2017 and 2021. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include vessel strikes and interactions with fisheries.

Fisheries Information

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2024).

Between 2017 and 2021, no fisheries-related mortality or serious injury of Sato's beaked whales was reported in U.S. waters.

Alaska Native Subsistence/Harvest Information

There is no known subsistence harvest of Sato's beaked whales by Alaska Natives.

Other Mortality

In Japanese waters, Sato's beaked whales are sometimes killed in the small-type whaling operations that occur in the southern Okhotsk Sea off the northern coast of Hokkaido (Brownell and Kasuya 2021). In this same region the species is also occasionally taken as bycatch (Yamada et al 2019, Brownell 2020, Brownell and Kasuya 2021).

STATUS OF STOCK

Sato's beaked whales are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. However, *Berardius* spp., including Sato's beaked whales, are included in Appendix I under the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are not available. Because the PBR is unknown, the mean annual U.S. commercial fishery-related mortality and serious injury that can be considered insignificant and approaching a zero mortality and serious injury rate is unknown. However, because human-caused mortality and serious injury is thought to be minimal, this stock is presumed to be non-strategic.

There are key uncertainties in the assessment of Sato's beaked whales. There is very little information available on the species' range, population structure, and habitat use. Therefore, reliable estimates of the minimum population size, population trends, and PBR are not available.

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HUMPBACK WHALE (*Megaptera novaeangliae kuzira*) - Western North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

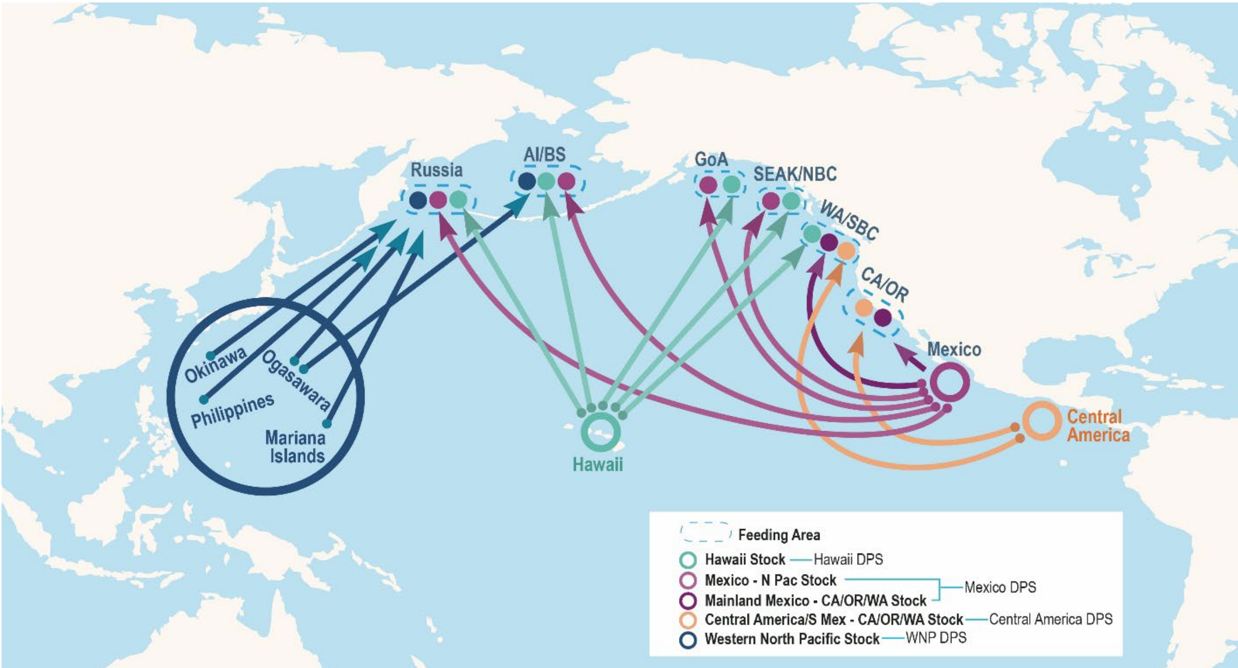

Figure 1. Pacific basin map showing wintering areas of five humpback whale stocks mentioned in this report. Also shown are summering feeding areas mentioned in the text. High-latitude summer feeding areas include Russia, Aleutian Islands / Bering Sea (AI/BS), Gulf of Alaska (GoA), Southeast Alaska / Northern British Columbia (SEAK/NBC), Washington / Southern British Columbia (WA/SBC), and California / Oregon (CA/OR).

Humpback whales occur worldwide and migrate seasonally from high latitude subarctic and temperate summering areas to low latitude subtropical and tropical wintering areas. Three subspecies are recognized globally (North Pacific, Atlantic, and Southern Hemisphere), based on restricted gene flow between ocean basins (Jackson et al. 2014). The North Pacific subspecies (*Megaptera novaeangliae kuzira*) occurs basin-wide, with summering areas in waters of the Russian Far East, Beaufort Sea, Bering Sea, Chukchi Sea, Gulf of Alaska, Western Canada, and the U.S. West Coast. Known wintering areas include waters of Okinawa and Ogasawara in Japan, Philippines, Mariana Archipelago, Hawaiian Islands, Revillagigedos Archipelago, Mainland Mexico, and Central America (Baker et al. 2013, Barlow et al. 2011, Calambokidis et al. 2008, Clarke et al. 2013, Fleming and Jackson 2011, Hashagen et al. 2009). In describing humpback whale population structure in the Pacific, Martien et al. (2020, 2023) note that "migratory whale herds", defined as groups of animals that share the same summering and wintering area, are likely to be demographically independent due to their strong, maternally-inherited fidelity to migratory destinations. Despite whales from multiple wintering areas sharing some summer feeding areas, Baker et al. (2013) reported significant genetic differences between North Pacific summering and wintering areas, driven by strong maternal site fidelity to feeding areas and natal philopatry to wintering areas. This differentiation is supported by photo ID studies showing little interchange of whales between summering areas (Calambokidis et al. 2001).

NMFS has identified 14 distinct population segments (DPSs) of humpback whales worldwide under the Endangered Species Act (ESA) (81 FR 62259, September 8, 2016), based on genetics and movement data (Baker et al. 2013, Calambokidis et al. 2008, Bettridge et al. 2015). In the North Pacific, 4 DPSs are recognized (with ESA listing status), based on their respective low latitude wintering areas: "Western North Pacific" (endangered), "Hawai'i" (not listed), "Mexico" (threatened), and "Central America" (endangered). The listing status of each DPS was determined following an evaluation of the ESA section 4(a)(1) listing factors as well as an evaluation of demographic risk factors. The evaluation is summarized in the final rule revising the ESA listing status of humpback whales (81 FR 62259, September 8, 2016).

In prior stock assessments, NMFS designated three stocks of humpback whales in the North Pacific: the California/Oregon/Washington (CA/OR/WA) stock, consisting of winter populations in coastal Central America and coastal Mexico which migrate to the coast of California and as far north as southern British Columbia in summer; 2) the Central North Pacific stock, consisting of winter populations in the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands; and 3) the Western North Pacific stock, consisting of winter populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands. These stocks, to varying extents, were not aligned with the more recently identified ESA DPSs (e.g., some stocks were composed of whales from more than one DPS), which led NMFS to reevaluate stock structure under the Marine Mammal Protection Act (MMPA).

NMFS evaluated whether these North Pacific DPSs contain one or more demographically independent populations (DIPs), where demographic independence is defined as "*...the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics)*" (NMFS 2023a). Evaluation of the four DPSs in the North Pacific by NMFS resulted in the delineation of three DIPs, as well as four "units" that may contain one or more DIPs (Martien et al. 2021, Taylor et al. 2021, Wade et al. 2021, Oleson et al. 2022, Table 1). Delineation of DIPs is based on evaluation of "strong lines of evidence" such as genetics, movement data, and morphology (Martien et al. 2019). From these DIPs and units, NMFS designated five stocks. North Pacific DIPs / units / stocks are described below, along with the lines of evidence used for each. In some cases, multiple units may be combined into a single stock due to lack of sufficient data and/or analytical tools necessary for effective management or for pragmatic reasons (NMFS 2019).

Table 1. DPS of origin for North Pacific humpback whale DIPs, units, and stocks. Names are based on their general winter and summering area linkages. The stock included in *this* report is shown in bold font. All others appear in separate reports.

DPS	ESA Status	DIPs / units	Stocks
Central America	Endangered	Central America - CA-OR-WA DIP	Central America / Southern Mexico - CA-OR-WA stock
Mexico	Threatened	Mainland Mexico - CA-OR-WA DIP	Mainland Mexico – CA-OR-WA stock
		Mexico - North Pacific unit	Mexico - North Pacific stock
Hawai‘i	Not Listed	Hawai‘i - North Pacific unit	Hawai‘i stock
		Hawai‘i - Southeast Alaska / Northern British Columbia DIP	
Western North Pacific	Endangered	Philippines / Okinawa - North Pacific unit	**Western North Pacific stock**
		Marianas / Ogasawara - North Pacific unit	

Delineation of the **Central America/Southern Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Taylor et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022a). Whales in this stock winter off the Pacific coast of Nicaragua, Honduras, El Salvador, Guatemala, Panama, Costa Rica and likely southern coastal Mexico (Taylor et al. 2021). Summer destinations for whales in this DIP include the U.S. West Coast waters of California, Oregon, and Washington (including the Salish Sea, Calambokidis et al. 2017).

Delineation of the **Mainland Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Martien et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off the mainland Mexico states of Nayarit and Jalisco, with some animals seen as far south as Colima and Michoacán. Summer destinations for whales in the Mainland Mexico DPS include U.S. West Coast waters of California, Oregon, Washington (including the Salish Sea, Martien et al. 2021), Southern British Columbia, Alaska, and the Bering Sea.

The **Mexico – North Pacific unit** is likely composed of multiple DIPs, based on movement data (Martien et al. 2021, Wade 2021, Wade et al. 2021). However, because currently available data and analyses are not sufficient to delineate or assess DIPs within the unit, it was designated as a single stock (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off Mexico and the Revillagigedo Archipelago and summer primarily in Alaska waters (Martien et al. 2021).

The **Hawai'i stock** consists of one DIP - **Hawai'i - Southeast Alaska / Northern British Columbia DIP** and one unit - **Hawai'i - North Pacific unit,** which may or may not be composed of multiple DIPs (Wade et al. 2021). The DIP and unit are managed as a single stock at this time, due to the lack of data available to separately assess them and lack of compelling conservation benefit to managing them separately (NMFS 2023a, NMFS 2019, NMFS 2022c). The DIP is delineated based on two strong lines of evidence: genetics and movement data (Wade et al. 2021). Whales in the Hawai'i - Southeast Alaska/Northern British Columbia DIP winter off Hawai'i and largely summer in Southeast Alaska and Northern British Columbia (Wade et al. 2021). The group of whales that migrate from Russia, western Alaska (Bering Sea and Aleutian Islands), and central Alaska (Gulf of Alaska excluding Southeast Alaska) to Hawai'i have been delineated as the **Hawai'i-North Pacific unit** (Wade et al. 2021). There are a small number of whales that migrate between Hawai'i and southern British Columbia/Washington, but current data and analyses do not provide a clear understanding of which unit these whales belong to (Wade et al. 2021).

The **Western North Pacific (WNP) stock** consists of two units- the **Philippines / Okinawa - North Pacific unit** and the **Marianas / Ogasawara - North Pacific unit**. The units are managed as a single stock at this time, due to a lack of data available to separately assess them (NMFS 2023a, NMFS 2019, NMFS 2022d). Recognition of these units is based on movements and genetic data (Oleson et al. 2022). Whales in the Philippines/Okinawa - North Pacific unit winter near the Philippines and in the Ryukyu Archipelago and migrate to summer feeding areas primarily off the Russian mainland (Oleson et al. 2022). Whales that winter off the Mariana Archipelago, Ogasawara, and other areas not yet identified and then migrate to summer feeding areas off the Commander Islands, and to the Bering Sea and Aleutian Islands comprise the Marianas/Ogasawara - North Pacific unit.

This stock assessment report includes information on the **Western North Pacific stock**. The stock definition is largely similar to previous marine mammal stock assessments, with two primary changes. The WNP stock is fully aligned with the WNP DPS and the stock range includes humpback whales in the Mariana Archipelago, as they are now known to be part of this DPS based on both photographic identification matches and genetics (Hill et al. 2020a).

POPULATION SIZE

Between 2004 and 2006, a basin-wide study took place on nearly all North Pacific summer and winter areas (Calambokidis et al. 2008, Barlow et al. 2011, Baker et al. 2013, Wade 2021). The study, known as SPLASH (Structure, Population Levels, And Status of Humpbacks), produced substantial photographic and genetic data which form the basis for the only partial range-wide estimates of population size for WNP humpback whales. SPLASH sampling in Asia was limited to the wintering areas in Okinawa and Ogasawara in Japan, and to the Babuyan Islands in the Philippines. Summer surveys in Russia also identified whales from the Kamchatka Peninsula, the Commander Islands, and Gulf of Anadyr, and from U.S. waters across the Aleutians and Bering Sea. A total of 566 unique individuals were seen in the Okinawa, Ogasawara, and Philippines wintering areas during the three winter field seasons of the SPLASH, and a preliminary mark-recapture abundance estimate of ~1,000 was estimated from the SPLASH data for the "Asia" study area using a multi-strata Hilborn model (Calambokidis et al. 2008). A recent comprehensive reanalysis of the SPLASH data using a multi-strata analysis (Wade et al. 2016, Wade 2021) resulted in an estimate for "Asia" of 1,084 (CV = 0.088) for 2004-2006. SPLASH did not include sampling in the Mariana Archipelago, such that this estimate is likely an underestimate of total population size. However, together with the movement probabilities published in Wade (2021), the portion of the stock that uses summering areas in U.S. waters was estimated by multiplying the probability of movement between each feeding area and the Asian wintering area, and then those abundances were added together. This resulted in an estimate of 127 (CV= 0.741) migrating to summering areas in U.S. waters.

Hill et al. (2020b) derived preliminary annual mark-recapture abundance estimates for their study region near Saipan in the Mariana Archipelago. Using an open population mark-recapture model (the POPAN generalization of the Jolly-Seber model), Hill et al. (2020b) estimated yearly abundances that ranged from 34 (CV = 0.56) whales in 2019 to 126 (CV = 0.35) whales in 2017, with an average of 61 (CV = 0.21) whales across all years. The sampling periods in each year were short relative to the length of the winter breeding season; therefore, the annual abundances potentially underestimate the numbers of whales associated with the study area throughout each winter.

Minimum Population Estimate

The minimum population estimate for this stock is the lower 20th percentile of the Asia wintering area estimate of 1,084 (CV = 0.088) derived from Wade's (2021) multi-strata analysis, which is 1,007 whales, or 75 whales in the U.S. portion of the summer feeding area. The U.S. summer feeding area estimate is not prorated further based on time in U.S. waters given the similarity of this estimate and the preliminary mark-recapture estimates provided for the Mariana Archipelago wintering area. In other words, the U.S summer feeding area estimate is serving as a minimum population estimate for whales in U.S. waters year-round. NMFS' Guidelines for Assessing Marine

Mammal Stocks suggest that the N_{MIN} estimate of the stock should be adjusted to account for potential abundance changes that may have occurred since the last survey and provide reasonable assurance that the stock size is at least as large as the estimate (NMFS 2023a). While the SPLASH data are more than 15 years old, more recent surveys in portions of the stock's range suggest this is a conservative estimate of total population size given it does not include whales from the Mariana Archipelago, which was not surveyed during SPLASH, nor account for recent increases in the number of whales observed in Russian summer feeding areas (Titova et al. 2018, 2019). The population was also assumed to have increased between 1991-1993 and 2004-2006 (Calambokidis et al. 2008). Additionally, there is no evidence that the apparent declines in humpback whale abundance and calf production following the 2014-2016 marine heatwave in the Gulf of Alaska (Arimitsu et al. 2021, Neilson and Gabriele 2019) affected this stock. For these reasons, the Wade (2021) derived estimate can still be considered a valid minimum population estimate as it provides reasonable assurance that the stock size is at least as large as the estimate (NMFS 2023a).

Current Population Trend

The SPLASH abundance estimate for "Asia" represents a 6.7% annual rate of increase over an abundance estimate from 1991-1993 (Calambokidis et al. 2008), though the 1991-1993 estimate represented only animals photo-identified in Ogasawara and Okinawa, whereas the SPLASH estimate also included effort from the Philippines. Since SPLASH, expanded survey efforts in Russia have yielded a much higher number of whales using some regions, including a sharp increase in the number of whales identified in the Commander Islands, from 17 during SPLASH to 545 in 2010 (Titova et al. 2018). This increase is too great to reflect population growth alone, and may suggest redistribution of whales from other regions, potentially including some not surveyed during SPLASH. The annual rate of increase for the WNP stock is unknown; while it was previously assumed to be increasing, assessments using more recent datasets will be required to assess the current trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are several studies that have attempted to estimate the annual rate of increase for humpback whale populations in the North Pacific, though most are limited by sampling within a specific study region. Mobley et al. (2001) estimated a trend of 7% per year for 1993-2000 using data from aerial surveys within the main Hawaiian Islands. Mizroch et al. (2004) estimated survival rates for North Pacific humpback whales using mark-recapture methods, and a Pradel model fit to data from Hawai'i for 1980-1996, resulting in an estimated rate of increase of 10% per year (95% CI: 3-16%). For shelf waters of the northern Gulf of Alaska, Zerbini et al. (2006) estimated an annual rate of increase for humpback whales of 6.6% from 1987 to 2003 (95% CI: 5.2-8.6%). The SPLASH abundance estimate for the total North Pacific represents an annual increase of 4.9% over the most complete estimate for the North Pacific for 1991 to 1993. In contrast, Zerbini et al. (2010) used life history data from humpback whale populations globally to produce plausible rates of population growth and determined two ranges, 7.3% (95% CI: 3.5-10.5%) and 8.6% (95% CI: 5.0-11.4%), depending on how juvenile survival was computed. Although there are no current estimates of growth rate for the WNP stock, it is reasonable to assume a growth rate of at least 6.7% (Calambokidis et al. 2008) derived from SPLASH and earlier abundance estimates.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,007) for the Asia wintering area, times one half the estimated population growth rate for this stock of humpback whales (½ of 6.7%), times a recovery factor of 0.1 (for an endangered stock with Nmin < 1,500; Taylor et al. 2003), resulting in a PBR of 3.4. The PBR for the whales that use U.S. waters (minimum population size of 75) is 0.2.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed marine mammals in Alaska between 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); however, only the mortality and serious injury data are included in the Stock Assessment Reports. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2023b). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorated values used for large whale reports with incomplete information, is reported in Freed et al. (2022).

Human-caused mortality and serious injury of humpback whales observed in Alaska includes whales from three stocks: the Mexico-North Pacific stock, the Hawai'i stock, and the WNP stock. Human-caused mortality and serious injury data are also available for some other regions of the WNP stock's range, but the data are incomplete and cannot be considered to be a range-wide estimate. To assess human-caused mortality and serious injury of the endangered WNP stock in areas where multiple stocks overlap, mortality and serious injury is prorated using the point estimates of the summering to wintering area movement probabilities reported by Wade (2021). These values are 0.020 (CV = 0.466) for mortality and serious injuries in the Aleutian Islands/Bering Sea and 0.003 (CV = 0.771) for mortality and serious injuries in the Gulf of Alaska.

Based on data described in the sections below, the minimum estimated mean annual level of human-caused mortality and serious injury for the WNP stock of humpback whales between 2016 and 2020 is 5.82 whales: 0.012 in U.S. commercial fisheries, 5.8 in non-U.S. commercial fisheries, 0.001 in unknown (commercial, recreational, or subsistence) fisheries, 0.005 in marine debris, and 0.004 due to other causes (intentional unauthorized removal, vessel strikes and intentional unauthorized take) (see text and tables below). However, this estimate is considered a minimum because observers have not been assigned to several fisheries that are known to interact with this stock and, due to limited data, total mortality and serious injury outside of U.S. waters is uncertain. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include vessel strikes and entanglement in fishing gear and marine debris.

Fisheries Information

U.S. Commercial Fisheries

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

Two humpback whale deaths were observed in the Bering Sea/Aleutian Islands pollock trawl fishery between 2016 and 2020, resulting in a minimum estimated mean annual mortality and serious injury rate of 0.4 humpback whales, of which 0.008 (CV = 0.49) was prorated to the WNP stock (Table 2; Breiwick 2013; MML, unpubl. data).

Table 2. Summary of incidental mortality and serious injury of humpback whales within the range of the Western North Pacific stock due to observed U.S. commercial fisheries between 2016 and 2020. The mean annual mortality estimate is prorated to the WNP stock by multiplying by the area-specific movement probabilities discussed above. Methods for calculating percent observer coverage for Alaska fisheries 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 - overall (CV)	Mean estimated annual mortality of WNP stock (CV)
Bering Sea/Aleutian Islands							
Bering Sea/Aleutian Is. pollock trawl	2016 2017 2018 2019 2020	obs data	99 99 99 98 91	0 0 1 0 1	0 0 1.0 (0.11) 0 1.1 (0.23)	0.4 (0.13)	0.008 (0.49)

Mortality and serious injury in unobserved U.S. commercial fisheries reported to the NMFS Alaska Region marine mammal stranding network and through Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 resulted in a minimum mean annual mortality and serious injury rate of 0.35 humpback whales between 2016 and 2020, of which 0.004 was prorated to the WNP stock (Table 3; Freed et al. 2022). 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.

In summary, the minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries for the WNP stock between 2016 and 2020 is 0.012 humpback whales, based on observer data from Alaska (Table 2: 0.008) and reports (in which the commercial fishery is confirmed) to the NMFS Alaska Region stranding network (Table 3: 0.004).

Table 3. Summary of mortality and serious injury of humpback whales within the range of the Western North Pacific stock, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and by Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 (Freed et al. 2022). Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2012). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorate values used for large whale reports with incomplete information, is reported in Freed et al. (2022). Total mean annual mortality estimates are prorated to the WNP stock by multiplying by the area-specific movement probabilities discussed above. Mean annual estimates are rounded but total estimates are based on unrounded estimates.

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality - total	Mean estimated annual mortality of WNP stock
Bering Sea/Aleutian Islands							
Entangled in Bering Sea/Aleutian Is. commercial Pacific cod pot gear	0	1	0	0	0.75†	0.35	0.004
Entangled in marine debris	1	0	0	0	0	0.2	0.004
Intentional unauthorized take	1	0	0	0	0	0.2	0.004
Gulf of Alaska							
Entangled in subsistence crab pot gear	0	0	0	0.75	0	0.15	0.000
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	0.000
Entangled in unidentified fishing gear*	0	0	1	0	0	0.2	0.001
Entangled in marine debris	1	0	0	0	0	0.2	0.001
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.52	0	0	0	0.1	0.000
Vessel strike by recreational vessel	0.2	0	0	0	0	0.04	0.000
TOTALS							
Total in commercial fisheries						0.35	0.004
Total in Alaska subsistence fisheries						0.15	0.000
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.35	0.001
Total in marine debris						0.40	0.005
Total due to other causes (intentional unauthorized take, vessel strike)						0.34	0.004

†Stock identification known to be Mexico–North Pacific stock based on known wintering and summering areas.
*Unknown if fishery is commercial, recreational, or subsistence.

Other Fisheries

Reports to the NMFS Alaska Region marine mammal stranding network of swimming, floating, or beachcast humpback whales entangled in fishing gear or with injuries caused by interactions with gear within the range of the WNP stock included: one entanglement in subsistence crab pot gear (with a serious injury prorated at 0.75), resulting in a minimum mean annual mortality and serious injury rate of 0.15 humpback whales, of which 0.000 were prorated to the WNP stock; and two entanglements (one of which was a serious injury prorated at 0.75) in unknown (commercial, recreational, or subsistence) fishing gear, resulting in a minimum mean annual mortality and serious injury rate of 0.35 humpback whales, of which 0.001 were prorated to the WNP stock (Table 3; Freed et al. 2022).

Member nations to the International Whaling Commission (IWC) report fisheries bycatch annually. Such reports are available for Japan and Korea for 2015 to 2019; these data were summarized from the IWC's database of annual progress reports by member nations (https://portal.iwc.int/progressreportspublic, accessed May 2023). China and Russia do not report bycatch to IWC. Japan reported 20 humpback whales died as bycatch in stationary uncovered pound nets from 2015 to 2019. Korea reported two humpback whales killed, one in pot gear and the other in a gillnet. The average mortality rate of humpback whales reported as bycatch in Japanese and Korean fisheries is 5.8 whales per year for 2015 to 2019 (Table 4). All of these are attributed to the WNP stock.

Table 4. Summary of fisheries bycatch (dead and seriously injured) reported to the International Whaling Commission by Japan and Korea for 2015 to 2019, the most recent 5-year period available. Although gear type is reported when known, attribution of bycatch to commercial, recreational, or subsistence fisheries is unknown.

