Alaska Marine Mammal Stock Assessments, ~~2017~~2018

Marcia~~.~~ M. Muto, Van~~.~~ T. Helker, Robyn~~.~~ P. Angliss, ~~B. A. Allen,~~ Peter~~.~~ L. Boveng,
Jeffrey~~.~~ M. Breiwick, Michael~~.~~ F. Cameron, Phillip~~.~~ J. Clapham, Shawn~~.~~ P. Dahle,
Marilyn~~.~~ E. Dahlheim, Brian~~.~~ S. Fadely, Megan~~.~~ C. Ferguson, Lowell~~.~~ W. Fritz,
Roderick~~.~~ C. Hobbs, Yulia~~.~~ V. Ivashchenko, Amy~~.~~ S. Kennedy, Joshua~~.~~ M. London,
Sally~~.~~ A. Mizroch, Rolf~~.~~ R. Ream, Erin~~.~~ L. Richmond, Kim~~.~~ E. W. Shelden, Kathryn L. Sweeney
Rodney~~.~~ G. Towell, Paul~~.~~ R. Wade, Janice~~.~~ M. Waite, and Alexandre~~.~~ N. Zerbini

Marine Mammal Laboratory
Alaska Fisheries Science Center
7600 Sand Point Way NE
Seattle, WA 98115

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 has 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 the Atlantic Coast (including the Gulf of Mexico). This report provides information on the marine mammal stocks of Alaska under the jurisdiction of the National Marine Fisheries Service.

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

The Stock Assessment Reports should be considered working documents, as they are updated as new information becomes available. The Alaska Stock Assessment Reports were originally developed in 1995 (Small and DeMaster 1995). Revisions have been published for the following years: 1996 (Hill et al. 1997), 1998 (Hill and DeMaster 1998), 1999 (Hill and DeMaster 1999), 2000 (Ferrero et al. 2000), 2001 (Angliss et al. 2001), 2002 (Angliss and Lodge 2002), 2003 (Angliss and Lodge 2004), 2005 (Angliss and Outlaw 2005), 2006 (Angliss and Outlaw 2007), 2007 (Angliss and Outlaw 2008), 2008 (Angliss and Allen 2009), 2009 (Allen and Angliss 2010), 2010 (Allen and Angliss 2011), 2011 (Allen and Angliss 2012), 2012 (Allen and Angliss 2013), 2013 (Allen and Angliss 2014), 2014 (Allen and Angliss 2015), 2015 (Muto et al. 2016), ~~and~~ 2016 (Muto et al. 2017), and 2017 (Muto et al. 2018). 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. New information for all strategic stocks (Western U.S. Steller sea lions, northern fur seals, bearded seals, Cook Inlet beluga whales, AT1 Transient killer whales, harbor porpoise, sperm whales, humpback whales, fin whales, North Pacific right whales, and bowhead whales) was reviewed in ~~2016-2017~~2017-2018. This review, and a review of other stocks, led to the revision of the following stock assessments for the ~~2017~~2018 document: Western U.S. stock of Steller sea lions; northern fur seals; ~~spotted seals~~bearded seals; ribbon seals; ~~Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, Bristol Bay, and~~ Cook Inlet stocks of beluga whales; AT1 Transient stock of killer whales; Pacific white-sided dolphins; Southeast Alaska, Gulf of Alaska, and Bering Sea stocks of harbor porpoise; Dall's porpoise; sperm whales; Western North Pacific and Central North Pacific stocks of humpback whales; fin whales; minke whales; North Pacific right whales; and bowhead whales. The Stock Assessment Reports for all stocks, however, are included in ~~this~~the final Stock Assessment Report document to provide a complete reference. Those sections of each Stock Assessment Report containing significant changes are listed in Appendix 1. The authors solicit any new information or comments which would improve future Stock Assessment Reports.

The U.S. Fish and Wildlife Service (USFWS) has management authority for polar bears, sea otters, and walruses. Copies of the stock assessments for these species are included in Appendix 8 of the final NMFS Stock Assessment Report for your convenience.

Ideas and comments from the Alaska Scientific Review Group (SRG) have significantly improved this document from its draft form. The authors wish to express their gratitude for the thorough reviews and helpful guidance provided by the Alaska Scientific Review Group members: John Citta, Thomas Doniol-Valcroze, Ari Friedlaender, ~~Karl Haflinger,~~ Mike Miller, Greg O'Corry-Crowe, Grey Pendleton (Chair in 2018), Lorrie Rea, Megan Peterson, Kate Stafford, and Kate Wynne (Chair from 2016 to 2018). We would also like to acknowledge the contributions from the NMFS Alaska Regional Office and the Communications Program of the Alaska Fisheries Science Center.

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

CONTENTS*

*NMFS Stock Assessment Reports and Appendices revised in ~~2017~~2018 are in boldface.

STELLER SEA LION (*Eumetopias jubatus*): Western U.S. Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Steller sea lions range along the North Pacific Rim from northern Japan to California (Loughlin et al. 1984)~~, with centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands~~ (Fig. 1). Large numbers of individuals disperse widely outside of the breeding season (late May-~~early~~ 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). ~~Despite~~There is an exchange of sea lions across the stock boundary, especially due to the wide-ranging seasonal movements of juveniles and adult males~~ in particular, exchange between rookeries by breeding adult females and males (other than between adjoining rookeries) is low, although males have a higher tendency to disperse than females~~ (~~NMFS 1995, Trujillo et al. 2004, Hoffman et al. 2006~~Baker et al. 2005, Jemison et al. 2013). During the breeding season, sea lions, especially adult females, typically return to their natal rookery, or a nearby breeding rookery to breed and pup (Hastings et al. 2017). However, mixing of mostly breeding females from Prince William Sound to Southeast Alaska began in the 1990s and two new, mixed-stock rookeries were established (Gelatt et al. 2007, Jemison et al. 2013, O'Corry-Crowe et al. 2014).

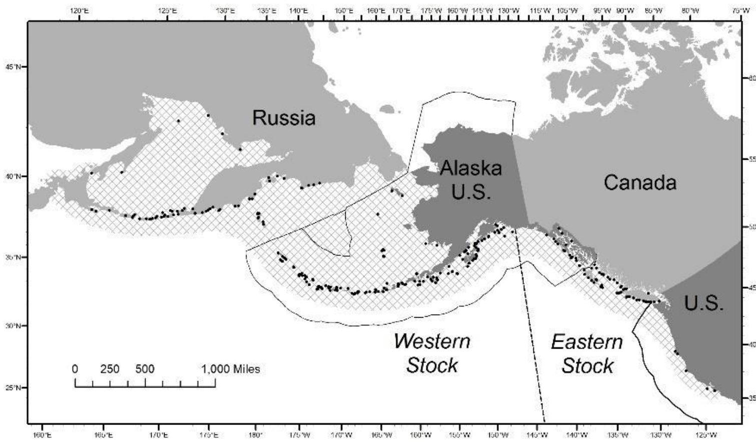

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific Ocean and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005, Olesiuk 2008). Black dashed line (144°W) indicates stock boundary (Loughlin 1997) and solid black line delineates U.S. Exclusive Economic Zone.

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~~, Pendleton et al. 2006~~); 3) Phenotypic data: differences in the length of pups (Merrick et al. 1995, Loughlin 1997); and 4) Genotypic data: substantial differences in mitochondrial DNA (Bickham et al. 1996). Based on this information, two separate stocks of Steller sea lions were recognized within U.S. waters: an Eastern U.S. stock, which includes animals born east of Cape Suckling, Alaska (144°W), and a Western U.S. stock, which includes animals born at and west of Cape Suckling (Loughlin 1997; Fig. 1). However, Jemison et al. (2013) summarized that there is regular movement of Steller sea lions from the western Distinct Population Segment (DPS) (males and females equally) and eastern DPS (almost exclusively males) across the DPS boundary.

Steller sea lions that breed in Asia are considered part of the western stock. Whereas Steller sea lions seasonally inhabit coastal waters of Japan in the winter, breeding rookeries of western stock animals outside of the U.S. are currently only located in Russia (Burkanov and Loughlin 2005). Analyses of genetic data differ in their interpretation of separation between Asian and Alaska sea lions. Based on analysis of mitochondrial DNA, Baker et al. (2005) found evidence of a genetic split between the Commander Islands (Russia) and Kamchatka that would include Commander Island sea lions within the Western U.S. stock and animals west of there in an Asian stock. However, Hoffman et al. (2006) did not support an Asian/western stock split based on their analysis of nuclear microsatellite markers indicating high rates of male gene flow. 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." 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 ~~recent~~ 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 stock delineation concept by noting that ancient population subdivision likely led to the sequestering of most mtDNA haplotypes as DPS or subspecies-specific (Phillips et al. 2011).

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. Collectively, this information demonstrates that these two most recently established rookeries in northern Southeast Alaska have been partially to predominately established by western stock females. While movements of animals marked as pups in both stocks support these genetic results (Jemison et al. 2013), overall the observations of marked 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 DPS indicate movement of western sea lions (especially adult females) into this area, the mixed part of the range remains ~~small~~geographically distinct (Jemison et al. 2013), and the overall discreteness of the eastern from the western stock remains distinct. Movement of western stock sea lions south of these rookeries and eastern stock sea lions moving to the west is less common (Jemison et al. 2013, O'Corry-Crowe et al 2014). 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. In fact, as stated by NMFS and the U.S. Fish and Wildlife Service (USFWS) in a 1996 response to a previous comment regarding stock discreteness policy (61 FR 47222), "*The Services do not consider it appropriate to require absolute reproductive isolation as a prerequisite to recognizing a distinct population segment*" or stock. 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), and Phillips et al. (2009, 2011).

POPULATION SIZE

The western stock of Steller sea lions decreased from an estimated 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 ~10 days after the mean pup birth dates in the survey area (4-14 June) after ~95% of all pups are born (Pitcher et al. 2001, Kuhn et al. 2017). Modeled counts and trends are reported for the total western DPS in Alaska and the six regions (eastern, central, and western Gulf of Alaska and the eastern, central, and western Aleutian Islands) that compose this geographic range. The boundaries for the six regions were identified based on metapopulation analysis of survey count data collected from 1976 to 1994 (York et al. 1996). The most recent comprehensive aerial photographic and land-based surveys of western Steller sea lions in Alaska were conducted during the ~~2015 and~~ 2016 and 2017 breeding seasons (~~Fritz et al. 2016,~~ Sweeney et al. 2016, 2017). Western Steller sea lion pup and non-pup counts in Alaska in ~~2016~~2017 were estimated to be ~~12,631~~11,952 (95% credible interval of ~~11,446-13,927~~10,879-13,195) and ~~40,672~~42,315 (~~35,737-46,305~~38,039-47,376), respectively, using the method of Johnson and Fritz (2014) and survey results from 1978 through ~~2016~~2017 (Sweeney et al. ~~2016~~2017). Demographic multipliers (e.g., pup production multiplied by 4.5) and 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 these methods problematic when applied to counts of western Steller sea lions in Alaska, including the lack of vital (survival and reproductive) 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).

Methods used to survey Steller sea lions in Russia differ from those used in Alaska, with less use of aerial photography and more use of skiff surveys and cliff counts for non-pups and ground counts for pups. The most recent total count of live pups on rookeries in Russia is available from counts conducted in 2013, 2015, and 2016, which totaled 5,218 pups, 5% lower than the 5,491 pups counted in 2011 (Burkanov 2017). Rookery pup counts represent more than 95% of pup counts at all sites (including haulouts) but are underestimates of total pup production.

Minimum Population Estimate

Because current population size (N) and a pup multiplier to estimate N are not known, we will use the best estimate of the total count of western Steller sea lions in Alaska as the minimum population estimate (N_{MIN}). Western Steller sea lion pup and non-pup estimates in ~~2016~~2017 in Alaska were ~~12,631~~11,952 and ~~40,672~~42,315, respectively (Sweeney et al. ~~2016~~2017). These sum to ~~53,303~~54,267, which will be used as the N_{MIN} for the U.S. portion of the western stock of Steller sea lions (Wade and Angliss 1997). This is considered a minimum estimate because it has not been corrected to account for animals that were at sea during the surveys.

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 ~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 to endangered in 1997 (NMFS 2008). Surveys in Alaska in 2002, however, 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).

Johnson and Fritz (2014) estimated regional and overall trends in counts of pups and non-pups in Alaska using data collected at all sites with at least two non-zero counts, rather than relying solely on counts at "trend" sites (also see Fritz et al. 2013, 2016). Using data collected from 1978 through ~~2016~~2017, there is strong evidence that pup and non-pup counts of western stock Steller sea lions in Alaska were at their lowest levels in 2002~~ and 2003, respectively,~~ and have increased at ~~2.19~~1.78% y^{-1} and ~~2.24~~2.14% y^{-1}, respectively, between ~~2003~~2002 and ~~2016~~2017 (Table 1; Fig. 2; Sweeney et al. ~~2016~~2017). However, there are strong regional differences across the range in Alaska, with positive trends in the Gulf of Alaska and eastern Bering Sea east of Samalga Pass (~170°W) and generally negative trends to the west in the Aleutian Islands (Table 1; Fig. ~~2~~3). Non-pup ~~T~~trends in ~~2003-2016~~2002-2017 in Alaska have a longitudinal gradient with highest rates of increase generally in the east (eastern Gulf of Alaska) and steadily decreasing rates to the west (Table 1).

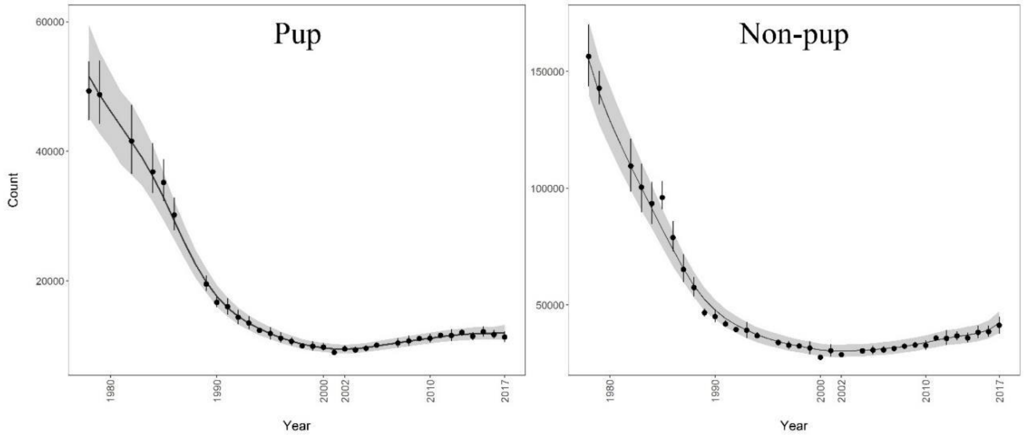

Figure 2. Realized and predicted counts of western Steller sea lion pups (left) and non-pups (right) in Alaska, 1978-2017. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

~~**Table 1.** Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in counts of western Steller sea lion non-pups (adults and juveniles) and pups in Alaska, by region, for 2003-2016 (Sweeney et al. 2016).~~

		Non-pups				Pups		
Region	**Latitude Range**	**Trend**	**-95%**	**+95%**		**Trend**	**-95%**	**+95%**
Western Stock in Alaska	144°W-172°E	2.24	1.30	3.24		2.19	1.46	2.90
E of Samalga Pass	144°-170°W	3.40	2.29	4.67		3.71	2.80	4.59
Eastern Gulf of Alaska	144°-150°W	5.36	1.74	9.11		4.61	2.33	6.83
Central Gulf of Alaska	150°-158°W	4.33	2.45	6.16		4.22	2.35	6.29
Western Gulf of Alaska	158°-163°W	3.28	1.19	5.11		3.70	1.92	5.31
Eastern Aleutian Islands	163°-170°W	1.71	-0.26	3.67		2.83	1.60	4.04
W of Samalga Pass	170°W-172°E	-1.42	-2.99	0.27		-1.89	-2.99	-0.63
Central Aleutian Islands	170°W-177°E	-0.73	-2.48	1.12		-1.33	-2.58	0.03
Western Aleutian Islands	172°-177°E	-6.71	-8.46	-5.08		-6.94	-8.19	-5.75

Table 1. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in counts of western Steller sea lion non-pups (adults and juveniles) and pups in Alaska, by region, for 2002-2017 (Sweeney et al. 2017).

		Non-pups				Pups		
Region	**Latitude Range**	**Trend**	**-95%**	**+95%**		**Trend**	**-95%**	**+95%**
Western Stock in Alaska	144°W-172°E	2.14	1.49	2.78		1.78	1.19	2.34
E of Samalga Pass	144°-170°W	3.09	2.35	3.90		3.18	2.48	3.87
Eastern Gulf of Alaska	144°-150°W	4.21	2.04	6.26		2.65	0.99	4.63
Central Gulf of Alaska	150°-158°W	3.90	2.88	4.98		3.28	1.73	4.84
Western Gulf of Alaska	158°-163°W	3.01	1.50	4.56		3.65	2.31	5.12
Eastern Aleutian Islands	163°-170°W	1.85	0.42	3.27		2.79	1.80	3.83
W of Samalga Pass	170°W-172°E	-0.84	-1.94	0.26		-1.90	-2.88	-0.82
Central Aleutian Islands	170°W-177°E	-0.07	-1.26	1.15		-1.33	-2.43	-0.18
Western Aleutian Islands	172°-177°E	-6.73	-8.34	-5.20		-6.83	-7.93	-5.71

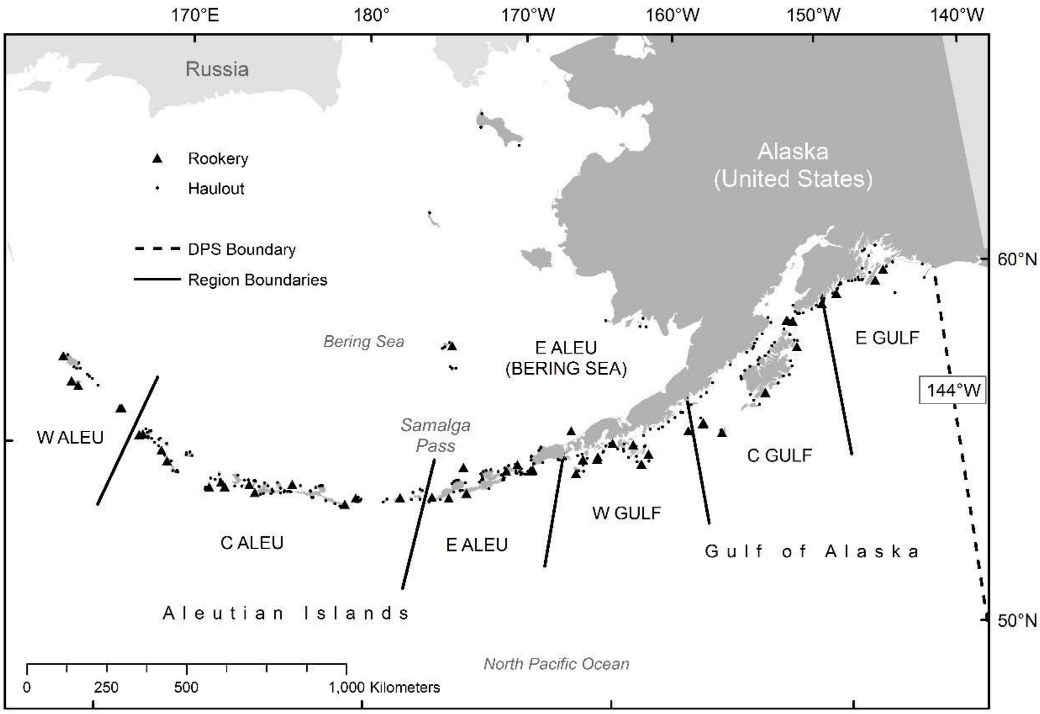

Figure 3. Regions of Alaska used for western Steller sea lion population trend estimation. E GULF, C GULF, and W GULF are eastern, central, and western Gulf of Alaska regions, respectively. E ALEU, C ALEU, and W ALEU are eastern, central, and western Aleutian Islands regions, respectively.

~~Estimated trends in n~~Non-pup and pup counts in the western Aleutians have been in a steep decline overall ~~since 2003 are still declining steeply, after adding the 2016 counts, but less steeply than without that year's data~~(Fig. 4).~~ This was largely due to relatively stable regional counts since 2013 (Sweeney et al. 2016).~~ ~~This~~However, there was a period of stability in this region from 2013 to 2017 (Sweeney et al. 2016, 2017). ~~overlapped with and followed 4 years (~~From 2011 to -2014~~) when fisheries for~~, Pacific cod and Atka mackerel fisheries were closed in the western Aleutian Islands; Pacific cod and Atka mackerel are two of the primary prey species of Steller sea lions in the Aleutian Islands (Sinclair et al. 2013, Tollit et al. 2017). The western Aleutians were largely re-opened to these two fisheries in 2015~~, the impact (if any) of which may be evident in the next Aleutian Islands Steller sea lion survey counts to be obtained in 2018 and 2020~~. Surveys in the Aleutian Islands were conducted opportunistically in 2017 as survey effort was focused in the Gulf of Alaska. As such, only 17 sites were surveyed west of Samalga Pass in 2017, producing high estimates with large confidence bounds in the central Aleutian Islands.

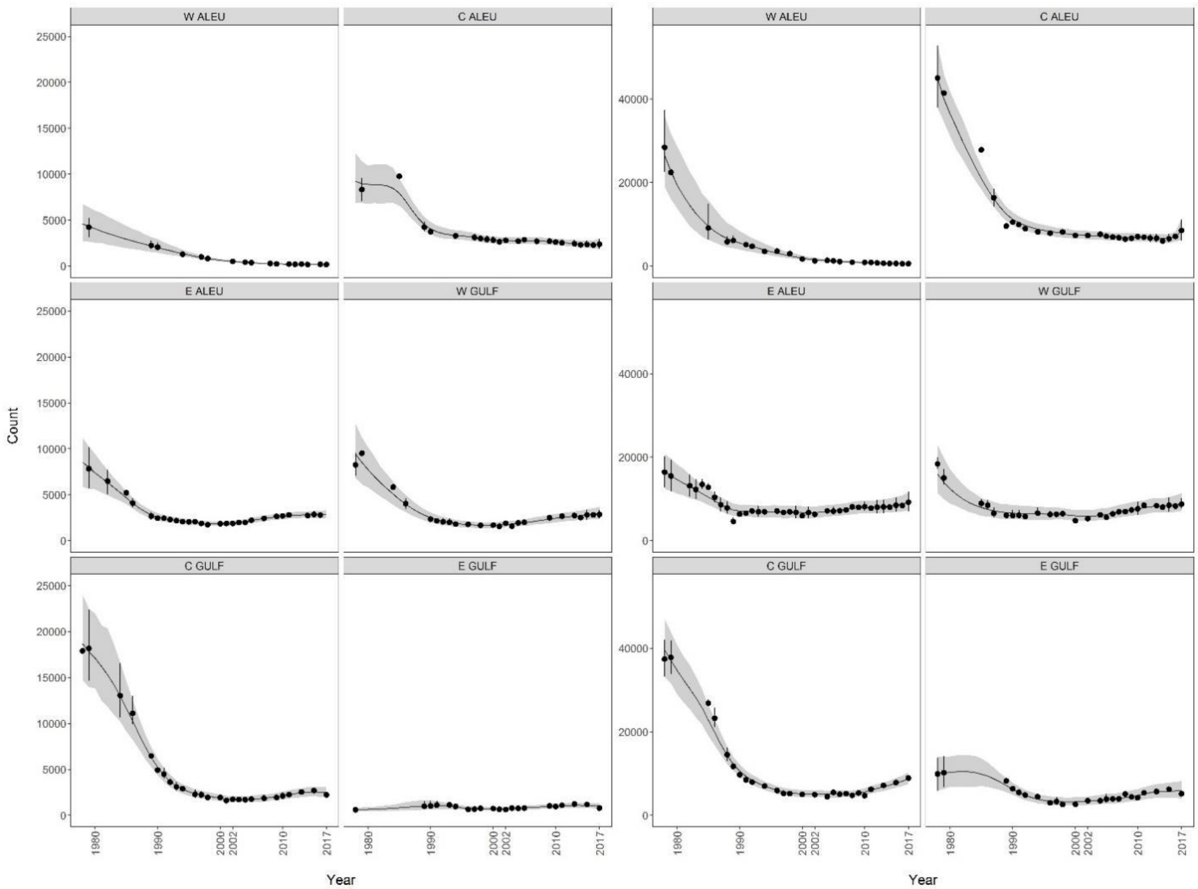

Figure 4. Realized and predicted counts of Steller sea lion pups (left) and non-pups (right) in the six regions that compose the western DPS in Alaska, 1978-2017. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

~~The n~~Net ~~magnitude of Steller sea lion~~ movements between the eastern and western stocks appears to be small during the breeding season ~~between the eastern and western stocks appears to be relatively small (~~, with an estimated net ~~increase of 76~~75 sea lions ~~in the~~moving west~~)~~ in 2016~~and would have a negligible impact on non-pup trend estimates for either stock~~ (Jemison et al. 2013, Fritz et al. 2016). As a result, trends in counts estimated from breeding season surveys should be relatively insensitive to inter-stock movements. ~~However, there is cross-boundary movement of 100s of animals during the breeding season with significant differences by sex.~~ Very few females move from Southeast Alaska to the western stock while ~~more than~~ ~500 were estimated to move from west to east (net increase in the east). Males move~~d~~ in both directions but with a net increase ~~of ~500 males~~ in the west. This pattern of movement is supported by mitochondrial DNA evidence that indicated that the newest rookeries in northern Southeast Alaska (eastern stock) were colonized in part by western females (Gelatt et al. 2007, O'Corry-Crowe et al. 2014).

Pup counts in the eastern (-33%) and central (-18%) Gulf of Alaska declined sharply between 2015 and 2017, counter to the relatively steady increases observed in both regions since 2002. 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 in 2014-2016 (Bond et al. 2015, Peterson et al. 2016).

Burkanov and Loughlin (2005) estimated that the Russian Steller sea lion population (pups and non-pups) declined from about 27,000 in the 1960s to 13,000 in the 1990s and increased to approximately 16,000 in 2005. Data collected through 2016 (Burkanov 2017) indicate that overall Steller sea lion abundance in Russia (~23,500 based on a life table multiplier of 4.5 on the most recent total pup count of 5,218) is greater than in 2005 but may not have increased back to levels observed in the 1960s. However, just as in the U.S. portion of the stock, there are significant regional differences in population trend in Russia. Pup production appears to be declining in most areas of Russia (Kuril Islands, eastern Kamchatka, the Commander Islands, parts of the Sea of Okhotsk, and the western Bering Sea); only Tuleny Island in the southern Sea of Okhotsk has had consistently increasing pup counts over the last 10 years (since 2007). The largest decline in Steller sea lions in Russia has been in the western Bering Sea (which has no rookeries), where non-pup counts declined 98% between 1982 and 2010.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the maximum net productivity rate (R_{MAX}) for Steller sea lions. Hence, until additional data become available, the ~~theoretical~~ maximum theoretical net productivity rate ~~(R_{MAX})~~ for pinnipeds of 12% 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 0.1, the default value for stocks listed as endangered under the ESA (Wade and Angliss 1997). Thus, for the U.S. portion of the western stock of Steller sea lions, PBR = ~~320~~326 sea lions (~~53,303~~54,267 $\times$ 0.06 $\times$ 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~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 Western U.S. Steller sea lions in ~~2011-2015~~2012-2016 is ~~241~~252 sea lions: ~~31~~40 in U.S. commercial fisheries, ~~1.4~~1.2 in unknown (commercial, recreational, or subsistence) fisheries, 2 in marine debris, ~~2.6~~5.5 due to other causes (arrow strike, entangled in hatchery net, illegal shooting, Marine Mammal Protection Act (MMPA) authorized research-related), and ~~204~~203 in the Alaska Native subsistence harvest. No observers have been assigned to several fisheries that are known to interact with this stock and estimates of entanglement in fishing gear and marine debris based solely on stranding reports in areas west of 144°W longitude may underestimate the entanglement of western stock animals that travel to parts of Southeast Alaska. Due to a lack of available resources, NMFS is not operating the Alaska Marine Mammal Observer Program (AMMOP) focused on marine mammal interactions that occur in fisheries managed by the State of Alaska. 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 vast majority of the Steller sea lions taken are likely to be from the eastern stock. Counts of annual illegal gunshot mortality in the Copper River Delta should be considered minimums as they are based solely on aerial carcass surveys in 2015 and 2016, no data are available for ~~2011~~2012-2014, 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 mortality or serious injury of this stock include subsistence harvest, incidental take, illegal shooting, disturbance, and entanglement in fishing gear and marine debris.

Fisheries Information

~~Detailed i~~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.

Based on historical reports and their geographic range, Steller sea lion mortality and serious injury could occur in several fishing gear types, including trawl, gillnet, longline, and troll 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 mortality and serious injury in non-trawl fisheries. Therefore, the potential for fisheries-caused mortality and serious injury may be greater than is reflected in existing observer data.

In ~~2011-2015~~2012-2016, mortality and serious injury of western Steller sea lions was observed in ~~the following 10~~11 ~~fisheries~~ of the ~~22~~ federally-~~regulated~~managed commercial fisheries in Alaska that are monitored for incidental mortality and serious injury by fisheries observers: 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 Pacific cod trawl, Gulf of Alaska Pacific cod longline, Gulf of Alaska Pacific halibut longline, Gulf of Alaska sablefish longline, Gulf of Alaska flatfish trawl, Gulf of Alaska rockfish trawl, and Gulf of Alaska pollock trawl fisheries, resulting in a mean annual mortality and serious injury rate of ~~16~~25 sea lions (Table 2; 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). No incidental mortality or serious injury was observed during 1990 for this fishery (Wynne et al. 1991), resulting in a mean annual mortality rate of 15 sea lions (CV = 1.0) ~~sea lions~~ for 1990 and 1991. It is not known whether this incidental mortality and serious injury rate is representative of the current rate in this fishery.

One Steller sea lion mortality resulting from entanglement in commercial longline gear was reported to the NMFS Alaska Region stranding network in 2015 (Helker et al. ~~2017~~in press), resulting in a mean annual mortality and serious injury rate of 0.2 sea lions in ~~2011-2015~~2012-2016 (Table 3). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~is a minimum because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined. ~~Two~~An additional mortality~~ies~~ reported in ~~2011-2015 (one in the Bering Sea/Aleutian Islands flatfish trawl fishery in 2011 and one in~~ the Prince William Sound salmon drift gillnet fishery in 2015~~:~~ (Helker et al. ~~2017~~in press) ~~are~~is already accounted for in the extrapolated estimates derived from AMMOP observer data for ~~these~~this fishery~~ies~~ (Table 2).

The estimated mean annual mortality and serious injury rate in U.S. commercial fisheries in ~~2011-2015~~2012-2016 is ~~31~~40 Steller sea lions from this stock (~~31~~40 from observer data + 0.2 from stranding data) (Tables 2 and 3). No observers have been assigned to several fisheries that are known to interact with this stock, thus, the estimated mortality and serious injury is likely an underestimate of the actual level.

Table 2. Summary of incidental mortality and serious injury of Western U.S. Steller sea lions due to U.S. commercial fisheries in ~~2011-2015~~2012-2016 (or the most recent data available) and calculation of the mean annual mortality and serious injury rate (Wynne et al. 1991, 1992; Breiwick 2013; MML, unpubl. data). N/A indicates that data are not available. Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~99~~ 99 99 99 99 99	~~7~~ 6 7 5 ~~4~~6 9	~~7~~ 6.0 7.0 5.0 ~~4~~6 9.0	~~5.8~~6.6 (CV = 0.01)
Bering Sea/Aleutian Is. Pacific cod trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~60~~ 68 80 80 72 68	~~1~~ 0 1 0 0 0	~~1.0~~ 0 1.9 0 0 0	~~0.6~~0.4 (CV = ~~0.45~~0.69)
Bering Sea/Aleutian Is. pollock trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~98~~ 98 97 98 99 99	~~9~~ 7 (+1)[a] 5 2 1 13	~~9.3~~ 7.0 (+1)[b] 5.1 2.1 1.2 13.1	~~4.9~~5.7 (+0.2)[c] (CV = 0.03)

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. Pacific cod longline	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~57~~ 51 66 64 62 57	~~0~~ 0 0 1 3 0	~~0~~ 0 0 1.7 4.8 0	1.3 (CV = ~~0.31~~0.32)
Gulf of Alaska Pacific cod longline	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~30~~ 13 29 31 37 30	~~0~~ 0 0 0 1 0	~~0~~ 0 0 0 1.2 0	0.2 (CV = ~~0.39~~0.4)
Gulf of Alaska Pacific halibut longline	2012 2013 2014 2015 2016	obs data	0.6 4.2 11 9.7 9.6	0 0 0 1 0	0 0 0 21 0	4.2 (CV = 0.96)
Gulf of Alaska Pacific cod trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~41~~ 25 10 12 13 13	~~0~~ 1 0 0 0 1	~~0~~ 1 0 0 0 9.8	~~0.2~~2.2 (CV = 0.82)
Gulf of Alaska sablefish longline	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~14~~ 14 14 19 20 14	~~0~~ 1 0 0 ~~0~~1 0	~~0~~ 5.5 0 0 ~~0~~5.2 0	~~1.1~~2.1 (CV = ~~0.89~~0.65)
Gulf of Alaska flatfish trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~31~~ 42 46 47 54 39	~~0~~ 0 0 0 0 (+1)[d] 0	~~0~~ 0 0 0 0 (+1)[e] 0	0 (+0.2)[f] (CV = N/A)
Gulf of Alaska rockfish trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	 93 	~~0~~ 0 0 0 0 (+1)[d] 0	~~0~~ 0 0 0 0 (+1)[e] 0	0 (+0.2)[f] (CV = N/A)
Gulf of Alaska pollock trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	 27 15 14 23 27	~~0~~ 0 0 0 0 (+5)[g] 1	~~0~~ 0 0 0 0 (+5)[h] 5.0	1.0 (+1)[i] (CV = ~~N/A~~0.9)
Prince William Sound salmon drift gillnet	1990 1991	obs data	4 5	0 2	0 29	15 (CV = 1.0)
Minimum total estimated annual mortality						~~31~~40 (CV = ~~0.52~~0.41)

[a]Total mortality and serious injury observed in 2012: 7 sea lions in sampled hauls + 1 sea lion in an unsampled haul.

AR024404

[b]Total estimate of mortality and serious injury in 2012: 7.0 sea lions (extrapolated estimate from 7 sea lions observed in sampled hauls) + 1 sea lion (1 sea lion observed in an unsampled haul).
[c]Mean annual mortality and serious injury for fishery: ~~4.9~~5.7 sea lions (mean of extrapolated estimates from sampled hauls) + 0.2 sea lions (mean of number observed in unsampled hauls).
[d]Total mortality and serious injury observed in 2015: 0 sea lions in sampled hauls + 1 sea lion in an unsampled haul.
[e]Total estimate of mortality and serious injury in 2015: 0 sea lions (extrapolated estimate from 0 sea lions observed in sampled hauls) + 1 sea lion (1 sea lion observed in an unsampled haul).
[f]Mean annual mortality and serious injury for fishery: 0 sea lions (mean of extrapolated estimates from sampled hauls) + 0.2 sea lions (mean of number observed in unsampled hauls).
[g]Total mortality and serious injury observed in 2015: 0 sea lions in sampled hauls + 5 sea lions in unsampled hauls.
[h]Total estimate of mortality and serious injury in 2015: 0 sea lions (extrapolated estimate from 0 sea lions observed in sampled hauls) + 5 sea lions (5 sea lions observed in unsampled hauls).
[i]Mean annual mortality and serious injury for fishery: 1.0 sea lions (mean of extrapolated estimates from sampled hauls) + 1 sea lion (mean of number observed in unsampled hauls).

Reports from the NMFS Alaska Region stranding network of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data (Table 3; Helker et al. ~~2017~~in press). From ~~2011 to 2015~~2012 to 2016, there were ~~five~~four reports of a Steller sea lion in poor body condition with a flasher lure (troll gear) hanging from its mouth and, in each case, the animal was believed to have ingested the hook (Table 3). Two additional animals were entangled in unidentified fishing gear. Fishery-related strandings in these unknown (commercial, recreational, or subsistence) fisheries during ~~2011-2015~~2012-2016 resulted in a minimum mean annual mortality and serious injury rate of ~~1.4~~1.2 sea lions from this stock (Table 3). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~is a minimum because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found or reported. Additionally, since Steller sea lions from parts of the western stock are known to regularly occur in parts of Southeast Alaska (NMFS 2013), and higher rates of entanglement of Steller sea lions have been observed in this area (e.g., Raum-Suryan et al. 2009), estimates based solely on stranding reports in areas west of 144°W longitude may underestimate the total entanglement of western stock sea lions in fishery-related and other marine debris.

Table 3. Summary of Western U.S. Steller sea lion mortality and serious injury, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and Alaska Department of Fish and Game in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). N/A indicates that data are not available.

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in commercial longline gear	~~0~~	0	0	0	1	0	0.2
Hooked by Southcentral Alaska salmon troll gear*	~~1~~	0	0	1	0	0	~~0.4~~0.2
Hooked by Alaska Peninsula troll gear*	~~0~~	1	0	0	0	0	0.2
Hooked by troll gear*	~~0~~	2	0	0	0	0	0.4
Entangled in unidentified fishing gear*	~~0~~	1	0	1	0	0	0.4
Entangled in marine debris	~~1~~	2	0	3	4	1	2
Struck by arrow	~~0~~	0	1	0	0	0	0.2
Entangled in commercial Kodiak salmon hatchery net	~~0~~	0	1	0	0	0	0.2
Illegally shot	~~N/A~~	N/A	N/A	N/A	8	1	~~1.6~~4.5[a]
MMPA authorized research-related	~~2~~	0	0	0	1	2	0.6
Total in commercial fisheries							0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries							~~1.4~~1.2
Total in marine debris							2
Total due to other causes (arrow strike, entangled in hatchery net, illegally shot, research-related)							~~2.6~~5.5

[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. ~~NMFS does not know whether the level of mortality detected in 2015 was typical, low, or high since~~Because similar data are not available for ~~2011~~2012-

2014~~. A 5-year average was used for the purpose of estimating the mean annual mortality by illegal shooting in this report, as NMFS cannot be certain if the 2015 value was appropriate for all years. If more data become available through future survey effort~~, the data ~~will be~~were averaged over the 2 years of survey effort for a more informed estimate of mean annual mortality.

~~NMFS studies using satellite-tracking devices attached to juvenile and adult female Steller sea lions suggest that these two age/sex classes rarely go beyond the U.S. Exclusive Economic Zone into international waters (Merrick and Loughlin 1997; Lander et al. 2009, 2011a, 2011b). Little is known about the at-sea distribution of sub-adult and adult males, however, since there have been no satellite-tracking devices attached to them. In the 1980s and 1990s, Steller sea lions of unknown sex and age were observed in international waters of the North Pacific Ocean and Bering Sea, but it is unclear how important these areas are for foraging (Himes-Boor and Small 2012).~~

The minimum average annual mortality and serious injury rate for all fisheries, based on observer data and stranding data (~~31~~40 sea lions) for U.S. commercial fisheries and stranding data (~~1.4~~1.2 sea lions) for unknown (commercial, recreational, or subsistence) fisheries, is ~~32~~41 western Steller sea lions.

Alaska Native Subsistence/Harvest Information

Information on the subsistence harvest of Steller sea lions comes via three sources: the Alaska Department of Fish and Game (ADF&G), the Ecosystem Conservation Office of the Aleut Community of St. Paul Island, and the Kayumixtax Eco-Office of the Aleut Community of St. George Island. 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 U.S. Steller sea lions for 7 communities on Kodiak Island in 2011 and 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 7.9 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; therefore, 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 retained and used for calculating an annual mortality and serious injury estimate for all areas except St. Paul and St. George Islands (Wolfe et al. 2005, 2006, 2008, 2009a, 2009b) (Table 4). Harvest data are collected in near real-time on St. Paul Island (e.g., ~~Lestenkof 2012~~Melovidov 2013) and St. George Island (e.g., Kashevarof 2015) and recorded within 36 hours of the harvest. The most recent 5 years of data from St. Paul (~~Lestenkof 2012;~~ Melovidov 2013, 2014, 2015, 2016; NMFS, unpubl. data) and St. George (Kashevarof 2015; NMFS, unpubl. data) are for ~~2011-2015~~2012-2016 (Table 4).

The mean annual subsistence ~~take~~harvest from this stock for all areas except St. Paul and St. George in 2004-2008 (172) combined with the mean annual ~~take~~harvest for St. Paul (30) and St. George (~~2.4~~1.4) in ~~2011-2015~~2012-2016 is ~~204~~203 western Steller sea lions (Table 4).

Table 4. Summary of the subsistence harvest data for Western U.S. 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 (2004-2008) will be retained and used for calculating an annual mortality and serious injury estimate for all areas except St. Paul and St. George Islands. Data from St. Paul and St. George are still being collected and will be updated with the most recent 5 years of data available (~~2011-2015~~2012-2016). N/A indicates that data are not available.

	All areas except St. Paul Island			**St. Paul Island**	**St. George Island**
Year	**Number harvested**	**Number struck and lost**	**Total**	**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]		
~~2011~~	~~N/A~~	~~N/A~~	~~N/A~~	~~32~~[f]	~~5~~[g]

	All areas except St. Paul Island			St. Paul Island	St. George Island
Year	**Number harvested**	**Number struck and lost**	**Total**	**Number harvested + Number struck and lost**	**Number harvested + Number struck and lost**
2012	N/A	N/A	N/A	24[~~h~~f]	3[g]
2013	N/A	N/A	N/A	34[~~i~~h]	0[g]
2014	N/A	N/A	N/A	35[~~j~~i]	1[g]
2015	N/A	N/A	N/A	24[~~k~~j]	3[g]
2016	N/A	N/A	N/A	31[k]	0[k]
Mean annual ~~take~~harvest	137	35	172	30	~~2.4~~1.4

[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]~~Lestenkof (2012)~~Melovidov (2013); [g]Kashevarof (2015); [h]~~Melovidov (2013);~~ [~~i~~h]Melovidov (2014); [~~j~~i]Melovidov (2015); [~~k~~j]Melovidov (2016); [k]NMFS, unpubl. data.

Other Mortality

Reports from the NMFS Alaska Region stranding network of Steller sea lions 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 ~~should be considered~~ are minimums because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined. From ~~2011 to 2015~~2012 to 2016, reports to the NMFS Alaska Region stranding network resulted in mean annual mortality and serious injury rates of ~~1.6~~4.5 Steller sea lions illegally shot in the Copper River Delta (2-year average), 2 observed entangled in marine debris, 0.2 struck by an arrow, and 0.2 entangled in a commercial Kodiak salmon hatchery net (Table 3; Helker et al. ~~2017~~in press).

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 ~~2011-2015~~2012-2016, there were three reports (~~2 in 2011 and~~ 1 in 2015 and 2 in 2016) of mortality incidental to research on the Western U.S. stock of Steller sea lions (Table 3; Helker et al. ~~2017~~in press), resulting in a mean annual mortality and serious injury rate of 0.6 sea lions from this stock.

STATUS OF STOCK

The minimum mean annual U.S. commercial fishery-related mortality and serious injury rate (~~31~~40 sea lions) is ~~less~~more than 10% of the PBR (10% of PBR = ~~32~~33) and, therefore, cannot be considered insignificant and approaching a zero mortality and serious injury rate. Based on available data, the total estimated annual level of human-caused mortality and serious injury (~~241~~252 sea lions) is below the PBR level (~~320~~326) for this stock. The Western U.S. 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 mortality and serious injury.

There are key uncertainties in the assessment of the Western U.S. stock of Steller sea lions. Some genetic studies support the separation of Steller sea lions in western Alaska from those in Russia; population numbers in this assessment are only from the U.S. to be consistent with the geographic range of information on mortality and serious injury. There is some overlap in range between animals in the western and eastern stocks in northern Southeast Alaska. 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 which are not observed; thus, there is likely to be unreported fishery-related mortality and serious injury of Steller sea lions. 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. Several factors may have been important drivers of the decline of the stock. However, there is ~~some~~ uncertainty about threats currently impeding their recovery, particularly in the Aleutian Islands.

HABITAT CONCERNS

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). Potential threats to Steller sea lion recovery are shown in Table 5. A number of management actions have been implemented since

1990 to promote the recovery of the Western U.S. stock of Steller sea lions, including 3-~~nautical mile~~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). Since the removal of the Eastern U.S. stock of Steller sea lions from protection under the ESA in 2013, NMFS has undertaken a review of ESA critical habitat for the Western U.S. stock.

Table 5. Potential threats and impacts to Steller sea lion recovery, as described by the Revised Steller Sea Lion Recovery Plan (NMFS 2008), and associated references. ~~Threats and impacts to recovery as described by the Revised Steller Sea Lion Recovery Plan (NMFS 2008).~~ Reference examples identify research related to corresponding threats and may or may not support the underlying hypotheses.

Threat	Impact on Recovery	Level of Uncertainty	Reference Examples
Environmental variability	Potentially high	High	Trites and Donnelly 2003, Fritz and Hinckley 2005
Competition with fisheries	Potentially high	High	Fritz and Ferrero 1998, Hennen 2004, Fritz and Brown 2005, Dillingham et al. 2006
Predation by killer whales	Potentially high	High	Springer et al. 2003, Williams et al. 2004, DeMaster et al. 2006, Trites et al. 2007
Toxic substances	Medium	High	Calkins et al. 1994, Lee et al. 1996, Albers and Loughlin 2003, Rea et al. 2013
Incidental take by fisheries	Low	High	Wynne et al. 1992, Nikulin and Burkanov 2000, Perez 2006
Subsistence harvest	Low	Low	Haynes and Mishler 1991, Loughlin and York 2000, Wolfe et al. 2005
Illegal shooting	Low	Medium	Loughlin and York 2000, NMFS 2001
Entanglement in marine debris	Low	Medium	Calkins 1985
Disease and parasitism	Low	Medium	Burek et al. 2005
Disturbance from vessel traffic and tourism	Low	Medium	Kucey and Trites 2006
Disturbance or mortality due to research activities	Low	Low	Calkins and Pitcher 1982, Loughlin and York 2000, Kucey 2005, Kucey and Trites 2006, Atkinson et al. 2008, Wilson et al. 2012

CITATIONS

Alaska Native Harbor Seal Commission (ANHSC). 2015. 2014 estimate of the subsistence harvest of harbor seals and sea lions by Alaska Natives in southcentral Alaska: summary of study findings. Alaska Native Harbor Seal Commission and Alaska Department of Fish & Game, Division of Subsistence. 15 p.

Albers, P. H., and T. R. Loughlin. 2003. Effects of PAHs on marine birds, mammals, and reptiles, p. 243-261. *In* P. E. T. Douben (ed.), PAHs: an Ecotoxicological Perspective. John Wiley and Sons, London.

Atkinson, S., D. P. DeMaster, and D. G. Calkins. 2008. Anthropogenic causes of the western Steller sea lion *Eumetopi~~u~~as jubatus* population decline and their threat to recovery. Mammal Rev. 38(1):1-18.

Baker, A. R., T. R. Loughlin, V. Burkanov, C. W. Matson, T. G. Trujillo, D. G. Calkins, J. K. Wickliffe, and J. W. Bickham. 2005. Variation of mitochondrial control region sequences of Steller sea lions: the three-stock hypothesis. J. Mammal. 86:1075-1084.

Berta, A., and M. Churchill. 2012. Pinniped taxonomy: review of currently recognized species and subspecies, and evidence used for their description. Mammal Rev. 42(2):207-234.

Bickham, J. W., J. C. Patton, and T. R. Loughlin. 1996. High variability for control-region sequences in a marine mammal: implications for conservation and biogeography of Steller sea lions (*Eumetopias jubatus*). J. Mammal. 77:95-108.

Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophys. Res. Lett. 42(9):3414-3420. DOI: dx.doi.org/10.1002/2015GL063306 .

Braham, H. W., R. D. Everitt, and D. J. Rugh. 1980. Northern sea lion decline in the eastern Aleutian Islands. J. Wildl. Manage. 44:25-33.

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

Burek, K. A., F. M. D. Gulland, G. Sheffield, K. B. Beckmen, E. Keyes, T. R. Spraker, A. W. Smith, D. E. Skilling, J. F. Evermann, J. L. Stott, J. T. Saliki, and A. W. Trites. 2005. Infectious disease and the decline of the Steller sea lions (*Eumetopias jubatus*) in Alaska, USA: insights from serologic data. J. Wildl. Dis. 41(3):512-524.

Burkanov, V. 2017. Results of breeding season Steller sea lion pup surveys in Russia, 2011-2016. Memorandum to T. Gelatt and J. Bengtson, April 6, 2017. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Burkanov, V., and T. R. Loughlin. 2005. Distribution and abundance of Steller sea lions on the Asian coast, 1720's–2005. Mar. Fish. Rev. 67(2):1-62.

Byrd, G. V. 1989. Observations of northern sea lions at Ugamak, Buldir, and Agattu Islands, Alaska in 1989. Unpubl. report, U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, P.O. Box 5251, NSA Adak, FPO Seattle, WA 98791.

Calkins, D. G. 1985. Steller sea lion entanglement in marine debris, p. 308-314. *In* R. S. Shomura and H. O. Yoshida (eds.), Proceedings of the Workshop on the Fate and Impact of Marine Debris, 27-29 November 1984, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-54, 580 p.

Calkins, D. G., and K. W. Pitcher. 1982. Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska. Environmental Assessment of the Alaskan Continental Shelf. Final Reports 19:455-546.

Calkins, D. G., E. Becker, T. R. Spraker, and T. R. Loughlin. 1994. Impacts on Steller sea lions, p. 119-139. *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez*. Academic Press, NY.

DeMaster, D. P. 2014. Results of Steller sea lion surveys in Alaska, June-July 2013. Memorandum to J. Balsiger, J. Kurland, B. Gerke, and L. Rotterman, NMFS Alaska Regional Office, Juneau, AK, January 30, 2014. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

DeMaster, D. P., A. W. Trites, P. Clapham, S. Mizroch, P. Wade, R. J. Small, and J. Ver Hoef. 2006. The sequential megafaunal collapse hypothesis: testing with existing data. Prog. Oceanogr. 68(2-4):329-342.

Dillingham, P. W., J. R. Skalski, and K. E. Ryding. 2006. Fine-scale geographic interactions between Steller sea lion (*Eumetopias jubatus*) trends and local fisheries. Can. J. Fish. Aquat. Sci. 63:107-119.

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

Fritz, L. W., and E. S. Brown. 2005. Survey-and fishery-derived estimates of Pacific cod (*Gadus macrocephalus*) biomass: implications for strategies to reduce interactions between groundfish fisheries and Steller sea lions (*Eumetopias jubatus*). Fish. Bull., U.S. 103:501-515.

Fritz, L. W., and R. C. Ferrero. 1998. Options in Steller sea lion recovery and groundfish fishery management. Biosphere Conserv. 1(1):7-19.

Fritz, L. W., and S. Hinckley. 2005. A critical review of the regime shift -"junk food"- nutritional stress hypothesis for the decline of the western stock of Steller sea lion. Mar. Mammal Sci. 21(3):476-518.

Fritz, L. W., R. C. Ferrero, and R. J. Berg. 1995. The threatened status of Steller sea lions, *Eumetopias jubatus*, under the Endangered Species Act: effects on Alaska groundfish fisheries management. Mar. Fish. Rev. 57(2):14-27.

Fritz, L., K. Sweeney, D. Johnson, M. Lynn, and J. Gilpatrick. 2013. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) conducted in Alaska in June-July 2008 through 2012, and an update on the status and trend of the western stock in Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-251, 91 p.

Fritz, L., K. Sweeney, R. Towell, and T. Gelatt. 2016. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) conducted in Alaska in June-July 2013 through 2015, and an update on the status and trend of the western distinct population segment in Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-321, 72 p.

Gelatt, T. S., A. W. Trites, K. Hastings, L. Jemison, K. Pitcher, and G. O'Corry-Crowe. 2007. Population trends, diet, genetics, and observations of Steller sea lions in Glacier Bay National Park, p. 145-149. *In* J. F. Piatt, and S. M. Gende (eds.), Proceedings of the Fourth Glacier Bay Science Symposium, October 26–28, 2004: U.S. Geological Survey Scientific Investigations Report 2007-5047.

Harlin-Cognato, A., J. W. Bickham, T. R. Loughlin, and R. L. Honeycutt. 2006. Glacial refugia and the phylogeography of Steller's sea lion (*Eumetopias jubatus*) in the North Pacific. J. Evol. Biol. 19:955-969. DOI: dx.doi.org/10.1111/j.1420-9101.2005.01052.x .

Haynes, T. L., and C. Mishler. 1991. The subsistence harvest and use of Steller sea lions in Alaska. Alaska Department of Fish and Game Technical Paper No. 198. 44 p.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hennen, D. R. 2004. The Steller sea lion (*Eumetopias jubatus*) decline and the Gulf of Alaska/Bering Sea commercial fishery. Unpubl. Ph.D. Dissertation, Montana State University, Bozeman, MT. 224 p.

Higgins, L. V., D. P. Costa, A. C. Huntley, and B. J. L. Boleuf. 1988. Behavioral and physiological measurements of maternal investment in the Steller sea lion, *Eumetopias jubatus*. Mar. Mammal Sci. 4:44-58.

~~Himes-Boor, G. K., and R. J. Small. 2012. Steller sea lion spatial-use patterns derived from a Bayesian model of opportunistic observations. Mar. Mammal Sci. 28:E375-E403. DOI: dx.doi.org/10.1111/j.1748-7692.2011.00541.x .~~

Hoffman, J. I., C. W. Matson, W. Amos, T. R. Loughlin, and J. W. Bickham. 2006. Deep genetic subdivision within a continuously distributed and highly vagile marine mammal, the Steller's sea lion (*Eumetopias jubatus*). Mol. Ecol. 15:2821-2832.

Hoffman, J. I., K. K. Dasmahapatra, W. Amos, C. D. Phillips, T. S. Gelatt, and J. W Bickham. 2009. Contrasting patterns of genetic diversity at three different genetic markers in a marine mammal metapopulation. Mol. Ecol. 18:2961-2978.

Holmes, E. E., L. W. Fritz, A. E. York, and K. Sweeney. 2007. Age-structured modeling provides evidence for a 28-year decline in the birth rate of western Steller sea lions. Ecol. Appl. 17(8):2214-2232.

Jemison, L. A., G. W. Pendleton, L. W. Fritz, K. K. Hastings, J. M. Maniscalco, A. W. Trites, and T. S. Gelatt. 2013. Inter-population movements of Steller sea lions in Alaska, with implications for population separation. PL~~O~~oS ONE 8(8):e70167.

Johnson, D. S., and L. W. Fritz. 2014. agTrend: a Bayesian approach for estimating trends of aggregated abundance. Methods Ecol. Evol. 5:1110-1115. DOI: dx.doi.org/10.1111/2041-210X.12231 .

Kashevarof, H. 2015. St. George co-management comprehensive report. St. George Island Traditional Council Kayumixtax Eco-Office, St. George Island, AK 99591.

Kucey, L. 2005. Human disturbance and the hauling out behaviour of Steller sea lions (*Eumetopias jubatus*). M.S. Thesis, University of British Columbia, Vancouver, BC. 67 p.

Kucey, L., and A. W. Trites. 2006. A review of the potential effects of disturbance on sea lions: assessing response and recovery, p. 581-589. *In* A. W. Trites, S. Atkinson, D. P. DeMaster, L. W. Fritz, T. S. Gelatt, L. D. Rea, and K. Wynne (eds.), Sea Lions of the World. Alaska Sea Grant College Program, University of Alaska Fairbanks AK-SG-06-01.

Kuhn, C. E., K. Chumbley, D. Johnson, and L. Fritz. 2017. A re-examination of the timing of pupping for Steller sea lions *Eumetopias jubatus* breeding on two islands in Alaska. Endang. Species Res. 32:213-222. DOI: dx.doi.org/10.3354/esr00796 .

~~Lander, M. E., T. R. Loughlin, M. G. Logsdon, G. R. VanBlaricom, B. S. Fadely, and L. W. Fritz. 2009. Regional differences in the spatial and temporal heterogeneity of oceanographic habitat used by Steller sea lions. Ecol. Appl. 19(6):1645-1659.~~

~~Lander, M. E., D. S. Johnson, J. T. Sterling, T. S. Gelatt, and B. S. Fadely. 2011a. Diving behaviors and movements of juvenile Steller sea lions (*Eumetopias jubatus*) captured in the central Aleutian Islands, April 2005. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-218, 41 p.~~

~~Lander, M. E., M. G. Logsdon, T. R. Loughlin, and G. R. VanBlaricom. 2011b. Spatial patterns and scaling behaviors of Steller sea lion (*Eumetopias jubatus*) distributions and their environment. J. Theor. Biol. 274: 74-83.~~

Lee, J. S., S. Tanabe, H. Umino, R. Tatsukawa, T. R. Loughlin, and D. C. Calkins. 1996. Persistent organochlorines in Steller sea lion (*Eumetopias jubatus*) from the bulk of Alaska and the Bering Sea, 1976-1981. Mar. Pollut. Bull. 32(7):535-544.

~~Lestenkof, P. M. 2012. 2011 subsistence hunting of Steller sea lions on St. Paul Island. Memorandum for the Record, May 30, 2012, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.~~

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks, p. 329-341. *In* A. Dizon, S. J. Chivers, and W. Perrin (eds.), Molecular genetics of marine mammals, incorporating the proceedings of a workshop on the analysis of genetic data to address problems of stock identity as related to management of marine mammals. Soc. Mar. Mammal., Spec. Rep. No. 3.
Loughlin, T. R., and A. E. York. 2000. An accounting of the sources of Steller sea lion mortality. Mar. Fish. Rev. 62(4):40-45.
Loughlin, T. R., D. J. Rugh, and C. H. Fiscus. 1984. Northern sea lion distribution and abundance: 1956-1980. J. Wildl. Manage. 48:729-740.
Maniscalco, J. M., P. Parker, and S. Atkinson. 2006. Interseasonal and interannual measures of maternal care among individual Steller sea lions (*Eumetopias jubatus*). J. Mammal. 87:304-311.
Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in districts 6, 7, and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 p.
McBeath, J. 2004. Greenpeace v. National Marine Fisheries Service: Steller sea lions and commercial fisheries in the North Pacific. Alaska Law Rev. 21:1-42.
Melovidov, P. I. 2013. 2012 subsistence hunting of Steller sea lions on St. Paul Island. Memorandum for the Record, February 25, 2013, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.
Melovidov, P. I. 2014. 2013 subsistence hunting of Steller sea lions on St. Paul Island. Memorandum for the Record, February 28, 2014, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.
Melovidov, P. I. 2015. 2014 subsistence hunting of Steller sea lions on St. Paul Island. Memorandum for the Record, February 20, 2015, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.
Melovidov, P. I. 2016. 2015 subsistence hunting of Steller sea lions on St. Paul Island. Memorandum for the Record, February 23, 2016, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.
~~Merrick, R. L., and T. R. Loughlin. 1997. Foraging behavior of adult female and young-of-the-year Steller sea lions in Alaskan waters. Can. J. Zool. 75(5):776-786.~~
Merrick, R. L., T. R. Loughlin, and D. G. Calkins. 1987. Decline in abundance of the northern sea lion, *Eumetopias jubatus*, in 1956-86. Fish. Bull., U.S. 85:351-365.
Merrick, R. L., R. Brown, D. G. Calkins, and T. R. Loughlin. 1995. A comparison of Steller sea lion, *Eumetopias jubatus*, pup masses between rookeries with increasing and decreasing populations. Fish. Bull., U.S. 93:753-758.
Milette, L. L., and A. W. Trites. 2003. Maternal attendance patterns of Steller sea lions (*Eumetopias jubatus*) from stable and declining populations in Alaska. Can. J. Zool. 81:340-348.
National Marine Fisheries Service (NMFS). 1990. Final rule. Listing of Steller Sea Lions as Threatened Under the Endangered Species Act. 55 FR 24345, 26 November 1990.
National Marine Fisheries Service (NMFS). 1995. Status review of the United States Steller sea lion (*Eumetopias jubatus*) population. Prepared by the National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115. 61 p.
National Marine Fisheries Service (NMFS). 1997. Final rule. Change in Listing Status of Steller Sea Lions Under the Endangered Species Act. 62 FR 24345, 5 May 1997.
National Marine Fisheries Service (NMFS). 2001. Endangered Species Act, Section 7 Consultation Biological Opinion and Incidental Take Statement on the Authorization of the Bering Sea/Aleutian Islands and Gulf of Alaska Groundfish Fishery Management Plan Amendments 61 and 70. NMFS Alaska Region, Protected Resources Division, Juneau, AK.
National Marine Fisheries Service (NMFS). 2008. Recovery Plan for the Steller sea lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 p.
National Marine Fisheries Service (NMFS). 2013. Occurrence of western Distinct Population Segment Steller sea lions east of 144° W longitude. December 18, 2013. NMFS Alaska Region, Protected Resources Division, Juneau, AK. 3 p.
Nikulin, V. S., and V. N. Burkanov. 2000. Species composition of marine mammal by-catch during Japanese driftnet salmon fishery in southwestern Bering Sea. Unpubl. manuscript. 2 p. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

O'Corry-Crowe, G., B. L. Taylor, and T. Gelatt. 2006. Demographic independence along ecosystem boundaries in Steller sea lions revealed by mtDNA analysis: implications for management of an endangered species. Can. J. Zool. 84:1796-1809.

O'Corry-Crowe, G., T. Gelatt, L. Rea, C. Bonin, and M. Rehberg. 2014. Crossing to safety: dispersal, colonization and mate choice in evolutionarily distinct populations of Steller sea lions, *Eumetopias jubatus*. Mol. Ecol. 23(22):5415-5434.

Olesiuk, P. F. 2008. Abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia. Department of Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Research Document 2008/063. 29 p. Available online: http://www.dfo-mpo.gc.ca/csas/ . Accessed ~~December 2017~~June 2018.

Pendleton, G. W., K. W. Pitcher, L. W. Fritz, A. E. York, K. L. Raum-Suryan, T. R. Loughlin, D. G. Calkins, K. K. Hastings, and T. S. Gelatt. 2006. Survival of Steller sea lions in Alaska: a comparison of increasing and decreasing populations. Can. J. Zool. 84:1163-1172.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167, 194 p.

Peterson, W., N. Bond, and M. Robert. 2016. The blob (part three): going, going, gone? PICES Press 24(1):46-48. Available online: https://search.proquest.com/docview/1785278412?accountid=28257 . Accessed June 2018.

Phillips, C. D., J. W. Bickham, J. C. Patton, and T. S. Gelatt. 2009. Systematics of Steller sea lions (*Eumetopias jubatus*): subspecies recognition based on concordance of genetics and morphometrics. Occas. Papers, Museum of Texas Tech University 283:1-15.

Phillips, C. D., T. S. Gelatt, J. C. Patton, and J. W. Bickham. 2011. Phylogeography of Steller sea lions: relationships among climate change, effective population size, and genetic diversity. J. Mammal. 92(5):1091-1104.

