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Alaska Marine Mammal Stock Assessments, 2017

M. M. Muto, V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

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Cover photo: Ringed seal pup in a snow lair, Kotzebue Sound, Alaska, May 2011. Photographer: Michael Cameron (AFSC-MML), NMFS Permit No. 15126-01.

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PREFACE

On 30 April 1994, Public Law 103-238 was enacted allowing significant changes to provisions within the Marine Mammal Protection Act (MMPA). Interactions between marine mammals and commercial fisheries are addressed under three new sections. This new regime replaced the interim exemption that 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). 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, 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. This review, and a review of other stocks, led to the revision of the following stock assessments for the 2017 document: Western U.S. stock of Steller sea lions; northern fur seals; spotted seals; Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, Bristol Bay, and Cook Inlet stocks of beluga whales; AT1 Transient stock of killer whales; Southeast Alaska, Gulf of Alaska, and Bering Sea stocks of harbor porpoise; sperm whales; Western North Pacific and Central North Pacific stocks of humpback whales; fin whales; North Pacific right whales; and bowhead whales. The Stock Assessment Reports for all stocks, however, are included in this 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 this 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: Thomas Doniol-Valcroze, Ari Friedlaender, Karl Haflinger, Mike Miller, Greg O'Corry-Crowe, Grey Pendleton, Megan Peterson, Kate Stafford, and Kate Wynne (Chair from 2016 to 2018). We would also like to acknowledge the contributions from the NMFS Alaska Region 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.

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Revised 12/30/2017

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 the wide-ranging 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).

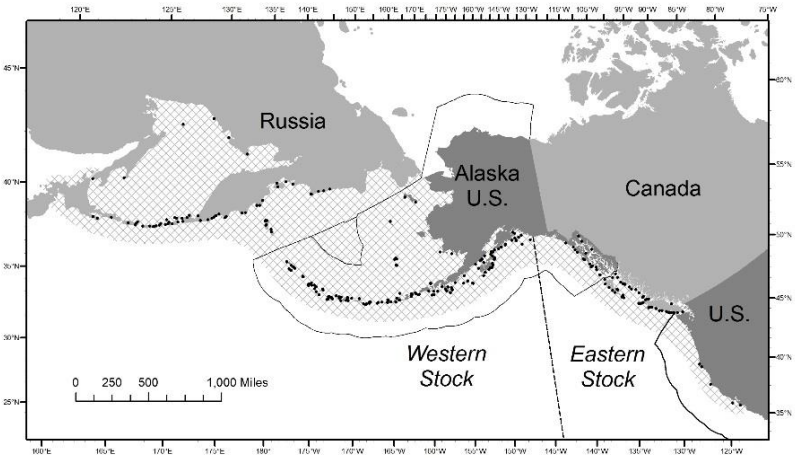

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005, Olesiuk 2008). Black 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 into this area, the mixed part of the range remains small (Jemison et al. 2013), and the overall discreteness of the eastern from the western stock remains distinct. Hybridization among subspecies and species along a contact zone such as now occurs near the stock boundary is not unexpected as the ability to interbreed is a primitive condition whereas reproductive isolation would be derived. 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). The most recent comprehensive aerial photographic and land-based surveys of western Steller sea lions in Alaska were conducted during the 2015 and 2016 breeding seasons (Fritz et al. 2016, Sweeney et al. 2016). Western Steller sea lion pup and non-pup counts in Alaska in 2016 were estimated to be 12,631 (95% credible interval of 11,446-13,927) and 40,672 (35,737-46,305), respectively, using the method of Johnson and Fritz (2014) and survey results through 2016 (Sweeney et al. 2016). 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 in Alaska were 12,631 and 40,672, respectively (Sweeney et al. 2016). These sum to 53,303, 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 through 2016, 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% y^{-1} and 2.24% y^{-1}, respectively, between 2003 and 2016 (Table 1; Sweeney et al. 2016). 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). Trends in 2003-2016 in Alaska have a longitudinal gradient with highest rates of increase in the east (eastern Gulf of Alaska) and steadily decreasing rates to the west (Table 1).

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

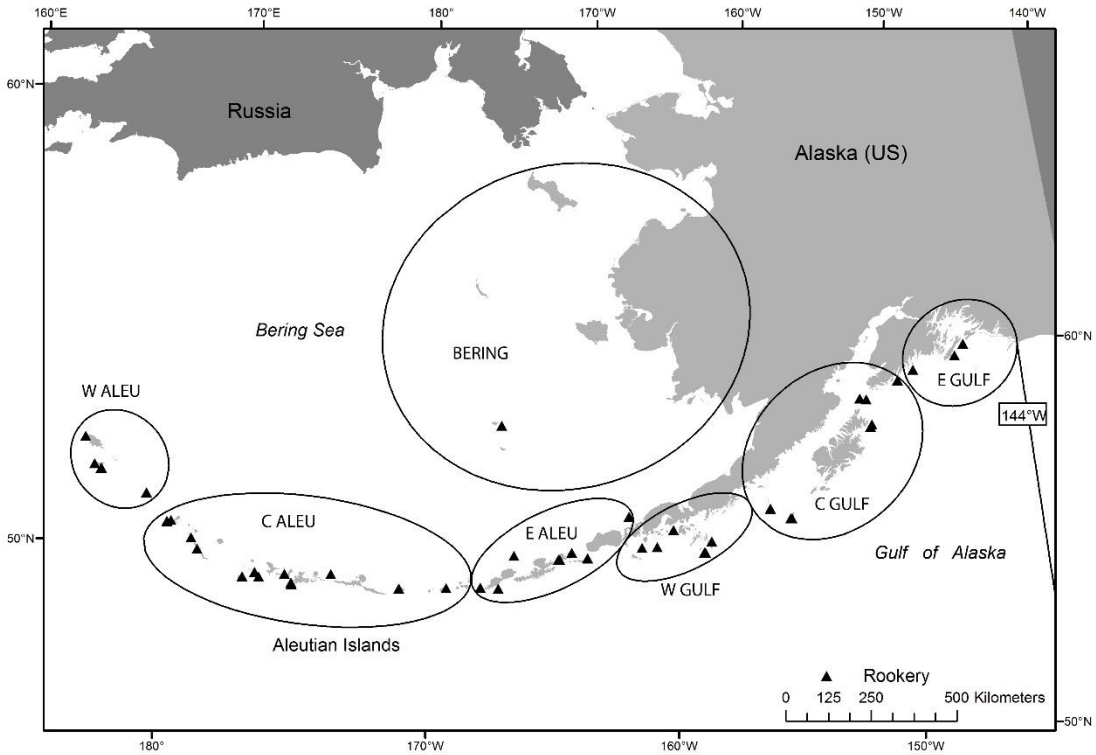

Figure 2. Regions of Alaska used for western Steller sea lion population trend estimation. E GULF, C GULF, and W GULF are eastern, central, and western Gulf of Alaska regions, respectively. E ALEU, C ALEU, and W ALEU are eastern, central, and western Aleutian Islands regions, respectively.

Estimated trends in non-pup and pup counts in the western Aleutians since 2003 are still declining steeply, after adding the 2016 counts, but less steeply than without that year's data. This was largely due to relatively stable regional counts since 2013 (Sweeney et al. 2016). This period of stability overlapped with and followed 4 years (2011-2014) when fisheries for Pacific cod and Atka mackerel 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). 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.

The net magnitude of Steller sea lion movements during the breeding season between the eastern and western stocks appears to be relatively small (net increase of 76 in the west) and would have a negligible impact on non-pup trend estimates for either stock (Jemison et al. 2013, Fritz et al. 2016). 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 moved 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).

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 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 for Steller sea lions. Hence, until additional data become available, the theoretical maximum 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 sea lions (53,303 × 0.06 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Western U.S. Steller sea lions in 2011-2015 is 241 sea lions: 31 in U.S. commercial fisheries, 1.4 in unknown (commercial, recreational, or subsistence) fisheries, 2 in marine debris, 2.6 due to other causes (arrow strike, entangled in hatchery net, illegal shooting, Marine Mammal Protection Act (MMPA) authorized research-related), and 204 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, no data are available for 2011-2014, a cause of death for all carcasses found was not determined, and it is not likely that all carcasses are detected. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include subsistence harvest, incidental take, illegal shooting, and entanglement in fishing gear and marine debris.

Fisheries Information

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

In 2011-2015, mortality and serious injury of western Steller sea lions was observed in the following 10 fisheries of the 22 federally-regulated 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 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 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 (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), resulting in a mean annual mortality and

serious injury rate of 0.2 sea lions in 2011-2015 (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 a minimum because not all entangled animals strand and not all stranded animals are found, reported, or have the cause of death determined. Two additional mortalities 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) are already accounted for in the extrapolated estimates derived from AMMOP observer data for these fisheries (Table 2).

The estimated mean annual mortality and serious injury rate in U.S. commercial fisheries in 2011-2015 is 31 Steller sea lions from this stock (31 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 (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	obs data	99	7	7	5.8 (CV = 0.01)
	2012		99	6	6.0	
	2013		99	7	7.0	
	2014		99	5	5.0	
	2015		99	4	4	
Bering Sea/Aleutian Is. Pacific cod trawl	2011	obs data	60	1	1.0	0.6 (CV = 0.45)
	2012		68	0	0	
	2013		80	1	1.9	
	2014		80	0	0	
	2015		72	0	0	
Bering Sea/Aleutian Is. pollock trawl	2011	obs data	98	9	9.3	4.9 (+0.2)[c] (CV = 0.03)
	2012		98	7 (+1)[a]	7.0 (+1)[b]	
	2013		97	5	5.1	
	2014		98	2	2.1	
	2015		99	1	1.2	
Bering Sea/Aleutian Is. Pacific cod longline	2011	obs data	57	0	0	1.3 (CV = 0.31)
	2012		51	0	0	
	2013		66	0	0	
	2014		64	1	1.7	
	2015		62	3	4.8	
Gulf of Alaska Pacific cod longline	2011	obs data	30	0	0	0.2 (CV = 0.39)
	2012		13	0	0	
	2013		29	0	0	
	2014		31	0	0	
	2015		37	1	1.2	
Gulf of Alaska Pacific cod trawl	2011	obs data	41	0	0	0.2 (CV = 0)
	2012		25	1	1	
	2013		10	0	0	
	2014		12	0	0	
	2015		13	0	0	
Gulf of Alaska sablefish longline	2011	obs data	14	0	0	1.1 (CV = 0.89)
	2012		14	1	5.5	
	2013		14	0	0	
	2014		19	0	0	
	2015		20	0	0	

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Gulf of Alaska flatfish trawl	2011 2012 2013 2014 2015	obs data	31 42 46 47 54	0 0 0 0 0 (+1)[d]	0 0 0 0 0 (+1)[e]	0 (+0.2)[f] (CV = N/A)
Gulf of Alaska rockfish trawl	2011 2012 2013 2014 2015	obs data	93	0 0 0 0 0 (+1)[d]	0 0 0 0 0 (+1)[e]	0 (+0.2)[f] (CV = N/A)
Gulf of Alaska pollock trawl	2011 2012 2013 2014 2015	obs data	23	0 0 0 0 0 (+5)[g]	0 0 0 0 0 (+5)[h]	0 (+1)[i] (CV = N/A)
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 (CV = 0.52)

[a]Total mortality and serious injury observed in 2012: 7 sea lions in sampled hauls + 1 sea lion in an unsampled haul.
[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 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: 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). From 2011 to 2015, there were five 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 resulted in a minimum mean annual mortality and serious injury rate of 1.4 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 a minimum because not all entangled animals strand and not 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 (Helker et al. 2017). N/A indicates that data are not available.

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

[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). NMFS does not know whether the level of mortality detected in 2015 was typical, low, or high since similar data are not available for 2011-2014. 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 averaged over 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 sea lions) for U.S. commercial fisheries and stranding data (1.4 sea lions) for unknown (commercial, recreational, or subsistence) fisheries, is 32 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 (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) 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) and St. George (Kashevarof 2015) are for 2011-2015 (Table 4).