<table>
<tr><th>Year</th><th>Japan</th><th>Gear Type</th><th>Korea</th><th>Gear Type</th><th>Total</th></tr>
<tr><td>2015</td><td>18</td><td rowspan="4">Stationary uncovered pound net</td><td>0</td><td></td><td>18</td></tr>
<tr><td>2016</td><td>3</td><td>0</td><td></td><td>3</td></tr>
<tr><td>2017</td><td>3</td><td>0</td><td></td><td>3</td></tr>
<tr><td>2018</td><td>3</td><td>1</td><td>Pot</td><td>4</td></tr>
<tr><td>2019</td><td>0</td><td></td><td>1</td><td>Gillnet</td><td>1</td></tr>
<tr><td colspan="5">Average 2015-2019</td><td>5.8</td></tr>
</table>

Fisheries Summary

The minimum estimate of the mean annual mortality and serious injury rate due to interactions with all fisheries between 2016 and 2020 is 5.81 WNP humpback whales (0.012 in U.S. commercial fisheries + 0.001 in unknown fisheries + 5.8 in non-U.S. unknown fisheries). These estimates of mortality and serious injury levels should be considered minimums. Observers have not been assigned to several U.S. fisheries that are known to interact with this stock, and bycatch in foreign fisheries is often unreported or data are not available, making the estimated mortality and serious injury rate an underestimate of actual mortality and serious injury.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska are not authorized to take humpback whales from this stock. An intentional unauthorized take of a humpback whale by Alaska Natives in Toksook Bay in 2016 resulted in a mean annual mortality and serious injury rate of 0.2 whales between 2016 and 2020 (0.004 attributed to the WNP stock; Table 3).

Other Mortality

In 2015, increased mortality of large whales was observed along the western Gulf of Alaska (including the areas around Kodiak Island, Afognak Island, Chirikof Island, the Semidi Islands, and the southern shoreline of the Alaska Peninsula) and along the central British Columbia coast (from the northern tip of Haida Gwaii to southern

Vancouver Island). NMFS declared an Unusual Mortality Event (UME) for large whales that occurred from 22 May to 31 December 2015 in the western Gulf of Alaska and from 23 April 2015 to 16 April 2016 in British Columbia (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed May 2023). Forty-six large whale deaths attributed to the UME included 12 fin whales and 22 humpback whales in Alaska and 5 fin whales and 7 humpback whales in British Columbia. Based on the findings from the investigation, the UME was likely caused by ecological factors (i.e., the 2015 El Niño, Warm Water Blob, and Pacific Coast Domoic Acid Bloom). Humpback whale strandings along the coast of Japan were also higher in 2015 (18) and 2016 (17) than in the recent past (https://portal.iwc.int/progressreportspublic/report, accessed May 2023).

Entanglements in marine debris reported to the NMFS Alaska Region marine mammal stranding network resulted in minimum mean annual mortality and serious injury rates of 0.4 humpback whales within the WNP stock range between 2016 and 2020 (0.005 attributed to the WNP stock, Table 3; Freed et al. 2022). Vessel strikes and other interactions with vessels unrelated to fisheries also occur with humpback whales (Table 3). The minimum mean annual mortality and serious injury rate due to vessel strikes within the range of the WNP stock in Alaska (Table 3) between 2016 and 2020 is 0.14 humpback whales (0.000 attributed to the WNP stock). Most vessel strikes of humpback whales are reported from Southeast Alaska, outside of the range of the WNP stock; however, there are also reports from the south-central, Kodiak Island, and Prince William Sound areas of Alaska (Freed et al. 2022). Vessel collision is also a potential threat to humpback whales in other parts of the WNP stock range. Humpback whales occur off the west side of Saipan where the only harbors on the island are located and vessel traffic is heavy. In 2014, a vessel transporting crew to a Navy ship anchored near the reef was reported to have struck a large whale (Hill et al. 2020c, Pacific Islands Regional Office, unpublished data). No photos were taken of the whale and it was recorded in the report as a possible humpback or sperm whale, but given the shallow-water location it was likely a humpback whale. Personnel from the CNMI Department of Fish and Wildlife responded to the report and found a group of four humpback whales within the immediate area, however none showed signs of recent vessel strike.

Historical Whaling

Whaling for humpback whales in the North Pacific occurred for centuries, with known hunting areas including Japan, Russia, Alaska, and the west coast of North America (Reeves and Smith 2006). The great majority of catches were made by modern whaling (after 1900), with most catches of humpback whales occurring during two periods, first from 1906 to 1928, and then during the post-World War II years from 1948 to 1966 (Ivashchenko and Clapham 2016). A total of 3,277 reported catches occurred in Asia between 1910 and 1964, with 817 catches from Ogasawara between 1924 and 1944 (Nishiwaki 1966, Rice 1998). After World War II, substantial catches occurred in Asia near Okinawa (including 970 between 1958 and 1961), as well as around the main islands of Japan and the Ogasawara Islands. On the feeding grounds, substantial catches occurred around the Commander Islands and western Aleutian Islands, as well as in the Gulf of Anadyr (Springer et al. 2006).

Until recently, the North Pacific-wide catch record was incomplete because of extensive illegal takes by the USSR (Ivashchenko et al. 2013), but recent work has provided what is thought to be a nearly complete catch record. Approximately 37,000-41,000 humpback whales in total were taken from the North Pacific during whaling from 1656 until 1972, with about 31,000 of those taken during the 20th century (1900-1972) (Ivashchenko and Clapham 2021). Catches of North Pacific humpbacks were prohibited beginning in the 1966 season, but catches were already very low by that time, and it was assumed that North Pacific populations had been greatly over-exploited at that point. Illegal takes of humpbacks in the North Pacific by the USSR continued until 1972 (Ivashchenko and Clapham 2016). Preliminary analyses as part of a Comprehensive Assessment of North Pacific humpback whales by the Scientific Committee of the International Whaling Commission suggest that most breeding populations in the North Pacific were depleted at that time (Ivashchenko et al. 2016), but definitive conclusions cannot be reached until that Comprehensive Assessment is completed.

STATUS OF STOCK

The WNP stock of humpback whales is equivalent to the "WNP DPS" of humpback whales listed as endangered under the ESA (Bettridge et al. 2015, Oleson et al. 2022); thus, it is considered a strategic and depleted stock under the MMPA. Total annual human-caused serious injury and mortality of humpback whales is the sum of bycatch reported by foreign nations (5.8/yr) and all takes attributed to this stock in U.S. waters (commercial and unknown fisheries, marine debris, and other causes including intentional unauthorized take and vessel strikes; 0.023/yr) for a total of 5.82 WNP humpback whales annually. The stock-wide PBR (3.4) is exceeded. Total U.S. commercial fishery mortality and serious injury (0.012/yr) is less than the PBR (0.2) for the portion of the stock occurring in U.S. waters. There is no estimate of the undocumented fraction of anthropogenic injuries and deaths to humpback whales on the U.S. summer or winter feeding areas. The Comprehensive Assessment of North Pacific humpback whales by the Scientific Committee of the IWC, when completed, may provide information on whether breeding populations in the North Pacific are currently estimated to be depleted.

HABITAT CONCERNS

This stock is the focus of a moderate whale-watching industry in the Okinawa and Ogasawara wintering areas. In land-based studies in both Hawaiʻi and Southeast Alaska, the presence of vessels was shown to induce energetically demanding avoidance behaviors in humpback whales. These include changes such as increases in swim speed and changes in swimming direction as well as several other changes in respiration metrics such as decreases in dive times, increased respiration rate, and decreased inter-breath intervals (Schuler et al. 2019, Currie et al. 2021).

Increasing levels of anthropogenic sound in the world's oceans (Andrew et al. 2002), such as those produced by shipping traffic, or LFA (Low Frequency Active) sonar, is a habitat concern for whales, as it can reduce acoustic space used for communication (masking) (Clark et al. 2009, NOAA 2016). This can be particularly problematic for baleen whales that may communicate using low-frequency sound (Erbe 2016). Based on vocalizations (Richardson et al. 1995; Au et al. 2006), reactions to sound sources (Lien et al. 1990, 1992; Maybaum 1993), and anatomical studies (Houser et al. 2001), humpback whales also appear to be sensitive to mid-frequency sounds, including those used in active sonar military exercises (U.S. Navy 2007).

Other potential concerns for this stock include harmful algal blooms (Geraci et al. 1989), possible changes in prey distribution with climate change, vessel strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes), oil and gas activities, an overlap between humpback whales and high concentrations of marine debris, and exposure to blast fishing in the Philippines (Acebes et al. 2008). In a study that quantified the amount and type of marine debris accumulation in Hawaiʻi coastal waters from 2013 to 2016, the degree of overlap between marine debris and cetacean distribution was greatest for humpback whales (Currie et al. 2017).

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HUMPBACK WHALE (*Megaptera novaeangliae kuzira*) - Hawai'i Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

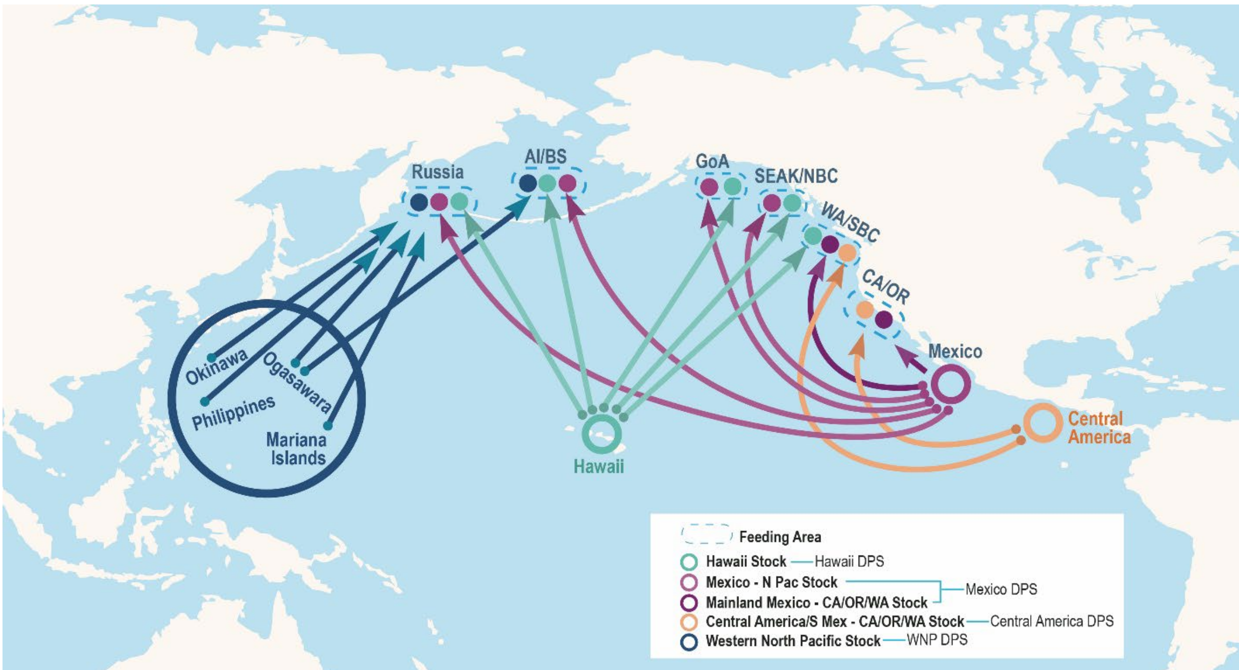

Figure 1. Pacific basin map showing wintering areas of five humpback whale stocks mentioned in this report. Also shown are summering feeding areas mentioned in the text. High-latitude summer feeding areas include Russia, Aleutian Islands / Bering Sea (AI/BS), Gulf of Alaska (GoA), Southeast Alaska / Northern British Columbia (SEAK/NBC), Washington / Southern British Columbia (WA/SBC), and California / Oregon (CA/OR).

Humpback whales occur worldwide and migrate seasonally from high latitude subarctic and temperate summering areas to low latitude subtropical and tropical wintering areas. Three subspecies are recognized globally (North Pacific, Atlantic, and Southern Hemisphere), based on restricted gene flow between ocean basins (Jackson et al. 2014). The North Pacific subspecies (*Megaptera novaeangliae kuzira*) occurs basin-wide, with summering areas in waters of the Russian Far East, Beaufort Sea, Bering Sea, Chukchi Sea, Gulf of Alaska, Western Canada, and the U.S. West Coast. Known wintering areas include waters of Okinawa and Ogasawara in Japan, Philippines, Mariana Archipelago, Hawaiian Islands, Revillagigedos Archipelago, Mainland Mexico, and Central America (Baker et al. 2013, Barlow et al. 2011, Calambokidis et al. 2008, Clarke et al. 2013, Fleming and Jackson 2011, Hashagen et al. 2009). In describing humpback whale population structure in the Pacific, Martien et al. (2020, 2023) note that "migratory whale herds", defined as groups of animals that share the same summering and wintering area, are likely to be demographically independent due to their strong, maternally-inherited fidelity to migratory destinations. Despite whales from multiple wintering areas sharing some summer feeding areas, Baker et al. (2013) reported significant genetic differences between North Pacific summering and wintering areas, driven by strong maternal site fidelity to feeding areas and natal philopatry to wintering areas. This differentiation is supported by photo ID studies showing little interchange of whales between summering areas (Calambokidis et al. 2001).

NMFS has identified 14 distinct population segments (DPSs) of humpback whales worldwide under the Endangered Species Act (ESA) (81 FR 62259, September 8, 2016), based on genetics and movement data (Baker et al. 2013, Calambokidis et al. 2008, Bettridge et al. 2015). In the North Pacific, 4 DPSs are recognized (with ESA listing status), based on their respective low latitude wintering areas: "Western North Pacific" (endangered), "Hawai'i" (not listed), "Mexico" (threatened), and "Central America" (endangered). The listing status of each DPS was determined following an evaluation of the ESA section 4(a)(1) listing factors as well as an evaluation of demographic risk factors. The evaluation is summarized in the final rule revising the ESA listing status of humpback whales (81 FR 62259, September 8, 2016).

In prior stock assessments, NMFS designated three stocks of humpback whales in the North Pacific: the California/Oregon/Washington (CA/OR/WA) stock, consisting of winter populations in coastal Central America and coastal Mexico which migrate to the coast of California and as far north as southern British Columbia in summer; 2) the Central North Pacific stock, consisting of winter populations in the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands; and 3) the Western North Pacific stock, consisting of winter populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands. These stocks, to varying extents, were not aligned with the more recently identified ESA DPSs (e.g., some stocks were composed of whales from more than one DPS), which led NMFS to reevaluate stock structure under the Marine Mammal Protection Act (MMPA).

NMFS evaluated whether these North Pacific DPSs contain one or more demographically independent populations (DIPs), where demographic independence is defined as "*...the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics)*" (NMFS 2023a). Evaluation of the four DPSs in the North Pacific by NMFS resulted in the delineation of three DIPs, as well as four "units" that may contain one or more DIPs (Martien et al. 2021, Taylor et al. 2021, Wade et al. 2021, Oleson et al. 2022, Table 1). Delineation of DIPs is based on evaluation of "strong lines of evidence" such as genetics, movement data, and morphology (Martien et al. 2019). From these DIPs and units, NMFS designated five stocks. North Pacific DIPs / units / stocks are described below, along with the lines of evidence used for each. In some cases, multiple units may be combined into a single stock due to lack of sufficient data and/or analytical tools necessary for effective management or for pragmatic reasons (NMFS 2019).

Table 1. DPS of origin for North Pacific humpback whale DIPs, units, and stocks. Names are based on their general winter and summering area linkages. The stock included in *this* report is shown in bold font. All others appear in separate reports.

DPS	ESA Status	DIPs / units	Stocks
Central America	Endangered	Central America - CA-OR-WA DIP	Central America / Southern Mexico - CA-OR-WA stock
Mexico	Threatened	Mainland Mexico - CA-OR-WA DIP	Mainland Mexico – CA-OR-WA stock
		Mexico - North Pacific unit	Mexico - North Pacific stock
Hawai‘i	Not Listed	Hawai‘i - North Pacific unit	**Hawai‘i stock**
		Hawai‘i - Southeast Alaska / Northern British Columbia DIP	
Western North Pacific	Endangered	Philippines / Okinawa - North Pacific unit	Western North Pacific stock
		Marianas / Ogasawara - North Pacific unit	

Delineation of the **Central America/Southern Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Taylor et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022a). Whales in this stock winter off the Pacific coast of Nicaragua, Honduras, El Salvador, Guatemala, Panama, Costa Rica and likely southern coastal Mexico (Taylor et al. 2021). Summer destinations for whales in this DIP include the U.S. West Coast waters of California, Oregon, and Washington (including the Salish Sea, Calambokidis et al. 2017).

Delineation of the **Mainland Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Martien et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off the mainland Mexico states of Nayarit and Jalisco, with some animals seen as far south as Colima and Michoacán. Summer destinations for whales in the Mainland Mexico DPS include U.S. West Coast waters of California, Oregon, Washington (including the Salish Sea, Martien et al. 2021), Southern British Columbia, Alaska, and the Bering Sea.

The **Mexico – North Pacific unit** is likely composed of multiple DIPs, based on movement data (Martien et al. 2021, Wade 2021, Wade et al. 2021). However, because currently available data and analyses are not sufficient to delineate or assess DIPs within the unit, it was designated as a single stock (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off Mexico and the Revillagigedo Archipelago and summer primarily in Alaska waters (Martien et al. 2021).

The **Hawaiʻi stock** consists of one DIP - **Hawaiʻi - Southeast Alaska / Northern British Columbia DIP** and one unit - **Hawaiʻi - North Pacific unit,** which may or may not be composed of multiple DIPs (Wade et al. 2021). The DIP and unit are managed as a single stock at this time, due to the lack of data available to separately assess them and lack of compelling conservation benefit to managing them separately (NMFS 2023a, NMFS 2019, NMFS 2022c). The DIP is delineated based on two strong lines of evidence: genetics and movement data (Wade et al. 2021). Whales in the Hawaiʻi - Southeast Alaska/Northern British Columbia DIP winter off Hawaiʻi and largely summer in Southeast Alaska and Northern British Columbia (Wade et al. 2021). The group of whales that migrate from Russia, western Alaska (Bering Sea and Aleutian Islands), and central Alaska (Gulf of Alaska excluding Southeast Alaska) to Hawaiʻi have been delineated as the **Hawaiʻi-North Pacific unit** (Wade et al. 2021). There are a small number of whales that migrate between Hawaiʻi and southern British Columbia/Washington, but current data and analyses do not provide a clear understanding of which unit these whales belong to (Wade et al. 2021).

The **Western North Pacific stock** consists of two units- the **Philippines / Okinawa - North Pacific unit** and the **Marianas / Ogasawara - North Pacific unit**. The units are managed as a single stock at this time, due to a lack of data available to separately assess them (NMFS 2023a, NMFS 2019, NMFS 2022d). Recognition of these units is based on movements and genetic data (Oleson et al. 2022). Whales in the Philippines /Okinawa - North Pacific unit winter near the Philippines and Ryukyu Archipelago and migrate to summer feeding areas primarily off the Russian mainland (Oleson et al. 2022). Whales that winter off the Mariana Archipelago, Ogasawara, and other areas not yet identified and then migrate to summer feeding areas off the Commander Islands, and to the Bering Sea and Aleutian Islands comprise the Marianas / Ogasawara - North Pacific unit.

This stock assessment report includes information on the Hawaiʻi stock. In previous marine mammal stock assessments, humpback whales that used the Hawaiʻi wintering area were considered to be the "Central North Pacific" stock, but that stock also included whales in Alaska belonging to the Mexico DPS, as well as Hawaiʻi DPS), so the Hawaiʻi stock is not equivalent to the previous Central North Pacific stock for that reason. Whales in Alaska from the Mexico DPSs are now assessed separately in the Mexico-North Pacific humpback whale stock assessment report. Whales that winter off Hawaiʻi and feed off Washington are now assessed as part of the Hawaiʻi stock.

Population Size

<u>Population Size in Hawaiʻi</u>

A large-scale study of humpback whales throughout the North Pacific was conducted from 2004 to 2006 (the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project). A total of 2,367 unique individuals were seen in the Hawaiian wintering areas during the three winter field seasons of the SPLASH, and a preliminary mark-recapture abundance estimate of ~10,000 was estimated from the SPLASH data for Hawaiʻi using a multi-strata Hilborn model (Calambokidis et al. 2008). Wade et al. (2016) and Wade (2021) finalized the multi-strata analysis, including providing a CV and confidence limits, resulting in an estimate for Hawaiʻi of 11,540 (CV = 0.042) for 2004-2006.

Data from multiple line-transect surveys since 2002 have been used to develop and update species distribution models (SDMs) for cetaceans within the U.S. Exclusive Economic Zone (EEZ) around the Hawaiian Islands (Becker et al. 2012, 2021; Forney et al. 2015), but these surveys were primarily in summer and fall. Until recently, systematic ship survey data in the winter months were limited to a single focused survey of the Main Hawaiian Islands (MHI) from 6–24 February 2009 (PIFSC 2009), and a few ship transits in proximity to the MHI. To better understand the abundance and distribution of cetaceans in the winter months, a winter survey (Winter Hawaiian Islands Cetacean and Ecosystem Assessment Survey, or WHICEAS) was conducted within offshore waters around the MHI from 18 January to 12 March 2020 (Yano et al. 2020). Becker et al. (2022) used the 2002-2020 survey data, along with environmental variables, to build an SDM to estimate the density and abundance of humpback whales in the Hawaiian Islands EEZ for recent years (2017-2020). Since a significant seasonal difference in abundance was evident for humpback whales, the final SDM was used to derive spatially-explicit monthly density estimates based on the average of weekly predictions spanning 2017–2020. Peak numbers of humpback whales are expected to occur within the Hawaiian Islands EEZ from approximately mid-February to mid-March (Au et al. 2000). The functional plot for Julian date in the SDM was consistent with these findings, with peak numbers of humpback whales expected to occur within the Hawaiian Islands EEZ from approximately February 19 through March 22 (Becker et al. 2022). Therefore, to obtain a single abundance estimate, weekly predictions for this time period were averaged to estimate the density and number of whales within the study area during 2020, the most recent year in the time series and the year of the WHICEAS survey effort. This estimate represents the peak abundance of humpback whales in the Hawaiian Islands EEZ during 2020, but may under-represent the full abundance of whales that overwinter in the region because individual whales may not have a very long residence time in Hawaiʻi; Craig et al. (2001) found that for the majority of whales (66%), two weeks or less elapsed between their first and last identification within the same field season. Therefore, some individual whales might only be found in Hawaiʻi outside of the peak period. The resulting estimate of abundance was 11,278 (CV = 0.56, 95% CI 4,049-31,412) (Becker et al. 2022), which is considered the best current estimate of abundance for Hawaiʻi and for the stock as a whole.

Population Size in Summer Areas

Although the population size and estimate of minimum abundance for the stock are based on the abundance in Hawaiʻi**,** abundance information from the summer feeding areas is also summarized here. The only comprehensive survey throughout most of the summer range was the SPLASH survey in 2004-2006. Resulting abundance estimates from a multi-strata mark-recapture analysis resulted in abundance estimates of 1,340 (CV = 0.30) for Russia, 7,758 for the Bering Sea and Aleutian Islands (CV = 0.20), 2,129 for the Gulf of Alaska (including the Shumagin Islands, CV = 0.081), 5,890 (CV = 0.08) for Southeast Alaska and northern British Columbia, and 347 (CV = 0.26) for southern British Columbia (CV = 0.26) (Wade et al. 2016, Wade 2021). However, in all of those areas those abundance estimates represent a mixture of whales from up to three winter areas, the western North Pacific (Asia), Hawaiʻi, and Mexico, and so cannot represent the abundance of just the Hawaiʻi stock in its summer areas. The one near exception is Southeast Alaska and northern British Columbia, where >90% of the whales were estimated to be from Hawaiʻi at the time of the SPLASH surveys (Wade 2021, Lizewski et al 2021). Therefore, that abundance estimate (5,890) could serve as an estimate of the number of whales in the Hawaiʻi - Southeast Alaska / Northern British Columbia DIP, though that estimate is now more than fifteen years old.

Relatively few estimates of abundance have been made for humpback whales in the summer areas of the Hawaiʻi stock in the last decade, with most that are available being for relatively small portions of the range (e.g., Teerlink et al. 2015, Rone et al. 2017, Gabriele et al. 2017). One exception was a line-transect survey throughout nearly all humpback whale habitat in British Columbia, with estimates of 4,935 (CV = 0.13) for the offshore area, 1,816 (CV = 0.13) for the North Coast area, and 279 (CV = 0.40) for the Salish Sea area (inland waters of the Strait of Georgia and Strait of Juan de Fuca) (Wright et al. 2021). The first two of those areas correspond to the northern British Columbia stratum during the SPLASH project, while the third area corresponds to the southern British Columbia stratum. Therefore, the summed estimate of 6,751 would represent the abundance of the northern British Columbia portion of the Hawaiʻi - Southeast Alaska / Northern British Columbia DIP. A more recent estimate of abundance for Southeast Alaska, if it becomes available, could be added to this to represent the abundance of the total DIP.

There are no recent abundance estimates for the summer range of the Hawaiʻi - North Pacific unit.

Minimum Population Estimate

The minimum population estimate for this stock is the lower 20th percentile of the 2020 estimate from Hawaiʻi of 11,278 (CV = 0.56; Becker et al. 2022), which is 7,265.

Current Population Trend

Until recently, most evidence indicated the number of humpback whales in Hawaiʻi and Alaska have been increasing for decades. For example, a comparison of the estimate for the entire stock provided by Calambokidis et al. (1997) with the 1981 estimate of 1,407 (95% CI: 1,113-1,701) from Baker et al. (1987) suggests that abundance increased in Hawaiʻi between the early 1980s and early 1990s. Mobley et al. (2001) estimated a trend of 7% per year for 1993 to 2000 using data from aerial surveys within the main Hawaiian Islands. Mizroch et al. (2004) estimated a rate of increase of 10% per year (95% CI: 3-16%) for humpbacks in Hawaiʻi from a Pradel mark-recapture model fit to data from Hawaiʻi for 1980 to 1996. For shelf waters of the northern Gulf of Alaska, Zerbini et al. (2006) estimated an annual rate of increase for humpback whales of 6.6% (95% CI: 5.2-8.6%) from 1987 to 2003. Comparisons of SPLASH abundance estimates for Hawaiʻi to estimates for 1991 to 1993 gave estimates of annual increase that ranged from 5.5 to 6.0% (Calambokidis et al. 2008). No confidence limits were calculated for these rates of increase from SPLASH data. Teerlink et al. (2015) estimated an average annual rate of increase of 4.53% (95 % CI 3.28–5.79 %) for 1978-2009 for humpback whales in Prince William Sound, Alaska. Gabriele et al. (2017) estimated an annual rate of increase of 5.1% (95% CI -1.3-11.9%) from 1985-2013 for Glacier Bay and Icy Strait in Southeast Alaska.