Pitcher, K. W., V. N. Burkanov, D. G. Calkins, B. J. LeBoeuf, E. G. Mamaev, R. L. Merrick, and G. W. Pendleton. 2001. Spatial and temporal variation in the timing of births of Steller sea lions. J. Mammal. 82(4):1047-1053.

Pitcher, K. W., P. F. Olesiuk, R. F. Brown, M. S. Lowry, S. J. Jeffries, J. L. Sease, W. L. Perryman, C. E. Stinchcomb, and L. F. Lowry. 2007. Abundance and distribution of the eastern North Pacific Steller sea lion (*Eumetopias jubatus*) population. Fish. Bull., U.S. 105(1):102-115.

Raum-Suryan, K., L. A. Jemison, and K. W. Pitcher. 2009. Entanglement of Steller sea lions (*Eumetopias jubatus*) in marine debris: identifying causes and finding solutions. Mar. Pollut. Bull. 58:1487-1495.

Rea, L. D., J. M. Castellini, L. Correa, B. S. Fadely, and T. M. O'Hara. 2013. Maternal Steller sea lion diets elevate fetal mercury concentrations in an area of population decline. Sci. Total Environ. 454-455:277-282. DOI: dx.doi.org/10.1016/j.scitotenv.2013.02.095 .

Sease, J. L., and C. J. Gudmundson. 2002. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) from the western stock in Alaska, June and July 2001 and 2002. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-131, 54 p.

Sease, J. L., and A. E. York. 2003. Seasonal distribution of Steller's sea lions at rookeries and haul-out sites in Alaska. Mar. Mammal Sci. 19(4):745-763.

Sease, J. L., W. P. Taylor, T. R. Loughlin, and K. W. Pitcher. 2001. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1999 and 2000. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-122, 52 p.

Sinclair, E. H., D. S. Johnson, T. K. Zeppelin, and T. S. Gelatt. 2013. Decadal variation in the diet of western stock Steller sea lions (*Eumetopias jubatus*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-248, 67 p.

Springer, A. M., J. A. Estes, G. B. van Vliet, T. M. Williams, D. F. Doak, E. M. Danner, K. A. Forney, and B. Pfister. 2003. Sequential megafaunal collapse in the North Pacific Ocean: an ongoing legacy of industrial whaling? Proc. Natl. Acad. Sci. 100:12223-12228.

Sweeney, K., L. Fritz, R. Towell, and T. Gelatt. 2016. Results of Steller sea lion surveys in Alaska, June-July 2016. Memorandum to D. DeMaster, J. Bengtson, J. Balsiger, J. Kurland, and L. Rotterman, December 5, 2016. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Sweeney, K., L. Fritz, R. Towell, and T. Gelatt. 2017. Results of Steller sea lion surveys in Alaska, June-July 2017. Memorandum to the Record, December 5, 2017. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Tollit, D., L. Fritz, R. Joy, K. Miller, A. Schulze, J. Thomason, W. Walker, T. Zeppelin, and T. Gelatt. 2017. Diet of endangered Steller sea lions (*Eumetopias jubatus*) in the Aleutian Islands: new insights from DNA detections and bioenergetics reconstructions. Can. J. Zool. 95:853-868. DOI: dx.doi.org/10.1139/cjz-2016-0253 .

Trites, A. W., and C. P. Donnelly. 2003. The decline of Steller sea lions in Alaska: a review of the nutritional stress hypothesis. Mammal Rev. 33:3-28.

Trites, A. W., V. B. Deecke, E. J. Gregr, J. K. B. Ford, and P. F. Olesiuk. 2007. Killer whales, whaling and sequential megafaunal collapse in the North Pacific: a comparative analysis of the dynamics of marine mammals in Alaska and British Columbia following commercial whaling. Mar. Mammal Sci. 23(4):751-765.

Trujillo, R. G., T. R. Loughlin, N. J. Gemmell, J. C. Patton, and J. W. Bickham. 2004. Variation in microsatellites and mtDNA across the range of the Steller sea lion, *Eumetopias jubatus*. J. Mammal. 85(2):338-346.

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

Williams, T. M., J. A. Estes, D. F. Doak, and A. M. Springer. 2004. Killer appetites: assessing the role of predators in ecological communities. Ecology 85(12):3373-3384.

Wilson, K., L. W. Fritz, E. Kunisch, K. Chumbley, and D. Johnson. 2012. Effects of research disturbance on the behavior and abundance of Steller sea lions (*Eumetopias jubatus*) at two rookeries in Alaska. Mar. Mammal Sci. 28(1):E58-E74.

Wolfe, R. J., J. A. Fall, and R. T. Stanek. 2005. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2004. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 303, Juneau, AK.

Wolfe, R. J., J. A. Fall, and R. T. Stanek. 2006. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2005. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 319, Juneau, AK.

Wolfe, R. J., J. A. Fall, and M. Riedel. 2008. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2006. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 339, Juneau, AK.

Wolfe, R. J., J. A. Fall, and M. Riedel. 2009a. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2007. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 345, Juneau, AK.

Wolfe, R. J., J. A. Fall, and M. Riedel. 2009b. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2008. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 347, Juneau, AK.

Wolfe, R. J., L. Hutchinson-Scarbrough, and M. Riedel. 2012. The subsistence harvest of harbor seals and sea lions on Kodiak Island in 2011. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 374, Anchorage, AK.

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 65 p. Available from NMFS Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

Wynne, K. M., D. Hicks, and N. Munro. 1992. 1991 marine mammal observer program for the salmon driftnet fishery of Prince William Sound Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 53 p. Available from NMFS Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

York, A. E., R. L. Merrick, and T. R. Loughlin. 1996. An analysis of the Steller sea lion metapopulation in Alaska, Chapter 12, p. 259-292. *In* D. R. McCullough (ed.), Metapopulations and Wildlife Conservation. Island Press, Covelo, CA.

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 ~~Sea~~ 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).

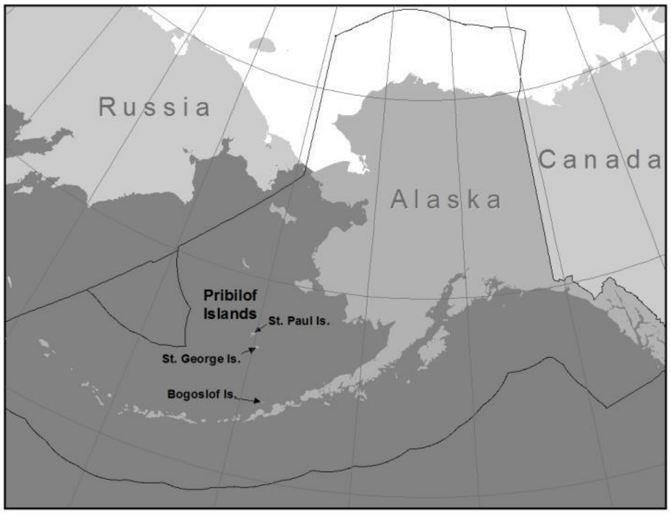

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area).

During the reproductive season, adult males usually are on shore during the 4-month period from May to August, though 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 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. 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 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: 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 ~~separately~~ in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

The population estimate for the Eastern Pacific stock of northern fur seals is calculated as the estimated number of pups born at rookeries in the eastern Bering Sea multiplied by a series of expansion factors determined from a life table analysis to estimate the number of yearlings, 2-year-olds, 3-year-olds, and animals 4 or more years old (Lander 1981). The resulting population estimate is equal to the pup production estimate multiplied by 4.47. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. There is no coefficient of variation (CV) for the expansion factor. Pup production is estimated at all islands using a mark-recapture method, or "shear-sampling" (Chapman and Johnson 1968, York and Kozloff 1987, Towell et al. 2006), with the exception of estimates conducted at Bogoslof Island through 1995, where the smaller population size in those years allowed direct counting of pups. As the majority of pups are born on St. Paul and St. George Islands, pup surveys are conducted biennially on these islands. Pup production estimates are available less frequently on Sea Lion Rock (adjacent to St. Paul Island) and Bogoslof Island (Table 1). Annual variation in female reproductive rates is reflected in the respective pup production estimates; because the estimation of stock population size relies on these estimates of pup production, means of recent pup production estimates are used to account for variability in the reproductive rates over time. The most recent estimate for the number of 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 ~~2010,~~ 2012, ~~and~~ 2014, and 2016), and on Bogoslof Island (mean of 2011 and 2015), is ~~637,561~~620,660 northern fur seals (4.47 × ~~142,631~~138,850).

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 (~~0.002~~0.006)
2016	80,641 (717)	"	20,490 (460)	"	134,131 (0.007)

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 ~~was~~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 (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of ~~637,561~~620,660 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock is ~~539,638~~525,333 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 after the termination of commercial sealing on St. George in 1972 and pelagic sealing for science in 1974; commercial sealing on St. Paul continued until 1984. The population then began to decrease, 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 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 that was similarly followed by a decline. However, pup production appeared to stabilize again on St. George Island beginning around 2002 (Fig. 3). During ~~1998-2014~~1998-2016, pup production declined ~~4.25~~4.12% per year (SE = ~~0.48~~0.40%; P < 0.01) on St. Paul Island and ~~1.42% per year~~showed no significant trend (SE = ~~0.54~~0.57%; P = ~~0.04~~0.13) on St. George Island. The estimated pup production in ~~2014~~2016 was below the ~~1917~~1919 level (~~Bower and Aller 1918~~Bower 1920) on both St. Paul and St. George Islands. Northern fur seal pup production at Bogoslof Island has grown at an exponential rate since the 1990s (Towell and Ream 2012) (Fig. 4). Despite continued growth at Bogoslof Island, recent estimates of pup production indicate that the rate of increase may be slowing. Between 1997 and 2015, pup production at Bogoslof Island increased 10.1% per year. 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.

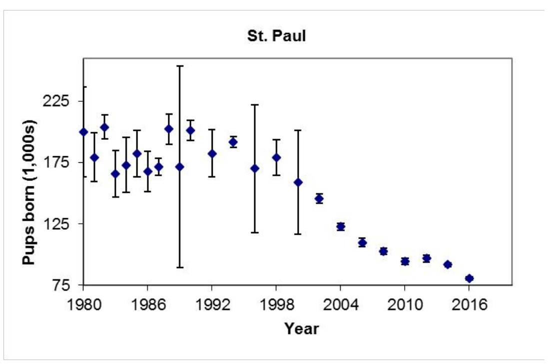

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, 1980-~~2014~~2016.

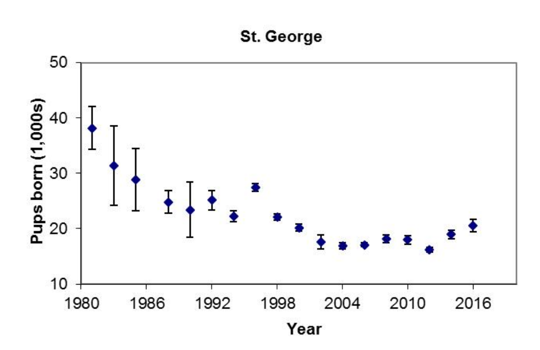

Figure 3. Estimated number of northern fur seal pups born on St. George Island, 1980-~~2014~~2016.

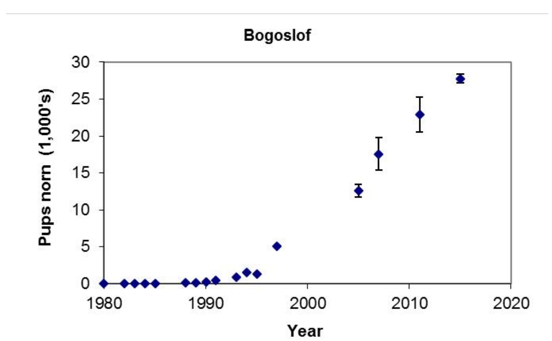

Figure 4. Estimated number of northern fur seal pups born on Bogoslof Island, 1980-2016.

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 during 1912-1924. 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 ~~theoretical~~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) (Wade and Angliss 1997). Thus, for the Eastern Pacific stock of northern fur seals, PBR = ~~11,602~~11,295 fur seals (~~539,638~~525,333 × 0.043 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~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 Eastern Pacific northern fur seals in ~~2011-2015~~2012-2016 is ~~436~~457 fur seals: ~~3.2~~2.4 in U.S. commercial fisheries, ~~2.4~~ 2 in unknown (commercial, recreational, or subsistence fisheries), ~~5.2~~5 in marine debris, 0.4 due to other causes (power plant entrainment and car strike), and ~~425~~447 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 in ~~2011-2015~~2012-2016 (see details in text and in Helker et al. ~~2017~~in press). 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

~~Detailed i~~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.

During ~~2011-2015~~2012-2016, incidental mortality and serious injury of northern fur seals was observed in one of the ~~22~~ federally-~~regulated~~managed 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 estimated mean annual mortality and serious injury rate in this fishery in ~~2011-2015~~2012-2016 is ~~0.6~~0.2 northern fur seals.

Observer programs for Alaska State-managed commercial fisheries have not documented any mortality or serious injury of northern fur seals (Wynne et al. 1991~~, 1992;~~, Manly ~~2006,~~ 2007).

Table 2. Summary of incidental mortality and serious injury of Eastern Pacific northern fur seals due to U.S. commercial fisheries in ~~2011-2015~~2012-2016 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~99~~ 99 99 99 99 99	~~0~~ 0 0 1 ~~2~~0 0	~~0~~ 0 0 1 ~~2~~0 0	~~0.6~~0.2 (CV = ~~0.02~~0.04)
Minimum total estimated annual mortality						~~0.6~~0.2 (CV = ~~0.02~~0.04)

Entanglements of northern fur seals have been observed on St. Paul, St. George, and Bogoslof Islands. Since 2011, there has been an increased effort to include entanglement reports in the NMFS Alaska Region stranding database. A summary of entanglements in fishing gear reported in ~~2011-2015~~2012-2016 is provided in Table 3 (Helker et al. ~~2017~~in press). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and ~~should be considered a~~are minimums because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined. Three northern fur seals entangled in commercial Bering Sea/Aleutian Islands halibut longline gear and ~~10~~eight northern fur seals entangled in commercial Bering Sea/Aleutian Islands trawl gear were reported to the NMFS Alaska Region stranding network in ~~2011-2015~~2012-2016, resulting in minimum mean annual mortality and serious injury rates of 0.6 and ~~2~~1.6 fur seals, respectively, in these fisheries (Table 3; Helker et al. ~~2017~~in press).

An additional ~~eight~~nine northern fur seals were initially considered to be seriously injured due to entanglement in commercial Bering Sea/Aleutian Islands trawl gear (~~2 in 2011,~~ 2 in 2012, 1 in 2014, and 1 in 2015), unidentified trawl gear (3 in 2016), and unidentified net (1 each in ~~2011 and~~ 2012 and 2016); however, ~~since~~because these animals were disentangled and released with non-serious injuries (Helker et al. ~~2017~~in press), they were not included in the mean annual mortality and serious injury rate for ~~2011-2015~~2012-2016.

The total mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in ~~2011-2015~~2012-2016 is ~~3.2~~2.4 northern fur seals (~~0.6~~0.2 from observer data + ~~2.6~~2.2 from stranding data).

The minimum mean annual mortality and serious injury rate due to entanglement in ~~pot gear (0.2), fishing line (0.2),~~ gillnet (0.4), unidentified fishing gear (0.2), ~~and~~ unidentified fishing net (0.8), and trawl gear (0.2) in Alaska waters in ~~2011-2015~~2012-2016 is ~~1.8~~1.6 northern fur seals (Table 3; Helker et al. ~~2017~~in press). 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 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 ~~will be~~is assigned to both the Eastern Pacific and California stocks of northern fur seals (see Table 3). During ~~2011-2015~~2012-2016, ~~three~~two northern fur seal entanglements in trawl gear, that occurred off the U.S. west coast in December through May 2014, were reported to the NMFS West Coast Region stranding network (Helker et al. ~~2017~~in press), resulting in an average annual mortality and serious injury rate of ~~0.6~~0.4 Eastern Pacific northern fur seals in these waters (Table 3). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~is a minimum because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined An additional northern fur seal that stranded with a serious injury, due to an unidentified fishery interaction, in May 2012 in California was treated and released with a non-serious injury (Helker et al. ~~2017~~in press); therefore, it was not included in the mean annual mortality and serious injury rate for ~~2011-2015~~2012-2016.

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 in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). Only cases of serious injuries are reported in this table; animals that were disentangled and released with non-serious injuries have been excluded.

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in commercial Bering Sea/Aleutian Is. halibut longline gear	~~0~~	0	0	3	0	0	0.6
Entangled in commercial Bering Sea/Aleutian Is. trawl gear	~~2~~	1	0	6	1	0	~~2~~1.6
~~Entangled in Bering Sea crab pot gear*~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
~~Entangled in Bering Sea/Aleutian Is. monofilament hook and line gear*~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
Entangled in Bering Sea/Aleutian Is. gillnet gear*	~~0~~	0	0	0	1	0	0.2
Entangled in Bering Sea/Aleutian Is. unidentified fisher~~y~~ing gear*	~~0~~	0	0	0	1	0	0.2
Entangled in gillnet*	~~0~~	0	0	1	0	0	0.2
Entangled in unidentified net*	~~0~~	3	0	1	0	0	0.8
Entangled in trawl gear*	~~1[a]~~	0	0	2[a]	0	1	0.6
Entangled in marine debris	~~10~~	4	1	11	0	9	~~5.2~~5
Entrained in power plant intake	~~0~~	1[a]	0	0	0	0	0.2
Struck by car	~~0~~	0	0	0	1	0	0.2
Total in commercial fisheries							~~2.6~~2.2
*Total in unknown (commercial, recreational, or subsistence) fisheries							~~2.4~~2
Total in marine debris							~~5.2~~5
Total due to other sources (power plant entrainment, car strike)							0.4

[a]The ~~M~~mortality or serious injury ~~that~~ occurred off the coasts 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

Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, with a 3-year take range based on historical local needs. Typically, only juvenile males are taken in the subsistence harvest, which results in a much smaller impact on population growth than a harvest that includes females. However, accidental harvesting of females and adult males does occur. A single female was killed during the harvest ~~on St. Paul Island in 2011 (Lestenkof et al. 2011), one female was killed~~ on St. George Island in 2012 (Lekanof 2013), three females were killed on St. Paul Island in 2013 (Lestenkof et al. 2014), four females were killed on St. Paul (Melovidov et al. 2014) and one was killed on St. George (Kashevarof 2014b) in 2014, ~~and~~ two females were killed on St. Paul in 2015 (Lestenkof et al. 2015), and one female was killed on St. Paul in 2016 (Melovidov et al. 2017). Fifty-four pups were killed ~~D~~during the inaugural pup harvest on St. George Island in 2014~~, 54 pups were killed~~ (Testa 2016), ~~and~~ 57 pups were killed in 2015 (Meyer 2016), and 46 were killed in 2016 (Meyer 2017). During ~~2011-2015~~2012-2016, the average annual subsistence harvest on the Pribilof Islands was ~~425~~447 northern fur seals (Table 4).

Table 4. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands in ~~2011-2015~~2012-2016.

Year	St. Paul	St. George	Total harvested
~~2011~~	~~323[a]~~	~~120[b]~~	~~443~~
2012	383~~[c]~~[a]	64~~[d]~~[b]	447
2013	301~~[e]~~[c]	80~~[f]~~[d]	381
2014	266~~[g]~~[e]	~~158[h, i]~~212[f]	~~424~~478
2015	314~~[j]~~[g]	~~118[k]~~175[f]	~~432~~489
2016	309[f]	129[f]	438
Mean annual ~~take~~harvest			~~425~~447

~~[a]Lestenkof et al. (2011); [b]Merculief (2011);~~ ~~[c]~~[a]Lestenkof et al. (2012); ~~[d]~~[b]Lekanof (2013); ~~[e]~~[c]Lestenkof et al. (2014); ~~[f]~~[d]Kashevarof (2014a); ~~[g]~~[e]Melovidov et al. (2014); [f]NMFS, unpubl. data;~~[h]Kashevarof (2014b); [i]Testa (2016);~~ ~~[j]~~[g]Lestenkof et al. (2015)~~; [k]Kashevarof (2015)~~.

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.

~~Since~~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 coasts of Washington, Oregon, or California during that time ~~will be~~is assigned to both stocks (see details in Table 3). Reports to ~~T~~the NMFS Alaska Region and West Coast Region stranding networks in 2012-2016 resulted in mean annual mortality and serious injury rates of 5 northern fur seals due to entanglement in marine debris in Alaska waters ~~(5.2)~~, ~~and~~0.2 due to a car strike on St. Paul Island ~~(0.2) is 5.4 Eastern Pacific northern fur seals in 2011-2015 (Table 3; Helker et al. 2017). A northern fur seal mortality in 2012~~, and 0.2 due to entrainment in the cooling water system of a California power plant ~~resulted in an additional mean annual mortality and serious injury rate of 0.2 Eastern Pacific northern fur seals in 2011-2015~~ (Table 3; Helker et al. ~~2017~~in press). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~ are minimums because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined

An additional ~~20~~23 northern fur seals that were initially considered seriously injured due to entanglement in marine debris (~~3 in 2011,~~ 7 in 2012, 4 in 2014, ~~and~~ 6 in 2015, and 6 in 2016) were disentangled and released with non-serious injuries (Helker et al. ~~2017~~in press); therefore, these animals were not included in the mean annual mortality and serious injury rate for ~~2011-2015~~2012-2016.

~~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 2011-2015, no research-related mortality or serious injury was reported for the Eastern Pacific stock of northern fur seals (Helker et al. 2017).~~

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 (~~3.2~~2.4 fur seals) is less than 10% of the calculated PBR (10% of PBR = ~~1,160~~1,130 fur seals) and, therefore, can be considered ~~to be~~ insignificant and approaching a zero mortality and serious injury rate. The total estimated annual level of human-caused mortality and serious injury (~~436~~457 fur seals) does not exceed the PBR (~~11,602~~11,295) for this stock. However, given that the population is declining for unknown reasons, and this decline is not explained by the relatively low level of known direct human-caused mortality and serious injury, there is no reason to believe that limiting mortality and serious injury to the level of the PBR will reverse the decline. 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

Northern fur seals are described as generalist or opportunistic foragers ~~on~~consuming a wide variety of midwater shelf and mesopelagic fish and squid species~~, including pollock~~. Walleye pollock is the predominant prey of northern fur seals foraging 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). ~~Some historically relevant prey items, such as capelin, have disappeared entirely from the fur seal diet and pollock consumption has increased (Sinclair et al. 1994, 1996; Antonelis et al. 1997).~~ Analyses of scats collected from Pribilof Island rookeries during 1987-2000 found that pollock (46-75% by frequency of occurrence, FO) and gonatid squids dominated in the diet and that other primary prey (FO >5%) included Pacific sand lance, Pacific herring, northern smoothtongue, Atka mackerel, and Pacific salmon (Zeppelin and Ream 2006, Zeppelin and Orr 2010). These analyses also found that diets associated with rookery complexes reflected patterns associated with foraging in the specific hydrographic domains identified by Robson et al. (2004). Comparison of ingested prey sizes based on scat and spew analysis indicate a much larger overlap between sizes of pollock consumed by fur seals and those caught by the commercial trawl fishery than was previously known (Gudmundson et al. 2006). Analysis of Bogoslof Island fur seal diet found that it comprised primarily off-shelf species (northern smoothtongue, squid, myctophids) as well as juvenile walleye pollock (Zeppelin and Orr 2010, Kuhn et al. 2014).

~~Tagging studies have shown~~Robson et al. (2004) and Kuhn et al. (2014) found that lactating female fur seals ~~and juvenile males from~~consistently use separate foraging habitats based on groups of breeding rookeries on St. Paul and St. George Islands ~~forage in specific and very different areas (Robson et al. 2004, Sterling and Ream 2004, Kuhn et al. 2014)~~. Sterling and Ream (2004) found that juvenile male fur seals also exhibit habitat segregation similar to that observed by lactating females and also some level of separation between the sexes. Call et al. (2008) also found lactating female northern fur seals had three types of individual foraging route tactics ~~at the~~as they depart from the rookery, which is important to consider in the context of adaptation to changes in environmental conditions and prey distributions. From 1982 to ~~2014~~2016, pup production declined on St. Paul and St. George Islands (Figs. 2 and 3). However, it remains unclear whether the pattern of declines in fur seal pup production on the two Pribilof Islands is related to natural or anthropogenic changes in the fur seals' summer foraging habitat ~~on the eastern Bering Sea shelf~~. In contrast, Bogoslof Island fur seals that forage in the deeper water of the Bering Sea Basin have shown dramatic increases in pup production (Fig. 4). Bogoslof Island experienced substantial volcanic activity beginning in December 2016 and continuing through the summer fur seal breeding season until September 2017. Volcanic activity involved explosive eruptions and ash emissions and dramatically changed the size and shape of the island. Live northern fur seals, including pups, were observed on land in photographs taken during both July and August 2017, but population level impacts on northern fur seals at Bogoslof Island are unknown. Adult female fur seals from Bogoslof Island and the Pribilof Islands spend approximately 8 months in varied regions of the North Pacific Ocean during winter and forage in areas associated with eddies and the subarctic-subtropical transition region (Ream et al. 2005). Thus, environmental changes in the North Pacific Ocean could potentially be affecting abundance and productivity of fur seals breeding in Alaska.

A variety of human activities other than commercial fishing, such as an increase in vessel traffic in Alaska waters and an increased potential for oil spills, may impact northern fur seals. A Conservation Plan for the Eastern Pacific stock was released in December ~~of~~ 2007 (NMFS 2007). This plan reviews known and potential threats to the recovery of fur seals in Alaska.

CITATIONS

~~Antonelis, G. A., E. H. Sinclair, R. R. Ream, and B. W. Robson. 1997. Inter-island variation in the diet of female northern fur seals (*Callorhinus ursinus*) in the Bering Sea. J. Zool., Lond. 242:435-451.~~

Baker, J. D., G. A. Antonelis, C. W. Fowler, and A. E. York. 1995. Natal site fidelity in northern fur seals, *Callorhinus ursinus*. Anim. Behav. 50(1):237-247.

~~Bower, W. T., and H. D. Aller. 1918. Alaska fisheries and fur industries in 1917. U.S. Dep. Commer., Bureau of Fisheries Document No. 847. Washington Government Printing Office. 123 p.~~

Bower, W. T. 1920. Alaska fisheries and fur industries in 1919. U.S. Dep. Commer., Appendix IX to Report of U.S. Commissioner of Fisheries for 1919. Bureau of Fisheries Document No. 891. Washington Government Printing Office. 160 p.

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

Briggs, L., and C. W. Fowler. 1984. Table and figures of the basic population data for northern fur seals of the Pribilof Islands. *In* Background papers submitted by the United States to the 27th annual meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, March 29-April 9, 1984, Moscow, U.S.S.R. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Call, K. A., R. R. Ream, D. Johnson, J. T. Sterling, and R. G. Towell. 2008. Foraging route tactics and site fidelity of adult female northern fur seal (*Callorhinus ursinus*) around the Pribilof Islands. Deep-Sea Res. II 55:1883-1896.

DeLong, R. L. 1982. Population biology of northern fur seals at San Miguel Island, California. Ph.D. Dissertation, University of California, Berkeley, CA. 185 p.

DeLong, R. L., and G. A. Antonelis. 1991. Impacts of the 1982-1983 El Niño on the northern fur seal population at San Miguel Island, California, p. 75-83. *In* F. Trillmich and K. Ono (eds.), Pinnipeds and El Niño: Responses to Environmental Stress. University of California Press, Berkeley, CA.

DeMaster, D. P. 1998. Minutes from the sixth meeting of the Alaska Scientific Review Group, 21-23 October 1997, Seattle, Washington. 40 p. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Dickerson B. R., R. R. Ream, S. N. Vignieri, and P. Bentzen. 2010. Population structure as revealed by mtDNA and microsatellites in northern fur seals, *Callorhinus ursinus*, throughout their range. PL~~O~~oS ONE 5(5):e10671. DOI: dx.doi.org/10.1371/journal.pone.0010671 .

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

Fiscus, C. F. 1983. Fur seals. *In* Background papers submitted by the United States to the 26th annual meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, Washington, DC, 28 March-5 April, 1983. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Gerrodette, T., D. Goodman, and J. Barlow. 1985. Confidence limits for population projections when vital rates vary randomly. Fish. Bull., U.S. 83:207-217.

Gudmundson, C. J., T. K. Zeppelin, and R. R. Ream. 2006. Application of two methods for determining diet of northern fur seals (*Callorhinus ursinus*). Fish. Bull., U.S. 104:445-455.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal, *Callorhinus ursinus*, in the eastern North Pacific Ocean and eastern Bering Sea. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-779, 49 p.

Kashevarof, H. 2014a. Northern fur seal harvests, St. George Island, AK: harvest report for the 2013 season 7.8.2013-8.7.2013. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK. 4 p.

Kashevarof, H. 2014b. Northern fur seal harvests, St. George Island, AK: harvest report for the 2014 season 7.7.2014-8.8.2014. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK. 3 p.

~~Kashevarof, H. 2015. Northern fur seal harvests, St. George Island, AK: harvest report for the 2015 season 7.7.2015-8.7.2015. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK. 4 p.~~

Kenyon K. W., and F. Wilke. 1953. Migration of the northern fur seal, *Callorhinus ursinus*. J. -Mammal. 34(1):86-98.

Kuhn, C. E., R. R. Ream, J. T. Sterling, J. R. Thomason, and R. G. Towell. 2014. Spatial segregation and the influence of habitat on the foraging behavior of northern fur seals (*Callorhinus ursinus*). Can. J. Zool. 92:861-873.

Lander, R. H. 1981. A life table and biomass estimate for Alaskan fur seals. Fish. Res. (Amst.) 1:55-70.

Lander, R. H., and H. Kajimura. 1982. Status of northern fur seals. FAO Fisheries Series 5:319-345.

Lekanof, T. 2013. Northern fur seal harvests, St. George Island, AK: harvest report for the 2012 season 7.8.2012-8.8.2012. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK. 5 p.

~~Lestenkof, P. M., P. I. Melovidov, D. V. Roberts, and P. A. Zavadil. 2011. The subsistence harvest of subadult northern fur seals on St. Paul Island, Alaska in 2011. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 24 p.~~

Lestenkof, P. M., P. I. Melovidov, M. Rukovishnikoff, and P. A. Zavadil. 2012. The subsistence harvest of subadult northern fur seals on St. Paul Island, Alaska in 2012. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 36 p.

Lestenkof, P. M., P. I. Melovidov, and M. Rukovishnikoff. 2014. The subsistence harvest of subadult northern fur seals on St. Paul Island, Alaska in 2013. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 17 p.

Lestenkof, P. M., P. I. Melovidov, and A. P. Lestenkof. 2015. The subsistence harvest of subadult northern fur seals on St. Paul Island, Alaska in 2015. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 16 p.

Loughlin, T. R., W. J. Ingraham, Jr., N. Baba, and B. W. Robson. 1999. Use of a surface-current model and satellite telemetry to assess marine mammal movements in the Bering Sea. University of Alaska Sea Grant Press, AK-SG-99-03, Fairbanks, AK.

~~Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Report to NMFS Alaska Region. 98 p.~~

Manly, B. F. J. 2007. Incidental take and interactions of marine mammals and birds in the Kodiak Island salmon set gillnet fishery, 2002 and 2005. Final Report to Alaska Marine Mammal Observer Program, NMFS Alaska Region. 221 p.

Melovidov, P. I., P. M. Lestenkof, M. Rukovishnikoff, Sr., and D. V. V. Roberts. 2014. The subsistence harvest of subadult northern fur seals on St. Paul Island, Alaska in ~~2011~~2014. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. ~~24~~16 p.

Melovidov, P. I., P. M. Lestenkof, A. P. Lestenkof, L. M. Divine, and R. M. Rukovishnikoff. 2017. The subsistence harvest of subadult northern fur seals on St. Paul Island, Alaska in 2016. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 14 p. + appendices.

~~Merculief, M. 2011. The subsistence harvest of northern fur seals on St. George Island in 2011. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK. 7 p.~~

Meyer, B. 2016. Harvest monitoring services, subsistence harvest of northern fur seals on St. George Island, AK: harvest report for the 2015 season September 15 to November 30, 2015. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK.

Meyer, B. 2017. Harvest monitoring services, subsistence harvest of northern fur seals on St. George Island, AK: harvest report for the 2016 season September 16 to November 30, 2016. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK.

National Marine Fisheries Service (NMFS). 1993. Final conservation plan for the northern fur seal (*Callorhinus ursinus*). Prepared by the National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, and the Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD. 80 p.

National Marine Fisheries Service (NMFS). 2007. Conservation plan for the Eastern Pacific stock of northern fur seal (*Callorhinus ursinus*). National Marine Fisheries Service, Alaska Regional Office, Juneau, AK.

Ream, R. R. 2002. Molecular ecology of northern otariids: genetic assessment of northern fur seal and Steller sea lion distributions. Ph.D. Dissertation, University of Washington, Seattle, WA. 134 p.

Ream, R. R., J. T. Sterling, and T. R. Loughlin. 2005. Oceanographic features related to northern fur seal migratory movements. Deep-Sea Res. II 52:823-843.

Robson, B. R., M. E. Goebel, J. D. Baker, R. R. Ream, T. R. Loughlin, R. C. Francis, G. A. Antonelis, and D. P. Costa. 2004. Separation of foraging habitat among breeding sites of a colonial marine predator, the northern fur seal (*Callorhinus ursinus*). Can. J. Zool. 82:20-29.

Roppel, A. Y. 1984. Management of northern fur seals on the Pribilof Islands, Alaska, 1786-1981. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-4, 32 p.

~~Sinclair, E., T. Loughlin, and W. Pearcy. 1994. Prey selection by northern fur seals (*Callorhinus ursinus*) in the eastern Bering Sea. Fish. Bull., U.S. 92(1):144-156.~~

~~Sinclair, E. H., G. A. Antonelis, B. W. Robson, R. R. Ream, and T. R. Loughlin. 1996. Northern fur seal, *Callorhinus ursinus*, predation on juvenile walleye pollock, *Theragra chalcogramma*, p. 167-178. *In* R. D. Brodeur, P. A. Livingston, T. R. Loughlin, and A. B. Hollowed (eds.), Ecology of walleye pollock, *Theragra chalcogramma*. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-126.~~

Sterling, J. T., and R. R. Ream. 2004. At-sea behavior of juvenile male northern fur seals (*Callorhinus ursinus*). Can. J. Zool. 82:1621-1637.

Testa, J. W. (ed.). 2016. Fur seal investigations, 2013-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-316, 124 p.

Towell, R., and R. Ream. 2012. 2011 northern fur seal pup production estimate on Bogoslof Island, Alaska. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 65 p. Available from NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

~~Wynne, K. M., D. Hicks, and N. Munro. 1992. 1991 marine mammal observer program for the salmon driftnet fishery of Prince William Sound Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 53 p. Available from NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.~~

York, A. E. 1987. Northern fur seal, *Callorhinus ursinus*, eastern Pacific population (Pribilof Islands, Alaska, and San Miguel Island, California), p. 9-21. *In* J. P. Croxall and R. L. Gentry (eds.), Status, biology, and ecology of fur seals. Proceedings of an international symposium and workshop, Cambridge, England, 23-27 April 1984. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-51.

York, A. E., and C. W. Fowler. 1992. Population assessment, Pribilof Islands, Alaska, p. 9-26. *In* H. Kajimura and E. Sinclair (eds.), Fur seal investigations, 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-2.

Zeppelin, T. K., and A. J. Orr. 2010. Stable isotope and scat analyses indicate diet and habitat partitioning in northern fur seals, *Callorhinus ursinus*, across the eastern Pacific. Mar. Ecol. Prog. Ser. 409:241-253.

Zeppelin, T. K., and R. R. Ream. 2006. Foraging habitats based on the diet of female northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands, Alaska. J. Zool. 270:565-576.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

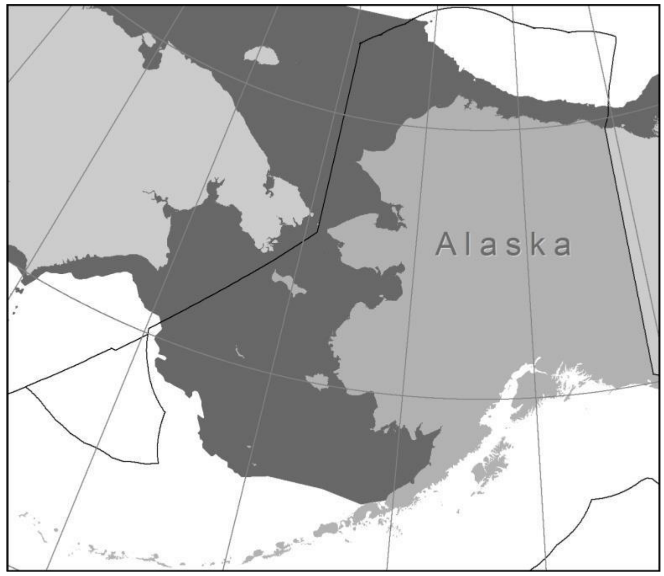

Figure 1. ~~Approximate distribution of bearded seals (dark shaded area) in Alaska. The combined summer and winter distribution are depicted.~~The Alaska stock of bearded seals is defined as the portion of the Beringia DPS (dark shaded areas) in U.S. waters.

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 ~~so~~ are closely linked to areas where the seafloor is shallow (less than 200 m).

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, ~~and~~ the Bering Sea, and the Sea of Okhotsk ~~seas~~ (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. As part of a status review of the bearded seal for consideration of listing as threatened or endangered under the Endangered Species Act (ESA), Cameron et al. (2010) defined longitude 145°E as the Eurasian delineation between the two subspecies and 112°W in the Canadian Arctic Archipelago as the North American delineation between the two subspecies. Based on evidence for discreteness and ecological uniqueness of bearded seals in the Sea of Okhotsk, the *E. b. nauticus* subspecies was further divided into an Okhotsk Distinct Population Segment (DPS) and a Beringia DPS, 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. For the purposes of this stock assessment, we define the Alaska stock of bearded seals to be that portion of the Beringia DPS ~~is considered the Alaska stock of the bearded seal~~in U.S. waters (Fig. 1).

Spring surveys conducted in 1999-2000 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). 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). 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). 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). 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 ~~south~~ 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

A reliable population estimate for the entire stock is not available, but research programs have ~~recently~~ developed ~~new~~ survey methods and partial, but useful, abundance estimates. In spring ~~of~~ 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). ~~The data from these image-based surveys are still being analyzed, but~~ Conn et al. (2014), using a very limited sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of approximately 299,174 bearded seals (95% CI: 245,476-360,544) ~~bearded seals~~ in ~~U.S.~~those waters. ~~These data do not include bearded seals that were in the Chukchi and Beaufort seas at the time of the surveys.~~Researchers expect to provide a population estimate for the entire Alaska stock of bearded seals once the final Bering Sea results can be combined with the results from spring surveys of the Chukchi Sea (conducted in 2016) and Beaufort Sea (planned for 2019).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for the entire stock cannot be determined because reliable abundance estimates are not available for the Chukchi and Beaufort seas. Using the 2012 Bering Sea abundance 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 ~~minimum population estimate (~~N_{MIN}~~)~~ for a stock is usually calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. The abundance estimate by Conn et al. (2014) was calculated using a Bayesian hierarchical framework, however, so we used the 20th percentile of the posterior distribution of abundance estimates in place of the CV in Equation 1. ~~An N_{MIN} for the entire stock cannot presently be determined because current reliable estimates of abundance estimates are not available for the Chukchi and Beaufort seas. Using the 2012 Bering Sea abundance estimate by Conn et al. (2014), however, provides an N_{MIN} of 273,676 bearded seals in the U.S. sector of the Bering Sea.~~

Current Population Trend

~~At present, r~~Reliable data on trends in population abundance for the Alaska stock of bearded seals are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is ~~currently~~ unavailable for the Alaska stock of bearded seals. Hence, until additional data become available, ~~it is recommended that~~ the pinniped maximum theoretical net productivity rate ~~(R_{MAX})~~ of 12% will be ~~employed~~used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

~~Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the~~ 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 with unknown population status (Wade and Angliss 1997). Using the N_{MIN} calculated for bearded seals in the Bering Sea, a PBR for bearded seals that overwinter and breed in the U.S. ~~portion of the~~ Bering Sea = 8,210 seals (273,676 × 0.06 × 0.5). However, this is not an estimate of PBR for the entire stock because a reliable estimate of N_{MIN} is ~~currently~~ not available for the entire stock; i.e., N_{MIN} is not available for the Chukchi and Beaufort seas.

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 Alaska bearded seals in 2012-2016 is 557 seals: 1.6 in U.S. commercial fisheries, 555 in the Alaska Native subsistence harvest (from 2011-2015 data, which are the most recent data available), and 0.4 due to MMPA research-related permanent removals from the population. This is a minimum estimate of the Alaska Native subsistence harvest because only a small proportion of the communities that harvest ice seals are surveyed each year. 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

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

During 2012-2016, incidental mortality and serious injury of bearded seals occurred in three ~~O~~of the ~~22~~ federally-~~regulated~~managed U.S. commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers~~, 12 fisheries could potentially interact with bearded seals. During 2010-2014, incidental mortality and serious injury of bearded seals occurred in three fisheries~~: the Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands flatfish trawl, and Bering Sea/Aleutian Islands Pacific cod trawl fisheries (Table 1; Breiwick 2013; MML, unpubl. data). The estimated minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2012-2106 is ~~1.4~~1.6 bearded seals, based exclusively on observer data.

Table 1. Summary of incidental mortality and serious injury of Alaska bearded seals due to U.S. commercial fisheries in ~~2010-2014~~2012-2016 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. pollock trawl	~~2010~~	obs data	~~86~~	~~0 (+1)[a]~~	~~0 (+1)[b]~~	0.4 ~~(+0.2)[c]~~ (CV = 0.11)
	~~2011~~		~~98~~	~~0~~	~~0~~	
	2012		98	1	1.0	
	2013		97	0	0	
	2014		98	1	1.0	
	2015		99	0	0	
	2016		99	0	0	
Bering Sea/Aleutian Is. flatfish trawl	~~2010~~	obs data	~~99~~	~~0~~	~~0~~	~~0.6~~1 (CV = ~~0.03~~0.01)
	~~2011~~		~~100~~	~~1~~	~~1~~	
	2012		99	1	1.~~0~~	
	2013		99	0	0	
	2014		99	1	1	
	2015		99	2	2	
	2016		99	1	1	
Bering Sea/Aleutian Is. Pacific cod trawl	~~2010~~	obs data	~~66~~	~~0~~	~~0~~	0.2 (CV = 0)
	~~2011~~		~~60~~	~~0~~	~~0~~	
	2012		68	0	0	
	2013		80	1	1	
	2014		80	0	0	
	2015		72	0	0	
	2016		68	0	0	
Minimum total estimated annual mortality						~~1.4~~1.6 (CV = ~~0.04~~0.03)

~~[a]Total mortality and serious injury observed in 2010: 0 seals in sampled hauls + 1 seal in an unsampled haul.~~

~~[b]Total estimate of mortality and serious injury in 2010: 0 seals (extrapolated estimate from 0 seals observed in sampled hauls) + 1 seal (1 seal observed in an unsampled haul).~~

~~[c]Mean annual mortality and serious injury for fishery: 0.4 seals (mean of extrapolated estimates from sampled hauls) + 0.2 seals (mean of number observed in unsampled hauls).~~

Alaska Native Subsistence/Harvest Information

Bearded seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska ~~Native~~coastal communities in ~~western and northern~~ Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee ~~2016~~2017). The Ice Seal Committee, as co-managers with NMFS, recognizes the importance of harvest information and has collected it since 2008~~, when funding and personnel have allowed~~. Annual household survey results compiled in a statewide harvest report include historical ice seal harvest information ~~back to~~from 1960 to 2015 (Quakenbush et al. 2011, Ice Seal Committee 2017).~~ This report is used to determine where and how often harvest information was collected and where to focus in the future (Ice Seal Committee 2016).~~ Bearded seal harvest ~~I~~information for ~~2009-2013~~2011-2015 is available for ~~12~~16 communities ~~(Point Lay, Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills)~~ (see Table 2).~~; but more than 50~~ However, a number of other communities harvest ~~bearded~~ice seals and ~~have not been~~were not surveyed in 2011-2015, ~~in this time period or~~including a few communities that have never been surveyed.

Household ~~H~~harvest surveys are designed to estimate the harvest within ~~the~~each surveyed community, but because of differences in bearded seal availability, cultural hunting practices, and environmental conditions, it is not appropriate to extrapolat~~e~~ ~~ing~~ harvest numbers beyond that community~~ is not appropriate~~. The number of communities surveyed and successive annual surveys in the same communities have also been limited. For example, during ~~2009-2013~~2011-2015, only ~~12~~16 of a possible 64 coastal communities were surveyed for ~~bearded~~ice seals~~ harvest~~; and, of ~~those~~the 16 communities, only ~~6~~4 were surveyed for two or more consecutive years (Ice Seal Committee ~~2016~~2017). Thus, annual community-level harvest estimates totaled across communities provide a partial (i.e., minimum) estimate of annual statewide harvest. The geographic distribution of communities with annual harvest estimates also varies among years, so total annual estimates across communities may be geographically or otherwise biased. During 2011-2015, the minimum annual bearded seal harvest estimates totaled across surveyed communities ranged from 148 (in 1 community) to 1,176 bearded seals (in 4 communities) (Table 2). Based on the available harvest data from these ~~12~~16 communities (Table 2), a minimum estimate of the average annual bearded seal harvest~~ of bearded seals~~ in ~~2009-2013~~2011-2015 is ~~390~~555 seals. The Ice Seal Committee is working ~~toward~~for a better understanding of ice seal harvest by conducting more consecutive surveys in more communities ~~with a~~and one of their goals is to report a statewide ice seal harvest estimate.

Table 2. Alaska bearded seal minimum harvest estimates in ~~2009-2013~~2011-2015 (Ice Seal Committee ~~2016~~2017). Empty cells represent the years in which the communities were not surveyed for harvest information.

Community	~~Estimated b~~Bearded seal minimum harvest estimates						
	~~2009~~	~~2010~~	2011	2012	2013	2014	2015
Nuiqsut						26	
Utqiaġvik (formerly Barrow)						1,070	
Point Lay				55			
Kivalina			123				
Noatak			65				
Buckland			~~47~~48				
Deering			49				
Golovin				11			
Emmonak			106				
Scammon Bay			82	51			
Hooper Bay	~~332~~	~~148~~	210	212	171	64	148
Tununak	~~21~~	~~40~~	42	44			
Tuntutuliak					53		
Quinhagak		~~29~~	26	44	49	16	
Togiak	~~0~~	~~0~~	2				
~~Twin Hills~~	~~0~~	~~0~~					
Dillingham				7			
Minimum ~~T~~total	~~353~~	~~217~~	~~752~~753	~~406~~424	~~220~~273	1,176	148

Other Mortality

~~Mortality and serious injury~~ Permanent removals from the population may occasionally occur ~~incidental to~~during marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. During ~~2010-2014~~2012-2016, ~~no~~two research-related ~~mortality or serious injury~~permanent removals ~~was~~were reported for the Alaska stock of bearded seals (~~Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910~~Helker et al. in press), resulting in a mean annual rate of 0.4 bearded seals.

Beginning in mid-July 2011, elevated numbers of sick or dead ~~seals~~pinnipeds, primarily ringed seals, with skin lesions were discovered in the Arctic and Bering Strait regions. By December 2011, there were more than 100 ~~cases of~~ affected pinnipeds in Alaska, including bearded seals, ringed seals, spotted seals, and walruses ~~in northern and western Alaska~~. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, NMFS and the USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on 20 December ~~20,~~ 2011 (https://alaskafisheries.noaa.gov/pr/ice-seals, accessed June 2018). ~~Disease surveillance efforts in 2012-2013 detected~~Since 2014, few new cases similar to those observed in 2011 have been reported, but the Arctic Pinniped UME investigation has remain~~s~~ed open for bearded seals, ringed seals, spotted seals, and ribbon seals based on continuing reports in 2013-2014 of ~~ice~~ seals in the Bering Strait region with patchy hair loss ~~(alopecia)~~. Some of these seals may be survivors from the 2011 UME. ~~To date, n~~No specific cause for the disease has been identified.

STATUS OF STOCK

On 28 December ~~28,~~ 2012, NMFS listed the Beringia DPS bearded seal (*E. b. nauticus*)~~;~~ and, thus, the Alaska 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 stemming 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). ~~On July 25, 2014, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit that challenged listing bearded seals under the ESA (Alaska Oil and Gas Association v. Pritzker, Case No. 4:13-cv-00018-RPB). The decision vacated NMFS' listing of the Beringia DPS of bearded seals as a threatened species. Consequently, it is also no longer designated as depleted or classified as a strategic stock.~~Because of its threatened status under the ESA, this stock is designated as depleted under the Marine Mammal Protection Act and is classified as a strategic stock. ~~Because the PBR for the entire stock 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. A PBR for only those bearded seals that overwinter and breed in the U.S. portion of the Bering Sea is 8,210 bearded seals. The~~A minimum estimate of the total ~~estimated~~ annual level of human-caused mortality and serious injury is ~~391~~557 bearded seals, which is less than the PBR of 8,210 seals calculated for only those bearded seals that overwinter and breed in the U.S. portion of the Bering Sea. The minimum mean annual rate of U.S. commercial fishery-related mortality and serious injury (1.6 seals) is less than 10% of the PBR (10% of PBR = 821) calculated for U.S. waters 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 ~~currently~~ unknown.

There are key uncertainties in the assessment of the Alaska stock of bearded seals. Abundance estimates are not available for the Beaufort and Chukchi seas and the 2012 Bering Sea abundance estimate by Conn et al. (2014) was calculated using only a limited sub-sample of the data and may be biased. Similarly, counts of harvest by Alaska Natives are taken from surveys of only a fraction of the communities known to harvest marine mammals and so are considered minimum estimates. 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 stems from the likelihood that a warming climate is reducing their preferred sea-ice habitats ~~are being modified by the warming climate~~. ~~Future s~~Scientific projections are for continued and perhaps accelerated warming (Cameron et al. 2010). For bearded seals, 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. Thus, 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 reliable assessment for the future conservation status of each bearded seal DPS requires a focus on projections of specific regional conditions, especially sea ice. End of century projections for the Bering Sea in April-May suggest that there will be sufficient ice only in small zones in the Gulf of Anadyr and in the area between St. Lawrence Island and the Bering Strait. Suitable ice in June in the Bering Sea is predicted to disappear as early as mid-century. To adapt to this regime, bearded seals would likely have to shift their nursing, rearing, and molting areas to the ice-covered seas north of the Bering Strait (Cameron et al. 2010). Laidre et al. (2008) also 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.

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. 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), and oil and gas exploration and development activities (particularly in the outer continental shelf leasing areas), such as disturbance from vessel traffic, seismic exploration noise, orand the potential for oil spills.

CITATIONS

Allen, J. A. 1880. History of North American Pinnipeds: A Monograph of the Walruses, Sea-lions, Sea-bears and Seals of North America. U.S. Department of the Interior, U.S. Government Printing Office, Washington, D.C. 785 p.

Bengtson, J. L., P. L. Boveng, L. M. Hiruki-Raring, K. L. Laidre, C. Pungowiyi, and M. A. Simpkins. 2000. Abundance and distribution of ringed seals (*Phoca hispida*) in the coastal Chukchi Sea, p. 149-160. *In* A. L. Lopez and D. P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1999. AFSC Processed Rep. 2000-11, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Bengtson, J. L., L. M. Hiruki-Raring, M. A. Simpkins, and P. L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999-2000. Polar Biol. 28:833-845.

Braham, H. W., J. J. Burns, G. A. Fedoseev, and B. D. Krogman. 1981. Distribution and density of ice-associated pinnipeds in the Bering Sea. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115. 27 p.

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

Burns, J. J. 1967. The Pacific bearded seal. Alaska Department of Fish and Game, Pittman-Robertson Project Report W-6-R and W-14-R. 66 p.

Burns, J. J. 1981. Bearded seal-*Erignathus barbatus* Erxleben, 1777, p. 145-170. *In* S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2. Seals. Academic Press, New York.

Burns, J. J., and K. J. Frost. 1979. The natural history and ecology of the bearded seal, *Erignathus barbatus*. Alaska Department of Fish and Game. 77 p.

Cameron, M., and P. Boveng. 2007. Abundance and distribution surveys for ice seals aboard USCG *Healy* and the *Oscar Dyson*, April 10-June 18, 2007. Alaska Fisheries Science Center Quarterly Report (April-May-June 2007):12-14.

Cameron, M., and P. Boveng. 2009. Habitat use and seasonal movements of adult and sub-adult bearded seals. Alaska Fisheries Science Center Quarterly Report (October-November-December 2009):1-4.

Cameron, M. F., J. L. Bengtson, P. L. Boveng, J. K. Jansen, B. P. Kelly, S. P. Dahle, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010. Status review of the bearded seal (*Erignathus barbatus*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-211, 246 p.

Conn, P. B., J. M. Ver Hoef, B. T. McClintock, E. E. Moreland, J. M. London, M. F. Cameron, S. P. Dahle, and P. L. Boveng. 2014. Estimating multispecies abundance using automated detection systems: ice-associated seals in the Bering Sea. Methods Ecol. Evol. 5:1280-1293. DOI: dx.doi.org/10.1111/2041-210X.12127.

Fay, F. H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea, p. 383-399. *In* D. W. Hood and E. J. Kelley (eds.), Oceanography of the Bering Sea. University of Alaska, Fairbanks, Institute of Marine Science, Occasional Publication 2.

Fedoseev, G. A. 1965. The ecology of the reproduction of seals on the northern part of the Sea of Okhotsk. Izvestiya TINRO 65:212-216. (Translated from Russian by the Fisheries and Marine Service, Quebec, Canada, Translation Series No. 3369. 8 p.)

Frost, K. J., M. F. Cameron, M. Simpkins, C. Schaeffer, and A. Whiting. 2005. Diving behavior, habitat use, and movements of bearded seal (*Erignathus barbatus*) pups in Kotzebue Sound and Chukchi Sea, p. 98-99. *In* Proceedings of the Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Frost, K. J., A. Whiting, M. F. Cameron, and M. A. Simpkins. 2008. Habitat use, seasonal movements and stock structure of bearded seals in Kotzebue Sound, Alaska. Tribal Wildlife Grants Program, Fish and Wildlife Service, Tribal Wildlife Grants Study U-4-IT. Final Report from the Native Village of Kotzebue, Kotzebue, AK, for U.S. Fish and Wildlife Service, Anchorage, AK. 16 p.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Heptner, L. V. G., K. K. Chapskii, V. A. Arsen'ev, and V. T. Sokolov. 1976. Bearded seal. *Erignathus barbatus* (Erxleben, 1777), p. 166-217. *In* L. V. G. Heptner, N. P. Naumov, and J. Mead (eds.), Mammals of the Soviet Union. Volume II, Part 3--Pinnipeds and Toothed Whales, Pinnipedia and Odontoceti. Vysshaya Shkola Publishers, Moscow, Russia. (Translated from Russian by P. M. Rao, 1996, Science Publishers, Inc., Lebanon, NH.)

~~Ice Seal Committee. 2016. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2014. 76 p.~~

Ice Seal Committee. 2017. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2015. 78 p. Available online: http://www.north-slope.org/departments/wildlife-management/co-management-organizations/ice-seal-committee . Accessed June 2018.

Johnson, M. L., C. H. Fiscus, B. T. Stenson, and M. L. Barbour. 1966. Marine mammals, p. 877-924. *In* N. J. Wilimovsky and J. N. Wolfe (eds.), Environment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Commission, Oak Ridge, TN.

Kelly, B. P. 1988. Bearded seal, *Erignathus barbatus*, p. 77-94. *In* J. W. Lentfer (ed.), Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, DC.

King, J. E. 1983. Seals of the World. 2nd edition. British Museum (Natural History) and Oxford University Press, London, UK. 240 p.

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

MacIntyre, K. Q., K. M. Stafford, C. L. Berchok, and P. L. Boveng. 2013. Year-round acoustic detection of bearded seals (*Erignathus barbatus*) in the Beaufort Sea relative to changing environmental conditions, 2008-2010. Polar Biol. 36(8):1161-1173.

MacIntyre, K. Q., K. M. Stafford, P. B. Conn, K. L. Laidre, and P. L. Boveng. 2015. The relationship between sea ice concentration and the spatio-temporal distribution of vocalizing bearded seals (*Erignathus barbatus*) in the Bering, Chukchi, and Beaufort seas from 2008 to 2011. Prog. Oceanogr. 136:241-249. DOI: dx.doi.org/10.1016/j.pocean.2015.05.008 .

Manning, T. H. 1974. Variation in the skull of the bearded seal, *Erignathus barbatus* (Erxleben). Biological Papers of the University of Alaska 16:1-21.

Moreland, E., M. Cameron, and P. Boveng. 2013. Bering Okhotsk Seal Surveys (BOSS), joint U.S.-Russian aerial surveys for ice-associated seals, 2012-13. Alaska Fisheries Science Center Quarterly Report (July-August-September 2013):1-6.

Nelson, R. K. 1981. Harvest of the sea: coastal subsistence in modern Wainwright. North Slope Borough, Barrow, AK. 125 p.

Nelson, R. R., J. J. Burns, and K. J. Frost. 1984. The bearded seal (*Erignathus barbatus*), p. 1-6. *In* J. J. Burns (ed.), Marine Mammal Species Accounts. Wildlife Technical Bulletin No. 7. Alaska Department of Fish and Game, Juneau, AK.

Ognev, S. I. 1935. Mammals of the U.S.S.R. and Adjacent Countries. Vol. 3. Carnivora (Fissipedia and Pinnipedia). Gosudarst. Izdat. Biol. Med. Lit., Moscow. (Translated from Russian by Israel Program for Scientific Translations, 1962. 741 p.)

Quakenbush, L., J. Citta, and J. Crawford. 2011. Biology of the bearded seal (*Erignathus barbatus*) in Alaska, 1961–2009. Final Report to NMFS. Arctic Marine Mammal Program, Alaska Department of Fish and Game, Fairbanks, AK. 71 p.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Soc.iety for Mar.ine Mammal.ogy, Spec. Publ. No. 4Lawrence, KS. 231 p.
Scheffer, V. B. 1958. Seals, Sea Lions and Walruses: A Review of the Pinnipedia. Stanford University Press, Palo Alto, CA. 179 p.
Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. L. Bengtson. 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. Polar Biol. 26:577-586.
Smith, T. G. 1981. Notes on the bearded seal, *Erignathus barbatus*, in the Canadian Arctic. Department of Fisheries and Oceans, Arctic Biological Station, Can. Tech. Rep. Fish. Aquat. Sci. No. 1042. 49 p.
Wade, P. R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 p.

RIBBON SEAL (*Histriophoca fasciata*): Alaska Stock

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). ~~Ribbon seals are very rarely seen on shorefast ice or land.~~ 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 ~~to the~~ 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~~wards~~ the Bering Strait and the southern part of the Chukchi Sea. ~~By the time the Bering Sea ice recedes through the Bering Strait, there is usually only a small number of ribbon seals hauled out on the ice.~~ 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 ~~and Aleutian Islands~~ (Boveng et al. 2013). However, of 72 ribbon seals satellite tagged in the central Bering Sea during 2007-2010, ~~only~~ 21 seals (29%) moved to the Bering Strait, Chukchi Sea, or Arctic Basin as the ice retreated northward, while the other tagged seals (51 seals)~~. About 9.5% of ribbon seals' time budget during July through October was in those areas. The majority of the seals tagged in the central Bering Sea~~ did not pass north of the Bering Strait (Boveng et al. 2013). Year-long passive acoustic sampling, 2008-2009, on the Chukchi Plateau also detected ribbon seal calls in October and November 2008 (Moore et al. 2012), similarly indicating presence of some ribbon seals north of the Bering Strait during fall. The~~se~~ 72 tagged seals~~,~~ and the 10 seals tagged ~~in 2005~~ near Kamchatka~~,~~ dispersed widely, occupying coastal areas as well as the ~~interior~~middle of the Bering Sea, both on and off the continental shelf (Boveng et al. 2013). ~~Year-long passive acoustic sampling on the Chukchi Plateau from autumn 2008-2009 detected ribbon seal calls only in October and November 2008 (Moore et al. 2012).~~

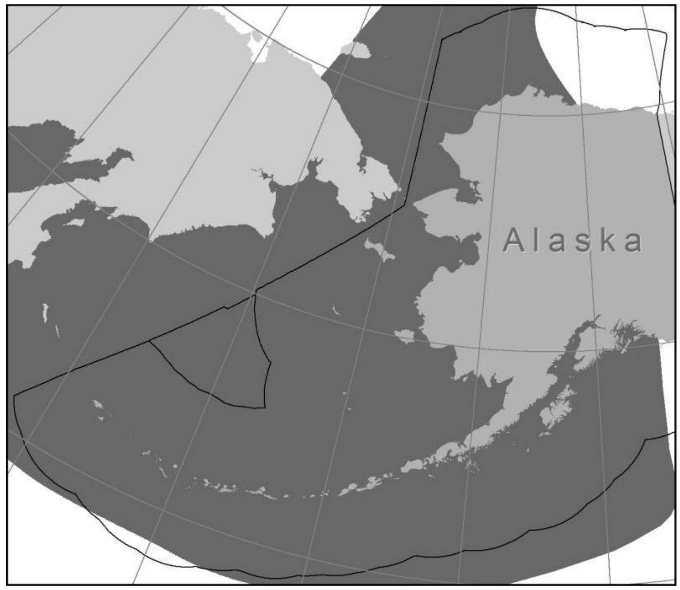

Figure 1. The Alaska stock of ribbon seals is defined as the portion of their distribution in U.S. waters. ~~Approximate distribution of ribbon seals (~~The dark shaded area~~s~~s~~) in Alaska waters.~~ depict ~~T~~the combined summer and winter distribution ~~is depicted~~.

The following information was considered in classifying stock structure based on 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~~,~~ and the absence of ~~any~~ significant fishery interactions, there is currently no strong evidence to ~~suggest~~support ~~splitting~~delineation of the distribution of ribbon seals into more than one stock (Boveng et al. 2013). Therefore, only the Alaska stock of ribbon seal is recognized in U.S. waters.

POPULATION SIZE

A reliable population estimate for the entire stock is not available, but research ~~programs have~~has ~~recently~~ developed ~~new~~ survey methods and partial, but useful, abundance estimates. In spring ~~of~~ 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys of the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). ~~The data from these image-based surveys are still being analyzed, but~~ Conn et al.

(2014), using a very limited sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of approximately 184,000 ribbon seals (95% CI: 145,752-230,134) ~~ribbon seals~~ in those waters. Al~~T~~though this ~~should be~~is ~~considered only~~ a preliminary estimate, ~~it is appropriate to consider~~ this abundance is a reasonable estimate for the entire U.S. population ~~of ribbon seals~~ because relatively few ribbon seals are expected ~~to be~~ north of the Bering Strait ~~in the spring when~~during these surveys ~~were conducted~~. When the final analyses for ~~both~~ the Bering Sea and Sea of Okhotsk ~~seas~~ are complete, they ~~should~~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 (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. ~~Using t~~The 2012 Bering Sea abundance estimate by Conn et al. (2014), however, was calculated using a Bayesian hierarchical framework and so it is more accurate to use the 20th percentile of the posterior distribution of abundance estimates in place of the CV in Equation 1 to provide~~s~~ an N_{MIN} of 163,086 ribbon seals in this stock.