The mean annual subsistence take from this stock for all areas except St. Paul and St. George in 2004-2008 (172) combined with the mean annual take for St. Paul (30) and St. George (2.4) in 2011-2015 is 204 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). 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]
2012	N/A	N/A	N/A	24[h]	3[g]
2013	N/A	N/A	N/A	34[i]	0[g]
2014	N/A	N/A	N/A	35[j]	1[g]
2015	N/A	N/A	N/A	24[k]	3[g]
Mean annual take	137	35	172	30	2.4

[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); [g]Kashevarof (2015); [h]Melovidov (2013); [i]Melovidov (2014); [j]Melovidov (2015); [k]Melovidov (2016).

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 a minimum because not all entangled animals strand and not all stranded animals are found, reported, or have the cause of death determined. From 2011 to 2015, reports to the NMFS Alaska Region stranding network resulted in mean annual mortality and serious injury rates of 1.6 Steller sea lions illegally shot in the Copper River Delta, 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).

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

STATUS OF STOCK

The mean annual U.S. commercial fishery-related mortality and serious injury rate (31 sea lions) is less than 10% of the PBR (10% of PBR = 32) and, therefore, can 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 sea lions) is below the PBR level (320) 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. 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 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 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
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

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STELLER SEA LION (*Eumetopias jubatus*): Eastern 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). Individual sea lions 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 of eastern and western stock sea lions in foraging areas (Sease and York 2003). Despite the wide-ranging 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, Jemison et al. 2013). A northward shift in the overall breeding distribution has occurred, with a contraction of the range in southern California and new rookeries established in Southeast Alaska (Pitcher et al. 2007).

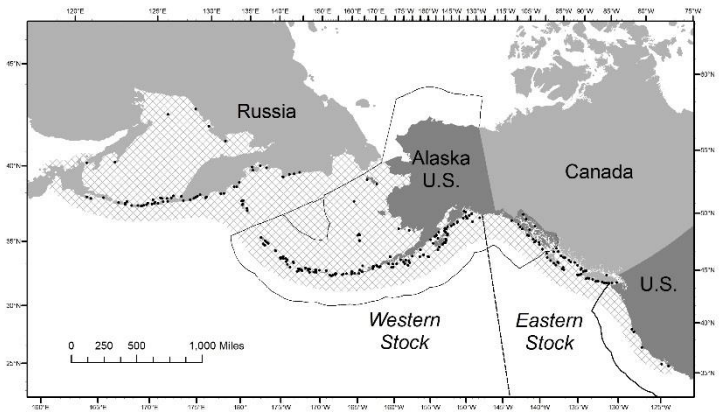

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005; S. Majewski, Fisheries and Oceans Canada, pers. comm.). 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); 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. Most of this movement, but not all, is likely to access seasonally available, but important, prey resources as discussed above.

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). However, 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. 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 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 into this area, the mixed part of the range remains small (Jemison et al. 2013) and the overall discreteness of the eastern from the western stock remains distinct. Hybridization among subspecies and species along a contact zone such as now occurs near the stock boundary is not unexpected as the ability to interbreed is a primitive condition whereas reproductive isolation would be derived. 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 and 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 eastern stock of Steller sea lions has historically bred on rookeries located in Southeast Alaska, British Columbia, Oregon, and California. However, within the last several years a new rookery has become established on the outer Washington coast (at the Carroll Island and Sea Lion Rock complex), with >100 pups born there in 2015 (R. DeLong and P. Gearin, NMFS-AFSC-MML, pers. comm.). Counts of pups on rookeries conducted near the end of the birthing season are nearly complete counts of pup production. The dates of the most recent aerial photographic and land-based surveys of eastern Steller sea lions have varied by region. Southeast Alaska was surveyed in June-July 2015 (Fritz et al. 2015), while counts used in population analyses for the contiguous U.S. (i.e., Washington, Oregon, and California) are from 2013 surveys and counts from Canada (i.e., British Columbia) are from the 2010 survey effort (NMFS, Fisheries and Oceans Canada, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, unpubl. data). For trend and population estimates, we used agTrend (Johnson and Fritz 2014) to augment missing counts in order to estimate 2015 counts. The 2015 estimated total eastern stock pup count is 19,423 (95% credible interval of 16,318-23,309). The 2015 estimated total eastern stock non-pup count is 52,139 (95% confidence interval of 45,428-59,711); this estimate does not account for animals at sea.

Minimum Population Estimate

Because of the uncertainty regarding the use of a pup multiplier or haulout rate to estimate N, we use the best estimate of the total count of eastern Steller sea lions as the minimum population estimate (N_{MIN}). The agTrend (Johnson and Fritz 2014) total count estimate of pups and non-pups for the entire eastern stock of Steller sea lions in 2015 is 71,562 (52,139 non-pups plus 19,423 pups). The estimated U.S. total count of the eastern stock of Steller sea lions is 41,638 (30,917 non-pups plus 10,721 pups; Table 1) and it will be used as the N_{MIN}. These counts are considered minimum estimates of population size because they have not been corrected for animals that are at sea during the surveys.

Current Population Trend

Using agTrend, we modeled the most recent count data to estimate annual trends from 1989 to 2015. This model indicates the eastern stock of Steller sea lions increased at a rate of 4.76% per year (95% confidence intervals of 4.09-5.45%) between 1989 and 2015 based on an analysis of pup counts in California, Oregon, British Columbia, and Southeast Alaska (Table 1, Figs. 2 and 3). A similar analysis of non-pup counts in the same regions plus Washington yielded an estimate of population increase of 2.84% per year (95% confidence intervals of 2.36-3.33%). Pitcher et al. (2007) reported that the Eastern U.S. stock increased at a rate of 3.1% per year during a 25-year time period from 1977 to 2002; however, they used a slightly different method to estimate population growth than the methods reported in NMFS (2013). The Eastern U.S. stock increase has been driven by growth in pup counts in all regions (NMFS 2013).

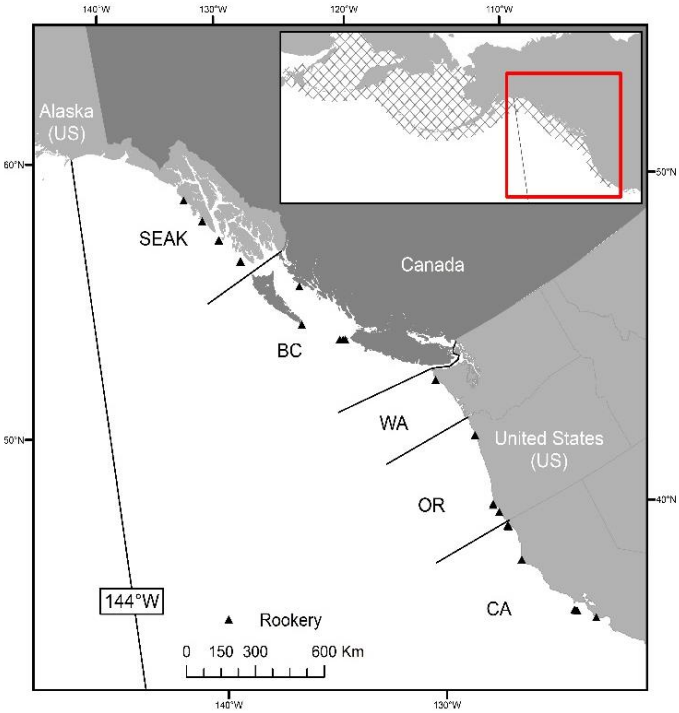

Figure 2. The eastern Steller sea lion rookery sites by region: SEAK (Southeast Alaska), BC (British Columbia, Canada), WA (Washington State), OR (Oregon State), and CA (California State).

Table 1. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in estimated counts of eastern Steller sea lion non-pups (adults and juveniles) and pups, by region and total population, for the period 1989-2015 (Johnson and Fritz 2014, Fritz et al. 2015). The agTrend estimated counts of non-pups and pups by region and the overall counts in 2015 are also shown. Total eastern stock counts are slightly greater than the sums of the regional counts due to the modeling process.

	Non-pups					**Pups**			
Region	**Trend**	**-95%**	**+95%**	**2015**		**Trend**	**-95%**	**+95%**	**2015**
California, U.S.	1.95	0.36	3.53	3,120		3.82	2.47	5.05	936
Oregon, U.S.	2.39	1.08	3.54	5,634		3.80	2.58	5.03	1,946
Washington, U.S.*	8.77	6.00	11.37	1,407					
British Columbia, Canada	3.43	2.64	4.22	20,689		7.89	6.22	9.61	8,630
Southeast Alaska, U.S.	2.33	1.54	3.07	20,756		3.20	2.59	3.82	7,838
Total Eastern Stock	2.84	2.36	3.33	52,139		4.76	4.09	5.45	19,423
Total U.S. Eastern Stock				30,917					10,721

*NMFS has never observed Steller sea lion pups born on known sites in Washington except within the last several years. A new rookery has become established on the outer Washington coast (at the Carroll Island and Sea Lion Rock complex), with a confirmed count of 45 pups in 2013 and >100 pups born there in 2015 (R. DeLong and P. Gearin, NMFS-AFSC-MML, pers. comm.).

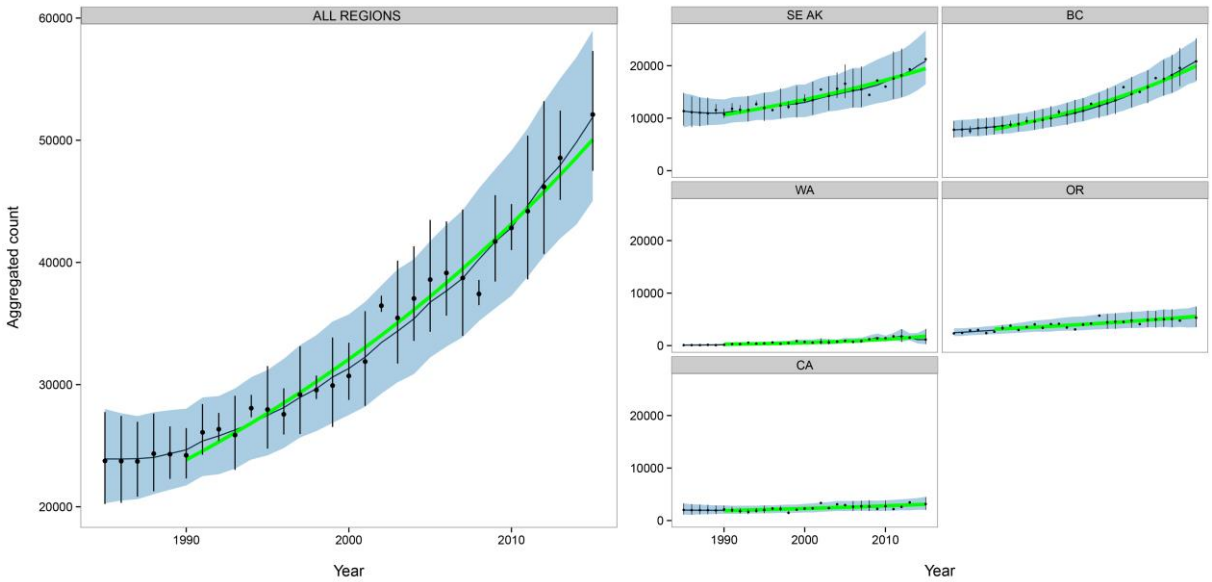

Figure 3. Estimated counts (modeled with agTrend) of eastern Steller sea lion non-pups (adults and juveniles) for the period from 1989 to 2015, with estimated trend (green line) from 1990 to 2015 for all regions and for the five separate regions: Southeast Alaska (SEAK), British Columbia (BC), Washington (WA), Oregon (OR), and California (CA) (Johnson and Fritz 2014, Fritz et al. 2015).

While the eastern stock of Steller sea lions has been increasing in all regions from 1990 to 2015, the most significant growth has been observed in Southeast Alaska and British Columbia, Canada (Fig. 3). These two regions comprise almost 85% of the total eastern stock count. Non-pups in Oregon and Washington have been increasing since 1990, though at a lower rate. Non-pup counts in California ranged between 4,000 and 6,000 with no apparent trend from 1927 to 1947 but subsequently declined. At Año Nuevo Island off central California, a steady decline in abundance began in 1970, and there was an 85% reduction in the breeding population by 1987 (LeBoeuf et al. 1991). Non-pup counts increased slightly from 1989 to 2015, ranging from approximately 2,000 to 3,100.