Recently, however, the encounter rate of humpback whales and the number of calves declined in Prince William Sound after the marine heatwave in the Gulf of Alaska in 2014-2016, presumably due to disruption of lower trophic level prey (Arimitus et al. 2021). A large whale Unusual Mortality Event in the western Gulf of Alaska in 2015-2016 (Savage 2017) suggested this was, at least partially, a true decline rather than just a shift in distribution. A similar decline in abundance and calf production rates of humpback whales in Glacier Bay and Icy Strait in Southeast

Alaska (Neilson and Gabriele 2019) indicates this decline may have occurred widely throughout the Gulf of Alaska. Therefore, it is unknown if this population is currently increasing.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are several studies that have attempted to estimate the annual rate of increase for humpback whale populations in the North Pacific, though most are limited by sampling within a specific study region. Zerbini et al. (2010) analyzed life history rates to estimate that rates of increase for humpback whales can theoretically be as high as 12%, and observed rates of increase approximately that high have been observed in several Southern Hemisphere populations. Estimated rates of increase for the Hawaiʻi stock include values for Hawaiʻi of 7.0% from aerial surveys (Mobely et al. 2001), 5.5-6.0% from mark-recapture abundance estimates (Calambokidis et al. 2008), 10% (95% CI: 3-16%) from a model fit to mark-recapture data (Mizroch et al. 2004), and a value for the northern Gulf of Alaska of 6.6% (95% CI: 5.2-8.6%) from ship surveys (Zerbini et al. 2006). Although there is no estimate of the maximum net productivity rate (R_{MAX}) for the stock, it is reasonable to assume that R_{MAX} for this stock would be at least 7%. Until additional data become available for the Hawaiʻi humpback whale stock, 7% will be used as R_{MAX} for this stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (7,265) times one half the estimated population growth rate for this stock of humpback whales (½ of 0.07) times a recovery factor of 0.5 (for a stock of unknown status relative to OSP), resulting in a PBR of 127.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); however, only the mortality and serious injury data are included in the Stock Assessment Reports. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2023b). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorate values used for large whale reports with incomplete information, is reported in Freed et al. (2022).

Human-caused mortality and serious injury of humpback whales observed in Alaska includes whales from three stocks: the Mexico-North Pacific stock, the Hawaiʻi stock, and the Western North Pacific stock. Human-caused mortality and serious injury of the Hawaiʻi stock also occurs in British Columbia, Washington, and Hawaiʻi. Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed marine mammals off California, Oregon, and Washington between 2016 and 2020 is listed in Carretta et al. (2022), and information for NMFS-managed marine mammals off Hawaiʻi is provided in reports by Bradford (2018a, 2018b, 2020, 2021, and 2023) and Bradford and Lyman (2018, 2019, 2020, 2022, 2023). Mortality and serious injury data are not currently available for British Columbia, although some information is available on humpback whales in Hawaiʻi carrying British Columbia fishing gear.

To assess human-caused mortality and serious injury of the Hawaiʻi stock in areas where multiple stocks overlap in summering areas, mortality and serious injury is prorated using point estimates of the summering to wintering area movement probabilities reported by Wade (2021). Mortality and serious injury occurring in Hawaiʻi is prorated using point estimates of the wintering to summering area movement probabilities, specifically using the summed estimates for movements to Southeast Alaska / Northern British Columbia and to Southern British Columbia/Washington for prorating to the Hawaiʻi-Southeast Alaska / Northern British Columbia DIP, and the summed estimates for movements to Russia, the Bering Sea / Aleutian Islands, and the Gulf of Alaska for prorating to the Hawaiʻi - North Pacific unit (Wade 2021; Table 2).

Based on data described in the sections below, the minimum estimated mean annual level of human-caused mortality and serious injury for the Hawaiʻi stock of humpback whales between 2016 and 2020 is 27.09 whales: 8.39 in U.S. commercial fisheries, 0.80 in Canadian commercial fisheries, 0.29 in recreational fisheries, 0.28 in Alaska subsistence fisheries, 0.34 in Washington tribal treaty fisheries, 4.83 in unknown (commercial, recreational, or subsistence) fisheries, 1.09 in marine debris, and 11.07 due to other causes (intentional unauthorized removal, vessel strikes, and entanglement in an Alaska Department of Fish and Game (ADF&G) salmon net pen and in mooring gear). This estimate is considered a minimum because observers have not been assigned to several fisheries that are known to interact with this stock and, due to limited Canadian observer program data, mortality and serious injury incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with humpback whales) is uncertain. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include vessel strikes and entanglement in fishing gear and marine debris.

Table 2. Movement probabilities from Wade (2021) (and unpublished CVs) used for prorating human-caused mortality and serious injury to the Hawaiʻi - Southeast Alaska / Northern British Columbia DIP and the Hawaiʻi - North Pacific unit, which together comprise the Hawaiʻi stock. For this stock assessment report, whales that winter off Hawaiʻi and summer off Washington are assigned to the Hawaiʻi - Southeast Alaska / Northern British Columbia DIP because of their geographic proximity.

DIP/Unit	**Location of Mortality or Serious Injury**				
	Aleutian Islands/ Bering Sea	**Gulf of Alaska**	**Southeast Alaska**	**Washington**	**Hawaiʻi**
Hawaiʻi - Southeast Alaska / Northern British Columbia DIP	-	-	0.976 (CV = 0.006)	0.688 (CV = 0.130)	0.809 (CV = 0.043)
Hawaiʻi - North Pacific unit	0.91 (CV = 0.024)	0.89 (CV = 0.022)	-	-	0.191 (CV = 0.179)

Fisheries Information

U.S. Commercial Fisheries

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

Two humpback whale mortalities were observed in the Bering Sea/Aleutian Islands pollock trawl fishery between 2016 and 2020, resulting in a minimum estimated mean annual mortality and serious injury rate of 0.4 humpback whales, of which 0.36 were prorated to the Hawaiʻi stock (Table 3; Breiwick 2013; MML, unpubl. data). There were no humpback whale injuries or mortalities in observed fisheries off Washington[1] (Carretta et al. 2022) or in the Hawaiʻi longline fisheries between 2016 and 2020, although one unidentified cetacean described as a probable humpback whale was non-seriously injured in the Hawaiʻi deep-set longline fishery in 2019 (Bradford 2018a, 2018b, 2020, 2021, 2023).

In 2012 and 2013, the Alaska Marine Mammal Observer Program 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 and 2013 programs (Manly 2015). In 2013, one humpback whale was seriously injured. Based on the one observed serious injury, 11 serious injuries were estimated for Districts 6, 7, and 8 in 2013, resulting in an estimated mean annual mortality and serious injury rate of 5.5 humpback whales in 2012 and 2013, of which 5.37 were prorated to the Hawaiʻi stock (Table 3). Because these three districts represent only a portion of the overall fishing effort in this fishery, this is considered to be a minimum estimate of mortality and serious injury for the fishery.

Mortality and serious injury in unobserved U.S. commercial fisheries reported to the NMFS Alaska Region, West Coast, and Pacific Islands Region marine mammal stranding networks and through Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 resulted in a minimum mean annual mortality and serious injury rate of: 1.90 humpback whales in Alaska, of which 1.69 were prorated to the Hawaiʻi stock (Table 4; Freed et al. 2022), 1.1 humpback whales in Washington[2], of which 0.76 were prorated to the Hawaiʻi stock (Table 4; Carretta et al. 2022), and 0.20 humpback whales in Hawaiʻi, all of which were attributed to the Hawaiʻi stock (Table 4; Bradford and Lyman 2018, 2019, 2020, 2022, 2023). These estimates 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.

[1] Jannot et al. (2021) report humpback whale mortalities and serious injuries in the Washington/Oregon/California sablefish pot fishery. Estimates are based on 2015-2019 data for the limited entry (LE) and open-access (OA) sablefish pot sectors combined. Two observer program entanglements since 2002 informed the bycatch estimates, both of which occurred in California and Oregon waters. Other sablefish pot cases opportunistically reported (at-sea sightings of entangled whales, strandings) have also been documented only in California and Oregon waters (Carretta et al. 2022). Because no entanglements have been documented for this fishery in Washington, the estimate from Jannot et al. (2021) is not prorated to the Hawaiʻi stock.

[2] This includes whales sighted in waters outside of Washington where the mortality or serious injury source was confirmed to be a Washington fishery.

In summary, the minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries for the Hawaiʻi stock between 2016 and 2020 is 8.39 humpback whales, based on observer data from Alaska (Table 3: 5.73) and reports (in which the commercial fishery is confirmed) to the NMFS Alaska (Table 4: 1.69), West Coast Region (Table 4: 0.76), and Pacific Islands Region stranding networks (Table 4: 0.20).

Other Fisheries

Reports to the NMFS Alaska Region, West Coast, and Pacific Islands Region marine mammal stranding networks of swimming, floating, or beachcast humpback whales entangled in fishing gear or with injuries caused by interactions with gear within the range of the Hawaiʻi stock between 2016 and 2020 include: two entanglements (each with a serious injury prorated at 0.75) in recreational pot fisheries gear, resulting in a minimum mean annual mortality and serious injury rate of 0.30 whales, of which 0.29 were prorated to the Hawaiʻi stock (Table 4; Freed et al. 2022); entanglements in Alaska subsistence crab pot gear and in unidentified Alaska subsistence gillnet (each with a serious injury prorated at 0.75), resulting in a minimum mean annual mortality and serious injury rate of 0.30 humpback whales, of which 0.28 were prorated to the Hawaiʻi stock (Table 4; Freed et al. 2022); entanglements in Washington tribal treaty gillnet fishery gear, resulting in a resulting in a minimum mean annual mortality and serious injury rate of 0.50 humpback whales, of which 0.34 were prorated to the Hawaiʻi stock (Table 4; Carretta et al. 2022); and entanglements in unknown (commercial, recreational, or subsistence) fishing gear, resulting in a minimum mean annual mortality and serious injury rate of 5.20 humpback whales (Table 4; 0.85 in Alaska, Freed et al. 2022; 1.00 in Washington, Carretta et al. 2022; and 3.35 in Hawaiʻi, Bradford and Lyman 2018, 2019, 2020, 2022, 2023), of which 4.83 were prorated to the Hawaiʻi stock. There were also reports of whales seen in Hawaiʻi carrying pot gear from British Columbia (commercial and unknown), resulting in a minimum mean annual mortality and serious injury rate of 0.8 (Table 4; Bradford and Lyman 2018, 2019, 2020, 2022, 2023), all attributed to the Hawaiʻi stock.

Table 3. Summary of incidental mortality and serious injury of humpback whales within the Hawaiʻi stock range due to observed U.S. commercial fisheries between 2016 and 2020 (or the most recent data available) and the mean annual mortality and serious injury rate (Breiwick 2013; Manly 2015; MML, unpubl. data). Mean annual mortality estimates are prorated to the Hawaiʻi - Southeast Alaska / Northern British Columbia (HI-SEAK/NBC) DIP and the Hawaiʻi - North Pacific (HI-NPac) unit, which together comprise the Hawaiʻi stock, by multiplying by the area-specific movement probabilities in Table 2. Methods for calculating percent observer coverage for Alaska fisheries 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 - overall (CV)**	**Mean estimated annual mortality – by DIP/unit**	
							DIP/unit	**Estimate (CV)**
Bering Sea/Aleutian Islands								
Bering Sea/Aleutian Is. pollock trawl	2016 2017 2018 2019 2020	obs data	99 99 99 98 91	0 0 1 0 1	0 0 1.0 (0.11) 0 1.1 (0.23)	0.4 (0.13)	HI-NPac	0.36 (0.13)
Southeast Alaska								
Southeast Alaska salmon drift gillnet (Districts 6, 7, 8)	2012 2013	obs data	6.4 6.6	0 1	0 11	5.5 (1.0)	HI-SEAK/NBC	5.37 (1.0)
Minimum total estimated annual mortality						5.9 (0.93)	HI-SEAK/NBC	5.37 (1.0)
							HI-NPac	0.36 (0.13)

Fisheries Summary

The minimum mean annual mortality and serious injury rate due to interactions with all fisheries between 2016 and 2020 is 14.93 Hawai‘i humpback whales (8.39 in U.S. commercial fisheries + 0.29 in recreational fisheries + 0.28 in Alaska subsistence fisheries + 0.34 in Washington tribal treaty fisheries + 4.83 in unknown fisheries + 0.8 in Canadian fisheries). These estimates should be considered minimums. Observers have not been assigned to several fisheries that are known to interact with this stock, making the estimated mortality and serious injury rate an underestimate of actual mortality and serious injury. Further, due to limited Canadian observer program data, mortality and serious injury incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with humpback whales) is uncertain. Though interactions are thought to be minimal, data regarding the level of humpback whale mortality and serious injury related to commercial fisheries in northern British Columbia are not available, again indicating that the estimated mortality and serious injury incidental to commercial fisheries is underestimated for this stock.

Table 4. Summary of mortality and serious injury of humpback whales, by year and type, reported to the NMFS Alaska Region, West Coast, and Pacific Islands marine mammal stranding networks and by Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 (Freed et al. 2022; Carretta et al. 2022; Bradford and Lyman 2018, 2019, 2020, 2022, 2023), except for vessel strikes off Washington; see text and Table 5. Total mean annual mortality estimates are prorated to the Hawai‘i - Southeast Alaska / Northern British Columbia (HI-SEAK/NBC) DIP and the Hawai‘i - North Pacific (HI-NPac) unit, which together comprise the Hawai‘i stock, by multiplying by the area-specific movement probabilities in Table 2. Mean annual estimates are rounded but total estimates are based on unrounded estimates.

Cause of injury	**2016**	**2017**	**2018**	**2019**	**2020**	**Mean annual mortality - total**	**Mean estimated annual mortality – by DIP/unit**	
Bering Sea/Aleutian Islands								
Entangled in Bering Sea/Aleutian Is. commercial Pacific cod pot gear	0	1	0	0	0.75[a]	0.35	HI-NPac	0.18
Entangled in marine debris	1	0	0	0	0	0.2	HI-NPac	0.18
Intentional unauthorized take	1	0	0	0	0	0.2	HI-NPac	0.18
Gulf of Alaska								
Entangled in subsistence crab pot gear	0	0	0	0.75	0	0.15	HI-NPac	0.13
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	HI-NPac	0.13
Entangled in unidentified fishing gear*	0	0	1	0	0	0.2	HI-NPac	0.18
Entangled in marine debris	1	0	0	0	0	0.2	HI-NPac	0.18
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.52	0	0	0	0.1	HI-NPac	0.09
Vessel strike by recreational vessel	0.2	0	0	0	0	0.04	HI-NPac	0.04

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality - total	Mean estimated annual mortality – by DIP/unit	
Southeast Alaska								
Entangled in Southeast Alaska commercial salmon drift gillnet (in ADF&G Districts that were not observed in 2012 and 2013)	2.25	0	1.5	0	1.75 + 0.75[b]	1.25	HI-SEAK/NBC	1.22
Entangled in Southeast Alaska commercial pot gear	0	0	0	0	0.75	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified commercial longline gear	0	0	0	0	0.75	0.15	HI-SEAK/NBC	0.15
Entangled in Southeast Alaska recreational shrimp pot gear	0	0	0.75	0	0	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified recreational pot gear	0	0	0	0.75	0	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified subsistence gillnet	0.75	0	0	0	0	0.15	HI-SEAK/NBC	0.15
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified fishing gear*	0	1	0	0.75	0	0.35	HI-SEAK/NBC	0.34
Entangled in marine debris	2.25	0.75	0	0.75	0	0.75	HI-SEAK/NBC	0.73
Entangled in ADF&G salmon net pen	0.75	0	0	0	0	0.15	HI-SEAK/NBC	0.15
Entangled in mooring gear	0.75	0	0	0	0	0.15	HI-SEAK/NBC	0.15
Vessel strike	1	1.34	3	3	0.4	1.75	HI-SEAK/NBC	1.71
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.2	0	0	0	0. 04	HI-SEAK/NBC	0.04
Washington								
Entangled in commercial Washington Dungeness crab pot gear	0	2	1.75	0.75	1	1.10	HI-SEAK/NBC	0.76
Entangled in Washington tribal gillnet gear	0	0	2.5	0	0	0.50	HI-SEAK/NBC	0.34
Entangled in unidentified fishing gear*	0	0	0	0.75	1.75	0.50	HI-SEAK/NBC	0.34
Entangled in unidentified pot/trap gear*	0	0	2.5	0	0	0.50	HI-SEAK/NBC	0.34

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality - total	Mean estimated annual mortality – by DIP/unit	
Hawai‘i								
Entangled in commercial Alaska king crab or cod pot gear	0	0	0	1	0	0.20	HI-SEAK/NBC	0.16
							HI-NPac	0.04
Entangled in British Columbia commercial pot gear	0	0	0	1	0	0.20	HI-SEAK/NBC	0.20
							HI-NPac	0.00
Entangled in unidentified British Columbia pot gear*	0	0	3[c]	0	0	0.60	HI-SEAK/NBC	0.60
							HI-NPac	0.00
Entangled in unidentified gillnet*	0	0	1	0	0	0.20	HI-SEAK/NBC	0.16
							HI-NPac	0.04
Entangled in unidentified fishing gear*	2.5	5.25	4	4	0	3.15	HI-SEAK/NBC	2.55
							HI-NPac	0.60
Vessel strike	0.2	1.2	4	2.2	9	3.32	HI-SEAK/NBC	2.69
							HI-NPac	0.63
TOTALS								
Total in U.S. commercial fisheries						3.20	HI-SEAK/NBC	2.43
							HI-NPac	0.22
Total in Canadian fisheries						0.80	HI-SEAK/NBC	0.80
							HI-NPac	0.00
Total in recreational fisheries						0.30	HI-SEAK/NBC	0.29
							HI-NPac	0.00
Total in Alaska subsistence fisheries						0.30	HI-SEAK/NBC	0.15
							HI-NPac	0.13
Total in Washington tribal treaty fisheries						0.50	HI-SEAK/NBC	0.34
							HI-NPac	0.00
*Total in unknown (commercial, recreational, or subsistence) fisheries						5.20	HI-SEAK/NBC	3.88
							HI-NPac	0.95
Total in marine debris						1.15	HI-SEAK/NBC	0.73
							HI-NPac	0.36
Total due to other causes (intentional unauthorized removal, entangled in salmon net pen, entangled in mooring gear, vessel strike)						5.75	HI-SEAK/NBC	4.72
							HI-NPac	0.94

[a] Animal known to be from the Mexico – North Pacific stock based on known wintering and summering areas.
[b] Animal was entangled in both AK SEAK salmon drift gillnet gear and AK salmon troll gear.
[c] Total for 2018 reflects correction of an error in the "Value for PBR" for the serious injury reported 01/27/2018 in Bradford and Lyman (2020).
* Unknown if fishery is commercial, recreational, or subsistence.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska are not authorized to take humpback whales from this stock. An intentional unauthorized take of a humpback whale by Alaska Natives in Toksook Bay in 2016 resulted in a mean annual mortality and serious injury rate of 0.2 whales between 2016 and 2020 (0.18 prorated to the Hawai‘i stock; Table 4).

Other Mortality

In 2015, increased mortality of large whales was observed along the western Gulf of Alaska (including the areas around Kodiak Island, Afognak Island, Chirikof Island, the Semidi Islands, and the southern shoreline of the Alaska Peninsula) and along the central British Columbia coast (from the northern tip of Haida Gwaii to southern

Vancouver Island). NMFS declared an Unusual Mortality Event (UME) for large whales that occurred from 22 May to 31 December 2015 in the western Gulf of Alaska and from 23 April 2015 to 16 April 2016 in British Columbia (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed May 2023). Forty-six large whale deaths attributed to the UME included 12 fin whales and 22 humpback whales in Alaska and 5 fin whales and 7 humpback whales in British Columbia. Based on the findings from the investigation, the UME was likely caused by ecological factors (i.e., the 2015 El Niño, Warm Water Blob, and Pacific Coast Domoic Acid Bloom).

Entanglements in marine debris, an ADF&G salmon net pen, and mooring gear reported to the NMFS Alaska Region marine mammal stranding network resulted in minimum mean annual mortality and serious injury rates of 1.15, 0.15, and 0.15 humpback whales (prorated as 1.09, 0.15, and 0.15 Hawai‘i stock humpback whales), respectively, between 2016 and 2020 (Table 4; Freed et al. 2022).

Vessel strikes

Vessel strikes and other interactions with vessels unrelated to fisheries occur frequently with humpback whales (Tables 4 and 5). The minimum mean annual mortality and serious injury rate due to vessel strikes in Alaska is 1.93, of which 1.87 were prorated to the Hawai‘i stock and in Hawai‘i is 3.32, all of which were assigned to the Hawai‘i stock (Table 4).

Fourteen vessel strike cases involving humpback whales were observed in California, Oregon, and Washington waters during 2016-2020 (8 in California, 1 in Oregon, and 5 in Washington), totaling 13.2 mortalities and serious injuries, or 2.6 whales per year (Carretta et al. 2022). Those occurring off Washington could be prorated to the Hawai‘i stock, but because most vessel strikes are likely undetected, we use modeled estimates reported by Rockwood et al. (2017) for these waters. Such analyses are not currently available for other parts of the Hawai‘i stock range. The estimated number of annual vessel strike deaths off California, Oregon, and Washington was 22 humpback whales, though this includes only the period July – November when whales are most likely to be present in the U.S. West Coast Exclusive Economic Zone and the season that overlaps with survey effort used in species distribution models (Becker et al. 2016, Rockwood et al. 2017). This estimate is based on an assumption of a moderate level of vessel avoidance by humpback whales, as measured by the behavior of satellite-tagged whales in the presence of vessels (McKenna et al. 2015). Based on estimate of 22 deaths due to vessel strikes annually, the number attributed to the Hawai‘i stock during 2016-2020 is 5.4 whales per year (Table 5). The ratio of mean annual observed to estimated vessel strike deaths and serious injuries of humpback whales during 2016-2020 is 2.6 / 22 = 0.11, implying that vessel strike counts from opportunistic observations represent a small fraction of overall incidents.

Combining these estimates results in a total of 10.59 vessel strikes prorated to the Hawai‘i stock.

Table 5. Summary of humpback whale vessel strike mortalities and serious injuries (M/SI) during 2016-2020 (Carretta et al. 2022). Estimates are based on prorating annual estimates of humpback vessel strike mortality off the U.S. West Coast (22/year, Rockwood et al. 2017) by the fraction of observed vessel strikes in different feeding areas (Washington vs. California/Oregon), which are then prorated to stock by multiplying by the area-specific movement probabilities in Table 2.

State Detected	**Observations**	**Fraction of Observations**	**Fraction of Observations *times* 22 M/SI per year estimated by Rockwood et al. (2017)**	**Mean estimated annual mortality prorated to the Hawai‘i stock**
Washington	5	0.357	7.86	5.4
California/Oregon	9	0.643	14.14	0
Total	14			5.4

Neilson et al. (2012) summarized 108 large whale vessel-strike events in Alaska from 1978 to 2011, 25 of which are known to have resulted in the whale’s death. Eighty-six percent of these reports involved humpback whales. Most vessel strikes of humpback whales are reported from Southeast Alaska; however, there are also reports from the south-central, Kodiak Island, and Prince William Sound areas of Alaska (Freed et al. 2022). Many of the vessel strikes occurring off Hawai‘i are reported from waters near Maui (Bradford and Lyman 2018, 2019). It is not known whether the difference in vessel-strike rates between Southeast Alaska and the northern portion of this stock is due to differences in reporting, amount of vessel traffic, densities of animals, or other factors.

Historic whaling

Whaling for humpback whales in the North Pacific occurred for centuries, with known hunting areas including Japan, Russia, Alaska, and the west coast of North America (Reeves and Smith 2006). The great majority of catches were made by modern whaling (after 1900), with most catches of humpback whales occurring during two periods, first from 1906 to 1928, and then during the post-World War II years from 1948 to 1966 (Ivashchenko and Clapham 2016). Until recently, the catch record was incomplete because of extensive illegal takes by the USSR (Ivashchenko et al. 2013), but recent work has allowed for what is thought to be a nearly complete catch record. Approximately 37,000-41,000 humpback whales in total were taken from the North Pacific during whaling from 1656 until 1972, with about 31,000 of those taken during the 20th century (1900-1972) (Ivashchenko and Clapham 2021). Catches of North Pacific humpbacks were prohibited beginning in the 1966 season, but catches were already very low by that time, and it was assumed that North Pacific populations had been greatly over-exploited at that point. Illegal takes of humpbacks in the North Pacific by the USSR continued until 1972 (Ivashchenko and Clapham 2016). Preliminary analyses as part of a Comprehensive Assessment of North Pacific humpback whales by the Scientific Committee of the International Whaling Commission suggest that most breeding populations in the North Pacific were depleted at that time (Ivashchenko et al. 2016), but definitive conclusions cannot be reached until that Comprehensive Assessment is completed.