Current Population Trend

~~At present, r~~Reliable data on trends in population abundance for the Alaska stock of ribbon seals are unavailable. This stock is thought to occupy its entire historically-observed range (Boveng et al. 2013).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is ~~currently~~ unavailable for the Alaska stock of ribbon seals. Hence, until additional data become available, ~~it is recommended that~~ the pinniped maximum theoretical net productivity rate ~~(R_{MAX})~~ of 12% will be ~~employed~~used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

~~Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the~~ 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 1.0, the value for stocks thought to be stable (Wade and Angliss 1997). Thus, the PBR for the Alaska stock of ribbon seals = 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 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 ribbon seals in 2012-2016 is 3.9 seals: 1.1 in U.S. commercial fisheries (from 2012-2016 data) and 2.8 in the Alaska Native subsistence harvest (from 2011-2015 data). This is a minimum estimate of the Alaska Native subsistence harvest because only a small proportion of the communities that harvest ice seals are surveyed each year. 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

~~Detailed i~~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.

~~Until 2003, there were three different federally regulated commercial fisheries in Alaska that could have interacted with ribbon seals and were monitored for incidental mortality and serious injury by fishery observers. As of 2003, changes in fishery definitions in the MMPA List of Fisheries have resulted in separating these 3 fisheries into 13 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. Between 2009 and 2013~~During 2012-2016, incidental mortality and serious injury of ribbon seals 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 Atka mackerel trawl, and~~ 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 minimum ~~average~~mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2012-2016 is ~~0.6~~1.1 ribbon seals, based exclusively on observer data.

Table 1. Summary of incidental mortality and serious injury of ~~the~~ Alaska ~~stock of~~ ribbon seals due to U.S. commercial fisheries ~~from 2009 to 2013~~in 2012-2016 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; ~~N~~MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	~~2009~~ ~~2010~~ ~~2011~~ 2012 2013 2014 2015 2016	obs data	~~99~~ ~~99~~ ~~99~~ 99 99 99 99 99	~~0~~ ~~0~~ ~~0~~ 1 0 1 0 0	~~0~~ ~~0~~ ~~0~~ 1 0 1 0 0	~~0.2~~0.4 (CV = ~~0.01~~0.03)
~~Bering Sea/Aleutian Is. Atka mackerel trawl~~	~~2009~~ ~~2010~~ ~~2011~~ ~~2012~~ ~~2013~~	~~obs data~~	~~99~~ ~~99~~ ~~99~~ ~~99~~ ~~99~~	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0.2~~ ~~(CV = 0.01)~~
Bering Sea/Aleutian Is. pollock trawl	~~2009~~ ~~2010~~ ~~2011~~ 2012 2013 2014 2015 2016	obs data	~~86~~ ~~86~~ ~~98~~ 98 97 98 99 99	~~1~~ ~~0~~ ~~0~~ 0 0 0 0 1	~~1~~ ~~0~~ ~~0~~ 0 0 0 0 1.0	0.2 (CV = 0.1~~1~~)
Bering Sea/Aleutian Is. Pacific cod trawl	2012 2013 2014 2015 2016	obs data	68 80 80 72 68	0 0 1 0 0	0 0 1.4 0 0	0.3 CV = 0.55
Bering Sea/Aleutian Is. rockfish trawl	2012 2013 2014 2015 2016	obs data	100 99 99 100 99	0 0 1 0 0	0 0 1 0 0	0.2 CV = 0.01
Minimum total estimated annual mortality						~~0.6~~1.1 (CV = ~~0.04~~0.14)

Alaska Native Subsistence/Harvest Information

Ribbon seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska ~~Native~~coastal communities in ~~western and northern~~ Alaska, from Bristol Bay to ~~Kaktovik~~the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee ~~2014~~2017). The Ice Seal Committee, as co-managers with NMFS, recognizes the importance of harvest information and has ~~been~~ collected~~ing~~ it since 2008~~ as funding and available personnel have allowed~~. Annual household survey results ~~are~~ compiled in a statewide harvest report ~~that~~ includes historical ice seal harvest information ~~back to~~from 1960 to 2015 (Quakenbush and Citta 2008, Ice Seal Committee 2017). ~~This report is used to determine where and how often harvest information has been collected and where efforts need to be focused in the future (Ice Seal Committee 2014).~~ ~~Current~~Ribbon seal harvest information~~, within the last 5 years,~~ for 2011-2015 is available for ~~11~~16 communities ~~(Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills)~~ (see Table 2)~~, but more than 50~~. However, a number of other communities harvest ~~ribbon~~ice seals and ~~have not been~~were not surveyed~~,~~ in ~~the last 5 years or~~2011-2015, including a few communities that have never been surveyed.

Household ~~H~~harvest surveys are designed to ~~confidently~~ estimate the harvest within ~~the~~each surveyed community, but because of differences in ribbon seal availability, cultural hunting practices, and environmental conditions, it is not appropriate to extrapolat~~e~~~~ing~~ harvest numbers beyond that community~~ is misleading~~. The number of communities surveyed and successive annual surveys in the same communities have also been limited. For example, during ~~the past 5 years (2009-2013)~~2011-2015, ~~only 11~~16 of ~~the~~ 64 coastal communities ~~have been~~were surveyed for ~~ribbon~~ice seals harvests and, of ~~those~~the 16 communities, only ~~6~~4 ~~have been~~were surveyed for two or more consecutive years (Ice Seal Committee ~~2015~~2017). Thus, annual community-level harvest estimates totaled across communities provide a partial (i.e., minimum) estimate of annual statewide harvest. The geographic distribution of communities with annual harvest estimates also varies among years, so total annual estimates across communities may be geographically or otherwise biased. During 2011-2015, the minimum annual ribbon seal harvest estimates totaled across surveyed communities ranged from 0 to 8 seals (Table 2). Based on the available harvest data from these ~~11~~16 communities (Table 2), a minimum estimate of the average annual ribbon seal harvest ~~of ribbon seals~~ in ~~2009-2013~~2011-2015 is ~~3.2~~2.8 seals. The Ice Seal Committee is working ~~toward~~for a better understanding of ice seal harvest by conducting more consecutive surveys in more communities, ~~with the~~and one of their goals is ~~of being able~~ to report a statewide ice seal harvest estimate~~ in the future~~.

Table 2. Alaska ~~R~~ribbon seal minimum harvest estimates ~~from 2009 to 2013~~in 2011-2015 ~~and the Alaska Native population for each community~~ (Ice Seal Committee ~~2015~~2017). Empty cells represent the years in which the communities were not surveyed for harvest information.

Community	~~Alaska Native population (2013)~~	~~Estimated r~~Ribbon seal minimum harvest estimates						
		~~2009~~	~~2010~~	2011	2012	2013	2014	2015
Nuiqsut							0	
Utqiaġvik (formerly Barrow)							0	
Point Lay					0			
Kivalina	~~352~~			0				
Noatak	~~514~~			1				
Buckland	~~519~~			0				
Deering	~~176~~			0				
Golovin					0			
Emmonak	~~782~~			0				
Scammon Bay	~~498~~			4	2			
Hooper Bay	~~1144~~	~~0~~	~~0~~	0	4	0	0	0
Tununak	~~342~~	~~0~~	~~0~~	0	0			
Tuntutuliak						0		
Quinhagak	~~694~~		~~2~~	3	0	0	0	
Togiak	~~842~~	~~0~~	~~0~~	0				
~~Twin Hills~~	~~66~~	~~0~~	~~0~~					
Dillingham					0			

Community	~~Alaska Native population (2013)~~	~~Estimated r~~Ribbon seal minimum harvest estimates						
		~~2009~~	~~2010~~	2011	2012	2013	2014	2015
Minimum ~~T~~total		~~0~~	~~2~~	8	6	0	0	0

Other Mortality

Beginning in mid-July 2011, elevated numbers of sick or dead ~~seals~~pinnipeds, primarily ringed seals, with skin lesions were discovered in the Arctic and Bering Strait regions~~ of Alaska~~. By December 2011, there were more than 100 ~~cases of~~ affected pinnipeds in Alaska, including bearded seals, ringed seals, spotted seals, ~~bearded seals,~~ and walruses~~, in northern and western Alaska~~. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, ~~NOAA~~NMFS and the USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on 20 December ~~20,~~ 2011 (https://alaskafisheries.noaa.gov/pr/ice-seals, accessed June 2018). ~~Disease surveillance efforts in 2012-2013~~ Since 2014, ~~did not detect any~~few new cases similar to those observed in 2011 have been reported, but the Arctic Pinniped UME investigation has remaineds open for ~~ice~~bearded seals, ringed seals, spotted seals, and ribbon seals, based on continuing reports in 2013 and 2014 of ~~ice~~ seals in the Bering Strait region with patchy hair loss. Some of these seals may be survivors from the 2011 UME. ~~To date, n~~No specific cause for the disease has been identified. ~~No ribbon seal cases were reported but they are not a coastal species and are seldom observed.~~

STATUS OF STOCK

Ribbon seals are not designated as "depleted" under the Marine Mammal Protection Act or listed as "threatened" or "endangered" under the Endangered Species Act~~ (ESA)~~. The minimum population estimate of ribbon seals in U.S. waters is 163,086 seals, with a PBR of 9,785. Because the estimated ~~average~~ annual level of U.S. commercial fishery-related mortality and serious injury (~~0.6~~1.1) is less than 10% of PBR (10% of PBR = 979), it can be considered insignificant and approaching zero mortality and serious injury rate. ~~The~~A minimum estimate of the total ~~estimated~~ annual level of human-caused mortality and serious injury ~~based on commercial fisheries observer data (0.6) and a minimum estimate of the Alaska Native harvest (3.2)~~ is ~~3.8~~3.9 ribbon seals. The Alaska stock of ribbon seals is not considered a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Alaska stock of ribbon seals. The abundance estimate by Conn et al. (2014) uses a very limited sub-sample of data from the U.S. portion of the Bering Sea and may be biased. Similarly, counts of harvest by Alaska Natives are taken from surveys of only a fraction of the communities known to harvest marine mammals and so are considered minimum estimates. Based on the best available information, ribbon seals are likely to be moderately sensitive to climate change.

HABITAT CONCERNS

~~Evidence indicates that the Arctic climate is changing significantly and that one result of the change is a reduction in the extent of sea ice in at least some regions of the Arctic (ACIA 2004, Johannessen et al. 2004). Ribbon seals, along with other seals that are dependent on sea ice for at least part of their life history, will be vulnerable to reductions in sea ice.~~ The main concern about the conservation status of ribbon seals stems from the likelihood that a warming climate is reducing their preferred sea-ice habitats~~ has been modified by the warming climate~~. ~~and, more so, that the s~~Scientific ~~consensus~~ projections are for continued and perhaps accelerated warming ~~in the foreseeable future~~ (Boveng et al. 2013). Ribbon seals, along with other seals that are dependent on sea ice for at least part of their life history (e.g., whelping and nursing young), will be vulnerable to reductions in sea ice. A second major concern, ~~related by the common driver~~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 ~~impact~~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. 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. Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait) and oil and gas exploration and development activities (particularly in the outer continental shelf leasing areas), such as disturbance from vessel traffic, seismic exploration noise, and the potential for oil spills.

CITATIONS

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

Boveng, P. L., J. L. Bengtson, M. F. Cameron, S. P. Dahle, E. A. Logerwell, J. M. London, J. E. Overland, J. T. Sterling, D. E. Stevenson, B. L. Taylor, and H. L. Ziel. 2013. Status review of the ribbon seal (*Histriophoca fasciata*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-255, 174 p.

Braham, H. W., J. J. Burns, G. A. Fedoseev, and B. D. Krogman. 1984. Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walruses in the Bering Sea, April 1976,. Pp. 25-47. *In* F. H. Fay and G. A. Fedoseev (eds.), Soviet-American cooperative research on marine mammals. Vol. 1. Pinnipeds. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-12.

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

Burns, J. J. 1970. Remarks on the distribution and natural history of pagophilic pinnipeds in the Bering and Chukchi Seas. J. Mammal. 51:445-454.

Burns, J. J. 1981. Ribbon seal-*Phoca fasciata*., Pp. 89-109. *In* S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2. Seals. Academic Press, New York.

Burns, J. J., L. H. Shapiro, and F. H. Fay. 1981. Ice as marine mammal habitat in the Bering Sea., Pp. 781-797. *In* D. W. Hood and J. A. Calder (eds.), The Eastern Bering Sea Shelf: Oceanography and Resources. Vol. 2. U.S. Dep. Commer., NOAA, Office of Marine Pollution Assessment, Juneau, AK.

Conn, P. B., J. M. Ver Hoef, B. T. McClintock, E. E. Moreland, J. M. London, M. F. Cameron, S. P. Dahle, and P. L. Boveng. 2014. Estimating multispecies abundance using automated detection systems: ice-associated seals in the Bering Sea. Methods Ecol. Evol. 5:1280-1293. DOI: dx.doi.org/10.1111/2041-210X.12127 .

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Ice Seal Committee. 2014. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2012. 76 pp.

Ice Seal Committee. 2015. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2013. 75 pp.

Ice Seal Committee. 2017. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2015. 78 p. Available online: http://www.north-slope.org/departments/wildlife-management/co-management-organizations/ice-seal-committee . Accessed June 2018.

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

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

Moore, S. E., K. M. Stafford, H. Melling, C. Berchok, Ø. Wiig, K. M. Kovacs, C. Lydersen, and J. Richter-Menge. 2012. Comparing marine mammal acoustic habitats in Atlantic and Pacific sectors of the High Arctic: year-long records from Fram Strait and the Chukchi Plateau. Polar Biol. 35:475-480. DOI: dx.doi.org/10.1007/s00300-011-1086-y .

Moreland, E., M. Cameron, and P. Boveng. 2013. Bering Okhotsk Seal Surveys (BOSS): joint U.S.-Russian aerial surveys for ice associated-seals, 2012-13. Alaska Fisheries Science Center Quarterly Report (July-August-September 2013).

Quakenbush, L., and J. Citta. 2008. Biology of the ribbon seal in Alaska. Report to NMFS. Arctic Marine Mammal Program, Alaska Department of Fish and Game, Fairbanks, AK. 45 p.

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

Revised ~~12/30/2017~~8/10/2018

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) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). In Alaska, depending on season and region, beluga whales may occur in both offshore and coastal waters, with genetically distinct summer concentrations in upper Cook Inlet, Bristol Bay, and the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea~~ (Mackenzie River Delta)~~ (Hazard 1988, O'Corry-Crowe et al. ~~1997~~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 ~~a few~~ whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show month to month ranges that include summering areas and autumn migratory routes that are relatively distinct ~~month to month~~ for ~~these~~each populations~~' summering areas and autumn migratory routes~~ (e.g., Hauser et al. 2014, Citta et al. 2017). Tag data for ~~B~~beluga whales found in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a, 2018) show tagged whales remained in those areas throughout the year~~, showing only small seasonal shifts in distribution~~.

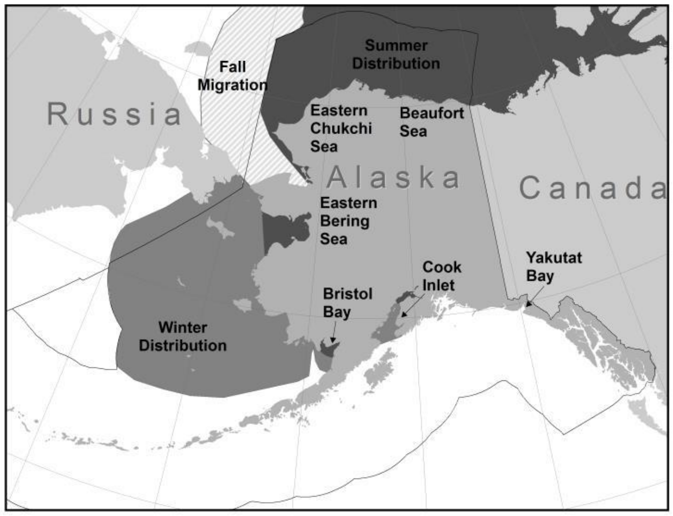

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration.

Beluga whale stock structure was based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous (Frost and Lowry 1990); 2) Population response data: possible extirpation of local populations, 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 populations in summering areas (O'Corry-Crowe et al. 2002). Based on this information, five beluga whale stocks are recognized within U.S. waters (Fig. 1): 1) Cook Inlet~~ (Fig. 1)~~, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea.

During ice-free months, Cook Inlet beluga whales are ~~typically~~often concentrated near river mouths (~~Rugh et al. 2010~~Shelden et al. 2015a). The fall-winter-spring distribution of this stock is not fully determined; however, there is evidence that most whales in this population inhabit upper Cook Inlet year-round (~~Hansen and Hubbard 1999, Rugh et al. 2004,~~ Lammers et al. 2013, Castellote et al. 2015, Shelden et al. 2015a). ~~During summers f~~From 1999 to 2002, satellite tags were attached to a total of 18 Cook Inlet beluga whales ~~in Cook Inlet~~ to determine their ~~distribution through the fall and winter months~~movement patterns (~~Hobbs et al. 2005,~~ Goetz et al. 2012a~~,~~; Shelden et al. 2015a, 2018). ~~Ten tags transmitted whale locations from September through November (fall) and, of those, three stopped transmitting in January (winter), three in March, and one in late May (spring) (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a).~~ All tagged beluga whales remained in Cook Inlet, primarily in the upper inlet ~~waters~~north of the East and West Forelands, with brief trips to the lower inlet (Shelden et al. 2015a, 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 whales occurred in the Gulf of Alaska outside Cook Inlet (Laidre et al. 2000). ~~A small number of beluga whales~~Yakutat Bay is the only area in the Gulf of Alaska outside of Cook Inlet where multiple sightings have occurred (~~fewer than 20 animals:~~ Laidre et al. 2000, Lucey et al. 2015, O'Corry-Crowe et al. 2015)~~ are regularly observed in Yakutat Bay~~. Based on genetic analyses, traditional ecological knowledge (TEK), and observations by fishermen and others~~ that were reported~~

year-round, the Yakutat beluga whales likely represent a small, resident group (fewer than 20 whales) that ishas 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 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 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 and designated as depleted.

POPULATION SIZE

Aerial surveys during June documentededing the early summer distribution and abundance of Cook Inlet beluga whales in Cook Inletand were conducted by NMFS each year from 19931994 to 2012 (Rugh et al. 2000, 2005; Shelden et al. 2013), after which NMFS began biennial surveys in 2014 (Shelden et al. 2015b) (Fig. 2). NMFS changed to a biennial survey schedule after detailed analysis showed that there would be little reduction in assessment qualitythe ability to detect a trend given the current growth rate of the population (Hobbs 2013).

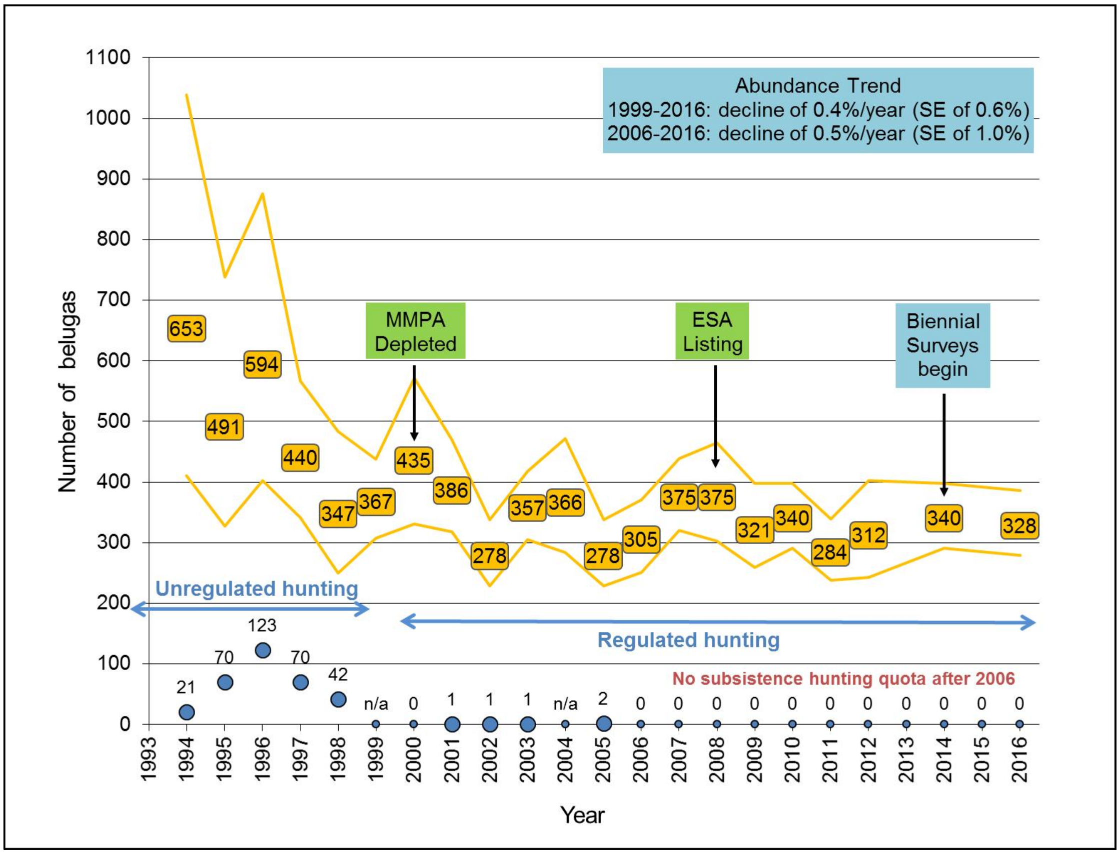

Figure 2. Annual abundance estimates of beluga whales in Cook Inlet, Alaska, 1994-20142016 (Hobbs et al. 2015a, Shelden et al. 2015b2017). Black squaresCircles show reported removals (landed plus struck and lost) during the Alaska Native subsistence hunt. A struck and lost average was calculated by the Cook Inlet Marine Mammal Council (CIMMC) and hunters for 1996, 1997, and 1998. Black vertical barsLines above and below each abundance estimate (number shown in box) depict plus and minus one standard error for each abundance estimate (number in box)the upper and lower confidence limit. From 1999 to 2014, the rate of decline (gray trend line) is 1.3% per year (with a 97% probability that the growth rate is declining), while the 10-year trend (2004-2014) is -0.4% per year (with a 76% probability of declining).

The abundance estimate for Cook Inlet beluga whales ~~in Cook Inlet~~ is based on counts by aerial observers and video analysis of whale groups. Paired, independent observers count each whale group while video is collected during each counting pass. Each count is corrected for subsurface animals (availability correction) and animals at the surface that were missed (sightability correction) based on an analysis of the video tapes (Hobbs et al. 2000). When video counts are not available, observers' counts are corrected for availability and sightability using a regression of counts and an interaction term with an encounter rate against the video count estimates (Hobbs et al. 2000). The estimate of the abundance equation variance was revised using the squared standard error of the average for the abundance estimates in place of the abundance estimate variance and the measurement error (Hobbs et al. 2015a). This reduced ~~the~~all coefficients of variation (CVs) by almost half (Hobbs et al. 2015a). The June ~~2014~~2016 survey resulted in an ~~corrected~~abundance estimate of ~~340~~328 whales (CV = 0.08) (Shelden et al. ~~2015b~~2017). ~~This estimate is more than the estimate of 312 beluga whales for 2012; however, it falls within the statistical variation around the recent trend line and probably represents variability of the estimation process rather than an increase in the population from 2012 to 2014.~~ Annual abundance estimates based on aerial surveys of Cook Inlet beluga whales during the most recent 3-survey period were ~~284 (2011),~~ 312 (2012), ~~and~~ 340 (2014), and 328 (2016) resulting in an average abundance estimate for this stock of ~~312~~327 beluga whales (CV = ~~0.10~~0.06). An abundance ~~estimate~~ survey was conducted in June ~~2016~~2018 and results are undergoing analysis.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997). Thus, $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 3-survey average population estimate (N) of ~~312~~327 whales and an associated CV(N) of ~~0.10~~0.06, N_{MIN} for the Cook Inlet beluga whale stock is ~~287~~311 beluga whales.

Current Population Trend

The corrected annual abundance estimates for 1994-~~2014~~2016 are shown in Figure 2. From 1999 to ~~2014~~2016, the rate of decline was ~~1.3~~0.4% (SE = ~~0.7~~0.6%) per year, with a ~~97~~73% probability that the growth rate is negative, while the 10-year trend (~~2004-2014~~2006-2016) is ~~-0.4~~0.5% per year (with a ~~76~~70% probability the population is declining) (Shelden et al. ~~2015b~~2017).

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. Hence, 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

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 (Wade and Angliss 1997). Using the N_{MIN} of ~~287~~311 beluga whales, the calculated PBR for this stock is ~~0.57~~0.62 beluga whales (~~287~~311 × 0.02 × 0.1). ~~Given the low abundance relative to historical estimates and low known levels of human-caused mortality since 1999, it was anticipated that this stock would grow at a rate between 2% and 6%, but for unknown reasons the Cook Inlet beluga whale stock is not increasing. Because this stock does not meet the assumption that it will increase when human-caused mortality is reduced, inherent to the use of the PBR, the calculated value for PBR is likely biased and any removals from this stock will likely further prevent recovery.~~

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~in press); 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 documented in ~~2011-2015~~2012-2016. There are no observers in ~~fisheries in~~ Cook Inlet fisheries, so the mean annual mortality and serious injury in commercial fisheries is unknown; although, it is likely low given that an observer program conducted in Cook Inlet in 1999~~ and ~~-2000 did not observe ~~any~~ 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 ~~contaminants and~~ ship strikes.

Fisheries Information

~~Detailed i~~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.

The estimated minimum average annual mortality and serious injury rate incidental to U.S. commercial fisheries is unknown, although probably low, given that an observer program directed at the Cook Inlet commercial set and drift gillnet fisheries in 1999-2000 did not observe ~~any~~ mortality or serious injury of beluga whales (Manly 2006).

One entanglement in a subsistence fishery was reported to the NMFS Alaska Region on 7 May 2012; a fisherman reported a juvenile beluga whale entangled and dead in ~~his~~a salmon set net near Kenai, Alaska. The beluga whale was ~~dead and~~ necropsied~~y findings~~ and the results indicated ~~that~~ it was in poor health ~~prior to entanglement~~ and the cause of death was drowning. However, it was not determined whether the beluga whale died before or after the net entanglement.

Alaska Native Subsistence/Harvest Information

Subsistence harvest of Cook Inlet beluga whales ~~in Cook Inlet~~ is important to ~~one local~~the Native ~~v~~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 2016).

Following a significant decline in Cook Inlet beluga whale abundance estimates between 1994 and 1998, the Cook Inlet hunters voluntarily ~~did not hunt~~stood down in 1999 and the Federal government took actions to conserve, protect, and prevent further declines in the abundance of these whales. ~~In 1999 and 2000,~~ Public Laws 106-31 (1999) and 106-553 (2000) established a moratorium on Cook Inlet beluga whale harvests ~~except for subsistence hunts conducted under~~unless such taking occurs pursuant to a cooperative agreement~~s~~ 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~~, so harvest was not authorized in 1999 and 2000~~. In December 2000, an administrative hearing was held to create interim ~~H~~harvest~~s~~ regulations ~~from~~for 2001 through 2004~~ were conducted under harvest regulations~~ (69 FR 17973, 6 April 2004)~~ following an interim harvest management plan developed through an administrative hearing~~. Three Cook Inlet beluga whales were harvested ~~in Cook Inlet~~ under this interim harvest plan (2001-2004). In August 2004, an administrative hearing was held to create a long-term harvest plan~~. An interim plan would have~~, which allowed up to eight whales to be harvested between 2005 and 2009 (https://alaskafisheries.noaa.gov/pr/interim-harvest-plan, accessed ~~December 2017~~June 2018). Two whales were ~~taken~~harvested in 2005 and ~~no takes were authorized~~whales were not successfully hunted in 2006~~ and later under this agreement~~. ~~A~~The long-term harvest plan (https://alaskafisheries.noaa.gov/pr/cib-long-term-harvest-management, accessed ~~December 2017~~June 2018) was signed in 2008 and established ~~allowable~~a harvest level~~s~~ 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. A harvest is not allowed if the previous 5-year average abundance is 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)~~, so the cooperative agreement was not signed and no hunt occurred~~. 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 current 5-year period (2013-2017). ~~The AFSC's Marine Mammal Laboratory~~NMFS changed to a biennial survey schedule after 2012, ~~so~~therefore, the 5-year average abundance ~~will~~is now ~~be~~ based on either two or three surveys in a 5-year period. ~~Analysis in~~ Hobbs (2013) showed that biennial rather than annual ~~abundance~~ surveys may lead to higher variation in harvests, but it is not expected to change the probability of recovery while using the algorithm that determines the allowable harvest level.

Other Mortality

Reports from the NMFS Alaska Region stranding network are another source of beluga whale mortality. Beluga whale carcasses are found along the shore from lower Cook Inlet to Knik and Turnagain Arms.

Mortality related to live stranding events, where a ~~group of~~ beluga whales group ~~becomes~~ strands~~ed~~ as the tide recedes, has been ~~reported~~regularly observed in upper Cook Inlet (Table 1). Improved ~~record-keeping was initiated in 1994, and~~ reports ~~have since~~ include~~d~~ the number of live stranded beluga whales, as well as floating and beachcast carcasses ~~and live stranded beluga whales~~ (NMFS 2016; ~~https://alaskafisheries.noaa.gov/sites/default/files/15strandings.pdf~~https://alaskafisheries.noaa.gov/sites/default/files/16strandings.pdf, accessed ~~December 2017~~June 2018). Most whales involved in a live stranding event survive, although some associated deaths may ~~be missed by~~not be observed~~rs~~ if the whales die later from live-stranding-related injuries (Vos and Shelden 2005, Burek-Huntington et al. 2015). Between ~~2011 and 2015~~2012 and 2016, there were approximately ~~118~~116 beluga whales involved in ~~seven~~six known live stranding events, with two associated deaths reported (Table 1; NMFS 2016). In 2014, necropsy results from two ~~dead~~ whales found in Turnagain Arm suggested ~~the whales had recently live stranded and~~ that ~~the~~a live stranding event ~~may have~~ contributed to their deaths as both had aspirated mud and water. No live stranding events were reported ~~to NMFS~~ prior to the discovery of these dead whales, suggesting that not all live stranding events are observed (Table 1). Most live strandings occur in Knik Arm ~~or~~and Turnagain Arm, ~~both of~~ which are shallow and ~~dangerous waterways~~ have extensive mudflats and strong currents. Turnagain Arm has the ~~largest tidal range~~highest tide in the U.S., with a mean of 9.2 m (30 ft).

Table 1. Cook Inlet beluga whale strandings investigated by NMFS during ~~2011-2015~~2012-2016 (NMFS 2016).

Year	Floating and beachcast carcasses	Number of beluga whales per live stranding event (number of associated known or suspected resulting deaths)
~~2011~~	~~3~~	~~2 (0)~~
2012	3	12 (0), 23 (0), 3 (0)
2013	5	0
2014	10	unknown (2), 76+ (0)
2015	3	2 (0)
2016	8	0
Total	~~24~~29	~~118+~~116+ (2)

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 ~~2015~~2016, NMFS received 31 reports of killer whale sightings in upper Cook Inlet (north of the East and West Forelands) ~~were reported to NMFS. It is not known which of these were mammal-eating killer whales (i.e., transient killer whales) that might prey on beluga whales and which were fish-eating killer whales (i.e., resident killer whales) that would not prey on beluga whales.~~ Up to 12 beluga whale deaths, inlet-wide, ~~during this time~~ were suspected to be a direct result of killer whale predation (NMFS 2016). The last confirmed killer whale predation of a Cook Inlet beluga whale ~~in Cook Inlet~~ occurred in 2008 in Turnagain Arm. ~~In June 2010, a beluga whale carcass found near Point Possession was speculated to have injuries associated with killer whale predation; however, the poor condition of the beluga whale carcass prevented a positive determination of cause of death.~~ From ~~2011~~2012 through ~~2015~~2016, NMFS received ~~three~~two separate ~~reports of~~ killer whale sighting reports (~~1 in 2011 and 2~~both in 2015~~, with one killer whale per sighting~~) in upper Cook Inlet, but there were no reports of predation attempts. Transient killer whale signals 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).

~~A photo-identification study (Kaplan et al. 2009) did not find any instances where Cook Inlet beluga whales appeared to have been entangled in, or to have otherwise interacted with, fishing gear. However, in 2010, a beluga whale with a rope entangled around its girth was observed and photo-documented during May through August. The same whale was photographed in July and August 2011, August 2012, and July 2013, still entangled in the rope line (McGuire et al. 2014). This whale is currently considered to have a non-serious injury (Helker et al. 2017).~~

Between 1998 and 2013, 38 necropsies were performed on beluga whale carcasses (23% of the known stranded carcasses ~~during this time period~~) (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 ~~C~~causes of death ~~in the others was~~were attributed to various types of trauma (18%), perinatal mortality (13%), mass stranding (13%), single stranding (11%), malnutrition (8%), or disease (8%). Several animals had mild to moderate pneumonia, kidney disease, and/or stomach ulcers that likely contributed to their deaths.

A photo-identification study (Kaplan et al. 2009) did not find any instances where Cook Inlet beluga whales appeared to have been entangled in, or to have otherwise interacted with, fishing gear. However, in 2010, a beluga whale with a rope entangled around its girth was observed and photo-documented during May through August. The same whale was photographed in July and August 2011, August 2012, and July 2013, still entangled in the rope line (McGuire et al. 2014). This whale is currently considered to have a non-serious injury (Helker et al. in press).

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~~, in 2008,~~ listed as endangered under the ESA in 2008 (73 FR 62919, 22 October 2008). Therefore, the Cook Inlet beluga whale stock is considered a strategic stock.

There are key uncertainties in the assessment of the Cook Inlet stock of beluga whales. The stock decline ~~has been~~is well documented. While the early ~~cause of the~~ decline was likely due to unrestricted subsistence hunting, it is unknown what has ~~been~~ prevent~~ing~~ed recovery of this stock, ~~since~~because ~~no takes have been allowed for~~ subsistence ~~purposes~~harvest has not been allowed since 2006, and the mortality and serious injury in commercial fisheries is likely ~~to be very~~ low. ~~The calculated PBR level is based on a default maximum net productivity rate which may not be relevant to this stock; the PBR level is likely biased.~~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 ~2-4%, it would currently be adding, on average, about 7-13 whales per year to the population. Although there is currently no known direct human-caused mortality (e.g., from fisheries bycatch, hunting, or other sources), even if the PBR level (~1 whale every 2 years) was taken, it is clear this would have little consequence for the overall population trend given the unexplained lack of increase by 7-13 whales per year. However, given the endangered status of this population, even one take every 2 years may still impede recovery.

HABITAT CONCERNS

Beluga whale critical habitat includes two geographic areas of marine habitat in Cook Inlet that comprise 7,800 km^2 (3,013 mi^2), excluding waters ~~by~~of the Port of Anchorage (76 FR 20180, 11 April 2011). Based on available information from aerial surveys, tagged whales, and opportunistic sightings, beluga whales remain within the inlet year-round. Review of beluga whale presence data from aerial surveys, satellite~~-~~ tagging, and opportunistic sightings collected in Cook Inlet from the late 1970s to 2014 show their range has contracted remarkably since the 1970s (Shelden et al. 2015a). 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 in early June during the aerial survey period, compared to roughly 50% in the past (1978-1979, 1993-1997, 1998-2008). The 2009-2014 ~~range~~distribution was estimated to be only 25% of the range observed in 1978-1979 (Shelden et al. 2015a). 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. 2015a). During surveys in the 1970s, large numbers of whales were scattered throughout the lower inlet in August (Shelden et al. 2015a). 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, ~~O~~only 2 of 10 tagged whales spent time in offshore waters and the lower inlet ~~in August~~ (Shelden et al. 2015a). The ~~N~~numbers of whales observed during the August calf index surveys, conducted from 2005 to 2012, ~~were also within the range of counts reported during~~was similar to the June surveys (Hobbs et al. 2015a, Shelden et al. 2015a), suggesting~~.~~ ~~This~~the contraction in range ~~appears to have~~ continued into late summer. While surveys were not conducted in September during the 1970s and 1980s, aerial surveys in 1993 ~~suggest~~showed some dispersal into lower inlet waters by late September (Shelden et al. 2015a). However, surveys in September and October of 2001 resulted in counts that were ~~within the range of counts made in~~similar to June ~~that same year~~ (Rugh et al. 2004). With the exception of three whales that spent brief periods of time in the lower inlet ~~in~~during September and/or October, most whales transmitting locations in 1999, 2000, 2001, and 2002 remained in the upper inlet north of the East and West Forelands (Shelden et al. 2015a). Counts during aerial surveys in September 2008 were also ~~within the range of counts obtained during surveys in~~similar to June (Shelden et al. 2015a). The population appears to ~~now~~ 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 ~~developed~~noisy (e.g., Moore et al. 2000, Lowry et al. 2006, Hobbs et al. 2015b, Kendall and Cornick 2015, Norman et al. 2015). 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 ~~a~~ small ~~number~~areas of preferred habitat~~ areas~~ (Goetz et al. 2007, 2012b) is unknown.

Goetz et al. (2012b) modeled habitat preferences using NMFS' 1994-2008 June abundance survey data. In large areas, such as the Susitna Delta (Beluga to Little Susitna rivers) and Knik Arm, ~~they found~~there was a high probability ~~of~~that beluga whales ~~presence~~were in larger group sizes. Beluga whale presence also increased closer to rivers with Chinook salmon (*Oncorhynchus tshawytscha*) runs, such as the Susitna River. The Susitna Delta also supports two major spawning migrations of a small, schooling ~~smelt (~~eulachon~~,~~ (*Thaleichthys pacificus*) in May and ~~July~~June (Goetz et al. 2012b). ~~Potential threats i~~Identified in the Cook Inlet Beluga Recovery Plan (NMFS 2016) are potential threats of 1) high concern:~~, including~~ catastrophic events (e.g., natural disasters, spills, mass strandings), cumulative effects of multiple stressors, and noise; ~~threats of~~2) medium concern:~~, including~~ disease agents (e.g., pathogens, parasites, and harmful algal blooms), habitat loss or degradation, reduction in prey, and unauthorized take; and ~~threats of~~3) low concern:~~, including~~ pollution, predation, and subsistence hunting. 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.

CITATIONS

Burek-Huntington, K. A., J. Dushane, C. E. C. Goertz, L. Measures, C. Romero, and S. Raverty. 2015. Morbidity and mortality in stranded Cook Inlet beluga whales (*Delphinapterus leucas*). Dis. Aquat. Organ. 114(1):45-60. DOI: dx.doi.org/10.3354/dao02839 .

Castellote, M., R. J. Small, J. Mondragon, J. Jenniges, and J. Skinner. 2015. Seasonal distribution and foraging behavior of Cook Inlet belugas based on acoustic monitoring. ADF&G Final Report to Department of Defense.

Castellote, M., R. J. Small, M. O. Lammers, J. J. Jenniges, J. Mondragon, and S. Atkinson. 2016a. Dual instrument passive acoustic monitoring of belugas in Cook Inlet, Alaska. J. Acoust. Soc. Am. 139:2697. DOI: dx.doi.org/10.1121/1.4947427 .

Castellote, M., R. J. Small, J. Mondragon, J. Jenniges, and J. Skinner. 2016b. Seasonal distribution and foraging behavior of Cook Inlet belugas based on acoustic monitoring. Alaska Department of Fish and Game, Final Wildlife Research Report, ADF&G/DWS/WRR-2016-3, Juneau, AK.

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

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

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

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

Goetz, K. T., D. J. Rugh, A. J. Read, and R. C. Hobbs. 2007. Summer habitat preferences of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska. Mar. Ecol. Prog. Ser. 330:247-256.

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

Goetz, K. T., R. A. Montgomery, J. M. Ver Hoef, R. C. Hobbs, and D. S. Johnson. 2012b. Identifying essential summer habitat of the endangered beluga whale *Delphinapterus leucas* in Cook Inlet, Alaska. Endang. Species Res. 16:135-147.

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

~~Hansen, D. J., and J. D. Hubbard. 1999. Distribution of Cook Inlet beluga whales (*Delphinapterus leucas*) in winter. Final Report OCS Study MMS 99-0024. U.S. Dep. Int., Minerals Management Service, Alaska OCS Region, Anchorage, AK.~~

Hauser, D. D. W., K. L. Laidre, R. S. Suydam, and P. R. Richard. 2014. Population-specific home ranges and migration timing of Pacific Arctic beluga whales (*Delphinapterus leucas*). Polar Biol. 37(8):1171-1183. DOI: dx.doi.org/10.1007/s00300-014-1510-1 .

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

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hobbs, R. C. 2013. Detecting changes in population trends for Cook Inlet beluga whales (*Delphinapterus leucas*) using alternative schedules for aerial surveys. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-252, 25 p.

Hobbs, R. C., J. M. Waite, and D. J. Rugh. 2000. Beluga, *Delphinapterus leucas*, group sizes in Cook Inlet, Alaska, based on observer counts and aerial video. Mar. Fish. Rev. 62(3):46-59.

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

Hobbs, R. C., K. E. W. Shelden, D. J. Rugh, C. L. Sims, and J. M. Waite. 2015a. Estimated abundance and trend in aerial counts of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, 1994-2012. Mar. Fish. Rev. 77(1):11-31. DOI: dx.doi.org/10.7755/MFR.77.1.2 .

Hobbs, R. C., P. R. Wade, and K. E. W. Shelden. 2015b. Viability of a small, geographically-isolated population of beluga whales, *Delphinapterus leucas*: effects of hunting, predation, and mortality events in Cook Inlet, Alaska. Mar. Fish. Rev. 77(2):59-88. DOI: dx.doi.org/10.7755/MFR.77.2.4 .

Kaplan, C. C., T. L. McGuire, M. K. Blees, and S. W. Raborn. 2009. Longevity and causes of marks seen on Cook Inlet beluga whales, Chapter 1. *In* Photo-identification of beluga whales in Upper Cook Inlet, Alaska: mark analysis, mark-resight estimates, and color analysis from photographs taken in 2008. Report prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for National Fish and Wildlife Foundation, Chevron, and ConocoPhillips Alaska, Inc. 32 p.

Kendall, L. S., and L. A. Cornick. 2015. Behavior and distribution of Cook Inlet beluga whales, *Delphinapterus leucas*, before and during pile driving activity. Mar. Fish. Rev. 77(2):106-114. DOI: dx.doi.org/10.7755/MFR.77.2.6 .

Laidre, K. L., K. E. W. Shelden, D. J. Rugh, and B. Mahoney. 2000. Beluga, *Delphinapterus leucas*, distribution and survey effort in the Gulf of Alaska. Mar. Fish. Rev. 62(3):27-36.

Lammers, M. O., M. Castellote, R. J. Small, S. Atkinson, J. Jenniges, A. Rosinski, J. N. Oswald, and C. Garner. 2013. Passive acoustic monitoring of Cook Inlet beluga whales (*Delphinapterus leucas*). J. Acoust. Soc. Am. 134:2497-2504. DOI: dx.doi.org/10.1121/1.4816575 .

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

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

Lucey, W., H. E. Abraham, G. O'Corry-Crowe, K. M. Stafford, and M. Castellote. 2015. Traditional knowledge and historical and opportunistic sightings of beluga whales, *Delphinapterus leucas*, in Yakutat Bay, Alaska. Mar. Fish. Rev. 77(1):41-46. DOI: dx.doi.org/10.7755/MFR.77.1.4 .

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Final Report to NMFS Alaska Region. 98 p.

McGuire, T., A. Stephens, and L. Bisson. 2014. Photo-identification of beluga whales in the Susitna River Delta, Upper Cook Inlet, Alaska. Final report of field activities in 2013. Report prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for National Fish and Wildlife Foundation and ConocoPhillips Alaska, Inc. 20 p. + appendices.

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

National Marine Fisheries Service (NMFS). 2016. Recovery plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). National Marine Fisheries Service, Alaska Region, Protected Resources Division, Juneau, AK.

Norman, S. A., R. C. Hobbs, C. E. C. Goertz, K. A. Burek-Huntington, K. E. W. Shelden, W. A. Smith, and L. A. Beckett. 2015. Potential natural and anthropogenic impediments to the conservation and recovery of Cook Inlet beluga whales, *Delphinapterus leucas*. Mar. Fish. Rev. 77(2):89-105. DOI: dx.doi.org/10.7755/MFR.77.2.5 .

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

O'Corry-Crowe, G. M., A. E. Dizon, R. S. Suydam, and L. F. Lowry. 2002. Molecular genetic studies of population structure and movement patterns in a migratory species: the beluga whale, *Delphinapterus leucas*, in the western Nearctic, p. 53-64. *In* C. J. Pfeiffer (ed.), Molecular and Cell Biology of Marine Mammals. Krieger Publishing Company, Malabar, FL.

O'Corry-Crowe, G., W. Lucey, F. I. Archer, and B. Mahoney. 2015. The genetic ecology and population origins of the beluga whales, *Delphinapterus leucas*, of Yakutat Bay. Mar. Fish. Rev. 77(1):47-58. DOI: dx.doi.org/10.7755/MFR.77.1.5 .

O'Corry-Crowe, G., R. Suydam, L. Quakenbush, B. Potgieter, L. Harwood, D. Litovka, T. Ferrer, J. Citta, V. Burkanov, K. Frost, and B. Mahoney 2018. Migratory culture, population structure and stock identity in North Pacific beluga whales (*Delphinapterus leucas*). PLoS ONE 13(3):e0194201. DOI: dx,doi.org/10.1371/journal.pone.0194201 .

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

Rugh, D. J., K. E. W. Shelden, and B. Mahoney. 2000. Distribution of beluga whales in Cook Inlet, Alaska, during June/July, 1993 to 1999. Mar. Fish. Rev. 62(3):6-21.

Rugh, D. J., B. A. Mahoney, and B. K. Smith. 2004. Aerial surveys of beluga whales in Cook Inlet, Alaska, between June 2001 and June 2002. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-145, 26 p.

Rugh, D. J., K. E. W. Shelden, C. L. Sims, B. A. Mahoney, B. K. Smith, L. K. Litzky, and R. C. Hobbs. 2005. Aerial surveys of belugas in Cook Inlet, Alaska, June 2001, 2002, 2003, and 2004. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-149, 71 p.

Rugh D. J., K. E. W. Shelden, and R. C. Hobbs. 2010. Range contraction in a beluga whale population. Endang. Species Res. 12:69-75.

Shelden, K. E. W., D. J. Rugh, B. A. Mahoney, and M. E. Dahlheim. 2003. Killer whale predation on belugas in Cook Inlet, Alaska: implications for a depleted population. Mar. Mammal Sci. 19(3):529-544.

Shelden, K. E. W., D. J. Rugh, K. T. Goetz, C. L. Sims, L. Vate Brattström, J. A. Mocklin, B. A. Mahoney, B. K. Smith, and R. C. Hobbs. 2013. Aerial surveys of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, June 2005 to 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-263, 122 p.

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

Shelden, K. E. W., C. L. Sims, L. Vate Brattström, K. T. Goetz, and R. C. Hobbs. 2015b. Aerial surveys of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2014. AFSC Processed Rep.ort 2015-03, 55 p.

Shelden, K. E. W., R. C. Hobbs, C. L. Sims, L. Vate Brattström, J. A. Mocklin, C. Boyd, and B. A. Mahoney. 2017. Aerial surveys, abundance, and distribution of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2016. AFSC Processed Rep. 2017-09, 62 p.

Shelden, K. E. W., K. T. Goetz, R. C. Hobbs, L. K. Hoberecht, K. L. Laidre, B. A. Mahoney, T. L. McGuire, S. A. Norman, G. O'Corry-Crowe, D. J. Vos, G. M. Ylitalo, S. A. Mizroch, S. Atkinson, K. A. Burek-Huntington, and C. Garner. 2018. Beluga whale, *Delphinapterus leucas*, satellite-tagging and health assessments in Cook Inlet, Alaska, 1999 to 2002. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-369, 227 p.

Vos, D. J., and K. E. W. Shelden. 2005. Unusual mortality in the depleted Cook Inlet beluga population. Northwest. Nat. 86(2):59-65.

Wade, P. R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Mar. Mammal Sci. 14:1-37. DOI: dx.doi.org/10.1111/j.1748-7692.1998.tb00688.x .

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

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).

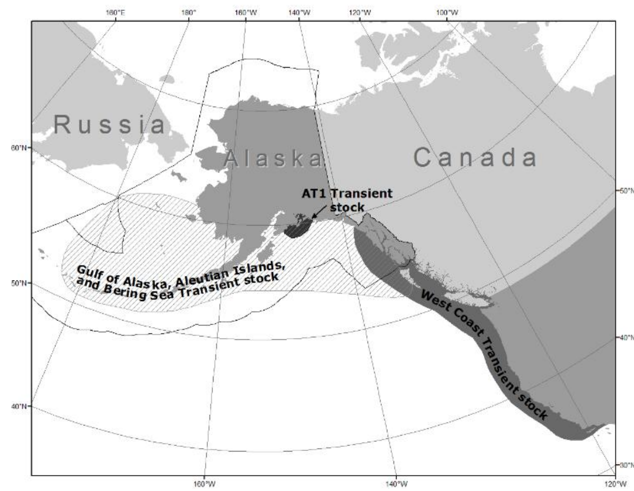

Figure 1. Approximate distribution of transient killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text).

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 ~~recent~~ 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 ~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 2017). 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, ~~recent data have identified~~ 14 out of 217 transients on the outer coast of Southeast Alaska and British Columbia ~~as~~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.

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. ~~At this time, t~~Transient-type killer whales from the Aleutian Islands and Bering Sea are considered to be part of a single population that includes Gulf of Alaska transients. Killer whales observed in the northern Bering Sea and north and east to the western Beaufort Sea have ~~physical~~ 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 (~~L. Barrett-Lennard, Vancouver Aquarium, pers. comm., 21 March 2014~~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 whales in Canadian waters are considered part of the West Coast Transient stock. The Hawaiian and Offshore stocks are reported ~~separately~~ 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 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), are genetically and acoustically distinct from other transient killer whales in the North Pacific (Barrett-Lennard 2000, Saulitis et al. 2005), 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 1989-1990, both genetically assigned to the AT1 population and one visually recognized as AT19, one of the missing nine (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 ~~2016~~2017, ~~six~~photographs of the seven remaining AT1 killer whales were ~~photographed~~confirmed by researchers from the North Gulf Oceanic Society (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).~~ Researcher Craig Matkin believes he saw AT6 (male, born 1976) in 2016 but did not obtain a photograph.~~ Therefore, the population estimate as of the summer of ~~2016~~2017 remains at seven whales (~~C. Matkin, ~~North Gulf Oceanic Society, ~~pers. comm.~~http://www.whalesalaska.org, ~~27 September 2016~~18 July 2017). 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; ~~C. Matkin, pers. comm., 27 September 2016~~North Gulf Oceanic Society, http://www.whalesalaska.org, 18 July 2017). 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 ~~in 2015~~that have been resighted since 2003, a decline of 68%. Most of the mortality apparently occurred in 1989-1990.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is unavailable for this stock of killer whales. Studies of resident killer whale pods in the Pacific Northwest resulted in estimated population growth rates of 2.9% and 2.5% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993). The current net productivity rate for this stock is 0, given that there has been no recruitment into the stock since 1984. Until additional stock-specific 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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 = 0.01 whales (7 × 0.02 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~in press); 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 in ~~2011-2015~~2012-2016. 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 1989-1990, following the *Exxon Valdez* oil spill).

Fisheries Information

~~Detailed i~~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.

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 ~~S~~state-managed commercial fisheries ~~prosecuted~~which operate within the range of this stock, such as the Prince William Sound salmon set and drift gillnet fisheries and various herring fisheries, ~~are not known to cause incidental mortality or serious injury of AT1 killer whales.~~ or in ~~S~~several subsistence fisheries (salmon, halibut, non-salmon finfish, and shellfish) which also occur within this area~~, and no incidental mortality or serious injury of AT1 killer whales has been reported for these fisheries~~; however, the state-managed fisheries are not observed or have not been observed in a long time.

Alaska Native Subsistence/Harvest Information

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

Other Mortality

Collisions with boats may be 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 rockfish trawl fishery in 2010; 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 ship strikes. 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 and designated as depleted under the MMPA (69 FR 31321, 3 June ~~3,~~ 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 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 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.

CITATIONS

Baird, R. W., and P. J. Stacey. 1988. Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska, and Washington State. Can. J. Zool. 66(11):2582-2585.

Baird, R. W., P. A. Abrams, and L. M. Dill. 1992. Possible indirect interactions between transient and resident killer whales: implications for the evolution of foraging specializations in the genus *Orcinus*. Oecologia 89:125-132.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fish. Bull., U.S. 93:1-14.

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Southwest Fisheries Science Center Administrative Report LJ-97-11. 25 p. Available from SWFSC, NMFS, 8901 La Jolla Shores Drive, La Jolla, CA 92037.

Barrett-Lennard, L. G. 2000. Population structure and mating patterns of killer whales as revealed by DNA analysis. Ph.D. Dissertation, University of British Columbia, Vancouver, BC, Canada. 97 p.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford, and K. C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State, p. 386-406. *In* P. S. Hammond, S. A. Mizroch, and G. P. Donovan (eds.), Individual Recognition of Cetaceans: Use of Photo-identification and Other Techniques to Estimate Population Parameters. Rep. Int. Whal. Comm. Special Issue 12.

Black, N. A., A. Schulman-Janiger, R. L. Ternullo, and M. Guerrero-Ruiz. 1997. Killer whales of California and western Mexico: a catalog of photo-identified individuals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-247, 174 p.

Braham, H. W., and M. E. Dahlheim. 1982. Killer whales in Alaska documented in the Platforms of Opportunity Program. Rep. Int. Whal. Comm. 32:643-646.

Brault, S., and H. Caswell. 1993. Pod-specific demography of killer whales (*Orcinus orca*). Ecology 74(5):1444-1454.

Committee on Taxonomy. 2017. List of marine mammal species and subspecies. Society for Marine Mammalogy. Available online: www.marinemammalscience.org . Accessed ~~December 2017~~June 2018.

Dahlheim, M. E., and P. A. White. 2010. Ecological aspects of transient killer whales (*Orcinus orca*) as predators in southeastern Alaska. Wildl. Biol. 16:308-322.

Dahlheim, M. E., D. Ellifrit, and J. Swenson. 1997. Killer Whales of Southeast Alaska: A Catalogue of Photoidentified Individuals. Day Moon Press, Seattle, WA. 82 p. + appendices.

Dahlheim, M. E., A. Schulman-Janiger, N. Black, R. Ternullo, D. Ellifrit, and K. C. Balcomb. 2008. Eastern temperate North Pacific offshore killer whales (*Orcinus orca*): occurrence, movements, and insights into feeding ecology. Mar. Mammal Sci. 24:719-729.

Ford, J. K. B. 2011. Killer whales of the Pacific Northwest coast: from pest to paragon. Whale Watcher 40(1):15-23.

Ford, J. K. B., and G. M. Ellis. 1999. Transients: Mammal-Hunting Killer Whales of British Columbia, Washington, and Southeastern Alaska. University of British Columbia Press, Vancouver, BC. 96 p.

Ford, J. K. B., and H. D. Fisher. 1982. Killer whale (*Orcinus orca*) dialects as an indicator of stocks in British Columbia. Rep. Int. Whal. Comm. 32:671-679.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 1994. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State. University of British Columbia Press, Vancouver, BC, and University of Washington Press, Seattle. 102 p.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 2000. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State. Second edition. University of British Columbia Press, Vancouver, BC, Canada. 104 p.

Ford, J. K. B, E. H. Stredulinsky, J. R. Towers, and G. M. Ellis. 2013. Information in support of the identification of critical habitat for transient killer whales (*Orcinus orca*) off the west coast of Canada. DFO Canadian Science Advisory Secretariat Research Document 2012/nnn.

Forney, K. A., and P. R. Wade. 2006. World-wide abundance and density of killer whales, p. 145-162. *In* J. A. Estes, D. P. DeMaster, D. F. Doak, T. M. Williams, and R. L. Brownell, Jr. (eds.), Whales, Whaling, and Ocean Ecosystems. University of California Press.

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull., U.S. 93:15-26.

George, J. C., and R. Suydam. 1998. Observations of killer whale (*Orcinus orca*) predation in the northeastern Chukchi and western Beaufort seas. Mar. Mammal Sci. 14:330-332. DOI: dx.doi.org/10.1111/j.1748-7692.1998.tb00722.x .

Goley, P. D., and J. M. Straley. 1994. Attack on gray whales (*Eschrichtius robustus*) in Monterey Bay, California, by killer whales (*Orcinus orca*) previously identified in Glacier Bay, Alaska. Can. J. Zool. 72:1528-1530.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990, p. 1-100. *In* J. J. Brueggeman (ed.), Oregon and Washington marine mammal and seabird surveys. Final Report OCS Study MMS 91-0093.

Heise, K., G. Ellis, and C. Matkin. 1991. A Catalogue of Prince William Sound Killer Whales. North Gulf Oceanic Society, Homer, AK. 51 p.

Heise, K., L. G. Barrett-Lennard, E. Saulitis, C. Matkin, and D. Bain. 2003. Examining the evidence for killer whale predation on Steller sea lions in British Columbia and Alaska. Aquat. Mamm. 29(3):325-334.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hoelzel, A. R., and G. A. Dover. 1991. Genetic differentiation between sympatric killer whale populations. Heredity 66:191-195.

Hoelzel, A. R., M. E. Dahlheim, and S. J. Stern. 1998. Low genetic variation among killer whales (*Orcinus orca*) in the eastern North Pacific, and genetic differentiation between foraging specialists. J. Hered. 89:121-128.

Hoelzel, A. R., A. Natoli, M. Dahlheim, C. Olavarria, R. Baird, and N. Black. 2002. Low worldwide genetic diversity in the killer whale (*Orcinus orca*): implications for demographic history. Proc. R. Soc. Lond. 269:1467-1473.

Leatherwood, J. S., and M. E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean Systems Center, Tech. Rep. 443:1-39.

Leatherwood, S., A. E. Bowles, E. Krygier, J. D. Hall, and S. Ingell. 1984. Killer whales (*Orcinus orca*) in Southeast Alaska, Prince William Sound, and Shelikof Strait: a review of available information. Rep. Int. Whaling Comm. 34:521-530.

Leatherwood, S., C. O. Matkin, J. D. Hall, and G. M. Ellis. 1990. Killer whales, *Orcinus orca*, photo-identified in Prince William Sound, Alaska 1976 to 1987. Can. Field Nat. 104:362-371.

Matkin, C. O., M. E. Dahlheim, G. Ellis, and E. Saulitis. 1993. Vital rates and pod structure of resident killer whales following the *Exxon Valdez* oil spill, p. 303-307. *In Exxon Valdez* Oil Spill Trustee Council, *Exxon Valdez* oil spill symposium abstract book, February 2-5, 1993, Anchorage, Alaska.

Matkin, C. O., G. M. Ellis, M. E. Dahlheim, and J. Zeh. 1994. Status of killer whales in Prince William Sound, 1985-1992, p. 141-162. *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez*. Academic Press, San Diego, CA.

Matkin, C., G. Ellis, E. Saulitis, L. Barrett-Lennard, and D. Matkin. 1999. Killer Whales of Southern Alaska. North Gulf Oceanic Society, Homer, AK. 96 p.

Matkin, C. O., G. M. Ellis, L. G. Barrett-Lennard, H. Yurk, E. L. Saulitis, D. Scheel, P. Olesiuk, and G. Ylitalo. 2003. Photographic and acoustic monitoring of killer whales in Prince William and Kenai Fjords, *Exxon Valdez* Oil Spill Restoration Project Final Report, Restoration Project 03012, North Gulf Oceanic Society, Homer, AK. 118 p.

Matkin, C. O., E. L. Saulitis, G. M. Ellis, P. Olesiuk, and S. D. Rice. 2008. Ongoing population-level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Mar. Ecol. Prog. Ser. 356:269-281.

Matkin, C. O., J. W. Durban, E. L. Saulitis, R. D. Andrews, J. M. Straley, D. R. Matkin, and G. M. Ellis. 2012. Contrasting abundance and residency patterns of two sympatric populations of transient killer whales (*Orcinus orca*) in the northern Gulf of Alaska. Fish. Bull., U.S. 110:143-155.

Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Board Can. 32:914-916.

Morin, P. A., F. I. Archer, A. D. Foote, J. Vilstrup, E. E. Allen, P. Wade, J. Durban, K. Parsons, R. Pitman, L. Li, P. Bouffard, S. C. A. Nielsen, M. Rasmussen, E. Willerslev, M. T. P. Gilbert, and T. Harkins. 2010. Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. Genome Res. 20:908-916.

Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. Int. Whal. Comm. (Special Issue 12):209-242.

Parsons, K. M., J. W. Durban, A. M. Burdin, V. N. Burkanov, R. L. Pitman, J. Barlow, L. G. Barrett-Lennard, R. G. LeDuc, K. M. Robertson, C. O. Matkin, and P. R. Wade. 2013. Geographic patterns of genetic differentiation among killer whales in the northern North Pacific. J. Hered. 104:737-754.

Riesch, R., L. G. Barrett-Lennard, G. M. Ellis, J. K. B. Ford, and V. B. Deecke. 2012. Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? Biol. J. Linn. Soc. 106:1-17.

Saulitis, E., C. O. Matkin, and F. H. Fay. 2005. Vocal repertoire and acoustic behavior of the isolated AT1 killer whale subpopulation in southern Alaska. Can. J. Zool. 83:1015-1029.

von Ziegesar, O., G. M. Ellis, C. O. Matkin, and B. Goodwin. 1986. Repeated sightings of identifiable killer whales (*Orcinus orca*) in Prince William Sound, Alaska, 1977-1983. Cetus 6(2):9-13.

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

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 ~~rarely~~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).

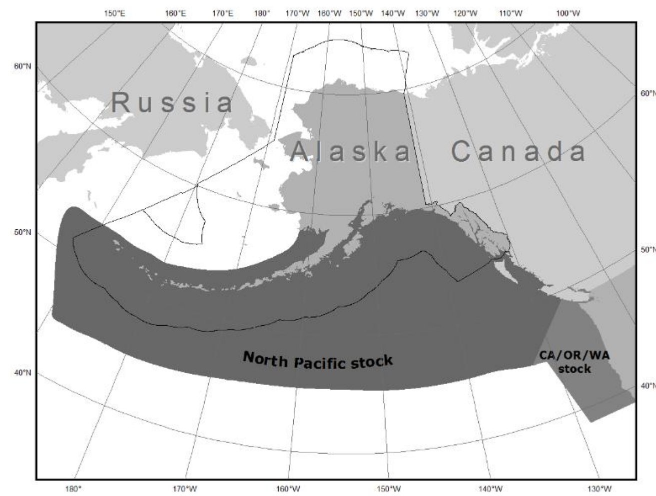

Figure 1. Approximate distribution of Pacific white-sided dolphins in the eastern North Pacific (dark shaded areas).