The net magnitude of Steller sea lion movements during the breeding season between the eastern and western stocks appears to be relatively small and would have a negligible impact on non-pup trend estimates in either area (Fritz et al. 2013, Jemison et al. 2013). However, there were significant differences by sex in cross-boundary movements: for females, there was a net increase of ~600 in the east and very few moved from east to west, while males moved 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).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the maximum net productivity rate for Steller sea lions. Pitcher et al. (2007) observed a rate of population increase of 3.1% per year for the eastern stock but concluded this rate did not represent a maximum rate of increase. NMFS (2013) estimated that the eastern stock increased at rates of 4.18% per year using pup counts and 2.99% per year using non-pup counts between 1979 and 2009. Here, we estimated that counts of pups and non-pups increased at rates of 4.76% and 2.84% per year, respectively, between 1989 and 2015 (Table 1). Until additional data become available, it is recommended that the theoretical maximum net productivity rate (R_{MAX}) for pinnipeds of 12% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. On 4 December 2013, the eastern stock of Steller sea lions was removed from the list of threatened species under the Endangered Species Act (ESA; 78 FR 66140, 4 November 2013). NMFS' decision to delist this species was based on the information presented in the Status Review (NMFS 2013), the factors for delisting in section 4(a)(1) of the ESA, the biological and threats-based recovery criteria in the 2008 Recovery Plan (NMFS 2008), the continuing efforts to protect the species, and

information received during public comment and peer review. NMFS' consideration of this information led to a determination that the eastern population has recovered and no longer meets the definition of a threatened species under the ESA. As recently noted within the humpback whale ESA listing final rule (81 FR 62259, 8 September 2016), in the case of a species or stock that achieved its depleted status solely on the basis of its ESA status, such as the eastern stock of Steller sea lions, the species or stock would cease to qualify as depleted under the terms of the definition set forth in MMPA Section 3(1) if the species or stock is no longer listed as threatened or endangered. Therefore, NMFS considers this stock not to be depleted; the recovery factor is 1.0 (recovery factor for a stock within its Optimum Sustainable Population), and the PBR = 2,498 (41,638 × 0.06 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Detailed information (including observer programs, observer coverage, and observed incidental takes of marine mammals) for federally-managed and state-managed U.S. commercial fisheries is presented in Appendices 3-6 of the Alaska Stock Assessment Reports (for fisheries in Alaska waters) and Appendix 1 of the U.S. Pacific Stock Assessment Reports (for fisheries in Washington, Oregon, and California waters).

During 2010-2014, no incidental mortality or serious injury of eastern Steller sea lions was observed in the 22 federally-regulated commercial fisheries in Alaska monitored for incidental mortality by fisheries observers (Breiwick 2013; MML, unpubl. data).

U.S. West Coast groundfish fishery observers monitored three federally-regulated commercial fisheries in 2010-2013 in which Steller sea lions from this stock were taken incidentally: the Washington/Oregon/California (WA/OR/CA) groundfish bottom trawl, WA/OR/CA groundfish midwater trawl (shoreside hake sector), and WA/OR/CA midwater trawl (at-sea hake sector) fisheries, resulting in a mean annual mortality and serious injury rate of 14 Steller sea lions from this stock (Table 2; Jannot et al. 2016).

The estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries is 14 eastern Steller sea lions, based on observer data for 2010-2013 (Table 2). Due to limited observer program coverage, no data exist on the mortality of marine mammals incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to take Steller sea lions). As a result, the number of Steller sea lions taken in Canadian waters is not known.

Table 2. Summary of incidental mortality and serious injury of Eastern U.S. Steller sea lions due to U.S. commercial fisheries in 2010-2013 (Jannot et al. 2016) and calculation of the mean annual mortality and serious injury rate.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
WA/OR/CA groundfish (bottom trawl)[a]	2010 2011 2012 2013	obs data	18 100 100 100	7 20 7 5	7[b] 20 7 5	9.8
WA/OR/CA groundfish (midwater trawl - shoreside hake sector)[c]	2011 2012 2013	obs data	100 100 100	1 0 0	1 0 0	0.3
WA/OR/CA groundfish (midwater trawl - at-sea hake sector)	2010 2011 2012 2013	obs data	100 100 100 100	9 2 1 2	9 2 1 2	3.5
Minimum total estimated annual mortality						14

[a]The bottom trawl fishery was a limited entry fishery in 2010 and a catch shares fishery in 2011-2013.
[b]The observed mortality and serious injury for this fishery will be used until published estimates are available.
[c]Fishery observers began monitoring the shoreside hake sector of the fishery in 2011.

Reports to the NMFS Alaska Region stranding network and the Alaska Department of Fish and Game (ADF&G) of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear provide additional information on fishery-related mortality and serious injury (Table 3; Helker et al. 2016). During 2010-2014, one Steller sea lion interaction with a recreational Southeast Alaska salmon troll fishery was reported, resulting in a minimum mean annual mortality and serious injury rate of 0.2 Steller sea lions per year in recreational troll fisheries. An additional 154 Steller sea lion interactions with troll fisheries were reported in 2010-2014 (including 11 that occurred in the Southeast Alaska salmon troll fishery and 99 that occurred in unidentified Southeast Alaska troll fisheries). In each case, animals had either ingested troll gear or were hooked in the mouth; however, it is not clear whether these interactions involved recreational or commercial components of the fisheries. Three of the animals that were seriously injured in the Southeast Alaska troll fisheries had dependent pups, so the pups were also considered seriously injured. Other fishery-related mortality and serious injury of eastern Steller sea lions in 2010-2014 was due to interactions with longline gear, monofilament gear, trawl gear, and unidentified fishing gear. The minimum mean annual mortality and serious injury rate due to all non-commercial fishery interactions reported to the NMFS Alaska Region and ADF&G in 2010-2014 is 38 eastern Steller sea lions: 0.2 in recreational fisheries + 38 in unknown (commercial, recreational, or subsistence) fisheries (Table 3; Helker et al. 2016). Estimates of fishery-related mortality and serious injury from stranding data are considered minimum estimates because not all entangled animals strand, and not all stranded animals are found or reported.

An additional four Steller sea lions initially considered seriously injured in a Yakutat salmon set gillnet (1 in 2011), Southeast Alaska pot gear (1 in 2012), Southeast Alaska salmon drift gillnet (1 in 2012), and marine debris (1 in 2014) were disentangled and released with non-serious injuries in Alaska waters, and one Steller sea lion pup with serious injuries caused by human harassment was rehabilitated and released with non-serious injuries in Washington waters in 2014 (Helker et al. 2016). None of these animals were included in the average annual mortality and serious injury rate for 2010-2014.

Table 3. Summary of Eastern U.S. Steller sea lion mortality and serious injury, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and ADF&G in 2010-2014 (Helker et al. 2016).

Cause of injury	**2010**	**2011**	**2012**	**2013**	**2014**	**Mean annual mortality**
Hooked by recreational SE Alaska salmon troll gear	0	0	0	0	1	0.2
Hooked by Gulf of Alaska longline gear*	1	0	0	0	0	0.2
Entangled in SE Alaska halibut longline gear*	0	1	0	0	0	0.2
Entangled in SE Alaska longline gear*	0	1	0	0	0	0.2
Hooked by SE Alaska salmon troll gear*	0	0	0	3	8	2.2
Hooked by SE Alaska troll gear*	42	30	27	-	0	25[a]
Dependent pup of animal seriously injured by SE Alaska troll gear*	2	0	1	-	0	0.8[a]
Hooked by troll gear*	0	0	0	3	41	8.8
Entangled in SE Alaska monofilament gear*	1	1	0	0	0	0.4
Entangled in trawl gear*	0	0	0	0	1	0.2
Hooked by unidentified fishing gear*	0	0	2	0	0	0.4
Entangled in marine debris	25	32	24	-	26	27[b]
Dependent pup of animal seriously injured by marine debris	0	1	0	-	3	1[b]
Entangled in foreign high-seas gillnet	1	0	0	0	0	0.2
Gunshot[c]	-	-	15	16	14	15[d]
Struck by arrow	0	0	0	1	0	0.2
Explosives	0	0	0	0	1	0.2

Cause of injury	2010	2011	2012	2013	2014	Mean annual mortality
Total in recreational fisheries						0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries						38
Total in marine debris						28
Total due to other sources (gunshot, arrow, foreign gillnet, explosives)						16

[a]A 4-year average (using the 2010-2012 and 2014 data) was calculated for this category, since we did not receive data on mortality and serious injury due to flasher entanglement (which is primarily assigned to SE Alaska troll gear) from the ADF&G in 2013. Although the NMFS Alaska Region did not assign any mortality and serious injury to SE Alaska troll gear in 2014, this mortality and serious injury is accounted for in the more general category of "troll gear" in 2014.
[b]A 4-year average (using 2010-2012 and 2014 data) was calculated for this category, since we did not receive data on mortality and serious injury due to marine debris entanglement from the ADF&G in 2013.
[c]Only animals reported to the NMFS West Coast Region are included in this table because animals reported to the NMFS Alaska Region are likely accounted for as "struck and lost" in the Alaska Native harvest.
[d]A 3-year average (using the 2012-2014 data) was calculated for this category, since we do not have gunshot data for 2010 and 2011.

The minimum estimated mean annual mortality and serious injury rate incidental to all fisheries in 2010-2014 is 52 Steller sea lions: 14 in U.S. commercial fisheries + 0.2 in recreational fisheries + 38 in unknown (commercial, recreational, or subsistence) fisheries.

Alaska Native Subsistence/Harvest Information

Information on the subsistence harvest of Steller sea lions is provided by the ADF&G. The ADF&G conducted systematic interviews with hunters and users of marine mammals in approximately 2,100 households in about 60 coastal communities within the geographic range of the Steller sea lion in Alaska in 2005-2008 (Wolfe et al. 2006, 2008, 2009a, 2009b). The interviews were conducted once per year in the winter (January to March) and covered hunter activities for the previous calendar year. Approximately 16 of the interviewed communities lie within the range of the Eastern U.S. stock. As of 2009, annual statewide data on community subsistence harvests are no longer being consistently collected. Data are being collected periodically in subareas. During 2010-2014, monitoring occurred only in 2012 (Wolfe et al. 2013), when one animal was landed and eight animals were struck and lost. Therefore, the most recent 5 years of data (2005-2008 and 2012) will be retained and used for calculating an annual mortality and serious injury estimate. The average number of animals harvested plus struck and lost is 11 animals per year during this 5-year period (Table 4).

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

Table 4. Summary of the subsistence harvest data for Eastern U.S. Steller sea lions in 2005-2008 and 2012. As of 2009, data on community subsistence harvests are no longer being consistently collected at a statewide level. Therefore, the most recent 5 years of data (2005-2008 and 2012) will be retained and used for calculating an annual mortality and serious injury estimate.

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

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

Other Mortality

Illegal shooting of sea lions in U.S. waters was thought to be a potentially significant source of mortality prior to the listing of sea lions as threatened under the ESA in 1990. (Note: the 1994 amendments to the MMPA made intentional lethal take of any marine mammal illegal except for subsistence hunting by Alaska Natives or where imminently necessary to protect human life).

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

Steller sea lion mortality and serious injury caused by gunshot wounds is reported to the NMFS Alaska Region and the NMFS West Coast Region. During 2012-2014, 45 animals with gunshot wounds were reported to the NMFS West Coast Region stranding network, resulting in a minimum average annual mortality and serious injury rate of 15 Steller sea lions from this stock (Table 3; Helker et al. 2016). An additional two animals with gunshot wounds were reported to the NMFS Alaska Region in 2010. Although it is likely that illegal shooting does occur in Alaska, these events are not included in the estimate of the average annual mortality and serious injury rate due to gunshot wounds because it could not be confirmed that the deaths were due to illegal shooting and were not already accounted for in the estimate of animals struck and lost in the Alaska Native subsistence harvest. Other non-fishery human-caused mortality and serious injury reported to the NMFS Alaska Region stranding network in 2010-2014 (and the resulting minimum mean annual mortality and serious injury rates) were due to entanglement in marine debris (27), dependent pups of animals seriously injured by marine debris (1), entanglement in foreign gillnet (0.2), arrow strike (0.2), and explosives (0.2) (Table 3; Helker et al. 2016). These estimates are considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel), and human-related stranding data are not available for British Columbia.