STATUS OF STOCK

Total annual human-caused serious injury and mortality of the Hawai‘i stock of humpback whales is the sum of U.S. commercial fisheries (8.39/year), Canadian fisheries (0.8/year), recreational fisheries (0.29/year), Alaska subsistence fisheries (0.28/year), Washington tribal treaty fisheries (0.34/year), unknown (commercial, recreational, or subsistence) fisheries (4.83/year), marine debris (1.09/year), and other causes (intentional unauthorized removal, vessel strikes, and entanglement in an Alaska Department of Fish and Game (ADF&G) salmon net pen and in mooring gear) (11.07/year), or 27.09 humpback whales annually. The minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (8.39 whales) is less than 10% of the calculated PBR for the entire stock (10% of PBR = 12.7) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. There is no estimate of the undocumented fraction of anthropogenic injuries and deaths to humpback whales in Alaska or Hawai‘i. On the U.S. West Coast, a comparison of observed vs. estimated annual vessel strikes suggests that approximately 10% of vessel strikes are documented.

The Hawai‘i stock of humpback whales is equivalent to the Hawai‘i DPS of humpback whales, which is not listed under the ESA (Bettridge et al. 2015, Wade et al. 2021). Humpback whales were previously considered to be depleted species-wide under the MMPA solely on the basis of the species' ESA listing. After the evaluation of the listing status of DPSs of humpback whales, humpback whale DPSs that are not listed as threatened or endangered were not considered to have depleted status under the MMPA (81 FR 62259, September 8, 2016). However, because the Central North Pacific stock included some whales from the ESA-listed Mexico and Western North Pacific DPSs, the stock was considered to be endangered and depleted, and as a result, was classified as a strategic stock. The newly defined Hawai‘i stock of humpback whales does not include whales from any listed DPSs and, therefore, is not currently considered depleted under the MMPA, and is also not a strategic stock due to its ESA status. It is also not strategic because total annual human-caused mortality and serious injury (27.09) does not exceed the stock's PBR (127).

As discussed above, it is widely believed that most breeding populations of humpback whales in the North Pacific were over-exploited by whaling and depleted as of ~1966. However, as also discussed above, it is thought that at least some populations in the North Pacific, including humpback whales in Hawai‘i and Alaska, have experienced substantial population growth from when monitoring began (~1980) until recently. The Comprehensive Assessment of North Pacific humpback whales by the Scientific Committee of the International Whaling Commission, when completed, may provide information on whether breeding populations in the North Pacific are currently estimated to be depleted.

One key uncertainty in the assessment of the Hawai‘i stock of humpback whales is that 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

This stock is the focus of a large whale-watching industry in its wintering grounds (Hawai‘i) and summering grounds (Alaska). Regulations concerning the minimum distance to keep from whales and how to operate vessels when in the vicinity of whales have been developed for Hawai‘i and Alaska waters in an attempt to minimize the effect of whale watching. In land-based studies in both Hawaiʻi and Southeast Alaska, the presence of vessels was shown to induce energetically demanding avoidance behaviors in humpback whales. These include changes such as increases in swim speed and changes in swimming direction as well as several other changes in respiration metrics such as decreases in dive times, increased respiration rate, and decreased inter-breath intervals (Schuler et al. 2019, Currie et al. 2021). Additional concerns have been raised in Hawaiʻi about the effect of jet skis and similar fast waterborne tourist-related traffic, notably in nearshore areas inhabited by mothers and calves. In Alaska, NMFS issued regulations in 2001 to prohibit approaches to humpback whales within 100 yards (91.4 m: 66 FR 29502, 31 May 2001). Similarly, in Hawaiʻi, NMFS first issued regulations in 1987 that made it unlawful to operate an aircraft within 1,000 feet, approach by any means within 100 yards, cause a vessel or other object to approach within a 100 yards, or disrupt the normal behavior or prior activity of a humpback whale by any other act or omission (52 FR 44912, 23 November 1987). In 2015, NMFS introduced a voluntary responsible viewing program called Whale SENSE to Juneau area whale-watch operators to provide additional protections for whales in Alaska (https://whalesense.org, accessed May 2023). The growth of the whale-watching industry is an ongoing concern as preferred habitats may be abandoned if disturbance levels are too high.

Increasing levels of anthropogenic sound in the world's oceans (Andrew et al. 2002), such as those produced by shipping traffic, or Low Frequency Active sonar, is a habitat concern for whales, as it can reduce acoustic space used for communication (masking) (Clark et al. 2009, NOAA 2016). This can be particularly problematic for baleen whales that may communicate using low-frequency sound (Erbe 2016). Based on vocalizations (Richardson et al. 1995, Au et al. 2006), reactions to sound sources (Lien et al. 1990, 1992; Maybaum 1993), and anatomical studies (Houser et al. 2001), humpback whales also appear to be sensitive to mid-frequency sounds, including those used in active sonar military exercises (U.S. Navy 2007).

Other potential concerns for this stock include harmful algal blooms (Geraci et al. 1989), possible changes in prey distribution with climate change, vessel strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes), oil and gas activities, and an overlap between humpback whales and high concentrations of marine debris. In a study that quantified the amount and type of marine debris accumulation in Hawaiʻi coastal waters from 2013 to 2016, the degree of overlap between marine debris and cetacean distribution was greatest for humpback whales (Currie et al. 2017).

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HUMPBACK WHALE (*Megaptera novaeangliae kuzira*): Mexico-North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

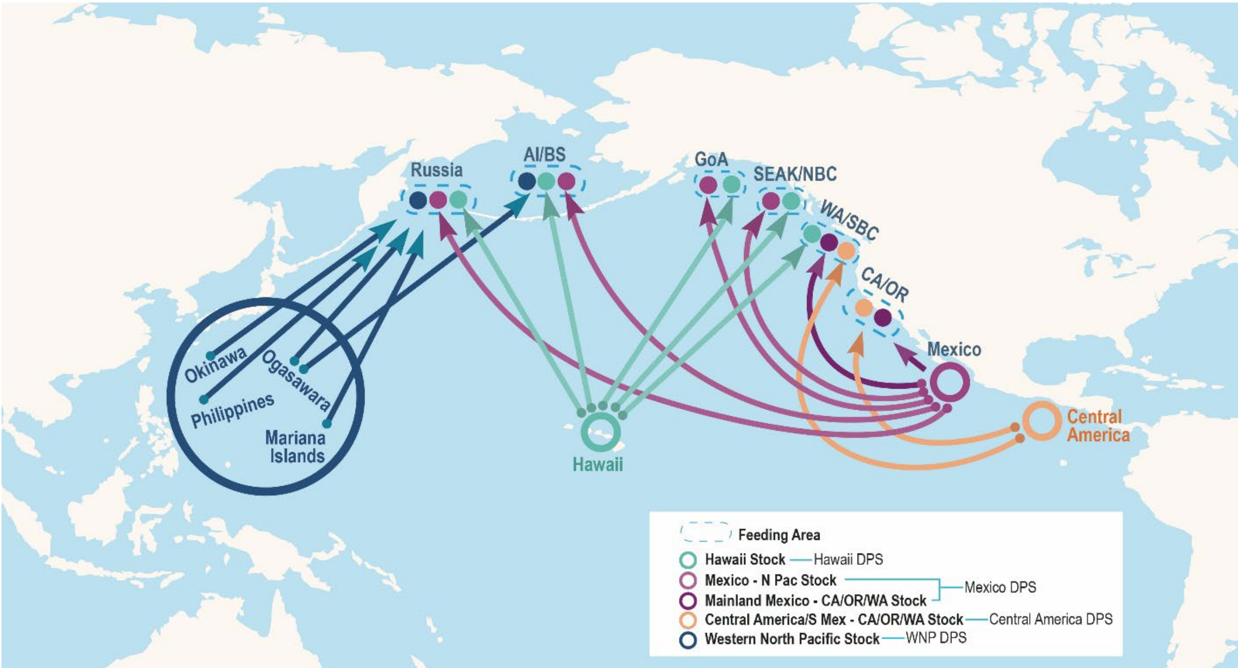

Figure 1. Pacific basin map showing wintering areas of five humpback whale stocks mentioned in this report. Also shown are summering feeding areas mentioned in the text. High-latitude summer feeding areas include Russia, Aleutian Islands / Bering Sea (AI/BS), Gulf of Alaska (GoA), Southeast Alaska / Northern British Columbia (SEAK/NBC), Washington / Southern British Columbia (WA/SBC), and California / Oregon (CA/OR).

Humpback whales occur worldwide and migrate seasonally from high latitude subarctic and temperate summering areas to low latitude subtropical and tropical wintering areas. Three subspecies are recognized globally (North Pacific, Atlantic, and Southern Hemisphere), based on restricted gene flow between ocean basins (Jackson et al. 2014). The North Pacific subspecies (*Megaptera novaeangliae kuzira*) occurs basin-wide, with summering areas in waters of the Russian Far East, Beaufort Sea, Bering Sea, Chukchi Sea, Gulf of Alaska, Western Canada, and the U.S. West Coast. Known wintering areas include waters of Okinawa and Ogasawara in Japan, Philippines, Mariana Archipelago, Hawaiian Islands, Revillagigedos Archipelago, Mainland Mexico, and Central America (Baker et al. 2013, Barlow et al. 2011, Calambokidis et al. 2008, Clarke et al. 2013, Fleming and Jackson 2011, Hashagen et al. 2009). In describing humpback whale population structure in the Pacific, Martien et al. (2020, 2023) note that "migratory whale herds", defined as groups of animals that share the same summering and wintering area, are likely to be demographically independent due to their strong, maternally-inherited fidelity to migratory destinations. Despite whales from multiple wintering areas sharing some summer feeding areas, Baker et al. (2013) reported significant genetic differences between North Pacific summering and wintering areas, driven by strong maternal site fidelity to feeding areas and natal philopatry to wintering areas. This differentiation is supported by photo ID studies showing little interchange of whales between summering areas (Calambokidis et al. 2001).

NMFS has identified 14 distinct population segments (DPSs) of humpback whales worldwide under the Endangered Species Act (ESA) (81 FR 62259, September 8, 2016), based on genetics and movement data (Baker et al. 2013, Calambokidis et al. 2008, Bettridge et al. 2015). In the North Pacific, 4 DPSs are recognized (with ESA listing status), based on their respective low latitude wintering areas: "Western North Pacific" (endangered), "Hawai'i" (not listed), "Mexico" (threatened), and "Central America" (endangered). The listing status of each DPS was determined following an evaluation of the ESA section 4(a)(1) listing factors as well as an evaluation of demographic risk factors. The evaluation is summarized in the final rule revising the ESA listing status of humpback whales (81 FR 62259, September 8, 2016).

In prior stock assessments, NMFS designated three stocks of humpback whales in the North Pacific: the California/Oregon/Washington (CA/OR/WA) stock, consisting of winter populations in coastal Central America and coastal Mexico which migrate to the coast of California and as far north as southern British Columbia in summer; 2) the Central North Pacific stock, consisting of winter populations in the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands; and 3) the Western North Pacific stock, consisting of winter populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands. These stocks, to varying extents, were not aligned with the more recently identified ESA DPSs (e.g., some stocks were composed of whales from more than one DPS), which led NMFS to reevaluate stock structure under the Marine Mammal Protection Act (MMPA).

NMFS evaluated whether these North Pacific DPSs contain one or more demographically independent populations (DIPs), where demographic independence is defined as "*…the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics)*" (NMFS 2023a). Evaluation of the four DPSs in the North Pacific by NMFS resulted in the delineation of three DIPs, as well as four "units" that may contain one or more DIPs (Martien et al. 2021, Taylor et al. 2021, Wade et al. 2021, Oleson et al. 2022, Table 1). Delineation of DIPs is based on evaluation of "strong lines of evidence" such as genetics, movement data, and morphology (Martien et al. 2019). From these DIPs and units, NMFS designated five stocks. North Pacific DIPs / units / stocks are described below, along with the lines of evidence used for each. In some cases, multiple units may be combined into a single stock due to lack of sufficient data and/or analytical tools necessary for effective management or for pragmatic reasons (NMFS 2019).

Table 1. DPS of origin for North Pacific humpback whale DIPs, units, and stocks. Names are based on their general winter and summering area linkages. The stock included in *this* report is shown in bold font. All others appear in separate reports.

DPS	ESA Status	DIPs / units	Stocks
Central America	Endangered	Central America - CA-OR-WA DIP	Central America / Southern Mexico - CA-OR-WA stock
Mexico	Threatened	Mainland Mexico - CA-OR-WA DIP	Mainland Mexico – CA-OR-WA stock
		Mexico - North Pacific unit	**Mexico - North Pacific stock**
Hawai'i	Not Listed	Hawai'i - North Pacific unit	Hawai'i stock
		Hawai'i - Southeast Alaska / Northern British Columbia DIP	
Western North Pacific	Endangered	Philippines / Okinawa - North Pacific unit	Western North Pacific stock
		Marianas / Ogasawara - North Pacific unit	

Delineation of the **Central America/Southern Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Taylor et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022a). Whales in this stock winter off the Pacific coast of Nicaragua, Honduras, El Salvador, Guatemala, Panama, Costa Rica and likely southern coastal Mexico (Taylor et al. 2021). Summer destinations for whales in this DIP include the U.S. West Coast waters of California, Oregon, and Washington (including the Salish Sea, Calambokidis et al. 2017).

Delineation of the **Mainland Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Martien et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off the mainland Mexico states of Nayarit and Jalisco, with some animals seen as far south as Colima and Michoacán. Summer destinations for whales in the Mainland Mexico DPS include U.S. West Coast waters of California, Oregon, Washington (including the Salish Sea, Martien et al. 2021), Southern British Columbia, Alaska, and the Bering Sea.

The **Mexico – North Pacific unit** is likely composed of multiple DIPs, based on movement data (Martien et al. 2021, Wade 2021, Wade et al. 2021). However, because currently available data and analyses are not sufficient to delineate or assess DIPs within the unit, it was designated as a single stock (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off Mexico and the Revillagigedo Archipelago and summer primarily in Alaska waters (Martien et al. 2021).

The **Hawaiʻi stock** consists of one DIP - **Hawaiʻi - Southeast Alaska / Northern British Columbia DIP** and one unit - **Hawaiʻi - North Pacific unit,** which may or may not be composed of multiple DIPs (Wade et al. 2021). The DIP and unit are managed as a single stock at this time, due to the lack of data available to separately assess them and lack of compelling conservation benefit to managing them separately (NMFS 2023a, NMFS 2019, NMFS 2022c). The DIP is delineated based on two strong lines of evidence: genetics and movement data (Wade et al. 2021). Whales in the Hawaiʻi - Southeast Alaska/Northern British Columbia DIP winter off Hawaiʻi and largely summer in Southeast Alaska and Northern British Columbia (Wade et al. 2021). The group of whales that migrate from Russia, western Alaska (Bering Sea and Aleutian Islands), and central Alaska (Gulf of Alaska excluding Southeast Alaska) to Hawaiʻi have been delineated as the **Hawaiʻi-North Pacific unit** (Wade et al. 2021). There are a small number of whales that migrate between Hawaiʻi and southern British Columbia/Washington, but current data and analyses do not provide a clear understanding of which unit these whales belong to (Wade et al. 2021).

The **Western North Pacific stock** consists of two units- the **Philippines / Okinawa - North Pacific unit** and the **Marianas / Ogasawara - North Pacific unit**. The units are managed as a single stock at this time, due to a lack of data available to separately assess them (NMFS 2023a, NMFS 2019, NMFS 2022d). Recognition of these units is based on movements and genetic data (Oleson et al. 2022). Whales in the Philippines /Okinawa - North Pacific unit winter near the Philippines and Ryukyu Archipelago and migrate to summer feeding areas primarily off the Russian mainland (Oleson et al. 2022). Whales that winter off the Mariana Archipelago, Ogasawara, and other areas not yet identified and then migrate to summer feeding areas off the Commander Islands, and to the Bering Sea and Aleutian Islands comprise the Marianas / Ogasawara - North Pacific unit.

In previous marine mammal stock assessments, most humpback whales that summer and feed in Alaska waters were treated as one stock (the "Central North Pacific stock"), with only whales that winter in Asia (a relatively small proportion of the whales in the Bering Sea, Aleutian Islands, and Gulf of Alaska) identified as belonging to a separate stock (the "Western North Pacific stock"). However, this meant that the Central North Pacific stock contained whales from both the Hawaiʻi and Mexico DPSs, making that previous stock incompatible with the ESA DPSs. Therefore, humpback whales that summer in Alaska have now been placed in one of three separate stocks defined by their winter area, which are consistent with their ESA DPSs. Regarding the whales that summer in Alaska and winter in Mexico, as noted above, two stocks have been designated within the Mexico DPS. Humpback whales that winter along the Mexico Mainland coast and feed in summer along the west coast of the United States are part of the Mainland Mexico – California/Oregon/Washington stock.

This stock assessment report includes information on humpback whales that winter in Mexico and summer primarily in Alaska. This includes some of the humpback whales that winter along the mainland coast of Mexico that migrate to Alaska in summer. Additionally, none of the whales in the offshore Revillagigedo Archipelago in Mexico migrate to the west coast of the U.S.; they primarily migrate to Alaska in summer (with a small number migrating to Russia or to southern British Columbia/Washington). Therefore, this stock, the Mexico – North Pacific stock, includes humpback whales that winter off mainland Mexico and the Revillagigedo Archipelago and summer primarily in Alaska waters (Martien et al. 2021). This stock specifically excludes any whales that migrate from Mexico to California or Oregon.

POPULATION SIZE

Winter Areas

All of the humpback whales in the Revillagigedo Archipelago are part of this stock. Therefore, an estimate of abundance for the Revillagigedo Archipelago can serve as a partial estimate for the stock. Such estimates will be negatively biased to an unknown degree, as they will not include an estimate of the number of whales in this stock found along the mainland coast of Mexico. There is currently no method that would allow partitioning the abundance of humpback whales along the mainland Mexico coast to the two Mexican stocks.

Using a modified model of the Jolly-Seber population model, Urbán et al. (1999) estimated that in 1991 there were 1,813 (95% CI: 918-2505) whales in the coastal stock and 914 (95% CI: 590-1193) whales in the Revillagigedo Archipelago stock. During the SPLASH project in 2004-2006, a total of 562 unique individuals were identified in the Revillagigedo Archipelago (Table 6 in Calambokidis et al. 2008). Abundance estimates were also calculated from those same data using a Hilborn mark-recapture model. From what they identified as the best-fitting model (the non-Markov p(n) model), the estimate of abundance for the Revillagigedo Archipelago was 681 (no CV was estimated) (Calambokidis et al. 2008). Martinez-Aguilar (2011) conducted mark-recapture abundance estimates from photo-identification data from 3 regions in the Mexican Pacific, including the Revillagigedo Archipelago. A number of closed population models were fit to the data, with the best model being a Chao m(th) model specifying time-varying and individual heterogeneity in capture probability. That model resulted in an estimate for the years 1987-1990 of 571

(95% CI 465-729) for the Revillagigedo Archipelago. Martinez-Aguilar (2011) also analyzed data from the 2004-2006 SPLASH years from Mexico, and added an additional year of data (2003) from outside the SPLASH years. For that time period, the Chao m(th) model resulted in an estimate of 2,352 (95% CI 2,030-2,762, with CV~0.075) for the Revillagigedo Archipelago.

Summer Areas

Abundance estimates from a multi-strata mark-recapture analysis from the SPLASH data resulted in abundance estimates of 7,758 for the Bering Sea and Aleutian Islands (CV=0.20), 2,129 for the Gulf of Alaska (including the Shumagin Islands, CV=0.081), and 5,890 (CV=0.075) for Southeast Alaska and northern British Columbia (Wade 2021). In all of those areas those abundance estimates represent a mixture of whales from up to three winter areas, the western North Pacific (Asia), Hawaiʻi, and Mexico, and so cannot represent the abundance of just the Mexico-North Pacific stock in its summer areas. To determine the number of animals in these feeding areas belonging to the Mexico-North Pacific stock, the abundance estimate for each feeding area was multiplied by the probability of movement between that feeding area and the Mexican wintering area, as estimated by Wade (2021), and then added together. This resulted in an estimate of 918 animals (CV=0.217).

Minimum Population Estimate

Using the Chao m(th) model abundance estimate for 2003-2006 reported by Martinez-Aguilar (2011), which is 2,352 with ~CV=0.075, N_{MIN} for this population would be 2,241. Using the estimate of 918 animals (CV=0.217) derived from Wade's (2021) multi-strata analysis of 2004-2006 SPLASH data, the N_{MIN} for this population would be 766. Both of these estimates of abundance are based on data collected more than 15 years ago. NMFS' Guidelines for Assessing Marine Mammal Stocks suggest that the N_{MIN} estimate of the stock should be adjusted to account for potential abundance changes that may have occurred since the last survey and provide reasonable assurance that the stock size is at least as large as the estimate (NMFS 2023a). There is no basis for adjusting the abundance estimates because the abundance trend is unclear. Although there was evidence that the population in the Revillagigedo Archipelago was increasing between 1987-1990 and 2003-2006, there are no estimates of the population trend for that area since 2003-2006. Additionally, as discussed below in the Current Population Trend section, it is no longer clear that the trend of the population is increasing. Therefore, the minimum population estimate for this stock is considered unknown.

Current Population Trend

Calambokidis et al. (2008) noted that the abundance estimate for all areas in Mexico estimated from the SPLASH data suggested an increase relative to previous estimates. Specifically, they noted that "an increase from about 2,500 whales in the early 1990s to the SPLASH estimate of 5,928 would be consistent with a 6.9% rate of annual increase, but should be interpreted cautiously given the variability in the earlier estimates" (Calambokidis et al. 2008). A comparison of two mark-recapture estimates for the Revillagigedo Archipelago for 1987-1990 and 2003-2006 resulted in an estimate of an annual rate of increase of 8.8% (Table 9 in Martinez-Aguilar 2011). Estimates of annual rates of increase from the same years of data for other parts of Mexico were 10.5% for the Baja Peninsula, 8.7% for the mainland Mexico coast, and 8.9% for all areas in Mexico combined. This suggests that the portion of this stock along the mainland coast was also increasing over this time period.

Whales in this stock migrate to areas of Alaska, particularly the Aleutian Islands, Bering Sea, and Gulf of Alaska. There are no trend data for humpback whales in the Aleutian Islands and Bering Sea. For shelf waters of the northern Gulf of Alaska, Zerbini et al. (2006) estimated an annual rate of increase for humpback whales of 6.6% (95% CI: 5.2-8.6%) from 1987 to 2003. Teerlink et al. (2015) estimated an average annual rate of increase of 4.53% (95 % CI 3.28–5.79%) for 1978-2009 for humpback whales in Prince William Sound, Alaska. Although these areas are a mixture of whales from Hawaii, Mexico, and Asia, and so do not reflect the trend of a single stock, the data are still consistent with the evidence above suggesting humpback whales in Mexico were increasing.

Recently, however, the encounter rate of humpback whales and the number of calves declined in Prince William Sound after the marine heatwave in the Gulf of Alaska in 2014-2016, presumably due to disruption of lower trophic level prey (Arimitsu et al. 2021). A large whale Unusual Mortality Event in the western Gulf of Alaska in 2015-2016 (Savage 2017) suggested this was, at least partially, a true decline rather than just a shift in distribution. A similar decline in abundance and calf production rates of humpback whales in Glacier Bay and Icy Strait in Southeast Alaska (Neilson and Gabriele 2019) indicates this decline may have occurred widely throughout the Gulf of Alaska. Therefore, it is unknown if this population is currently increasing.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Zerbini et al. (2010) analyzed observed life history rates to estimate that rates of increase for humpback whales can theoretically be as high as 12%, and rates of increase approximately that high have been observed in several Southern Hemisphere populations. As mentioned above, Martinez-Aguilar (2011) estimated an annual increase of 8.8% (no CV or CI reported) for the Revillagigedo Archipelago over a 16-year period (1987-1990 to 2003-2006), based on point estimates of 571 and 2,352, respectively. Taking the upper confidence limit for the first time period (729) and the lower confidence limit of the second time period (2030) represents an annual rate of increase of at least 6.6%.

An estimated rate of increase for humpback whales in the northern Gulf of Alaska of 6.6% (95% CI: 5.2-8.6%) was estimated from ship survey data (Zerbini et al. 2006); although this represents a mixture of several stocks (including the Mexico—North Pacific stock), this value is consistent with the increase reported for the Revillagigedo Archipelago, and is a feeding area used by this stock.

There is no estimate of the maximum net productivity rate (R_{MAX}) for the entire stock (i.e., including both the Revillagigedo Archipelago and the whales along the mainland Mexico coast that migrate to Alaska). However, Martinez-Aguilar (2011) reports an annual rate of increase of 8.7% for coastal areas of Mexico. Therefore, it is reasonable to assume that R_{MAX} for this stock would be at least 6.6%. Until additional data become available for the Hawai‘i humpback whale stock, 6.6% will be used as R_{MAX} for this stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock would be calculated as the minimum population size times one half the estimated population growth rate for this stock of humpback whales (½ of 6.6%) times a recovery factor of 0.5, the default value for a stock part of a DPS listed as Threatened (NMFS 2023a). Due to a lack of quantitative data, it is assumed that this stock spends approximately half its time outside the U.S. Exclusive Economic Zone (EEZ), the PBR in U.S. waters would be ½ of the calculated value. However, because N_{MIN} is considered unknown, PBR is undetermined.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); however, only the mortality and serious injury data are included in the Stock Assessment Reports. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2023b). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorate values used for large whale reports with incomplete information, is reported in Freed et al. (2022).