The 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 ~~separately~~ 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 ~~central North Pacific~~ 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)~~ animals~~, 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~~n~~ 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) ~~Pacific white-sided dolphins~~ 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 of a school, or parts thereof,(188 individuals with possible repeat sightings) off Port Moller (R. Hobbs, NMFS-AFSC-NMML, pers. comm.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, the current minimum population estimate for this stockN_{MIN} is considered unknown.

Current Population Trend

At present, tThere 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 currently 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 (R_{MAX}) was based. Thus, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% will be employedused for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the pPotential 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). The estimate of abundance for Pacific white-sided dolphins is more than 8 years old; Wade and Angliss (1997) recommendHowever, the 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) state that abundance estimates older than 8 years no longershould not be used to calculate a PBR leveldue 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. ThusTherefore, the PBR for this stock is considered undetermined (NMFS 2005).

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.

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

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.

~~Detailed i~~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.

~~Until 2003, there were six different federally-regulated commercial fisheries in Alaska that could have interacted with Pacific white-sided dolphins. These fisheries were monitored for incidental mortality and serious injury by fishery observers. As of 2003, changes in fishery definitions in the MMPA List of Fisheries have resulted in separating these 6 fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort but provides managers with better information on the component of each fishery that is responsible for the incidental mortality or serious injury of marine mammal stocks in Alaska.~~ No mortality or serious injury of Pacific white-sided dolphins was observed incidental to ~~observed~~ U.S. federal commercial fisheries in Alaska ~~was reported between 2009 and 2013~~in 2012-2016 (Breiwick 2013; ~~N~~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.

~~Note that no observers have been assigned to several of the gillnet fisheries that are known to interact with this stock, making the estimated mortality and serious injury rate unreliable. However, because the stock size is large, it is unlikely that unreported mortality and serious injury from those fisheries would be significant.~~

Alaska Native Subsistence/Harvest Information

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

Other Mortality

From ~~2009~~2012 to ~~2013~~2016, no human-caused mortality or serious injury of Pacific white-sided dolphins was reported to the NMFS Alaska Region stranding ~~database~~network (Helker et al. ~~2015~~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 ~~for Pacific white-sided dolphins~~ is undetermined and fisheries observer coverage is limited, ~~the level of human-caused mortality and serious injury relative to PBR~~it is unknown ~~and the level~~if the minimum estimate of the mean annual mortality and serious injury rate (zero) in U.S. commercial fisher~~y~~ies ~~-related mortality and serious injury 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 ~~currently~~ 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 in press).

CITATIONS

Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating serious and non-serious injury of marine mammals: report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-39, 94 p.

Angliss, R. P., and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13, 48 p.

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

Buckland, S. T., K. L. Cattanach, and R. C. Hobbs. 1993. Abundance estimates of Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987/90., Pp. 387-407. *In* W. Shaw, R. L. Burgner, and J. Ito (eds.), Biology, distribution and stock assessment of species caught in the high seas driftnet fisheries in the North Pacific Ocean. International North Pacific Fisheries Commission Symposium; 4-6 November 1991, Tokyo, Japan.

Chivers, S. J., K. M. Peltier, W. T. Norman, P. A. Akin, and J. Heyning. 1993. Population structure of cetaceans in California coastal waters. Paper SOCCS9 presented at the Status of California Cetacean Stocks Workshop, held in La Jolla, California, March 31-April 2, 1993. 49 pp.

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

Ferrero, R. C., and W. A. Walker. 1996. Age, growth, and reproductive patterns of the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) taken in high seas drift nets in the central North Pacific Ocean. Can. J. Zool. 74(9):1673-1687.

Helker, V. T., B. M. Allen, and L. A. Jemison. 2015. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2009-2013. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-300, 94 p.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hobbs, R. C., and J. A. Lerczak. 1993. Abundance of Pacific white-sided dolphin and Dall's porpoise in Alaska estimated from sightings in the North Pacific Ocean and the Bering Sea during 1987-1991. 13 pp. Available from NMarine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Linnenschmidt, M., J. Teilmann, T. Akamatsu, R. Dietz, and L. A. Miller. 2013. Biosonar, dive, and foraging activity of satellite tracked harbor porpoises (*Phocoena phocoena*). Mar. Mammal Sci. 29(2):77-97.

Lux, C. A., A. S. Costa, and A. E. Dizon. 1997. Mitochondrial DNA population structure of the Pacific white-sided dolphin. Rep. Int. Whal. Comm. 47:645-652.

NMFS (National Marine Fisheries Service). 2005. Revisions to guidelines for assessing marine mammal stocks. 24 pp. Available online: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf. Accessed December 2015.

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

NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf. Accessed December 2015.

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

Waite, J. M., and K. W. Shelden. In press. The northern extent of Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) distribution in the eastern North Pacific. Northwest. Naturalist.

Walker, W. A., S. Leatherwood, K. R. Goodrich, W. F. Perrin, and R. K. Stroud. 1986. Geographical variation and biology of the Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, in the north-eastern Pacific,. Pp. 441-465. *In* M. M. Bryden and R. Harrison (eds.), Research on Dolphins. Clarendon Press, Oxford.

HARBOR PORPOISE (*Phocoena phocoena*): Southeast 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. ~~At this time, n~~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, 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 greatest densities observed in the Glacier Bay/Icy Strait region and near Zarembo and Wrangell Islands and the adjacent waters of Sumner Strait (Dahlheim et al. 2009, 2015). The average density of harbor porpoise in Alaska appears to be less than that reported off the west coast of the continental U.S., although areas of high densities do occur in 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).

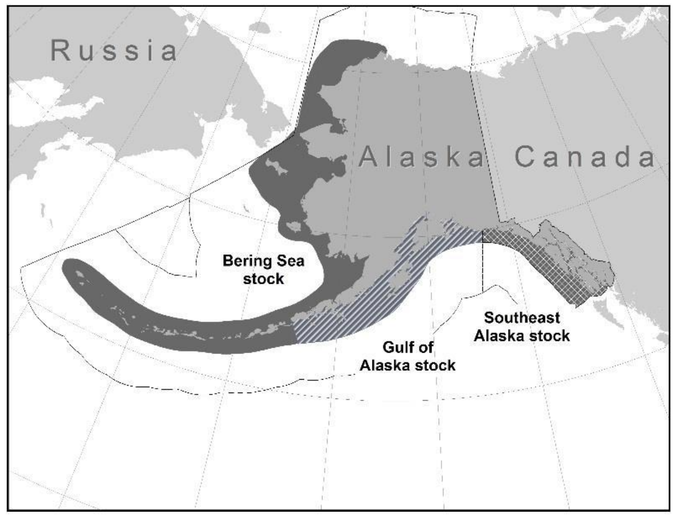

Figure 1. Approximate distribution of harbor porpoise in Alaska waters.

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. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimens from the North Atlantic (Rosel et al. 1999). Numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles (Walton 1997). In a molecular 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~~ at this time~~.

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint it would be prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). Accordingly, from the above information, three harbor porpoise stocks in Alaska were specified, recognizing that the boundaries of these three stocks were identified primarily based upon geography or perceived areas of porpoise low density: 1) the Southeast Alaska stock - occurring from Dixon Entrance to Cape Suckling, Alaska, 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). ~~To date, t~~There have been no analyses to assess the validity of these stock designations or to assess possible substructure within these stocks. For example, the porpoise concentrations found in Glacier Bay/Icy Strait and around Zarembo/Wrangell Islands may represent different subpopulations (Dahlheim et al. 2015) based on analogy with other west coast harbor porpoise populations, differences in trends in abundance of the two concentrations, and a hiatus in distribution between the northern and southern harbor porpoise concentrations. NMFS will consider whether these concentrations should be considered "prospective stocks" in a future Stock Assessment Report. Incidental takes from commercial fisheries within a small region (e.g., Wrangell and Zarembo Islands area) are of concern because of the potential impact on undefined localized stocks of harbor porpoise.

POPULATION SIZE

Information on harbor porpoise abundance and relative abundance has been collected for coastal and inside waters of Southeast Alaska by the Alaska Fisheries Science Center's Marine Mammal Laboratory (MML) using both aerial and shipboard surveys. Aerial surveys of this stock were conducted in June and July 1997 and resulted in an observed abundance estimate of 3,766 harbor porpoise (CV = 0.16~~2~~) (Hobbs and Waite 2010); the surveys included a subset of smaller bays and inlets. Correction factors for observer perception bias and porpoise availability at the surface were used to develop an estimated corrected abundance of 11,146 harbor porpoise (3,766 × 2.96; CV = 0.24~~2~~) in the coastal and inside waters of Southeast Alaska (Hobbs and Waite 2010).

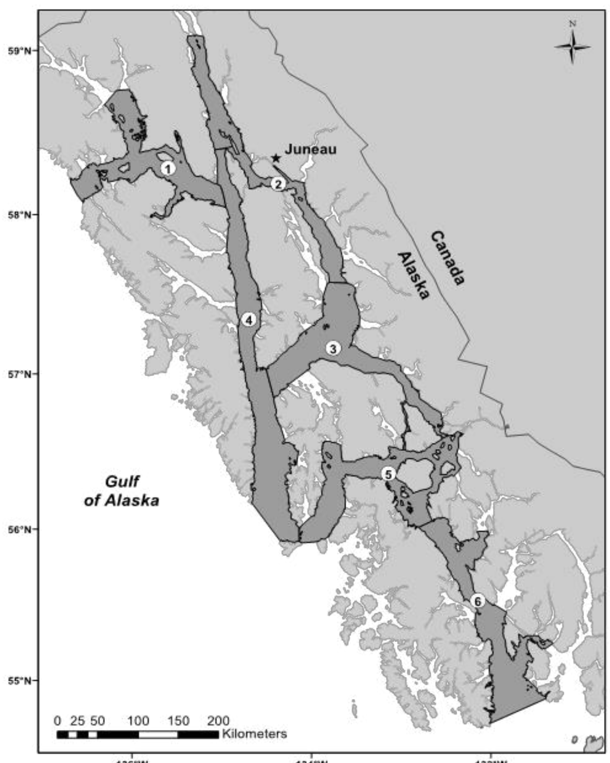

Figure 2. Survey strata defined for line-transect survey effort allocation in Southeast Alaska (as illustrated in Fig. 1 of Dahlheim et al. 2015).

In 1991, researchers initiated harbor porpoise studies aboard the NOAA ship *John N. Cobb* with broad survey coverage through the inland waters of Southeast Alaska. Between 1991 and 1993, line-transect methodology was used to 1) obtain population estimates of harbor porpoise, 2) establish a baseline for detecting trends in abundance, and 3) define overall distributional patterns and seasonality of harbor porpoise. The 1991-1993 vessel surveys were carried out each year in the spring, summer, and fall. Annual surveys were continued between 1994 and 2005; however, only two trips per year were conducted, one either in spring or summer and the other in fall. These surveys were not designed to survey harbor porpoise habitat and standard line-transect methodology was not used; however, all cetaceans observed were recorded. During this 12-year period, observers reported fewer overall encounters with harbor porpoise. To fully assess abundance and population trends for harbor porpoise, line-transect methodology was used during the survey cruises in 2006 and 2007 (Dahlheim et al. 2009) and in 2010-2012 (Dahlheim et al. 2015). Previous studies reported no evidence of seasonal variation in the abundance of harbor porpoise occupying the inland waters of Southeast Alaska. Thus, only data collected during the summer were analyzed, given the broader spatial coverage and the greater number of surveys (i.e., a total of eight line-transect vessel surveys) completed during this season. Methods applied to the 2006-2012 surveys were comparable to those employed during the early 1990s; however, because these surveys only covered a portion of inland waters and not the entire range of this stock, they are not used to compute a stock-specific estimate of abundance. ~~Each year, greater densities of harbor porpoise were observed in the Glacier Bay/Icy Strait region and near Zarembo and Wrangell Islands and adjacent waters of Sumner Strait.~~ The relative abundance of harbor porpoise in inland waters of Southeast Alaska was found to vary across survey periods spanning the 22-year study (1991-2012). Abundance estimated in 1991-1993 (N = 1,076; 95% CI = 910-1,272) was higher than the estimate obtained for 2006-2007 (N = 604; 95% CI = 468-780) but comparable to the estimate for 2010-2012 (N = 975; 95% CI = 857-1,109; Dahlheim et al. 2015). These estimates assume the probability of detection directly on the trackline to be unity (g(0) = 1) because estimates of g(0) ~~have~~could not ~~been~~be computed for these surveys. Therefore, these abundance estimates may be biased low to an unknown degree. A range of possible g(0) values for harbor porpoise vessel surveys in other regions is 0.5-0.8 (Barlow 1988, Palka 1995), suggesting that as much as 50% of the porpoise can be missed, even by experienced observers.

Using the 2010-2012 survey data for the inland waters of Southeast Alaska, Dahlheim et al. (2015) calculated abundance estimates for the concentrations of harbor porpoise in the northern (Areas 1, 2, and 4) and southern (Areas 3, 5, and 6) regions of the inland waters (Fig. 2). The resulting abundance estimates are 398 harbor porpoise (CV = 0.12) in the northern inland waters (including Cross Sound, Icy Strait, Glacier Bay, Lynn Canal, Stephens Passage, and Chatham Strait) and 577 harbor porpoise (CV = 0.14) in the southern inland waters (including Frederick Sound, Sumner Strait, Wrangell and Zarembo Islands, and Clarence Strait as far south as Ketchikan). Because these abundance estimates have not been corrected for g(0), these estimates are likely underestimates.

Minimum Population Estimate

For the Southeast Alaska stock of harbor porpoise, the minimum population estimate (N_{MIN}) for the ~~1997~~2010-2012 ~~aerial~~shipboard surveys is ~~1,996~~897 porpoise calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$, where N = 975 and CV = 0.10. ~~These survey data are now more than 8 years old. Using the 2010-2012 abundance estimate for harbor porpoise occupying the inland waters of Southeast Alaska of 975 and the associated coefficient of variation (CV) of 0.10, N_{MIN} is 896 harbor porpoise.~~ Since ~~the~~this abundance estimate represents some portion of the total number of animals in the stock, using this estimate to calculate N_{MIN} results in a negatively-biased N_{MIN} for the stock. Although harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska have not been determined to be subpopulations or stocks, PBR calculations for these areas may provide a frame of reference for comparison to harbor porpoise mortality and serious injury in the portion of the Southeast Alaska salmon drift gillnet fishery that was monitored in 2012-2013. ~~We used~~The pooled 2010-2012 abundance estimates of 398 (CV = 0.12; assumes g(0) = 1) for the northern region and 577 (CV = 0.14; assumes g(0) = 1) for the southern region ~~(Dahlheim et al. 2015) to calculate~~results in N_{MINs} of ~~359~~360 and 513, respectively~~, for the concentrations of harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska~~. ADF&G Districts 6, 7, and 8, where the Southeast Alaska salmon drift gillnet fishery was observed in 2012-2013 (Manly 2015), partially overlap porpoise survey areas (Areas 5 and 6: Dahlheim et al. 2015) in the southern region of the inland waters.

Current Population Trend

~~The abundance of harbor porpoise in the Southeast Alaska stock was estimated in 1993 and 1997. In 1993, abundance estimates were determined from a coastal aerial survey from Prince William Sound to Dixon Entrance and a vessel survey in the inside waters of Southeast Alaska (Dahlheim et al. 2000). These surveys produced abundance estimates of 3,982 and 1,586 for the two areas, respectively, giving a combined estimate of 5,568 porpoise for the range of the Southeast Alaska harbor porpoise stock. The 1997 abundance estimate was determined with an aerial survey for both the coastal region from Prince William Sound to Dixon Entrance and the inside waters of Southeast Alaska (Hobbs and Waite 2010). The 1997 estimate of 11,146 is double the 1993 estimate; however, these estimates are not directly comparable because of differences in survey methods. The total area surveyed in 1997 was greater than in 1993 and included a correction of perception bias. For this reason, these estimates from aerial surveys are not appropriate to estimate trends.~~

An analysis of the line-transect vessel survey data collected throughout the inland waters of Southeast Alaska between 1991 and 2010 suggested high probabilities of a population decline ranging from 2 to 4% per year for the whole study area and highlighted a potentially important conservation issue (Zerbini et al. 2011). However, when data from 2011 and 2012 were added to this analysis, the population decline was no longer significant (Dahlheim et al. 2015). It is unclear why a negative trend in harbor porpoise numbers was detected in inland waters of Southeast Alaska in 1991-2010 and reversed thereafter (Dahlheim et al. 2015). Regionally, abundance was relatively constant in the northern region of the inland waters of Southeast Alaska throughout the survey period, while declines and subsequent increases were documented in the southern region (Dahlheim et al. 2015).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Southeast Alaska stock of harbor porpoise. Hence, until additional data become available, the cetacean maximum theoretical net productivity rate of 4% will be used (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). Using the N_{MIN} of ~~896~~897 (based on the 2010-2012 abundance estimate for harbor porpoise in the inland waters of Southeast Alaska), PBR is 8.9 harbor porpoise (~~896~~897 × 0.02 × 0.5).

~~Based on text above related to prospective stocks, we have also calculated~~Computing N_{MINs} and PBRs for harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska~~. These PBR calculations~~ may provide a frame of reference for the observed mortality and serious injury of harbor porpoise in the portion of the Southeast Alaska salmon drift gillnet fishery that was monitored in 2012-2013. Based on the pooled 2010-2012 abundance estimates and corresponding N_{MINs}, the PBR calculations for the northern and southern regions of the inland waters of Southeast Alaska are 3.6 (N = 398; CV = 0.12; N_{MIN} = ~~359~~360) and 5.1 harbor porpoise (N = 577; CV = 0.14; N_{MIN} = 513), respectively.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~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 Southeast Alaska harbor porpoise in 2012-2016 is 34 porpoise in U.S. commercial fisheries~~ in 2011-2015~~; 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

~~Detailed i~~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 harbor porpoise from the Southeast Alaska stock was observed incidental to U.S. federal commercial fisheries in Alaska in ~~2011-2015~~2012-2016 (Breiwick 2013; MML, unpubl. data).

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

In 2012 and 2013, the AMMOP placed observers on independent vessels in the state-managed Southeast Alaska salmon drift gillnet fishery in ADF&G Management Districts 6, 7, and 8 to assess mortality and serious injury of marine mammals (Manly 2015). These Management Districts cover areas of Frederick Sound, Sumner Strait, Clarence Strait, and Anita Bay which include, but are not limited to, areas around and adjacent to Petersburg and Wrangell and Zarembo Islands. In 2013, four harbor porpoise were observed entangled and released: two were determined to be seriously injured and two were determined to be not seriously injured. Based on the two observed serious injuries, 23 serious injuries were estimated for Districts 6, 7, and 8 in 2013, resulting in an estimated mean annual mortality and serious injury rate of 12 harbor porpoise in 2012-2013 (Table 1). Since these three districts represent only a portion of the overall fishing effort in this fishery, this is a minimum estimate of mortality and serious injury for the fishery.

Table 1. Summary of incidental mortality and serious injury of Southeast Alaska harbor porpoise due to U.S. commercial fisheries in ~~2011-2015~~2012-2016 (or the most recent data available) and calculation of the mean annual mortality and serious injury rate (Manly 2009, 2015). 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
Yakutat salmon set gillnet	2007 2008	obs data	5.3 7.6	1 3	16.1 27.5	22 (CV = 0.54)
Southeast Alaska salmon drift gillnet (Districts 6, 7, and 8)	2012 2013	obs data	6.4 6.6	0 2	0 23	12 (CV = 1.0)
Minimum total estimated annual mortality						34 (CV = 0.77)

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. ~~Therefore, b~~Based on observed mortality and serious injury in two commercial fisheries (Table 1), the minimum estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2012-2016 is 34 harbor porpoise ~~in 2011-2015~~.

Alaska Native Subsistence/Harvest Information

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

STATUS OF STOCK

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 total estimated annual level of human-caused mortality and serious injury for Southeast Alaska harbor porpoise (34 porpoise) exceeds the calculated PBR (8.9 porpoise), which means this stock is strategic. The mean annual U.S. commercial fishery-related mortality and serious injury rate (34 porpoise) is more than 10% of the calculated PBR (10% of PBR = 0.9 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 estimates from 2010-2012 surveys of only a portion (the inside waters of Southeast Alaska) of the range of this stock as currently designated. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

There are key uncertainties in the assessment of the Southeast Alaska stock of harbor porpoise. This stock likely comprises multiple, smaller stocks based on analogy with harbor porpoise populations that have been the focus of specific studies on stock structure. Concentrations of harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska are identified, and N_{MINs} and PBR levels are calculated for these areas. Abundance estimates have not been corrected for g(0) so the estimates are expected to be underestimates. The trend in abundance of harbor porpoise in these regions is unclear; an early decline appears to have reversed in recent years. Several commercial fisheries overlap with the range of this stock and are not observed or have not been observed in a long time; thus, the estimate of commercial fishery mortality and serious injury is expected to be a minimum estimate. Estimates of human-caused mortality and serious injury from stranding data 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 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).

CITATIONS

Barlow, J. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: I. Ship surveys. Fish. Bull., U.S. 86:417-432.

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

Calambokidis, J., and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California, p. 101-110. *In* J. E. Reynolds III and D. K. Odell (eds.), Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987, Miami, Florida. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-98.

Chivers, S. J., A. E. Dizon, P. J. Gearin, and K. M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbor porpoise (*Phocoena phocoena*) indicated by molecular genetic analyses. J. Cetacean Res. Manage. 4(2):111-122.

Christman, C. L., and L. M. Aerts. 2015. Harbor porpoise (*Phocoena phocoena*) sightings from shipboard surveys in the Chukchi Sea during summer and fall, 2008-2014, p. 197. *In* Book of Abstracts, 2015 Alaska Marine Science Symposium, Anchorage, Alaska, January 19-23, 2015.

Dahlheim, M., A. York, R. Towell, J. Waite, and J. Breiwick. 2000. Harbor porpoise (*Phocoena phocoena*) abundance in Alaska: Bristol Bay to Southeast Alaska, 1991-1993. Mar. Mammal Sci. 16:28-45.

Dahlheim, M., P. A. White, and J. Waite. 2009. Cetaceans of Southeast Alaska: distribution and seasonal occurrence. J. Biogeogr. 36(3):410-426.

Dahlheim, M. E., A. N. Zerbini, J. M. Waite, and A. S. Kennedy. 2015. Temporal changes in abundance of harbor porpoise (*Phocoena phocoena*) inhabiting the inland waters of Southeast Alaska. Fish. Bull., U.S. 113(3):242-255.

Gaskin, D. E. 1984. The harbor porpoise *Phocoena phocoena* (L.): regional populations, status, and information on direct and indirect catches. Rep. Int. Whal. Comm. 34:569-586.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hobbs, R. C., and J. M. Waite. 2010. Abundance of harbor porpoise (*Phocoena phocoena*) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. Fish. Bull., U.S. 108(3):251-267.

Linnenschmidt, M., J. Teilmann, T. Akamatsu, R. Dietz, and L. A. Miller. 2013. Biosonar, dive, and foraging activity of satellite tracked harbor porpoises (*Phocoena phocoena*). Mar. Mammal Sci. 29(2):77-97.

Manly, B. F. J. 2009. Incidental catch of marine mammals and birds in the Yakutat salmon set gillnet fishery, 2007 and 2008. Final Report to NMFS Alaska Region. 96 p.

Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in districts 6, 7, and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 p.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Rep. Int. Whal. Comm. (Special Issue 16):27-50.

Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, University of California San Diego. 191 p.

Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, *Phocoena phocoena*, on inter-oceanic and regional scales. Can. J. Fish. Aquat. Sci. 52:1210-1219.

Rosel, P. E., R. Tiedemann, and M. Walton. 1999. Genetic evidence for limited trans-Atlantic movements of the harbor porpoise *Phocoena phocoena*. Mar. Biol. 133: 583-591.

Shelden, K. E. W., B. A. Agler, J. J. Brueggeman, L. A. Cornick, S. G. Speckman, and A. Prevel-Ramos. 2014. Harbor porpoise, *Phocoena phocoena vomerina*, in Cook Inlet, Alaska. Mar. Fish. Rev. 76(1-2):22-50.

Taylor, B. L., P. R. Wade, D. P. DeMaster, and J. Barlow. 1996. Models for management of marine mammals. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/48/SM50). 12 p.

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

Walton, M. J. 1997. Population structure of harbour porpoises *Phocoena phocoena* in the seas around the UK and adjacent waters. Proc. R. Soc. Lond. B 264:89-94.

Westgate, A. J., and K. A. Tolley. 1999. Geographical differences in organochlorine contaminants in harbour porpoises *Phocoena phocoena* from the western North Atlantic. Mar. Ecol. Prog. Ser. 177:255-268.

Zerbini, A. N., M. E. Dahlheim, J. M. Waite, A. S. Kennedy, P. R. Wade, and P. J. Clapham. 2011. Evaluation of population declines of harbor porpoise (*Phocoena phocoena*) in Southeastern Alaska inland waters, p. 23. *In* Book of Abstracts, 19th Biennial Conference on the Biology of Marine Mammals, Tampa, Florida, USA, 28 November-2 December 2011.

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. ~~At this time, n~~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).

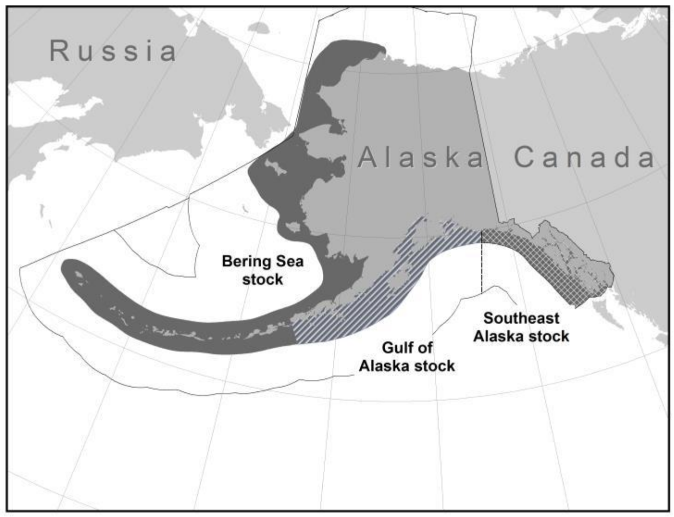

Figure 1. Approximate distribution of harbor porpoise in Alaska waters.

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. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimens from the North Atlantic (Rosel et al. 1999). Numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles (Walton 1997). In a molecular 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~~ at this time~~.

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint it would be prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). Accordingly, from the above information, three harbor porpoise stocks in Alaska were specified, recognizing that the boundaries of these three stocks were inferred primarily based upon geography or perceived areas of low porpoise density: 1) the Southeast Alaska stock - occurring from Dixon Entrance to Cape Suckling, Alaska, 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). ~~To date, t~~There have been no analyses to assess the validity of these stock designations or to assess possible substructure within these stocks.

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 ~~for~~ observers (perception bias) and ~~one~~another to correct for porpoise that were submerged and not ~~availability/visibility~~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 (CV = ~~0.115~~0.12) (Hobbs and Waite 2010), which includes a correction factor (1.372; CV = ~~0.066~~0.07) for perception bias~~ to correct for animals that were present but not counted because they were not detected by observers~~. 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~~0~~); 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 this correction factor to the 1998 estimate results in ~~The estimated~~a corrected abundance ~~estimate from the 1998 survey is~~of 31,046 porpoise (10,489 × 2.96 = 31,046; CV = ~~0.214~~0.21) for the Gulf of Alaska stock (Hobbs and Waite 2010).

This latest estimate of abundance (31,046) is considerably higher than the estimate reported in the 1999 stock assessment (8,271; CV = ~~0.309~~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 1991-1993 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 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 (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 31,046 and its associated coefficient of variation (CV) of ~~0.214~~0.21, N_{MIN} for the Gulf of Alaska stock of harbor porpoise is ~~25,987~~26,064~~ (Hobbs and Waite 2010)~~. However, because the survey data are now more than 8 years old, N_{MIN} is considered unknown.

Current Population Trend

There is no reliable information on trends in abundance for the Gulf of Alaska stock of harbor porpoise since 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. Hence, until additional data become available, the cetacean maximum theoretical net productivity rate of 4% will be used (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population 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. Therefore, the PBR for this stock is considered undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~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 Gulf of Alaska harbor porpoise in 2012-2016 is 72 porpoise~~ in 2011-2015~~: 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

~~Detailed i~~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 incidental mortality or serious injury of the Gulf of Alaska stock of harbor porpoise was observed in U.S. federal commercial fisheries in ~~2011-2015~~2012-2016 (Breiwick 2013; MML, unpubl. data). Alaska Marine Mammal Observer Program (AMMOP) ~~O~~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 that 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 (2 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 6 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

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
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)

Strandings of marine mammals with fishing gear attached or with injuries caused by interactions with fishing gear are another source of mortality data. In ~~2011-2015~~2012-2016, ~~one~~ Gulf of Alaska harbor porpoise mortality in ~~a~~Prince William Sound commercial salmon drift gillnet (1 in 2016) and Cook Inlet commercial salmon drift gillnet (1 in 2013)~~near Kenai, Alaska,~~ was reported to the NMFS Alaska Region stranding network and harbor porpoise ~~five~~ mortality~~ies~~ in Kodiak Island commercial salmon set gillnet (3 in 2012) ~~were~~was reported ~~through the~~by Marine Mammal Authorization Program fisherman self-reports (Helker et al. ~~2017~~in press). However, ~~all of these events are accounted for in the~~ extrapolated estimates ~~(~~derived from ~~Alaska Marine Mammal Observer Program~~AMMOP observer data~~) of~~ are used to determine the mean annual mortality and serious injury rates ~~occurring in~~for all of these ~~commercial Cook Inlet salmon drift gillnet fishery and commercial Kodiak Island salmon set gillnet~~ fisher~~y~~ies (Table 1). An additional harbor porpoise mortality from this stock, due to entanglement in unidentified fishing net near Homer, Alaska, was reported to the NMFS Alaska Region stranding network in 2014, resulting in a minimum mean annual mortality and serious injury rate of 0.2 harbor porpoise in unknown (commercial, recreational, or subsistence) fisheries in ~~2011-2015~~2012-2016 (Table 2; Helker et al. ~~2017~~in press). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~is a minimum because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ 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 in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in unidentified net*	~~0~~	0	0	1	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 ~~placements in~~program for all of the salmon and herring fisheries operating within the range of this stock. ~~However, b~~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 in 2012-2016 is 72 harbor porpoise from this stock (72 in U.S. commercial fisheries + 0.2 in unknown fisheries)~~ in 2011-2015~~.

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

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 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 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).

CITATIONS

Barlow, J., C. W. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. Fish. Bull., U.S. 86:433-444.

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

Calambokidis, J., and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California, p. 101-110. *In* J. E. Reynolds III and D. K. Odell (eds.), Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987, Miami, Florida. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-98.

Calambokidis, J., J. R. Evenson, J. C. Cubbage, S. D. Osmek, D. Rugh, and J. L. Laake. 1993. Calibration of sighting rates of harbor porpoise from aerial surveys. Final Report to the National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115. 55 p.

Chivers, S. J., A. E. Dizon, P. J. Gearin, and K. M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbor porpoise (*Phocoena phocoena*) indicated by molecular genetic analyses. J. Cetacean Res. Manage. 4(2):111-122.

Christman, C. L., and L. M. Aerts. 2015. Harbor porpoise (*Phocoena phocoena*) sightings from shipboard surveys in the Chukchi Sea during summer and fall, 2008-2014, p. 197. *In* Book of Abstracts, 2015 Alaska Marine Science Symposium, Anchorage, Alaska, January 19-23, 2015.

Dahlheim, M., A. York, R. Towell, J. Waite, and J. Breiwick. 2000. Harbor porpoise (*Phocoena phocoena*) abundance in Alaska: Bristol Bay to Southeast Alaska, 1991-1993. Mar. Mammal Sci. 16:28-45.

Dahlheim, M., P. A. White, and J. Waite. 2009. Cetaceans of Southeast Alaska: distribution and seasonal occurrence. J. Biogeogr. 36(3):410-426.

Dahlheim, M. E, A. N. Zerbini, J. M. Waite, and A. S. Kennedy. 2015. Temporal changes in abundance of harbor porpoise (*Phocoena phocoena*) inhabiting the inland waters of Southeast Alaska. Fish. Bull., U.S. 113(2):242-255. DOI: dx.doi.org/10.7755/FB.113.3.2 .

Gaskin, D. E. 1984. The harbor porpoise *Phocoena phocoena* (L.): regional populations, status, and information on direct and indirect catches. Rep. Int. Whal. Comm. 34:569-586.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hobbs, R. C., and J. M. Waite. 2010. Abundance of harbor porpoise (*Phocoena phocoena*) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. Fish. Bull., U.S. 108(3):251-267.

Laake, J. L., J. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manage. 61(1):63-75.

Linnenschmidt, M., J. Teilmann, T. Akamatsu, R. Dietz, and L. A. Miller. 2013. Biosonar, dive, and foraging activity of satellite tracked harbor porpoises (*Phocoena phocoena*). Mar. Mammal Sci. 29 (2):77-97.

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Final Report to NMFS Alaska Region. 98 p.

Manly, B. F. J. 2007. Incidental take and interactions of marine mammals and birds in the Kodiak Island salmon set gillnet fishery, 2002 and 2005. Final Report to NMFS Alaska Region. 221 p.

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

Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, University of California San Diego. 191 p.

Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, *Phocoena phocoena*, on inter-oceanic and regional scales. Can. J. Fish. Aquat. Sci. 52:1210-1219.

Rosel, P. E., R. Tiedemann, and M. Walton. 1999. Genetic evidence for limited trans-Atlantic movements of the harbor porpoise *Phocoena phocoena*. Mar. Biol. 133:583-591.

Shelden, K. E. W., B. A. Agler, J. J. Brueggeman, L. A. Cornick, S. G. Speckman, and A. Prevel-Ramos. 2014. Harbor porpoise, *Phocoena phocoena vomerina*, in Cook Inlet, Alaska. Mar. Fish. Rev. 76(1-2):22-50.

Taylor, B. L., P. R. Wade, D. P. DeMaster, and J. Barlow. 1996. Models for management of marine mammals. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/48/SM50). 12 p.

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

Walton, M. J. 1997. Population structure of harbour porpoises *Phocoena phocoena* in the seas around the UK and adjacent waters. Proc. R. Soc. Lond. B 264:89-94.

Westgate, A. J., and K. A. Tolley. 1999. Geographical differences in organochlorine contaminants in harbour porpoises *Phocoena phocoena* from the western North Atlantic. Mar. Ecol. Prog. Ser. 177:255-268.

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 65 p. Available from NMFS Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

Wynne, K. M., D. Hicks, and N. Munro. 1992. 1991 marine mammal observer program for the salmon driftnet fishery of Prince William Sound Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 53 p. Available from NMFS Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

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. ~~At this time, n~~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).

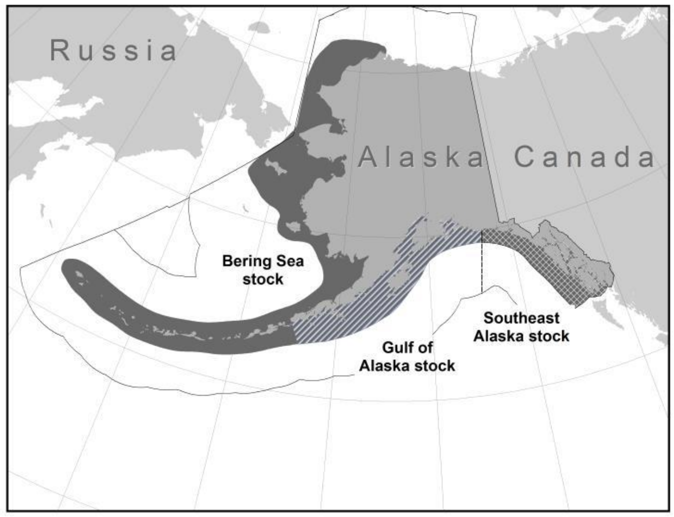

Figure 1. Approximate distribution of harbor porpoise in Alaska waters.

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. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimens from the North Atlantic (Rosel et al. 1999). Numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles (Walton 1997). In a molecular 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~~ at this time~~.

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint it would be prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). Accordingly, from the above information, three harbor porpoise stocks in Alaska were specified, recognizing that the boundaries of these three stocks were inferred primarily based upon geography or perceived areas of low porpoise density: 1) the Southeast Alaska stock - occurring from Dixon Entrance to Cape Suckling, Alaska, 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). ~~To date, t~~There have been no analyses to assess the validity of these stock designations or to assess possible substructure within these stocks.

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 2010 (Funk et al. 2010, 2011; Aerts et al. 2011; Reiser et al. 2011). 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-October monitoring period (Funk et al. 2011, Reiser et al. 2011). Over the 2006-2010 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 ~~for observer perception bias~~ to correct for animals available but not counted because they were ~~not observed~~missed by the observer (perception bias) and ~~one~~another to correct for porpoise ~~availability/visibility~~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 (CV = 0.13~~2~~: Hobbs and Waite 2010), which includes the perception bias correction factor (1.337; CV = 0.06~~2~~) 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~~0~~); 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. ~~However the Laake et al. (1997) correction results from a different area and should be replaced with a correction derived from data collected in Alaska.~~ 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~~3~~). 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 (Friday et al. 2013); however, correction factors were not applied for perception bias, availability bias, or responsive movement to the ship. The abundance estimate was 1,971 porpoise (CV = 0.46) for 2002, 4,056 (CV = 0.40) for 2008, and 833 (CV = 0.66) for 2010. Although the 2010 estimate is the lowest of the three years, it is not significantly different from the 2002 and 2008 estimates (Friday et al. 2013). These surveys are useful for showing distribution throughout the southeastern Bering Sea and the relationship to hydrographic domains; however, because the surveys were not designed ~~for~~to estimate abundance of harbor porpoise and no correction factors to account for groups missed on the trackline or responsive movement are available, these ~~abundance~~ estimates are not used to calculate ~~a~~minimum population estimates.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 1999 partial population estimate (N) of 48,215 and its associated coefficient of variation (CV) of 0.22~~3~~, N_{MIN} for the Bering Sea stock of harbor porpoise is ~~40,039~~40,150 ~~(Hobbs and Waite 2010)~~. However, 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. Hence, until additional data become available, the cetacean maximum theoretical net productivity rate of 4% will be used (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population 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. Therefore, the PBR for this stock is considered undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~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 Bering Sea harbor porpoise in ~~2011-2015~~2012-2016 is 0.4 porpoise: 0.2 in U.S. commercial fisheries and 0.2 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

~~Detailed i~~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.

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 during ~~2011-2015~~2012-2016 (Breiwick 2013; MML, unpubl. data). However, strandings of marine mammals with fishing gear attached or with injuries caused by interactions with fishing gear provide some mortality data. One harbor porpoise mortality due to entanglement in a commercial salmon set gillnet in Kotzebue, Alaska, was reported to the NMFS Alaska Region stranding network in 2013 (Table 1; Helker et al. ~~2017~~in press), resulting in a minimum average annual mortality and serious injury rate of 0.2 Bering Sea harbor porpoise in U.S. commercial fisheries in ~~2011-2015~~2012-2016 (Table 1). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~is a minimum because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined. A complete estimate of the total mortality and serious injury rate incidental to U.S. commercial fisheries is unavailable for this stock because of the absence of an observer ~~placements in~~program for all of the salmon and herring fisheries operating within the range of ~~this~~the stock.

In 2012, one harbor porpoise entangled in a subsistence salmon gillnet in Nome, Alaska (Helker et al. ~~2017~~in press), resulting in a minimum average annual mortality and serious injury rate of 0.2 harbor porpoise due to subsistence fishery interactions in ~~2011-2015~~2012-2016 (Table 1).

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 in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in Kotzebue commercial salmon set gillnet	~~0~~	0	1	0	0	0	0.2
Entangled in Nome subsistence salmon gillnet	~~0~~	1	0	0	0	0	0.2
Total in commercial fisheries							0.2
Total in subsistence fisheries							0.2

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

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 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 (0.2 porpoise from stranding data) in U.S. commercial fisheries can be considered insignificant and approaching 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 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, 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 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 ~~habitat~~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.

CITATIONS

Aerts, L. A. M., A. Kirk, C. Schudel, K. Lomac-Macnair, A. McFarland, P. Seiser, and B. Watts. 2011. Marine mammal distribution and abundance in the northeastern Chukchi Sea, July – October 2008-2010. Final Report, 27 October 2011, prepared by OASIS Environmental, Inc., for ConocoPhillips Company, Shell Exploration & Production Company, and Statoil USA E & P, Inc. Available from OASIS Environmental, Inc., 825 W. 8th Ave., Anchorage, AK 99501.

Barlow, J., C. W. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. Fish. Bull., U.S. 86:433-444.

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

Calambokidis, J., and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California, p. 101-110. *In* J. E. Reynolds III and D. K. Odell (eds.), Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987, Miami, Florida. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-98.

Calambokidis, J., J. R. Evenson, J. C. Cubbage, S. D. Osmek, D. Rugh, and J. L. Laake. 1993. Calibration of sighting rates of harbor porpoise from aerial surveys. Final Report to the National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE Seattle, WA 98115. 55 p.

Chivers, S. J., A. E. Dizon, P. J. Gearin, and K. M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbor porpoise (*Phocoena phocoena*) indicated by molecular genetic analyses. J. Cetacean Res. Manage. 4(2):111-122.

Christman, C. L., and L. M. Aerts. 2015. Harbor porpoise (*Phocoena phocoena*) sightings from shipboard surveys in the Chukchi Sea during summer and fall, 2008-2014, p. 197. *In* Book of Abstracts, 2015 Alaska Marine Science Symposium, Anchorage, Alaska, January 19-23, 2015.

Dahlheim, M., A. York, R. Towell, J. Waite, and J. Breiwick. 2000. Harbor porpoise (*Phocoena phocoena*) abundance in Alaska: Bristol Bay to Southeast Alaska, 1991-1993. Mar. Mammal Sci. 16:28-45.

Dahlheim, M., P. A. White, and J. Waite. 2009. Cetaceans of Southeast Alaska: distribution and seasonal occurrence. J. Biogeogr. 36(3):410-426.

Dahlheim, M. E., A. N. Zerbini, J. M. Waite, and A. S. Kennedy. 2015. Temporal changes in abundance of harbor porpoise (*Phocoena phocoena*) inhabiting the inland waters of Southeast Alaska. Fish. Bull., U.S. 113(3):242-255.

Friday, N. A., J. M. Waite, A. N. Zerbini, and S. E. Moore. 2012. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf: 1999-2004. Deep-Sea Res. II 65-70:260-272.

Friday, N. A., J. M. Waite, A. N. Zerbini, S. E. Moore, and P. J. Clapham. 2013. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf, June and July of 2002, 2008 and 2010. Deep-Sea Res. II 94:244-256.

Funk, D. W., D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.). 2010. Joint monitoring program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL, Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 p. + appendices.

Funk, D. W., C. M. Reiser, D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.). 2011. Joint monitoring program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Draft Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL, Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc., and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. + appendices.

Gaskin, D. E. 1984. The harbor porpoise *Phocoena phocoena* (L.): regional populations, status, and information on direct and indirect catches. Rep. Int. Whal. Comm. 34:569-586.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hobbs, R. C., and J. M. Waite. 2010. Abundance of harbor porpoise (*Phocoena phocoena*) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. Fish. Bull., U.S. 108(3):251-267.

Laake, J. L., J. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manage. 61(1):63-75.

Linnenschmidt, M., J. Teilmann, T. Akamatsu, R. Dietz, and L. A. Miller. 2013. Biosonar, dive, and foraging activity of satellite tracked harbor porpoises (*Phocoena phocoena*). Mar. Mammal Sci. 29(2):77-97.

Moore, S. E., J. M. Waite, N. A. Friday, and T. Honkalehto. 2002. Cetacean distribution and relative abundance on the central-eastern and the southeastern Bering Sea shelf with reference to oceanographic domains. Prog. Oceanogr. 55:249-261.

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

Reiser, C. M., D. W. Funk, R. Rodrigues, and D. Hannay (eds.). 2011. Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc., in the Alaskan Chukchi and Beaufort seas, July–October 2010: 90-day report. LGL Report P1171E–1. Report from LGL Alaska Research Associates, Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC, for Shell Offshore, Inc., Houston, TX, National Marine Fisheries Service, Silver Spring, MD, and U.S. Fish and Wildlife Service, Anchorage, AK. 240 p. + appendices.

Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, University of California San Diego. 191 p.

Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, *Phocoena phocoena*, on inter-oceanic and regional scales. Can. J. Fish. Aquat. Sci. 52:1210-1219.

Rosel, P. E., R. Tiedemann, and M. Walton. 1999. Genetic evidence for limited trans-Atlantic movements of the harbor porpoise *Phocoena phocoena*. Mar. Biol. 133:583-591.

Shelden, K. E. W., B. A. Agler, J. J. Brueggeman, L. A. Cornick, S. G. Speckman, and A. Prevel-Ramos. 2014. Harbor porpoise, *Phocoena phocoena vomerina*, in Cook Inlet, Alaska. Mar. Fish. Rev. 76(1-2):22-50.

Taylor, B. L., P. R. Wade, D. P. DeMaster, and J. Barlow. 1996. Models for management of marine mammals. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/48/SM50). 12 p.

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

Walton, M. J. 1997. Population structure of harbour porpoises *Phocoena phocoena* in the seas around the UK and adjacent waters. Proc. R. Soc. Lond. B 264:89-94.

Westgate, A. J., and K. A. Tolley. 1999. Geographical differences in organochlorine contaminants in harbour porpoises *Phocoena phocoena* from the western North Atlantic. Mar. Ecol. Prog. Ser. 177:255-268.

Revised ~~12/30/2015~~8/10/2018

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

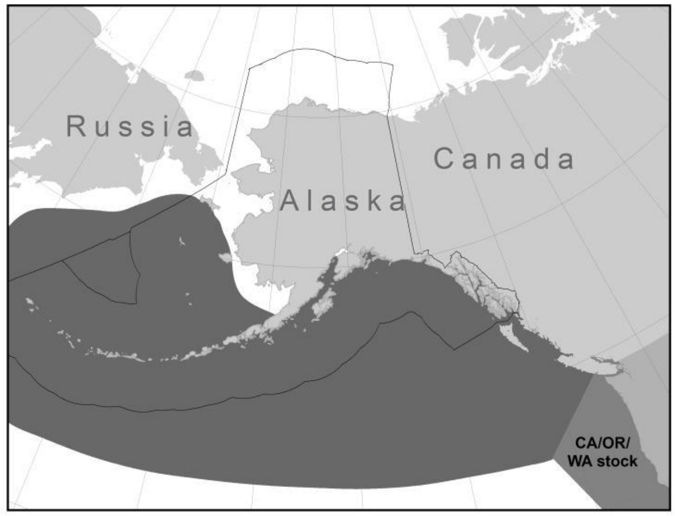

Figure 1. Approximate distribution of Dall's porpoise in the eastern North Pacific Ocean (dark shaded area). The Alaska stock is defined as the portion of the distribution in Alaska waters ~~(dark shaded area)~~.

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

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 ~~this~~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). Ship 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).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 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, ~~but~~ based on patterns of stock differentiation in the western North Pacific, where they have been more intensively studied, it is expected that separate stocks will emerge when data become available (Perrin and Brownell 1994). Based primarily on the population response data (Jones et al. 1986) and preliminary genetic~~s~~ 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~~n~~ waters. Dall's porpoise along the west coast of the continental U.S. from California to Washington comprise a separate stock and are reported ~~separately~~ in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

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

Sighting surveys for cetaceans were conducted 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 ~~range~~study area of the survey, which corresponded to only a fraction of the range of the Alaska stock, was ~~completed~~fully covered in three of those years (2002, 2008, and 2010). ~~and~~ Dall's porpoise estimates were calculated for each of these surveys (Friday et al. 2013). The abundance estimates ~~was~~were 35,303 porpoise (CV = 0.53) in 2002, 14,543 (CV = 0.32) in 2008, and 11,143 (CV = 0.32) in 2010. Although the 2010 estimate is the lowest of the three years, it is not ~~significantly~~statistically different from the 2002 and 2008 estimates (Friday et al. 2013). ~~These estimates have not been corrected for animals missed on the trackline (perception bias) or animals submerged when the ship passed (availability bias).~~

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 overlapping, areas in the two years and estimated Dall's porpoise abundance as 15,432 (CV = 0.28) in 2013 and 13,110 (CV = 0.22) in 2015.

Estimates of abundance for the NMFS pollock stock assessment surveys in the Bering Sea 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 animals missed on the trackline (perception bias) or for animals submerged when the ship passed (availability bias). ~~They~~These estimates are also uncorrected for potential biases from responsive movements (ship attraction), which is known to result in severe positive bias when calculating abundance of Dall's porpoise (Turnock and Quinn 1991). ~~and,~~ Therefore, these estimates are~~, therefore,~~ not used as minimum population estimates.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. However, ~~since~~because the abundance estimate is based on data older than 8 years, the N_{MIN} is considered unknown.

Current Population Trend

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

POTENTIAL BIOLOGICAL REMOVAL

~~Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the~~ PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. ~~Wade and Angliss (1997) recommend~~However, the 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) state that abundance estimates older than 8 years ~~no longer~~should not be used to calculate ~~a~~ PBR ~~level~~due to a decline in confidence in the reliability of an aged abundance estimate.~~; thus, because the abundance estimate for this stock is more than 8 years old, the N_{MIN} is unknown and~~ ~~t~~Therefore, the PBR ~~level~~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 Alaska stock of Dall's porpoise in 2012-2016 is 38 Dall's porpoise in U.S. commercial fisheries (37 from observer data and 0.6 from fisherman self-reports). 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.

~~**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

~~Detailed i~~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.

~~Until 2003, there were six different federally-regulated commercial fisheries in Alaska that could have interacted with Dall's porpoise and were monitored for incidental mortality and serious injury by fishery observers. As of 2003, changes in fishery definitions in the MMPA List of Fisheries have resulted in separating these 6 fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. For the fisheries with observed takes, the range of observer coverage in 2009-2013, as well as the annual observed and estimated mortality and serious injury, are presented in Table 1.~~No mortality or serious injury of the Alaska stock of Dall's porpoise was observed incidental to federally-managed U.S. commercial fisheries in 2012-2016 (Breiwick 2013; MML, unpubl. data).

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

In 2012 and 2013, the ~~Alaska Marine Mammal Observer Program (~~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, 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. ~~However, due to the large stock size, it is unlikely that unreported mortality and serious injury from those fisheries are a significant source of mortality.~~ Combining the estimates from the ~~Bering Sea and Gulf of Alaska fisheries (0.5) with the estimate from the~~ Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery (28) and the Southeast Alaska salmon drift gillnet fishery (9) results in an estimated average annual mortality and serious injury rate ~~in observed fisheries~~ of ~~38~~37 Dall's porpoise from this stock.

Table 1. Summary of incidental mortality and serious injury of the Alaska stock of Dall's porpoise due to U.S. commercial fisheries ~~from 2009 to 2013~~in 2012-2016 (or the most recent data available) and calculation of the mean annual mortality and serious injury rate (Wynne et al. 1991; Breiwick 2013; Manly 2015; ~~N~~MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
~~Bering Sea/Aleutian Is. pollock trawl~~	~~2009~~ ~~2010~~ ~~2011~~ ~~2012~~ ~~2013~~	~~obs data~~	~~86~~ ~~86~~ ~~98~~ ~~98~~ ~~97~~	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~1.04~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0.2~~ ~~(CV = 0.19)~~
~~Bering Sea/Aleutian Is. Pacific cod longline~~	~~2009~~ ~~2010~~ ~~2011~~ ~~2012~~ ~~2013~~	~~obs data~~	~~60~~ ~~64~~ ~~57~~ ~~51~~ ~~67~~	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~1.5~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0.3~~ ~~(CV = 0.77)~~
S~~E~~outheast Alaska salmon drift gillnet (Districts 6, 7, 8)	2012 2013	obs data	6.4 6.6	1 0	18 0	9 (CV = 1.0)
A~~K~~laska Peninsula/Aleutian Is. salmon drift gillnet	1990	obs data	4	1	28	28 (CV = 0.585)
Minimum total estimated annual mortality						~~38~~37 (CV = ~~0.498~~0.505)

~~From 2009 to 2013, no m~~Mortality ~~or~~and serious injury of Dall's porpoise due to entanglements in Prince William Sound commercial salmon drift gillnet (1 in 2013), Southeast Alaska commercial salmon drift gillnet (1 in 2014 in District 15C), and Kodiak Island commercial salmon purse seine gear (1 in 2013) was reported ~~to the NMFS Alaska Region stranding database~~ by Marine Mammal Authorization Program (MMAP) fisherman self-reports in 2012-2016 (Table 2; Helker et al. ~~2015~~in press). Because observer data are not available for these fisheries, this mortality and serious injury is used to calculate mean annual mortality and serious injury rates of 0.2 Dall's porpoise for each of these fisheries (Table 2). 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.

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

Cause of injury	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in Prince William Sound commercial salmon drift gillnet	0	1[a]	0	0	0	0.2
Entangled in Southeast Alaska commercial salmon drift gillnet (District 15C)	0	0	1[a]	0	0	0.2
Entangled in Kodiak Island commercial salmon purse seine gear	0	1[a]	0	0	0	0.2
Total in commercial fisheries						0.6

[a]MMAP fisherman self-report.

A complete estimate of the total mortality and serious injury incidental to U.S. commercial fisheries is unavailable for this stock because not all of the salmon and herring fisheries operating within the range of this stock have been observed. Based on observed mortality and serious injury in two commercial fisheries (Table 1) and by MMAP fisherman self-reports (Table 2), the minimum estimated mean annual mortality and serious injury rate incidental to commercial fisheries in 2012-2016 is 38 Dall's porpoise from this stock.

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 level of human-caused mortality and serious injury (38) is not known to exceed the PBR, which is undetermined as t~~The ~~most recent~~minimum abundance estimate for this stock is unknown because the most recent abundance estimate is more than 8 years old and so the PBR level is considered undetermined. Because the PBR is undetermined and fisheries observer coverage is limited and aged, it is unknown if the minimum estimate of the mean annual ~~level of~~mortality and serious injury rate (38 porpoise) in U.S. commercial ~~fishery-related mortality and serious injury that~~fisheries can be considered insignificant and approaching zero mortality and serious injury rate ~~is unknown~~. The Alaska stock of Dall's porpoise is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are ~~currently~~ unknown.

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

HABITAT CONCERNS

While the majority of Dall's porpoise are found throughout 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 Dall's porpoise 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). Climate change and changes to sea-ice coverage may be opening up new habitats, or resulting in shifts in habitat, as evident by an increase in the number of reported sightings of Dall's porpoise in the Chukchi Sea (Funk et al. 2010, 2011). Shipping and noise from oil and gas activities may also be a habitat concern for Dall's porpoise, particularly in the Chukchi Sea.

CITATIONS

~~Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating serious and non-serious injury of marine mammals: report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-39, 94 p.~~

~~Angliss, R. P., and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13, 48 p.~~

Boucher, G. C., and C. J. Boaz. 1989. Documentation for the marine mammal sightings database of the National Marine Mammal Laboratory. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-159, 60 p.

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

Buckland, S. T., K. L. Cattanach, and R. C. Hobbs. 1993. Abundance estimates of Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987/90., ~~P~~p. 387-407. *In* W. Shaw, R. L. Burgner, and J. Ito (eds.), Biology, distribution and stock assessment of species caught in the high seas driftnet fisheries in the North Pacific Ocean. International North Pacific Fisheries Commission Symposium; 4-6 November 1991, Tokyo, Japan.

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

Ferrero, R. C., and W. A. Walker. 1999. Age, growth, and reproductive patterns of Dall's porpoise (*Phocoenoides dalli*) in the central North Pacific Ocean. Mar. Mammal Sci. 15(2):273-313.

Friday, N. A., J. M. Waite, A. N. Zerbini, and S. E. Moore. 2012. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf: 1999-2004. Deep-Sea Res. II 65-70:260-272.

Friday, N. A., A. N. Zerbini, J. M. Waite, S. E. Moore, and P. J. Clapham. 2013. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf in June and July of 2002, 2008, and 2010. Deep-Sea Res. II 94:244-256.

Funk, D. W., D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.). 2010. Joint monitoring program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL, Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc., and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 ~~p~~p. + appendices.

Funk, D. W., C. M. Reiser, D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.). 2011. Joint monitoring program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Draft Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL, Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc., and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 ~~p~~p. + appendices.

Hall, J. 1979. A survey of cetaceans of Prince William Sound and adjacent waters - their numbers and seasonal movements. Unpubl. report to Alaska Outer Continental Shelf Environmental Assessment Programs. NOAA OCSEAP Juneau Project Office, Juneau, AK. 37 ~~p~~p.

~~Helker, V. T., B. M. Allen, and L. A. Jemison. 2015. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2009-2013. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-300, 94 p.~~

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hobbs, R. C., and J. A. Lerczak. 1993. Abundance of Pacific white-sided dolphin and Dall's porpoise in Alaska estimated from sightings in the North Pacific Ocean and the Bering Sea during 1987 through 1991. Annual Report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Jones, L. L., J. M. Breiwick, G. C. Boucher, and B. J. Turnock. 1986. Untitled document. Submitted as NOAA-2 in Docket #MMPAH - 1986-01 in Seattle Administrative Building, 1986.

Leatherwood, J. S., and M. R. Fielding. 1974. A survey of distribution and movements of Dall's porpoise, *Phocoenoides dalli*, off southern California and Baja California. Working paper No. 42, FAO, United Nations, ACMRR Meeting, La Jolla, CA.

Linnenschmidt, M., J. Teilmann, T. Akamatsu, R. Dietz, and L. A. Miller. 2013. Biosonar, dive, and foraging activity of satellite tracked harbor porpoises (*Phocoena phocoena*). Mar. Mammal Sci. 29(2):77-97.

Loeb, V. J. 1972. A study of the distribution and feeding habits of the Dall's porpoise in Monterey Bay, CA. MA Thesis, San Jose State University, CA. 62 ~~p~~p.

Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in districts 6, 7, and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 p~~p. Available online: https://alaskafisheries.noaa.gov/sites/default/files/incidentaltakes2012-2013.pdf. Accessed December 2015.~~

Moore, S. E., J. M. Waite, N. A. Friday, and T. Honkalehto. 2002. Distribution and comparative estimates of cetacean abundance on the central and south-eastern Bering Sea shelf with observations on bathymetric and prey associations. Prog. Oceanogr. 55(1-2):249-262.

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

~~NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf. Accessed December 2015.~~

Perrin, W. F., and R. L. Brownell, Jr. 1994. A brief review of stock identity in small marine cetaceans in relation to assessment of driftnet mortality in the North Pacific. Rep. Int. Whal. Comm. (Special Issue 15):393-401.

Rone, B. K., A. N. Zerbini, A. B. Douglas, D. W. Weller, and P. J. Clapham. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. Mar. Biol. 164:23. DOI: dx.doi.org/10.1007/s00227-016-3052-2 .

Turnock, B. J., and T. J. Quinn. 1991. The effect of responsive movement on abundance estimation using line transect sampling. Biometrics 47:701-715.

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

Winans, G. A., and L. L. Jones. 1988. Electrophoretic variability in Dall's porpoise (*Phocoenoides dalli*) in the North Pacific Ocean and Bering Sea. J. Mammal. 69(1):14-21.

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 65 pp. Available from NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

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).

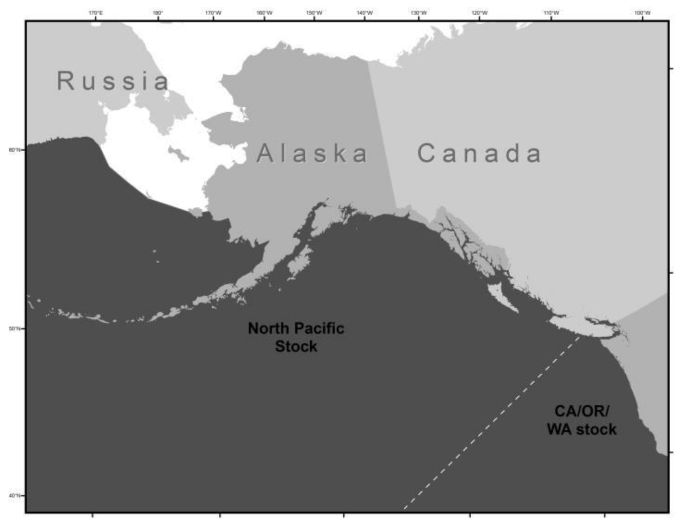

Figure 1. The approximate distribution of sperm whales in the North Pacific Ocean includes deep waters south of 62°N to the equator.

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 ~~marks~~tags ~~given to~~implanted in sperm whales in the 1960s ~~can~~could, ~~if~~when re~~dis~~covered from a dead whale, provide useful information on historical movements. Mizroch and Rice (2013) examined 261 Discovery ~~mark~~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. The U.S. ~~marked~~tagged 176 sperm whales from 1962 to 1969 off southern California and northern Baja California (Mizroch and Rice 2013). Seven of those ~~marked~~tagged whales were recovered in locations ranging from offshore California, Oregon, and British Columbia to the western Gulf of Alaska. A male whale ~~marked~~tagged by Canadian researchers moved from near Vancouver Island, British Columbia, to the Aleutian Islands near Adak. A whale ~~marked~~tagged by Soviet researchers moved from coastal Michoacán, mainland Mexico, to a location about 1,300 km offshore of Washington State. ~~Marking~~Discovery tag data show extensive movements throughout the North Pacific and along the U.S. west coast into the Gulf of Alaska and Bering Sea/Aleutian Islands region (Mizroch and Rice 2013). 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).

~~From analyzing whaling data,~~ 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 (ca. 28-34°N) and the subarctic frontal zones (ca. 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 ~~marking~~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 ~~has~~was not ~~been~~ 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 ~~whale marking~~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); 2) California/Washington/Oregon; and 3) Hawaii. ~~Information from~~ Mizroch and Rice (2013) suggest~~s~~ that this ~~structure~~ should be reviewed and updated to reflect ~~current~~additional data, but there is insufficient information to propose a reasonable alternative structure. The California/Oregon/Washington and Hawaii sperm whale stocks are reported ~~separately~~ 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 ~~biased~~unreliable; caution should be exercised in interpreting published estimates. The abundance of sperm whales in the North Pacific was ~~reported~~estimated to be 1,260,000 prior to exploitation, which by the late 1970s was ~~estimated~~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)~~, but~~; the acoustic data produced an estimate of 32,100 sperm whales (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, however, 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. ~~The overall number of sperm whales occurring in Alaska waters is unknown.~~These estimates are for a small area that was unlikely to include females and juveniles and 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 North Pacific stock is ~~not~~considered unavailable.

Minimum Population Estimate

~~At this time, it is not possible to produce a reliable estimate of minimum abundance for this stock.~~A minimum population estimate (N_{MIN}) for this stock can be calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the estimate (N) of 345 from surveys in the Gulf of Alaska in 2015 (Rone et al. 2017), and the associated coefficient of variation 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

~~No current estimate of abundance exists for this stock; therefore,~~There is no reliable information on trends in abundance for this stock~~ is not available~~ (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. Hence, 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 (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 which are classified as endangered (Wade and Angliss 1997). ~~However, because a reliable estimate of N_{MIN} is not available, the PBR for this stock is unknown.~~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

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~in press); 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 NOAA (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 Helker et al. (in press). A minimum estimate of the total annual level of human-caused mortality and serious injury for North Pacific sperm whales in ~~2011-2015~~2012-2016 is ~~3.7~~4.4 whales in U.S. commercial fisheries. Sperm whales have been observed depredating both halibut and sablefish longline fisheries in the Gulf of Alaska and this is also widespread 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

~~Detailed i~~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.