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. Three mortalities occurred incidental to research on the Eastern U.S. stock of Steller sea lions in 2011 (Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910), resulting in a mean annual mortality and serious injury rate of 0.6 sea lions from this stock in 2010-2014.

The minimum mean annual human-caused mortality and serious injury rate in 2010-2014 from sources other than fisheries or Alaska Native harvest is 45 eastern Steller sea lions.

STATUS OF STOCK

Based on currently available data, the minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (14 sea lions) is less than 10% of the calculated PBR (10% of PBR = 250) 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 (108 sea lions) does not exceed the PBR (2,498) for this stock. The Eastern U.S. stock of Steller sea lions is currently not listed under the ESA and is not considered depleted under the MMPA. This stock is classified as a non-strategic stock. Because the counts of eastern Steller sea lions have steadily increased over a 30+ year period, this stock is likely within its Optimum Sustainable Population (OSP); however, no determination of its status relative to OSP has been made.

HABITAT CONCERNS

Unlike the Western U.S. stock of Steller sea lions, there has been a sustained and robust increase in abundance of the Eastern U.S. stock throughout its breeding range. In the southern end of its range (Channel Islands in southern California), it has declined considerably since the late 1930s and several rookeries and haulouts south of Año Nuevo Island have been abandoned. Changes in the ocean environment, particularly warmer temperatures, may be factors that have favored California sea lions over Steller sea lions in the southern portion of the Steller's range (NMFS 2008). The risk of oil spills to this stock may increase in the next several decades due to increased shipping, including tanker traffic, from ports in British Columbia and possibly Washington State (COSEWIC 2013, NMFS 2013, Wiles 2014) and LNG facility and pipeline construction (COSEWIC 2013).

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern fur seals occur from southern California north to the Bering Sea (Fig. 1) and west to the 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).

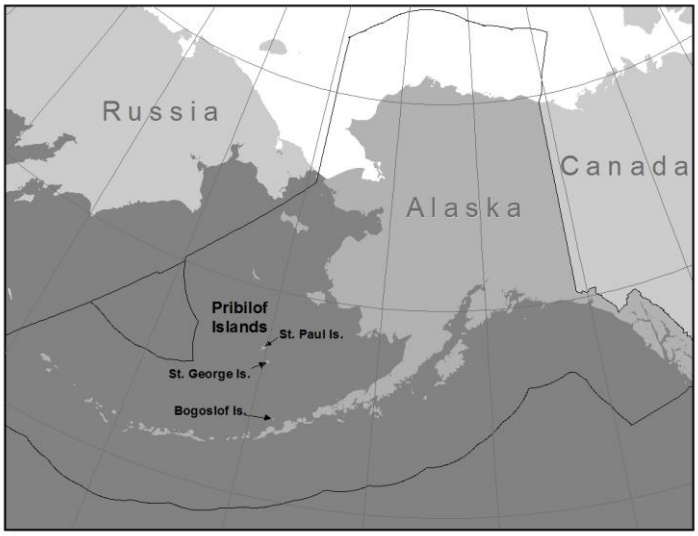

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area).

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. 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). 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 on Bogoslof Island (mean of 2011 and 2015), is 637,561 northern fur seals (4.47 × 142,631).

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)

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 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 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock is 539,638 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 decline. However, pup production appeared to stabilize again on St. George Island beginning around 2002 (Fig. 3). During 1998-2014, pup production declined 4.25% per year (SE = 0.48%; $P < 0.01$) on St. Paul Island and 1.42% per year (SE = 0.54%; $P = 0.04$) on St. George Island. The estimated pup production in 2014 was below the 1917 level (Bower and Aller 1918) 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). 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.

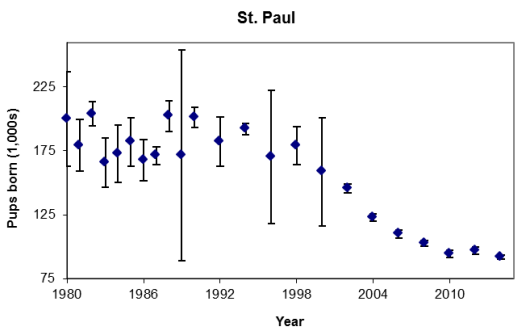

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, 1980-2014.

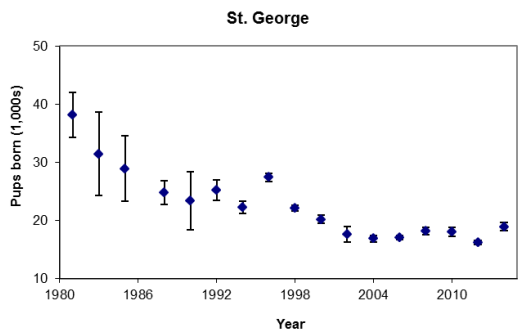

Figure 3. Estimated number of northern fur seal pups born on St. George Island, 1980-2014.

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 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 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 fur seals (539,638 × 0.043 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Eastern Pacific northern fur seals in 2011-2015 is 436 fur seals: 3.2 in U.S. commercial fisheries, 2.4 in unknown (commercial, recreational, or subsistence fisheries), 5.2 in marine debris, 0.4 due to other causes (power plant entrainment and car strike), and 425 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 (see details in text and in Helker et al. 2017). 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 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, incidental mortality and serious injury of northern fur seals was observed in one of the 22 federally-regulated 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 is 0.6 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 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	obs data	99 99 99 99 99	0 0 0 1 2	0 0 0 1 2	0.6 (CV = 0.02)
Minimum total estimated annual mortality						0.6 (CV = 0.02)

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 is provided in Table 3 (Helker et al. 2017). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and should be considered a minimum because not all entangled animals strand and not 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 northern fur seals entangled in commercial Bering Sea/Aleutian Islands trawl gear were reported to the NMFS Alaska Region stranding network in 2011-2015, resulting in minimum mean annual mortality and serious injury rates of 0.6 and 2 fur seals, respectively, in these fisheries (Table 3; Helker et al. 2017).

An additional eight 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) and unidentified net (1 each in 2011 and 2012); however, since these animals were disentangled and released with non-serious injuries (Helker et al. 2017), they were not included in the mean annual mortality and serious injury rate for 2011-2015.

The total mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2011-2015 is 3.2 northern fur seals (0.6 from observer data + 2.6 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) in Alaska waters in 2011-2015 is 1.8 northern fur seals (Table 3; Helker et al. 2017). 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 assigned to both the Eastern Pacific and California stocks of northern fur seals. During 2011-2015, three northern fur seal entanglements in trawl gear that occurred off the U.S. west coast in December through May were reported to the NMFS West Coast Region stranding network (Helker et al. 2017), resulting in an average annual mortality and serious injury rate of 0.6 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 a minimum because not all entangled animals strand and not 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); therefore, it was not included in the mean annual mortality and serious injury rate for 2011-2015.

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 (Helker et al. 2017). 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**	**Mean annual mortality**
Entangled in commercial Bering Sea/Aleutian Is. halibut longline gear	0	0	0	3	0	0.6
Entangled in commercial Bering Sea/Aleutian Is. trawl gear	2	1	0	6	1	2
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	0.2
Entangled in Bering Sea/Aleutian Is. unidentified fishery gear*	0	0	0	0	1	0.2
Entangled in gillnet*	0	0	0	1	0	0.2
Entangled in unidentified net*	0	3	0	1	0	0.8
Entangled in trawl gear*	1[a]	0	0	2[a]	0	0.6
Entangled in marine debris	10	4	1	11	0	5.2
Entrained in power plant intake	0	1[a]	0	0	0	0.2
Struck by car	0	0	0	0	1	0.2
Total in commercial fisheries						2.6
*Total in unknown (commercial, recreational, or subsistence) fisheries						2.4
Total in marine debris						5.2
Total due to other sources (power plant entrainment, car strike)						0.4

[a]Mortality or serious injury that occurred off the coasts of Washington, Oregon, or California in December through May 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 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). 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). During 2011-2015, the average annual subsistence harvest on the Pribilof Islands was 425 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.

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

[a]Lestenkof et al. (2011); [b]Merculief (2011); [c]Lestenkof et al. (2012); [d]Lekanof (2013); [e]Lestenkof et al. (2014); [f]Kashevarof (2014a); [g]Melovidov et al. (2014); [h]Kashevarof (2014b); [i]Testa (2016); [j]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 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 assigned to both stocks. The mean annual mortality and serious injury rate due to entanglement in marine debris in Alaska waters (5.2) and 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 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). These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and should be considered a minimum because not all entangled animals strand and not all stranded animals are found, reported, or have the cause of death determined

An additional 20 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) were disentangled and released with non-serious injuries (Helker et al. 2017); therefore, these animals were not included in the mean annual mortality and serious injury rate for 2011-2015.

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 fur seals) is less than 10% of the calculated PBR (10% of PBR = 1,160 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 fur seals) does not exceed the PBR (11,602) 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.

HABITAT CONCERNS

Northern fur seals forage on a variety of fish species, including pollock. 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 that lactating female fur seals and juvenile males from 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). Call et al. (2008) also found northern fur seals had three types of individual foraging route tactics at the rookery, which is important to consider in the context of adaptation to changes in environmental conditions and prey distributions. From 1982 to 2014, 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. 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.

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HARBOR SEAL (*Phoca vitulina richardii*)

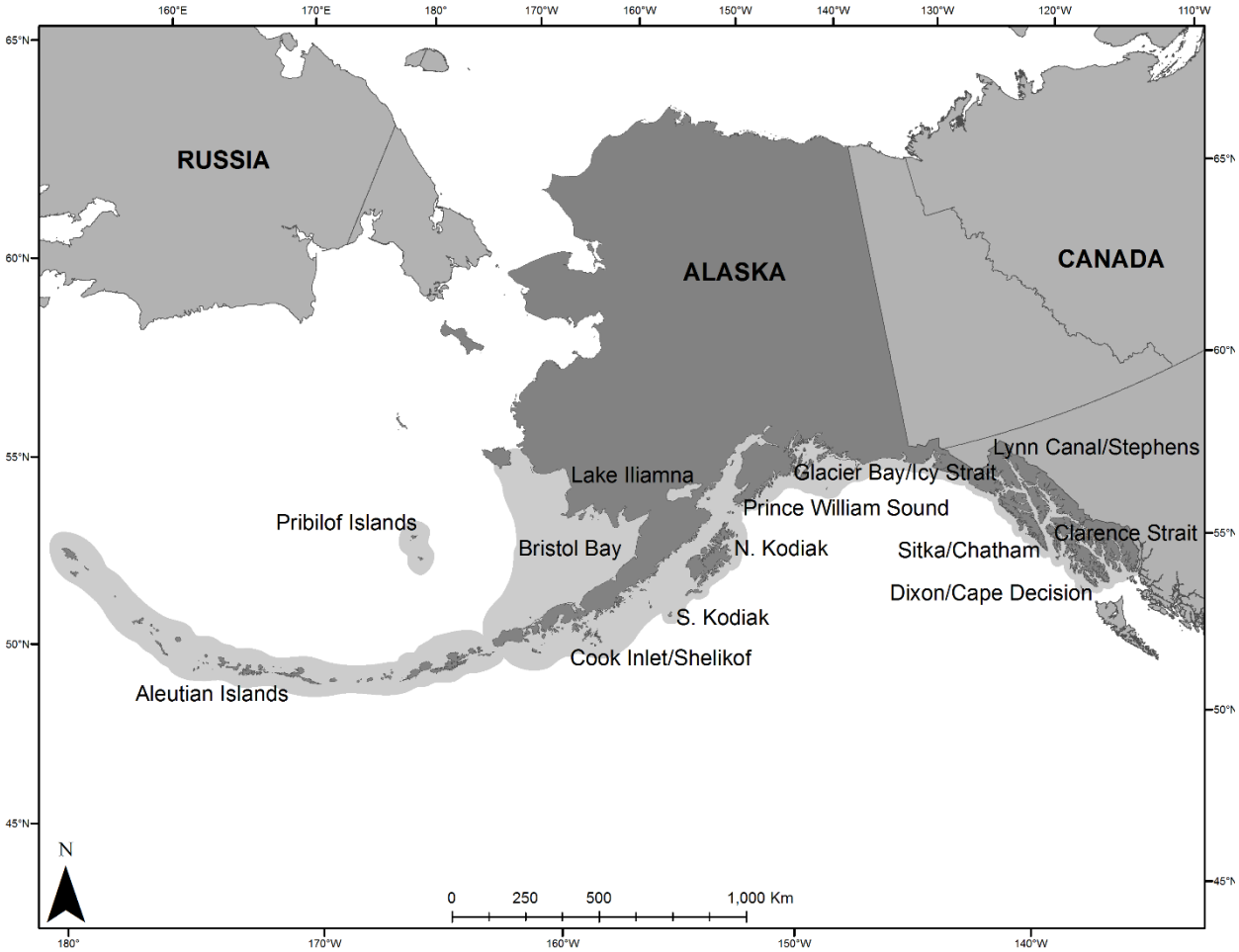

Figure 1. Approximate distribution of harbor seals in Alaska waters (shaded coastline area).