Human-caused mortality and serious injury of humpback whales observed in Alaska includes whales from three stocks: the Mexico-North Pacific stock, the Hawai‘i stock, and the Western North Pacific stock. Human-caused mortality and serious injury of the Mexico-North Pacific stock also occurs in Mexico, but those data are not currently available. To assess human-caused mortality and serious injury of the Hawai‘i stock in areas where multiple stocks overlap, mortality and serious injury is prorated using point estimates of the summering to wintering area movement probabilities reported by Wade (2021) (Table 2).

Table 2. Movement probabilities from Wade (2021) (and unpublished CVs) used for prorating human-caused mortality and serious injury to the Mexico-North Pacific stock.

Stock or DIP/Unit	Aleutian Islands/Bering Sea	Gulf of Alaska	Southeast Alaska
Mexico-North Pacific	0.071 (CV = 0.280)	0.106 (CV = 0.177)	0.024 (CV = 0.260)

Based on data described in the sections below, the minimum estimated mean annual level of human-caused mortality and serious injury for the Mexico-North Pacific stock of humpback whales between 2016 and 2020 in U.S. waters is 0.57 whales: 0.36 in U.S. commercial fisheries, 0.01 in recreational fisheries, 0.02 in Alaska subsistence fisheries, 0.05 in unknown (commercial, recreational, or subsistence) fisheries, 0.05 in marine debris, and 0.08 due to other causes (intentional unauthorized removal, vessel strikes, and entanglement in an Alaska Department of Fish and Game (ADF&G) salmon net pen and in mooring gear) (see text and tables below). This estimate is considered a minimum because observers have not been assigned to several fisheries that are known to interact with this stock.

Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include vessel strikes and entanglement in fishing gear and marine debris.

Fisheries Information

U.S. Commercial Fisheries

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

Two humpback whale mortalities were observed in the Bering Sea/Aleutian Islands pollock trawl fishery between 2016 and 2020, resulting in a minimum estimated mean annual mortality and serious injury rate of 0.4 humpback whales, of which 0.03 were prorated to the Mexico-North Pacific stock (Table 3; Breiwick 2013; MML, unpubl. data).

In 2012 and 2013, the Alaska Marine Mammal Observer Program 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 and 2013 programs (Manly 2015). In 2013, one humpback whale was seriously injured. Based on the one observed serious injury, 11 serious injuries were estimated for Districts 6, 7, and 8 in 2013, resulting in an estimated mean annual mortality and serious injury rate of 5.5 humpback whales in 2012 and 2013, of which 0.13 were prorated to the Mexico-North Pacific stock (Table 3). Because these three districts represent only a portion of the overall fishing effort in this fishery, this is considered to be a minimum estimate of mortality and serious injury for the fishery.

Table 3. Summary of incidental mortality and serious injury of humpback whales due to observed U.S. commercial fisheries between 2016 and 2020 (or the most recent data available) and the mean annual mortality and serious injury rate for Alaska fisheries (Breiwick 2013; Manly 2015; MML, unpubl. data). Mean annual mortality estimates are prorated to the Mexico-North Pacific stock by multiplying by the area-specific movement probabilities in Table 2. Methods for calculating percent observer coverage for Alaska fisheries 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 - overall (CV)	Mean estimated annual mortality of Mexico-North Pacific stock (CV)
Bering Sea/Aleutian Islands							
Bering Sea/Aleutian Is. pollock trawl	2016 2017 2018 2019 2020	obs data	99 99 99 98 91	0 0 1 0 1	0 0 1.0 (0.11) 0 1.1 (0.23)	0.4 (0.13)	0.03 (0.31)
Southeast Alaska							
Southeast Alaska salmon drift gillnet (Districts 6, 7, 8)	2012 2013	obs data	6.4 6.6	0 1	0 11	5.5 (1.0)	0.13 (1.1)
Minimum total estimated annual mortality						5.9 (0.93)	0.16 (0.88)

Mortality and serious injury in unobserved U.S. commercial fisheries reported to the NMFS Alaska Region marine mammal stranding network and through Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 resulted in a minimum mean annual mortality and serious injury rate of 1.90 humpback whales between 2016 and 2020 (Table 4; Freed et al. 2022), of which 0.20 were prorated to the Mexico-North Pacific stock. 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 or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

In summary, the minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries for the Mexico-North Pacific stock between 2016 and 2020 (or the most recent data available) is 0.36 humpback whales, based on observer data from Alaska (Table 3: 0.16) and reports (in which the commercial fishery is confirmed) to the NMFS Alaska Region stranding network (Table 4: 0.20).

Other Fisheries

Reports to the NMFS Alaska Region marine mammal stranding network of swimming, floating, or beachcast humpback whales entangled in fishing gear or with injuries caused by interactions with gear within the range of the Mexico-North Pacific stock between 2016 and 2020 included: two (each with a serious injury prorated as 0.75) entanglements in recreational pot fisheries gear, resulting in a minimum mean annual mortality and serious injury rate of 0.3 humpback whales, of which 0.01 were prorated to the Mexico-North Pacific stock; entanglements in Alaska subsistence crab pot gear and in unidentified Alaska subsistence gillnet (each with a serious injury prorated as 0.75), resulting in a minimum mean annual mortality and serious injury rate of 0.3 humpback whales, of which 0.02 were prorated to the Mexico-North Pacific stock; and entanglements in unknown (commercial, recreational, or subsistence) fishing gear, resulting in a minimum mean annual mortality and serious injury rate of 0.85 humpback whales, of which 0.05 were prorated to the Mexico-North Pacific stock (Table 4; Freed et al. 2022).

Fisheries Summary

The minimum estimate of the mean annual mortality and serious injury rate due to interactions with all fisheries between 2016 and 2020 is 0.44 Mexico-North Pacific humpback whales (0.36 in commercial fisheries + 0.01 in recreational fisheries + 0.02 in Alaska subsistence fisheries + 0.05 in unknown fisheries). These estimates of mortality and serious injury levels should be considered minimums. Observers have not been assigned to several fisheries that are known to interact with this stock, making the estimated mortality and serious injury rate an underestimate of actual mortality and serious injury.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska are not authorized to take humpback whales from this stock. An intentional unauthorized take of a humpback whale by Alaska Natives in Toksook Bay in 2016 resulted in a mean annual mortality and serious injury rate of 0.2 whales between 2016 and 2020 (0.01 prorated to the Mexico-North Pacific stock; Table 4).

Other Mortality

In 2015, increased mortality of large whales was observed along the western Gulf of Alaska (including the areas around Kodiak Island, Afognak Island, Chirikof Island, the Semidi Islands, and the southern shoreline of the Alaska Peninsula) and along the central British Columbia coast (from the northern tip of Haida Gwaii to southern Vancouver Island). NMFS declared an Unusual Mortality Event (UME) for large whales that occurred from 22 May to 31 December 2015 in the western Gulf of Alaska and from 23 April 2015 to 16 April 2016 in British Columbia (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed May 2023). Forty-six large whale deaths attributed to the UME included 12 fin whales and 22 humpback whales in Alaska and 5 fin whales and 7 humpback whales in British Columbia. Based on the findings from the investigation, the UME was likely caused by ecological factors (i.e., the 2015 El Niño, Warm Water Blob, and Pacific Coast Domoic Acid Bloom).

Entanglements in marine debris, an ADF&G salmon net pen, and mooring gear reported to the NMFS Alaska Region marine mammal stranding network resulted in minimum mean annual mortality and serious injury rates of 1.15, 0.15, and 0.15 humpback whales (prorated as 0.05, 0.004, and 0.004 Mexico-North Pacific stock humpback whales), respectively, between 2016 and 2020 (Table 4; Freed et al. 2022). The mean minimum annual morality and serious injury due to vessel strikes and other interactions with vessels unrelated to fisheries between 2016 and 2020 is 1.93 humpback whales (prorated as 0.06 Mexico-North Pacific stock humpback whales; Table 4). Neilson et al. (2012) summarized 108 large whale vessel-strike events in Alaska from 1978 to 2011, 25 of which are known to have resulted in the whale's death. Eighty-six percent of these reports involved humpback whales. Most vessel strikes of humpback whales are reported from Southeast Alaska; however, there are also reports from the south-central, Kodiak Island, and Prince William Sound areas of Alaska (Freed et al. 2022). It is not known whether the difference in vessel-strike rates between Southeast Alaska and the northern portion of this stock is due to differences in reporting, amount of vessel traffic, densities of animals, or other factors.

Table 4. Summary of mortality and serious injury of humpback whales within the range of the Mexico-North Pacific stock, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and by Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 (Freed et al. 2022). Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2023b). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorate values used for large whale reports with incomplete information, is reported in Freed et al. (2022). Total mean annual mortality estimates are prorated to the Mexico-North Pacific stock by multiplying by the area-specific movement probabilities from Table 2. Mean annual estimates are rounded but total estimates are based on unrounded estimates.

Cause of injury	**2016**	**2017**	**2018**	**2019**	**2020**	**Mean annual mortality - total**	**Mean estimated annual mortality of Mexico-North Pacific stock**
Bering Sea/Aleutian Islands							
Entangled in Bering Sea/Aleutian Is. commercial Pacific cod pot gear	0	1	0	0	0.75[a]	0.35	0.16
Entangled in marine debris	1	0	0	0	0	0.2	0.01
Intentional unauthorized take	1	0	0	0	0	0.2	0.01
Gulf of Alaska							
Entangled in subsistence crab pot gear	0	0	0	0.75	0	0.15	0.02
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	0.02
Entangled in unidentified fishing gear*	0	0	1	0	0	0.2	0.02
Entangled in marine debris	1	0	0	0	0	0.2	0.02
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.52	0	0	0	0.1	0.01
Vessel strike by recreational vessel	0.2	0	0	0	0	0.04	0.004
Southeast Alaska							
Entangled in Southeast Alaska commercial salmon drift gillnet (in ADF&G Districts that were not observed in 2012 and 2013)	2.25	0	1.5	0	1.75 + 0.75[b]	1.25	0.03
Entangled in Southeast Alaska commercial pot gear	0	0	0	0	0.75	0.15	0.00
Entangled in unidentified commercial longline gear	0	0	0	0	0.75	0.15	0.00
Entangled in Southeast Alaska recreational shrimp pot gear	0	0	0.75	0	0	0.15	0.00
Entangled in unidentified recreational pot gear	0	0	0	0.75	0	0.15	0.00
Entangled in unidentified subsistence gillnet	0.75	0	0	0	0	0.15	0.00
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	0.00
Entangled in unidentified fishing gear*	0	1	0	0.75	0	0.35	0.01
Entangled in marine debris	2.25	0.75	0	0.75	0	0.75	0.02
Entangled in ADF&G salmon net pen	0.75	0	0	0	0	0.15	0.00
Entangled in mooring gear	0.75	0	0	0	0	0.15	0.00
Vessel strike	1	1.34	3	3	0.4	1.75	0.04

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality - total	Mean estimated annual mortality of Mexico-North Pacific stock
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.2	0	0	0	0.04	0.001
TOTALS							
Total in commercial fisheries						1.90	0.20
Total in recreational fisheries						0.30	0.01
Total in Alaska subsistence fisheries						0.30	0.02
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.85	0.05
Total in marine debris						1.15	0.05
Total due to other causes (entangled in salmon net pen, entangled in mooring gear, vessel strike)						2.23	0.08

[a] Known to be Mexico-North Pacific stock based on known wintering and summering areas.

[b] Animal was entangled in both AK SEAK salmon drift gillnet gear and AK salmon troll gear.

* Unknown if fishery is commercial, recreational, or subsistence.

Historic whaling

Whaling for humpback whales in the North Pacific occurred for centuries, with known hunting areas including Japan, Russia, Alaska, and the west coast of North America (Reeves and Smith 2006). The great majority of catches were made by modern whaling (after 1900), with most catches of humpback whales occurring during two periods, first from 1906 to 1928, and then during the post-World War II years from 1948 to 1966 (Ivashchenko and Clapham 2016). Until recently, the catch record was incomplete because of extensive illegal takes by the USSR (Ivashchenko et al. 2013), but recent work has allowed for the completion of a nearly complete catch record. Approximately 37,000-41,000 humpback whales in total were taken from the North Pacific during whaling from 1656 until 1972, with about 31,000 of those taken during the 20th century (1900-1972) (Ivashchenko and Clapham 2021). Mexico was the only breeding ground which had relatively high catches and was also connected to feeding areas with high catches, making it likely that the breeding populations in Mexico were over-exploited. A total of at least 1,264 whales were caught in the Revillagigedo Archipelago, with all known takes occurring between 1859-1868 and between 1914-1935 (Ivashchenko and Clapham 2021).

Catches of North Pacific humpbacks were prohibited beginning in the 1966 season, but catches were already very low by that time, and it was assumed that all or most North Pacific populations had been greatly over-exploited at that point. Illegal takes of humpbacks in the North Pacific by the USSR continued until 1972 (Ivashchenko and Clapham 2016). Preliminary modeling analyses as part of a Comprehensive Assessment of North Pacific humpback whales by the Scientific Committee of the International Whaling Commission suggest that most breeding populations in the North Pacific were depleted as of 1972 (Ivashchenko et al. 2016), but definitive conclusions cannot be reached until that Comprehensive Assessment is completed.

STATUS OF STOCK

The Mexico-North Pacific stock of humpback whales is one of two stocks that make up the “Mexico DPS” of humpback whales, which are listed as threatened under the ESA (Bettridge et al. 2015, Martien et al. 2021), and is therefore considered “depleted” and “strategic” under the MMPA. Total annual human-caused serious injury and mortality of Mexico-North Pacific humpback whales is the sum of U.S. commercial fisheries (0.36/year), recreational fisheries (0.01/year), Alaska subsistence fisheries (0.02/year), unknown (commercial, recreational, or subsistence) fisheries (0.05/year), marine debris (0.05/year), and other causes (intentional unauthorized removal, vessel strikes, and entanglement in an Alaska Department of Fish and Game (ADF&G) salmon net pen and in mooring gear) (0.08/year), or 0.57 humpback whales annually. PBR is unknown, so it cannot be determined if total commercial fishery mortality and serious injury (0.36/yr) is less than PBR or less than 10% of PBR for this stock. There is no estimate of the undocumented fraction of anthropogenic injuries and deaths to humpback whales in Alaska or in Mexico; on the U.S. West Coast, a comparison of observed vs. estimated annual vessel strikes suggests that approximately 10% of vessel strikes are documented, so reports of such vessel strikes may also be underreported for this stock. The abundance of humpback whales in the Revillagigedo Archipelago, which represents a substantial portion of this stock, was estimated to have increased at an annual rate of 8.8% between 1987-1990 and 2003-2006 (Table 9 in Martinez-Aguilar 2011); no more recent trend data are available for that area.

There are key uncertainties in the assessment of the Mexico-North Pacific stock of humpback whales. The stock is likely composed of multiple DIPs, but currently available data and analyses are not sufficient to delineate or assess DIPs within the stock. There is no current estimate of abundance or trend for this stock and PBR is undetermined. The 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

Increasing levels of anthropogenic sound in the world's oceans (Andrew et al. 2002), such as those produced by shipping traffic, or Low Frequency Active sonar, is a habitat concern for whales, as it can reduce acoustic space used for communication (masking) (Clark et al. 2009, NOAA 2016). This can be particularly problematic for baleen whales that may communicate using low-frequency sound (Erbe 2016). Based on vocalizations (Richardson et al. 1995; Au et al. 2006), reactions to sound sources (Lien et al. 1990, 1992; Maybaum 1993), and anatomical studies (Hauser et al. 2001), humpback whales also appear to be sensitive to mid-frequency sounds, including those used in active sonar military exercises (U.S. Navy 2007).

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FIN WHALE (*Balaenoptera physalus*): Northeast Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the U.S. waters in the Pacific Ocean, fin whales are found seasonally off the coast of North America and in the Bering Sea during the summer (Fig. 1). Information on seasonal fin whale distribution has been gleaned from the detection of fin whale calls using bottom-mounted, offshore hydrophone arrays along the U.S. Pacific coast, in the central North Pacific, and in the western Aleutian Islands (Moore et al. 1998, 2006; Watkins et al. 2000; Stafford et al. 2007; Širović et al. 2013; Soule and Wilcock 2013; Archer et al. 2019). Moore et al. (1998, 2006), Watkins et al. (2000), and Stafford et al. (2007) documented fin whale calling along the U.S. Pacific coast where rates were highest from August/September through February, suggesting that these may be important feeding areas during the winter. Širović et al. (2013) speculated that both resident and migratory fin whales may occur off southern California based on shifts in peaks in fin whale calling data. Širović et al. (2015) noted that fin whales were detected in the Southern California Bight year-round and found an overall increase in the fin whale call index from 2006 to 2012. Soule and Wilcock (2013) documented fin whale call rates in a presumed feeding area along the Juan de Fuca Ridge, offshore of northern Washington State, and found that some whales appear to transit northwest from August to October. They speculate that some fin whales migrate northward from the Juan de Fuca Ridge in fall and southward in winter. While peaks in call rates occurred during late summer, fall, and winter in the central North Pacific and the Aleutian Islands, fin whale calls were seldom detected during summer months even though fin whales are regularly seen in summer months in the Gulf of Alaska (Stafford et al. 2007). Fin whale calls have been detected in the southeast Bering Sea by a moored hydrophone. During April 2006 through April 2007, peaks in fin whale call detections were found from September through November 2006 and also in February and March 2007 (Stafford et al. 2010). In addition, fin whale calls were detected in the northeastern Chukchi Sea using instruments moored there from July through October between 2007 and 2010 (Delarue et al. 2013). Call data collected from the Bering Sea suggest that several putative fin whale stocks may feed in the Bering Sea; however, only one of these likely migrates into the Chukchi Sea to feed (Delarue et al. 2013). Some fin whale calls have also been recorded in the Hawaiian portion of the U.S. Exclusive Economic Zone in all months except June and July (Thompson and Friedl 1982, McDonald and Fox 1999). Sightings of fin whales in Hawaii are extremely rare: there was a sighting in 1976 (Shallenberger 1981), a sighting in 1979 (Mizroch et al. 2009), a sighting during an aerial survey in 1994 (Mobley et al. 1996), and five sightings during a survey in 2002 (Barlow 2006).

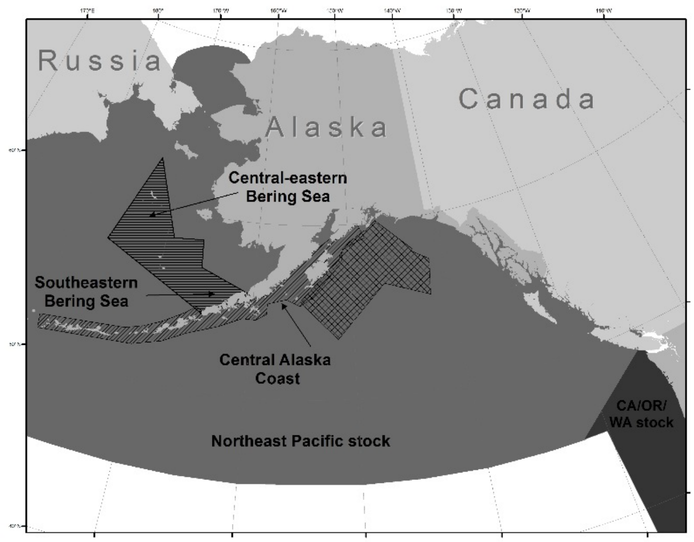

Figure 1. Approximate distribution of fin whales in the eastern North Pacific. Striped areas indicate where vessel surveys occurred in 1999-2010 (horizontal stripes - Bering Sea: Moore et al. 2002; Friday et al. 2012, 2013); 2001-2003 (diagonal stripes - Central Alaska coast and Aleutian Islands: Zerbini et al. 2006); and 2009, 2013, and 2015 (crosshatch - Gulf of Alaska: Rone et al. 2017).

Surveys on the Bering Sea shelf in 1997, 1999, 2000, 2002, 2004, 2008, and 2010 and in coastal waters of the Aleutian Islands and the Alaska Peninsula from 2001 to 2003 provided information about the distribution and abundance of fin whales in these areas (Moore et al. 2000, 2002; Zerbini et al. 2006; Friday et al. 2012, 2013). Fin whales were the most common large whale sighted during the Bering Sea shelf surveys in all years except for 1997 and 2004 (Friday et al. 2012, 2013). Fin whales were consistently distributed both in the “green belt,” an area of high productivity along the edge of the eastern Bering Sea continental shelf (Springer et al. 1996), and, at a lower frequency, in the middle shelf. Abundance estimates for fin whales in the Bering Sea were consistently higher in cold years than in warm years (Friday et al. 2012, 2013) indicating a shift in distribution. This is consistent with a fine-scale comparison of fin whale occurrence on the middle shelf between a cold year (1999) and a warm year (2002), which found that the group and individual encounter rates were 7 to 12 times higher in the cold year (Stabeno et al. 2012). Cold years are known to be more favorable for large copepods and euphausiids over the Bering Sea shelf (Stabeno et al. 2012) and fin whale distributions are likely driven by availability of preferred prey.

Based on whaling data, the historical range of fin whales extended into the southern Sea of Okhotsk and Chukchi Sea. It was assumed that they passed through the Bering Strait into the southwestern Chukchi Sea during August and September. Many fin whales were taken as far west as Mys (Cape) Shmidta (68°55'N, 179°24'E) and as far north as 69°04'N, 171°06'W (Mizroch et al. 2009). Fin whale sightings have been increasing during surveys conducted in the U.S. portion of the northern Chukchi Sea from July to October (Funk et al. 2010, Aerts et al. 2012, Clarke et al. 2013, Brower et al. 2018) and fin whale calls were recorded each year from 2007 to 2010 in August and September in the northeastern Chukchi Sea (Delarue et al. 2013) and August to October just north of the Bering Strait (Tsujii et al. 2016), suggesting they may be re-occupying habitat used prior to large-scale commercial whaling. A comparison of data from aerial surveys that covered the same general areas between 1982 and 1991 and between 2008 and 2016 found no fin whale sightings in the earlier time period as compared to regular sightings of fin whales in the latter (Brower et al 2018). In part, this could be due to increased effort from 2008 to 2016; however, the combination of acoustic and visual data seem to support increasing numbers and extended seasonal residency of fin whales in the Alaska Arctic.

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous in winter, possibly isolated in summer; 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. Based on this limited information, the International Whaling Commission (IWC) considers fin whales in the North Pacific to all belong to the same stock (Mizroch et al. 1984), although Mizroch et al. (1984) cited additional evidence that supported the establishment of subpopulations in the North Pacific. Further, Fujino (1960) described eastern and western groups, which are mostly isolated with the exception of potential intermingling around the Aleutian Islands. Recoveries of Discovery tags (Rice 1974, Mizroch et al. 2009) indicate that animals wintering off the coast of southern California range from central California to the Gulf of Alaska during the summer months.

Mizroch et al. (2009) provided a comprehensive summary of whaling catch data, recovery of Discovery tags, and opportunistic sightings data and found evidence to suggest there may be at least six populations of fin whales: two that are migratory (eastern and western North Pacific) and two to four more that are resident year-round in peripheral seas such as the Gulf of California, East China Sea, Sanriku-Hokkaido, and possibly the Sea of Japan. It appears likely that the two migratory stocks mingle in the Bering Sea in July and August, rather than in the Aleutian Islands as Fujino (1960) previously concluded (Mizroch et al. 2009). During winter months, fin whales have been seen over a wide geographic area from 23°N to 60°N, but winter distribution and location of primary wintering areas (if any) are poorly known and need further study. As a result, stock structure of fin whales remains uncertain.

For management purposes, three stocks of fin whales are currently recognized in U.S. Pacific waters: 1) Alaska (Northeast Pacific) (Fig. 1), 2) California/Washington/Oregon, and 3) Hawaii. Mizroch et al. (2009) suggest that this structure should be reviewed and updated, if appropriate, to reflect recent analyses, but the absence of any substantial new data on stock structure makes this difficult. The California/Oregon/Washington and Hawaii fin whale stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

There are no reliable estimates of current and historical abundances for the entire Northeast Pacific fin whale stock. Several studies provide information on the distribution and occurrence of fin whales in the Northeast Pacific, as well as estimates of abundance in certain areas within the range of the stock, however, many of these are over a decade or more old.

Visual shipboard surveys for cetaceans were conducted on the eastern Bering Sea shelf during summer in 1997, 1999, 2000, 2002, 2004, 2008, and 2010 (Moore et al. 2000, 2002; Friday et al. 2012, 2013). These surveys were conducted in conjunction with the Alaska Fisheries Science Center (AFSC) echo-integrated trawl surveys for walleye pollock. The surveys covered 789 to 3,752 km of tracklines and observation effort for marine mammals varied according to the availability of observers during each cruise. Results of the surveys in 2002, 2008, and 2010, years when the entire AFSC pollock survey sampling area was surveyed (see Fig. 1), provided estimates of 419 (coefficient of variation (CV) = 0.33), 1,368 (CV = 0.34), and 1,061 (CV = 0.38) fin whales (Friday et al. 2013).

Dedicated line-transect cruises were conducted in coastal waters (as far as 85 km offshore) of western Alaska and the eastern and central Aleutian Islands in July and August from 2001 to 2003 (Zerbini et al. 2006). Over 9,053 km of tracklines were surveyed between the Kenai Peninsula (150°W) and Amchitka Pass (178°W). Fin whales (n = 276) were observed from east of Kodiak Island to Samalga Pass, with high aggregations recorded near the Semidi Islands. Zerbini et al. (2006) estimated that 1,652 fin whales (95% CI: 1,142-2,389) occurred in these areas between 2001 and 2003.