In ~~2011-2015~~2012-2016, five serious injuries of sperm whales were observed in the Gulf of Alaska sablefish longline fishery (two each in 2012 and 2013 and one in ~~2014~~2016) and one in the Bering Sea/Aleutian Islands Pacific halibut longline fishery (in 2015). Each of these injuries was prorated at a value of 0.75 and extrapolated to fishery-wide estimates when possible, resulting in a minimum average annual estimated mortality and serious injury rate of ~~3.7~~4.4 sperm whales in U.S. commercial fisheries in ~~2011-2015~~2012-2016 (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 in ~~2011-2015~~2012-2016 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NOAA (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 Helker et al. (in press).

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. Pacific halibut longline	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~16~~ 1.8 13 ~~11~~14 ~~14~~15 12	~~0~~ 0 0 0 0.75 0	~~0~~ 0 0 0 ~~7.3~~7.6 0	1.5 (CV=~~0.91~~0.99)
Gulf of Alaska sablefish longline	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~14~~ 14 14 19 20 14	~~0~~ 1.5 0.75 (+0.75)[a] 0 ~~(+0.75)[c]~~ 0 0.75	~~0~~ 3.4 6.2 (+0.75)[b] 0 ~~(+0.75)[d]~~ 0 4.0	~~1.9~~2.7 (+~~0.3~~0.2)[~~e~~c] (CV = ~~0.63~~0.52)
Minimum total estimated annual mortality						~~3.7~~4.4 (CV = ~~0.53~~0.49)

[a]Total mortality and serious injury observed in 2013: 0.75 whales in sampled hauls + 0.75 whales in an unsampled haul.
[b]Total estimate of mortality and serious injury in 2013: 6.2 whales (extrapolated estimate from 0.75 whales observed in sampled hauls) + 0.75 whales (0.75 whales observed in an unsampled haul).
~~[c]Total mortality and serious injury observed in 2014: 0 whales in sampled hauls + 0.75 whales in an unsampled haul.~~
~~[d]Total estimate of mortality and serious injury in 2014: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 0.75 whales (0.75 whales observed in an unsampled haul).~~
[~~e~~c]Mean annual mortality and serious injury for fishery: ~~1.9~~2.7 whales (mean of extrapolated estimates from sampled hauls) + ~~0.3~~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 (BSAI) region. The BSAI catches were dominated by males. After 1967, whalers moved out of the BSAI 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 was 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 ~~biased~~incorrect (i.e., too low) because of falsified catch information from both the Japanese coastal and pelagic fisheries (Kasuya 1999, Ivashchenko and Clapham 2015~~, Clapham and Ivashchenko 2016~~).

From ~~2011~~2012 to ~~2015~~2016, one suspected human-related sperm whale mortality was reported to the NMFS Alaska Region stranding network (Helker et al. ~~2017~~in press). A beachcast sperm whale was found in 2012 on a beach near Yakutat with a net from an unknown fishery wrapped around its lower jaw. However, due to the advanced decomposition of this whale, the cause of death could not be determined.

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 during 1995-1997 in which sperm whales were deterred by fishermen (i.e., ~~yelling at the whales or~~ 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; ~~the majority of interactions occur~~interaction rates are increasing significantly in the ~~West Yakutat and~~ East Yakutat/Southeast Alaska and Central Gulf management areas (~~Perez 2006,~~ Hanselman et al. ~~2008~~2018). ~~Sigler et al. (2008) analyzed catch data from 1998 to 2004 and found that catch rates were about 2% less at locations where depredation occurred, but the effect was not significant (p = 0.34). Hill et al. (1999) analyzed data collected by fisheries observers in Alaska waters and also found no significant effect on catch. A small, significant effect on catch rates was found in a study using data collected in Southeast Alaska, in which longline fishery catches in sets with sperm whales present were compared to catches in sets with sperm whales absent (3% reduction, t-test, 95% CI of 0.4-5.5%, p = 0.02: Straley et al. 2005). Sperm whales may be present during longline haul back without depredating; in these instances, it is presumed that whales are consuming discard.~~ 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 total annual level of human-caused mortality and serious injury is ~~3.7~~4.4 whales in U.S. commercial fisheries. ~~Because the PBR is unknown, it is not known if this~~The minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate (~~3.7~~4.4 whales) ~~can be considered insignificant and approaching zero mortality and serious injury rate~~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 and should not be used for management purposes.

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.

CITATIONS

Allison, C. 2012. IWC Catch Database, version 5.3 (25 October 2012). Available from the International Whaling Commission, Cambridge, UK.

Barlow, J., and B. L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. Mar. Mammal Sci. 21:429-445.

Berzin, A. A. 2008. The truth about Soviet whaling: a memoir. Mar. Fish. Rev. 70(2):4-59.

Braham, H. 1992. Endangered whales: status update. Working document presented at A Workshop on the Status of California Cetacean Stocks (SOCCS/14). 35 p. + tables. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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

Clapham, P. J., and Y. V. Ivashchenko. 2016. Stretching the truth: length data highlight extensive falsification of Japanese sperm whale catch statistics in the Southern Hemisphere. Royal Society Open Science 3:160506. DOI: dx.doi.org/10.1098/rsos.160506 .

Cooke, J. G., W. K. de la Mare, and J. R. Beddington. 1983. Some aspects of the reliability of the length data for the western North Pacific stock of sperm whales. Rep. Int. Whal. Comm. 33:265-267.

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

Donovan, G. P. 1991. A review of IWC stock boundaries. Rep. Int. Whal. Comm. (Special Issue 13):39-68.

Hanselman, D. H., C. R. Lunsford, J. T. Fujioka, and C. J. Rodgveller. 2008. Assessment of the sablefish stock in Alaska, Section 3, p. 303-420. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska. North Pacific Fisheries Management Council, Anchorage, AK.

Hanselman, D. H., B. J. Pyperb, and M. J. Peterson. 2018. Sperm whale depredation on longline surveys and implications for the assessment of Alaska sablefish. Fish. Res. 200:75-83. DOI: dx.doi.org/10.1016/j.fishres.2017.12.017 .

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hill, P. S., and E. Mitchell. 1998. Sperm whale interactions with longline vessels in Alaska waters during 1997. Unpubl. doc. submitted to Fish. Bull., U.S. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Hill, P. S., J. L. Laake, and E. Mitchell. 1999. Results of a pilot program to document interactions between sperm whales and longline vessels in Alaska waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-108, 42 p.

International Whaling Commission (IWC). 2017. Report of the planning meeting for the 2017 IWC-POWER cruise in the North Pacific with initial discussions for the 2018 and 2019 cruises. Document SC/67a/Rep 01. Available from ~~the~~ International Whaling Commission, Cambridge, UK.

Ivashchenko, Y. V., and P. J. Clapham. 2015. What's the catch? Validity of whaling data for Japanese catches of sperm whales in the North Pacific. Royal Society Open Science 2:150177. DOI: dx.doi.org/10.1098/rsos.150177 .

Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell, Jr. 2013. Soviet catches of whales in the North Pacific: revised totals. J. Cetacean Res. Manage. 13(1):59-71.

Ivashchenko, Y. V., R. L. Brownell, Jr., and P. J. Clapham. 2014. Distribution of Soviet catches of sperm whales *Physeter macrocephalus* in the North Pacific. Endang. Species Res. 25:249-263.

Kasuya, T. 1999. Examination of the reliability of catch statistics in the Japanese coastal sperm whale fishery. J. Cetacean Res. Manage. 1:109-122.

Kasuya T., and T. Miyashita. 1988. Distribution of sperm whale stocks in the North Pacific. Sci. Rep. Whales Res. Inst. 39: 31-75.

Kato, H., and T. Miyashita. 1998. Current status of North Pacific sperm whales and its preliminary abundance estimates. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/50/CAWS/52). 6 p.

Mellinger, D. K., K. M. Stafford, and C. G. Fox. 2004. Seasonal occurrence of sperm whale (*Physeter macrocephalus*) sounds in the Gulf of Alaska, 1999-2001. Mar. Mammal Sci. 20(1):48-62.

Mesnick, S. L., B. L. Taylor, F. I. Archer, K. K. Martien, S. Escorza Treviño, B. L. Hancock-Hanser, S. C. Moreno Medina, V. L. Pease, K. M. Robertson, J. M. Straley, R. W. Baird, J. Calambokidis, G. S. Schorr, P. Wade, V. Burkanov, C. R. Lunsford, L. Rendell, and P. A. Morin. 2011. Sperm whale population structure in the eastern and central North Pacific inferred by the use of single nucleotide polymorphisms, microsatellites and mitochondrial DNA. Mol. Ecol. Res. 11(Suppl. 1):278-298.

Mizroch, S. A., and D. W. Rice. 2006. Have North Pacific killer whales switched prey species in response to depletion of the great whale populations? Mar. Ecol. Prog. Ser. 310:235-246.

Mizroch, S. A., and D. W. Rice. 2013. Ocean nomads: distribution and movements of sperm whales in the North Pacific shown by whaling data and Discovery marks. Mar. Mammal Sci. 29(2):E136-E165. DOI: dx.doi.org/10.1111/j.1748-7692.2012.00601.x .

NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-policies-guidance-and-regulations . Accessed June 2018.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167, 194 p.

Peterson, M. J., and D. Hanselman. 2017. Sablefish mortality associated with whale depredation in Alaska. ICES J. Mar. Sci. 74 (5):1382-1394. DOI: dx.doi.org/10.1093/icesjms/fsw239 .

Rice, D. W. 1989. Sperm whale, *Physeter macrocephalus*, p. 177-233. *In* S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals. Vol. 4. River Dolphins and the Larger Toothed Whales. Academic Press, New York.

Rone, B. K., A. N. Zerbini, A. B. Douglas, D. W. Weller, and P. J. Clapham. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. Mar. Biol. 164:23. DOI: dx.doi.org/10.1007/s00227-016-3052-2 .

Sigler, M. F., C. R. Lunsford, J. M. Straley, and J. B. Liddle. 2008. Sperm whale depredation of sablefish longline gear in the northeast Pacific Ocean. Mar. Mammal Sci. 24(1):16-27.

Straley, J., T. O'Connell, S. Mesnick, L. Behnken, and J. Liddle. 2005. Sperm whale and longline fisheries interactions in the Gulf of Alaska. North Pacific Research Board R0309 Final Report. 15 p.

Straley, J. M., G. S. Schorr, A. M. Thode, J. Calambokidis, C. R. Lunsford, E. M. Chenoweth, V. M. O'Connell, and R. D. Andrews. 2014. Depredating sperm whales in the Gulf of Alaska: local habitat use and long distance movements across putative population boundaries. Endang. Species Res. 24:125-135.

Townsend, C. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica 19:1-50.

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

Whitehead, H., and T. Arnbom. 1987. Social organization of sperm whales off the Galapagos Islands, February-April 1985. Can. J. Zool. 65(4):913-919.

Revised ~~12/30/2017~~8/10/2018

HUMPBACK WHALE (*Megaptera novaeangliae*): Western North Pacific Stock

NOTE – NMFS is in the process of reviewing humpback whale stock structure under the Marine Mammal Protection Act (MMPA) in light of the 14 Distinct Population Segments established under the Endangered Species Act (ESA) (81 FR 62259, 8 September 2016). A complete revision of the humpback whale stock assessments will be postponed until this review is complete. In the interim, new information on humpback whale mortality and serious injury is provided within this report.

STOCK DEFINITION AND GEOGRAPHIC RANGE

The humpback whale is distributed worldwide in all ocean basins. In winter, most humpback whales occur in the subtropical and tropical waters of the Northern and Southern Hemispheres. Humpback whales in the high latitudes of the North Pacific Ocean are seasonal migrants that feed on euphausiids and small schooling fishes (Nemoto 1957, 1959; Clapham and Mead 1999). The humpback whale population was considerably reduced as a result of intensive commercial exploitation during the 20th century.

A large-scale study of humpback whales throughout the North Pacific was conducted in 2004-2006 (the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project). Initial results from this project (Calambokidis et al. 2008, Barlow et al. 2011), including abundance estimates and movement information, have been reported in Baker et al. (2008, 2013) and are also summarized in Fleming and Jackson (2011); however, these results are still being considered for stock structure analysis.

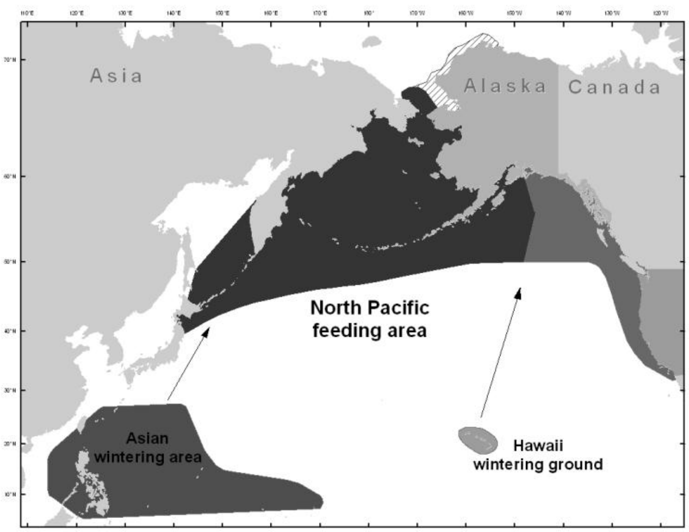

Figure 1. Approximate distribution of humpback whales in the western North Pacific (dark shaded areas). Feeding and wintering grounds are presented above (see text). Area within the hash lines is a probable distribution area based on sightings in the Beaufort Sea (Hashagen et al. 2009). See Figure 1 in the Central North Pacific humpback whale Stock Assessment Report for humpback whale distribution in the eastern North Pacific.

The historical summer feeding range of humpback whales in the North Pacific encompassed coastal and inland waters around the Pacific Rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk and north of the Bering Strait (Zenkovich 1954, Nemoto 1957, Tomlin 1967, Johnson and Wolman 1984). Historically, the Asian wintering area extended from the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands (Rice 1998). Humpback whales are currently found throughout this historical range (Clarke et al. 2013b), with sightings during summer months occurring as far north as the Beaufort Sea (Hashagen et al. 2009). Most of the current winter range of humpback whales in the North Pacific is relatively well known, with aggregations of whales in Japan, the Philippines, Hawaii, Mexico, and Central America. The winter range includes the main islands of the Hawaiian archipelago, with the greatest concentration along the west side of Maui. In Mexico, the winter breeding range includes waters around the southern part of the Baja California peninsula, the central portions of the Pacific coast of mainland Mexico, and the Revillagigedo Islands off the mainland coast. The winter range also extends from southern Mexico into Central America, including Guatemala, El Salvador, Nicaragua, and Costa Rica (Calambokidis et al. 2008).

Photo-identification data, distribution information, and genetic analyses have indicated that in the North Pacific there are at least three breeding populations (Asia, Hawaii, and Mexico/Central America) that all migrate between their respective winter/spring calving and mating areas and their summer/fall feeding areas (Calambokidis et al. 1997, Baker et al. 1998). Calambokidis et al. (2001) further suggested that there may be as many as six subpopulations on the wintering grounds. From photo-identification and Discovery tag ~~mark~~ information there are known connections between Asia and Russia, between Hawaii and Alaska, and between Mexico/Central America and California (Darling 1991, Darling and Cerchio 1993, Calambokidis et al. 1997, Baker et al. 1998). This information led to the designation of three stocks of humpback whales in the North Pacific: 1) the California/Oregon/Washington and Mexico stock, consisting of winter/spring 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/fall (Calambokidis et al. 1989, 1993; Steiger et al. 1991); 2) the Central North Pacific stock, consisting of winter/spring populations of the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997); and 3) the Western North Pacific stock, consisting of winter/spring populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands (Fig. 1).

Information from the SPLASH project largely confirms this view of humpback whale distribution and movements in the North Pacific. For example, the SPLASH results confirm low rates of interchange between the three principal wintering regions (Asia, Hawaii, and Mexico). However, the full SPLASH results suggest that the ~~current~~previous view of population structure ~~is incomplete~~was inaccurate. The overall pattern of movements is complex but indicates a high degree of population structure. Whales from wintering areas at the extremes of their range on both sides of the Pacific migrate to coastal feeding areas that are on the same side of the Pacific: whales from Asia in the west migrate to Russia and whales from mainland Mexico and Central America in the east migrate to coastal waters off California/Oregon.

The SPLASH data ~~now~~ show the Revillagigedo whales are seen in all sampled feeding areas except northern California/Oregon and the south side of the Aleutians. They are primarily distributed in the Bering Sea, Gulf of Alaska, and Southeast Alaska/northern British Columbia but are also found in Russia and southern British Columbia/Washington. The migratory destinations of humpback whales from Hawaii were found to be quite similar, and a number of matches (14) were seen during SPLASH between Hawaii and the Revillagigedos (Calambokidis et al. 2008).

The winter distribution of humpback whales in the Western stock includes several island chains in the western North Pacific. In the Ogasawara Islands, humpback whale sampling during SPLASH was conducted at the three main island groups of Chichi-jima, Haha-jima, and Muko-jima, separated from each other by ~50-70 km. SPLASH sampling in Okinawa (southwest of Honshu) occurred at the Okinawa mainland and Zamami in the Kerama Islands (40 km from the Okinawa mainland), and in the Philippines SPLASH sampling occurred only at the northern tip of the archipelago around the Babuyan Islands. Humpback whales are reported to also occur in the South China Sea north of the Philippines near Taiwan, and east of Ogasawara in the Marshall and Mariana Islands (Rice 1998), but ~~as yet~~ there ~~are~~were no known areas of high density in these regions that could be efficiently sampled.

The SPLASH project also found that whales from the Aleutian Islands and Bering Sea, and perhaps the Gulf of Anadyr and the Chukotka Peninsula on the west side of the Bering Strait in Russia, have an unusually low resighting rate in winter areas compared to whales from other feeding areas. It is ~~now~~ believed that some of these whales have a winter migratory destination that was not sampled during the SPLASH project. Given the location of these feeding areas, the most parsimonious explanation would be that some of these whales winter somewhere between Hawaii and Asia, which would include the possibility of the Mariana Islands (southwest of the Ogasawara Islands), the Marshall Islands (approximately half-way between the Mariana Islands and the Hawaiian Islands), and the Northwestern Hawaiian Islands. Subsequent to the SPLASH project, a survey in 2007 documented humpback whales from a number of locations in the Northwestern Hawaiian Islands at relatively low densities (Johnston et al. 2007), but no sampling occurred there during the SPLASH project. Some humpback whales, including mother/calf pairs, have also been found in the Mariana Islands (Hill et al. 2016). Both of these locations are plausible migratory destinations for whales from the Aleutian Islands and Bering Sea. Which stock that whales in these locations would belong to is ~~currently~~ unknown.

The migratory destination of Western North Pacific humpback whales is not completely known. Discovery tag ~~recaptures~~recoveries have indicated movement of whales between Ogasawara and Okinawa and feeding areas in the Bering Sea, on the southern side of the Aleutian Islands, and in the Gulf of Alaska (Omura and Ohsumi 1964, Nishiwaki 1966, Ohsumi and Masaki 1975). Research on humpback whales at the Ogasawara Islands has documented ~~recent~~ movements of whales between there and British Columbia (Darling et al. 1996), the Kodiak Archipelago in the central Gulf of Alaska (Calambokidis et al. 2001), and the Shumagin Islands in the western Gulf of Alaska (Witteveen et al. 2004), but no photo-identification studies had previously been conducted in Russia. Individual movement information from the SPLASH study documents that Russia is likely the primary migratory destination for whales in Okinawa and the Philippines but also reconfirms that some Asian whales go to Ogasawara, the Aleutian Islands, Bering Sea, and Gulf of Alaska (Calambokidis et al. 2008). A small amount of inter-yearly interchange was also found between the wintering areas (Philippines, Okinawa, and Ogasawara).

During the SPLASH study in Russia, humpback whales were primarily found along the Pacific east side of the Kamchatka Peninsula, near the Commander Islands between Kamchatka and the Aleutian Islands, and in the Gulf of Anadyr just southwest of the Bering Strait. Analysis of whaling data shows historical catches of humpback whales well into the Bering Sea and catches in the Bering Strait and Chukchi Sea in August-October in the 1930s (Mizroch and Rice 2007), but no survey effort occurred during SPLASH north of the Bering Strait. Humpback whales are increasingly seen north of the Bering Strait into the northeastern Chukchi Sea (Clarke et al. 2013a, 2013b), with some indication that more humpback whales are seen on the Russian side north of the Bering Strait (Clarke et al. 2013b). Humpback whales are the most commonly recorded cetacean on hydrophones just north of the Bering Strait and occurred from September into early November from 2009 to 2012 (K. Stafford, Applied Physics Laboratory-University of Washington, Seattle, WA, pers. comm.). Other locations in the far western Pacific where humpback whales have been seen in summer include the northern Kuril Islands (V. Burkanov, NMFS-AFSC-MML, pers. comm.), far offshore southeast of the Kamchatka Peninsula and south of the Commander Islands (Miyashita 2006), and along the north coast of the Chukotka Peninsula in the Chukchi Sea (Melnikov 2000).

These results indicate humpback whales from the Western North Pacific (Asian) breeding stock overlap broadly on summer feeding grounds with whales from the Central North Pacific breeding stock, as well as with whales that winter in the Revillagigedos in Mexico. Given the relatively small size of the Asian population, Asian whales probably represent a small fraction of all the whales found in the Aleutian Islands, Bering Sea, and Gulf of Alaska, which are primarily whales from Hawaii and the Revillagigedos. The only feeding area that appears to be primarily (or exclusively) composed of Asian whales is along the Kamchatka Peninsula in Russia. The initial SPLASH abundance estimates for Asia ranged from about 900 to 1,100, and the estimates for Kamchatka in Russia ranged from about 100 to 700, suggesting a large portion of the Asian population migrates to Kamchatka. This also shows that Asian whales that migrate to feeding areas besides Russia would be only a small fraction of the total number of whales in those areas, given the much larger abundance estimates for the Bering Sea and Aleutian Islands (6,000-14,000) and the Gulf of Alaska (3,000-5,000) (Calambokidis et al. 2008). A full description of the distribution and density of humpback whales in the Aleutian Islands, Bering Sea, and Gulf of Alaska is in the Stock Assessment Report for the Central North Pacific stock of humpback whales.

In summary, information from a variety of sources indicates that humpback whales from the Western and Central North Pacific stocks mix to a limited extent on summer feeding grounds ranging from British Columbia through the central Gulf of Alaska and up to the Bering Sea.

NMFS ~~has~~ conducted a global Status Review of humpback whales (Bettridge et al. 2015) and ~~recently~~ revised the ESA listing of the species (81 FR 62259, 8 September 2016);~~. NMFS is evaluating the stock structure of humpback whales under the MMPA, but no changes to current stock structure are presented at this time. However,~~ the effects of the ESA-listing final rule on the status of the stock are discussed below.

POPULATION SIZE

In the SPLASH study, fluke photographs were collected by over 400 researchers in all known feeding areas from Russia to California and in all known wintering areas from Okinawa and the Philippines to the coast of Central America and Mexico during 2004-2006. Over 18,000 fluke identification photographs were collected, and these have been used to estimate the abundance of humpback whales in the entire North Pacific Basin. A total of 566 unique individuals were seen in the Asian wintering areas during the 2-year period (3 winter field seasons) of the SPLASH study. Based on a comparison of all winter identifications to all summer identifications, the Chapman-Petersen estimate of abundance ~~is~~was 21,808 (CV = 0.04) (Barlow et al. 2011). A simulation study identifies significant biases in this estimate from violations of the closed population assumption (+5.3%), exclusion of calves (-10.3%), failure to achieve random geographic sampling (+1.5%), and missed matches (+9.8%) (Barlow et al. 2011). Sex-biased sampling favoring males in wintering areas does not add significant bias if both sexes are proportionately sampled in the feeding areas. The bias-corrected estimate is 20,800 after accounting for a net positive bias of 4.8%. This estimate is likely to be lower than the true abundance due to two additional sources of bias: individual heterogeneity in the probability of being sampled (unquantified) and the likely existence of an unknown and unsampled wintering area (-7.2%).

During the SPLASH study, surveys were conducted in three winter field seasons (2004-2006). The total numbers of unique individuals found in each area during the study were 77 in the Philippines, 215 in Okinawa, and 294 in the Ogasawara Islands. There was a total of 20 individuals seen in more than one area, leaving a total of 566 unique individuals seen in the Asian wintering areas (Calambokidis et al. 2008). For abundance in winter or summer areas, a multistrata Hilborn mark-recapture model was used, which is a form of a spatially-stratified model that explicitly estimates movement rates between winter and summer areas. Two broad categories of models were used making different assumptions about the movement rates, and four different models were used for capture probability. Point estimates of abundance for Asia (combined across the three areas) were relatively consistent across models, ranging from 938 to 1,107. The model that fit the data the best (as selected by AICc) gave an estimate of 1,107 for the Ogasawara Islands, Okinawa, and the Philippines. No ~~C~~confidence limits or coefficients of variation (CVs) ~~have not yet been~~were calculated for the SPLASH abundance estimates. Although no other high density aggregations of humpback whales are known on the Asian wintering ground, whales have been seen in other locations, indicating this is likely to represent an underestimate of the stock's true abundance to an unknown degree. This estimate is more than 8 years old and is outdated for use in stock assessments; however, this population increased between estimates in 1991-1993 and 2004-2006 (Calambokidis et al. 2008), and this is still considered a valid minimum population estimate (NMFS 2016).

On the summer feeding grounds, the initial SPLASH abundance estimates for Kamchatka in Russia ranged from about 100 to 700, suggesting a large portion of the Asian population occurs near Kamchatka. No separate estimates are available for the other areas in Russia, the Gulf of Anadyr and the Commander Islands; abundance from those areas is included in the estimate of abundance for the Bering Sea and Aleutian Islands, which ranged from about 6,000 to 14,000. Abundance estimates for the Gulf of Alaska and for Southeast Alaska/northern British Columbia both ranged from 3,000 to 5,000 (Calambokidis et al. 2008).

Minimum Population Estimate

~~As discussed above, p~~Point estimates of abundance for Asia ranged from 938 to 1,107 (for 2004-2006), but no associated CV ~~has yet been~~was calculated. The 1991-1993 abundance estimate for Asia using similar (though likely less) data had a CV of 0.084. Therefore, it is unlikely the CV of ~~the~~a SPLASH estimate~~, once calculated,~~ would be greater than 0.300. The minimum population estimate (N_{MIN}) for this stock is calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the SPLASH population estimate (N) of 1,107 from the best fit model and an assumed conservative CV(N) of 0.300 would result in an N_{MIN} for this humpback whale stock of 865. The 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) recommend that N_{MIN} be considered "unknown" if the abundance estimate is more than 8 years old, unless there is compelling evidence that the stock has not declined since the last estimate. This population increased between estimates in 1991-1993 and 2004-2006 (Calambokidis et al. 2008), and this is still considered a valid minimum population estimate.

Current Population Trend

The SPLASH abundance estimate for Asia represents a 6.7% annual rate of increase over the 1991-1993 abundance estimate (Calambokidis et al. 2008). However, the 1991-1993 estimate was for Ogasawara and Okinawa only, whereas the SPLASH estimate includes the Philippines, so the annual rate of increase is ~~biased high to an unknown degree~~unknown.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Utilizing a birth-interval model, Barlow and Clapham (1997) have estimated a population growth rate of 6.5% (SE = 1.2%) for the well-studied humpback whale population in the Gulf of Maine, although there are indications that this rate ~~has~~subsequently slowed ~~in recent years~~ (Clapham et al. 2003). Mobley et al. (2001) estimated a trend of 7% per year for 1993-2000 using data from aerial surveys that were conducted in a consistent manner for several years across all of the Hawaiian Islands and were developed specifically to estimate a trend for the Central North Pacific stock. Mizroch et al. (2004) estimated survival rates for North Pacific humpback whales using mark-recapture methods, and a Pradel model fit to data from Hawaii for the years 1980-1996 resulted 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 from 1987 to 2003 of 6.6% (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 1991-1993. Comparisons of SPLASH abundance estimates for Hawaii to estimates for 1991-1993 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.

Estimates of observed rates of increase can be used to estimate maximum net productivity rates (R_{MAX}), although in most cases these estimates may be biased low, as maximum net productivity rates are only achieved at very low population sizes. However, if the observed rates of increase are greater than the default value ~~recommended~~ for R_{MAX}, it would be reasonable to use a higher value based on those observations. The rates of increase summarized above include estimates for the North Pacific of 7%, 10%, and 6.6%. Although there is no estimate of ~~the maximum net productivity rate~~R_{MAX} for just the Western stock (i.e., from trends in abundance in the Asia breeding areas), it is reasonable to assume that R_{MAX} for this stock would be at least 7% based on the other observations from the North Pacific. Hence, until additional data become available for the Western North Pacific humpback whale stock, 7% will be used as ~~the maximum net productivity rate (~~R_{MAX}~~)~~ for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum ~~theoretical~~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 0.1, the value for cetacean stocks listed as endangered under the ESA (Wade and Angliss 1997; see Status of Stock section below regarding ESA listing status). Using the N_{MIN} of 865 calculated from the SPLASH abundance estimate for 2004-2006, of 1,107 with an assumed CV of 0.300, the PBR is calculated to be 3.0 whales (865 × 0.035 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~in press); 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 NOAA (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 Helker et al. (in press). The total estimated annual level of human-caused mortality and serious injury for Western North Pacific humpback whales in ~~2011-2015~~2012-2016 is ~~3.2~~3 whales: 0.8 in U.S. commercial fisheries, 0.4 in recreational fisheries, ~~0.6~~0.2 in unknown (commercial, recreational, or subsistence) fisheries, ~~0.8~~0.7 in marine debris, and ~~0.6~~0.9 due to other causes (ship strikes, ~~and~~ entanglement in a ship's ground tackle, and an intentional unauthorized take); however, this estimate is considered a minimum because there are no data concerning fishery-related mortality and serious injury in Japanese, Russian, or international waters. Assignment of mortality and serious injury to both the Western North Pacific and Central North Pacific stocks of humpback whales, when stock is unknown and events occur within the area where the stocks are known to overlap, may result in overestimating stock specific mortality and serious injury. 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 with changes in sea-ice coverage).

Fisheries Information

~~Detailed i~~Information ~~on~~for 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.

In 2012, one humpback whale mortality occurred in the Bering Sea/Aleutian Islands pollock trawl fishery (Table 1; Breiwick 2013; MML, unpubl. data). Since the stock of the whale is unknown, and the event occurred within the area where the Western North Pacific and Central North Pacific stocks are known to overlap, the mortality in this fishery was assigned to both stocks of humpback whales. The estimated average annual mortality and serious injury rate from observed U.S. commercial fisheries in 2012-2016 is 0.2 Western North Pacific humpback whales ~~in 2011-2015~~ (Table 1).

Table 1. Summary of incidental mortality and serious injury of Western North Pacific humpback whales due to U.S. commercial fisheries in ~~2011-2015~~2012-2016 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. pollock trawl[a]	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~98~~ 98 97 98 99 99	~~0~~ 1 0 0 0 0	~~0~~ 1.0 0 0 0 0	0.2 (CV = 0.16)
Minimum total estimated annual mortality						0.2 (CV = 0.16)

[a]Mortality and serious injury in this fishery ~~is~~was assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales, since the stock is unknown and the two stocks overlap within the area of operation of the fishery.

Mortality and serious injury due to entanglements in Kodiak Island commercial salmon purse seine gear (1 mortality in 2012), Kodiak Island commercial salmon set gillnet (1 serious injury in 2015, prorated at 0.75~~ under the injury determination guidelines for large whales (NOAA 2012), since the severity of the injury is unknown~~), and Bering Sea/Aleutian Islands commercial pot gear (1 mortality in 2015) was reported to the NMFS Alaska Region stranding network and by Marine Mammal Authorization Program (MMAP) fisherman self-reports in ~~2011-2015~~2012-2016 (Table 2; Helker et al. ~~2017~~in press). Because observer data are not available for these fisheries, this mortality and serious injury is used to calculate a minimum mean annual mortality and serious injury rate of 0.6 humpback whales in ~~2011-2015~~2012-2016 in these fisheries (Table 2). ~~Mortality and serious injury in~~Since all of these events ~~that~~ occurred in the area where the two stocks overlap, this mortality and serious injury ~~is~~was assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales (NMFS 2016).

The minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in ~~2011-2015~~2012-2016 is 0.8 Western North Pacific humpback whales (0.2 based on observed fisheries + 0.6 based on other data); however, this estimate is considered a minimum because there are no data concerning fishery-related mortality and serious injury in Japanese, Russian, or international waters.

Reports of swimming, floating, or beachcast humpback whales entangled in fishing gear or with injuries caused by interactions with gear, which may be from commercial, recreational, or subsistence fisheries, are another source of fishery-related mortality and serious injury data (Table 2). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~are ~~a~~ minimums because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined. Since all of these events occurred in the area where the two stocks overlap, the mortality and serious injury ~~is~~was assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales. In 2015, two humpback whales (each with a serious injury prorated at 0.75) entangled in Gulf of Alaska recreational pot fisheries (1 in Dungeness crab pot gear and 1 in shrimp pot gear) were reported to the NMFS Alaska Region stranding network, resulting in a minimum mean annual mortality and serious injury rate of 0.4 whales in recreational gear in ~~2011-2015~~2012-2016 (Table 2; Helker et al. ~~2017~~in press). The minimum mean annual mortality and serious injury rate from fishery-related gear entanglements and interactions reported to the NMFS Alaska Region stranding network in ~~2011-2015~~2012-2016, in which the events have not been attributed to a specific fishery listed on the MMPA List of Fisheries (82 FR 3655, 12 January 2017), is ~~0.6~~0.2 humpback whales (Table 2; Helker et al. ~~2017~~in press).

The minimum average annual mortality and serious injury rate due to interactions with all fisheries in ~~2011-2015~~2012-2016 is ~~1.8~~1.4 Western North Pacific humpback whales (0.8 in commercial fisheries + 0.4 in recreational fisheries + ~~0.6~~0.2 in unknown fisheries).

Table 2. Summary of mortality and serious injury of Western North Pacific humpback whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and ~~the~~by Marine Mammal Authorization Program (MMAP) fisherman self-reports in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). All events occurred within the area of known overlap between the Western North Pacific and Central North Pacific humpback whale stocks. Since the stock is unknown, the mortality and serious injury is reflected in the Stock Assessment Reports for both stocks. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NOAA (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 Helker et al. (~~2017~~in press).

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in Kodiak Island commercial salmon purse seine gear	~~0~~	1[a]	0	0	0	0	0.2
Entangled in Kodiak Island commercial salmon set gillnet	~~0~~	0	0	0	0.75	0	0.2
Entangled in Bering Sea/Aleutian Is. commercial pot gear	~~0~~	0	0	0	1	0	0.2
Entangled in Gulf of Alaska recreational Dungeness crab pot gear	~~0~~	0	0	0	0.75	0	0.2
Entangled in Gulf of Alaska recreational shrimp pot gear	~~0~~	0	0	0	0.75	0	0.2
~~Entangled in Bering Sea pot gear*~~	~~0.75~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
Entangled in Prince William Sound shrimp pot gear*	~~0~~	0	0	1	0	0	0.2
~~Entangled in gillnet*~~	~~0.75~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
Entangled in marine debris	~~2.5~~	0.75	0	0.75	0	2	~~0.8~~0.7
Entangled in ship's ground tackle	~~0~~	0	1	0	0	0	0.2
Ship strike	~~0~~	1.2	0	1.2	0	0.2	~~0.4~~0.5
Intentional unauthorized take		0	0	0	0	1	0.2
Total in commercial fisheries							0.6
Total in recreational fisheries							0.4
*Total in unknown (commercial, recreational, or subsistence) fisheries							~~0.6~~0.2
Total in marine debris							~~0.8~~0.7
Total due to other sources (entangled in ship's ground tackle, ship strike, intentional unauthorized take)							~~0.6~~0.9

[a]~~Marine Mammal Authorization Program~~ MMAP fisherman self-~~-~~report.

Brownell et al. (2000) compiled records of bycatch in Japanese and Korean commercial fisheries between 1993 and 2000. During 1995-1999, there were six humpback whales indicated as "bycatch." In addition, two strandings were reported during this period. Furthermore, genetic analysis of four samples from meat found in markets indicated that humpback whale meat was being sold. ~~At this time, i~~It is not known whether any or all strandings were caused by incidental interactions with commercial fisheries; similarly, it is not known whether the humpback whales identified in market samples were killed as a result of incidental interactions with commercial fisheries. It is also not known which fishery may be responsible for the bycatch. Regardless, these data indicate a minimum mortality level of 1.1 per year (using bycatch data only) to 2.4 per year (using bycatch, stranding, and market data) in the waters of Japan and Korea. Because many mortalities pass unreported, the actual rate in these areas is likely higher. An analysis of entanglement rates from photographs collected for the SPLASH study found a minimum entanglement rate of 31% for humpback whales from the Asia breeding grounds (Cascadia Research NFWF Report #2003-0170-019).

Alaska Native Subsistence/Harvest Information

There were no reported takes of humpback whales from this stock by Native subsistence hunters in Alaska or Russia in ~~2011-2015~~2012-2016.

Other Mortality

In 2015, increased mortality of large whales ~~(including 11 fin whales, 14 humpback whales, 1 gray whale, and 4 unidentified cetaceans from May to mid-August 2015)~~ 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) ~~(http://www.nmfs.noaa.gov/pr/health/mmume/faqs_2015_large_whale.html, accessed December 2017)~~. ~~On 20 August 2015,~~ 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 (http://www.nmfs.noaa.gov/pr/health/mmume/faqs_2015_large_whale.html, accessed June 2018)~~; however, no specific cause for the increased mortality has been identified~~. 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 reported to the NMFS Alaska Region stranding network account for a minimum mean annual mortality and serious injury rate of ~~0.8~~0.7 Western North Pacific humpback whales in ~~2011-2015~~2012-2016 (Table 2; Helker et al. ~~2017~~in press). Ship strikes and other interactions with vessels unrelated to fisheries resulted in a minimum mean annual mortality and serious injury rate of ~~0.6~~0.7 humpback whales from this stock in ~~2011-2015~~2012-2016, based on ship strikes (~~0.4~~0.5) and entanglement in a ship's ground tackle (0.2) reported to the NMFS Alaska Region stranding network (Table 2; Helker et al. ~~2017~~in press). Because all of these events occurred in the area where the stocks overlap, the mortality and serious injury ~~is~~was assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales. These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~ are minimums because not all entangled animals strand ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined.

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 in 2012-2016 (Table 2).

HISTORICAL WHALING

Rice (1978) estimated that the number of humpback whales in the North Pacific may have been approximately 15,000 individuals prior to exploitation; however, this was based upon incomplete data and, given the level of known catches (legal and illegal) since World War II, may be an underestimate. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century (Rice 1978). 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 1978). 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).

Humpback whales in the North Pacific were theoretically fully protected in 1965, but illegal catches by the U.S.S.R. continued until 1972 (Ivashchenko et al. ~~2007~~2013). From ~~1961~~1948 to 1971, ~~6,793~~7,334 humpback whales were killed ~~illegally~~ by the U.S.S.R., and 2,654 of these were illegally taken and not reported to the IWC (Ivashchenko et al. 2013). Many animals during this period were taken from the Gulf of Alaska and Bering Sea (Doroshenko 2000); however, additional illegal catches were made across the North Pacific, from the Kuril Islands to Haida Gwaii, and other takes ~~in earlier years~~ may have gone unrecorded. The Soviet factory ship *Aleut* is known to have taken 535 humpback whales during the period 1933-1947 (Ivashchenko et al. 2013).

STATUS OF STOCK

The total estimated annual level of human-caused mortality and serious injury of ~~3.2~~3 Western North Pacific humpback whales is ~~more than~~equal to the calculated PBR level for this stock (3.0). The minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (0.8 whales) exceeds 10% of the PBR (10% of PBR = 0.3) and cannot be considered insignificant and approaching a zero mortality and serious injury rate. In addition, there is a lack of information about fisheries bycatch from Russia, Japan, Korea, and international waters, as well as earlier evidence of bycatch in Japan and Korea (Brownell et al.

2000: 1.1 to 2.4 whales per year based on bycatch, stranding, and market data). The humpback whale ESA listing final rule (81 FR 62259, 8 September 2016) established 14 Distinct Population Segments (DPSs) with different listing statuses. The DPSs that occur in waters under the jurisdiction of the United States do not equate to the existing MMPA stocks. Some of the listed DPSs partially coincide with the currently defined Western North Pacific stock. Because we cannot manage one portion of an MMPA stock as ESA-listed and another portion of a stock as not ESA-listed, until such time as the MMPA stock delineations are reviewed in light of the DPS designations and Bettridge et al. (2015), NMFS continues to use the existing MMPA stock structure and considers this stock to be endangered and depleted for MMPA management purposes (e.g., selection of a recovery factor, stock status). As a result, the Western North Pacific stock of humpback whales is classified as a strategic stock.

There are key uncertainties in the assessment of the Western North Pacific stock of humpback whales. New DPSs were recently identified under the ESA; however, stocks have not been revised. The feeding areas of the Western North Pacific stock and the Central North Pacific stock overlap in waters from British Columbia to the Bering Sea, so human-related mortality and serious injury estimates must be assigned to or prorated to multiple stocks. The migratory destination of the Western North Pacific stock is not well understood. The population estimate was based on studies from the Asian wintering grounds; although no other large aggregations of whales are known, the estimate is likely conservative relative to the actual abundance. An estimate of variance is not available. The ~~current~~ abundance estimate is calculated using data collected in 2004-2006; however, the population increased between estimates in 1991-1993 and 2004-2006 (Calambokidis et al. 2008), and the N_{MIN} is still considered a valid minimum population estimate (NMFS 2016). 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

Elevated levels of sound from anthropogenic sources (e.g., shipping, military sonars) are a potential concern for humpback whales in the North Pacific, but no specific habitat concerns have been identified for this stock. Other potential impacts include possible changes in prey distribution with climate change, entanglement, ~~and~~ ship strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes and through the Bering Sea with changes in sea-ice coverage), and oil and gas activities.

CITATIONS

Baker, C. S., S. R. Palumbi, R. H. Lambertsen, M. T. Weinrich, J. Calambokidis, and S. J. O'Brien. 1990. Influence of seasonal migration on geographic distribution of mitochondrial DNA haplotypes in humpback whales. Nature 344:238-240.

Baker, C. S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J. M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Mol. Ecol. 7:695-707.

Baker, C. S., D. Steel, J. Calambokidis, J. Barlow, A. M. Burdin, P. J. Clapham, E. A. Falcone, J. K. B. Ford, C. M. Gabriele, U. González-Peral, R. LeDuc, D. Mattila, T. J. Quinn, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán-R., M. Vant, P. Wade, D. Weller, B. H. Witteveen, K. Wynne, and M. Yamaguchi. 2008. *geneSPLASH*: an initial, ocean-wide survey of mitochondrial (mt) DNA diversity and population structure among humpback whales in the North Pacific. Final Report for Contract 2006-0093-008 to the National Fish and Wildlife Foundation.

Baker, C. S., D. Steel, J. Calambokidis, E. Falcone, U. González-Peral, J. Barlow, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán, P. R. Wade, D. Weller, B. H. Witteveen, and M. Yamaguchi. 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. Mar. Ecol. Prog. Ser. 494:291-306. DOI: dx.doi.org/10.3354/meps10508 .

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology 78(2):535-546.

Barlow, J., J. Calambokidis, E. A. Falcone, C. S. Baker, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. K. Mattila, T. J. Quinn II, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., P. Wade, D. Weller, B. H. Witteveen, and M. Yamaguchi. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Mar. Mammal Sci. 27:793-818.

Bettridge, S., C. S. Baker, J. Barlow, P. J. Clapham, M. Ford, D. Gouveia, D. K. Mattila, R. M. Pace III, P. E. Rosel, G. K. Silber, and P. R. Wade. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-540, 240 p.

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

Brownell, R. L., T. Kasuya, W. P. Perrin, C. S. Baker, F. Cipriano, J. Urban R., D. P. DeMaster, M. R. Brown, and P. J. Clapham. 2000. Unknown status of the western North Pacific humpback whale population: a new conservation concern. Unpubl. report to the International Whaling Commission. 5 p.

Calambokidis, J., G. H. Steiger, J. C. Cubbage, K. C. Balcomb III, and P. Bloedel. 1989. Biology of humpback whales in the Gulf of the Farallones. Report to Gulf of the Farallones National Marine Sanctuary, San Francisco, CA, by Cascadia Research Collective, 218½ West Fourth Avenue, Olympia, WA. 93 p.

Calambokidis, J., G. H. Steiger, and J. R. Evenson. 1993. Photographic identification and abundance estimates of humpback and blue whales off California in 1991-92. Final Contract Report 50ABNF100137 to Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037. 67 p.

Calambokidis, J., G. H. Steiger, J. M. Straley, T. Quinn, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. Urban R., J. Jacobson, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, N. Higashi, S. Uchida, J. K. B. Ford, Y. Miyamura, P. Ladrón de Guevara, S. A. Mizroch, L. Schlender, and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific basin. Final Contract Report 50ABNF500113 to Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037. 72 p.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urbán R., J. K. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P. Ladrón de Guevara P., M. Yamaguchi, F. Sato, S. A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, and T. J. Quinn II. 2001. Movements and population structure of humpback whales in the North Pacific. Mar. Mammal Sci. 17(4):769-794.

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final Report for Contract AB133F-03-RP-00078, U.S. Dep. Commer., Western Administrative Center, Seattle, WA. Available online: http://www.cascadiaresearch.org/files/publications/SPLASH-contract-Report-May08.pdf . Accessed ~~December 2017~~June 2018.

Clapham, P. J., and J. G. Mead. 1999. *Megaptera novaeangliae*. Mamm. Species 604:1-9.

Clapham, P. J., J. Barlow, M. Bessinger, T. Cole, D. Mattila, R. Pace, D. Palka, J. Robbins, and R. Seton. 2003. Abundance and demographic parameters of humpback whales from the Gulf of Maine, and stock definition relative to the Scotian Shelf. J. Cetacean Res. Manage. 5:13-22.

Clarke, J. T., C. L. Christman, A. A. Brower, and M. C. Ferguson. 2013a. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2012. Annual Report, OCS Study BOEM 2013-00117. Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Clarke, J., K. Stafford, S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013b. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26(4):136-149.

Darling, J. D. 1991. Humpback whales in Japanese waters. Ogasawara and Okinawa. Fluke identification catalog 1987-1990. Final Contract Report, World Wide Fund for Nature, Japan. 22 p.

Darling, J. D., and S. Cerchio. 1993. Movement of a humpback whale (*Megaptera novaeangliae*) between Japan and Hawaii. Mar. Mammal Sci. 1:84-89.

Darling, J. D., J. Calambokidis, K. C. Balcomb, P. Bloedel, K. Flynn, A. Mochizuki, K. Mori, F. Sato, H. Suganuma, and M. Yamaguchi. 1996. Movement of a humpback whale (*Megaptera novaeangliae*) from Japan to British Columbia and return. Mar. Mammal Sci. 12(2):281-287.

Doroshenko, N. V. 2000. Soviet catches of humpback whales (*Megaptera novaeangliae*) in the North Pacific, p. 48-95. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet Whaling Data (1949-1979). Center for Russian Environmental Policy, Marine Mammal Council, Moscow.

Fleming, A., and J. Jackson. 2011. Global review of humpback whales (*Megaptera novaeangliae*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-474, 206 p.

Hashagen, K. A., G. A. Green, and B. Adams. 2009. Observations of humpback whales, *Megaptera novaeangliae*, in the Beaufort Sea, Alaska. Northwest. Nat. 90:160-162.

~~Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. 2017. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2011-2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-354, 112 p.~~
Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.
Hill, M. C., E. M. Oleson, S. Baumann-Pickering, A. M. Van Cise, A. D. Ligon, A. R. Bendlin, A. C. Ü, J. S. Trickey, and A. L. Bradford. 2016. Cetacean monitoring in the Mariana Islands Range Complex, 2015. Prepared for the U.S. Pacific Fleet Environmental Readiness Office. PIFSC Data Report DR-16-01. 36 p. + appendix.
~~Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell, Jr. (eds.). 2007. Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-175, 36 p. (Translation: Y. V. Ivashchenko) + appendix.~~
Ivashchenko, Y. V., R. L. Brownell, Jr., and P. J. Clapham. 2013. Soviet whaling in the North Pacific: revised catch totals. J. Cetacean Res. Manage. 13:59-71.
Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish. Rev. 46(4):30-37.
Johnston, D. W., M. E. Chapla, L. E. Williams, and D. K. Mattila. 2007. Identification of humpback whale *Megaptera novaeangliae* wintering habitat in the Northwestern Hawaiian Islands using spatial habitat modeling. Endang. Species Res. 3:249-257.
Melnikov, V. V. 2000. Humpback whales *Megaptera novaeangliae* off Chukchi Peninsula. Russ. J. Oceanogr. 4:844-849.
Miyashita, T. 2006. Cruise report of the sighting survey in the waters east of the Kuril Islands and the Kamchatka Peninsula in 2005. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/NPM5).
Mizroch, S. A., and D. W. Rice. 2007. Distribution and movements of humpback whales (*Megaptera novaeangliae*) in the North Pacific Ocean. Presented at the 17th Biennial Conference on the Biology of Marine Mammals, Cape Town, South Africa.
Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, and O. von Ziegesar. 2004. Estimating the adult survival rate of central North Pacific humpback whales. J. Mammal. 85(5):963-972.
Mobley, J. M., S. Spitz, R. Grotefendt, P. Forestell, A. Frankel, and G. Bauer. 2001. Abundance of humpback whales in Hawaiian waters: Results of 1993-2000 aerial surveys. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary. 16 p.
National Marine Fisheries Service (NMFS). 2016. Guidelines for preparing stock assessment reports pursuant to the 1994 amendments to the Marine Mammal Protection Act. 23 p. Available online: https://www.fisheries.noaa.gov/national/marine-mammal-protection/guidelines-assessing-marine-mammal-stocks . Accessed June 2018.
Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. Tokyo 12:33-89.
Nemoto, T. 1959. Food of baleen whales with reference to whale movements. Sci. Rep. Whales Res. Inst. 14:149-290.
Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results, p. 172-191. *In* K. S. Norris (ed.), Whales, Dolphins and Porpoises. University of California Press, Berkeley, CA.
NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-policies-guidance-and-regulations . Accessed June 2018.
Ohsumi, S., and Y. Masaki. 1975. Japanese whale marking in the North Pacific, 1963-1972. Bull. Far Seas Fish. Res. 12:171-219.
Omura, H., and S. Ohsumi. 1964. A review of Japanese whale marking in the North Pacific to the end of 1962, with some information on marking in the Antarctic. Norsk Hvalfangst-Tidende 4:90-112.
Perry, A., C. S. Baker, and L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. Rep. Int. Whal. Comm. (Special Issue 12):307-317.

Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation and numbers, Appendix 4, p. 29-44. *In* K. S. Norris and R. R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. U.S. Dep. Commer., Nat. Tech. Info. Serv. PB-280 794. Springfield, VA.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Soc. Mar. Mammal. Spec. Publ. No. 4.

Springer, A. M., G. B. van Vliet, J. F. Piatt, and E. M. Danner. 2006. Whales and whaling in the North Pacific Ocean and Bering Sea: oceanographic insights and ecosystem impacts, p. 245-261. *In* J. A. Estes, R. L. Brownell, Jr., D. P DeMaster, D. F. Doak, and T. M. Williams (eds.), Whales, Whaling and Ocean Ecosystems. University of California Press. 418 p.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mammal Sci. 7:306-310.

Tomlin, A. G. 1967. Mammals of the USSR and adjacent countries. Vol. 9. Cetacea. Israel Program for Scientific Translations No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 p. (Translation of Russian text published in 1957.)

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

Witteveen, B. H., J. M. Straley, O. von Ziegesar, D. Steel, and C. S. Baker. 2004. Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska. Can. J. Zool. 82:1352-1359.

Zenkovich, B. A. 1954. Vokrug sveta za kitami, Vol. Gosudarstvennoe Izdatel'stvo Geograficheskoi Literatury, Moscow.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53(11):1772-1790.

Revised ~~12/30/2017~~8/10/2018

HUMPBACK WHALE (*Megaptera novaeangliae*): Central North Pacific Stock

NOTE – NMFS is in the process of reviewing humpback whale stock structure under the Marine Mammal Protection Act (MMPA) in light of the 14 Distinct Population Segments established under the Endangered Species Act (ESA) (81 FR 62259, 8 September 2016). A complete revision of the humpback whale stock assessments will be postponed until this review is complete. In the interim, new information on humpback whale mortality and serious injury is provided within this report.

STOCK DEFINITION AND GEOGRAPHIC RANGE

The humpback whale is distributed worldwide in all ocean basins. In winter, most humpback whales occur in the subtropical and tropical waters of the Northern and Southern Hemispheres. Humpback whales in the high latitudes of the North Pacific Ocean are seasonal migrants that feed on euphausiids and small schooling fishes (Nemoto 1957, 1959; Clapham and Mead 1999). The humpback whale population was considerably reduced as a result of intensive commercial exploitation during the 20th century.

A large-scale study of humpback whales throughout the North Pacific was conducted in 2004-2006 (the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project). ~~Initial r~~Results from this project (Calambokidis et al. 2008, Barlow et al. 2011), including abundance estimates and movement information, have been reported in Baker et al. (2008, 2013) and are also summarized in Fleming and Jackson (2011); however, these results are still being considered for stock structure analysis.

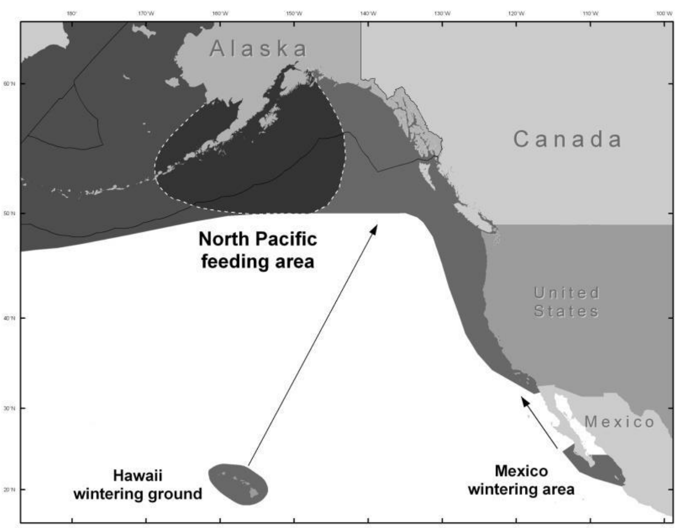

Figure 1. Approximate distribution of humpback whales in the eastern North Pacific (dark shaded areas). Feeding and wintering areas are presented above (see text). Area within the dotted line is known to be an area where the Central North Pacific and Western North Pacific stocks overlap. See Figure 1 in the Western North Pacific humpback whale Stock Assessment Report for distribution of humpback whales in the western North Pacific.

The historical summer feeding range of humpback whales in the North Pacific encompassed coastal and inland waters around the Pacific Rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk and north of the Bering Strait (Zenkovich 1954, Nemoto 1957, Tomlin 1967, Johnson and Wolman 1984). Historically, the Asian wintering area extended from the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands (Rice 1998). Humpback whales are currently found throughout this historical range. Most of the current winter range of humpback whales in the North Pacific is relatively well known, with aggregations of whales in Japan, the Philippines, Hawaii, Mexico, and Central America. The winter range includes the main islands of the Hawaiian archipelago, with the greatest concentration along the west side of Maui. In Mexico, the winter breeding range includes waters around the southern part of the Baja California peninsula, the central portions of the Pacific coast of mainland Mexico, and the Revillagigedo Islands off the mainland coast. The winter range also extends from southern Mexico into Central America, including Guatemala, El Salvador, Nicaragua, and Costa Rica (Calambokidis et al. 2008).

Photo-identification data, distribution information, and genetic analyses have indicated that in the North Pacific there are at least three breeding populations (Asia, Hawaii, and Mexico/Central America) that all migrate between their respective winter/spring calving and mating areas and their summer/fall feeding areas (Calambokidis et al. 1997, Baker et al. 1998). Calambokidis et al. (2001) further suggested that there may be as many as six subpopulations on the wintering grounds. From photo-identification and Discovery tag ~~mark~~ information there are known connections between Asia and Russia, between Hawaii and Alaska, and between Mexico/Central America and California (Darling 1991, Darling and Cerchio 1993, Calambokidis et al. 1997, Baker et al. 1998). This information led to the designation of three stocks of humpback whales in the North Pacific: 1) the California/Oregon/Washington and Mexico stock, consisting of winter/spring 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/fall (Calambokidis et al. 1989, 1993; Steiger et al. 1991); 2) the Central North Pacific stock, consisting of winter/spring populations of the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997) (Fig. 1) ; and 3) the Western North Pacific stock, consisting of winter/spring populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands.

Information from the SPLASH project largely confirms this view of humpback whale distribution and movements in the North Pacific. For example, the SPLASH results confirm low rates of interchange between the three principal wintering regions (Asia, Hawaii, and Mexico). However, the full SPLASH results suggest that the current view of population structure is incomplete. The overall pattern of movements is complex but indicates a high degree of population structure. Whales from wintering areas at the extremes of their range on both sides of the Pacific migrate to coastal feeding areas that are on the same side of the Pacific: whales from Asia in the west migrate to Russia and whales from mainland Mexico and Central America in the east migrate to coastal waters off California/Oregon.

The SPLASH data now show the Revillagigedo whales are seen in all sampled feeding areas except northern California/Oregon and the south side of the Aleutians. They are primarily distributed in the Bering Sea, Gulf of Alaska, and Southeast Alaska/northern British Columbia but are also found in Russia and southern British Columbia/Washington. The migratory destinations of humpback whales from Hawaii were found to be quite similar, and a significant number of matches (14) were seen during SPLASH between Hawaii and the Revillagigedos (Calambokidis et al. 2008). The SPLASH project also found that whales from the Aleutian Islands and Bering Sea, and perhaps the Gulf of Anadyr and the Chukotka Peninsula on the west side of the Bering Strait in Russia, have an unusually low resighting rate in winter areas compared to whales from other feeding areas. It is now believed that some of these whales have a winter migratory destination that was not sampled during the SPLASH project. Given the location of these feeding areas, the most parsimonious explanation would be that some of these whales winter somewhere between Hawaii and Asia, which would include the possibility of the Mariana Islands (southwest of the Ogasawara Islands), the Marshall Islands (approximately half-way between the Mariana Islands and the Hawaiian Islands), and the Northwestern Hawaiian Islands. Subsequent to the SPLASH project, a survey in 2007 documented humpback whales from a number of locations in the Northwestern Hawaiian Islands at relatively low densities (Johnston et al. 2007), but no sampling occurred there during the SPLASH project. Some humpback whales, including mother/calf pairs, have also been found in the Mariana Islands (Hill et al. 2016). Both of these locations are plausible migratory destinations for whales from the Aleutian Islands and Bering Sea. Which stock that whales in these locations would belong to is currently unknown.

The winter distribution of the Central North Pacific stock is primarily in the Hawaiian archipelago. In the SPLASH study, sampling occurred on Kauai, Oahu, Penguin Bank (off the southwest tip of the island of Molokai), Maui, and the island of Hawaii (the Big Island). Interchange within Hawaii was extensive. Although most of the Hawaii identifications came from the Maui sub-area, identifications from the Big Island and Kauai at the eastern and western end of the region showed a high rate of interchange with Maui.

In summer, the majority of whales from the Central North Pacific stock are found in the Aleutian Islands, Bering Sea, Gulf of Alaska, and Southeast Alaska/northern British Columbia. High densities of humpback whales are found in the eastern Aleutian Islands, particularly along the northern side of Unalaska Island, and along the Bering Sea shelf edge and break to the north towards the Pribilof Islands. Small numbers of humpback whales are known from a few locations not sampled during the SPLASH study, including northern Bristol Bay and the Chukchi and Beaufort seas. In the Gulf of Alaska, high densities of humpback whales are found in the Shumagin Islands, south and east of Kodiak Island, and from the Barren Islands through Prince William Sound. Although densities in any particular location are not high, humpback whales are also found in deep waters south of the continental shelf from the eastern Aleutians through the Gulf of Alaska. Relatively high densities of humpback whales occur throughout much of Southeast Alaska and northern British Columbia.

NMFS ~~has~~ conducted a global Status Review of humpback whales (Bettridge et al. 2015) and ~~recently~~ revised the ESA listing of the species (81 FR 62259, September 8, 2016);~~. NMFS is evaluating the stock structure of humpback whales under the MMPA, but no changes to current stock structure are presented at this time. However,~~ the effects of the ESA-listing final rule on the status of the stock are discussed below.

POPULATION SIZE

Prior to the SPLASH study, the most complete estimate of abundance for humpback whales in the North Pacific was from data collected in 1991-1993, with a best mark-recapture estimate of 6,010 (CV = 0.08) for the entire North Pacific, using a winter-to-winter comparison (Calambokidis et al. 1997). Estimates for Hawaii and Mexico were higher, using marks from summer feeding areas with recaptures on the winter grounds, and totaled almost 10,000 summed across all winter areas. In the SPLASH study, fluke photographs were collected by over 400 researchers in all known feeding areas from Russia to California and in all known wintering areas from Okinawa and the Philippines to the coast of Central America and Mexico during 2004-2006. Over 18,000 fluke identification photographs were collected, and these have been used to estimate the abundance of humpback whales in the entire North Pacific Basin. Based on a comparison of all winter identifications to all summer identifications, the Chapman-Petersen estimate of abundance is 21,808 (CV = 0.04) (Barlow et al. 2011). A simulation study identifies significant biases in this estimate from violations of the closed population assumption (+5.3%), exclusion of calves (-10.3%), failure to achieve random geographic sampling (+1.5%), and missed matches (+9.8%) (Barlow et al. 2011). Sex-biased sampling favoring males in wintering areas does not add significant bias if both sexes are proportionately sampled in the feeding areas. The bias-corrected estimate is 20,800 after accounting for a net positive bias of 4.8%. This estimate is likely to be lower than the true abundance due to two additional sources of bias: individual heterogeneity in the probability of being sampled (unquantified) and the likely existence of an unknown and unsampled wintering area (-7.2%).

The Central North Pacific stock of humpback whales winters in Hawaiian waters (Baker et al. 1986). Preliminary mark-recapture abundance estimates from the SPLASH data were calculated in Calambokidis et al. (2008), using a multistrata Hilborn model. The best estimate for Hawaii (as chosen by AICc) was 10,103; no confidence limit or coefficient of variation (CV) was calculated for that estimate. This estimate is more than 8 years old and is outdated for use in stock assessments; however, because this population is ~~growing~~increasing in localized areas in Alaska, e.g., Prince William Sound (~~Calambokidis et al. 2008~~Teerlink et al. 2015), this is still considered a valid minimum population estimate (NMFS 2016).