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

Local or regional trends in harbor seal numbers have been monitored at various time intervals since the 1970s, revealing diverse spatial patterns in apparent population trends. Where declines have been observed, they seem

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

Westlake and O'Corry-Crowe's (2002) analysis of genetic information from 881 samples across 181 sites revealed population subdivisions on a scale of 600-820 km. These results suggest that genetic differences within Alaska, and most likely over their entire North Pacific range, increase with increasing geographic distance. New information revealed substantial genetic differences indicating that female dispersal occurs at region specific spatial scales of 150-540 km. This research identified 12 demographically independent clusters within the range of Alaskan harbor seals; however, significant geographic areas within the Alaskan harbor seal range remain unsampled (O'Corry-Crowe et al. 2003).

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

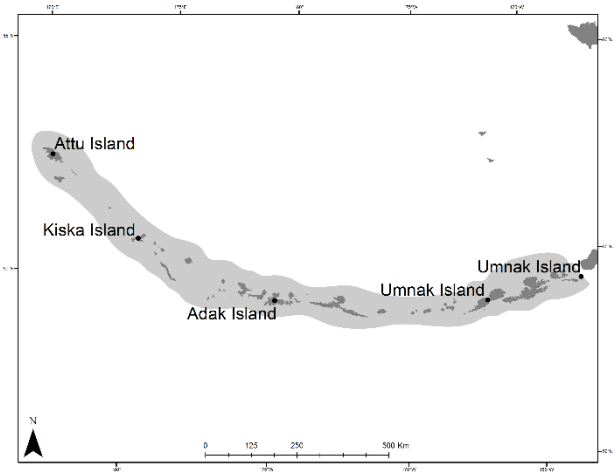

Figure 2a. Approximate distribution of Aleutian Islands harbor seal stock (shaded area).

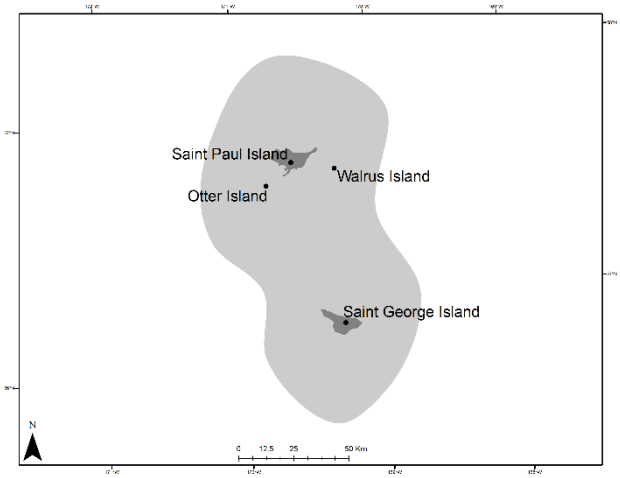

Figure 2b. Approximate distribution of Pribilof Islands harbor seal stock (shaded area).

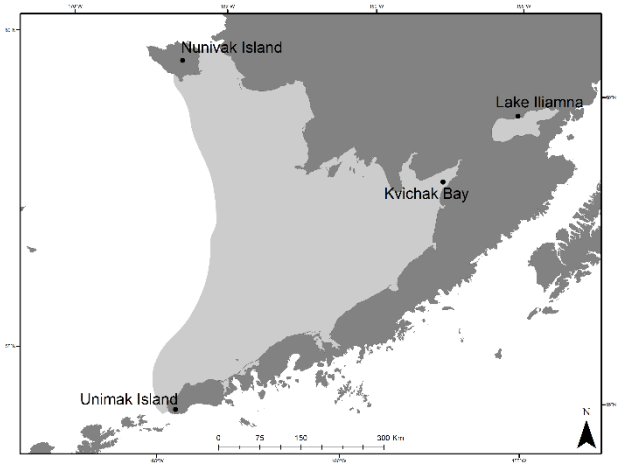

Figure 2c. Approximate distribution of Bristol Bay harbor seal stock (shaded area).

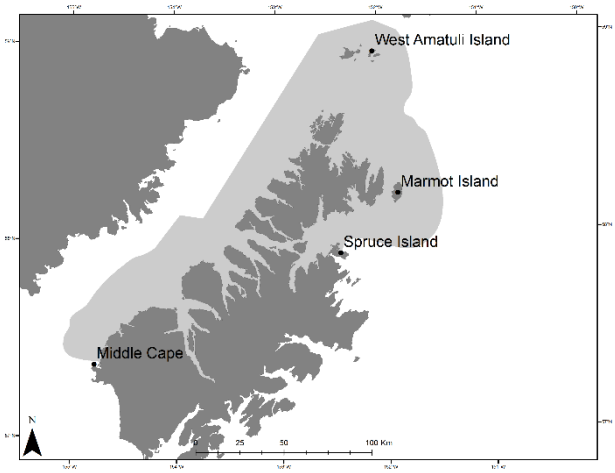

Figure 2d. Approximate distribution of North Kodiak harbor seal stock (shaded area).

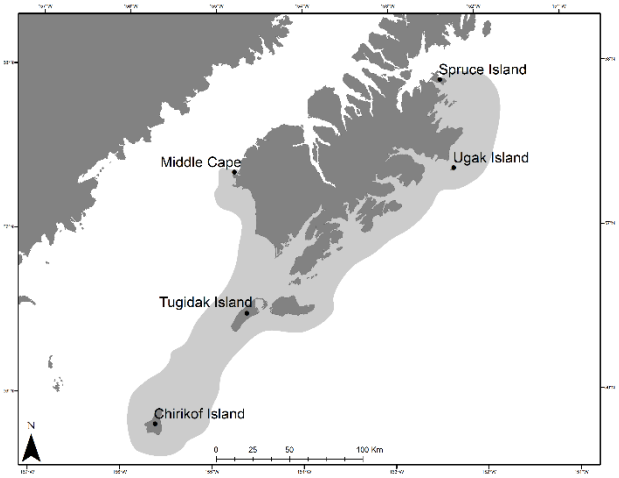

Figure 2e. Approximate distribution of South Kodiak harbor seal stock (shaded area).

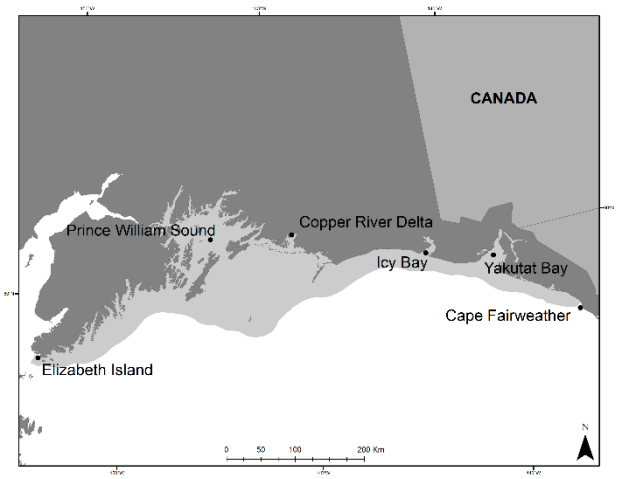

Figure 2f. Approximate distribution of Prince William Sound harbor seal stock (shaded area).

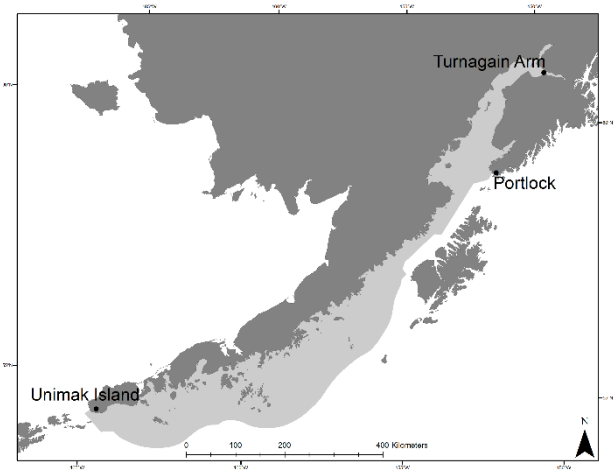

Figure 2g. Approximate distribution of Cook Inlet/Shelikof Strait harbor seal stock (shaded area).

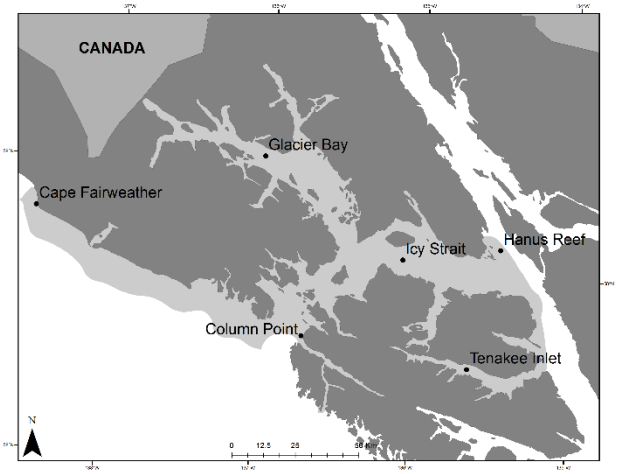

Figure 2h. Approximate distribution of Glacier Bay/Icy Strait harbor seal stock (shaded area).

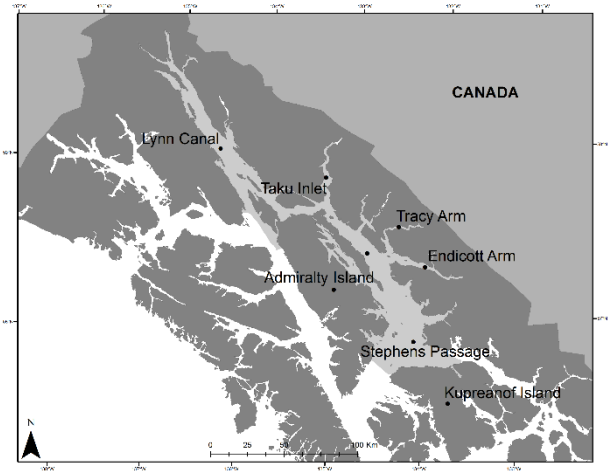

Figure 2i. Approximate distribution of Lynn Canal/Stephens Passage harbor seal stock (shaded area).

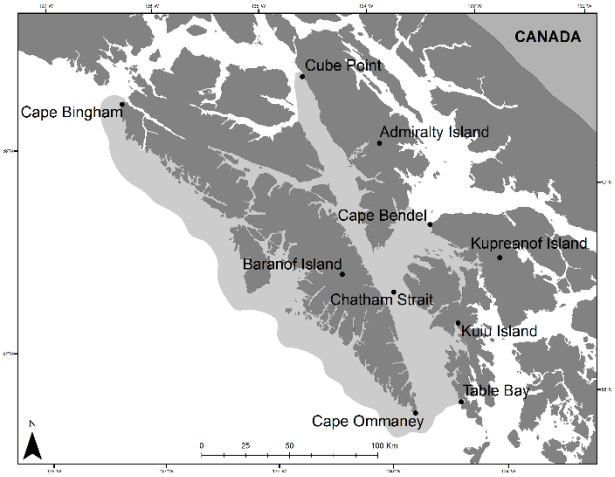

Figure 2j. Approximate distribution of Sitka/Chatham Strait harbor seal stock (shaded area).