In 2013 and 2015, dedicated line-transect surveys of the offshore waters of the Gulf of Alaska recorded, respectively, 171 and 38 sightings of fin whales (Rone et al. 2017). These surveys provided fin whale abundance estimates of 3,168 fin whales (CV = 0.26) in 2013 and 916 (CV = 0.39) in 2015. The marked differences in these estimates can be partially explained by differences in sampling coverage across the two cruises (Rone et al. 2017).

Estimates of fin whale abundance in the eastern Bering Sea and in the Gulf of Alaska in any given year cannot be considered representative of the entire Northeast Pacific stock because the geographic coverage of surveys was limited relative to the range of the stock. In addition, these estimates have not been corrected for animals missed on the trackline, animals submerged when the ship passed, and responsive movement away from or towards the survey vessel. However, even though no data are available to compute correction factors, it is expected that these estimates are robust because previous studies have shown that these sources of bias are small for this species (Barlow 1995).

Minimum Population Estimate

Although the full range of the Northeast Pacific stock of fin whales in Alaska waters has not been surveyed, a rough estimate of the size of the population west of the Kenai Peninsula has been calculated in previous Stock Assessment Reports by summing the estimates from Moore et al. (2002) and Zerbini et al. (2006) (n = 5,700). However, based on analyses presented in Mizroch et al. (2009), whales surveyed in the Aleutians (Zerbini et al. 2006) could migrate northward and be counted during the Bering Sea surveys. There are also indications that fin whale distribution in the Bering Sea is related to oceanographic conditions and prey density (Stabeno et al. 2012, Friday et al. 2013, Zerbini et al. 2016), making it possible that whales could be double counted when estimates from different years are summed (Moore et al. 2002). Until recently, the best provisional estimate of the fin whale population west and north of the Kenai Peninsula in U.S. waters was 1,368 whales, the greater of the minimum estimates from the 2008 and 2010 surveys (Friday et al. 2013). However, the Gulf of Alaska surveys (Rone et al. 2017) are more recent. The higher of the two abundances computed for fin whales in this region, 3,168 whales (CV = 0.26), better represents a minimum abundance for the Northeast Pacific stock because it is more precise and because it represents a broader survey coverage. A minimum population estimate (N_{MIN}) for this stock can be calculated according to 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 best provisional estimate (N) of 3,168 from the 2013 survey and the associated CV(N) of 0.26 results in an N_{MIN} of 2,554 whales. However, this is an underestimate for the entire stock because it is based on surveys which covered only a small portion of the stock's range.

Current Population Trend

Zerbini et al. (2006) estimated rates of increase of fin whales in coastal waters south of the Alaska Peninsula (Kodiak and Shumagin Islands). An annual increase of 4.8% (95% CI: 4.1-5.4%) was estimated between 1987 and 2003. This estimate is the first available for North Pacific fin whales and is consistent with other estimates of population growth rates of large whales. It should be used with caution, however, due to uncertainties in the initial population estimate (in 1987) and due to uncertainties about the population structure of fin whales in the area. Also, the study represented only a small fraction of the range of the Northeast Pacific stock and it may not be appropriate to extrapolate this to a broader range.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Zerbini et al. (2006) estimated an annual increase of 4.8% (95% CI: 4.1-5.4%) between 1987 and 2003 for fin whales in coastal waters south of the Alaska Peninsula. However, there are uncertainties in the initial population estimate from 1987, as well as uncertainties regarding fin whale population structure in this area. Therefore, a reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Northeast Pacific fin whale stock. Until additional data become available, the default cetacean maximum theoretical net productivity rate of 4% will be used for this stock (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 0.1, the recommended value for cetacean stocks that are listed as endangered (NMFS 2016). Using the best provisional estimate of 3,168 (CV = 0.26) from the 2013 survey and the associated N_{MIN} of 2,554, PBR is calculated to be 5.1

fin whales (2,554 × 0.02 × 0.1). However, because the estimate of minimum abundance is for only a small portion of the stock's range, the calculated PBR is likely biased low for the entire Northeast Pacific fin whale stock.

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 and 2018 is listed, by marine mammal stock, in Young et al. (2020); 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 Northeast Pacific fin whales between 2014 and 2018 is 0.6 whales due to ship strikes. Ship strikes are a known threat for this stock and reductions in sea-ice coverage may lead to range extension and increased susceptibility to ship strikes from increased shipping in the Chukchi and Beaufort seas.

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).

No incidental mortality or serious injury of Northeast Pacific fin whales due to interactions with fisheries in Alaska waters was reported to the NMFS Alaska Region marine mammal stranding network between 2014 and 2018.

Table 1. Summary of mortality and serious injury of Northeast Pacific fin whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2014 and 2018 (Young et al. 2020).

Cause of injury	2014	2015	2016	2017	2018	Mean annual mortality
Ship strike	1	0	1	0	1	0.6
Total due to ship strikes						0.6

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska and Russia have not been reported to take fin whales from this stock.

Other Mortality

Between 1900 and 1999, 75,538 fin whales were reportedly killed in commercial whaling operations throughout the North Pacific (Rocha et al. 2014).

In 2015, increased mortality of large whales was observed along the western Gulf of Alaska (including the areas around Kodiak Island, Afognak Island, Chirikof Island, the Semidi Islands, and the southern shoreline of the Alaska Peninsula) and along the central British Columbia coast (from the northern tip of Haida Gwaii to southern Vancouver Island). NMFS declared an Unusual Mortality Event (UME) for large whales that occurred from 22 May to 31 December 2015 in the western Gulf of Alaska and from 23 April 2015 to 16 April 2016 in British Columbia (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). Forty-six large whale deaths attributed to the UME included 12 fin whales and 22 humpback whales in Alaska and 5 fin whales and 7 humpback whales in British Columbia. Based on the findings from the investigation, the UME was likely caused by ecological factors (i.e., the 2015 El Niño, Warm Water Blob, and Pacific Coast Domoic Acid Bloom).

Fin whale mortality due to ship strikes in Alaska waters was reported to the NMFS Alaska Region marine mammal stranding network in 2014, 2016, and 2018 (Young et al. 2020), resulting in a minimum mean annual mortality and serious injury rate of 0.6 fin whales due to ship strikes between 2014 and 2018 (Table 1).

STATUS OF STOCK

The fin whale is listed as endangered under the Endangered Species Act of 1973, and therefore designated as depleted under the MMPA. As a result, the Northeast Pacific stock is classified as a strategic stock. While estimates of the minimum population size and population trends are available for a portion of this stock, much of the

North Pacific range has not been surveyed. Therefore, the status of the stock relative to its Optimum Sustainable Population is not available. The minimum estimated mean annual level of human-caused mortality and serious injury for Northeast Pacific fin whales (0.6 whales) does not exceed the calculated PBR (5.1 whales). The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (0 whales) is less than 10% of the calculated PBR (10% of PBR = 0.5) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate.

There are key uncertainties in the assessment of the Northeast Pacific stock of fin whales. While a single stock of fin whales is currently recognized in the Northeast Pacific, fin whale acoustic data suggest that multiple stocks overlap in the Bering Sea. Little is known about the pelagic distribution of fin whales due to the lack of dedicated marine mammal survey effort in the Bering Sea and Gulf of Alaska. The calculated PBR level is likely biased low because only a portion of the range has been surveyed. A reliable estimate of the trend in abundance is not available for this stock.

HABITAT CONCERNS

Changes in ocean conditions that affect the seasonal distribution and quality of prey may affect fin whale movements, distribution, and foraging energetics. Ship strikes are a known source of mortality, and reductions in sea-ice coverage may lead to range extension and concomitant exposure to increased shipping and oil and gas activities in the Bering and Chukchi seas. Ocean warming may increase the frequency of algal blooms that produce biotoxins known to be associated with large whale mortality. However, few data are available to assess the likelihood or extent of such impacts.

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MINKE WHALE (*Balaenoptera acutorostrata*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the North Pacific Ocean, minke whales occur from the Bering and Chukchi seas south to near the Equator (Leatherwood et al. 1982). The following information was considered in classifying stock structure according to the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous; 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. Based on this limited information, in 1991 the International Whaling Commission (IWC) recognized three stocks of minke whales in the North Pacific: one in the Sea of Japan/East China Sea, one in the rest of the western Pacific west of 180°N, and one in the "remainder" of the Pacific (Donovan 1991). The "remainder" stock designation reflects the lack of exploitation in the eastern Pacific and does not indicate that only one population exists in this area (Donovan 1991). In the "remainder" area, minke whales are relatively common in the Bering and Chukchi seas and in the inshore waters of the Gulf of Alaska (Moore et al 2000, Friday et al. 2012, Clarke et al. 2013) but are not considered abundant in any other part of the eastern Pacific (Leatherwood et al. 1982, Brueggeman et al. 1990). Visual and acoustic data found minke whales in the Chukchi Sea north of Bering Strait in July and August (Clarke et al. 2013), and minke whale "boing" sounds have been detected in the northeast Chukchi Sea in August, October, and November (Delarue 2013). There are two types of geographically distinct boing sounds produced by minke whales in the North Pacific (Rankin and Barlow 2005). Those recorded in the Chukchi Sea matched "central Pacific" boing sounds leading the authors to hypothesize that minke whales from the Chukchi Sea might winter in the central North Pacific, not near Hawaii (Delarue et al. 2013).

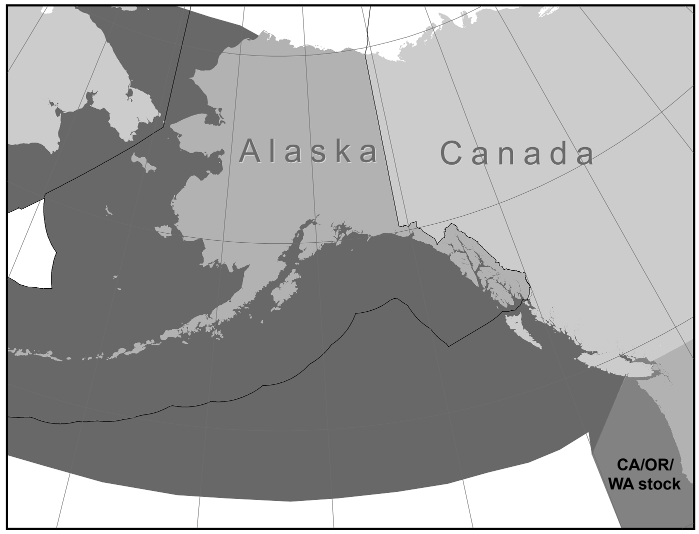

Figure 1. Approximate distribution of minke whales in the eastern North Pacific (dark shaded areas). The U.S. Exclusive Economic Zone is delineated by the solid black line.

Ship surveys on the eastern Bering Sea shelf in 1999, 2000, 2002, 2004, 2008, and 2010 resulted in new information about the distribution and relative abundance of minke whales in this area (Moore et al. 2002; Friday et al. 2012, 2013). When comparing distribution and abundance in years when the entire study area was surveyed (2002, 2008, and 2010), Friday et al. (2013) found that minke whales were scattered throughout the study area in all oceanographic domains (coastal, middle shelf, and outer shelf/slope) in 2002 and 2008 but were concentrated in the outer shelf and slope in 2010. The highest minke whale abundance in the study area occurred in 2010 and abundance was greater in cold years (2008 and 2010) than a warm year (2002); however, changes in abundance were thought to be due at least in part to changes in distribution (Friday et al. 2013).

So few minke whales were seen during three offshore Gulf of Alaska surveys for cetaceans in 2009, 2013, and 2015 that a population estimate for the species in this area could not be determined (Rone et al. 2017).

In the northern part of their range, minke whales are believed to be migratory, whereas, they appear to establish home ranges in the inland waters of Washington and along central California (Dorsey et al. 1990). Because the "resident" minke whales from California to Washington appear behaviorally distinct from migratory whales farther north, minke whales in Alaska are considered a separate stock from minke whales in California, Oregon, and Washington (Dorsey et al. 1990). Accordingly, two stocks of minke whales are recognized in U.S. waters: 1) Alaska, and 2) California/Washington/Oregon (Fig. 1). The California/Oregon/Washington minke whale stock is reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

No estimates have been made for the number of minke whales in the entire North Pacific. However, some information is available on the numbers of minke whales in some areas of Alaska. Visual surveys for cetaceans were conducted on the eastern Bering Sea shelf in 2002, 2008, and 2010 in cooperation with research on commercial fisheries (Friday et al. 2013). The surveys included 3,752 km, 3,253 km, and 1,638 km of effort in 2002, 2008, and 2010, respectively. Results of the surveys in 2002, 2008, and 2010 provide provisional abundance estimates of 389 (CV = 0.52), 517 (CV = 0.69), and 2,020 (CV = 0.73) minke whales on the eastern Bering Sea shelf, respectively (Friday et al. 2013). These estimates are considered provisional because they have not been corrected for animals missed on the trackline, animals submerged when the ship passed, or responsive movement. Additionally, line-transect surveys were conducted in shelf and nearshore waters (within 30-45 nautical miles of land) in 2001-2003 from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands. Minke whale abundance was estimated to be 1,233 (CV = 0.34) for this area (Zerbini et al. 2006). This estimate has also not been corrected for animals missed on the trackline. The majority of the sightings were in the Aleutian Islands, rather than in the Gulf of Alaska, and in water shallower than 200 m. So few minke whales were seen during three offshore Gulf of Alaska surveys for cetaceans in 2009, 2013, and 2015 that a population estimate for the species in this area could not be determined (Rone et al. 2017). These estimates cannot be used as an estimate of the entire Alaska stock of minke whales because only a portion of the stock's range was surveyed.

Minimum Population

It is not possible to produce a reliable estimate of minimum abundance for this stock, as current estimates of abundance are not available.

Current Population Trend

There are no data on trends in minke whale abundance in Alaska waters.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of minke whale populations in the North Pacific (Best 1993). Until additional data become available, the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% will be used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. Given the status of this stock is unknown, the appropriate recovery factor (F_R) is 0.5 (Wade and Angliss 1997). However, because an estimate of minimum abundance is not available, the PBR for the Alaska minke whale stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2012-2016 is listed, by marine mammal stock, in Helker et al. (in press); 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 Alaska minke whales in 2012-2016 is zero.

Fisheries Information

Information on U.S. commercial fisheries in Alaska waters (including observer programs, observer coverage, and observed incidental takes of marine mammals) is presented in Appendices 3-6 of the Alaska Stock Assessment Reports.

No mortality or serious injury of minke whales was observed in U.S. commercial fisheries in 2012-2016 (Breiwick 2013; MML, unpubl data).

Alaska Native Subsistence/Harvest Information

No minke whales were ever taken by the modern shore-based whale fishery in the eastern North Pacific, which lasted from 1905 to 1971 (Rice 1974). Subsistence takes of minke whales by Alaska Natives are rare but have been known to occur. Only seven minke whales are reported to have been taken for subsistence by Alaska Natives between 1930 and 1987 (C. Allison, International Whaling Commission, UK, pers. comm.). The most recent reported catches (two whales) in Alaska occurred in 1989 (Anonymous 1991), but reporting is likely incomplete. Based on this information, the average annual subsistence take was zero minke whales in 2012-2016.

Other Mortality

From 2012 to 2016, no human-related mortality or serious injury of minke whales was reported to the NMFS Alaska Region stranding network (Helker et al. in press).

STATUS OF STOCK

Minke whales are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. The abundance estimate for this stock is unknown and, thus, PBR is unknown. However, because minke whales are considered common in the waters off Alaska and human-caused mortality and serious injury is thought to be minimal, this stock is presumed to be a non-strategic stock. Because the PBR is unknown, the mean annual U.S. commercial fishery-related mortality and serious injury rate that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. 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 minke whales. The greatest uncertainty is the stock structure of this species in the eastern North Pacific. Differences in abundance in warm and cold years on the eastern Bering Sea shelf (due at least in part to changes in distribution) are an additional source of uncertainty. Reliable estimates of the minimum population size, population trends, and PBR are not available.

HABITAT CONCERNS

Potential concerns include elevated levels of sound from anthropogenic sources (e.g., shipping, military sonars), possible changes in prey distribution with climate change, entanglement in fishing gear, ship strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes), and oil and gas activities.

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NORTH PACIFIC RIGHT WHALE (*Eubalaena japonica*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

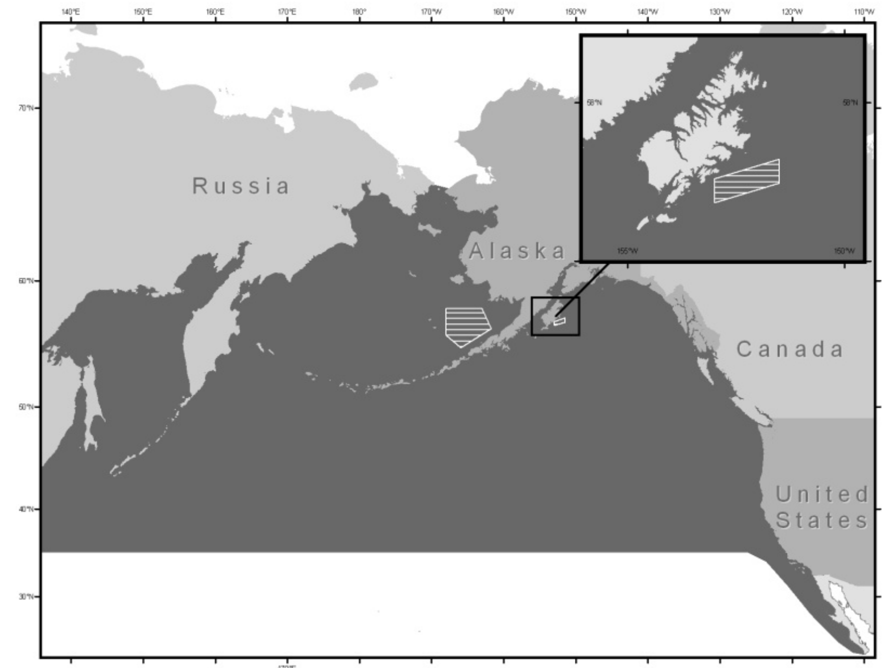

Figure 1. Approximate historical distribution of North Pacific right whales in the North Pacific (dark shaded area). Striped areas indicate North Pacific right whale critical habitat (73 FR 19000, 8 April 2008).

Once distributed widely across the North Pacific from North America to the Far East, North Pacific right whales (*Eubalaena japonica*) are today among the world's rarest marine mammals (Wade et al. 2011). A distinct geographic distribution, different catch and recovery histories, and recent genetic analysis have led to the generally accepted belief that the species comprises eastern and western populations that are largely or wholly discrete (Brownell et al. 2001, LeDuc et al. 2012, Pastene et al. 2022). The summer range of the eastern stock includes the Gulf of Alaska and the Bering Sea, while the western stock is believed to feed in the Okhotsk Sea and in pelagic waters of the northwestern North Pacific. The winter calving grounds of both stocks remain unknown.

Right whales were the subject of intensive commercial exploitation, beginning in the Gulf of Alaska in 1835, and by 1849 were already seriously depleted in the eastern Pacific (Scarff 1986, 1991; Josephson et al. 2008). Additional hunting in the 1850s reduced the population in the western Pacific, and by 1900 the species was effectively considered commercially extinct throughout its range. Although there were sporadic opportunistic catches in the early 20th century, the stock was likely undergoing a modest recovery by about 1960; however, this was entirely negated by large illegal catches by the U.S.S.R. in the 1960s, which likely wiped out the bulk of the eastern population (Ivashchenko and Clapham 2012, Ivashchenko et al. 2017).

Analysis of whaling records from the 19th century, together with the more recent Soviet catches, has shown that right whales were broadly distributed across the eastern North Pacific (Scarff 1986, Brownell et al. 2001, Ivashchenko and Clapham 2012). There are sporadic records from below 20°N, but the bulk of the data show right whales concentrated north of 35°N. This includes coastal and offshore waters ranging from Washington State and British Columbia through the Gulf of Alaska, Alaska Peninsula, Aleutian Islands, and Bering Sea.

Modern information on the summer and autumn distribution of right whales has been derived from dedicated vessel and aerial surveys, bottom-mounted acoustic recorders, and vessel surveys for fisheries ecology and management that have also included dedicated marine mammal observers. Aerial and vessel surveys for right whales (LeDuc et al. 2001, Wade et al. 2006, Clapham et al. 2013, Matsuoka et al. 2021) have occurred in a portion of the southeastern Bering Sea (Fig. 1) where right whales have been observed or acoustically detected in most summers since 1996 (Goddard and Rugh 1998, Munger et al. 2008, Rone et al. 2012, Wright 2017). North Pacific right whales have been observed consistently in this area, although it is clear from historical and Japanese sighting survey data (Fig. 2) that right whales often range outside this area and occur elsewhere in the Bering Sea (Scarff 1986, Moore et al. 2000, 2002; LeDuc et al. 2001; Clapham et al. 2004; Matsuoka et al. 2021). Because of the paucity of right whales in the eastern North Pacific, sightings today are relatively rare and are often of single individuals (Fig. 2). In the summer of 2017, however, the International Whaling Commission's (IWC) Pacific Ocean Whale and Ecosystem Research (POWER) survey used a combination of passive acoustic monitoring and visual sightings to find 12 right whales in the southeastern Bering Sea (Matsuoka et al. 2021). The majority of these sightings (7 of 12 animals) were in Bristol Bay approximately 60 nmi east of the North Pacific right whale critical habitat, with others in the critical habitat itself. Three additional right whales were sighted during the 2018 IWC POWER survey (Matsuoka et al. 2021). Two were within the critical habitat, while the third was sighted approximately 5 nmi south of St. Lawrence Island, in the northern Bering Sea.

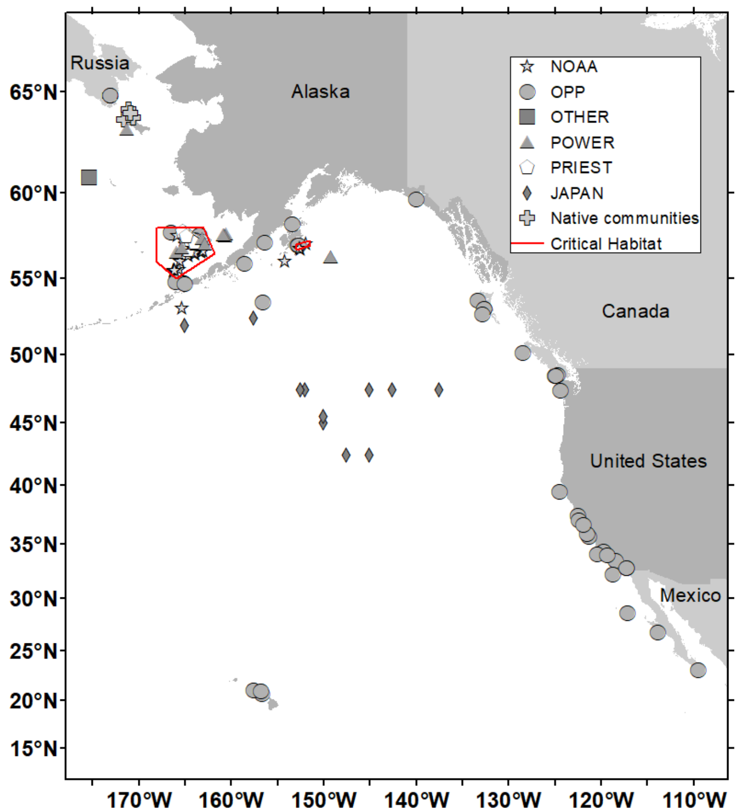

Figure 2. Location of all Eastern North Pacific right whale sightings in the North Pacific by platform since 1970. PRIEST = BOEM-NOAA (Pacific RIght whale Ecology STudy) survey (2007-2010); NOAA = other NOAA surveys (1998-2021); POWER = IWC's Pacific Ocean Whale and Ecosystem Research survey (2012, 2017-2018); OPP = opportunistic sighting reports, including those documented in MML's Platforms of Opportunity database (1973-2023); Japan = Japanese sighting survey (1973-1979); Other = Bering Sea (Navarin Basin) survey (Brueggeman et al. 1984).

Bottom-mounted acoustic recorders were deployed in the southeastern Bering Sea (2000-present) and the northern Gulf of Alaska (1999-2001, 2019-present) to document the seasonal distribution of right whale calls. Analysis of the data from those recorders supports the survey data and shows that right whales remain in the southeastern Bering Sea from May through December with peak call detection in September (Mellinger et al. 2004, Munger et al. 2008, Stafford and Mellinger 2009, Stafford et al. 2010, Clapham et al. 2013, Wright 2017, Wright et al. 2019). Recorders deployed by the Alaska Fisheries Science Center's Marine Mammal Laboratory indicated that North Pacific right whales occurred in two passes of the eastern Aleutian Islands (Umnak and Unimak Pass) (Wright 2017, Wright et al. 2018). No North Pacific right whale calls were detected from January to April in the southeastern Bering Sea, which supports the theory that North Pacific right whales migrate out of the Bering Sea during winter months (Wright 2017). However, a recent sighting of two skim-feeding North Pacific right whales in February 2022 just north of Unimak Pass is the first photographic evidence of overwintering by this species in the Bering Sea.