In the SPLASH study, the number of unique identifications in different regions during 2004 and 2005 included 63 in the Aleutian Islands (defined as everything on the south side of the islands), 491 in the Bering Sea, 301 in the western Gulf of Alaska (including the Shumagin Islands), and 1,038 in the northern Gulf of Alaska (including Kodiak and Prince William Sound), with a few whales seen in more than one area (Calambokidis et al. 2008). The SPLASH combined estimates ranged from 6,000 to 19,000 for the Aleutian Islands, Bering Sea, and Gulf of Alaska, a considerable increase from previous estimates that were available (e.g., Waite et al. 1999, Moore et al. 2002, Witteveen et al. 2004, Zerbini et al. 2006). However, the SPLASH surveys covered areas not covered in those previous surveys, such as parts of Russian waters (Gulf of Anadyr and Commander Islands), the western and central Aleutian Islands, offshore waters in the Gulf of Alaska and Aleutian Islands, and Prince William Sound. Additionally, mark-recapture estimates can be higher than line-transect estimates because they estimate the total number of whales that have used the study area during the study period, whereas, line-transect surveys provide a snapshot of average abundance in the survey area at the time of the survey. For the Aleutian Islands and Bering Sea (including the Commander Islands and Gulf of Anadyr in Russia), the SPLASH estimates ranged from 2,889 to 13,594; for the Gulf of Alaska (from Prince William Sound to the Shumagin Islands, including Kodiak Island), the SPLASH estimates ranged from 2,845 to 5,122. Given known overlap in the distribution of the Western and Central North Pacific humpback whale stocks, estimates for these feeding areas may include whales from the Western North Pacific stock.

The SPLASH study showed a relatively high rate of interchange between Southeast Alaska and northern British Columbia, so they are considered together. Humpback whale studies have been conducted since the late 1960s in Southeast Alaska. ~~Baker et al. (1992) estimated an abundance of 547 (95% CI: 504-590) using data collected in 1979-1986. Straley (1994) recalculated the estimate using a different analytical approach (Jolly-Seber open model for capture-recapture data) and obtained a mean population estimate of 393 animals (95% CI: 331-455) using the same 1979-1986 data set. Using 1986-1992 data and the Jolly-Seber approach, Straley et al. (1995) estimated that the annual abundance of humpback whales in Southeast Alaska was 404 animals (95% CI: 350-458).~~ Straley et al. (2009) examined data for the northern portion of Southeast Alaska in 1994-2000 and provided an updated abundance estimate of 961 (CV = 0.12). Using 1992-2006 photo-identification data and an SIR Jolly-Seber model, Ford et al. (2009) estimated an abundance of 2,145 humpback whales (95% CI: 1,970-2,331) in British Columbia waters. During the SPLASH study, 1,115 unique identifications were made in Southeast Alaska and 583 in northern British Columbia, for a total of 1,669 individual whales, after subtracting whales seen in both areas (1,115+583-13-16 = 1,669) (Calambokidis et al. 2008). From the SPLASH study, the estimates of abundance for Southeast Alaska/northern British Columbia ranged from 2,883 to 6,414. The estimates from SPLASH are considerably larger than the estimate from Straley et al. (2009). This is because the SPLASH estimates included areas not part of the Straley et al. (2009) estimate, including southern Southeast Alaska, northern British Columbia, and offshore waters of both British Columbia and Southeast Alaska.

Minimum Population Estimate

A total of 2,367 unique individuals were seen in the Hawaiian wintering areas during the 2-year period (3 winter field seasons, 2004-2006) of the SPLASH study. As discussed above, point estimates of abundance for Hawaii from SPLASH ranged from 7,469 to 10,103: the estimate from the best model was 10,103, but no associated CV ~~has yet been~~was calculated. The 1991-1993 abundance estimate for Hawaii using similar (but less) data had a CV of 0.095. Therefore, it is unlikely the CV of ~~the~~a SPLASH estimate~~, once calculated,~~ would be greater than 0.300. The minimum population estimate (N_{MIN}) for this stock is calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 10,103 from the best fit model and an assumed conservative CV(N) of 0.300 results in an N_{MIN} for the Central North Pacific humpback whale stock of ~~7,890~~7,891. The 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) recommend that N_{MIN} be considered "unknown" if the abundance estimate is more than 8 years old, unless there is compelling evidence that the stock has not declined since the last estimate. Because this population is ~~growing~~increasing in localized areas in Alaska, e.g., Prince William Sound (~~Calambokidis et al. 2008~~Teerlink et al. 2015), this is still considered a valid minimum population estimate.

Although the Southeast Alaska/northern British Columbia feeding aggregation is not formally considered a stock, the calculation of what a PBR would be for this area is useful for management purposes. The total number of unique individuals seen during the SPLASH study was 1,669 (1,115 in Southeast Alaska). The abundance estimate of Straley et al. (2009) had a CV of 0.12, and the SPLASH abundance estimates are unlikely to have a much higher CV. Using the lowest population estimate (N) of 2,883 and an assumed worst case CV(N) of 0.300, N_{MIN} for this aggregation is ~~2,251~~2,252. Similarly, for the Aleutian Islands and Bering Sea, using the lowest SPLASH estimate of 2,889 with an assumed worst-case CV of 0.300 results in an N_{MIN} of 2,256. For the Gulf of Alaska (from Prince William Sound to the Shumagin Islands, including Kodiak Island), using the lowest SPLASH estimate of 2,845 with an assumed worst-case CV of 0.300 results in an N_{MIN} of 2,222. Estimates for these feeding areas may include whales from the Western North Pacific stock and the Mexican breeding population.

Current Population Trend

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 Hawaii between the early 1980s and early 1990s. Mobley et al. (2001) estimated a trend of 7% per year for 1993-2000 using data from aerial surveys that were conducted in a consistent manner for several years across all of the Hawaiian Islands and were developed specifically to estimate a trend for the Central North Pacific stock. Mizroch et al. (2004) estimated survival rates for North Pacific humpback whales using mark-recapture methods, and a Pradel model fit to data from Hawaii for the years 1980-1996 resulted 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 from 1987 to 2003 of 6.6% (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 1991-1993. Comparisons of SPLASH abundance estimates for Hawaii to estimates for 1991-1993 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. It is also clear that the abundance has increased in Southeast Alaska, although a trend for the Southeast Alaska portion of this stock cannot be estimated from the data because of differences in methods and areas covered.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Using a birth-interval model, Barlow and Clapham (1997) have estimated a population growth rate of 6.5% (SE = 1.2%) for the well-studied humpback whale population in the Gulf of Maine, although there are indications that this rate has slowed over the last decade (Clapham et al. 2003). Estimated rates of increase for the Central North Pacific stock include values for Hawaii of 7.0% (from aerial surveys), 5.5-6.0% (from mark-recapture abundance estimates), and 10% (95% CI: 3-16%) (from a model fit to mark-recapture data) and a value for the northern Gulf of Alaska of 6.6% (95% CI: 5.2-8.6%) from ship surveys (Calambokidis et al. 2008). Although there is no estimate of the maximum net productivity rate (R_{MAX}) for the Central North Pacific stock, it is reasonable to assume that R_{MAX} for this stock would be at least 7%. Hence, until additional data become available for the Central North Pacific humpback whale stock, 7% will be used as ~~the maximum net productivity rate (~~R_{MAX}~~)~~ for this stock.

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum ~~theoretical~~estimated net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The default recovery factor (F_R) for this stock is 0.1, the recommended value for cetacean stocks listed as endangered under the ESA (Wade and Angliss 1997; see Status of Stock section below regarding ESA listing status); however, a recovery factor of 0.3 is used in calculating the PBR for this stock based on the suggested guidelines of Taylor et al. (2003). The default value of ~~0.04~~% for ~~the maximum net productivity rate~~R_{MAX} is replaced by ~~0.07~~%, which is the best estimate of the current rate of increase and is considered a conservative estimate of ~~the maximum net productivity rate~~R_{MAX}. For the Central North Pacific stock of humpback whales, using the SPLASH study abundance estimate from the best fit model for 2004-2006 for Hawaii of 10,103 with an assumed CV of 0.300 and its associated N_{MIN} of ~~7,890~~7,891, PBR is calculated to be 83 whales (~~7,890~~7,891 x 0.035 x 0.3).

At this time, stock structure of humpback whales is under consideration and revisions may be proposed within the next few years. Just for information purposes, PBR calculations are completed here for the feeding area aggregations. For Southeast Alaska and northern British Columbia, the smallest abundance estimates from the SPLASH study were used with an assumed worst-case CV of 0.300 to calculate PBRs for feeding areas. Using the suggested guidelines presented in Taylor et al. (2003), it would be appropriate to use a recovery factor of 0.3 for the Southeast Alaska/northern British Columbia feeding aggregation since this aggregation has an N_{MIN} greater than 1,500 and less than 5,000 and has an increasing population trend. A recovery factor of 0.1 is appropriate for the Aleutian Islands and Bering Sea feeding aggregation and the Gulf of Alaska feeding aggregation because the N_{MIN} is greater than 1,500 and less than 5,000 and has an unknown population trend. If we calculated a PBR for the Southeast Alaska/northern British Columbia feeding aggregation it would be 24 (~~2,251~~2,252 x 0.035 x 0.3). If we calculated a PBR for the Aleutian Islands and Bering Sea, it would be 7.9 (2,256 x 0.035 x 0.1). If we calculated a PBR for the Gulf of Alaska, it would be 7.8 (2,222 x 0.035 x 0.1). However, note that the actual PBR for the Central North Pacific stock is 83 based on the breeding population size in Hawaii, as calculated above.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~in press); 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 NOAA (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 Helker et al. (in press). The total estimated annual level of human-caused mortality and serious injury for Central North Pacific humpback whales in ~~2011-2015~~2012-2016 is ~~25~~26 whales: ~~8.5~~9.9 in U.S. commercial fisheries, ~~0.7~~0.4 in recreational fisheries, ~~0.3~~0.5 in subsistence fisheries, ~~8.8~~7.7 in unknown (commercial, recreational, or subsistence) fisheries, ~~2.8~~2.6 in marine debris, and ~~4.4~~4.6 due to other causes (ship strikes and entanglement in a ship's ground tackle, a salmon net pen, and mooring gear); however, this estimate is considered a minimum because no observers have 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. Assignment of mortality and serious injury to both the Central North Pacific and Western North Pacific stocks of humpback whales, when stock is unknown and events occur within the area where the stocks are known to overlap, may result in overestimating stock specific mortality and serious injury. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include ship strikes and entanglement in fishing gear.

Fisheries Information

~~Detailed i~~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.

In 2012, one humpback whale mortality occurred in the Bering Sea/Aleutian Islands pollock trawl fishery, resulting in a mean annual mortality and serious injury rate of 0.2 humpback whales in ~~2011-2015~~2012-2016 (Table 1; Breiwick 2013; MML, unpubl. data). Since the stock of the whale is unknown, and the event occurred within the area where the Central North Pacific and Western North Pacific stocks are known to overlap, the mortality in this fishery was assigned to both stocks of humpback whales (NMFS 2016). ~~Two Central North Pacific humpback whales were seriously injured in Hawaii longline fisheries in 2011-2015: one in the Hawaii shallow-set longline fishery in 2011 (prorated at 0.75 under the injury determination guidelines for large whales (NOAA 2012), because the severity of the injury could not be determined) and o~~One Central North Pacific humpback whale was seriously injured in the Hawaii deep-set longline fishery in 2014, resulting in a mean annual mortality and serious injury rate~~s~~ of ~~0.2 and~~ 0.9 whales~~, respectively,~~ in ~~these~~this fishery~~ies~~ in ~~2011-2015~~2012-2016 (Table 1; Bradford and Forney 2017; ~~NMFS-PIFSC, unpubl. data~~Bradford 2018).

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 2012-2013 program (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 Central North Pacific humpback whales 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 and serious injury for the fishery.

Mortality and serious injury due to entanglements in Kodiak Island commercial salmon purse seine gear (1 mortality in 2012), Southeast Alaska commercial salmon purse seine gear (1 serious injury in both 2013 and 2015, each prorated at 0.75), Kodiak Island commercial salmon set gillnet (1 serious injury in 2015, prorated at 0.75), Prince William Sound commercial salmon drift gillnet (2 serious injuries in 2015, each prorated at 0.75), Southeast Alaska salmon drift gillnet (11 serious injur~~y~~ies in ~~2014~~2012-2016 in ADF&G Districts ~~13B~~that were not observed in 2012-2013 (i.e., districts with no observer data), including 9 serious injuries prorated at 0.75), Bering Sea/Aleutian Islands commercial pot gear (1 mortality in 2015), and Southeast Alaska commercial pot gear (2 serious injuries in 2015, each prorated at 0.75) was reported to the NMFS Alaska Region stranding network and by Marine Mammal Authorization Program (MMAP) fisherman self-reports in ~~2011-2015~~2012-2016 (Table 2; Helker et al. ~~2017~~in press). Because observer data are not available for these fisheries, ~~this~~these reports of mortality and serious injury ~~is~~are used to calculate ~~a~~ minimum mean annual mortality and serious injury rates for these fisheries (Table 2), resulting in a mean annual mortality and serious injury rate of ~~1.7~~3.3 humpback whales in ~~2011-2015~~2012-2016 in these fisheries ~~(Table 2)~~. Mortality and serious injury in events that occurred in the area where the two stocks overlap ~~is~~was assigned to both the Central North Pacific and Western North Pacific stocks of humpback whales (as noted in Table 2). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~ are minimums because not all entangled animals strand or are self-reported ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined.

The minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries for the ~~entire~~ Central North Pacific stock in ~~2011-2015~~2012-2016 (or the most recent data available) is ~~8.5~~9.9 humpback whales, based on observer data from Alaska (Table 1: 0.2 in federal fisheries + 5.5 in the state-managed Southeast Alaska salmon drift gillnet fishery), ~~and~~observer data from Hawaii (Table 1: ~~1.1~~0.9), and ~~on~~ MMAP fishermen self-reports and reports, in which the commercial fishery is confirmed, to the NMFS Alaska Region stranding network (Table 2: ~~1.7~~3.3).

Table 1. Summary of incidental mortality and serious injury of Central North Pacific humpback whales due to U.S. commercial fisheries in ~~2011-2015~~2012-2016 (or the most recent data available) and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; Manly 2015; Bradford and Forney 2017~~; Manly 2015; NMFS-PIFSC, unpubl. data~~; Bradford 2018; MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. pollock trawl[a]	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~98~~ 98 97 98 99 99	~~0~~ 1 0 0 0 0	~~0~~ 1.0 0 0 0 0	0.2 (CV = 0.16)

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	0 1	0 11	5.5 (CV = 1.0)
~~Hawaii shallow-set longline~~	~~2011~~ ~~2012~~ ~~2013~~ ~~2014~~ ~~2015~~	~~obs data~~	~~100~~ ~~100~~ ~~100~~ ~~100~~ ~~100~~	~~1[b]~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0.75[b]~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0.2~~
Hawaii deep-set longline	~~2011~~ 2012 2013 2014 2015 2016	obs data	~~20~~ 20 20 20 20 20	~~0~~ 0 0 1 0 0	~~0~~ 0 0 5 0 0	0.9 (CV = 2.1)
Minimum total estimated annual mortality					Bering Sea/Aleutian Is.: Southeast Alaska: Hawaii: Total:	0.2 5.5 ~~1.1~~0.9 ~~6.8~~6.6 (CV = 0.88)

[a]Mortality and serious injury in this fishery ~~is~~was assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales, since ~~the~~ stock is unknown and the two stocks overlap within the area of operation of the fishery.
~~[b]A humpback whale was entangled and cut free with trailing gear. Due to the unknown configuration of the entanglement, this injury was prorated at a value of 0.75 (Bradford and Forney 2017).~~

Reports of swimming, floating, or beachcast humpback whales entangled in fishing gear or with injuries caused by interactions with gear, which may be from commercial, recreational, or subsistence fisheries, are another source of information on fishery-related mortality and serious injury. Mortality and serious injury in events that occurred in the area where the two stocks overlap ~~is~~was assigned to both the Central North Pacific and Western North Pacific stocks (as noted in Table 2). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~ are minimums because not all entangled animals strand or are self-reported ~~and not~~nor are all stranded animals ~~are~~ found, reported, or have the cause of death determined. In 2015, two humpback whales (each with a serious injury prorated at 0.75) entangled in Gulf of Alaska recreational pot fisheries gear (1 in Dungeness crab pot gear and 1 in shrimp pot gear) were reported to the NMFS Alaska Region stranding network, resulting in a minimum mean annual mortality and serious injury rate of 0.4 whales in recreational gear in Alaska waters in ~~2011-2015~~2012-2016 (Table 2; Helker et al. ~~2017~~in press). ~~In addition, two whales (each with a serious injury prorated at 0.75) entangled in recreational troll gear were reported to the NMFS Pacific Islands Region in 2011, resulting in a minimum mean annual mortality and serious injury rate of 0.3 Central North Pacific humpback whales in recreational gear in Hawaii waters in 2011-2015 (Table 3; Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data).~~ Two whales with serious injuries (each prorated at 0.75) entangled in ~~subsistence~~ Southeast Alaska subsistence halibut longline gear and one whale with a serious injury (prorated at 0.75) entangled in unidentified subsistence gillnet were reported to the NMFS Alaska Region stranding network in ~~2011-2015~~2012-2016, resulting in a minimum mean annual mortality and serious injury rate of ~~0.3~~0.5 humpback whales in ~~this~~subsistence fisher~~y~~ies (Table 2; Helker et al. ~~2017~~in press). Based on events that have not been attributed to a specific fishery listed on the MMPA List of Fisheries (82 FR 3655, 12 January 2017), the minimum mean annual mortality and serious injury rate from gear entanglements in unknown (commercial, recreational, or subsistence) fisheries in 2012-2016 is ~~8.8~~7.7 humpback whales ~~in 2011-2015~~: ~~2.2~~1.4 reported to the NMFS Alaska Region stranding network (Table 2; Helker et al. ~~2017~~in press) and ~~6.6~~6.3 reported to the NMFS Pacific Islands Region stranding network (Table 3; Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data).

The minimum average annual mortality and serious injury rate due to interactions with all fisheries in ~~2011-2015~~2012-2016 is ~~18~~19 Central North Pacific humpback whales (~~8.5~~9.9 in commercial fisheries + ~~0.7~~0.4 in recreational fisheries + ~~0.3~~0.5 in subsistence fisheries + ~~8.8~~7.7 in unknown fisheries).

Table 2. Summary of mortality and serious injury of Central North Pacific humpback whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and ~~the~~by Marine Mammal Authorization Program (MMAP) fisherman self-reports in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). Injury events lacking detailed injury information ~~on the injury~~ are assigned prorated values following injury determination guidelines described in NOAA (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 Helker et al. (~~2017~~in press).

Cause of injury	~~**2011**~~	**2012**	**2013**	**2014**	**2015**	**2016**	**Mean annual mortality**
Entangled in Kodiak Island commercial salmon purse seine gear	~~0~~	1[a, b]	0	0	0	0	0.2
Entangled in Southeast Alaska commercial salmon purse seine gear	~~0~~	0	0.75[a]	0	0.75	0	0.3
Entangled in Kodiak Island commercial salmon set gillnet	~~0~~	0	0	0	0.75[b]	0	0.2
Entangled in Prince William Sound commercial salmon drift gillnet	~~0~~	0	0	0	1.5	0	0.3
Entangled in Southeast Alaska commercial salmon drift gillnet ~~(District 13B)~~	~~0~~	~~0~~1.75	0.75	~~0.75[a]~~ 3.25[c]	0.75	2.25	~~0.2~~1.8
Entangled in Bering Sea/Aleutian Is. commercial pot gear	~~0~~	0	0	0	1[b]	0	0.2
Entangled in Southeast Alaska commercial pot gear	~~0~~	0	0	0	1.5	0	0.3
Entangled in Gulf of Alaska recreational Dungeness crab pot gear	~~0~~	0	0	0	0.75[b]	0	0.2
Entangled in Gulf of Alaska recreational shrimp pot gear	~~0~~	0	0	0	0.75[b]	0	0.2
Entangled in Southeast Alaska subsistence halibut longline gear	~~0~~	0.75	0	0	0.75	0	0.3
Entangled in unidentified subsistence gillnet		0	0	0	0	0.75	0.2
~~Entangled in Bering Sea pot gear*~~	~~0.75[b]~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
Entangled in Prince William Sound shrimp pot gear*	~~0~~	0	0	1[b]	0	0	0.2
~~Entangled in Southeast Alaska longline gear*~~	~~0.75~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
~~Entangled in Southeast Alaska golden king crab pot gear*~~	~~0.75~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
Entangled in Southeast Alaska unidentified fishery gear*	~~0~~	0	0	0	2.25	0	0.5
Entangled in Southeast Alaska unidentified net*	~~0~~	0	0	0	1.5	0	0.3
Entangled in gillnet*	~~0.75[b]~~	1	0	0	0	0	~~0.4~~0.2
Entangled in unidentified net*	~~0~~	0	0.75	0	0	0	0.2
Entangled in marine debris[~~e~~d]	~~5.5~~	0.75	1.5	4.5	1.75	4.25	~~2.8~~2.6
Entangled in salmon net pen		0	0	0	0	0.75	0.2
Entangled in mooring gear		0	0	0	0	0.75	0.2
Entangled in ship's ground tackle	~~0~~	0	1[b]	0	0	0	0.2
Ship strike[~~d~~e]	~~2~~	2.6	~~0.14~~ 1.14	~~4.52~~ 4.72	2.8	1.2	~~2.4~~2.5

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Total in commercial fisheries							~~1.7~~3.3
Total in recreational fisheries							0.4
Total in subsistence fisheries							~~0.3~~0.5
*Total in unknown (commercial, recreational, or subsistence) fisheries							~~2.2~~1.4
Total in marine debris							~~2.8~~2.6
Total due to other sources (entangled in salmon net pen, entangled in mooring gear, entangled in ship's ground tackle, ship strike)							~~2.6~~3.1

[a]~~Marine Mammal Authorization Program~~ MMAP fisherman self-~~-~~report.
[b]Mortality and serious injury assigned to both the Central North Pacific (CNP) and Western North Pacific (WNP) stocks.
[c]One of the serious injuries, prorated at 0.75, was reported by MMAP fisherman self-report.
[~~c~~d]Marine debris mortality and serious injury (prorated values) assigned to both the CNP and WNP stocks: ~~2.5 whales in 2011;~~ 0.75 whales in 2012; ~~and~~ 0.75 in 2014, and 2 in 2016.
[~~d~~e]Ship strike mortality and serious injury (prorated values) assigned to both the CNP and WNP stocks: 1.2 whales in 2012, ~~and~~ 1.2 in 2014, and 0.2 in 2016.

Table 3. Summary of mortality and serious injury of Central North Pacific humpback whales reported to the NMFS Pacific Islands Region stranding network in ~~2011-2015~~2012-2016 (Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data).

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
~~Entangled in recreational troll gear~~	~~1.5~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.3~~
~~Entangled in Alaska king crab pot gear*~~	~~0.75~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
Entangled in Alaska tanner crab pot gear*	~~0~~	1	0	0	0	0	0.2
Entangled in Alaska shrimp pot gear*	~~0~~	0	0	1	0	0	0.2
Entangled in Alaska king crab, tanner crab, or finfish pot gear*	~~0~~	0	0	0.75	0	0	0.2
Entangled in longline gear*	~~0~~	0	1	1	0	0	0.4
Entangled in unidentified fishing gear*	~~3.25~~	4.25	5.25	~~6.25~~6.5	7.75	2.5	~~5.4~~5.3
Ship strike	~~1.72~~	1.72	3.56	1	1.2	0.2	~~1.8~~1.5
~~Total in recreational fisheries~~							~~0.3~~
*Total in unknown (commercial, recreational, or subsistence) fisheries							~~6.6~~6.3
Total due to other sources (ship strike)							~~1.8~~1.5

However, these estimates of mortality and serious injury levels should be considered a minimum. No observers have 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.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska are not authorized to take from this stock of humpback whales, and no takes were reported in ~~2011-2015~~2012-2016.

Other Mortality

In 2015, increased mortality of large whales ~~(including 11 fin whales, 14 humpback whales, 1 gray whale, and 4 unidentified cetaceans from May to mid-August 2015)~~ 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) ~~(http://www.nmfs.noaa.gov/pr/health/mmume/faqs_2015_large_whale.html, accessed December 2017)~~. ~~On 20 August 2015,~~ 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 (http://www.nmfs.noaa.gov/pr/health/mmume/faqs_2015_large_whale.html, accessed June 2018)~~; however, no specific cause for the increased mortality has been identified~~. 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, a salmon net pen, and mooring gear reported to the NMFS Alaska Region stranding network ~~account for~~resulted in ~~a~~ minimum mean annual mortality and serious injury rates of ~~2.8~~2.6, 0.2, and 0.2 Central North Pacific humpback whales, respectively, in ~~2011-2015~~2012-2016 (Table 2; Helker et al. ~~2017~~in press).

Ship strikes and other interactions with vessels unrelated to fisheries occur frequently with humpback whales (Tables 2 and 3). Neilson et al. (2012) summarized 108 large whale ship-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. The minimum mean annual mortality and serious injury rate due to ship strikes and entanglement in a ship's ground tackle reported in Alaska (Table 2: ~~2.6~~2.7) and ship strikes reported in Hawaii (Table 3: ~~1.8~~1.5) in ~~2011-2015~~2012-2016 is ~~4.4~~ 4.2 humpback whales. Most ship strikes of humpback whales are reported from Southeast Alaska; however, there are also reports from the southcentral and Kodiak Island areas of Alaska (Helker et al. ~~2017~~in press). Many of the ship strikes occurring off Hawaii are reported from waters near Maui (Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data). It is not known whether the difference in ship-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.

HISTORICAL WHALING

Rice (1978) estimated that the number of humpback whales in the North Pacific may have been approximately 15,000 individuals prior to exploitation; however, this was based upon incomplete data and, given the level of known catches (legal and illegal) since World War II, may be an underestimate. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century. Humpback whales in the North Pacific were theoretically fully protected in 1965, but illegal catches by the U.S.S.R. continued until 1972 (Ivashchenko et al. ~~2007~~2013). From ~~1961~~1948 to 1971, ~~6,793~~7,334 humpback whales were killed ~~illegally~~ by the U.S.S.R., and 2,654 of these were illegally taken and not reported to the IWC (Ivashchenko et al. 2013). Many animals during this period were taken from the Gulf of Alaska and Bering Sea (Doroshenko 2000); however, additional illegal catches were made across the North Pacific, from the Kuril Islands to Haida Gwaii, and other takes ~~in earlier years~~ may have gone unrecorded. The Soviet factory ship *Aleut* is known to have taken 535 humpback whales during the period 1933-1947 (Ivashchenko et al. 2013).

On the feeding grounds of the Central North Pacific stock after World War II, the highest densities of catches occurred around the western Aleutian Islands, in the eastern Aleutian Islands (and adjacent Bering Sea to the north and Pacific Ocean to the south), and British Columbia (Springer et al. 2006). Lower but still relatively high densities of catches occurred south of the Commander Islands, along the south side of the Alaska Peninsula, and around Kodiak Island. Lower densities of catches also occurred in the Gulf of Anadyr, in the central Aleutian Islands, in much of the offshore Gulf of Alaska, and in Southeast Alaska. No catches were reported in the winter grounds of the Central North Pacific stock in Hawaii nor in Mexican winter areas.

STATUS OF STOCK

NMFS recently concluded a global humpback whale Status Review (Bettridge et al. 2015). Although the estimated annual level of human-caused mortality and serious injury for the entire Central North Pacific stock (~~25~~26 whales) is considered a minimum, it is unlikely that the total level of human-caused mortality and serious injury exceeds the PBR level (83) for the entire stock. The minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (~~8.5~~9.9 whales) is more than 10% of the calculated PBR for the entire stock (10% of PBR = 8.3) and, therefore, cannot be considered ~~to be~~ insignificant and approaching a zero mortality and serious injury rate. The humpback whale ESA listing final rule (81 FR 62259, 8 September 2016) established 14 Distinct Population Segments (DPSs) with different listing statuses. The DPSs that occur in waters under the jurisdiction of the United States do not equate to the existing MMPA stocks. Some of the listed DPSs partially coincide with the currently defined Central North Pacific stock. Because we cannot manage one portion of an MMPA stock as ESA-listed and another portion of a stock as not ESA-listed, until such time as the MMPA stock delineations are reviewed in light of the DPS designations and Bettridge et al. (2015), NMFS continues to use the existing MMPA stock structure and considers this stock to be endangered and depleted for MMPA management purposes (e.g., selection of a recovery factor, stock status). As a result, the Central North Pacific stock of humpback whales is classified as a strategic stock. Humpback whale mortality and serious injury in Hawaii-based fisheries involves whales from the Hawaii DPS; this DPS is not listed as threatened or endangered under the ESA.

There are key uncertainties in the assessment of the Central North Pacific stock of humpback whales. New DPSs were recently identified under the ESA; however, stocks have not been revised. No estimate of variance is available for the abundance estimate. The feeding areas of the Central North Pacific stock and the Western North Pacific stock overlap in waters from British Columbia to the Bering Sea, so human-related mortality and serious injury estimates must be assigned to or prorated to multiple stocks. The current abundance estimate is calculated using data collected in 2004-2006; however, the N_{MIN} is still considered a valid minimum population estimate because the population is ~~growing~~increasing (NMFS 2016). There is considerable site fidelity of humpback whales to particular feeding areas; human-related mortality and serious injury could have a disproportionate impact on a local feeding population even if the impacts to the DPS as currently described are low relative to the PBR level. 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 (Hawaii) and summering grounds (Alaska). Regulations concerning minimum distance to keep from whales and how to operate vessels when in the vicinity of whales have been developed for Hawaii and Alaska waters in an attempt to minimize the effect of whale watching. Additional concerns have been raised in Hawaii 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). 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 ~~December 2017~~June 2018). The growth of the whale-watching industry is an ongoing concern as preferred habitats may be abandoned if disturbance levels are too high. Other 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.

CITATIONS

Baker, C. S., L. M. Herman, A. Perry, W. S. Lawton, J. M. Straley, A. A. Wolman, G. D. Kaufman, H. E. Winn, J. D. Hall, J. M. Reinke, and J. Ostman. 1986. Migratory movement and population structure of humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. Mar. Ecol. Prog. Ser. 31:105-119.

Baker, C. S., A. Perry, and L. M. Herman. 1987. Reproductive histories of female humpback whales (*Megaptera novaeangliae*) in the North Pacific. Mar. Ecol. Prog. Ser. 41:103-114.

Baker, C. S., S. R. Palumbi, R. H. Lambertsen, M. T. Weinrich, J. Calambokidis, and S. J. O'Brien. 1990. Influence of seasonal migration on geographic distribution of mitochondrial DNA haplotypes in humpback whales. Nature 344:238-240.

Baker, C. S., J. M. Straley, and A. Perry. 1992. Population characteristics of individually identified humpback whales in southeastern Alaska: summer and fall 1986. Fish. Bull., U.S. 90:429-437.

Baker, C. S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J. M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Mol. Ecol. 7:695-707.

Baker, C. S., D. Steel, J. Calambokidis, J. Barlow, A. M. Burdin, P. J. Clapham, E. A. Falcone, J. K. B. Ford, C. M. Gabriele, U. González-Peral, R. LeDuc, D. Mattila, T. J. Quinn, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán-R., M. Vant, P. Wade, D. Weller, B. H. Witteveen, K. Wynne, and M. Yamaguchi. 2008. *geneSPLASH*: an initial, ocean-wide survey of mitochondrial (mt) DNA diversity and population structure among humpback whales in the North Pacific. Final Report for Contract 2006-0093-008 to the National Fish and Wildlife Foundation.

Baker, C. S., D. Steel, J. Calambokidis, E. Falcone, U. González-Peral, J. Barlow, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán, P. R. Wade, D. Weller, B. H. Witteveen, and M. Yamaguchi. 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. Mar. Ecol. Prog. Ser. 494:291-306. DOI: dx.doi.org/10.3354/meps10508 .

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology 78(2):535-546.

Barlow, J., J. Calambokidis, E. A. Falcone, C. S. Baker, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. K. Mattila, T. J. Quinn, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., P. Wade, D. Weller, B. H. Witteveen, and M. Yamaguchi. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Mar. Mammal Sci. 27:793-818.

Bettridge, S., C. S. Baker, J. Barlow, P. J. Clapham, M. Ford, D. Gouveia, D. K. Mattila, R. M. Pace III, P. E. Rosel, G. K. Silber, and P. R. Wade. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-540, 240 p.

Bradford, A. L. 2018. Injury determinations for marine mammals observed interacting with Hawaii and American Samoa longline fisheries during 2016-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-PIFSC-XX, XX p.

Bradford, A. L., and K. A. Forney. 2017. Injury determinations for marine mammals observed interacting with Hawaii and American Samoa longline fisheries during 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-PIFSC-62, 28 p. DOI: dx.doi.org/10.7289/V5/TM-PIFSC-62 .

Bradford, A. L., and E. Lyman. 2015. Injury determinations for humpback whales and other cetaceans reported to NOAA Response Networks in the Hawaiian Islands during 2007-2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-PIFSC-45, 29 p.

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

Calambokidis, J., G. H. Steiger, J. C. Cubbage, K. C. Balcomb III, and P. Bloedel. 1989. Biology of humpback whales in the Gulf of the Farallones. Report to Gulf of the Farallones National Marine Sanctuary, San Francisco, CA, by Cascadia Research Collective, 218½ West Fourth Avenue, Olympia, WA. 93 p.

Calambokidis, J., G. H. Steiger, and J. R. Evenson. 1993. Photographic identification and abundance estimates of humpback and blue whales off California in 1991-92. Final Contract Report 50ABNF100137 to Southwest Fisheries Science Center, La Jolla, CA 92037. 67 p.

Calambokidis, J., G. H. Steiger, J. M. Straley, T. Quinn, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. Urban R., J. Jacobson, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, N. Higashi, S. Uchida, J. K. B. Ford, Y. Miyamura, P. Ladrón de Guevara, S. A. Mizroch, L. Schlender, and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific basin. Final Contract Report 50ABNF500113 to Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037. 72 p.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urban R., J. K. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P. Ladrón de Guevara P., M. Yamaguchi, F. Sato, S. A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, and T. J. Quinn II. 2001. Movements and population structure of humpback whales in the North Pacific. Mar. Mammal Sci. 17(4):769-794.

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final Report for Contract AB133F-03-RP-00078. 58 p.
Available online: http://www.cascadiaresearch.org/files/publications/SPLASH-contract-Report-May08.pdf . Accessed December 2017June 2018.

Clapham, P. J., and J. G. Mead. 1999. *Megaptera novaeangliae*. Mamm. Species 604:1-9.

Clapham, P. J., J. Barlow, M. Bessinger, T. Cole, D. Mattila, R. Pace, D. Palka, J. Robbins, and R. Seton. 2003. Abundance and demographic parameters of humpback whales from the Gulf of Maine, and stock definition relative to the Scotian Shelf. J. Cetacean Res. Manage. 5:13-22.

Darling, J. D. 1991. Humpback whales in Japanese waters. Ogasawara and Okinawa. Fluke identification catalog 1987-1990. Final Contract Report, World Wide Fund for Nature, Japan. 22 p.

Darling, J. D., and S. Cerchio. 1993. Movement of a humpback whale (*Megaptera novaeangliae*) between Japan and Hawaii. Mar. Mammal Sci. 1:84-89.

Doroshenko, N. V. 2000. Soviet catches of humpback whales (*Megaptera novaeangliae*) in the North Pacific, p. 48-95. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet Whaling Data (1949-1979), Center for Russian Environmental Policy, Marine Mammal Council, Moscow.

Fleming, A., and J. Jackson. 2011. Global review of humpback whales (*Megaptera novaeangliae*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-474, 206 p.

Ford J. K. B., A. L. Rambeau, R. M. Abernethy, M. D. Boogaards, L. M. Nichol, and L. D. Spaven. 2009. An assessment of the potential for recovery of humpback whales off the Pacific coast of Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/015. iv + 33 p.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Hill, M. C., E. M. Oleson, S. Baumann-Pickering, A. M. Van Cise, A. D. Ligon, A. R. Bendlin, A. C. Ü, J. S. Trickey, and A. L. Bradford. 2016. Cetacean monitoring in the Mariana Islands Range Complex, 2015. Prepared for the U.S. Pacific Fleet Environmental Readiness Office. PIFSC Data Report DR-16-01. 36 p. + appendix.

~~Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell, Jr. (eds.). 2007. Scientific reports of Soviet whaling expeditions, 1955-1978. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-175, 36 p. (Translation: Y. V. Ivashchenko) + appendix.~~

Ivashchenko, Y. V., R. L. Brownell, Jr., and P. J. Clapham. 2013. Soviet whaling in the North Pacific: revised catch totals. J. Cetacean Res. Manage. 13:59-71.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish. Rev. 46:30-37.

Johnston, D. W., M. E. Chapla, L. E. Williams, and D. K. Mattila. 2007. Identification of humpback whale *Megaptera novaeangliae* wintering habitat in the Northwestern Hawaiian Islands using spatial habitat modeling. Endang. Species Res. 3:249-257.

Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in districts 6, 7 and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 p.

Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, and O. von Ziegesar. 2004. Estimating the adult survival rate of central North Pacific humpback whales. J. Mammal. 85(5):963-972.

Mobley, J. M., S. Spitz, R. Grotefendt, P. Forestell, A. Frankel, and G. Bauer. 2001. Abundance of humpback whales in Hawaiian waters: results of 1993-2000 aerial surveys. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary. 16 p.

Moore, S. E., J. M. Waite, N. A. Friday, and T. Honkalehto. 2002. Distribution and comparative estimates of cetacean abundance on the central and south-eastern Bering Sea shelf with observations on bathymetric and prey associations. Prog. Oceanogr. 55(1-2):249-262.

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

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. Summary of reported whale-vessel collisions in Alaskan waters. J. Mar. Biol. 2012: Article ID 106282. 18 p. DOI: dx.doi.org/10.1155/2012/106282 .

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. Tokyo 12:33-89.

Nemoto, T. 1959. Food of baleen whales with reference to whale movements. Sci. Rep. Whales Res. Inst. 14:149-290.

NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-policies-guidance-and-regulations . Accessed June 2018.

Perry, A., C. S. Baker, and L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. Rep. Int. Whal. Comm. (Special Issue 12):307-317.

Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation and numbers, Appendix 4, p. 29-44. *In* K. S. Norris and R. R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. U.S. Dep. Commer., Natl. Tech. Info. Serv. PB-280794. Springfield, VA.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Soc. Mar. Mammal. Spec. Publ. No. 4.

Springer, A. M., G. B. van Vliet, J. F. Piatt, and E. M. Danner. 2006. Whales and whaling in the North Pacific Ocean and Bering Sea: oceanographic insights and ecosystem impacts, p. 245-261. *In* J. A. Estes, R. L. Brownell, Jr., D. P. DeMaster, D. F. Doak, and T. M. Williams (eds.), Whales, Whaling and Ocean Ecosystems. University of California Press. 418 p.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mammal Sci. 7:306-310.

Straley, J. M. 1994. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. Master's Thesis, University of Alaska - Fairbanks, Fairbanks, AK 99775. 121 p.

Straley, J. M., C. M. Gabriele, and C. S. Baker. 1995. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska, p. 229-237. *In* D. R. Engstrom (ed.), Proceedings of the Third Glacier Bay Science Symposium, 1993. National Park Service, Anchorage, AK.

Straley, J. M., C. M. Gabriele, and T. J. Quinn II. 2009. Assessment of mark recapture models to estimate the abundance of a humpback whale feeding aggregation in Southeast Alaska. J. Biogeogr. 36:427-438.

Taylor, B. L., M. Scott, J. Heyning, and J. Barlow. 2003. Suggested guidelines for recovery factors for endangered marine mammals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-354, 6 p.

Teerlink, S. F., O. von Ziegesar, J. M. Straley, T. J. Quinn II, C. O. Matkin, and E. L. Saulitis. 2015. First time series of estimated humpback whale (*Megaptera novaeangliae*) abundance in Prince William Sound. Environ. Ecol. Stat. 22:345. DOI: dx.doi.org/10.1007/s10651-014-0301-8 .

Tomlin, A. G. 1967. Mammals of the USSR and Adjacent Countries. Vol. 9. Cetacea. Israel Program for Scientific Translations No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 p. (Translation of Russian text published in 1957.)

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

Waite, J. M., M. E. Dahlheim, R. C. Hobbs, S. A. Mizroch, O. von Ziegesar-Matkin, J. M. Straley, L. M. Herman, and J. Jacobsen. 1999. Evidence of a feeding aggregation of humpback whales (*Megaptera novaeangliae*) around Kodiak Island, Alaska. Mar. Mammal Sci. 15:210-220.

Witteveen, B. H., J. M. Straley, O. von Ziegesar, D. Steel, and C. S. Baker. 2004. Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska. Can. J. Zool. 82:1352-1359.

Zenkovich, B. A. 1954. Vokrug sveta za kitami, Vol. Gosudarstvennoe Izdatel'stvo Geograficheskoi Literatury, Moscow.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53(11):1772-1790.

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 reception of fin whale calls by 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). 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 ~~were~~have been detected in the southeast Bering Sea ~~using an instrument moored there, from~~by a moored hydrophone. During April 2006 through April 2007, ~~which showed~~ 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 ~~of~~ 2007-2010 (Delarue et al. 2013). Call data collected from the Bering Sea suggest that several putative fin whale stocks may feed in the Bering Sea~~, but call data collected~~; however, only one of these likely migrates in~~to~~ the ~~northeast~~ Chukchi Sea ~~suggest that only one of the putative Bering Sea stocks appears to migrate that far north~~ 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).

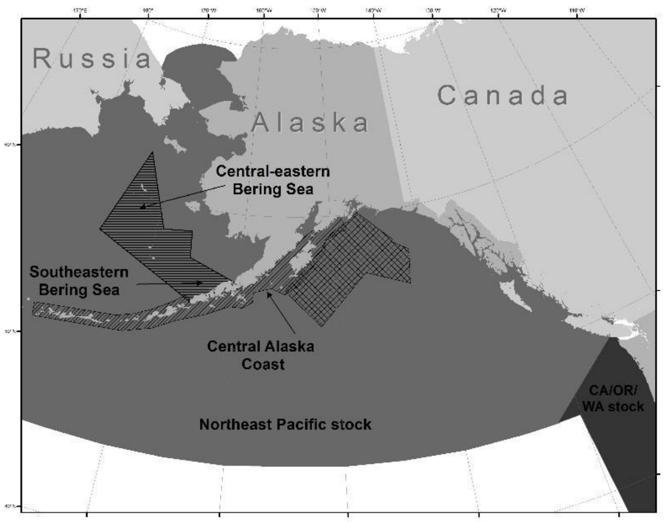

Figure 1. Approximate distribution of fin whales in the eastern North Pacific. Striped areas indicate where vessel surveys occurred in 1999-2010 (horizontal stripes - Bering Sea: Moore et al. 2002; Friday et al. 2012, 2013); ~~and~~ 2001-2003 (diagonal stripes - Central Alaska coast and Aleutian Islands: Zerbini et al. 2006); and 2009, 2013, and 2015 (cross hatch - 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 relative 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 ~~with the highest abundances occurring in the “green belt.”~~ 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 7-12 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 in summer (Funk et al. 2010, Aerts et al. 2012, Clarke et al. 2013) 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), suggesting they may be re-occupying habitat used prior to large-scale commercial whaling. In August 2012, fin whale calls were recorded in the Alaska Chukchi Sea at a location 280 km northeast of the closest prior acoustic detection and 365 km northeast of the closest confirmed visual sighting of a fin whale, suggesting a possible northward range expansion over time as sea ice has retreated (Crance et al. 2015).

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 ~~those authors~~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 ~~mark recoveries~~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 ~~mark recoveries~~tags, and opportunistic sightings data and found evidence ~~that~~to suggest~~s~~ there may be at least six populations of fin whales: two that are migratory (eastern and western North Pacific) and 2-4 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), 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 ~~separately~~ 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, although they do not provide estimates of population size. A survey conducted in August ~~of~~ 1994 covering 2,050 nautical miles of trackline south of the Aleutian Islands encountered only four fin whale groups (Forney and Brownell 1996). However, this survey did not include all of the waters off Alaska where fin whale sightings have been reported, thus, no population estimate could be made.

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 789-3,752 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 ~~provisional~~ estimates of 419 (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-August 2001-2003 (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 ~~sightings~~ (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 in 2001-2003.

In 2013 and 2015, dedicated line-transect surveys of the offshore waters of the Gulf of Alaska recorded, respectively, 171 and 38 sightings (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 ~~are likely biased low because they~~ have not been corrected for animals missed on the trackline, animals submerged when the ship passed, and responsive movement. However, ~~E~~even though no data are available to ~~make these corrections~~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) ~~provide~~are more recent ~~estimates~~. 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 ~~was computed from a cruise with~~represents a broader survey coverage. ~~This estimate is considered a minimum abundance because the survey only encompassed a portion of the known range of the stock.~~ A minimum population estimate (N_{MIN}) for this stock can be calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the best provisional estimate (N) of 3,168 from the 2013 survey and the associated coefficient of variation 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 ~~purported~~ 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 for 1987-2003. 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 (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.

Friday et al. (2013) estimated a 14% (95% CI: 1.0-26.5%) annual rate of increase in abundance of fin whales from 2002 to 2010 in the Bering Sea. However, this apparent high rate of increase ~~in abundance~~, which is higher than most plausible estimates for large whale populations (see Zerbini et al. 2010 for a discussion of maximum rates of increase for humpback whale populations)~~. It is likely that the high rate of increase in abundance in the study area~~, is due, at least in part, to changes in distribution and not just to population growth. Further, in this study, the abundance of fin whales in the survey area increased in colder years, likely due to shifts in the distribution of prey. Stafford et al. (2010) provided evidence of prey-driven distribution where fin and right whale call rates in the vicinity of mooring M2 (approximate location: 57.9°N, 164.1°W) increased following peaks in euphausiid and copepod biomass, providing further evidence of distribution shifting.

Similar issues with shifting distributions confounding estimates of rate of increase were documented for fin whales off California by Moore and Barlow (2011). Here, trends in fin whale abundance from 1991 to 2008 were analyzed and the authors found sufficient variability in trend estimates to conclude that the estimates were likely demonstrating ~~dispersal of new individuals~~immigration into the study area rather than ~~actual~~inherent population ~~trends~~growth.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Zerbini et al. (2006) estimated an annual increase in coastal waters south of the Alaska Peninsula of 4.8% (95% CI: 4.1-5.4%) for 1987-2003. 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 unavailable for the Northeast Pacific fin whale stock. Hence, 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

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 (Wade and Angliss 1997). 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 ~~purported~~ range, the calculated PBR is likely biased low for the entire Northeast Pacific fin whale stock.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~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 Northeast Pacific fin whales in ~~2011-2015~~2012-2016 is ~~0.4~~0.6 whales: 0.2 in U.S. commercial fisheries and ~~0.2~~0.4 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

~~Detailed i~~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.

One incidental mortality of a fin whale due to entanglement in the ground tackle of a commercial mechanical jig fishing vessel was reported to the NMFS Alaska Region in 2012 (Table 1; Helker et al. ~~2017~~in press). Because observer data are not available for this fishery, this mortality results in a mean annual mortality and serious injury rate of 0.2 fin whales in ~~2011-2015~~2012-2016 (Table 1). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and ~~should be considered~~is a minimum.

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 in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in ground tackle of commercial mechanical jig fishing vessel	~~0~~	1	0	0	0	0	0.2
Ship strike	~~0~~	0	0	1	0	1	~~0.2~~0.4
Total in commercial fisheries							0.2
Total due to other causes (ship strike)							~~0.2~~0.4

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 ~~taken~~killed in commercial whaling operations throughout the North Pacific (Rocha et al. 2014).

In 2015, increased mortality of large whales ~~(including 11 fin whales, 14 humpback whales, 1 gray whale, and 4 unidentified cetaceans from May to mid-August 2015)~~ 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)~~(http://www.nmfs.noaa.gov/pr/health/mmume/faqs_2015_large_whale.html, accessed December 2017)~~. ~~On 20 August 2015,~~ 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 (http://www.nmfs.noaa.gov/pr/health/mmume/faqs_2015_large_whale.html, accessed June 2018)~~; however, no specific cause for the increased mortality has been identified~~. 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).

~~A f~~Fin whale mortality due to a ship strike in Alaska waters ~~in 2014~~ was reported to the NMFS Alaska Region stranding network in 2014 and 2016 (Helker et al. ~~2017~~in press), resulting in a mean annual mortality and serious injury rate of ~~0.2~~0.4 fin whales due to ship strikes in ~~2011-2015~~2012-2016 (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 reliable 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 total estimated annual level of human-caused mortality and serious injury for Northeast Pacific fin whales (~~0.4~~0.6 whales) does not exceed the calculated PBR (5.1 whales)., ~~and~~ ~~t~~The minimum mean annual rate of U.S. commercial fishery-related mortality and serious injury (0.2 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 time 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 plausible 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 Chukchi and Beaufort seas. Ocean warming may increase the frequency of algal blooms that produce biotoxins known to be associated with large whale mortality. However, few ~~or no~~ data are available to assess the likelihood or extent of such impacts.

CITATIONS

Aerts, L. A. M., A. Kirk, C. Schudel, B. Watts, P. Seiser, A. Mcfarland, and K. Lomac-Macnair. 2012. Marine mammal distribution and abundance in the northeastern Chukchi Sea, July-October 2008-2011. Report prepared by LAMA Ecological for ConocoPhillips Alaska, Inc., Shell Exploration and Production Company and Statoil USA E&P, Inc. 69 p.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part 1: Ship surveys in summer and fall of 1991. Fish. Bull., U.S. 93:1-14.

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar. Mammal Sci. 22(2):446-464.

Clarke, J., K. Stafford, S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26(4):136-149. DOI: dx.doi.org/10.5670/oceanog.2013.81 .

Crance, J. L., C. L. Berchok, J. Bonnel, and A. M. Thode. 2015. Northeasternmost record of a North Pacific fin whale (*Balaenoptera physalus*) in the Alaskan Chukchi Sea. Polar Biol. 38:1767-1773.

Delarue, J., B. Martin, D. Hannay, and C. Berchok. 2013. Acoustic occurrence and affiliation of fin whales detected in the northeastern Chukchi Sea, July to October 2007–2010. Arctic 66(2):159-172.

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

Forney, K. A., and R. L. Brownell. 1996. Preliminary report of the 1994 Aleutian Island marine mammal survey. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/48/O11). 15 p.

Friday, N. A., A. N. Zerbini, J. M. Waite, and S. E. Moore. 2012. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf: 1999-2004. Deep-Sea Res. II ~~(~~65-70~~)~~:260-272. DOI: dx.doi.org/10.1016/j.dsr2.2012.02.006 .

Friday, N. A., A. N. Zerbini, J. M. Waite, S. E. Moore, and P. J. Clapham. 2013. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf in June and July of 2002, 2008, and 2010. Deep-Sea Res. II 94:244-256. DOI: dx.doi.org/10.1016/j.dsr2.2013.03.011 .

Fujino, K. 1960. Monogenetic and marking approaches to identifying sub-populations of the North Pacific whales. Sci. Rep. Whales Res. Inst. Tokyo 15:84-142.

Funk, D. W., D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.). 2010. Joint monitoring program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 506 p. + appendices.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

McDonald, M. A., and C. G. Fox. 1999. Passive acoustic methods applied to fin whale population density estimation. J. Acoust. Soc. Am. 105(5):2643-2651.

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The fin whale, *Balaenoptera physalus*. Mar. Fish. Rev. 46(4):20-24.

Mizroch, S. A., D. Rice, D. Zwiefelhofer, J. Waite, and W. Perryman. 2009. Distribution and movements of fin whales in the North Pacific Ocean. Mammal Rev. 39(3):193-227.

Mobley, J. R., Jr., M. Smultea, T. Norris, and D. Weller. 1996. Fin whale sighting north of Kaua'i, Hawai'i. Pac. Sci. 50(2):230-233.

Moore, J. E., and J. Barlow. 2011. Bayesian state-space model of fin whale abundance trends from a 1991–2008 time series of line-transect surveys in the California Current. J. Applied Ecol. 48:1195-1205.

AR024522

Moore, S. E., K. M. Stafford, M. E. Dahlheim, C. G. Fox, H. W. Braham, J. J. Polovina, and D. E. Bain. 1998. Seasonal variation in reception of fin whale calls at five geographic areas in the North Pacific. Mar. Mammal Sci. 14(3):617-627.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. C. Hobbs. 2000. Provisional estimates of mysticete whale abundance on the central Bering Sea shelf. J. Cetacean Res. Manage. 2(3):227-234.

Moore, S. E., J. M. Waite, N. A. Friday, and T. Honkalehto. 2002. Distribution and comparative estimates of cetacean abundance on the central and south-eastern Bering Sea shelf with observations on bathymetric and prey associations. Prog. Oceanogr. 55(1-2):249-262.

Moore, S. E., K. M. Stafford, D. K. Mellinger, and C. G. Hildebrand. 2006. Listening for large whales in the offshore waters of Alaska. BioScience 56(1):49-55.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific, p. 170-195. *In* W. E. Schevill (ed.), The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Rocha, R. C., Jr., P. J. Clapham, and Y. V. Ivashchenko. 2014. Emptying the oceans: a summary of industrial whaling catches in the 20th century. Mar. Fish. Rev. 76:37-48. DOI: dx.doi.org/10.7755/MFR.76.4.3 .

Rone, B. K., A. N. Zerbini, A. B. Douglas, D. W. Weller, and P. J. Clapham. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. Mar. Biol. 164:23. DOI: dx.doi.org/10.1007/s00227-016-3052-2 .

Shallenberger, E. W. 1981. The status of Hawaiian cetaceans. Final ~~r~~Report for MMC Contract MM7AC028. Natl. Tech. Info. Ser. PB82-109398.

Širović, A., L. N. Williams, S. M. Kerosky, S. M. Wiggins, and J. A. Hildebrand. 2013. Temporal separation of two fin whale call types across the eastern North Pacific. Mar. Biol. 160:47-57.

Širović, A., A. Rice, E. Chou, J. A. Hildebrand, S. M. Wiggins, and M. A. Roch. 2015. Seven years of blue and fin whale call abundance in the Southern California Bight. Endang. Species Res. 28:61-76.

Soule, D. C., and W. S. D. Wilcock. 2013. Fin whale tracks recorded by a seismic network on the Juan de Fuca Ridge, Northeast Pacific Ocean. J. Acoust. Soc. Am. 133(3):1751-1761.

Springer, A. M., C. P. McRoy, and M. V. Flint. 1996. The Bering Sea green belt: shelf-edge processes and ecosystem production. Fish. Oceanogr. 5:205-223.

Stabeno, P., S. Moore, J. Napp, M. Sigler, and A. Zerbini. 2012. Comparison of warm and cold years on the southeastern Bering Sea shelf and some implications for the ecosystem. Deep-Sea Res. II 65-70:31-45.

Stafford, K. M., D. K. Mellinger, S. E. Moore, and C. G. Fox. 2007. Seasonal variability and detection range modeling of baleen whale calls in the Gulf of Alaska, 1999-2002. J. Acoust. Soc. Amer. 122(6):3378-3390.

Stafford, K. M., S. E. Moore, P. J. Stabeno, D. V. Holliday, J. M. Napp, and D. K. Mellinger. 2010. Biophysical ocean observation in the southeastern Bering Sea. Geophys. Res. Lett. 37:L02606. DOI: dx.doi.org/10.1029/2009GL040724 .

Thompson, P. O., and W. A. Friedl. 1982. A long term study of low frequency sound from several species of whales off Oahu, Hawaii. Cetology 45:1-19.

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

Watkins, W. A., M. A. Daher, G. M. Reppucci, J. E. George, D. L. Martin, N. A. DiMarzio, and D. P. Gannon. 2000. Seasonality and distribution of whale calls in the North Pacific. Oceanography 13(1):62-67.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53(11):1772-1790.

Zerbini, A. N., P. J. Clapham, and P. R. Wade. 2010. Assessing plausible rates of population growth in humpback whales from life-history data. Mar. Biol. 157:1225-1236.

Zerbini, A. N., N. A. Friday, D. M. Palacios, J. M. Waite, P. H. Ressler, B. K. Rone, S. E. Moore, and P. J. Clapham. 2016. Baleen whale abundance and distribution in relation to environmental variables and prey density in the eastern Bering Sea. Deep-Sea Res. II 134:312-330. DOI: dx.doi.org/10.1016/j.dsr2.2015.11.002 .

MINKE WHALE (*Balaenoptera acutorostrata*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

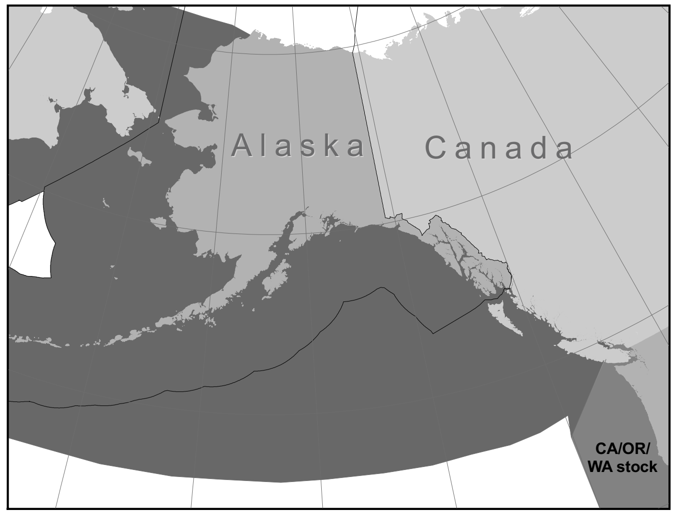

Figure 1. Approximate distribution of minke whales in the eastern North Pacific (dark shaded areas).

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). ~~Recent v~~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" boings 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).

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 ~~two~~three offshore Gulf of Alaska surveys for cetaceans in 2009, ~~and~~ 2013, and 2015 that a population estimate for this species in this area could not be determined (Rone et al. ~~2010, 2014~~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 ~~separately~~ 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 this 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

~~At this time, i~~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). Hence, until additional data become available, ~~it is recommended that~~ the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% will be ~~employed~~used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

~~Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the p~~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~~ at this time~~.

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.

~~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 historical 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

~~Detailed i~~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.

~~Six different commercial fisheries operating in Alaska waters within the range of the Alaska minke whale stock were monitored for incidental take by NMFS observers during 2009-2013: the Bering Sea/Aleutian Islands groundfish trawl, longline, and pot fisheries and the Gulf of Alaska groundfish trawl, longline, and pot fisheries. However, n~~No mortality or serious injury of minke whales ~~occurred in~~was observed in U.S. commercial fisheries in ~~2009-2013~~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 ~~2009-2013~~2012-2016.

Other Mortality

From ~~2009~~2012 to ~~2013~~2016, no human-related mortality or serious injury of minke whales was reported to the NMFS Alaska Region stranding ~~database~~network (Helker et al. ~~2015~~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 greatest uncertainty regarding the status of the Alaska minke whale stock has to do with the uncertainty pertaining to the stock structure of this species in the eastern North Pacific.~~ The abundance estimate for this stock is unknown and, thus, PBR is unknown. However, ~~B~~because minke whales are considered common in the waters off Alaska and~~, because the number of~~ human-~~related~~caused ~~removals~~mortality and serious injury is ~~currently~~ thought to be minimal, this stock is presumed to ~~not~~ be a non-strategic stock. ~~Reliable estimates of the minimum population size, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population are currently not available.~~ Because the PBR is unknown, the ~~level of~~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.

CITATIONS

~~Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating serious and non-serious injury of marine mammals: report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-39, 94 p.~~

~~Angliss, R. P., and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13, 48 p.~~

Anonymous. 1991. International Whaling Commission Report. Rep. Int. Whal. Comm. 41:1-2.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

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

Brueggeman, J. J., G. A. Green, K. C. Balcomb, C. E. Bowlby, R. A. Grotefendt, K. T. Briggs, M. L. Bonnell, R. G. Ford, D. H. Varoujean, D. Heinemann, and D. G. Chapman. 1990. Oregon-Washington marine mammal and seabird survey: information synthesis and hypothesis formulation. U.S. Dep. Interior, Outer Continental Shelf Study, Minerals Management Service 89-0030.

Clarke, J., K. Stafford S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26(4):136-149.

Delarue, J., B. Martin, and D. Hannay. 2013. Minke whale boing sound detections in the northeastern Chukchi Sea. Mar. Mammal Sci. 29:E333–E341.

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

Donovan, G. P. 1991. A review of IWC stock boundaries. Rep. Int. Whal. Comm. (Special Issue 13):39-68.

Dorsey, E. M., S. J. Stern, A. R. Hoelzel, and J. Jacobsen. 1990. Minke whales (*Balaenoptera acutorostrata*) from the west coast of North America: individual recognition and small scale site fidelity. Rep. Int. Whal. Comm. (Special Issue 12):357-368.

Friday, N. A., J. M. Waite, A. N. Zerbini, and S. E. Moore. 2012. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf: 1999–2004. Deep-Sea Res. II 65-70:260-272.

Friday, N. A., A. N. Zerbini, J. M. Waite, S. E. Moore, and P. J. Clapham. 2013. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf in June and July of 2002, 2008, and 2010. Deep-Sea Res. II 94:244-256.

~~Helker, V. T., B. M. Allen, and L. A. Jemison. 2015. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2009-2013. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-300, 94 p.~~

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: a guide to their identification. U.S. Dep. Commer., NOAA Tech. Rep. NMFS Circular 444, 245 p.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. C. Hobbs. 2000. Provisional estimates of mysticete whale abundance on the central Bering Sea shelf. J. Cetacean Res. Manage. 2(3):227-234.

Moore, S. E., J. M. Waite, N. A. Friday and T. Honkalehto. 2002. Distribution and comparative estimates of cetacean abundance on the central and south-eastern Bering Sea shelf with observations on bathymetric and prey associations. Prog. Oceanogr. 55(1-2):249-262.

~~NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf. Accessed December 2015.~~

Rankin, S., and J. Barlow. 2005. Source of the North Pacific "boing" sound attributed to minke whales. J. Acoust. Soc. Am. 118:3346–3351.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific,~~ –~~ ~~P~~p. 170-195. *In* W. E. Schevill (ed.), The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

~~Rone, B. K., A. B. Douglas, A. N. Zerbini, L. Morse, A. Martinez, P. J. Clapham, and J. Calambokidis. 2010. Results from the April 2009 Gulf of Alaska line transect survey (GOALS) in the Navy training exercise area. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-209, 39 p.~~

~~Rone, B. K., A. B. Douglas, T. M. Yack, A. N. Zerbini, T. N. Norris, E. Ferguson, and J. Calambokidis. 2014. Report for the Gulf of Alaska Line-Transect Survey (GOALS) II: marine mammal occurrence in the Temporary Maritime Activities Area (TMAA). Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific, Honolulu, HI under Contract No. N62470-10-D-3011, Task Order 0022, issued to HDR Inc., San Diego, CA. Prepared by Cascadia Research Collective, Olympia, WA; Alaska Fisheries Science Center, Seattle, WA; and Bio-Waves, Inc., Encinitas, CA. April 2014.~~

Rone, B. K., A. N. Zerbini, A. B. Douglas, D. W. Weller, and P. J. Clapham. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. Mar. Biol. 164:23. DOI: dx.doi.org/10.1007/s00227-016-3052-2 .