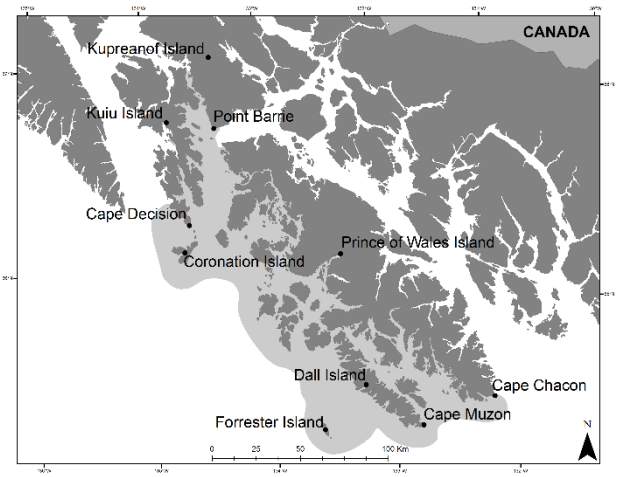

Figure 2k. Approximate distribution of Dixon/Cape Decision harbor seal stock (shaded area).

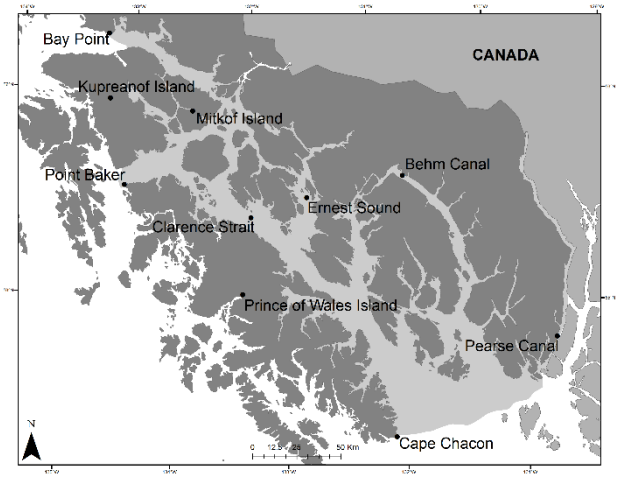

Figure 2l. Approximate distribution of Clarence Strait harbor seal stock (shaded area).

POPULATION SIZE

The Alaska Fisheries Science Center's National Marine Mammal Laboratory routinely conducts aerial surveys of harbor seals across their entire range in Alaska. Prior to 2008, Alaska was divided into five survey regions, with one region surveyed per year. In 2010, the survey sites were prioritized based on the newly defined harbor seal stock divisions, and annual aerial surveys attempt to sample the full geographic range of harbor seals in Alaska, with a focus on sites that make up a significant portion of each stock's population every year; sites with fewer seals are flown every 3 to 5 years. This site specific survey approach is designed to provide the counts necessary to estimate stock specific population abundance and trend for all 12 stocks annually. To derive an accurate estimate of population size from these surveys, a method was developed to address the influence of external conditions on the number of seals hauled out on shore, and counted, during the surveys. Many factors influence the propensity of seals to haul out, including tides, time of day, and date in the seals' annual life-history cycle. A statistical model defining the relationship between these factors and the number of seals hauled out was developed. Based on those models, the survey counts for each year were adjusted to the number of seals that would have been ashore during a hypothetical survey conducted under ideal conditions for hauling out (Boveng et al. 2003). In a separate analysis of radio-tagged seals, a similar statistical model was used to estimate the proportion of seals that were hauled out under those ideal conditions (Simpkins et al. 2003). The results from these two analyses were combined for each region to estimate the population size of each stock in Alaska.

Abundance Estimates and Minimum Population Estimates

The current statewide abundance estimate for Alaskan harbor seals is 205,090 (Boveng et al. in press a), based on aerial survey data collected during 1998-2011. See Table 1 for abundance estimates of the 12 stocks of harbor seals in Alaska. The minimum population estimate (N_{MIN}) for 11 of the 12 stocks of harbor seals in Alaska is calculated as the lower bound of the 80% credible interval obtained from the posterior distribution of abundance estimates. This approach is consistent with the definition of potential biological removal (PBR) in the current guidelines (Wade and Angliss 1997). The abundance estimate and N_{MIN} for the remaining stock, the Pribilof Islands stock, is simply the number counted in the most recent survey of this very small group.

Table 1. Abundance and 5-year trend estimates, by stock, for harbor seals in Alaska, along with respective estimates of standard error. The probability of decrease represents the proportion of the posterior probability distribution for the 5-year trend that fell below a value of 0 seals per year.

Stock	Year of last survey	Abundance estimate	SE	5-year trend estimate	SE	Probability of decrease	N_{MIN}
Aleutian Islands	2011	6,431	882	75	220	0.36	5,772
Pribilof Islands	2010	232	n/a	n/a	n/a	n/a	232
Bristol Bay	2011	32,350	6,882	1,209	1,941	0.25	28,146
North Kodiak	2011	8,321	1,619	531	590	0.16	7,096
South Kodiak	2011	19,199	2,429	-461	761	0.72	17,479
Prince William Sound	2011	29,889	13,846	26	3,498	0.56	27,936
Cook Inlet/Shelikof Strait	2011	27,386	3,328	313	1,115	0.38	25,651
Glacier Bay/Icy Strait	2011	7,210	1,866	179	438	0.40	5,647
Lynn Canal/Stephens Passage	2011	9,478	1,467	-176	388	0.71	8,605
Sitka/Chatham Strait	2011	14,855	2,106	411	568	0.23	13,212
Dixon/Cape Decision	2011	18,105	1,614	216	360	0.29	16,727
Clarence Strait	2011	31,634	4,518	921	1,246	0.21	29,093

Current Population Trend

Aerial surveys of harbor seal haulout sites throughout Alaska have been conducted annually and provide information on trends in abundance. The most current estimates of trend (Table 1) were estimated as the means of the

slopes of 1,000 simple linear regressions over the most recent eight annual estimates in each of the 1,000 Markov Chain Monte Carlo (MCMC) samples from the posterior distributions for abundance. Thus, they are in units of seals per year, rather than the typical annual percent growth rate. There is no appropriate method for converting these estimates of trend to annual percent growth rate. As a reflection of uncertainty in trend estimates, the proportion of the posterior distribution for each stock's trend that lies below the value of 0 is used as an estimate of the probability that a stock is currently decreasing (Table 1). This allows a probabilistic determination of the qualitative trend status: a value greater than 0.5 means the evidence suggests that the stock is decreasing; less than 0.5 means the stock is increasing. Because there will typically be a 2-3 year lag between the most recent surveys and the Stock Assessment Report update, a 5-year interval was used for estimating trend. This ensures trend estimates are based on data no more than about 8 years old, which is considered to be the approximate threshold of reliability for Marine Mammal Protection Act (MMPA) stock assessment data. One caveat of this approach is that, due to the skewness inherent in the posterior distribution, it is possible for a stock to exhibit a positive trend while also having a probability of decrease greater than 0.5. The following summarizes historical and recent information on the population trend for each of the 12 stocks.

Aleutian Islands: A partial estimate of harbor seal abundance in the Aleutian Islands was determined from skiff surveys of 106 islands from 1977 to 1982 (8,601 seals). Small et al. (2008) compared counts from the same islands during a 1999 aerial survey (2,859 seals). Counts decreased at a majority of the islands. Islands with greater than 100 seals decreased by 70%. The overall estimates showed a 67% decline during the approximate 20-year period (Small et al. 2008). The current (2007-2011) estimate of the population trend in the Aleutian Islands is +75 seals per year, with a probability that the stock is decreasing of 0.36 (Table 1).

Pribilof Islands: Counts of harbor seals in the Pribilof Islands ranged from 250 to 1,224 in the 1970s. Counts in the 1980s and 1990s ranged between 119 and 232 harbor seals. Prior to July 2010, the most recent count was in 1995 when a total of 202 seals were counted. In July 2010, approximately 185 adults and 27 pups were observed on Otter Island plus approximately 20 on all the other islands combined for a total of 232 harbor seals. Maximum seal counts (all ages) are nearly identical to the 1995 counts (212 vs. 202), but 2010 pup numbers were slightly less (27 vs. 42). The current population trend in the Pribilof Islands is unknown.

Bristol Bay: At Nanvak Bay, the largest haulout in northern Bristol Bay, harbor seals declined in abundance from 1975 to 1990 and increased from 1990 to 2000 (Jemison et al. 2006). Land-based harbor seal counts at Nanvak Bay from 1990 to 2000 increased at 9.2% per year during the pupping period and 2.1% per year during the molting period (Jemison et al. 2006). The Iliamna Lake harbor seal population of about 400 seals, that forms a small portion of the Bristol Bay stock, likely increased through the 1990s and is now stable at around 400 animals (Boveng et al. in press b). The current (2007-2011) estimate of the population trend in the Bristol Bay stock is +1,209 seals per year, with a probability that the stock is decreasing of 0.25 (Table 1).

North Kodiak: The current (2007-2011) estimate of the North Kodiak population trend is +531 seals per year, with a probability that the stock is decreasing of 0.16 (Table 1).

South Kodiak: A significant portion of the harbor seal population within the South Kodiak stock is located at and around Tugidak Island off the southwest coast of Kodiak Island. Sharp declines in the number of seals present on Tugidak were observed between 1976 and 1998. The highest rate of decline was 21% per year between 1976 and 1979 (Pitcher 1990). While the number of seals on Tugidak has stabilized and shown some evidence of increase since the decline, the population in 2000 remained reduced by 80% compared to the levels in the 1970s (Jemison et al. 2006). The current (2007-2011) estimate of the South Kodiak population trend is -461 seals per year, with a probability that the stock is decreasing of 0.72 (Table 1).

Prince William Sound: The Prince William Sound stock includes harbor seals both within and adjacent to Prince William Sound proper. Within Prince William Sound proper, harbor seals declined in abundance by 63% between 1984 and 1997 (Frost et al. 1999). In Aialik Bay, adjacent to Prince William Sound proper, there has been a decline in pup production by 4.6% annually from 40 down to 32 pups born from 1994 to 2009 (Hoover-Miller et al. 2011). The current (2007–2011) estimate of the Prince William Sound population trend over a 5-year period is +26 seals per year, with a probability that the stock is decreasing of 0.56 (Table 1). As noted earlier, this is an example where the skewed nature of the posterior distribution of the abundance estimate has resulted in a higher than 0.5 probability of decrease while subsequently showing an increasing trend.

Cook Inlet/Shelikof Strait: A multi-year study of seasonal movements and abundance of harbor seals in Cook Inlet was conducted between 2004 and 2007. This study involved multiple aerial surveys throughout the year, and the data indicated a stable population of harbor seals during the August molting period (Boveng et al. 2011). Aerial surveys along the Alaska Peninsula present greater logistical challenges and have therefore been conducted less frequently. The current (2007-2011) estimate of the Cook Inlet/Shelikof Strait population trend is +313 seals per year, with a probability that the stock is decreasing of 0.38 (Table 1).

Glacier Bay/Icy Strait: The Glacier Bay/Icy Strait stock showed a negative population trend estimate for harbor seals from 1992 to 2008 in June and August for glacial (-7.7%/yr; -8.2%/yr) and terrestrial sites (-12.4%/yr, August only) (Womble et al. 2010). Trend estimates by Mathews and Pendleton (2006) were similarly negative for both glacial and terrestrial sites. Long-term monitoring of harbor seals on glacial ice has occurred in Glacier Bay since the 1970s (Mathews and Pendleton 2006) and has shown this area to support one of the largest breeding aggregations in Alaska (Steveler 1979, Calambokidis et al. 1987). After a dramatic retreat of Muir Glacier (more than 7 km), in the East Arm of Glacier Bay, between 1973 and 1986 and the subsequent grounding and cessation of calving in 1993, floating glacial ice was greatly reduced as a haul-out substrate for harbor seals and ultimately resulted in the abandonment of upper Muir Inlet by harbor seals (Calambokidis et al. 1987, Hall et al. 1995, Mathews 1995). Prior to 1993, seal counts were up to 1,347 in the East Arm of Glacier Bay; 2008 counts were fewer than 200 (Streveler 1979, Molnia 2007). The current (2007–2011) estimate of the Glacier Bay/Icy Strait population trend is +179 seals per year, with a probability that the stock is decreasing of 0.40 (Table 1).