There continues to be debate regarding the northern extent of the right whale's range, specifically whether they once commonly occurred in the northern Bering Sea and north of the Bering Strait. Records from historical whaling in such areas are often compromised by uncertainty regarding whether these could have been bowhead whales; the extent of overlap between the two species remains unclear. In recent years, there have been a few reliable records of right whales in this region: an individual right whale was visually identified north of St. Lawrence Island in November 2012, an individual was sighted on 26 June 2018 by hunters off of St. Lawrence Island on the northeast side of Sivuqaq mountain and on 15 May 2019 about 37 nmi northwest of Savoonga (G. Sheffield, University of Alaska Fairbanks, Nome, AK), and the IWC POWER cruise recorded a single right whale just south of St. Lawrence in July 2018 (Matsuoka et al. 2021). This latter individual was subsequently observed and photographed by an ecotourism cruise in Pengkingney Fjord in Russian waters just south of the Bering Strait (Filatova et al. 2019). Passive acoustic monitoring from 2008 to 2016 of the northern Bering Sea detected calls matching the North Pacific right whale up-call criterion in late fall through spring only in 2016 (Wright et al. 2019). It remains unknown whether these recent northern detections and sightings represent a reoccupation of their historical distribution or a northward shift in their distribution.

There have been far fewer sightings of right whales in the Gulf of Alaska than in the Bering Sea (Brownell et al. 2001); although, until the summer of 2015, survey effort was lacking in the Gulf, notably in the offshore areas where right whales commonly occurred during whaling days (Ivashchenko and Clapham 2012). Nonetheless, sightings in the Gulf of Alaska since the cessation of whaling are extremely rare (Fig. 2), and there have been only a few acoustic detections (Mellinger et al. 2004, Širović et al. 2015).

Four separate surveys have occurred in the Gulf of Alaska in the summer. In summer 2013, the U.S. Navy-funded Gulf of Alaska Line-Transect Survey (GOALS-II) surveyed for marine mammals within the Temporary Maritime Activities Area (TMAA) using visual line-transect methods and passive acoustic monitoring (Rone et al. 2014). In August 2015, a dedicated vessel survey for right whales was conducted by NMFS using visual and acoustic survey techniques, surveying both the shelf and deeper waters to the south (Rone et al. 2017). In summer 2019, the IWC POWER cruise systematically surveyed the northern Gulf of Alaska, within the U.S. Exclusive Economic Zone, from Umnak Pass in the Aleutian Islands to the Canadian border in the eastern North Pacific (Matsuoka et al. 2020). In all three surveys, right whales were acoustically detected in the Barnabas Trough area off Kodiak Island, but were not visually observed. However, in summer 2021, the Pacific Marine Assessment Program for Protected Species (PacMAPPS) cruise surveyed the shelf and slope of the northern Gulf of Alaska, from the west side of Kodiak Island to Kayak Island near Chugach, Alaska. Four North Pacific right whales were sighted during this survey, two in Barnabas Trough near the southern end of the critical habitat and two near the Trinity Islands to the southwest of Kodiak Island (Crance et al. 2022). One of the individuals sighted in Barnabas Trough was matched to an animal that was seen by Canada's Department of Fisheries and Oceans (DFO) off Haida Gwaii in British Columbia on 12 June earlier that year (Little 2021), which marks the first time a North Pacific right whale has been initially sighted in British Columbia and then resighted elsewhere.

Most of the illegal Soviet catches of right whales occurred in offshore areas, including a large area to the east and southeast of Kodiak Island (Doroshenko 2000, Ivashchenko and Clapham 2012); the Soviet catch distribution closely parallels that seen in plots of 19th-century American whaling catches by Townsend (1935). Whether this region remains an important habitat for this species is currently unknown. The recent PacMAPPS sightings and acoustic detection of right whales in coastal waters east of Kodiak Island indicate at least occasional use of this area; however, the lack of visual detections of right whales during the GOALS-II cruise in July 2013, the NMFS cruise in August 2015, and the IWC POWER cruise in 2019 adds to the concern that right whales may today be extremely rare in the Gulf of Alaska. To date, there have been no matches of photographically identified individuals between the Gulf of Alaska and the Bering Sea, and there is no information to address the question of whether these regions are connected or whether they form largely separate subpopulations.

As noted above, the location of winter calving grounds for North Pacific right whales has long been a mystery. North Atlantic (*E. glacialis*) and Southern Hemisphere (*E. australis*) right whales calve in coastal waters during the winter months. However, in the eastern North Pacific no such calving grounds have been identified (Scarff 1986). Migratory patterns of North Pacific right whales are unknown, although it is thought they migrate from high-latitude feeding grounds in summer to more temperate waters during the winter, possibly including offshore waters (Braham and Rice 1984, Scarff 1986, Clapham et al. 2004). A right whale sighted off Maui in April 1996 (Salden and Michelsen 1999) was identified 119 days later and 4,111 km north in the Bering Sea (Kennedy et al. 2011); to date this is the only low- to high-latitude match of an individually identified right whale in the eastern North Pacific. There is one other modern record from Hawaii of a right whale, an animal seen twice in March and April 1979 (Herman et al. 1980, Rowntree et al. 1980) (Fig. 2).

Although there were a handful of sightings of right whales in the eastern North Pacific from Japanese sighting surveys in the 1970s (Fig. 2), sightings in that area since then have been extremely rare. Two sightings of individual right whales occurred off British Columbia in 2013, one in June and one in October (Ford et al. 2016). The two different individuals represent the first right whale sightings in Canadian waters since the 1950s. Another right whale sighting was made by the Canadian Coast Guard in the same area in June 2018. Most recently, a right whale was sighted off Vancouver Island in May 2020, and another was sighted off Haida Gwaii in June 2021. The timing of these sightings lends support to the theory that right whales migrate to more temperate waters during the winter.

Occasional sightings of right whales have been made off California and off Baja California, Mexico (Fig. 2); this includes two recent records from California in 2017 (off La Jolla and in the Channel Islands, both of which were single whales) as well as a sighting of a single skim-feeding right whale off Año Nuevo, CA in April 2022 and an animal in Monterey Bay in March 2023. While the scarcity of records from this region superficially suggests (as did Brownell et al. 2001) that it lacked historical importance for the species, this ignores the fact that right whales had been severely depleted in their feeding grounds prior to 1854, when the first coastal whaling station was established in California. It remains possible that California and Mexico, and possibly offshore waters of Hawaii, were once the principal calving grounds for right whales from the Gulf of Alaska and Bering Sea.

The following information was considered in classifying stock structure according to the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: distinct geographic distribution; 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: evidence for some isolation of populations. Based on this limited information, two transboundary stocks of North Pacific right whales are currently recognized: a Western North Pacific stock (feeding primarily in the Sea of Okhotsk) and an Eastern North Pacific stock (feeding primarily in the southeastern Bering Sea) (Rosenbaum et al. 2000, Brownell et al. 2001, LeDuc et al. 2012, Pastene et al. 2022).

In summary, the range of the right whale in the North Pacific was historically broad, with feeding grounds in the Bering Sea, Gulf of Alaska, Okhotsk Sea, and northwestern North Pacific; all of these areas remain inhabited today from May to December.

POPULATION SIZE

The historical (pre-whaling) population size of the North Pacific right whale is unknown. However, Scarff (1991) estimated that 26,500 to 37,000 animals were killed during the period from 1839 to 1909, with the majority being taken in a single decade (1840 to 1849). The U.S.S.R. illegally killed an estimated 771 right whales in the eastern and western North Pacific, with the majority (662) killed between 1962 and 1968 (Ivashchenko et al. 2017). These takes severely impacted the two populations concerned, notably in the east (Ivashchenko and Clapham 2012, Ivashchenko et al. 2013). Of the 662 right whales killed in the 1960s, 517 were taken in the eastern North Pacific, including 366 in the Gulf of Alaska, 31 in the Aleutian Islands, 116 in the Bering Sea, and 4 in unspecified pelagic waters (Ivashchenko et al. 2013).

Earlier estimates of population size were at best speculative. Based on sighting data, Wada (1973) estimated a total population of 100-200 right whales in the North Pacific in 1970. Rice (1974) stated that only a few individuals remained in the Eastern North Pacific stock and that for all practical purposes the stock was extinct because no sightings of a mature female with a calf had been confirmed since 1900. However, various sightings made since 1996 have invalidated this view (Wade et al. 2006, Zerbini et al. 2015, Ford et al. 2016, Matsuoka et al. 2021). Brownell et al. (2001) suggested from a review of sighting records that the abundance of this species in the western North Pacific was likely in the "low hundreds," including the population in the Sea of Okhotsk.

The North Pacific Right Whale Photo-identification Catalogue currently contains a minimum of 30 confirmed unique individual whales from the eastern North Pacific. Since 2017, 28 right whales have been sighted, 18 of which have been photographically identified to individuals. Of the 18 identified, 8 animals were confirmed new and added to the catalog and 10 were matched to previously known individuals (Matsuoka et al. 2021). Fifteen animals were sighted in 2017: 12 in the Bering Sea (8 matched, 2 confirmed new, 2 unconfirmed new), 1 near Kodiak, 1 in the Channel Islands (confirmed new), and 1 near La Jolla, CA. Four were sighted in 2018 in the Bering Sea (1 matched, 2 confirmed new, 1 not identified). One right whale was sighted near St. Lawrence Island in 2019, and one right whale was sighted in 2020 off Vancouver Island; neither was identified. Four were sighted in 2021 in the Gulf of Alaska: 1 matched and 3 confirmed new (one of which was first sighted off British Columbia by DFO a month prior). Three right whales were sighted in 2022: 2 near Unimak Pass, Aleutian Islands and 1 off Año Nuevo, CA. A single whale was seen in Monterey Bay, CA, in 2023.

LeDuc et al. (2012) analyzed 49 biopsy samples from 24 individual right whales, all but one of which were from the eastern North Pacific. The analysis revealed a male-biased sex ratio and a loss of genetic diversity that appeared to be midway between that observed for right whales in the North Atlantic and the Southern Hemisphere. The analysis also suggested a degree of separation between eastern and western populations, a male:female ratio of 2:1, and a low effective population size for the Eastern North Pacific stock, which LeDuc et al. (2012) considered to be at "extreme risk" of extirpation. Six biopsy samples were obtained from right whales in the Bering Sea during the IWC POWER cruises (3 in 2017, 3 in 2018), all from individuals of previously unknown sex. None were obtained during the 2019 or 2021 cruises. Of the six whales sampled, five were male and only one was female. In 2022, Pastene et al. re-analyzed all genetic samples, including those from the 2012 LeDuc study. After removing duplicates, 32 individual eastern North Pacific right whale samples were included. For the eastern stock, the proportion of males was 0.75, indicating a higher (3:1) male-biased sex ratio than LeDuc's 2:1 (Pastene et al. 2022). However, despite the high proportion of males and the extremely low population size, the eastern stock showed relatively high genetic diversity (Pastene et al. 2022). Finally, the results of the Pastene et al. study confirmed that the two populations of North Pacific right whales are genetically distinct. .

The only recent estimate of abundance comes from mark-recapture analyses of photo-identification and genetic data. Photographic (18 identified individuals) and genotype (21 identified individuals) data through 2008 were used to calculate the first mark-recapture estimates of abundance for right whales in the Bering Sea and Aleutian Islands, resulting in separate estimates of 31 (95% CL: 23-54; CV = 0.226) and 28 (95% CL: 24-42), respectively (Wade et al. 2011). The abundance estimates are for the last year of each study, corresponding to 2008 for the photo-identification estimate and 2004 for the genetic identification estimate. Wade et al. (2011) also estimated that the population consisted of 8 females (95% CL: 7-18) and 20 males (95% CL: 17-37).

The Wade et al. (2011) estimates may relate to a subpopulation that uses the Bering Sea; there is no estimate for right whales in the Gulf of Alaska, and to date there have been no photo-identification matches between the two regions. Consequently, the total size of the Eastern North Pacific population may be somewhat higher than the Wade et al. (2011) estimates. However, given the extreme paucity of sightings in the Gulf of Alaska, it seems unlikely that the overall abundance is significantly larger.

Minimum Population Estimate

The minimum estimate of abundance (N_{MIN}) of Eastern North Pacific right whales is 26 whales based on the 20th percentile of the photo-identification estimate of 31 whales (CV = 0.226: Wade et al. 2011). This estimate is more than 10 years old. However, given that the stock has an extremely low abundance, very low calf production, and no known anthropogenic mortality or serious injuryit seems unlikely that the current abundance is significantly different.

Current Population Trend

Due to a low resighting rate and the extremely low population size, no estimate of trend in abundance is available for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Due to insufficient information, the default cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% is used for this stock (NMFS 2023). However, given the small apparent size, male bias, and very low calf production in this population, this rate is likely to be unrealistically high.

POTENTIAL BIOLOGICAL REMOVAL

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 recommended value for cetacean stocks which are listed as endangered (NMFS 2023). A reliable estimate of N_{MIN} for this stock is 26 whales based on the mark-recapture estimate of 31 whales (CV = 0.226: Wade et al. 2011). The calculated PBR level for this stock is therefore 0.05 (26 × 0.02 × 0.1), which would be equivalent to one take every 20 years. However, the male bias likely results in lower than expected calf production and, thus, this PBR could be overestimated.

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 2017 and 2021 is listed, by marine mammal stock, in Freed et al. (2023); however, only the mortality and serious injury data are included in the Stock Assessment Reports. No human-caused mortality or serious injury of Eastern North Pacific right whales was reported between 2017 and 2021; although, given the remote nature of the known and likely habitats of North Pacific right whales, it is very unlikely that any mortality or serious injury in this population would be observed. Consequently, it is possible that the current absence of reported mortality or serious injury due to entanglement in fishing gear, vessel strikes, or other anthropogenic causes (e.g., oil spills) is not a reflection of the true situation.

Fisheries Information

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2024).

There are no historical reports of fisheries-caused mortality or serious injury of Eastern North Pacific right whales. However, given what we know about susceptibility of other large whales to fisheries-caused mortality and serious injury in the eastern North Pacific and elsewhere, potential for such interactions with North Pacific right whales almost certainly exists. Entanglement in fishing gear, including lobster pot and sink gillnet gear, is a significant source of mortality and serious injury for North Atlantic right whales (Knowlton et al. 2022). Mortality and serious injury of humpback, fin, gray, and bowhead whales in a variety of gear types, including trawl, gillnet, and pot gear has been documented (Muto et al. 2022, Carretta et al. 2022, George et al. 2017). While much of the Alaska and U.S. West Coast trawl fleet has observer coverage, several gillnet fisheries and pot fisheries in the range of Eastern North Pacific right whales do not. Therefore, the potential for fisheries-caused mortality and serious injury may be greater than is reflected in existing observer data.

Right whales, presumably from the Western North Pacific population, have suffered fisheries-caused mortality or serious injury. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989 (Kornev 1994). The Marine Mammal Commission reported that in February 2015, a young right whale was found entangled in aquaculture gear in South Korea; much of the gear was cut off, but the whale's fate is unknown. In October 2016, an entangled right whale was reported to have died while being disentangled in Volcano Bay, Hokkaido, Japan. And in July 2018, fishermen in the Sea of Okhotsk took video of a right whale that was entangled in the rope of a crab pot but later freed itself. No other incidental takes of right whales are known to have occurred in the North Pacific, although two photographs from the North Pacific Right Whale Photo-identification Catalogue show possible fishing gear entanglement (A. Kennedy, NMFS-AFSC-MML, pers. comm., 21 September 2011; Ford et al. 2016). The right whale photographed on 25 October 2013 off British Columbia and northern Washington State showed evidence of probable fishing gear entanglement (Ford et al. 2016). Given the very small estimate of abundance, any mortality or serious injury incidental to commercial fisheries would be considered significant.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska and Russia do not hunt animals from this stock.

Other Mortality

Vessel strikes are considered one of the primary sources of human-caused mortality and serious injury of right whales in the North Atlantic (Cole et al. 2005; Henry et al. 2012, 2019; Hayes et al. 2018), and it is likely that right whales in the North Pacific are also vulnerable to this source of mortality. However, due to their rare occurrence and scattered distribution, it is not currently possible to assess the threat of vessel strikes to the Eastern North Pacific stock of right whales. There is concern that increased shipping through Arctic waters and the Bering Sea, with retreating sea ice, may increase the potential risk to right whales from shipping.

Overall, given the remote nature of the known and likely habitats of North Pacific right whales, it is very unlikely that any mortality or serious injury in this population would be observed. Consequently, it is possible that the current absence of reported vessel-strike-related or other anthropogenic mortality or serious injury in this stock is not a reflection of the true situation.

STATUS OF STOCK

The right whale is listed as endangered under the Endangered Species Act of 1973, and therefore designated as depleted under the Marine Mammal Protection Act. In 2008, NMFS relisted the North Pacific right whale as endangered as a separate species (*Eubalaena japonica*) from the North Atlantic species, *E. glacialis* (73 FR 12024, 06 March 2008). As a result, the stock is classified as a strategic stock. The abundance of this stock is considered to represent only a small fraction of its pre-commercial whaling abundance, i.e., the stock is well below its Optimum Sustainable Population (OSP). The minimum estimated mean annual level of human-caused mortality and serious injury is unknown for this stock. The reason(s) for the apparent lack of recovery for this stock is (are) also unknown. Brownell et al. (2001) and Ivashchenko and Clapham (2012) noted the devastating impact of extensive illegal Soviet catches in the eastern North Pacific in the 1960s, and both suggested that the prognosis for right whales in this area was poor. Biologists working aboard the Soviet factory ships that killed right whales in the eastern North Pacific in the 1960s considered that the fleets had caught close to 100% of the animals they encountered (Ivashchenko and Clapham 2012); accordingly, it is quite possible that the Soviets killed the great majority of the animals in the population at that time. In its review of the status of right whales worldwide, the IWC expressed "considerable concern" over the status of this population (IWC 2001). A genetic analysis of biopsy samples from North Pacific right whales found low frequencies of females and calves, extremely low effective population size, and genetic isolation from conspecifics in the western Pacific indicating that right whales in the eastern North Pacific are in severe danger of immediate extirpation from the eastern North Pacific (LeDuc et al. 2012, Pastene et al. 2022).

There are key uncertainties in the assessment of the Eastern North Pacific stock of North Pacific right whales. The abundance of this stock is critically low and migration patterns, calving grounds, and breeding grounds are not well known. There appear to be three times more males than females in the population and calf production is very low (Pastene et al. 2022). PBR is designed to allow stocks to recover to, or remain above, the maximum net productivity level (MNPL) (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 OSP, and that some surplus growth could be removed while still allowing recovery. However, the Eastern North Pacific right whale population is far below historical levels and at a very small population size, and small populations can have different dynamics than larger populations from Allee effects and stochastic dynamics. Although there is currently no known direct human-caused mortality, given the small number of animals estimated to be in the population, any human-caused mortality or serious injury from vessel strikes or commercial fisheries is likely to have a serious population-level impact.

OTHER FACTORS THAT MAY BE CAUSING A DECLINE OR IMPEDING RECOVERY

NMFS conducted an analysis of right whale distribution in historical times and in more recent years and stated that principal habitat requirements for right whales are dense concentrations of prey (Clapham et al. 2006) and, on this basis, proposed two areas of critical habitat: one in the southeastern Bering Sea and another south of Kodiak Island (70 FR 66332, 2 November 2005). In 2006, NMFS issued a final rule designating these two areas as northern right whale critical habitat, one in the Gulf of Alaska and one in the Bering Sea (71 FR 38277, 6 July 2006; Fig. 1). In 2008, NMFS redesignated the same two areas as Eastern North Pacific right whale critical habitat under the newly recognized species name, *E. japonica* (73 FR 19000, 8 April 2008; Fig. 1).

Potential threats to the habitat of this population derive primarily from commercial shipping and fishing vessel activity. There is considerable fishing activity within portions of the critical habitat of this species, increasing the risk of entanglement. However, photographs of right whales in the eastern North Pacific to date have shown little evidence of entanglement scars; the sole exception is the animal photographed in the Strait of Juan de Fuca in October 2013 (Ford et al. 2016). Unimak Pass is a choke-point for shipping traffic between North America and Asia, with shipping density and risk of an accidental spill highest in the summer (Renner and Kuletz 2015), a time when right whales are believed to be present (Wright et al. 2018). The high volume of large vessels transiting Unimak Pass (e.g., 7,803 voyages through Unimak Pass by vessels larger than 400 gross tons from 2014-2018; Sullender et al. 2021), a subset of which continue north through the Bering Sea, increases both the risk of vessel strikes and the risk of a large or very large oil spill in areas in which right whales may occur. The risk of accidents in Unimak Pass, specifically, is predicted to increase in the coming decades, and studies indicate that more accidents are likely to involve container vessels (Wolniakowski et al. 2011).

Past offshore oil and gas leasing has occurred in the Gulf of Alaska and Bering Sea in the northern areas of known right whale habitat. In 2018, the Bureau of Ocean Energy Management (BOEM) proposed an Outer Continental Shelf leasing plan for 2019-2024 that included oil and gas lease sales for the Aleutian Basin and Aleutian Arc in 2023, but those areas were subsequently removed from consideration. BOEM's final lease sale schedule for 2024-2029 does not include any lease sales in Alaska. It is noteworthy that two tagged right whales were observed to briefly visit the North Aleutian Basin area, one in 2004 and one in 2009 (Zerbini et al. 2015). The development of oil fields off Sakhalin Island in Russia is occurring within habitat of the western North Pacific population of right whales (NMFS 2006). However, no oil exploration or production is currently underway in offshore areas of the Bering Sea or Gulf of Alaska, and no lease sales are currently scheduled to occur in those areas (excepting Cook Inlet). The possibility remains that there will be lease sales in these areas in the future, even though no discoveries have yet been announced and most leases have not contained commercially viable deposits (NMFS 2006). However, in Cook Inlet, lease sales are ongoing (the most recent federal sale under the existing 2017-2022 leasing plan occurred in December 2022 and state sales currently occur annually) and exploration activity is occurring in both state and federal waters. BOEM (2016) conducted an oil spill model for lower Cook Inlet that suggested if a very large oil spill occurs in offshore waters it will impact right whale habitat around Kodiak Island and along the Alaska Peninsula. Although there is currently no oil and gas activity in the Alaska Chukchi Sea, oil exploration and production is ongoing in the Beaufort Sea, and this will likely include an increased level of associated vessel traffic through the Bering Sea en route to and from the Arctic, which could increase risks to right whales from vessel strikes.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

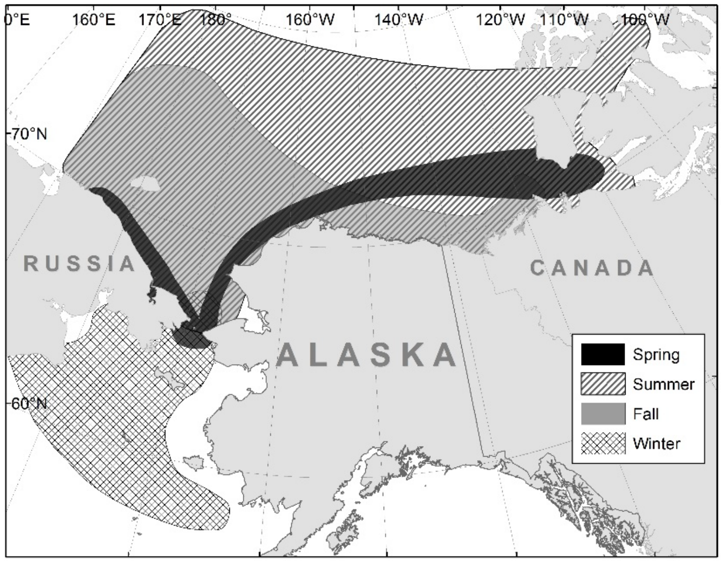

Figure 1. Annual range of the Western Arctic stock of bowhead whales by season from satellite tracking data, 2006-2017 (map based on Quakenbush et al. (2018): Fig. 2).

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, Vacquié-Garcia et al. 2017). 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 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 Seas 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 Western Arctic bowhead whale stock that migrates throughout waters of northern and western Alaska and northeastern Russia (IWC 2008, 2018).

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. 2010, 2018; Citta et al. 2015). During winter and spring, bowhead whales are closely associated with sea ice (Moore and Reeves 1993, Quakenbush et al. 2010, 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 where industrial activity related to petroleum exploration often occurs (e.g., Richardson et al. 1987, Davies 1997). Summer aerial surveys conducted in the western Beaufort Sea during July and August of 2012-2019 have had relatively high sighting rates of bowhead whales, including cows with calves and feeding animals, in some years and within localized areas within the western Beaufort Sea (Clarke et al. 2018a, 2018b, 2022), 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, and although there is interannual variability, the migration appears to be occurring later (Citta et al. 2018, Clarke et al. 2018b, Stafford et al. 2021). 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). 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. 2010, Citta et al. 2015).

This stock assessment report assesses the abundance and Alaska Native subsistence harvest of Western Arctic bowhead whales throughout the transboundary stock's entire geographic range. Human-caused mortality and serious injury, other than Alaska 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 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 Aboriginal Whaling Scheme (IWC 2018) requires that abundance estimates be updated at least 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. More recent satellite tagging data also indicate that only a small proportion (~4%) of the population migrates to Chukotka in spring (Quakenbush and Citta 2019).

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 1). These population estimates and their associated errors (Raftery and Zeh 1998, Schweder et al. 2009, Koski et al. 2010) are comparable to the estimates obtained from the combined ice-based visual and acoustic counts. 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 1). However, because the 2011 ice-based estimate had a lower coefficient of variation (CV) than the estimate derived from the aerial photographs, the IWC Scientific Committee considered the ice based estimate the most appropriate for management and use in the SLA (IWC 2018).