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

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends, and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53:1772-1790.

NORTH PACIFIC RIGHT WHALE (*Eubalaena japonica*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

A review of all 20th-century sightings, catches, and strandings of North Pacific right whales was conducted by Brownell et al. (2001). Data from this review were subsequently combined with historical whaling records to map the known distribution of the species (Fig. 1; Clapham et al. 2004, Shelden et al. 2005). Although whaling records initially indicated that right whales ranged across the entire North Pacific Ocean north of 35°N and occasionally as far south as 20°N (Fig. 1; Scarff 1986, 1991), analysis shows a pronounced longitudinally bimodal distribution (Josephson et al. 2008a). Before right whales in the North Pacific were heavily exploited by commercial whalers, concentrations were found in the Gulf of Alaska, eastern Aleutian Islands, south-central Bering Sea, Sea of Okhotsk, and Sea of Japan (Braham and Rice 1984). An analysis conducted on the North Pacific right whale fishery by Josephson et al. (2008b) showed that within the course of a decade (1840s), right whale abundance was severely depleted, particularly in the eastern portion of their range. In a comprehensive review, Brownell et al. (2001) found only 82 published sightings of right whales in the entire eastern North Pacific from 1962 to 1999, with the majority of these occurring in the Bering Sea and adjacent areas of the Aleutian Islands; this surprising lack of sightings ultimately led to the discovery that right whales had been subject to large illegal catches (primarily from 1962 to 1968) by the former U.S.S.R. (Ivashchenko and Clapham 2012~~,~~; Ivashchenko et al. 2013, 2017).

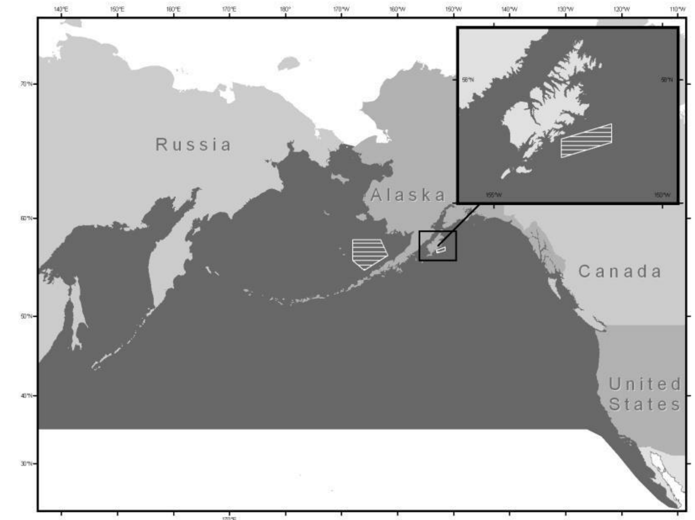

Figure 1. Approximate historical distribution of North Pacific right whales in the North Pacific (dark shaded area). Striped areas indicate ~~northern~~North Pacific right whale critical habitat (~~71 FR 38277, 6 July 2006~~73 FR 19000, 8 April 2008).

In lower latitude waters, North Pacific right whales have been reported as far south as central Baja California and Hawaii; in higher latitudes, they have been observed as far east as Yakutat Bay, Haida Gwaii, and Vancouver Island in the eastern North Pacific~~,~~ and as far north as the subarctic waters of the Bering Sea in the summer (Herman et al. 1980, Rowntree et al. 1980, Berzin and Doroshenko 1982, Salden and Mickelsen 1999, Brownell et al. 2001, Ford et al. 2016). However, most right whale sightings (and most survey effort) in the past 20 years, starting in 1996, have occurred in the southeastern Bering Sea, with a few records in the Gulf of Alaska near Kodiak Island, Alaska (Waite et al. 2003; Shelden et al. 2005; Wade et al. 2011a, 2011b).

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 well offshore (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). While the photographic match confirms that Bering Sea animals occasionally travel south, there is currently no reason to believe that either Hawaii or tropical Mexico have ever been anything except extra-limital habitats for this species (Brownell et al. 2001).

Passive acoustic monitoring from 2008 to 2015 of the northern Bering Sea detected calls matching the North Pacific right whale up-call criterion in late fall through spring (Wright 2015, 2017), suggesting that North Pacific right whales occur in the northern Bering Sea during winter months; however, there remains a possibility that some winter calls were made by bowhead whales. An individual North Pacific right whale was visually identified north of St. Lawrence Island in November 2012 (G. Sheffield, University of Alaska Fairbanks, Nome, AK), confirming their presence at higher latitudes late in the season. However, the winter upsweeps were observed during bowhead whale song and heavy ice conditions. As a result, these calls were termed "ambiguous winter up-calls" because the northern region winter up-calls of this subtype could not be definitively classified as either bowhead whale or North Pacific right whale calls (Wright 2015, 2017). However, the acoustic data suggest that North Pacific right whales could possibly occupy the northern Bering/southern Chukchi seas during the winter months.

Information on the summer and autumn distribution of right whales is available 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 have occurred in a portion of the southeastern Bering Sea (Fig. 1) where right whales have been observed most summers between 1996 and 2010 (Goddard and Rugh 1998, Rone et al. 2012). North Pacific right whales were observed consistently in this area, although it is clear from historical and Japanese sighting survey data that right whales often range outside this area and occur elsewhere in the Bering Sea (Moore et al. 2000, 2002; LeDuc et al. 2001; Clapham et al. 2004). Bottom-mounted acoustic recorders were deployed in the southeastern Bering Sea (2000-2017) and the northern Gulf of Alaska (1999-2001) to document the seasonal distribution of right whale calls (Mellinger et al. 2004). Analysis of the data from those recorders deployed between October 2000 and January 2006 indicates that right whales remain in the southeastern Bering Sea from May through December with peak call detection in September (Munger and Hildebrand 2004). Data from recorders deployed between May 2006 and April 2007 show the same trends (Stafford and Mellinger 2009, Stafford et al. 2010). Recorders have been deployed by the Alaska Fisheries Science Center's Marine Mammal Laboratory (MML) from 2007 through 2017 at various locations throughout the Bering Sea and Aleutian Passes. ~~Passive acoustic monitoring (PAM) data from the North Pacific right whale critical habitat have not been fully analyzed, but 2012-2013 data indicate the presence of right whales in the southeastern Bering Sea in July-January, with a peak in September and a sharp decline in detections by mid-November (Wright 2015). PAM data from Unimak Pass (2009-2015) indicate seasonal presence of North Pacific right whales, with consistent low detections in winter months (December-February) across years (Wright 2015, 2017). Up-calls with characteristics matching those of North Pacific right whales were also recorded at multiple northern Bering Sea locations around St. Lawrence Island (2008-2015) during winter months (January-March) across years, although these calls were flagged as ambiguous with regard to species identification due to the presence of bowhead whale song (Wright 2015, 2017). Analysis of recorders from the middle Bering Sea (between the North Pacific right whale critical habitat and St. Matthew Island) is underway.~~

Results from passive acoustic monitoring from the eastern Bering shelf (2011-2015) indicated that North Pacific right whales occurred in two passes of the eastern Aleutian Islands (Umnak and Unimak Pass) and that North Pacific right whale calling occurred at consistently high levels in the southeastern Bering shelf (SEBS) during ice-free months (Wright 2017). No North Pacific right whale calls were detected from January to April in the southeastern Bering Sea, which coincides with persistent winter detections in the waters of the eastern Aleutian Islands, supporting the theory that North Pacific right whales migrate out of the SEBS during winter months (Wright 2017).

The probability of acoustically detecting right whales in the Bering Sea has been found to be strongly influenced by the abundance of the copepod *Calanus marshallae* (Baumgartner et al. 2013), and those authors propose that *C. marshallae* is the primary prey for right whales on the Bering Sea shelf. The seasonal development of these copepods into later life-history stages that can be exploited by right whales closely matches the peak timing of right whale call detections (Munger et al. 2008, Baumgartner et al. 2013). Additionally, right whale "gunshot" call detections increased shortly after peaks in copepod biovolume (Stafford et al. 2010). Baumgartner et al. (2013) suggest that the availability of *C. marshallae* on the middle shelf of the southeastern Bering Sea is the reason right whales aggregate there annually. Satellite-telemetry data from four whales tagged in 2008 and 2009 provide further indication of this area's importance as foraging habitat for Eastern North Pacific right whales (Zerbini et al. 2015). Right whales were not observed outside the localized area in the southeastern Bering Sea during surveys conducted for fishery management purposes that covered a broader area of Bristol Bay and the Bering Sea (Moore et al. 2000, 2002; see Fig. 1 in the Northeast Pacific fin whale Stock Assessment Report for locations of tracklines for these surveys).

In the summer of 2017, 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 17 right whales in the southeastern Bering Sea (IWC 2017). The majority of these sightings were in Bristol Bay east of the North Pacific right whale critical habitat, with others in the critical habitat. Through comparisons of photographs to those in the North Pacific Right Whale Photo-identification Catalogue (curated by MML), eight previously known individuals were identified, and another four were tentatively categorized as new animals (with the caveat that some whales in the existing catalogue are poorly photographed and therefore might represent duplicates).

There are 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, there was little survey effort in this region, notably in the offshore areas where right whales commonly occurred during whaling days (Ivashchenko and Clapham 2012). Waite et al. (2003) summarized sightings from the Platforms of Opportunity Program from 1959 to 1997. Additional lone animals were observed off Kodiak Island in the Barnabus Canyon area from NOAA surveys in August 2004, 2005, and 2006 (Wade et al. 2011b). A single right whale was reported in Pasagshak Bay, Kodiak, by a kayaker in May of 2010, and one was sighted in December 2011 by humpback whale researchers in Uganik Bay, Kodiak (A. Kennedy, NMFS-AFSC-MML, pers. comm., 7 October 2012). A single right whale was sighted south of the Alaska Peninsula (53.5°N, 156.5°W) during a seismic survey in July 2011 (Davis et al. 2011). On 17 July 2017, a tentatively new individual was observed and photographed by a sailboat charter at Kilokak Rocks (57 10.5°N, 156 18°W) in the Gulf of Alaska between Kodiak Island and the Alaska Peninsula (https://www.happywhale.com/browse?view=map&enc=20924https://www.happywhale.com/browse?view=map&enc=20924, accessed June 2018). Acoustic monitoring from May 2000 to July 2001 at seven sites in the Gulf of Alaska detected right whale calls at only two sites: one off eastern Kodiak and the other in deep water south of the Alaska Peninsula (detection distance in 10s of kilometers) (Mellinger et al. 2004). More recently, right whale up and gunshot calls were detected in Unimak Pass in May-September and December-February on recorders deployed in 2009-2015 (Wright 2017). Similarly, gunshot calls were detected at Umnak Pass in July-September on a recorder deployed in 2009 (Wright 2015). Additionally, right whale up-calls were detected on a recorder deployed near Quinn Seamount in the Gulf of Alaska on a few days each in June, July, August, and September 2013 (Širović et al. 2015).

A dedicated vessel survey for right whales was conducted by NMFS in August 2015 aboard the NOAA ship *Reuben Lasker*; the cruise used visual and acoustic survey techniques and followed tracklines on the shelf and in deeper waters to the south and east of Kodiak (Rone et al. 2017). Right whales were acoustically detected twice on the shelf in the Barnabus Trough area, but none were visually observed.

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 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 *Reuben Lasker* cruise in August 2015 adds to the concern that the Gulf of Alaska population may be extremely small.

There have been two sightings of single right whales in the waters of British Columbia. The first was observed off Haida Gwaii on 9 June 2013 and the second, a large adult, was seen in the Strait of Juan de Fuca on 25 October 2013; this second animal had an apparently healed major wound across the rostrum, which may have been caused by a previous entanglement in fishing gear (Ford et al. 2016). Two right whale calls were detected on a bottom-mounted hydrophone off the Washington Coast on 29 June 2013 (Širović et al. 2015). No right whale calls were detected in previous years at this site.

There were two photographically documented but unpublished observations of right whales made by the public off California in 2017: one off La Jolla and another in the Channel Islands. The animals concerned appeared to be different individuals, although good photos of the La Jolla whale are unavailable. The Channel Islands whale was well photographed and represents a new individual to the North Pacific Right Whale Photo-identification Catalogue.

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 stocks of North Pacific right whales are currently recognized: a Western North Pacific and an Eastern North Pacific stock (Rosenbaum et al. 2000, Brownell et al. 2001, LeDuc et al. 2012). The former is believed to feed primarily in the Sea of Okhotsk.

POPULATION SIZE

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). Based on sighting data, Wada (1973) estimated a total population of 100-200 right whales in the North Pacific. 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, confirmed sightings over the last 20 years, starting in 1996 (Goddard and Rugh 1998), have invalidated this view (Wade et al. 2006, Zerbini et al. 2015, Ford et al. 2016, IWC 2017). 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.

Biopsy samples of right whales encountered in the southeastern Bering Sea were taken in 1997 and 1999. Genetic analyses identified three individuals in 1997 and four individuals in 1999; of the animals identified, one was identified in both years, resulting in a total genetic count of six individuals (LeDuc et al. 2001). Genetic analyses of samples from all six whales sampled in 1999 determined that the animals were male (LeDuc et al. 2001). Two right whales were observed during a vessel-based survey in the central Bering Sea in July 1999 (Moore et al. 2000). Three biopsies were obtained by the IWC POWER cruise in the southeastern Bering Sea in the summer of 2017 (IWC 2017); one of these was from a previously unknown individual.

During the southeastern Bering Sea survey in 2002, there were seven sightings of right whales (LeDuc 2004). One of the sightings in 2002 included a right whale calf; this is the first confirmed sighting of a calf in decades (a possible calf or juvenile sighting was also reported in Goddard and Rugh 1998). This concentration also included two probable calves. In the southeastern Bering Sea during September 2004, multiple right whales were acoustically located and subsequently sighted by another survey vessel approaching the position of an individual located with a satellite tag (Wade et al. 2006). An analysis of photographs confirmed at least 17 individual whales (not including the tagged whales). Genetic analysis of biopsy samples identified 17 individuals: 10 males and 7 females. The discovery of seven females was significant, as only one female had been identified previously, and at least two calves were present.

The North Pacific Right Whale Photo-identification Catalogue currently contains a minimum of ~~30~~25 individual whales from the eastern North Pacific. From 2008 to ~~2013~~2017, ~~16~~25 ~~individual~~ right whales were photographically identified, some repeatedly (Clapham et al. 2013, Ford et al. 2016). Including individuals observed more than once, ~~T~~this ~~includes~~comprises 8 ~~individuals~~animals photographed in 2008 (all in the Bering Sea), 7 in 2009 (Bering Sea), ~~2~~3 in 2010 (1 in the Bering Sea, ~~1~~2 off Kodiak), 2 in 2011 (Bering Sea), 1 in 2012 (Gulf of Alaska), ~~and~~ 2 in 2013 (both off British Columbia), and 14 in 2017 (12 in the Bering Sea, 1 in Kodiak, 1 in the Channel Islands). These numbers include four individuals that were tracked with satellite-monitored radio tags in the Bering Sea in 2004, 2008, ~~or~~and 2009 (Zerbini et al. 2015).

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 estimates of 31 (95% CL: 23-54; CV = 0.22) and 28 (95% CL: 24-42), respectively (Wade et al. 2011a). 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 estimates. Wade et al. (2011a) also estimate the population consists of 8 females (95% CL: 7-18) and 20 males (95% CL: 17-37). Wade et al. (2011a) summarized the photo-identification and genetic-identification catalogues as follows: twenty-one individuals were identified from genotyping from the Aleutian Islands and Bering Sea from 1997 to 2004, comprising 15 males and 6 females. In aggregate, there were eight photo matches of individual whales across years involving five individuals. Wade et al. (2006) reported 17 individuals (including 7 females) identified from genotyping in 2004; that number was revised to 16 individuals (including 6 females) because a typographical error was subsequently discovered that masked a duplicate sample. There were four biopsies taken in 2008 and 2009 of two males and two females; three of these animals had been sampled in previous years. These samples were not included in the Wade et al. (2011a) abundance estimate.

Another seven individuals were observed in the summer of 2009, and one individual was seen in the summer of 2010 (Clapham et al. 2013). Four individuals were seen in the summer of 2011 (Berchok et al. 2011, 2015). The two sightings of right whales (one in June and one in October) in British Columbia waters in 2013 (noted above) were the first sightings of this species in this region in decades (Ford et al. 2016). Comparisons with the North Pacific Right Whale ~~p~~Photo-identification ~~c~~Catalogue ~~curated at the Marine Mammal Laboratory~~ showed that neither individual observed in British Columbia had been previously photographed elsewhere. Whether these two sightings indicate that right whales are returning to these coastal waters where they were once hunted is unclear.

As noted above, 12 individuals were photographed by the IWC POWER cruise in the Bering Sea in the summer of 2017; four were likely new to the catalogue.

LeDuc et al. (2012) analyzed 49 biopsy samples from right whales identified as being from 24 individuals, of which, all but one 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.

Detections of right whales have been very rare in the Gulf of Alaska, even though large numbers of whales were caught there in the 1800s and 1960s. With the exception of the Soviet catches, primarily in 1963-1964 (Ivashchenko and Clapham 2012), from the 1960s through 2013, only seven sightings of right whales were reported in the Gulf of Alaska. These included an opportunistic sighting in March 1979 near Yakutat Bay in the eastern Gulf of Alaska (Shelden et al. 2005); a sighting during an aerial survey for harbor porpoise in July 1998 south of Kodiak Island (Waite et al. 2003); four sightings of right whales from 2004 to 2006 in the Barnabus Trough region on Albatross Bank, south of Kodiak Island (Wade et al. 2011b); and a single sighting made during an International Whaling Commission (IWC) sighting survey in the Gulf of Alaska southeast of Kodiak Island at 56˚17.5'N 149˚10.7'E on 24 July 2012 (IWC, unpubl. data). A sighting survey conducted off Kodiak Island in the summer of 2015 made two acoustic (and no visual) detections of right whales (Rone et al. 2017).

The sightings of right whales in Barnabus Trough occurred at locations with the highest density of zooplankton, as measured by active-acoustic backscatter. Fecal hormone metabolite analysis from one whale estimated levels consistent with an immature male, indicating either recent reproduction in the Gulf of Alaska or movements between the Bering Sea and Gulf of Alaska. Photo-identification (of two whales) and genotyping (of one whale) failed to reveal a match to Bering Sea right whales. No matches were made of the single right whale observed by the IWC cruise in August 2012.

The only relativelymajority of recent detections of right whales in pelagic waters of the Gulf of Alaska came from passive acoustic recorders. These detections of calls are exceptionally rare (Mellinger et al. 2004, Širović et al. 2015). However, it is interesting to note the contrasting data from the southeastern Bering Sea, where similar instruments on the middle shelf (<100 m depth) detected right whale calls on more than 6 days per month in July-October (Munger et al. 2008), despite a population estimated to be only 31 whales (Wade et al. 2011a). The paucity of detections of right whales in pelagic waters of the Gulf of Alaska may still be partially due to a lack of survey and recording effort in those areas, but the lack of calls in passive-acoustic monitoring suggests that right whales are very rare in the pelagic areas monitored. More extensive coverage of shelf and nearshore waters of the Gulf of Alaska during previous ship and airplane surveys for cetaceans (summarized in Wade et al. 2011b) detected a single right whale near Kodiak Island (Waite et al. 2003), and there were two acoustic detections from the *Reuben Lasker* survey in August 2015 (Rone et al. 2017). Therefore, the Barnabus Trough/Albatross Bank area represents the only location in the Gulf of Alaska where right whales have been repeatedly detected in the last 4 decades, and those detections add only a minimum of two additional whales (from photo-identification in 2005 and 2006) to the total Eastern North Pacific population. However, with the exception of the August 2015 study off Kodiak Island, there has been virtually no survey coverage of the offshore waters in which right whales commonly occurred during historical and more recent (1960s) whaling periods (Townsend 1935, Ivashchenko and Clapham 2012).

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. 2011a). This estimate will be 10 years old in 2018 and the 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) recommend that N_{MIN} be considered "unknown" if the abundance estimate is more than 8 years old; however, given the extremely low abundance of this stock and the very low calf production, it seems unlikely that the current abundance is significantly different. The photo-identification catalogue used in the mark-recapture abundance estimate has a minimum of 20 unique individuals seen from 1998 to 2013, yet this number could be higher given that there are many animals with poor quality photos or poor coverage (one side only). The genetic-identification catalogue has a total of 23 individuals identified in the eastern North Pacific from 1997 to 2011 (LeDuc et al. 2012).

Current Population Trend

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 (Wade and Angliss 1997). However, given the small apparent size, male bias, and very low observed calving rate ofcalf 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 (Wade and Angliss 1997). A reliable estimate of ~~minimum abundance~~ N_{MIN} for this stock is 26 whales based on the mark-recapture estimate of 31 whales (CV = 0.226: Wade et al. 2011a). 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 PBR framework was not designed for populations that are at such a small fraction of their carrying capacity (Wade 1998). Because the Eastern North Pacific right whale population is far below historical levels and considered to include fewer than 30 mature females, the calculated value for PBR is likely biased.~~

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~in press); 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 in ~~2011-2015~~2012-2016; however, 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, ship strikes, or other anthropogenic causes (e.g., oil spills) is not a reflection of the true situation.

Fisheries Information

~~Detailed i~~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.

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, we assume that the potential exists for North Pacific right whales. Mortality and serious injury of humpback whales and fin whales in trawl gear, gray whales in gillnet gear, and bowhead whales in pot gear has been documented. While much of the 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~~, which was presumably from the Western North Pacific population,~~ 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. And in October 2016, an entangled right whale was reported to have died while being disentangled in Volcano Bay, Hokkaido, Japan. 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 ~~c~~Catalogue show potential 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 potential fishing gear entanglement (Ford et al. 2016). ~~Vessel collisions are considered the primary source of human-caused mortality and serious injury of right whales in the North Atlantic (Cole et al. 2005, Henry et al. 2012).~~ Given the very small estimate of abundance, any mortality or serious injury incidental to commercial fisheries would be considered significant. 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 (Waring et al. 2014).

Although ~~T~~there are no records of mortality or serious injury of Eastern North Pacific right whales in any U.S. fishery~~. 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 entanglement-related mortality or serious injury in this stock is not a reflection of the true situation.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska and Russia do not hunt animals from this stock.

Other Mortality

Ship strikes are ~~a significant source of mortality and serious injury for the North Atlantic stock of right whales~~considered the primary source of human-caused mortality and serious injury of right whales in the North Atlantic (Cole et al. 2005, Henry et al. 2012), and it is possible 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 impossible to assess the threat of ship strikes to the Eastern North Pacific stock of right whales. There is concern regarding the effects of increased shipping through Arctic waters and the Bering Sea with retreating sea ice, which 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 ship-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 total estimated 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) 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 wiped out 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), which is currently the most endangered stock of large whales in the world for which an abundance estimate is available. A genetic analysis of biopsy samples from North Pacific right whales found an apparent loss of genetic diversity, low frequencies of females and calves, extremely low effective population size, and possible 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).

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 ~~unknown~~not well known. There appear to be more males than females in the population and ~~the observed calving rate~~calf production is very low~~, so the calculated PBR level is likely biased~~. 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, ~~G~~given the small number of animals estimated to be in the population, any human-related mortality or serious injury from ship strikes or commercial fisheries is likely to have a serious population-level impact.

HABITAT CONCERNS

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 American 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. The high volume of large vessels transiting Unimak Pass (e.g., 1,961 making 4,615 transits in 2012: Nuka Research and Planning Group, LLC 2014a, 2014b), a subset of which continue north through the Bering Sea, increases both the risk of ship 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). ~~The U.S. Department of the Interior has designated areas within the southeastern Bering Sea, including areas designated as right whale critical habitat, as an outer continental shelf oil and gas lease area. This planning area, referred to as the North Aleutian Basin, was not included in the 2017-2022 national lease schedule by the Bureau of Ocean Energy Management, and there are no residual active leases from past sales. On 16 December 2014, President Obama announced that, under authority granted him by Section 12(a) of the Outer Continental Lands Act (OCSLA), he was withdrawing the North Aleutian Basin from future oil and gas leasing, development, or production "for a time period without specific expiration." In addition, a withdrawal of leasing and drilling for the Chukchi Sea and Bering Strait was announced in December 2016. Thus, oil and gas leasing in federal waters in these areas are not likely for the foreseeable future.~~ 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. The Bureau of Ocean Energy Management (BOEM) proposed an Outer Continental Shelf leasing plan for 2007-2012 that prioritized lease sales for the North Aleutian Basin in 2010 and 2012 (Aplin and Elliott 2007), but it was later withdrawn by Presidential Executive Order. Therefore, the North Aleutian Basin was not included in the 2017-2022 national lease schedule by BOEM, and there are no residual active leases from past sales. However, BOEM has announced plans to replace the 2017-2022 OCS plan (with a new 2019-2024 leasing plan) and to reconsider all current moratoria on offshore oil and gas exploration and extraction (82 FR 30886, 3 July 2017). 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. 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 planned (the next federal sale under the existing 2017-2022 leasing plan will occur in 2021 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 ship strikes.

CITATIONS

Aplin, D., and W. Elliott. 2007. Conservation concerns for cetaceans in the Bering Sea and adjacent waters: offshore oil development and other threats. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/59/E9). 14 p.

Baumgartner, M. F., N. Lysiak, H. Carter Esch, A. N. Zerbini, C. L. Berchok, and P. J. Clapham. 2013. Associations between North Pacific right whales and their zooplanktonic prey in the southeastern Bering Sea. Mar. Ecol. Prog. Ser. 490: 267-284.

Berchok, C. L., J. L. Crance, P. J. Stabeno, J. M. Napp, B. K. Rone, and A. H. Spear. 2011. CHAOZ (Chukchi Acoustic, Oceanographic, and Zooplankton) Study 2011 Cruise Report. Submitted to BOEM under Inter-Agency Agreement Number M09PG00016 (AKC 083). October 2011. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Berchok, C. L, J. L. Crance, E. C. Garland, J. A. Mocklin, P. J. Stabeno, J. M. Napp, B. K. Rone, A. H. Spear, M. Wang, and C. W. Clark. 2015. Chukchi Offshore monitoring In Drilling Area (COMIDA): ~~F~~factors affecting the distribution and relative abundance of endangered whales and other marine mammals in the Chukchi Sea. Final Report of the Chukchi Sea Acoustics, Oceanography, and Zooplankton Study, OCS Study BOEM 2015-034. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Berzin, A. A., and N. V. Doroshenko. 1982. Distribution and abundance of right whales in the North Pacific. Rep. Int. Whal. Comm. 32:381-383.

Braham, H. W., and D. W. Rice. 1984. The right whale, *Balaena glacialis*. Mar. Fish. Rev. 46(4):38-44.

Brownell, R. L., P. J. Clapham, T. Miyashita, and T. Kasuya. 2001. Conservation status of North Pacific right whales. J. Cetacean Res. Manage. (Special Issue 2):269-286.

Bureau of Ocean Energy Management (BOEM). 2016. Cook Inlet Planning Area Oil and Gas Lease Sale 244, in the Cook Inlet, Alaska - Final Environmental Impact Statement. Appendix A.

Clapham, P. J., C. Good, S. E. Quinn, R. R. Reeves, J. E. Scarff, and R. L. Brownell, Jr. 2004. Distribution of North Pacific right whales (*Eubalaena japonica*) as shown by 19th and 20th century whaling catch and sighting records. J. Cetacean Res. Manage. 6(1):1-6.

Clapham, P. J., K. E. W. Shelden, and P. R. Wade. 2006. Review of information relating to possible critical habitat for Eastern North Pacific right whales, p. 1-27. *In* P. J. Clapham, K. E. W. Shelden, and P. R. Wade (eds.), Habitat requirements and extinction risks of Eastern North Pacific right whales. AFSC Processed Report 2006-06. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Clapham, P. J., A. S. Kennedy, B. K. Rone, A. N. Zerbini, J. L. Crance, and C. L. Berchok. 2013. North Pacific right whales in the southeastern Bering Sea: Final Report. U.S. Dep. Commer., OCS Study BOEM 2012-074. 175 p. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Cole, T. V. N., D. L. Hartley, and R. M. Merrick. 2005. Mortality and serious injury determinations for large whale stocks along the eastern seaboard of the United States, 1999-2003. U.S. Dep. Commer., NEFSC Ref. Doc. 05-08, 20 p. Available from National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Davis, K., S. Milne, M. Wood, and C. Voigtlander. 2011. L-DEO Shillington Aleutian Cruise – *Langseth* PSO & PAM Weekly Summary Report 17 July 2011 - 23 July 2011. 13 p.

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

Doroshenko, N. V. 2000. Soviet whaling for blue, gray, bowhead and right whales in the North Pacific Ocean, 1961-1979, p. 96-103. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet Whaling Data (1949-1979). Center for Russian Environmental Policy, Marine Mammal Council, Moscow.

Ford, J. K. B., J. F. Pilkington, B. Gisborne, T. R. Frasier, R. M. Abernethy, and G. M. Ellis. 2016. Recent observations of critically endangered North Pacific right whales (*Eubalaena japonica*) off the west coast of Canada. Marine Biodiversity Records 9:50. DOI: dx.doi.org/10.1186/s41200-016-0036-3 .

Goddard, P. C., and D. J. Rugh. 1998. A group of right whales seen in the Bering Sea in July 1996. Mar. Mammal Sci. 14(2):344-349.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Henry, A. G., T. V. N. Cole, M. Garron, L. Hall, W. Ledwell, and A. Reid. 2012. Mortality and serious injury determinations for baleen whale stocks along the Gulf of Mexico, United States east coast and Atlantic Canadian provinces, 2006-2010. U.S. Dep. Commer., NEFSC Reference Document 12-11, 24 p. Available from National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Herman, L. M., C. S. Baker, P. H. Forestell, and R. C. Antinoja. 1980. Right whale, *Balaena glacialis,* sightings near Hawaii: a clue to the wintering grounds? Mar. Ecol. Prog. Ser. 2:271-275.

International Whaling Commission (IWC). 2001. Report of the workshop on the comprehensive assessment of right whales: a worldwide comparison. J. Cetacean Res. Manage. (Special Issue 2):1-60.

International Whaling Commission (IWC). 2017. Report of the planning meeting for the 2018 and 2019 IWC-POWER cruise in the North Pacific. Document SC/67b/Rep01. Available from International Whaling Commission, Cambridge, UK.

Ivashchenko, Y. V., and P. J. Clapham. 2012. Soviet catches of right whales *Eubalaena japonica* and bowhead whales *Balaena mysticetus* in the North Pacific Ocean and the Okhotsk Sea. Endang. Species Res. 18:201-217.

Ivashchenko, Y. V., R. L. Brownell, Jr., and P. J. Clapham. 2013. Soviet whaling in the North Pacific: revised catch totals. J. Cetacean Res. Manage. 13:59-71.
Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell, Jr. 2017. New data on Soviet catches of blue (*Balaenoptera musculus*) and right whales (*Eubalaena japonica*) in the North Pacific. J. Cetacean Res. Manage. 17:15-22.
Josephson, E., T. D. Smith, and R. R. Reeves. 2008a. Historical distribution of right whales in the North Pacific. Fish Fish. 9:155-168.
Josephson, E. A., T. D. Smith, and R. R. Reeves. 2008b. Depletion within a decade: the American 19th-century North Pacific right whale fishery, p. 133-147. *In* D. J. Starkey, P. Holm, and M. Barnard (eds.), Oceans Past: Management Insights from the History of Marine Animal Populations. Earthscan, London.
Kennedy, A. S., D. R. Salden, and P. J. Clapham. 2011. First high- to low-latitude match of an Eastern North Pacific right whale (*Eubalaena japonica*). Mar. Mammal Sci. 28(4):E539-E544. DOI: dx.doi.org/10.1111/j.1748-7692.2011.00539.x .
Kornev, S. I. 1994. A note on the death of a right whale (*Eubalaena glacialis*) off Cape Lopakta (Kamchatka). Rep. Int. Whal. Comm. (Special Issue 15):443-444.
LeDuc, R. 2004. Report of the results of the 2002 survey for North Pacific right whales. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-357, 58 p.
LeDuc, R. G., W. L. Perryman, J. W. Gilpatrick, Jr., J. Hyde, C. Stinchcomb, J. V. Carretta, and R. L. Brownell, Jr. 2001. A note on recent surveys for right whales in the southeastern Bering Sea. J. Cetacean Res. Manage. (Special Issue 2):287-289.
LeDuc, R. G., B. L. Taylor, K. Martien, K. M. Robertson, R. L. Pitman, J. C. Salinas, A. M. Burdin, A. S. Kennedy, P. R. Wade, P. J. Clapham, and R. L. Brownell, Jr. 2012. Genetic analysis of right whales in the eastern North Pacific confirms severe extinction risk. Endang. Species Res. 18:163-167.
Mellinger, D. K., K. M. Stafford, S. E. Moore, L. Munger, and C. G. Fox. 2004. Detection of North Pacific right whale (*Eubalaena japonica*) calls in the Gulf of Alaska. Mar. Mammal Sci. 20:872-879.
Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. C. Hobbs. 2000. Provisional estimates of mysticete whale abundance on the central Bering Sea shelf. J. Cetacean Res. Manage. 2(3):227-234.
Moore, S. E., J. M. Waite, N. A. Friday, and T. Honkalehto. 2002. Distribution and comparative estimates of cetacean abundance on the central and south-eastern Bering Sea shelf with observations on bathymetric and prey associations. Prog. Oceanogr. 55(1-2):249-262.
Munger, L. M., and J. A. Hildebrand. 2004. Final Report: Bering Sea right whales: acoustic recordings and public outreach. North Pacific Research Board Grant Report T-2100.
Munger, L. M., S. M. Wiggins, S. E. Moore, and J. A. Hildebrand. 2008. North Pacific right whale (*Eubalaena japonica*) seasonal and diel calling patterns from long-term acoustic recordings in the southeastern Bering Sea, 2000-2006. Mar. Mammal Sci. 24(4):795-814.
National Marine Fisheries Service (NMFS). 2006. Review of the status of the right whales in the North Atlantic and North Pacific Oceans. 68 p.
Nuka Research and Planning Group, LLC. 2014a. Aleutian Islands risk assessment project; recommending an optimal response system for the Aleutian Islands: summary report. 51 p.
Nuka Research and Planning Group, LLC. 2014b. Summary of large vessel transits of Unimak Pass in 2012. Aleutian Islands Risk Assessment Phase B.
Renner, M., and K. J. Kuletz. 2015. A spatial-seasonal analysis of the oiling risk from shipping traffic to seabirds in the Aleutian Archipelago. Mar. Pollut. Bull. 101(1):127-136.
Rice, D. W. 1974. Whales and whale research in the eastern North Pacific, p. 170-195. *In* W. E. Schevill (ed.), The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.
Rone, B. K., C. L. Berchok, J. L. Crance, and P. J. Clapham. 2012. Using air-deployed passive sonobuoys to detect and locate critically endangered North Pacific right whales. Mar. Mammal Sci. 28:E528-E538.
Rone, B. K., A. N. Zerbini, A. B. Douglas, D. W. Weller, and P. J. Clapham. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. Mar. Biol. 164:23. DOI: dx.doi.org/10.1007/s00227-016-3052-2 .
Rosenbaum, H. C., R. L. Brownell, M. W. Brown, C. Schaeff, V. Portway, B. N. White, S. Malik, L. A. Pastene, N. J. Patenaude, C. S. Baker, M. Goto, P. B. Best, P. J. Clapham, P. Hamilton, M. Moore, R. Payne, V. Rowntree, C. T. Tynan, J. L. Bannister, and R. DeSalle. 2000. World-wide genetic differentiation of *Eubalaena*: questioning the number of right whale species. Mol. Ecol. 9(11):1793-1802.
Rowntree, V., J. Darling, G. Silber, and M. Ferrari. 1980. Rare sighting of a right whale (*Eubalaena glacialis*) in Hawaii. Can. J. Zool. 58:308-312.

Salden, D. R., and J. Mickelsen. 1999. Rare sightings of a North Pacific right whale (*Eubalaena glacialis*) in Hawaii. Pac. Sci. 53:341-345.

Scarff, J. E. 1986. Historic and present distribution of the right whale (*Eubalaena glacialis*) in the eastern North Pacific south of 50°N and east of 180°W. Rep. Int. Whal. Comm. (Special Issue 10):43-63.

Scarff, J. E. 1991. Historic distribution and abundance of the right whale, *Eubalaena glacialis*, in the North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan from the Maury Whale Charts. Rep. Int. Whal. Comm. 41:467-487.

Shelden, K. E. W., S. E. Moore, J. M. Waite, P. R. Wade, and D. J. Rugh. 2005. Historic and current habitat use by North Pacific right whales *Eubalaena japonica* in the Bering Sea and Gulf of Alaska. Mammal Rev. 35:129-155.

Širović, A., S. C. Johnson, L. K. Roche, L. M. Varga, S. M. Wiggins, and J. A. Hildebrand. 2015. North Pacific right whales (*Eubalaena japonica*) recorded in the northeastern Pacific Ocean in 2013. Mar. Mammal Sci. 31(2):800-807. DOI: dx.doi.org/10.1111/mms.12189 .

Stafford, K. M., and D. K. Mellinger. 2009. Analysis of acoustic and oceanographic data from the Bering Sea, May 2006 – April 2007. North Pacific Research Board Final Report, NPRB Project No. 719. 24 p.

Stafford, K. M., S. E. Moore, P. J. Stabeno, D. V. Holliday, J. M. Napp, and D. K. Mellinger. 2010. Biophysical ocean observation in the southeastern Bering Sea. Geophys. Res. Lett. 37(2). DOI: dx.doi.org/10.1029/2009GL040724 .

Townsend, C. H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica NY 19:1-50.

Wada, S. 1973. The ninth memorandum on the stock assessment of whales in the North Pacific. Rep. Int. Whal. Comm. 23:164-169.

Wade, P. R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Mar. Mammal Sci. 14:1-37. DOI: dx.doi.org/10.1111/j.1748-7692.1998.tb00688.x .

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

Wade, P. R., M. P. Heide-Jørgensen, K. Shelden, J. Barlow, J. Carretta, J. Durban, R. LeDuc, L. Munger, S. Rankin, A. Sauter, and C. Stinchcomb. 2006. Acoustic detection and satellite tracking leads to discovery of rare concentration of endangered North Pacific right whales. Biol. Lett. 2:417-419.

Wade, P. R., A. Kennedy, R. LeDuc, J. Barlow, J. Carretta, K. Shelden, W. Perryman, R. Pitman, K. Robertson, B. Rone, J. C. Salinas, A. Zerbini, R. L. Brownell, Jr., and P. Clapham. 2011a. The world's smallest whale population. Biol. Lett. 7:83-85.

Wade, P. R., A. De Robertis, K. Hough, R. Booth, A. Kennedy, R. LeDuc, L. Munger, J. Napp, K. E. W. Shelden, S. Rankin, O. Vasquez, and C. Wilson. 2011b. Rare detections of North Pacific right whales in the Gulf of Alaska, with observations of their potential prey. Endang. Species Res. 13:99-109.

Waite, J. M., K. Wynne, and D. K. Mellinger. 2003. Documented sighting of a North Pacific right whale in the Gulf of Alaska and post-sighting acoustic monitoring. Northwest. Nat. 84:38-43.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel (eds.). 2014. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2013. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NE-228, 464 p.

Wolniakowski, K. U., J. Wright, G. Folley, and M. R. Franklin. 2011. Aleutian Islands Risk Assessment Project. Phase A Summary Report. 58 p.

Wright, D. L. 2015. Simultaneous identification of four mysticete species in the Bering Sea using passive acoustic monitoring increases confidence in acoustic identification of the critically endangered North Pacific right whale (*Eubalaena japonica*). Final Report, International Fund for Animal Welfare. 63 p. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Wright, D. L. 2017. Passive acoustic monitoring of the critically endangered Eastern North Pacific right whale (*Eubalaena japonica*). Final Report to Marine Mammal Commission, 4340 East-West Highway, Suite 700, Bethesda, MD 20814. 58 p.

Zerbini, A. N., M. F. Baumgartner, A. S. Kennedy, B. K. Rone, P. R. Wade, and P. J. Clapham. 2015. Space use patterns of the endangered North Pacific right whale (*Eubalaena japonica*) in the Bering Sea. Mar. Ecol. Prog. Ser. 532:269-281. DOI: dx.doi.org/10.3354/meps11366 .

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984, Moore and Reeves 1993). For management purposes, four stocks of bowhead whales have been recognized worldwide by the International Whaling Commission (IWC 2010). Small stocks, comprising only a few hundred individuals, occur in the Sea of Okhotsk and the offshore waters of Spitsbergen (Zeh et al. 1993, Shelden and Rugh 1995, Wiig et al. 2009, Shpak et al. 2014, Boertmann et al. 2015). Bowhead whales occur in western Greenland (Hudson Bay and Foxe Basin) and eastern Canada (Baffin Bay and Davis Strait), and evidence suggests that these should be considered one stock based on genetics (Postma et al. 2006, Bachmann et al. 2010, Heide-Jørgensen et al. 2010, Wiig et al. 2010), aerial surveys (Cosens et al. 2006), and tagging data (Dueck et al. 2006; Heide-Jørgensen et al. 2006; IWC 2010, 2011). This stock, previously thought to include only a few hundred animals, may number over a thousand (Heide-Jørgensen et al. 2006, Wiig et al. 2011), and perhaps over 6,000 (IWC 2008). The only stock found within U.S. waters is the Western Arctic stock (Fig~~s~~. 1~~ and 2~~), also known as the Bering-Chukchi-Beaufort stock (Rugh et al. 2003) or Bering Sea stock (Burns et al. 1993). Although Jorde et al. (2007) suggested there might be multiple stocks of bowhead whales in U.S. waters, several studies (George et al. 2007, Taylor et al. 2007, Rugh et al. 2009) and the IWC Scientific Committee concluded that data are most consistent with one stock that migrates throughout waters of northern and western Alaska and northeastern Russia (IWC 2008).

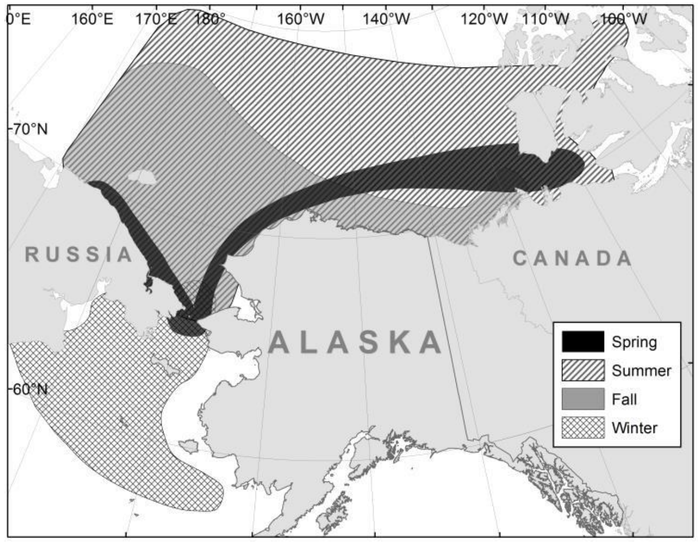

Figure 1. Annual range of the Western Arctic stock of bowhead whales by season from satellite tracking data, 2006-2017 (Quakenbush et al. 2018).

The majority of the Western Arctic stock migrates annually from wintering areas (December to March) in the northern Bering Sea, through the Chukchi Sea in the spring (April through May), to the eastern Beaufort Sea (Fig. 1) where they spend much of the summer (June through early to mid-October) before returning again to the Bering Sea (Fig. ~~2~~1) in the fall (September through December) to overwinter (Braham et al. 1980, Moore and Reeves 1993, Quakenbush et al. 2010a, Citta et al. 2015). ~~Some~~ Increasing numbers of bowhead whales are found in the western Beaufort~~,~~, and Chukchi~~, and Bering~~ seas in summer, and these are thought to be a part of the expanding Western Arctic stock (Rugh et al. 2003~~;~~, Citta et al. 2015, Clarke et al. ~~2013, 2014, 2015~~2017~~; Citta et al. 2015~~).

During winter and spring, bowhead whales are closely associated with sea ice (Moore and Reeves 1993, Quakenbush et al. 2010a, Citta et al. 2015). The bowhead whale spring migration follows fractures in the sea ice ~~around~~along the coast ~~of Alaska~~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. In most years, ~~D~~during summer, most of the population is in relatively ice-free waters of Amundsen Gulf in the ~~southeastern~~eastern Canadian Beaufort Sea (Citta et al. 2015), an area often exposed to industrial activity related to petroleum exploration (e.g., Richardson et al. 1987, Davies 1997). Summer aerial surveys conducted in the western Beaufort Sea during July and August of 2012-~~2014~~2017 have had relatively high sighting rates of bowhead whales, including cows with calves and feeding animals (Clarke et al. ~~2013, 2014, 2015~~2018, Clarke et al. in press). During the autumn migration through the Beaufort Sea, bowhead whales generally select shelf waters (Citta et al. 2015). During the autumn migration across the Chukchi Sea, bowhead whales generally select cold, saline waters that are mostly of Bering Sea origin (Citta et al. 2017). In winter in the Bering Sea, bowhead whales often use areas with ~100% sea-ice cover, even when polynyas are available (Quakenbush et al. 2010a, Citta et al. 2015).

Evidence suggests that Western Arctic bowhead whales feed on concentrations of zooplankton throughout their range. Likely or confirmed feeding areas include Amundsen Gulf and the eastern Canadian Beaufort Sea; the central and western U.S. Beaufort Sea; Wrangel Island; and the coast of Chukotka, between Wrangel Island and the Bering Strait (Lowry et al. 2004; Ashjian et al. 2010; Clarke and Ferguson 2010~~a~~; Quakenbush et al. 2010a, 2010b; Okkonen et al. 2011; Clarke et al. ~~2012, 2013, 2014, 2015~~2017; Citta et al. 2015, 2017). Bowhead whales have also been observed feeding during the summer in the northeastern Chukchi Sea (~~Clarke and Ferguson 2010b~~Clarke et al. 2016). In winter, dive behavior suggests that bowhead whales are feeding in the Bering Sea shelf waters, from Being Strait, south through Anadyr Strait, and near the entrance of the Gulf of Anadyr (Citta et al. 2012, 2015)

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 10,400-23,000 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 (9,190-13,950; 5th and 95th percentiles, respectively) in 1848 at the start of commercial whaling.

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

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

Because the IWC requires a population estimate at least every 10 years in order to determine a strike limit for aboriginal subsistence hunting, systematic counts of bowhead whales have been conducted since 1978 (Krogman et al. 1989; Table 1). These include ice-based visual and acoustic counts. 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), whales missed when no watch was in effect (through interpolations from sampled periods), and whales missed during a watch (estimated as a function of visibility, number of observers, and distance offshore: Zeh et al. 1993, Givens et al. 2016). These 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.

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~~2). These population estimates and their associated error ranges are comparable to the estimates obtained from the combined ice-based visual and acoustic counts (Raftery and Zeh 1998, Schweder et al. 2009, Koski et al. 2010). An aerial photographic survey was conducted near Point Barrow concurrently with the ice-based spring census in 2011; ~~these data are currently being analyzed to produce~~which, in addition to ~~a revised~~an abundance estimate based on sight-resight data, also provided a revised survival estimate for the population (~~Mocklin et al. 2012, Vate Brattström et al. 2016~~Givens et al. 2017).

Table 2. Summary of abundance estimates for the Western Arctic stock of bowhead whales from aerial sight-resight surveys. Estimates are reported in da Silva et al. 2000, 2007 (1986 estimate), Koski et al. 2010 (2004 estimate), and Givens et al. 2017 (2011 estimate). LB = lower bound.

Year	Abundance range	Survival estimate (LB)
1986	4,719 - 7,331	0.985 (0.958)
2004	7,900 - 19,700	
2011	12,403 - 28,486	0.996 (0.976)

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated from Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 2011 population estimate (N) from the ice-based survey of 16,820 and its associated coefficient of variation CV(N) of 0.052 (Table 1), N_{MIN} for the Western Arctic stock of bowhead whales is 16,100 whales.

Current Population Trend

Based on concurrent passive acoustic and ice-based visual surveys, Givens et al. (2013) reported that the Western Arctic stock of bowhead whales increased at a rate of 3.7% (95% CI = 2.9-4.6%) from 1978 to 2011, during which time abundance tripled from approximately 5,000 to approximately 16,820 whales (Givens et al. 2016) (Fig. ~~3~~2). Schweder et al. (2009) estimated the yearly growth rate to be 3.2% (95% CI = 0.5-4.8%) between 1984 and 2003 using a sight-resight analysis of aerial photographs.

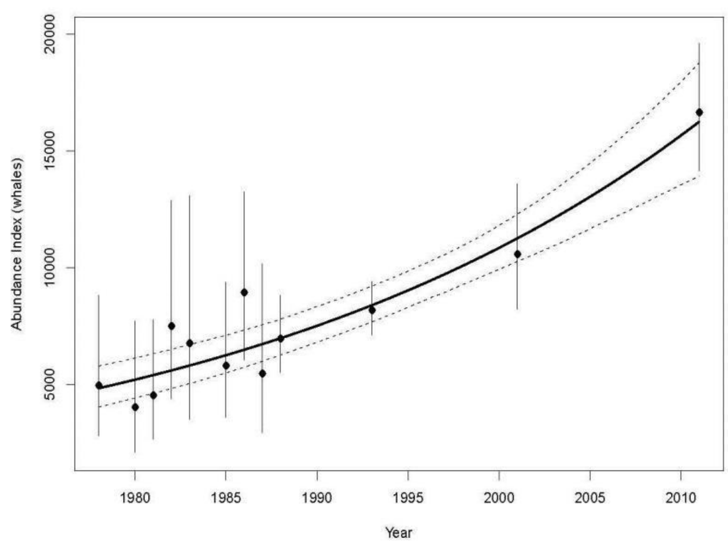

Figure 2. Abundance estimates for the Western Arctic stock of bowhead whales, 1978-2011 (Givens et al. 2013), as computed from ice-based counts, acoustic data, and aerial ~~transect~~photo-ID data collected during bowhead whale spring migrations past Point Barrow, Alaska.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The current estimate for the rate of increase for this stock of bowhead whales (3.2-3.7%) should not be used as an estimate of the maximum net productivity rate (R_{MAX}) because the population is currently being harvested. It is recommended that the cetacean maximum theoretical net productivity rate ~~(R_{MAX})~~ of 4% be used for the Western Arctic stock of bowhead whales (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock has been set at 0.5 rather than the default value of 0.1 for endangered species because population levels are increasing in the presence of a known take (see Wade and Angliss 1997, p. 27-28). Thus, PBR = 161 whales (16,100 × 0.02 × 0.5). The calculation of a PBR level for the Western Arctic bowhead whale stock is required by the MMPA even though the subsistence harvest quota is established under the authority of the IWC based on an extensively tested strike limit algorithm (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. For 2013-2018, the IWC established a block quota of 306 landed bowhead whales. Because some whales are struck and lost, the IWC set a strike limit of 67 (plus up to 15 previously unused strikes) ~~is permitted each~~per year. In recent years, an arrangement 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. ~~This quota includes an allowance of five animals per year to be taken by~~Under this arrangement, the Chukotka Natives in Russia may use no more than seven strikes, and the Alaska Eskimos may use no more than 75 strikes. The 2013-2018 quota maintains the *status quo* of the previous 5-year block quota (2008-2012) but was extended for 6 years.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~Detailed i~~Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in ~~2011-2015~~2012-2016 is listed, by marine mammal stock, in Helker et al. (~~2017~~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 Western Arctic bowhead whales in ~~2011-2015~~2012-2016 is ~~43~~46 whales: 0.2 in U.S. commercial fisheries and ~~43~~46 landed in subsistence takes by Natives of Alaska, Russia, and Canada. 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 commercial shipping in the Chukchi and Beaufort seas).

Fisheries Information

~~Detailed i~~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.

While there are no observer program records of bowhead whale mortality or serious injury incidental to U.S. commercial fisheries in Alaska, 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. Several cases of line or net entanglement have been reported from whales taken in the subsistence hunt (Philo et al. 1993). George et al. (2017) examined records for 904 bowhead whales harvested between 1990 and 2012. Of these, 521 records were examined for at least one of the three types of scars indicating injuries from line entanglement wounds (515 records), attacks by killer whales (378 records), and ship strikes (and/or propeller injuries) (505 records). Their best estimate of the occurrence of entanglement scars was ~12.1% (59/486; an additional 29 records with possible entanglement scars were excluded from the analysis) with the cause most likely from fishing/crab pot gear in the Bering Sea. Most entanglement injuries occurred on the peduncle and were rarely observed on smaller subadult and juvenile whales (<10 m).

~~While there are no observer program records of bowhead whale mortality incidental to U.S. commercial fisheries in Alaska, 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. Indeed, some bowhead whales have had interactions with crab pot gear and fishing nets. Twelve percent of harvested bowhead whales showed entanglement scars from commercial fishing gear (George et al. 2017).~~ One dead whale was found floating in Kotzebue Sound in early July 2010, entangled in crab pot gear similar to that used by commercial crabbers in the Bering Sea (Suydam et al. 2011), and one entangled bowhead whale was photographed during the 2011 spring aerial photographic survey of bowhead whales near Point Barrow (Mocklin et al. 2012), but it was not considered to be seriously injured. In July 2015, a dead adult female bowhead whale ~~(2015-FD2)~~ drifting near Saint Lawrence Island in the Bering Strait was found entangled in fishing gear (Suydam et al. 2016). The gear included lines, two floats, and an attached color coded/numbered permit tag for the 2012/2013 winter commercial blue king crab fishery located in Saint Matthew Island waters of the northern Bering Sea (Sheffield and Savoonga Whaling Captains Association 2015). The minimum estimated average annual mortality and serious injury rate in U.S. commercial fisheries in ~~2011-2015~~2012-2016 is 0.2 bowhead whales (Table ~~2~~3; Helker et al. ~~2017~~in press); however, the actual rate is currently unknown. This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and ~~should be~~

~~considered~~is a minimum because not all entangled animals are found, reported, or have the cause of death determined.

Table ~~2~~3. Summary of mortality and serious injury of Western Arctic bowhead whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network in ~~2011-2015~~2012-2016 (Helker et al. ~~2017~~in press). Only cases of mortality and serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	~~2011~~	2012	2013	2014	2015	2016	Mean annual mortality
Entangled in Bering Sea/Aleutian Is. commercial blue king crab pot gear	~~0~~	0	0	0	1	0	0.2
Total in commercial fisheries							0.2

Alaska Native Subsistence/Harvest Information

Eskimos 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 population per annum (Philo et al. 1993, Suydam et al. 2011). Under this quota, the total number of bowhead whales landed by Alaska Natives between 1974 and ~~2015~~2016 ranged from 8 to 55 whales (Suydam and George 2012; Suydam et al. 2012, 2013, 2014, 2015, 2017; George and Suydam 2014). The maximum number of strikes per year is set by a quota which is determined by subsistence needs and bowhead whale abundance and trend estimates (Stoker and Krupnik 1993). 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 ~~38 whales in 2011 (Suydam et al. 2012),~~ 55 whales in 2012 (Suydam et al. 2013), 46 in 2013 (George and Suydam 2014, Suydam et al. 2014), 38 in 2014 (Suydam et al. 2015), ~~and~~ 39 in 2015 (Suydam et al. 2016), and 47 in 2016 (Suydam et al. 2017). The number of whales landed at each village varies greatly from year to year, as success is influenced by village size and ice and weather conditions. The efficiency of the hunt (the percent of whales struck that are retrieved) has increased since the implementation of the bowhead whale quota in 1978. In 1978, the efficiency was about 50%. In ~~2015~~2016, ~~39 of 49~~47 of 59 whales struck were landed, resulting in an efficiency of 80% (Suydam et al. ~~2016~~2017). Suydam et al. (~~2016~~2017) reported that the ~~current~~ mean efficiency~~,~~ from 2006 through 2015~~,~~ ~~is~~was ~~75.3~~75%.

Canadian and Russian Natives also take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996. No catches for Western Arctic bowhead whales were reported by either Canadian or Russian hunters for 2006-2007 (IWC 2008, 2009) or by Russia in 2009, 2011, 2012, 2014, or 2015 (IWC 2011; Ilyashenko 2013; Ilyashenko and Zharikov 2015, 2016), but two bowhead whales were taken in Russia in 2008 (IWC 2010), two in 2010 (IWC 2012), ~~and~~ one in 2013 (Ilyashenko and Zharikov 2014), and two in 2016 (Ilyashenko and Zharikov 2017). The average annual subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from ~~2011~~2012 through ~~2015~~2016 is ~~43~~46 landed bowhead whales.

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. During 1848-1919, 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 animals (Woodby and Botkin 1993). An unknown percentage of the animals taken by the shore-based operations were harvested for subsistence and not commercial 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 animals.

Transient killer whales are the only known predators of 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 378 complete records for killer whale scars collected from 1990 to 2012, 30 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 during 2002-2012 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. ~~At least 2 of ~11 bowhead whale carcasses observed during t~~The Aerial Surveys of Arctic Marine Mammals (ASAMM) project ~~in 2015 had clear evidence of killer whale predation (rake marks, missing jaw/tongue)~~ photo-documented bowhead whale carcasses having injuries consistent with killer whale predation in two carcasses per year in 2012, 2013, and 2015; three carcasses in 2016; and one carcass in 2017 (~~Suydam et al. 2016~~ Willoughby et al. 2018).

With increasing ship traffic and oil and gas exploration and development activities in the Chukchi and Beaufort seas, bowhead whales may become increasingly at risk from ship strikes. Currently, ship-strike injuries appear to be uncommon on bowhead whales in Alaska (George et al. 2017). Only 10 whales harvested between 1990 and 2012 (~2% of the total sample) showed clear evidence of scarring from ship propeller injuries.

STATUS OF STOCK

Based on currently available data, the minimum estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries (0.2 whales) is not known to exceed 10% of the PBR (10% of PBR = 16) and, therefore, can be considered ~~to be~~ insignificant and approaching a zero mortality and serious injury rate. The total annual level of human-caused mortality and serious injury (~~43~~46 whales) is not known to exceed the PBR (161) nor the IWC annual maximum strike limit (67 + up to 15 previously unused strikes). The Western Arctic bowhead whale stock has been increasing; the estimate of 16,820 whales from 2011 is between 31% and 168% of the pre-exploitation abundance of 10,000 to 55,000 whales estimated by Brandon and Wade (2004, 2006). However, the stock is classified as a strategic stock because the bowhead whale is listed as endangered under the U.S. Endangered Species Act and is therefore also designated as depleted under the MMPA.

There are key uncertainties in the assessment of the Western Arctic stock of bowhead whales. Although there are few records of bowhead whales being killed or seriously injured incidental to commercial fishing, about 12% of harvested bowhead whales examined for scarring (59/486 records) had scars indicating line entanglement wounds (George et al. 2017) and the southern range of the population does overlap with commercial pot fisheries (Citta et al. 2014). The stock may be particularly sensitive to anthropogenic sound; under some circumstances, the stock changes either distribution or calling behavior in response to levels of anthropogenic sounds that are slightly above ambient (Blackwell et al. 2015). The reduction in sea ice may lead to increased predation of bowhead whales by killer whales.

HABITAT CONCERNS

Vessel traffic in arctic waters is increasing, largely due to an increase in commercial shipping. This increase in vessel traffic could result in an increased number of vessel collisions with bowhead whales (Huntington et al. 2015).

~~Increasing o~~Oil and gas development in the Arctic ~~has led to an increased~~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. Also of concern is noise produced by seismic surveys and vessel traffic resulting from shipping and offshore energy exploration, development, and production operations. Evidence indicates that bowhead whales are sensitive to noise from offshore drilling platforms and seismic survey operations (Richardson and Malme 1993, Richardson 1995, Davies 1997). Bowhead whales often avoid sound sources associated with active drilling (Schick and Urban 2000) and seismic operations (Miller et al. 1999). Studies in the 1980s indicated that bowhead whales reacting to seismic activity in feeding areas appeared to recover from behavioral changes within 30-60 minutes following the end of the activity (Richardson et al. 1986, Ljungblad et al. 1988). However, monitoring studies of 3-D seismic exploration in the nearshore Beaufort Sea during 1996-1998 demonstrated that nearly all fall-migrating bowhead whales avoided an area within 20 km of an active seismic source (Richardson et al. 1999). Furthermore, the studies also suggested that the bowhead whales' offshore displacement may have begun roughly 35 km (19 nautical miles or 22 statute miles) east of the activity and may have persisted more than 30 km to the west (Richardson et al. 1999). Richardson et al. (1986) observed that some feeding bowhead whales started to turn away from a 30-airgun array with a source level of 248 dB re 1 μPa at a distance of 7.5 km (4.7 mi) and swam away when the vessel was within about 2 km (1.2 mi); other whales in the area continued feeding until the seismic vessel was within 3 km (1.9 mi). Further studies have shown that feeding bowhead whales had a greater tolerance of higher sound levels than did migrating whales (Miller et al. 2005, Harris et al. 2007). Data from an aerial monitoring program in the Alaska Beaufort Sea during 2006-2008 also indicated that bowhead whales feeding during late summer and autumn did not exhibit large-scale distribution changes in relation to seismic operations (Funk et al. 2010). Persistent feeding behavior in the presence of seismic survey noise does not necessarily mean that the feeding bowhead whales are unaffected by the noise. Feeding bowhead whales may be sufficiently motivated to continue feeding in a given area despite noise-induced stress or physiological effects (MMS 2008). A study by Blackwell et al. (2015) found that bowhead whales react differently to different thresholds of seismic noise. At relatively low cumulative exposure levels (as soon as airguns were just detectable), bowhead whales almost doubled their call rates. Once cumulative exposure levels exceeded 127 dB re 1 μPa^2-s, call rates decreased. Bowhead whales went completely silent at received levels over 160 dB re 1 μPa^2-s. These authors note that the existence of two behavioral thresholds for calling by bowhead whales can explain results of previous studies that found variability in bowhead whale call rates in the presence or absence of airgun pulses (i.e., Greene et al. 1998).

Climate change is resulting in warming of northern latitudes at about twice the rate of more temperate latitudes, increasing the immediacy of this threat for bowhead whales and other arctic species. Global climate model projections for the next 50-100 years consistently show pronounced warming over the Arctic, accelerated sea-ice loss, and continued permafrost degradation (IPCC 2007, USGS 2011, 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. Laidre et al. (2008) concluded that on a worldwide basis, bowhead whales were likely to be moderately sensitive to climate change, based on an analysis of various life-history features that could be affected by climate. Currently, there are insufficient data to make reliable projections of the effects of arctic climate change on bowhead whales. George et al. (2006) showed that landed bowhead whales had better body condition during years of light ice cover. Similarly, George et al. (2015) found an overall improvement in bowhead whale body condition and a positive correlation between body condition and summer sea-ice loss over the last 2.5 decades in the Pacific Arctic. George et al. (2015) speculated that sea-ice loss has positive effects on secondary trophic production in the short term within the Western Arctic bowhead whales' summer feeding region.