Lynn Canal/Stephens Passage: The current (2007-2011) estimate of the Lynn Canal/Stephens Passage population trend is -176 seals per year, with a probability that the stock is decreasing of 0.71 (Table 1).

Sitka/Chatham Strait: The current (2007-2011) estimate of the Sitka/Chatham Strait population trend is +411 seals per year, with a probability that the stock is decreasing of 0.23 (Table 1).

Dixon/Cape Decision: The current (2007-2011) estimate of the Dixon/Cape Decision population trend is +216 seals per year, with a probability that the stock is decreasing of 0.29 (Table 1).

Clarence Strait: The current (2007-2011) estimate of the Clarence Strait population trend is +921 seals per year, with a probability that the stock is decreasing of 0.21 (Table 1).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reliable rates of maximum net productivity have not been estimated directly from the 12 stocks of harbor seals identified in Alaska. Based on monitoring in Washington State from 1978 to 1999, Jeffries et al. (2003) estimated R_{MAX} to be 12.6% and 18.5% for harbor seals of the inland and coastal stocks, respectively. Harbor seals have been protected in British Columbia since 1970, and the monitored portion of that population responded with an annual rate of increase of approximately 12.5% through the late 1980s (Olesiuk et al. 1990), though a more recent evaluation suggested that 11.5% may be a more appropriate figure (DFO 2010). These empirical estimates of R_{MAX} indicate that the continued use of the pinniped maximum theoretical net productivity rate of 12% is appropriate for the Alaska stocks (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized MMPA, the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. Marine mammal stocks such as the harbor seal stocks in Alaska that are taken by subsistence hunting may be given F_R values up to 1.0, provided they are "known to be increasing" or "not known to be decreasing" and "there have not been recent increases in the levels of takes" (Wade and Angliss 1997). For harbor seals in Alaska, these guidelines were followed by assigning all harbor seal stocks an initial, default recovery factor of 0.5. The default value was adjusted up to 0.7 if the estimated probability of decrease was greater than 0.7. The value was adjusted down to 0.3 if the estimated probability of decrease was less than 0.3. This provides a simple, balanced approach for providing a recovery factor consistent with current guidelines while incorporating results from novel statistical methods. Table 2 summarizes the PBR levels for each stock of harbor seals in Alaska based on N_{MIN} estimates, R_{MAX} = 12%, and F_R values.

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

Stock	N_{MIN}	R_{MAX}	**Recovery Factor (F_R)**	**PBR**
			(default value = 0.5)	
Aleutian Islands	5,772	0.12	0.5	173
Pribilof Islands	232	0.12	0.5	7
Bristol Bay	28,146	0.12	0.7	1,182
North Kodiak	7,096	0.12	0.7	298
South Kodiak	17,479	0.12	0.3	314
Prince William Sound	27,936	0.12	0.5	838
Cook Inlet/Shelikof Strait	25,651	0.12	0.5	770
Glacier Bay/Icy Strait	5,647	0.12	0.5	169
Lynn Canal/Stephens Passage	8,605	0.12	0.3	155
Sitka/Chatham Strait	13,212	0.12	0.7	555
Dixon/Cape Decision	16,727	0.12	0.7	703
Clarence Strait	29,093	0.12	0.7	1,222

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Previous stock assessments for harbor seals indicated three observed commercial fisheries operated within the range of the Bering Sea stocks of harbor seals, three within the range of stocks in Southeast Alaska, and five within the range of harbor seal stocks in the Gulf of Alaska. As of 2003, changes in how fisheries are defined in the MMPA List of Fisheries have resulted in separating these fisheries into 14 fisheries in the Bering Sea, 9 fisheries in Southeast Alaska, and 22 fisheries in the Gulf of Alaska based on both gear type and target species (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.

Observer programs have documented mortality and serious injury of harbor seals in the Bering Sea/Aleutian Islands (BSAI) flatfish trawl fishery (1 in 2011 and 2 in 2012), Gulf of Alaska (GOA) Pacific cod trawl fishery (1 in 2010), and GOA flatfish trawl fishery (1 in 2011 and 2 in 2013) in 2009-2013 (Breiwick 2013; NMML, unpubl. data) (Table 3).

Although a reliable estimate of the overall mortality and serious injury rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in salmon gillnet fisheries known to interact with several of these stocks, for the purposes of stock assessment, mean annual mortality and serious injury rates are assigned to the following harbor seal stocks based on the location of takes in observed fisheries in 2009-2013 (Table

3): Bristol Bay stock: 0.6 from the BSAI flatfish trawl fishery; South Kodiak stock: 0.6 from the GOA Pacific cod trawl fishery + 1.3 from the GOA flatfish trawl fishery; Cook Inlet/Shelikof Strait stock: 0.4 from the GOA flatfish trawl fishery mortality in 2011 (this seal could have been from either the South Kodiak or Cook Inlet/Shelikof Strait stock, so the mortality is assigned to both stocks).

Table 3. Summary of incidental mortality and serious injury of harbor seals in Alaska due to U.S. commercial fisheries in 2009-2013 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; NMML, unpubl. data).

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	obs data	99 99 99 99 99	0 0 1 2 0	0 0 1 2 0	0.6 (CV = 0.02)
Gulf of Alaska Pacific cod trawl	2009 2010 2011 2012 2013	obs data	29 31 41 25 11	0 1 0 0 0	0 2.8 0 0 0	0.6 (CV = 0.81)
Gulf of Alaska flatfish trawl	2009 2010 2011 2012 2013	obs data	21 26 31 42 46	0 0 1 0 2[a]	0 0 1.9 0 4.7	1.3 (CV = 0.69)[b]
Minimum total estimated annual mortality						2.5 (CV = 0.41)

[a]Two pinnipeds incidentally caught in 2013 were recently genetically identified as harbor seals.
[b]The CV for this fishery does not accommodate the 2013 data.

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

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

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

Reports to the NMFS Alaska Region stranding database of harbor seals entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data (Helker et al. 2015). During 2009-2013, harbor seal mortality and serious injury occurred due to interactions with unknown fisheries (1 Clarence Strait harbor seal was observed with a hook and weight in its mouth in 2010 and 1 Cook Inlet/Shelikof Strait harbor seal entangled in an unknown set net in 2011) and recreational fishing gear (1 Prince William Sound harbor seal was caught in hook and line gear and cut loose with trailing gear in 2009), resulting in mean annual mortality and serious injury rates of 0.2 harbor seals from each of these stocks due to fishery-related strandings.

Alaska Native Subsistence/Harvest Information

The Alaska Native subsistence harvest of harbor seals has been estimated by the Alaska Native Harbor Seal Commission (ANHSC) and the Alaska Department of Fish and Game (ADF&G). Information from the ADF&G indicates the average harvest levels for the 12 stocks of harbor seals identified in Alaska from 2004 to 2008, including struck and lost, as follows (see Table 5; average annual harvest column). In 2011 and 2012, data on community subsistence harvests were collected for Kodiak Island, Prince William Sound, and Southeast Alaska (see Table 5; annual harvest 2011-2012 column). The remaining stocks have no updated community subsistence data, therefore, the most recent 5-years of data (2004-2008) will be retained and used for estimating average annual mortality and serious injury for these stocks.

Table 5. Summary of the subsistence harvest data for all 12 harbor seal stocks in Alaska, 2004-2008 and 2011-2012. Data are from Wolfe et al. (2005, 2006, 2008, 2009a, 2009b, 2012, 2013).

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

Other Mortality

Reports to the NMFS Alaska Region stranding database of harbor seals entangled in marine debris or with injuries caused by other types of human interaction are another source of mortality and serious injury data (Helker et al. 2015). During 2009-2013, one harbor seal (observed towing a buoy in 2011) was determined to be seriously injured due to entanglement in marine debris and one harbor seal mortality due to a ship strike occurred in 2009, 2010, and 2012. The estimated average annual serious injury and mortality rates based on these stranding data are 0.6 Clarence Strait harbor seals (0.2 due to entanglement in marine debris/gear + 0.4 due to ship strikes in 2009 and 2012) and 0.2 Lynn Canal/Stephens Passage harbor seals (due to a ship strike in 2010) for 2009 to 2013. An additional average annual mortality and serious injury rate of 0.2 will be applied to the Prince William Sound stock for a harbor seal entanglement, observed (with a remotely operated vehicle) in the salmon seine net of a sunken fishing vessel in Prince William Sound in 2011, that was reported to the NMFS Alaska Region (Helker et al. 2015). Mortality and serious injury may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2003 and 2007, there was no mortality or serious injury resulting from research on any stock of harbor seals in Alaska (Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

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

Aleutian Islands: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 17 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 (commercial fisheries) + 90 (harvest) + 0 (other fisheries + other mortality) = 90) is not known to exceed the PBR (173). The Aleutian Islands stock of harbor seals is not classified as a strategic stock.

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

Bristol Bay: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 118 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.6 + 141 + 0 = 142) is not known to exceed the PBR (1,182). The Bristol Bay stock of harbor seals is not classified as a strategic stock.

North Kodiak: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 30 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 37 + 0 = 37) is not known to exceed the PBR (298). The North Kodiak stock of harbor seals is not classified as a strategic stock.

South Kodiak: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 32 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.9 + 126 + 0 = 128) is not known to exceed the PBR (315). The South Kodiak stock of harbor seals is not classified as a strategic stock.

Prince William Sound: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 84 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and

serious injury (24 + 255 + 0.4 = 279) is not known to exceed the PBR (838). The Prince William Sound stock of harbor seals is not classified as a strategic stock.

Cook Inlet/Shelikof Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 77 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 233 + 0.2 = 234) is not known to exceed the PBR (770). The Bristol Bay stock of harbor seals is not classified as a strategic stock.

Glacier Bay/Icy Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 17 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 104 + 0 = 104) is not known to exceed the PBR (169). The Glacier Bay/Icy Strait stock of harbor seals is not classified as a strategic stock.

Lynn Canal/Stephens Passage: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 16 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 50 + 0.2 = 50) is not known to exceed the PBR (155). The Lynn Canal/Stephens Passage stock of harbor seals is not classified as a strategic stock.

Sitka/Chatham Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 56 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 77 + 0 = 77) is not known to exceed the PBR (555). The Sitka/Chatham Strait stock of harbor seals is not classified as a strategic stock.

Dixon/Cape Decision: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 70 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 69 + 0 = 69) is not known to exceed the PBR (703). The Dixon/Cape Decision stock of harbor seals is not classified as a strategic stock.

Clarence Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 122 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 40 + 0.8 = 41) is not known to exceed the PBR (1,222). The Clarence Strait stock of harbor seals is not classified as a strategic stock.

HABITAT CONCERNS

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

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SPOTTED SEAL (*Phoca largha*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Spotted seals are distributed along the continental shelf of the Bering, Chukchi, and Beaufort seas, and the Sea of Okhotsk south to the western Sea of Japan and northern Yellow Sea (Fig. 1). Eight main areas of spotted seal breeding have been reported (Shaughnessy and Fay 1977). On the basis of small samples and preliminary analyses of genetic composition, potential geographic barriers, and significance of breeding groups, Boveng et al. (2009) grouped those breeding areas into three Distinct Population Segments (DPSs): the Bering DPS, which includes breeding areas in the Bering Sea and portions of the East Siberian, Chukchi, and Beaufort seas that may be occupied outside the breeding period; the Okhotsk DPS; and the Southern DPS, which includes spotted seals breeding in the Yellow Sea and Peter the Great Bay in the Sea of Japan. For the purposes of this stock assessment, we define the Alaska stock of spotted seals to be that portion of the Bering DPS in U.S. waters.