In 2019, a spring ice-based visual survey and a summer aerial line-transect survey were conducted to provide independent estimates of abundance. For the 2019 ice-based survey, Givens et al. (2021b) presented an estimate of abundance of 14,025 whales (CV=0.228; Table 1), which included a new correction factor to account for disturbance to the migration from powered skiffs. Givens et al. (2021b) acknowledged that this estimate is likely biased low due to numerous factors, including closed leads in the sea ice that inhibited survey effort early in the migration;

unprecedented wide leads later in the migration that resulted in an unusual migration route that was sometimes too distant from observers to detect whales; and an unusually short observation platform compared to previous surveys. The 2019 aerial line-transect survey data were analyzed using a spatially-explicit density surface model, resulting in an estimated abundance of 17,175 whales (CV = 0.237; Ferguson et al. 2022; Table 1). The aerial survey abundance estimate is likely biased low because the study area did not encompass the entire known range of the stock during summer and because the estimate was not corrected for a purely statistical bias that arises in certain cases when estimates of random effects are transformed using a nonlinear function to produce a derived variable (Ferguson et al. 2022; Thorson and Kristensen 2016). Both the ice-based and aerial line-transect abundance estimates from 2019 were endorsed by the IWC Scientific Committee as Category 1A (acceptable for providing management advice using an Aboriginal Whaling Management Procedure Strike Limit Algorithm; IWC 2021, 2022).

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 and are from Woodby and Botkin (1993). Ice-based census count estimates for 1978-2001 are reported in George et al. (2004) and Zeh and Punt (2005), for 2011 in Givens et al. (2016), and for 2019 in Givens et al. (2021a, 2021b). Aerial sight-resight survey estimates for 1986 are reported in da Silva et al. (2000, 2007); for 2004 in Koski et al. (2010); and for 2011 in Givens et al. (2018). The 2019 aerial line-transect survey estimate is reported in Ferguson et al. (2022).

Year	Abundance range or estimate (CV)	Method
Historical	10,400-23,000	recruitment model back projection
End of commercial whaling	1,000-3,000	recruitment model back projection
1978	4,765 (0.305)	ice-based census count
1980	3,885 (0.343)	ice-based census count
1981	4,467 (0.273)	ice-based census count
1982	7,395 (0.281)	ice-based census count
1983	6,573 (0.345)	ice-based census count
1985	5,762 (0.253)	ice-based census count
1986	8,917 (0.215)	ice-based census count
1986	4,719 - 7,331	aerial sight-resight surveys

Year	Abundance range or estimate (CV)	Method
1987	5,298 (0.327)	ice-based census count
1988	6,928 (0.12)	ice-based census count
1993	8,167 (0.017)	ice-based census count
2001	10,545 (0.128)	ice-based census count
2004	12,631 (0.244)	aerial sight-resight surveys
2011	16,820 (0.052)	ice-based census count
2011	27,133 (0.217)	aerial sight-resight surveys
2019	14,025 (0.228)	ice-based census count
2019	17,175 (0.237)	aerial line-transect survey

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 2023a): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. Because there are two equally valid abundance estimates for 2019, N was computed as the inverse-variance weighted average of the ice-based and aerial line-transect abundance estimates (NMFS 2023a). The resulting N is 15,229 whales (CV(N)=0.165) and N_{MIN} is 13,263 whales.

Current Population Trend

Based on concurrent passive acoustic and ice-based visual surveys, Givens et al. (2016) 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). The population trend since 2011 has not been formally analyzed. Although the ice-based abundance estimate from 2019 (Givens et al. 2021a, 2021b) is lower than that from 2011, Givens et al. (2021a) do not interpret this to be a true decline in population abundance due to the abnormal ice conditions and migration route that were not accounted for in the abundance estimate and likely resulted in an underestimate of abundance. 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.

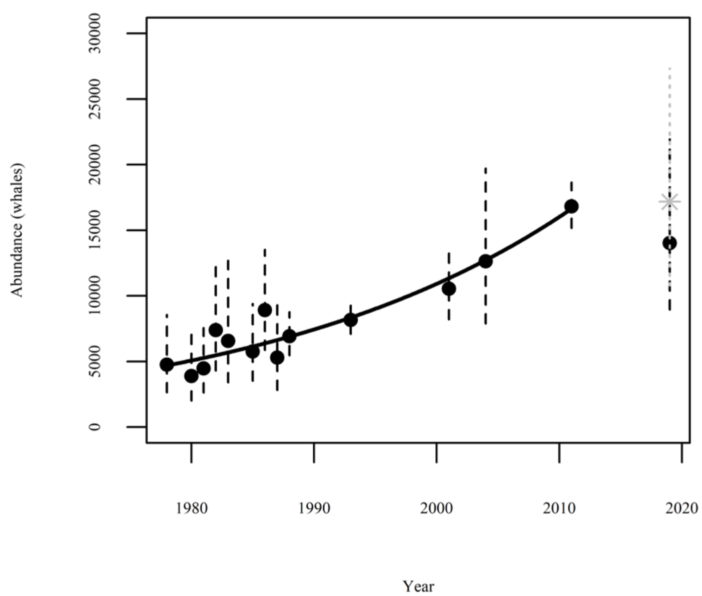

Figure 2. Estimated abundance and trend of Western Arctic bowhead whales, 1978-2011 (Givens et al. 2016), as computed from ice-based counts and acoustic data collected during bowhead whale spring migrations past Point Barrow, Alaska. The 2019 ice-based abundance estimate and confidence interval (Givens et al. 2021a, 2021b) are shown as a black dot and the 2019 aerial survey line-transect estimate and confidence interval (Ferguson et al. 2022) are shown as a gray asterisk; however, the trend line has not been extended because a formal analysis has not been conducted to determine whether the population is likely to have continued to increase exponentially.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The presumed current estimate for the rate of increase for the Western Arctic stock of bowhead whales (3.7%: 95% CI = 2.9-4.6%: Givens et al. 2016) 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, the cetacean maximum theoretical net productivity rate of 4% will be used for the Western Arctic stock of bowhead whales (NMFS 2023a).

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 not known to be decreasing (Givens et al. 2021a, 2021b) in the presence of known take (NMFS 2023a). Thus, PBR derived from the inverse-variance weighted average of the 2019 abundance estimates is 133 whales (13,263 × 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 because it is managed under the Whaling Convention Act, an international treaty. In 2018, the IWC revised the bowhead whale subsistence quota (IWC 2018 Schedule amendment). Under the revisions, the total seven-year block quota for 2019 to 2025 is 392 landed whales (an average of 56/year), 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 (i.e., no more than 33 strikes) is added to the strike quota for any one year (IWC 2018 Schedule amendment, section 13(b)1). Hence, 67 strikes are allocated annually, with the possibility of adding 33 strikes if they are available from the prior three quota blocks. In September 2024, the IWC approved a six-year extension of the catch limits (for 2026-2031) with a block limit of 336 whales. 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 93 strikes per 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 2017 and 2021 is listed, by marine mammal stock, in Freed et al. (2023); 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 2017 and 2021 is 57 whales, calculated as the sum of subsistence takes by Alaska Natives (57; mean actual number of landed whales plus mean annual struck and lost mortality) plus whales landed in subsistence takes by Natives of Russia (0.4; struck and lost whales not reported). Two bowhead whales harvested by Alaska Natives were found to have been seriously injured by unknown (commercial, recreational, or subsistence) fisheries prior to harvest (mean of 0.4/year; Freed et al. 2023); to avoid double counting, these are not added to the total mortality and serious injury for the stock. 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 vessel strikes due to increased vessel traffic (from increased commercial shipping in Bering Strait and the Chukchi and Beaufort seas).

Fisheries Information

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2024).

Based on historical reports and the stock’s geographic range, pot fishery gear is the only documented source of fisheries-caused bowhead whale mortality and serious injury. The levels of interactions 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 also would not be reflected in observer data.

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 2). 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. George et al. (2017) analyzed scarring data for bowhead whales harvested between 1990 and 2012 to estimate the frequency of line entanglement. 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 whales with possible entanglement scars were excluded). Most of the entanglement scars occurred on the peduncle, and entanglement scars were rare on smaller subadult and juvenile whales (body length <10 m), possibly because young whales are less likely to survive entanglements and have 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 catalog from 1985 to 2011 found the probability of scarring due to entanglement 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).

Between 2017 and 2021, there were two reports of bowhead whale mortality or serious injury caused by interactions with fishing gear (Table 2). Two 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 (Freed et al. 2023), resulting in a mean annual mortality and serious injury rate of 0.4 bowhead whales in unknown (commercial, recreational, or subsistence) fisheries between 2017 and 2021 (Table 2). These two whales are also included in the Alaska Native subsistence harvest for 2017 (Table 3).

Thus, the minimum estimated mean annual mortality and serious injury rate in unknown (commercial, recreational, or subsistence) fisheries between 2017 and 2021 is 0.4 whales (Table 2; Freed et al. 2023), although the actual rates are currently unknown. These mortality and serious injury estimates result from actual counts of verified human-caused deaths and serious injuries and are minimums because not all entangled animals are found, reported, or have the cause of death determined.

Table 2. Summary of mortality and serious injury of Western Arctic bowhead whales, by year and type, reported between 2017 and 2021 (NMFS Alaska Region marine mammal stranding network, Freed et al. 2023).

Cause of injury		**2017**	**2018**	**2019**	**2020**	**2021**	**Mean annual mortality**
Entangled in Bering Sea/Aleutian Island pot gear*		2	0	0	0	0	0.4
*Total in unknown (commercial, recreational, or subsistence) fisheries							0.4

Alaska Native Subsistence/Harvest Information

NMFS has an agreement with the Alaska Eskimo Whaling Commission (in 1998, as last amended in 2019) to protect the bowhead whale and Alaska Native 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 May 2024).

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 year (Philo et al. 1993, Suydam et al. 2011). Under this quota, the number of bowhead whales landed by Alaska Natives between 1974 and 2021 ranged from 8 to 57 whales per year (Suydam and George 2012; Suydam et al. 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020; George and Suydam 2014; Scheimreif et al. 2021, 2022). 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 238 bowhead whales between 2017 and 2021 and 46 of the 62 whales that were struck and lost were determined to have died or had a poor chance of survival, resulting in a mean annual take (number of whales landed + struck and lost mortality) of 57 whales (Table 3). Unlike the NMFS process for determining serious injuries (described in NMFS 2023b), the 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, bowhead migratory patterns, 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

2021, 57 of 70 whales struck were landed, resulting in an efficiency of 81% and the mean efficiency for 2010 to 2020 was 78% (Scheimreif et al. 2022).

Native Peoples in Canada and Russia also take whales from this stock. No catches of Western Arctic bowhead whales were reported by Canadian hunters between 2017 and 2021. One bowhead whale was landed in Russia in 2017 (Zharikov 2018), none in 2018 (Zharikov et al. 2019), one in 2019 (Zharikov et al. 2020), none in 2020 (Sidorov et al. 2021), and none in 2021 (Sidorov et al. 2022), resulting in an average annual take of 0.4 (landed) whales by Indigenous Russians between 2017 and 2021.

The total mean annual subsistence take between 2017 and 2021 is 57 bowhead whales: 57 whales taken by Alaska Natives (equals the number of landed whales plus the struck and lost mortality; Table 3) plus 0.4 whales landed by Indigenous Russians (struck and lost whales not reported).

Table 3. Summary of the Alaska Native subsistence harvest of Western Arctic bowhead whales between 2017 and 2021.

Year	Landed	Struck and lost	Struck and lost mortality[a]	Total (landed + struck and lost mortality)
2017[b]	50	7	5	55
2018[c]	47	21	17	64
2019[d]	30	6	2	32
2020[e]	54	15	13	67
2021[f]	57	13	9	66
Mean annual number taken (landed + struck and lost mortality)				57

[a]Struck and lost mortality includes animals determined to have died or had a poor chance of survival (per the criteria described in Suydam et al. 1995); [b]Suydam et al. (2018); [c]Suydam et al. (2019); [d]Suydam et al. (2020); [e]Scheimreif et al. (2021); [f] Scheimreif et al. (2022).

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.

Currently, vessel-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 vessel propellers (George et al. 2017), while only seven whales from the photo-identification catalog from 1985 to 2011 (1% of the sample) had evidence of vessel-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). Two whales landed in the harvest in 2021 had healing wounds that appeared to be vessel-strike injuries (Stimmelmayr et al. 2022).

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 whales) is not known to exceed 10% of the PBR (10% of PBR = 12) 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 (57 whales) is not known to exceed the PBR (133), the IWC annual maximum strike limit (67 + up to 33 previously unused strikes), nor the IWC block-level landing limit (392 whales, or 56 landings per year). By 2011, the Western Arctic bowhead whale stock; had increased to 16,820 whales; this represents between 31% and 168% of the pre-exploitation abundance of 10,000 to 55,000 whales estimated by Brandon and Wade (2004, 2006). The most recent ice-based abundance estimate from 2019 (Givens et al. 2021a, 2021b) and aerial line-transect abundance estimate from 2019 (Ferguson et al. 2022) are not statistically different from the corresponding estimate for 2011; therefore, the abundance is not believed to have decreased. However, the stock is classified as strategic 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. Status of this stock relative to its Optimum Sustainable Population size has not been quantified.

There are key uncertainties in the assessment of the Western Arctic stock of bowhead whales. One of the current best estimates of abundance is based on the 2019 ice-based survey, which was negatively affected by disturbance from powered skiffs and anomalies in sea ice conditions that subsequently affected observation effort and the whales' migration route (Givens et al. 2021a). Givens et al. (2021b) derived a correction factor to account for the disturbance from powered skiffs, but the other known sources of negative bias were not accounted for in the best abundance estimate. The aerial line-transect abundance estimate from 2019 did not cover the entire summer range of the Western Arctic stock, and it has not yet been corrected for back-transformation bias (Ferguson et al. 2022), and both of these sources of bias would result in an underestimate of abundance. 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).

OTHER FACTORS THAT MAY BE CAUSING A DECLINE OR IMPEDING RECOVERY

Non-Human Caused Mortality and Serious Injury

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), 2013 (three), 2015 (three), 2016 (four), 2017 (one), 2018 (four), and 2019 (seven; Willoughby et al. 2020, 2022). Scars from interactions with killer whales were also present on landed whales in 2020 (two) and 2021 (three), and on two of three carcasses observed during North Slope Borough autumn aerial surveys conducted in 2021 (Stimmelmayr et al. 2022).

During 2017-2021, 33 stranded bowhead whales were documented within the range of the Western Arctic Stock (Table 4; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 29 November 2022). One stranding was determined to have no evidence of human interaction and the remaining carcasses could not be fully evaluated for evidence of human interaction.

Table 4. Number of strandings of bowhead whales during 2017-2021, including those for which evidence of human interaction (HI) could not be determined (CBD) or no evidence was determined. Data are from the NOAA National Marine Mammal Health and Stranding Response Database (unpublished data, accessed 29 November 2022). Please note "HI Yes" does not necessarily mean the interaction caused the animal's death.

Year	2017			2018			2019			2020			2021		
Type	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD
Western Arctic Stock	0	0	1	0	0	6	0	0	15	0	0	0	0	1	10
Annual Total	1			6			15			0			11		

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, Hauser et al. 2018, USCMTS 2019, George et al. 2020). For example, in January 2021 large vessels carrying liquefied natural gas transited through Anadyr Strait (west of Saint Lawrence Island; Smith 2021) and there are plans for consistent year-round shipping through the Strait (Stolyarov 2021), including the wintering area for western Arctic bowhead whales. The increase in vessel traffic could result in an increased number of vessel collisions with bowhead whales (Huntington et al. 2015, Hauser et al. 2018, Halliday et al. 2022) and increased acoustic disturbance (Halliday et al. 2021). Oil and gas development in the Beaufort Sea 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 (Blackwell and Thode 2021). 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, including calling rates (reviewed in Blackwell and Thode 2021).

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 (Moore et al. 2019). 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, 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 bowhead whales 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. 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. Ashjian et al. (2021) found that interannual variability in sea ice and winds in the Chukchi Sea affect krill population structure in the bowhead whale feeding hotspot near Point Barrow. 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. Stafford et al. (2021) found that bowhead whales delayed their migration out of the Beaufort Sea by 7 days per year from 2008-2018. Insley et al. (2021) used passive acoustic monitoring to document the first known occurrence of bowhead whales overwintering in Amundsen Gulf and the eastern Beaufort Sea. 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. The reduction in sea ice may lead to increased predation of bowhead whales by killer whales. 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.

Ocean acidification, driven primarily by the release 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 2023 stock assessments (last revised 5/10/2024). An 'X' indicates sections where the information presented has been updated since the 2022 stock assessments were released. Stock Assessment Reports for those stocks in boldface were updated in 2023.

Stock	Stock definition	Population size	PBR	Fishery mortality	Subsistence mortality	Status
Steller sea lion (Western)		**X**	**X**	**X**	**X**	**X**
Steller sea lion (Eastern)		**X**	**X**	**X**	**X**	**X**
Northern fur seal (Eastern Pacific)						
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)						
Bearded seal (Beringia)						
Ringed seal (Arctic)						
Ribbon seal						
Beluga whale (Beaufort Sea)						
Beluga whale (Eastern Chukchi Sea)						
Beluga whale (Eastern Bering Sea)						
Beluga whale (Bristol Bay)						
Beluga whale (Cook Inlet)						
Narwhal (Unidentified)						
Killer whale (ENP Alaska Resident)						
Killer whale (ENP Northern Resident)						
Killer whale (ENP Gulf of Alaska, Aleutian Islands, and Bering Sea Transient)						
Killer whale (AT1 Transient)						
Killer whale (West Coast Transient)						
Pacific white-sided dolphin (North Pacific)						
Harbor porpoise (Northern Southeast Alaska Inland Waters)						
Harbor porpoise (Southern Southeast Alaska Inland Waters)						
Harbor porpoise (Yakutat/Southeast Alaska Offshore Waters)						
Harbor porpoise (Gulf of Alaska)						
Harbor porpoise (Bering Sea)						
Dall's porpoise (Alaska)						
Sperm whale (North Pacific)						
Baird's beaked whale (Alaska)						
Cuvier's beaked whale (Alaska)						
Stejneger's beaked whale (Alaska)						
Sato's beaked whale	**X**	**X**	**X**	**X**	**X**	**X**
Humpback whale (Western North Pacific)						
Humpback whale (Hawai'i)						

Stock	**Stock definition**	**Population size**	**PBR**	**Fishery mortality**	**Subsistence mortality**	**Status**
Humpback whale (Mexico-North Pacific)						
Fin whale (Northeast Pacific)						
Minke whale (Alaska)						
North Pacific right whale (Eastern North Pacific)	**X**	**X**				
Bowhead whale (Western Arctic)		**X**	**X**	**X**	**X**	**X**

Appendix 2. Stock summary table (last revised 5/10/2024). 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.

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	Y	49,837		73,211 (49,837 in U.S. only)	0.12	0.1	439 (299 for U.S. only)	267 (267 in U.S. only)	39	218	S	2023	2021-2022	N_{EST} is best estimate of counts, which have not been corrected for animals at sea during abundance surveys.
Steller sea lion	Eastern	Y	36,308		36,308 (U.S. only)	0.12	1.0	2,178 (U.S. only)	92.3 (U.S. only)	20.5	11	NS	2023	2015-2022	N_{EST} is best estimate of counts, which have not been corrected for animals at sea during abundance surveys.
Northern fur seal	Eastern Pacific	N	626,618	0.2	530,376	0.086	0.5	11,403	373	3.5	360	S	2021	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	N	461,625		423,237	0.12	1.0	25,394	5,254	1	5,253	NS	2020	2012-2013	
Bearded seal	Beringia	N				0.12	0.5		6,709	1.8	6,707	S	2020	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
Ringed seal	Arctic	N				0.12	0.5		6,459	5	6,454	S	2020	2012-2013	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.
Ribbon seal		N	184,697		163,086	0.12	1.0	9,785	163	0.9	162	NS	2020	2012-2013	
Beluga whale	Beaufort Sea	N	39,258	0.229	N/A	0.04	1.0	UNDET	104	0	104	NS	2020	1992	
Beluga whale	Eastern Chukchi Sea	N	13,305	0.51	8,875	0.04	1.0	178	56	0	56	NS	2020	2017	
Beluga whale	Eastern Bering Sea	N	12,269	0.118	11,112	0.048	1.0	267	227	0	227	NS	2022	2017	
Beluga whale	Bristol Bay	N	2,040	0.26	1,645	0.04	1.0	33	19	0	19	NS	2020	2016	
Beluga whale	Cook Inlet	N	279	0.061	267	0.04	0.1		0	0	0	S	2021	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	N/A	0.04	0.5	N/A	0	0	0	NS	2016		
Killer whale	Eastern North Pacific Alaska Resident	N	1,920	N/A	1,920	0.04	0.5	19	1.3	1.1	0	NS	2022	2005-2019	N_{EST} is based on counts of individuals identified from photo-ID catalogs.
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 catalogs.

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	Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient	N	587	N/A	587	0.04	0.5	5.9	0.8	0.8	0	NS	2020	2012	N_{EST} is based on counts of individuals identified from photo-ID catalogs.
Killer whale	AT1 Transient	N	7	N/A	7	0.04	0.1		0	0	0	S	2020	2019	N_{EST} is based on counts of individuals identified from photo-ID catalogs. PBR has been calculated, however, important caveats exist; see SAR text for details.
Killer whale	West Coast Transient	N	349	N/A	349	0.04	0.5	3.5	0.4	0.2	0	NS	2020	2018	N_{EST} is based on counts of individuals identified from photo-ID catalogs 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	Northern Southeast Alaska Inland Waters	N	1,619	0.26	1,250	0.04	0.5	13	5.6	5.6	0	NS	N/A (New SAR in 2022)	2019	New stock split from Southeast Alaska stock in 2022.
Harbor porpoise	Southern Southeast Alaska Inland Waters	N	890	0.37	610	0.04	0.5	6.1	7.4	7.4	0	S	N/A (New SAR in 2022)	2019	New stock split from Southeast Alaska stock in 2022.

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 porpoise	Yakutat/Southeast Alaska Offshore Waters	N	N/A		N/A	0.04	0.5	N/A	22.2	22.2	0	NS	N/A (New SAR in 2022)	1997	New stock split from Southeast Alaska stock.
Harbor porpoise	Gulf of Alaska	N	31,046	0.21	N/A	0.04	0.5	UNDET	72	72	0	S	2020	1998	
Harbor porpoise	Bering Sea	N			N/A	0.04	0.5	UNDET	0.4	0	0	S	2020	2008	N_{EST} has been calculated, however, important caveats exist; see SAR text for details.
Dall's porpoise	Alaska	N				0.04	0.5		37	37	0	NS	2021	2015	N_{EST}, N_{MIN}, and PBR have been calculated, however, important caveats exist; see SAR text for details.
Sperm whale	North Pacific	N				0.04	0.1		3.5	3.3	0	S	2020	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		
Sato's beaked whale		Y	N/A		N/A	0.04	0.5	N/A	0	0	0	NS	N/A (New SAR in 2023)		

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**
Humpback whale	Western North Pacific	N	1,084	0.088	1,007	0.067	0.1	3.4 (0.2 for U.S. waters)	5.82 (0.06 in U.S. waters)	0.012	0.004	S	N/A (New SAR in 2022)	2004-2006	New SAR in 2022 following North Pacific humpback whale stock structure changes
Humpback whale	Hawai‘i	N	11,278	0.56	7,265	0.07	0.5	127	27.09	8.39	0.18	NS	N/A (New SAR in 2022)	2002-2020	New SAR in 2022 following North Pacific humpback whale stock structure changes
Humpback whale	Mexico-North Pacific	N			N/A	0.066	0.5	UNDET	0.57	0.36	0.01	S	N/A (New SAR in 2022)	2003-2006	New SAR in 2022 following North Pacific humpback whale stock structure changes. N_{EST} has been calculated, however, important caveats exist; see SAR text for details.
Fin whale	Northeast Pacific	N				0.04	0.1		0.6	0	0	S	2020	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
Minke whale	Alaska	N	N/A		N/A	0.04	0.5	N/A	0	0	0	NS	2018		
North Pacific right whale	Eastern North Pacific	Y	31	0.226	26	0.04	0.1		0	0	0	S	2023	2008	PBR has been calculated, however, important caveats exist; see SAR text for details.
Bowhead whale	Western Arctic	Y	15,227	0.165	13,263	0.04	0.5	133	57	0	57	S	2023	2019	

Appendix 3. Percent observer coverage in Alaska commercial fisheries 1990-2021 (last revised 5/10/2024).

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	2020	2021
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	N/A	NA
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	35	39	38	82
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	28	28	100	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	20	23	9.5	13
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	94	95	93	96
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	N/A	NA
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	39	28	33	0	30
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	2.5	2.9	1.3	2	2.2	1.3	20
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	5	4.4	6.3	0	0.8	6.2	34
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	18	12	10	8.9	12	6.1	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	N/A	NA
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	0	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	N/A	NA
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	13	14
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	18	10
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	57	80
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	N/A	NA
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	100	99
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	100	99
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	74	58

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	2020	2021
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	91	77
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	100	96
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	N/A	NA
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	52	0
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	53	55
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	3.9	3	1.6	3	2.2	1.4	3.1
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	71	53	0	82	73	100	55
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	23	7.1	7.7	9.4	30	19
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.	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.	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.	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.	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.	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.	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.	not obs.	not obs.
Southeast Alaska salmon drift gillnet (Districts 6, 7, and 8)[c]	% 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.	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 the total catch that was observed. 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.

[c] Total percent observer coverage levels for the observed areas (Alaska Department of Fish & Game districts 6, 7, and 8) are shown (Manly 2015). Coverage levels varied by sub-district and year. Coverage levels in 2012 and 2013 by sub-district were 7.3% and 6.7% (6A), 5.5% and 6.0% (6B), 6.0% and 7.9% (7A), 6.9% and 8.9% (8A), and 6.3% and 5.7% (8B), respectively.

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