Another 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 bowhead whale survival and recruitment because their primary prey are small crustaceans, especially calanoid copepods, euphausiids, gammarid and hyperid amphipods, and mysids (Lowry et al. 2004), that have exoskeletons comprised of chitin and calcium carbonate which will be weakened by ocean acidification. Other species of invertebrates and fishes are also consumed (Sheffield and George 2013). Sheffield and George (2013) presented evidence that the occurrence of fish in the diets of Western Arctic bowhead whales near Utqiaġvik in the autumn may be increasing. 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.

CITATIONS

Ashjian, C. J., S. R. Braund, R. G. Campbell, J. C. George, J. Kruse, W. Maslowski, S. E. Moore, C. R. Nicolson, S. R. Okkonen, B. F. Sherr, E. B. Sherr, and Y. H. Spitz. 2010. Climate variability, oceanography, bowhead whale distribution, and Iñupiat subsistence whaling near Barrow, Alaska. Arctic 63(2):179-194.

Bachmann, L., Ø. Wiig, M. P. Heide-Jørgensen, K. L. Laidre, L. D. Postma, L. Dueck, and P. J. Palsbøl. 2010. Genetic diversity in Eastern Canadian and Western Greenland bowhead whales (*Balaena mysticetus*). Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG26). 6 p.

Blackwell S. B., C. S. Nations, T. L. McDonald, A. M. Thode, D. Mathias, K. H. Kim, C. R. Greene, Jr., and A. M. Macrander. 2015. Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds. PLOoS ONE 10(6):e0125720. DOI: dx.doi.org/10.1371/journal.pone.0125720 .

Braham, H. W. 1984. The bowhead whale, *Balaena mysticetus*. Mar. Fish. Rev. 46(4):45-53.

Braham, H. W., M. A. Fraker, and B. D. Krogman. 1980. Spring migration of the Western Arctic population of bowhead whales. Mar. Fish. Rev. 42(9-10):36-46.

Bockstoce, J. R., and J. J. Burns. 1993. Commercial whaling in the North Pacific sector, p. 563-577. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Bockstoce, J. R., D. B. Botkin, A. Philp, B. W. Collins, and J. C. George. 2007. The geographic distribution of bowhead whales (*Balaena mysticetus*) in the Bering, Chukchi, and Beaufort seas: evidence from whaleship records, 1849-1914. Mar. Fish. Rev. 67(3):1-43.

Boertmann, D., L. A. Kyhn, L. Witting, and M. P. Heide-Jorgensen. 2015. A hidden getaway for bowhead whales in the Greenland Sea. Polar Biol. 38(8):1315-1319. DOI: dx.doi.org/10.1007/s00300-015-1695-y .

Brandon, J., and P. R. Wade. 2004. Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/56/BRG20). 32 p.

Brandon, J., and P. R. Wade. 2006. Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales using Bayesian model averaging. J. Cetacean Res. Manage. 8(3):225-239.

Burns, J. J., J. J. Montague, and C. J. Cowles (eds.). 1993. The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2. 787 p.

Chapman, W. L., and J. E. Walsh. 2007. Simulations of arctic temperature and pressure by global coupled models. J. Climate 20:609-632.

Citta, J. J., J. J. Burns, L. T. Quakenbush, V. Vanek, J. C. George, R. J. Small, M. P. Heide-Jørgensen, and H. Brower. 2014. Potential for bowhead whale entanglement in cod and crab pot gear in the Bering Sea. Mar. Mammal Sci. 30(2):445-459. DOI: dx.doi.org/10.1111/mms.12047 .

Citta, J. J., L. T. Quakenbush, S. R. Okkonen, M. L. Druckenmiller, W. Maslowski, J. Clement-Kinney, J. C. George, H. Brower, R. J. Small, C. J. Ashjian, L. A. Harwood, and M. P. Heide-Jørgensen. 2015. Ecological characteristics of core-use areas used by Bering-Chukchi-Beaufort (BCB) bowhead whales, 2006-2012. Prog. Oceanogr. 136:201-222.

Citta, J. J., S. R. Okkonen, L. T. Quakenbush, W. Maslowski, R. Osinski, J. C. George, R. J. Small, H. Brower, Jr., M. P. Heide-Jørgensen, and L. A. Harwood. 2017. Oceanographic characteristics associated with autumn movements of bowhead whales in the Chukchi Sea. Deep Sea Research II. DOI: dx.doi.org/10.1016/j.dsr2.2017.03.009 .

Clark, C. W., S. Mitchell, and R. Charif. 1994. Distribution and behavior of the bowhead whale, *Balaena mysticetus*, based on preliminary analysis of acoustic data collected during the 1993 spring migration off Point Barrow, Alaska. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/46/AS19). 24 p.

Clarke, J. T., and M. C. Ferguson. 2010~~a~~. Aerial surveys for bowhead whales in the Alaskan Beaufort Sea: BWASP update 2000-2009 with comparisons to historical data. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG14). 11 p.

~~Clarke, J. T., and M. C. Ferguson. 2010b. Aerial surveys of large whales in the northeastern Chukchi Sea, 2008-2009, with review of 1982-1991 data. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG13). 18 p.~~

~~Clarke, J. T., C. L. Christman, A. A. Brower, and M. C. Ferguson. 2012. Distribution and relative abundance of marine mammals in the Alaskan Chukchi and Beaufort seas, 2011. Annual Report, OCS Study BOEM 2012-009. Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

~~Clarke, J. T., C. L. Christman, A. A. Brower, and M. C. Ferguson. 2013. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2012. Annual Report, OCS Study BOEM 2013-00117. Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

Clarke, J., K. Stafford, S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26(4):136-149. DOI: dx.doi.org/10.5670/oceanog.2013.81 .

~~Clarke, J. T., A. A. Brower, C. L. Christman, and M. C. Ferguson. 2014. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2013. Annual Report, OCS Study BOEM 2014-018. Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

~~Clarke, J. T., A. A. Brower, M. C. Ferguson, A. S. Kennedy, and A. L. Willoughby. 2015. Distribution and relative abundance of marine mammals in the eastern Chukchi and western Beaufort seas, 2014. Annual Report, OCS Study BOEM 2015-040. Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

Clarke, J. T., A. S. Kennedy, and M. C. Ferguson. 2016. Bowhead and gray whale distributions, sighting rates, and habitat associations in the eastern Chukchi Sea, summer and fall 2009-15, with a retrospective comparison to 1982-91. Arctic 69(4):359-377.

Clarke, J. T., A. A. Brower, M. C. Ferguson, and A. L. Willoughby. 2017. Distribution and relative abundance of marine mammals in the eastern Chukchi and western Beaufort seas, 2016. Annual Report, OCS Study BOEM 2017-078. Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Clarke, J. T., M. C. Ferguson, A. A. Brower, and A. L. Willoughby. 2018. Bowhead whale calves in the western Beaufort Sea, 2012-2017. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/67b/AWMP3). 11 p.

Clarke, J. T., M. C. Ferguson, A. L. Willoughby, and A. A. Brower. In press. Bowhead whale and beluga distributions, sighting rates, and habitat associations in the western Beaufort Sea, summer and fall 2009-2016, with a retrospective comparison to 1982-91. Arctic.

Cosens, S. E., H. Cleator, and P. Richard. 2006. Numbers of bowhead whales (*Balaena mysticetus*) in the eastern Canadian Arctic, based on aerial surveys in August 2002, 2003 and 2004. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/BRG7). 19 p.

da Silva, C. Q., J. Zeh, D. Madigan, J. Laake, D. Rugh, L. Baraff, W. Koski, and G. Miller. 2000. Capture-recapture estimation of bowhead whale population size using photo-identification data. J. Cetacean Res. Manage. 2(1):45-61.

da Silva, C. Q., P. V. S. Gomes, and M. A. Stradioto. 2007. Bayesian estimation of survival and capture probabilities using logit link and photoidentification data. Comput. Stat. Data Anal. 51:6521-6534

Davies, J. R. 1997. The impact of an offshore drilling platform on the fall migration path of bowhead whales: a GIS-based assessment. Unpubl. MS Thesis, Western Washington University, Bellingham, WA. 51 p.

Dueck, L. P., M. P. Heide-Jørgensen, M. V. Jensen, and L. D. Postma. 2006. Update on investigations of bowhead whale (*Balaena mysticetus*) movements in the eastern Arctic, 2003-2005, based on satellite-linked telemetry. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/BRG5). 17 p.

Funk, D. W., R. Rodrigues, D. S. Ireland, and W. R. Koski. 2010. Summary and assessment of potential effects on marine mammals, Chapter 11. *In* D. W. Funk, D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.), Joint monitoring program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL, Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc., and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 506 p. + appendices.

George, J. C., and R. S. Suydam. 2014. Update on characteristics of bowhead whale (*Balaena mysticetus*) calves. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG20Rev). 7 p.

George, J. C., L. Philo, K. Hazard, D. Withrow, G. Carroll, and R. Suydam. 1994. Frequency of killer whale (*Orcinus orca*) attacks and ship collisions based on scarring on bowhead whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort Seas stock. Arctic 47(3):247-55.

George, J. C., J. Zeh, R. Suydam, and C. Clark. 2004. Abundance and population trend (1978-2001) of Western Arctic bowhead whales surveyed near Barrow, Alaska. Mar. Mammal Sci. 20:755-773.

George, J. C., C. Nicolson, S. Drobot, J. Maslanik, and R. Suydam. 2006. Sea ice density and bowhead whale body condition preliminary findings. Poster presented to the Society for Marine Mammalogy, San Diego, CA.

George, J. C., S. E. Moore, and R. Suydam. 2007. Summary of stock structure research on the Bering-Chukchi-Beaufort Seas stock of bowhead whales 2003-2007. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/59/BRG3). 15 p.

George, J. C., M. L. Druckenmiller, K. L. Laidre, R. Suydam, and B. Person. 2015. Bowhead whale body condition and links to summer sea ice and upwelling in the Beaufort Sea. Prog. Oceanogr. 136:250-262.

George, J. C., G. Sheffield, D. J. Reed, B. Tudor, R. Stimmelmayr, B. T. Person, T. Sformo, and R. Suydam. 2017. Frequency of injuries from line entanglements, killer whales, and ship strikes on Bering-Chukchi-Beaufort Sea bowhead whales. Arctic 70(1):37-46. DOI: dx.doi.org/10.14430/arctic4631 .

Givens, G. H., S. L. Edmondson, J. C. George, R. Suydam, R. A. Charif, A. Rahaman, D. Hawthorne, B. Tudor, R. A. DeLong, and C. W. Clark. 2013. Estimate of 2011 abundance of the Bering-Chukchi-Beaufort Seas bowhead whale population. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65a/BRG1). 30 p.

Givens, G. H., S. L. Edmondson, J. C. George, R. Suydam, R. A. Charif, A. Rahaman, D. Hawthorne, B. Tudor, R. A. DeLong, and C. W. Clark. 2016. Horvitz-Thompson whale abundance estimation adjusting for uncertain recapture, temporal availability variation, and intermittent effort. Environmetrics 27:134-146. DOI: dx.doi.org/10.1002/env.2379 .

Givens, G. H., J. A. Mocklin, L. Vate Brattström, B. J. Tudor, W. R. Koski, J. C. George, J. E. Zeh, and R. Suydam. 2017. Survival rate and 2011 abundance of Bering-Chukchi-Beaufort seas bowhead whales from photo-identification data over three decades. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/67a/AWMP09). 23 p.

Greene, C. R., Jr., W. J. Richardson, and N. S. Altman. 1998. Bowhead whale call detection rates versus distance from airguns operating in the Alaskan Beaufort Sea during fall migration, 1996. J. Acoust. Soc. Am. 104:1826. DOI: dx.doi.org/10.1121/1.423473 .

Harris, R. E., T. Elliot, and R. A. Davis. 2007. Results of mitigation and monitoring program, Beaufort Span 2-D marine seismic program, open water season 2006. LGL, Ltd., LGL Report TA4319-1, Report from LGL, Ltd., King City, Ont., for GX Technol., Houston, TX. 48 p.

Heide-Jørgensen, M. P., K. L. Laidre, M. V. Jensen, L. Dueck, and L. D. Postma. 2006. Dissolving stock discreteness with satellite tracking: bowhead whales in Baffin Bay. Mar. Mammal Sci. 22:34-45.

Heide-Jørgensen, M. P., K. L. Laidre, Ø. Wiig, and L. Dueck. 2010. Large scale sexual segregation of bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG23). 13 p.

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

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Huntington, H. P., R. Daniel, A. Hartsig, K. Harun, M. Heiman, R. Meehan, G. Noongwook, L. Pearson, M. Prior-Parks, M. Robards, and G. Stetson. 2015. Vessels, risks, and rules: planning for safe shipping in Bering Strait. Marine Policy 51:119-127.

Ilyashenko, V. U. 2013. Aboriginal harvest of gray and bowhead whales in the Russian federation in 2008 – 2012. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65a/BRG24). 2 p.

Ilyashenko, V., and K. Zharikov. 2014. Aboriginal harvest of gray and bowhead whales in the Russian federation in 2013. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG3). 1 p.

Ilyashenko, V., and K. Zharikov. 2015. Aboriginal subsistence whaling in the Russian federation in 2014. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66a/BRG07). 5 p.

Ilyashenko, V., and K. Zharikov. 2016. Aboriginal subsistence whaling in the Russian federation in 2015. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66b/BRG22). 1 p.

Ilyashenko, V., and K. Zharikov. 2017. Aboriginal subsistence whaling in the Russian federation in 2016. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/67a/AWMP03). 2 p.

Intergovernmental Panel on Climate Change (IPCC). 2007. Summary for policymakers. *In* S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller (eds.), Climate Change 2007: The ~~p~~Physical ~~s~~Science ~~b~~Basis~~ summary for policymakers~~. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. ~~United Nations, Geneva, Switzerland~~Cambridge University Press, Cambridge, UK and New York, NY. Available online: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf . Accessed ~~December 2017~~June 2018.

International Whaling Commission (IWC). 2003. Report of the fourth workshop on the development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). J. Cetacean Res. Manage. 5(Suppl.):489-497.

International Whaling Commission (IWC). 2008. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 10(Suppl.):150-166.

International Whaling Commission (IWC). 2009. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 11(Suppl.):169-192.

International Whaling Commission (IWC). 2010. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 11(Suppl. 2):154-179.

International Whaling Commission (IWC). 2011. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 12(Suppl.):168-184.

International Whaling Commission (IWC). 2012. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 13(Suppl.):154-174.

Jeffries, M. O., J. Richter-Menge, and J. E. Overland (eds.). 2015. Arctic report card 2015. Available online: http://www.arctic.noaa.gov/reportcard . Accessed ~~December 2017~~June 2018.

Jorde, P. E., T. Schweder, J. W. Bickham, G. H. Givens, R. Suydam, D. Hunter, and N. C. Stenseth. 2007. Detecting genetic structure in migrating bowhead whales off the coast of Barrow, Alaska. Mol. Ecol. 16:1993-2004.

Koski, W., J. Zeh, J. Mocklin, A. R. Davis, D. J. Rugh, J. C. George, and R. Suydam. 2010. Abundance of Bering-Chukchi-Beaufort bowhead whales (*Balaena mysticetus*) in 2004 estimated from photo-identification data. J. Cetacean Res. Manage. 11(2):89-99.

Krogman, B., D. Rugh, R. Sonntag, J. Zeh, and D. Ko. 1989. Ice-based census of bowhead whales migrating past Point Barrow, Alaska, 1978-1983. Mar. Mammal Sci. 5:116-138.

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

Ljungblad, D. K., B. Würsig, S. L. Swartz, and J. M. Keene. 1988. Observations on the behavioral responses of bowhead whales (*Balaena mysticetus*) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic 41(3):183-194.

Lowry, L. F., G. Sheffield, and J. C. George. 2004. Bowhead whale feeding in the Alaskan Beaufort Sea, based on stomach contents analyses. J. Cetacean Res. Manage. 6(3):215-223.

Marquette, W. M., and J. R. Bockstoce. 1980. Historical shore-based catch of bowhead whales in the Bering, Chukchi, and Beaufort seas. Mar. Fish. Rev. 42(9-10):5-19.

Miller, G. W., R. E. Elliott, W. R. Koski, V. D. Moulton, and W. J. Richardson. 1999. Whales, p. 5-1 to 5-109. *In* W. J. Richardson (ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Report TA2230–3. Report from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and National Marine Fisheries Service, Anchorage, AK, and Silver Spring, MD. 390 p.

Miller, G. W., V. D. Moulton, R. A. Davis, M. Holst, P. Millman, A. MacGillivray, and D. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001-2002, p. 511-542. *In* S. L. Armsworthy, P. J. Cranford, and K. Lee (eds.), Offshore Oil and Gas Development Effects Monitoring/Approaches and Technologies. Battelle Press, Columbus, OH.

Minerals Management Service (MMS). 2008. Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas Lease Sales 209, 212, 217, and 221, Draft Environmental Impact Statement: U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, MMS 2008-055, November. Available online: http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/2008-055-vol2.pdf . Accessed ~~December 2017~~June 2018.

Mocklin, J., J. C. George, M. Ferguson, L. Vate Brattström, V. Beaver, B. Rone, C. Christman, A. Brower, B. Shea, and C. Accardo. 2012. Aerial photography of bowhead whales near Barrow, Alaska, during the 2011 spring migration. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/64/BRG3). 9 p.

Moore, S. E., and R. R. Reeves. 1993. Distribution and movement, p. 313-386. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Okkonen, S. R., C. J. Ashjian, R. G. Campbell, J. Clarke, S. E. Moore, and K. D. Taylor. 2011. Satellite observations of circulation features associated with the Barrow area bowhead whale feeding hotspot. Remote Sens. Environ. 115:2168-2174.

Philo, L. M., E. B. Shotts, and J. C. George. 1993. Morbidity and mortality, p. 275-312. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Postma, L. D., L. P. Dueck, M. P. Heide-Jørgensen, and S. E. Cosens. 2006. Molecular genetic support of a single population of bowhead whales (*Balaena mysticetus*) in Eastern Canadian Arctic and Western Greenland waters. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/BRG4). 15 p.

Quakenbush, L. T., R. J. Small, and J. J. Citta. 2010a. Satellite tracking of Western Arctic bowhead whales. Unpubl. report submitted to the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE 2010-033).

Quakenbush, L. T., J. J. Citta, J. C. George, R. J. Small, and M. P. Heide-Jørgensen. 2010b. Fall and winter movements of bowhead whales (*Balaena mysticetus*) in the Chukchi Sea and within a potential petroleum development area. Arctic 63(3):289-307.

Quakenbush, L., J. Citta, J. C. George, M. P. Heide-Jørgensen, H. Brower, L. Harwood, B. Adams, C. Pokiak, J. Pokiak, and E. Lea. 2018. Bering-Chukchi-Beaufort stock of bowhead whales: 2006-2017 satellite telemetry results with some observations on stock sub-structure. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/67B/AWMP/04). 25 p.

Raftery, A., and J. Zeh. 1998. Estimating bowhead whale population size and rate of increase from the 1993 census. J. Am. Stat. Assoc. 93:451-463.

Richardson, W. J. 1995. Documented disturbance reactions, p. 241-324. *In* W. J. Richardson, C. R. Greene, C. I. Malme, and D. H. Thomson (eds.), Marine Mammals and Noise. Academic Press, San Diego, CA.

Richardson, W. J., and C. I. Malme. 1993. Man-made noise and behavioral responses, p. 631-700. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Richardson, W. J., B. Würsig, and C. R. Greene, Jr. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. J. Acoust. Soc. Am. 79(4):1117-1128.

Richardson, W. J., R. A. Davis, C. R. Evans, D. K. Ljungblad, and P. Norton. 1987. Summer distribution of bowhead whales, *Balaena mysticetus*, relative to oil industry activities in the Canadian Beaufort Sea, 1980-84. Arctic 40(2):93-104.

Richardson, W. J., G. W. Miller, and C. R. Greene, Jr. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. J. Acoust. Soc. Am. 106(4, Pt. 2):2281.

Ross, W. G. 1993. Commercial whaling in the North Atlantic sector, p. 511-561. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Rugh, D., D. DeMaster, A. Rooney, J. Breiwick, K. Shelden, and S. Moore. 2003. A review of bowhead whale (*Balaena mysticetus*) stock identity. J. Cetacean Res. Manage. 5(3):267-279.

Rugh, D., W. Koski, J. George, and J. Zeh. 2009. Inter-year re-identification of bowhead whales during their spring migration past Barrow, Alaska, 1984-1994. J. Cetacean Res. Manage. 10(3):195-200.

Schick, R. S., and D. L. Urban. 2000. Spatial components of bowhead whale (*Balaena mysticetus*) distribution in the Alaskan Beaufort Sea. Can. J. Fish. Aquat. Sci. 57:2193-2200.

Schweder, T., D. Sadykova, D. Rugh, and W. Koski. 2009. Population estimates from aerial photographic surveys of naturally and variably marked bowhead whales. J. Agric. Biol. Environ. Stat. 15(1):1-19.

Sheffield, G., and J. C. George. 2013. Section V – North Slope Borough research: B - diet studies, p. 253-277. *In* K. E. W. Shelden and J. A. Mocklin (eds.), Bowhead Whale Feeding Ecology Study (BOWFEST) in the western Beaufort Sea. Final Report, OCS Study BOEM 2013-0114. Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Sheffield, G., and Savoonga Whaling Captains Association. 2015. Bowhead whale entangled in commercial crab pot gear recovered near Saint Lawrence Island, Bering Strait. UAF Alaska Sea Grant, Marine Advisory Program, Report to the North Slope Borough Department of Wildlife Management, Barrow, AK. 8 p.

Shelden, K. E. W., and D. J. Rugh. 1995. The bowhead whale (*Balaena mysticetus*): status review. Mar. Fish. Rev. 57(3-4):1-20.

Shpak, O. V., I. G. Meschersky, A. N. Chichkina, D. M. Kuznetsova, A. Y. Paramonov, and V. V. Rozhnov. 2014. New data on the Okhotsk Sea bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG17). 5 p.

Stoker, S. W., and I. I. Krupnik. 1993. Subsistence whaling, p. 579-629. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Suydam, R., and J. C. George. 2012. Preliminary analysis of subsistence harvest data concerning bowhead whales (*Balaena mysticetus*) taken by Alaskan Natives, 1974 to 2011. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/64/AWMP8). 13 p.

Suydam, R., J. C. George, B. Person, C. Hanns, and G. Sheffield. 2011. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2010. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/63/BRG2). 7 p.

Suydam, R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2012. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2011. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/64/BRG2). 8 p.

Suydam R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2013. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2012. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65a/BRG19). 7 p.

Suydam, R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2014. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2013. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG8). 10 p.

Suydam, R., J. C. George, B. Person, D. Ramey, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2015. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2014. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66a/BRG6). 9 p.

Suydam, R., J. C. George, B. Person, D. Ramey, R. Stimmelmayr, T. Sformo, L. Pierce, and G. Sheffield. 2016. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2015 and other aspects of bowhead biology and science. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66b/BRG3). 10 p.

Suydam, R., J. C. George, B. Person, D. Ramey, R. Stimmelmayr, T. Sformo, L. Pierce, and G. Sheffield. 2017. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2016. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/67a/AWMP02rev). 8 p.

Taylor, B., R. LeDuc, J. C. George, R. Suydam, S. Moore, and D. Rugh. 2007. Synthesis of lines of evidence for population structure for bowhead whales in the Bering-Chukchi-Beaufort region. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/59/BRG35). 12 p.

U.S. Geological Survey (USGS). 2011. An evaluation of the science needs to inform decisions on Outer Continental Shelf energy development in the Chukchi and Beaufort seas. L. Holland-Bartels and B. Pierce (eds.), Alaska: U.S. Geological Survey Circular 1370. 278 p.

~~Vate Brattström, L., J. Mocklin, B. Tudor, J. C. George, and G. H. Givens. 2016. Update on the bowhead whale aerial photoID program and 2011 aerial spring survey. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66b/BRG4). 11 p.~~

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

Walsh, J. E. 2008. Climate of the arctic marine environment. Ecol. Appl. 18(2)Suppl.:S3-S22. DOI: dx.doi.org/10.1890/06-0503.1 .

Wiig, Ø., L. Bachmann, N. Øien, K. M. Kovacs, and C. Lydersen. 2009. Observations of bowhead whales (*Balaena mysticetus*) in the Svalbard area 1940-2008. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/61/BRG2). 5 p.

Wiig, Ø., L. Bachmann, M. P. Heide-Jørgensen, K. L. Laidre, L. D. Postma, L. Dueck, and P. J. Palsbøl. 2010. Within and between stock re-identification of bowhead whales in Eastern Canada and West Greenland. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG25). 7 p.

Wiig, Ø., M. P. Heide-Jørgensen, C. Lindqvist, K. L. Laidre, P. J. Palsbøll, and L. Bachmann. 2011. Population estimates of mark and recaptured genotyped bowhead whales (*Balaena mysticetus*) in Disko Bay, West Greenland. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/63/BRG18). 4 p.

Willoughby, A. L., J. T. Clarke, M. C. Ferguson, R. Stimmelmayr, and A. B. Brower. 2018. Bowhead whale carcasses in the eastern Chukchi and western Beaufort seas, 2009-2017. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/67b/AWMP2). 10 p.

Woodby, D. A., and D. B. Botkin. 1993. Stock sizes prior to commercial whaling, p. 387-407. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

Zeh, J. E., and A. E. Punt. 2004. Updated 1978-2001 abundance estimates and their correlations for the Bering-Chukchi-Beaufort Seas stock of bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/56/BRG1). 10 p.

Zeh, J. E., C. W. Clark, J. C. George, D. E. Withrow, G. M. Carroll, and W. R. Koski. 1993. Current population size and dynamics, p. 409-489. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Appendix 1. Summary of substantial changes to the text and/or values in the ~~2017~~2018 stock assessments (last revised ~~12/30/2017~~8/10/2018). An 'X' indicates sections where the information presented has been updated since the ~~2016~~2017 stock assessments were released. Stock Assessment Reports for those stocks in boldface were updated in ~~2017~~2018.

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

Appendix 2. Stock summary table (last revised ~~12/30/2017~~8/10/2018). Stock Assessment Reports for those stocks in boldface were updated in ~~2017~~2018. 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 for details).

Species	Stock	N_{EST}	CV	N_{MIN}	Year of last survey	R_{MAX}	F_R	PBR	Annual U.S. commercial fishery mortality/serious injury	Annual Native subsistence mortality	Total annual mortality/ serious injury	Strategic status
Steller sea lion	**Western U.S.**	**~~53,303[a]~~ 54,267[a]**		**~~53,303~~ 54,267**	**~~2016~~2017**	**0.12**	**0.1**	**~~320~~326**	**~~31~~40**	**~~204~~203**	**~~241~~252**	**S**
Steller sea lion	Eastern U.S.	41,638[a]		41,638	2015	0.12	1.0	2,498	14	11	108	NS
Northern fur seal	**Eastern Pacific**	**~~637,561~~ 620,660**	**0.2**	**~~539,638~~ 525,333**	**~~2015~~2016**	**0.086**	**0.5**	**~~11,602~~ 11,295**	**~~3.2~~2.4**	**~~425~~447**	**~~436~~457**	**S**
Harbor seal	Aleutian Islands	6,431		5,772	2011	0.12	0.5	173	0	90	90	NS
Harbor seal	Pribilof Islands	232		232	2010	0.12	0.5	7	0	0	0	NS
Harbor seal	Bristol Bay	32,350		28,146	2011	0.12	0.7	1,182	0.6	141	142	NS
Harbor seal	North Kodiak	8,321		7,096	2011	0.12	0.7	298	0	37	37	NS
Harbor seal	South Kodiak	19,199		17,479	2011	0.12	0.3	314	1.9	126	128	NS
Harbor seal	Prince William Sound	29,889		27,936	2011	0.12	0.5	838	24	255	279	NS
Harbor seal	Cook Inlet/Shelikof Strait	27,386		25,651	2011	0.12	0.5	770	0.4	233	234	NS
Harbor seal	Glacier Bay/Icy Strait	7,210		5,647	2011	0.12	0.5	169	0	104	104	NS
Harbor seal	Lynn Canal/Stephens Passage	9,478		8,605	2011	0.12	0.3	155	0	50	50	NS
Harbor seal	Sitka/Chatham Strait	14,855		13,212	2011	0.12	0.7	555	0	77	77	NS
Harbor seal	Dixon/Cape Decision	18,105		16,727	2011	0.12	0.7	703	0	69	69	NS
Harbor seal	Clarence Strait	31,634		29,093	2011	0.12	0.7	1,222	0	40	41	NS
Spotted seal	Alaska	461,625		423,237	2013	0.12	0.5	12,697	0.9	328	329	NS
Bearded seal	**Alaska**	[b]		[b]	**2013**	**0.12**	**0.5**	[b]	**~~1.4~~1.6**	**~~390~~555**	**~~391~~557**	**~~NS~~S**
Ringed seal	Alaska	[b]		[b]	2013	0.12	0.5	[b]	3.9	1,050	1,054	NS

AR024554

Species	Stock	N_{EST}	CV	N_{MIN}	Year of last survey	R_{MAX}	F_R	PBR	Annual U.S. commercial fishery mortality/serious injury	Annual Native subsistence mortality	Total annual mortality/ serious injury	Strategic status
Ribbon seal	**Alaska**	**184,000**		**163,086**	**2013**	**0.12**	**1.0**	**9,785**	**~~0.6~~1.1**	**~~3.2~~2.8**	**~~3.8~~3.9**	**NS**
Beluga whale	Beaufort Sea	39,258	0.229	N/A	1992	0.04	1.0	UNDET	0	139	139	NS
Beluga whale	Eastern Chukchi Sea	20,752	0.70	12,194	2012	0.04	1.0	244	0.2	67	67	NS
Beluga whale	Eastern Bering Sea	6,994	0.37	N/A	2000	0.04	1.0	UNDET	0.2	206	206	NS
Beluga whale	Bristol Bay	1,926	0.25	N/A	2005	0.048	1.0	UNDET	0.2	25	25	NS
Beluga whale	**Cook Inlet**	**~~312~~327**	**~~0.10~~ 0.06**	**~~287~~311**	**~~2014~~2016**	**0.04**	**0.1**	[b]	**0**	**0**	**0**	**S**
Narwhal	Unidentified	N/A		N/A		0.04	0.5	N/A	0	0	0	NS
Killer whale	Eastern North Pacific Alaska Resident	2,347[c]	N/A	2,347	2012	0.04	0.5	24	1	0	1	NS
Killer whale	Eastern North Pacific Northern Resident (British Columbia)	261[c]	N/A	261	2011	0.03	0.5	1.96	0	0	0	NS
Killer whale	Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient	587[c]	N/A	587	2012	0.04	0.5	5.9	1	0	1	NS
Killer whale	**AT1 Transient**	**7[c]**	**N/A**	**7**	**~~2016~~2017**	**0.04**	**0.1**	**0.01**	**0**	**0**	**0**	**S**
Killer whale	West Coast Transient	243[c]	N/A	243	2009	0.04	0.5	2.4	0	0	0	NS
Pacific white-sided dolphin	**North Pacific**	**26,880**	**N/A**	**N/A**	**1990**	**0.04**	**0.5**	**UNDET**	**0**	**0**	**0**	**NS**
Harbor porpoise	**Southeast Alaska**	[b]	[b]	[b]	**2012**	**0.04**	**0.5**	[b]	**34**	**0**	**34**	**S**
Harbor porpoise	**Gulf of Alaska**	**31,046**	**0.214**	**N/A**	**1998**	**0.04**	**0.5**	**UNDET**	**72**	**0**	**72**	**S**
Harbor porpoise	**Bering Sea**	**48,215**	**0.223**	**N/A**	**1999**	**0.04**	**0.5**	**UNDET**	**0.2**	**0**	**0.4**	**S**
Dall's porpoise	**Alaska**	**83,400**	**0.097**	**N/A**	**~~1993~~1991**	**0.04**	**1.0**	**UNDET**	**38**	**0**	**38**	**NS**
Sperm whale	**North Pacific**	**~~N/A~~** [b]	[b]	**~~N/A~~** [b]	**2015**	**0.04**	**0.1**	**~~N/A~~** [b]	**~~3.7~~4.4**	**0**	**~~3.7~~4.4**	**S**
Baird's beaked whale	Alaska	N/A		N/A		0.04	0.5	N/A	0	0	0	NS
Cuvier's beaked whale	Alaska	N/A		N/A		0.04	0.5	N/A	0	0	0	NS
Stejneger's beaked whale	Alaska	N/A		N/A		0.04	0.5	N/A	0	0	0	NS
Humpback whale	**Western North Pacific**	**1,107**	**0.300**	**865**	**2006**	**0.07**	**0.1**	**3.0**	**0.8**	**0**	**~~3.2~~3**	**S**
Humpback whale	**Central North Pacific - entire stock**	**10,103**	**0.300**	**~~7,890~~7,891**	**2006**	**0.07**	**0.3**	**83**	**~~8.5~~9.9**	**0**	**~~25~~26**	**S**
Fin whale	**Northeast Pacific**	[b]	[b]	[b]	**2013**	**0.04**	**0.1**	[b]	**0.2**	**0**	**~~0.4~~0.6**	**S**
Minke whale	**Alaska**	**N/A**		**N/A**		**0.04**	**0.5**	**N/A**	**0**	**0**	**0**	**NS**
North Pacific right whale	**Eastern North Pacific**	**31**	**0.226**	**26**	**2015**	**0.04**	**0.1**	[b]	**0**	**0**	**0**	**S**
Bowhead whale	**Western Arctic**	**16,820**	**0.052**	**16,100**	**2011**	**0.04**	**0.5**	**161**	**0.2**	**~~43~~46**	**~~43~~46**	**S**

N_{EST} = the AFSC Marine Mammal Laboratory's best estimate of the size of the population.
Strategic status: S = Strategic, NS = Not Strategic.

[a]N_{EST} is the best estimate of pup and non-pup counts, which have not been corrected to account for animals at sea during abundance surveys.
[b]N_{EST}, N_{MIN}, and PBR have been calculated for this stock; however, important caveats exist. See Stock Assessment Report text for details.
[c]N_{EST} is based on counts of individual animals identified from photo-identification catalogues. Surveys for abundance estimates of these stocks are conducted infrequently.

Appendix 3. Summary table for Alaska **Category 2** commercial fisheries (last updated ~~12/30/2016~~8/10/2018). Notice of continuing effect of list of fisheries.

Fishery (area, target species, and gear type)	Mngmt	Active Permits/Vessels[~~1~~a]	Soak time	Landings per day	Sets per day	Season duration	Fishery trends (2012-2016)
AK Southeast salmon drift gillnet	State	~~451~~422	20 min - 3 hrs; day/night	1	6 - 20	June 18 to Early Oct	# vessels stable but may vary with price of salmon; catch - high
AK Yakutat salmon set gillnet	State	~~149~~112	continuous soak during opener; day/night	1	net picked every 2 - 4 hrs/day or continuous during peak	June 4 to mid-Oct	# sites fished stable; catch - variable
AK Prince William Sound salmon drift gillnet	State	~~529~~520	15 min - 3 hrs; day/night	1 or 2	10 - 14	mid-May to end of Sept	# vessels stable; catch - stable
AK Cook Inlet salmon drift gillnet	State	~~548~~493	15 min - 3 hrs or continuous; day only	1	6 - 18	June 25 to end of Aug	# vessels stable; catch - variable
AK Cook Inlet salmon set gillnet	State	~~717~~531	continuous soak during opener, but net dry with low tide; upper CI - day/night lower CI - day only except during fishery extensions	1	upper CI - picked on slack tide lower CI - picked every 2 - 6 hrs/day	June 2 to mid-Sept	# sites fished stable; catch - up for sockeye and kings, down for pinks
AK Kodiak salmon set gillnet	State	~~182~~154	continuous during opener; day only	1 or 2	picked 2 or more times	June 9 to end of Sept	# sites fished stable; catch - variable
AK Peninsula/Aleutian Islands salmon drift gillnet	State	~~150~~142	2 -5 hrs; day/night	1	3 - 8	mid-June to mid-Sept	# vessels stable; catch up
AK Peninsula/Aleutian Islands salmon set gillnet	State	~~108~~89	continuous during opener; day/night	1	every 2 hrs	June 18 to mid-Aug	# sites fished stable; catch - up since 90; down in 96
AK Bristol Bay salmon drift gillnet	State	~~1,811~~1,548	continuous soaking of part of net while other parts picked; day/night	2	continuous	June 17 to end of Aug or mid-Sept	# vessels stable; catch - variable
AK Bristol Bay salmon set gillnet	State	~~941~~885	continuous during opener, but net dry during low tide; day/night	1	2 or continuous	June 17 to end of Aug or mid-Sept	# sites fished stable; catch - variable
AK Bering Sea, Aleutian Islands flatfish trawl	Federal	31	near continuous, 3-4 hours; day/night	NA	~ 4 per day	Jan 20 to end of Dec	# of vessels stable, catch variable
AK Bering Sea, Aleutian Islands pollock trawl	Federal	~~100~~118	near continuous, 3-4 hours; day/night	NA	~ 3 per day	Jan 20 to Nov 1	# of vessels stable, catch variable
AK Bering Sea, Aleutian Islands rockfish trawl	Federal	18	near continuous, 2-3 hours; day/night	NA	~ 3 per day	Jan 20 to end of Dec	# of vessels stable, catch variable
AK Bering Sea, Aleutian Islands Pacific cod longline	Federal	34	near continuous, 1-hours; day/night	1	~ 3 per day	Year-round	# of vessels stable, catch variable

[~~1~~a]For state-managed fisheries, this is the number of active permits in ~~2016~~2017. For federally-managed fisheries, this is the number of active vessels participating in the fishery in 2015.

~~CITATIONS~~REFERENCES

~~Alaska Commercial Fisheries Entry Commission (CFEC). 2016. Fishery Permits & Permit Holders, Permit Status. Available online: https://www.cfec.state.ak.us/pstatus/14052016.htm. Accessed 7/28/2016.~~

National Marine Fisheries Service. 2016a. List of Fisheries. Final Rule. U.S. Dep. Commer., NOAA 81 FR 20550. 25 p.

Appendix 4. Interaction table for Alaska **Category 2** commercial fisheries (last revised ~~12/30/2016~~8/10/2018). Notice of continuing effect of list of fisheries.

Fishery Name (area, target species, and gear type)	Mngmt	Active Permits/Vessels[~~1~~a]	Observer data[~~2~~b]	Species recorded as taken incidentally in this fishery (records dating back to 1988)	Data type
AK Southeast salmon drift gillnet	State	~~451~~422	2012 - 2013	Steller sea lion, harbor seal, harbor porpoise, Dall's porpoise, Pacific white-sided dolphin, humpback whale, sea otter	logbook, observer, stranding data, self-reports
AK Yakutat salmon set gillnet	State	~~149~~112	2007 - 2008	harbor seal, harbor porpoise (obs), humpback whale, gray whale (stranding)	logbook, observer, stranding
AK Prince William Sound salmon drift gillnet	State	~~529~~520	1990 - 1991	Steller sea lion (obs), northern fur seal, harbor seal (obs), harbor porpoise (obs), Dall's porpoise, Pacific white-sided dolphin, sea otter	logbook, observer, stranding
AK Cook Inlet salmon drift gillnet	State	~~548~~493	1999 - 2000	Steller sea lion, harbor seal, harbor porpoise, Dall's porpoise, Cook Inlet beluga whale (Note: observer program in 1999 and 2000 recorded one incidental mortality/serious injury of a harbor porpoise)	observer, logbook
AK Cook Inlet salmon set gillnet	State	~~717~~531	1999 - 2000	harbor seal, harbor porpoise, Dall's porpoise, Cook Inlet beluga whale, humpback whale, Steller sea lion, sea otter (Note: observer program in 1999 and 2000 recorded one incidental mortality/serious injury of a harbor porpoise)	observer, logbook
AK Kodiak salmon set gillnet	State	~~182~~154	2002, 2005	harbor seal, harbor porpoise, sea otter, Steller sea lion	observer, logbook
AK Peninsula/Aleutian Islands salmon drift gillnet	State	~~150~~142	1990-1991	northern fur seal, harbor seal, harbor porpoise, Dall's porpoise (obs)	observer, logbook
AK Peninsula/Aleutian Islands salmon set gillnet	State	~~108~~89	never observed	Steller sea lion, harbor porpoise, northern sea otter	logbook
AK Bristol Bay salmon drift gillnet	State	~~1,811~~1,548	never observed	Steller sea lion, northern fur seal, harbor seal, spotted seal, Pacific white-sided dolphin, beluga whale, gray whale	logbook
AK Bristol Bay salmon set gillnet	State	~~941~~885	never observed	northern fur seal, harbor seal, spotted seal, beluga whale, gray whale	logbook
AK Bering Sea, Aleutian Islands flatfish trawl	Federal	31	1976 - 2015	bearded seal, harbor porpoise (Bering Sea), harbor seal (Bering Sea), killer whale (Alaska Resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient), northern fur seal, spotted seal, ringed seal, ribbon seal, gray whale, Steller sea lion (Western U.S.), walrus, humpback whale	observer
AK Bering Sea, Aleutian Islands pollock trawl	Federal	~~100~~118	1976 - 2015	Dall's porpoise, harbor seal, humpback whale (Central North Pacific), humpback whale (Western North Pacific), fin whale, killer whale (GOA, Aleutian Islands, and Bering Sea Transient), minke whale, ribbon seal, spotted seal, ringed seal, bearded seal, northern fur seal, Steller sea lion (Western U.S.), beluga whale	observer
AK Bering Sea, Aleutian Islands rockfish trawl	Federal	18	1976 - 2015	killer whale (Alaska Resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient)	observer
AK Bering Sea, Aleutian Islands Pacific cod longline	Federal	34	1976 - 2015	killer whale (Alaska Resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient), ribbon seal, northern fur seal, ringed seal, spotted seal, Steller sea lion (Western U.S.), Dall's porpoise	observer

[~~1~~a]For state-managed fisheries, this is the number of active permits in ~~2016~~2017 and for federally-managed fisheries, this is the number of active vessels participating in the fishery in 2015.
[~~2~~b]Observer data indicates the years of observer data included in these reports.

Note: Only species with positive records of being taken incidentally in a fishery since 1988 (the first year of the Marine Mammal Protection Act interim exemption program) have been included in this table. A species' absence from this table does not necessarily mean it is not taken in a particular fishery. Rather, in most fisheries, only logbook or stranding data are available which resulted in many reports of unidentified or misidentified marine mammals. Observer program indicates most recent year of observer data included in these reports.

~~CITATIONS~~REFERENCES

~~Alaska Commercial Fisheries Entry Commission (CFEC). 2016. Fishery Permits & Permit Holders, Permit Status. Available online: https://www.cfec.state.ak.us/pstatus/14052016.htm . Accessed 7/28/2016.~~

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Final Report to NMFS Alaska Region. 98 p.~~ Available online: https://alaskafisheries.noaa.gov/sites/default/files/1999-2000cookinlet.pdf . Accessed December 2016.~~

Manly, B. F. J. 2007. Incidental take and interactions of marine mammals and birds in the Kodiak Island salmon set gillnet fishery, 2002 and 2005. Final Report to NMFS Alaska Region. 221 p.~~ Available online: https://alaskafisheries.noaa.gov/sites/default/files/kodiakreport02_05.pdf . Accessed December 2016.~~

Manly, B. F. J. 2009. Incidental catch of marine mammals and birds in the Yakutat salmon set gillnet fishery, 2007 and 2008. Final report to NMFS Alaska Region. 96 p.~~ Available online: https://alaskafisheries.noaa.gov/sites/default/files/yakutat07-08.pdf . Accessed December 2016.~~

Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in district 6, 7 and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 p.~~ Available online: https://alaskafisheries.noaa.gov/sites/default/files/incidentaltakes2012-2013.pdf . Accessed December 2016.~~

Manly, B. F. J., A. S. Van Atten, K. J. Kuletz, and C. Nations. 2003. Incidental catch of marine mammals and birds in the Kodiak Island set gillnet fishery in 2002. Final report to NMFS Alaska Region. 91 p.

National Marine Fisheries Service. 2011. U.S. National Bycatch Report [W. A. Karp, L. L. Desfosse, S. G. Brooke, Editors]. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-117E, 508 p.

National Marine Fisheries Service. 2013. U.S. National Bycatch Report First Edition Update 1 [L. R. Benaka, C. Rilling, E. E. Seney, and H. Winarsoo, Editors]. U.S. Dep. Commer., 57 p.

National Marine Fisheries Service. 2016a. List of Fisheries. Final Rule. U.S. Dep. Commer., NOAA 81 FR 20550. 25 p.

National Marine Fisheries Service. 2016b. U.S. National Bycatch Report First Edition Update 2 [L. R. Benaka, D. Bullock, J. Davis, E. E. Seney, and H. Winarsoo, Editors]. U.S. Dep. Commer., 90 p.

National Marine Fisheries Service. 2016c. Protected Resource Division, Alaska Region Marine Mammal Stranding Database. Accessed 8/15/2016.

National Marine Fisheries Service. 2016d. Catch Accounting System. Accessed 8/24/2016.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167, 194 p.

Appendix 5. Interaction table for Alaska **Category 3** commercial fisheries (last revised ~~12/30/2016~~8/10/2018). Notice of continuing effect of list of fisheries.

Fishery name (area, target species, and gear type)	Mngmt	Active Permits/Vessels~~[1]~~[a]	Observer data~~[2]~~[b]	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
AK Prince William Sound salmon set gillnet	State	29	1990-1991 only	Steller sea lion, harbor seal, sea otter	logbook
AK Peninsula/Aleutian Islands salmon set gillnet	State	~~1~~89	never observed	humpback whale	stranding
AK Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	State	~~1184~~1,113	never observed	harbor porpoise	n/a
AK roe herring and food/bait herring gillnet	State	~~426~~33	never observed	none documented	none
AK salmon purse seine	State	~~442~~346	never observed	harbor seal, gray whale (Eastern North Pacific)	logbook
AK salmon beach seine	State	~~23~~1	never observed	none documented	none
AK roe herring and food/bait herring purse seine	State	~~331~~59	never observed	none documented	none
AK roe herring and food/bait herring beach seine	State	~~8~~0	never observed	none documented	none
AK Metlakatla purse seine (tribal)	Tribal	17	never observed	none documented	none
AK Cook Inlet salmon purse seine	State	~~74~~20	never observed	humpback whale	stranding
AK Kodiak salmon purse seine	State	~~324~~181	never observed	humpback whale	stranding
AK Southeast salmon purse seine	State	~~293~~181	never observed	none documented	none
AK miscellaneous finfish purse seine	State	~~9~~2	never observed	none documented	none
AK miscellaneous finfish beach seine	State	0	never observed	none documented	none
AK salmon troll (includes hand and power troll)	State	~~1705~~1,057	never observed	Steller sea lion (Western U.S.), Steller sea lion (Eastern U.S.)	logbook
AK state waters longline /setline (incl. sablefish/ rockfish/lingcod/misc. finfish)	State	775	never observed	none documented	none
AK Gulf of Alaska halibut longline	Federal	798	~~2013~~2014	none documented	observer
AK Gulf of Alaska rockfish longline	Federal	~~13~~7	~~2013~~2014	none documented	observer
AK Gulf of Alaska Pacific cod longline	Federal	~~95~~77	~~2013~~2014	Steller sea lion (Western U.S.)	observer
AK Gulf of Alaska sablefish longline	Federal	~~281~~255	~~2013~~2014	Steller sea lion, sperm whale	observer
AK Bering Sea, Aleutian Islands Greenland turbot longline	Federal	3	~~2013~~2014	killer whale (Eastern North Pacific Resident), killer whale (Eastern North Pacific Transient), killer whale (Alaska Resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient)	observer
AK Bering Sea, Aleutian Islands rockfish longline	Federal	1	~~2013~~2014	none documented	observer
AK Bering Sea, Aleutian Islands sablefish longline	Federal	16	~~2013~~2014	none documented	observer
AK halibut longline/set line (state and federal waters)	State	~~878~~889	~~2013~~2014	Steller sea lion	self-reports
AK octopus/squid longline	State	~~8~~3	never observed	none documented	none
AK shrimp otter and beam trawl (statewide and Cook Inlet)	State	~~28~~9	never observed	none documented	none
AK Gulf of Alaska flatfish trawl	Federal	~~21~~20	~~2013~~2014	northern elephant seal, harbor seal	observer
AK Gulf of Alaska Pacific cod trawl	Federal	54	~~2013~~2014	Steller sea lion (Western U.S.), harbor seal	observer
AK Gulf of Alaska pollock trawl	Federal	63	~~2013~~2014	Steller sea lion (Western U.S.), fin whale, northern elephant seal, Dall's porpoise	observer
AK Gulf of Alaska rockfish trawl	Federal	~~37~~36	~~2013~~2014	none documented	observer
AK Bering Sea, Aleutian Islands Atka mackerel trawl	Federal	14	~~2013~~2014	ribbon seal, Steller sea lion (Western U.S.), northern elephant seal	observer
AK Bering Sea, Aleutian Islands Pacific cod trawl	Federal	64	~~2013~~2014	harbor seal, Steller sea lion (Western U.S.), ringed seal, bearded seal	observer
AK State-managed waters of Cook Inlet, Kachemak Bay, Prince William Sound, Southeast AK groundfish trawl	State	18	never observed	none documented	none
AK miscellaneous finfish otter/beam trawl	State	292	never observed	none documented	none
AK food/bait herring trawl (Kodiak area only)	State	~~3~~45	never observed	none documented	none
AK Bering Sea, Aleutian Islands Pacific cod pot	Federal	~~116~~48	~~2013~~2014	possible harbor seal	observer

Fishery name (area, target species, and gear type)	Mngmt	Active Permits/Vessels[~~1~~a]	Observer data[~~2~~b]	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
AK Bering Sea, Aleutian Islands crab pot	State	~~248~~120	~~never observed~~1998-current[c]	gray whale (Eastern North Pacific)	stranding
AK Gulf of Alaska crab pot	State	~~271~~300	never observed	humpback whale	stranding
AK Gulf of Alaska Pacific cod pot	Federal	116	~~2013~~2014	harbor seal, gray whale (Eastern North Pacific)	observer, stranding
AK Southeast Alaska crab pot	State	~~375~~300	never observed	humpback whale	stranding
AK Southeast Alaska shrimp pot	State	~~210~~99	never observed	humpback whale	stranding
AK octopus/squid pot	State	~~15~~0	never observed	none documented	none
AK snail pot	State	1	never observed	none documented	none
AK Aleutian Islands sablefish pot	Federal	2	~~2013~~2014	humpback whale	observer
AK Bering Sea sablefish pot	Federal	3	~~2013~~2014	humpback whale	observer
AK statewide miscellaneous finfish pot	State	~~201~~127	never observed	none documented	none
AK shrimp pot, except Southeast AK	State	~~141~~31	never observed	none documented	none
AK North Pacific halibut handline and mechanical jig	State	~~71~~9	never observed	none documented	none
AK miscellaneous finfish handline/hand troll and mechanical jig	State	~~572~~155	never observed	~~none documented~~humpback whale, fin whale	~~none~~self-reports
AK herring spawn on kelp pound net	State	~~291~~133	never observed	none documented	none
AK Southeast herring roe/food/bait pound net	State	~~0~~111	never observed	none documented	none
AK scallop dredge	State	6	never observed	none documented	none
AK Dungeness crab (hand pick/dive)	State	0	never observed	none documented	none
AK herring spawn-on-kelp (hand pick/dive)	State	~~226~~0	never observed	none documented	none
AK urchin and other fish/shellfish (hand pick/dive)	State	~~214~~215	never observed	none documented	none
AK commercial passenger fishing vessel	State	~~1006~~1,000	never observed	killer whale (stock unknown), Steller sea lion (Western U.S.), Steller sea lion (Eastern U.S.)	n/a
AK abalone	State	0	never observed	none documented	none
AK clam	State	~~87~~80	never observed	none documented	none

[~~1~~a]For state-managed fisheries, this is the number of active permits in 2016. For federally-managed fisheries, this is the number of active vessels participating in the fishery in 2015. For 'AK commercial passenger fishing vessel', this is the number of active vessels in the commercial passenger fishing vessel in 2014, the most current year of data available.

[~~2~~b]Observer data indicates most recent year of observer data included in these reports. Prior to 2013, there were no observer data from vessels less than 60 feet in length, regardless of fishery. Also prior to 2013, there were no observer data for the halibut Individual Fishing Quota (IFQ) fishery, regardless of vessel size.

[c]While this fishery is observed, the program is not tailored to monitoring crab pot gear interactions with marine mammals as many such interactions are thought to more often occur during the times that the fishery is not tended or observed.

Note: Only species with positive records of being taken incidentally in a fishery since 1990 (the first year of the MMPA interim exemption logbook program) have been included in this table. A species' absence from this table does not necessarily mean it is not taken in a particular fishery. Rather, in most fisheries, only logbook or stranding data are available which resulted in many reports of unidentified or misidentified marine mammals.

~~CITATIONS~~REFERENCES

~~Alaska Commercial Fisheries Entry Commission (CFEC). 2016. Fishery Permits & Permit Holders, Permit Status. Available online: https://www.cfec.state.ak.us/pstatus/14052016.htm. Accessed 7/28/2016.~~

National Marine Fisheries Service. 2011. U.S. National Bycatch Report [W. A. Karp, L. L. Desfosse, S. G. Brooke, Editors]. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-117E, 508 p.

National Marine Fisheries Service. 2013. U.S. National Bycatch Report First Edition Update 1 [L. R. Benaka, C. Rilling, E. E. Seney, and H. Winarsoo, Editors]. U.S. Dep. Commer., 57 p.

National Marine Fisheries Service. 2016a. List of Fisheries. Final Rule. U.S. Dep. Commer., NOAA 81 FR 20550. 25 p.

National Marine Fisheries Service. 2016b. U.S. National Bycatch Report First Edition Update 2 [L. R. Benaka, D. Bullock, J. Davis, E. E. Seney, and H. Winarsoo, Editors]. U.S. Dep. Commer., 90 p.

National Marine Fisheries Service. 2016c. Protected Resource Division, Alaska Region Marine Mammal Stranding Database. Accessed 8/15/2016.

National Marine Fisheries Service. 2016d. Catch Accounting System. Accessed 8/24/2016.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167, 194 p.

Powers, B., and D. Sigurdsson. 2016. Participation, effort, and harvest in the sport fish business/guide licensing and logbook programs, 2014. Alaska Department of Fish and Game, Fishery Data Series No. 16-02, Anchorage, AK.

Appendix 6. Percent observer coverage in Alaska commercial fisheries 1990-~~2015~~2016 (last revised ~~12/30/2017~~8/10/2018).

Fishery name[1][a]	**Method for calculating observer coverage[2][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**
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
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
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
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
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						93	
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
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	37	30
GOA Pacific halibut longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	51.3	47.1	51.1	43.0	41.4	9.6	36.4	6.5	2.8	N/A	N/A	N/A		2.3	0.6	4.2	11	9.7	9.6
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							
GOA sablefish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.9	14.0	15.2	12.4	13.7	9.4	37.7	10.4	11.2	37	35	38	15	14	14	14	19	20	14
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
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							
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

Fishery name[1][a]	Method for calculating observer coverage[2][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
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
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							
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							
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
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	99	99	99	99	98
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	99	99	99	99	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
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	97	98	99	99
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	99	99	100	99
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
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				52	
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
BSAI Pacific 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~~14	~~14~~15	12
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							

Fishery name[1a]	Method for calculating observer coverage[2b]	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
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							
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.
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.
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.
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.
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.
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.
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.
Southeast Alaska salmon drift gillnet (Districts 6, 7, and 8)	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	6.4	6.6	not obs.	not obs.	not obs.

[1a]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.

[2b]Observer coverage in the groundfish fisheries (trawl, longline, and pots) was determined by the percentage of tons caught which were observed. Observer coverage in the groundfish fisheries is assigned according to vessel length; where vessels greater than 125 feet have 100% coverage, vessels 60-125 feet have 30% coverage, and vessels less than 60 feet are not observed. Observer coverage in the groundfish fisheries varies by statistical area; the pooled percent coverage for all areas is provided here. Observer coverage in the drift gillnet fisheries was calculated as the percentage of the estimated sets that were observed. Observer coverage in the set gillnet fishery was calculated as the percentage of estimated setnet hours (determined by number of permit holders and the available fishing time) that were observed.

~~CITATIONS~~REFERENCES

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

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Final Report to NMFS Alaska Region. 98 p.

Manly, B. F. J. 2007. Incidental take and interactions of marine mammals and birds in the Kodiak Island salmon set gillnet fishery, 2002 and 2005. Final Report to NMFS Alaska Region. 221 p.

Manly, B. F. J. 2009. Incidental catch of marine mammals and birds in the Yakutat salmon set gillnet fishery, 2007 and 2008. Final Report to NMFS Alaska Region. 96 p.

Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in districts 6, 7, and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 p.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167, 194 p.

Perez, M. A. Unpubl. ms. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 67 p. Available from Marine Mammal Laboratory, AFSC, 7600 Sand Point Way NE, Seattle, WA 98115.

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 65 p. Available from NMFS Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

Wynne, K. M., D. Hicks, and N. Munro. 1992. 1991 marine mammal observer program for the salmon driftnet fishery of Prince William Sound Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. 53 p. Available from NMFS Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

Appendix 7. Self-reported fisheries information.

The Marine Mammal Exemption Program (MMEP) was initiated in mid-1989 as a result of the 1988 amendments to the Marine Mammal Protection Act (MMPA). The MMEP required fishers involved in Category I and II fisheries to register with NMFS and to complete annual logbooks detailing each day's fishing activity, including: date fished, hours fished, area fished, marine mammal species involved, injured and killed due to gear interactions, and marine mammal species harassed, injured and killed due to deterrence from gear or catch. If the marine mammal was deterred, the method of deterrence was required, as well as indication of its effectiveness. Fishers were also required to report whether there were any losses of catch or gear due to marine mammals. These logbooks were submitted to NMFS on an annual basis, as a prerequisite to renewing their registration. Fishers participating in Category III fisheries were not required to submit complete logbooks, but only to report mortalities of marine mammals incidental to fishing operations. Logbook data are available for part of 1989 and for the period covering 1990-1993. Logbook data received during the period covering part of 1994 and all of 1995 was not entered into the MMEP logbook database in order for NMFS personnel to focus their efforts on implementing the 1994 amendments to the MMPA. Thus, aside from a few scattered reports from the Alaska Region, self-reported fisheries information is not available for 1994 and 1995.

In 1994, the MMPA was amended again to implement a long-term regime for managing mammal interactions with commercial fisheries (the Marine Mammal Authorization Program, or MMAP). Logbooks are no longer required. Instead, vessel owners/operators in any commercial fishery (Category I, II, or III) are required to submit one-page pre-printed reports for all interactions resulting in an injury or mortality to a marine mammal. The report must include the owner/operator's name and address, vessel name and ID, where and when the interaction occurred, the fishery, species involved, and type of injury (if animal was released alive). These postage-paid report forms are mailed to all Category I and II fishery participants that have registered with NMFS, and must be completed and returned to NMFS within 48 hours of returning to port for trips in which a marine mammal injury or mortality occurred. This reporting requirement was implemented in April 1996. During 1996, only 5 mortality/injury reports were received by fishers participating in all of Alaska's commercial fisheries. This level of reporting was a drastic drop in the number of reports compared to the numbers of interactions reported in the annual logbooks. As a result, the Alaska Scientific Review Group (SRG) considers the MMAP reports unreliable and has recommended that NMFS not utilize the reports to estimate marine mammal mortality (see June 1998 Alaska SRG meeting minutes; DeMaster 1998). As of the stock assessment reports for 2006, these records are no longer used to estimate annual fishery-related mortalities.

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Minimum estimated mortality
Steller sea lion (Western U.S. stock)																
Alaska Peninsula/Aleutian Islands salmon set gillnet	0	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Bristol Bay salmon drift gillnet	0	4	2	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.5
Prince William Sound set gillnet	0	0	2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Alaska miscellaneous finfish set gillnet	0	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Alaska halibut longline (state and federal waters)	0	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2
Kodiak salmon set gillnet	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	2	2
Steller sea lion (Eastern U. S. stock)																
Southeast Alaska salmon drift gillnet	0	1	2	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.25
Northern fur seal (Eastern Pacific stock)																
Prince William Sound salmon drift gillnet	1	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Alaska Peninsula/Aleutian Islands salmon drift gillnet	2	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Bristol Bay salmon drift gillnet	5	0	49	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.5
Alaska misc. finfish pair trawl	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	1	1

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Minimum estimated mortality
Harbor seal (Southeast Alaska stock)																
Southeast Alaska salmon drift gillnet	8	1	4	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	3.2
Yakutat salmon set gillnet	0	18	31	61	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	27.5
Harbor seal (Gulf of Alaska stock)																
Cook Inlet salmon set gillnet	6	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.75
Prince William Sound set gillnet	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Kodiak salmon set gillnet	3	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Alaska salmon purse seine (except for Southeast)	0	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Alaska Peninsula/Aleutian Islands salmon drift gillnet	9	2	12	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7
Harbor seal (Bering Sea stock)																
Bristol Bay salmon drift gillnet	38	23	2	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.25
Bristol Bay salmon set gillnet	0	0	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
AK misc. finfish pair trawl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	1
Spotted seal (Alaska stock)																
Bristol Bay salmon drift gillnet	5	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.5
Beluga whale (Bristol Bay stock)																
Bristol Bay salmon drift gillnet	0	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Bristol Bay salmon set gillnet	1	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Pacific white-sided dolphin (North Pacific stock)																
Prince William Sound salmon drift gillnet	1	4	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.25
Southeast Alaska salmon drift gillnet	0	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Bristol Bay salmon drift gillnet	3	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Harbor porpoise (Southeast Alaska stock)																
Southeast Alaska salmon drift gillnet	2	2	7	2	N/A	N/A	2	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	2.7
Harbor porpoise (Gulf of Alaska stock)																
Cook Inlet salmon drift and set gillnet fisheries	3	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	0.8
AK Peninsula/Aleutian Island salmon drift gillnet	2	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Kodiak salmon set gillnet	8	4	2	1	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	3.2
Harbor porpoise (Bering Sea stock)																
AK Peninsula/Aleutian Island salmon set gillnet	0	0	2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Bristol Bay salmon drift gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Bristol Bay salmon set gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
AK Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Dall's porpoise (Alaska stock)																
Prince William Sound salmon drift gillnet	0	2	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Southeast Alaska salmon drift gillnet	6	6	4	6	N/A	N/A	N/A	1	N/A	1	N/A	1	N/A	?	N/A	3.6
Cook Inlet set and drift gillnet fisheries	1	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Eastern North Pacific gray whale																
Bristol Bay salmon drift and set gillnet fisheries	2	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
WA/OR/CA crab pot	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	0.5

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Minimum estimated mortality
Humpback whale (Central North Pacific stock)																
Southeast Alaska salmon drift gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Southeast Alaska salmon purse seine	0	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2

~~CITATIONS~~REFERENCES

DeMaster, D. P. 1998. Minutes from the sixth meeting of the Alaska Scientific Review Group, 21-23 October 1997, Seattle, Washington. 40 p. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.