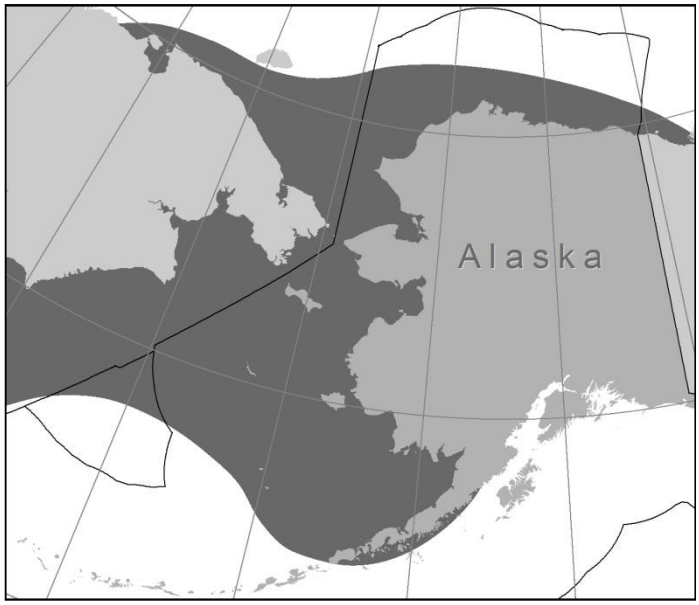

Figure 1. Approximate distribution of spotted seals in the Bering DPS (dark shaded area). The Alaska stock is defined as the portion of the Bering DPS within U.S. waters.

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

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; 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 splitting Alaska spotted seals into more than one stock. Therefore, only one Alaska stock is recognized in U.S. waters.

POPULATION SIZE

In spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire Bering Sea (defined as south of 65°45'N) and Sea of Okhotsk (Moreland et al. 2013). Conn et al. (2014), using a very limited sub-sample of the data collected only from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of approximately 461,625 spotted seals (95% CI: 388,732-560,348) in those waters. Although the entire Alaska stock of spotted seals is believed to be in the Bering Sea in the spring (Boveng et al. 2009), the proportion of the Alaska stock that occupies U.S. (vs. Russian) waters at that time is not known. As the Conn et al. (2014) estimate is only for the U.S. Bering Sea it is possible that it is a biased estimate of the Alaska stock, but the direction of any bias cannot be determined at this time.

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): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. The 2012 Bering Sea abundance estimate by Conn et al. (2014), however, was calculated using a Bayesian hierarchical framework and so we used the 20th percentile of the posterior distribution of abundance estimates in place of the CV in Equation 1 to provide an N_{MIN} of 423,237 spotted seals in the U.S. portion of the Bering Sea in the spring.

Current Population Trend

Reliable data on trends in population abundance for the Alaska stock of spotted seals are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is unavailable for the Alaska stock of spotted seals. Hence, until additional data become available, the pinniped maximum theoretical net productivity rate (R_{MAX}) of 12% 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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Using the N_{MIN} calculated from Conn et al. (2014), the PBR for the Alaska stock of spotted seals is 12,697 seals (423,237 × 0.06 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Alaska spotted seals in 2011-2015 is 329 seals: 0.9 in U.S. commercial fisheries and 0.2 due to mortality incidental to Marine Mammal Protection Act (MMPA)-authorized research (from 2011-2015 data) and 328 in the Alaska Native subsistence harvest (from 2010-2014 data). However, the total mortality and serious injury due to commercial fisheries is unknown because some of the reported harbor seal takes in U.S. commercial fisheries may actually have been spotted seals (since it is virtually impossible to distinguish between these two species) and there have been no observer programs in nearshore Bristol Bay fisheries that are known to interact with spotted seals. Additional potential threats most likely to result in direct human-caused mortality or serious injury of this stock include the increased potential for oil spills due to an increase in vessel traffic in Alaska waters (with changes in sea-ice coverage).

Fisheries Information

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

In 2011-2015, incidental mortality and serious injury of spotted seals occurred in 2 of the 22 federally-regulated U.S. commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl and Bering Sea/Aleutian Islands Pacific cod longline 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 2011-2015 is 0.9 spotted seals, based exclusively on observer data.

Mortality and serious injury of harbor seals incidental to commercial fisheries occurred in 2011-2015 and, because it is virtually impossible to distinguish between these two species, some of the reported harbor seal takes may actually have been spotted seals. Further, there have been no observer programs on nearshore Bristol Bay fisheries that are known to interact with spotted seals, making the total mortality and serious injury due to fisheries unknown.

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

Fishery name	**Years**	**Data type**	**Percent observer coverage**	**Observed mortality**	**Estimated mortality**	**Mean estimated annual mortality**
Bering Sea/Aleutian Is. flatfish trawl	2011 2012 2013 2014 2015	obs data	99 99 99 99 99	0 2 0 0 1	0 2 0 0 1	0.6 (CV = 0.03)
Bering Sea/Aleutian Is. Pacific cod longline	2011 2012 2013 2014 2015	obs data	57 51 66 64 62	1 0 0 0 0	1.6 0 0 0 0	0.3 (CV = 0.61)
Minimum total estimated annual mortality						0.9 (CV = 0.21)

Alaska Native Subsistence/Harvest Information

Spotted seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee 2016). 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 1960 (Quakenbush et al. 2009). This report is used to determine where and how often harvest information has been collected and where to focus in the future (Ice Seal Committee 2016). Information for 2010-2014 is available for 12 communities (Point Lay, Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills) (Table 2), but more than 50 other communities harvest spotted seals and have not been surveyed in this time period or have never been surveyed. Harvest surveys are designed to estimate harvest within the surveyed community, but because of differences in seal availability, cultural hunting practices, and environmental conditions, extrapolating harvest numbers beyond that community is not appropriate. For example, during 2010-2014, only 12 of 64 coastal communities were surveyed for spotted seals and, of those communities, only 5 were surveyed for two or more consecutive years (Ice Seal Committee 2016). 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 2010-2014, the minimum annual spotted seal harvest estimates totaled across surveyed communities ranged from 83 (in 2 communities) to 518 spotted seals (in 10 communities) (Table 2). Based on the harvest data from these 12 communities (Table 2), a minimum estimate of the average annual harvest of spotted seals in 2010-2014 is 328 seals. The Ice Seal Committee is working toward a better understanding of ice seal harvest by conducting more consecutive surveys in more communities with a goal to report a statewide ice seal harvest estimate.

Table 2. Alaska spotted seal minimum harvest estimates in 2010-2014 (Ice Seal Committee 2016).

Community	Estimated spotted seal harvest				
	2010	2011	2012	2013	2014
Point Lay			8		
Kivalina		21			
Noatak		25			
Buckland		84			
Deering		3			
Emmonak		28			
Scammon Bay		56	53		
Hooper Bay	71	57	46	61	27
Tununak	96	100	51		
Quinhagak	179	78	128	195	56
Togiak[1]	132	66			
Twin Hills[1]	18				
Minimum total	496	518	286	256	83

[1]Spotted seals or harbor seals.

Other Mortality

Beginning in mid-July 2011, elevated numbers of sick or dead 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, including spotted seals, ringed 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, NMFS and the USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on 20 December 2011 (https://alaskafisheries.noaa.gov/pr/ice-seals, accessed December 2017). Since 2014, few new cases similar to those observed in 2011 have been seen, but the UME investigation remains open for spotted seals based on continuing reports of ice seals with patchy hair loss (alopecia). Some of these seals may be survivors of the 2011 mortality event. No specific cause for the disease has been identified.

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 2014, there was one report of a mortality incidental to research on the Alaska stock of spotted seals, resulting in a mean annual mortality and serious injury rate of 0.2 spotted seals from this stock in 2011-2015 (Table 3) (Helker et al. 2017).

Table 3. Summary of mortality and serious injury of Alaska spotted seals, by year and type, reported to NMFS in 2011-2015 (Helker et al. 2017).

Cause of injury	2011	2012	2013	2014	2015	Mean annual mortality
MMPA authorized research-related	0	0	0	1	0	0.2
Total						0.2

STATUS OF STOCK

Spotted seals in Alaska are not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act (ESA). NMFS completed a comprehensive status review of the spotted seal under the ESA in 2009 and concluded that listing the Bering DPS of spotted seals was not warranted at that time (73 FR 51615, 20 October 2009). Based on available data, the minimum estimated U.S. commercial fishery-related mortality and serious injury rate for this stock (0.9) is less than 10% of the calculated PBR (10% of

PBR = 1,270) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The PBR of the Alaska stock (i.e., portion of the Bering DPS that occurs in U.S. waters) is 12,697 spotted seals. The total estimated annual level of human-caused mortality and serious injury is 329 spotted seals. The Alaska stock of spotted 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 spotted seals. Though the entire Alaska stock is believed to be in the Bering Sea in the spring, the proportion that occupies U.S. (vs. Russian) waters at that time is not known. As such, it is possible that using the Conn et al (2014) abundance estimates to describe the entire Alaska stock may be biased. Further, the sample size available for genetics analysis was small so there could be additional stock structure within the Alaska stock. Nearshore commercial fisheries are not observed, and fishery-related mortality and serious injury in these fisheries could occur undetected. Similarly, the estimates 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, spotted seals are likely to be moderately sensitive to climate change.

HABITAT CONCERNS

The main concern about the conservation status of spotted seals stems from the likelihood that their preferred sea-ice habitats are being modified by the warming climate. Scientific projections are for continued and perhaps accelerated warming (Boveng et al. 2009). Despite the recent dramatic reductions in Arctic Ocean ice extent during summer, the sea ice in the Bering Sea is expected to continue forming annually in winter for the foreseeable future. There will likely be more frequent years in which ice coverage is reduced, resulting in a decline in the long-term average ice extent, but Bering Sea spotted seals will likely continue to encounter sufficient ice to support adequate vital rates. Even if sea ice were to vanish completely from the Bering Sea, there may be prospects for spotted seals to adjust their breeding grounds to follow the northward shift of the annual ice front into the Chukchi Sea. Laidre et al. (2008) concluded that on a worldwide basis spotted seals were likely to be moderately sensitive to climate change, based on an analysis of various life history features that could be affected by climate.

A second major concern, driven primarily by the production of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may affect spotted seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The nature and timing of such impacts are extremely uncertain. Because of spotted seals' apparent dietary flexibility, this threat should be of less immediate concern than the direct effects of sea-ice degradation (Boveng et al. 2009).

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bearded seals are a boreoarctic species with a circumpolar distribution (Fedoseev 1965; Johnson et al. 1966; Burns 1967, 1981; Burns and Frost 1979; Smith 1981; Kelly 1988). Their normal range extends from the Arctic Ocean (85°N) south to Sakhalin Island (45°N) in the Pacific and south to Hudson Bay (55°N) in the Atlantic (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).

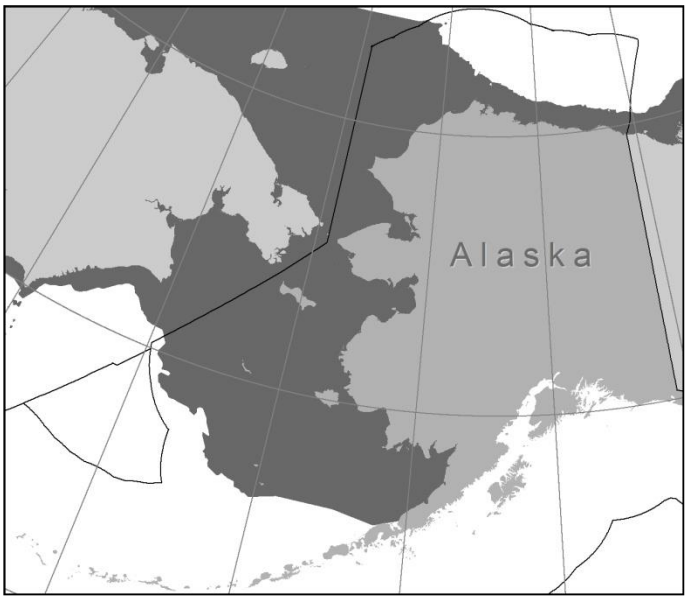

Figure 1. Approximate distribution of bearded seals (dark shaded area) in Alaska. The combined summer and winter distribution are depicted.

Two subspecies have been described: *E. b. 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 and 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 the Beringia DPS is considered the Alaska stock of the bearded seal (Fig. 1).

Spring surveys conducted in 1999-2000 along the Alaska coast indicate that bearded seals are typically more abundant 20-100 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 (95% CI: 245,476-360,544) bearded seals in U.S. waters. These data do not include bearded seals that were in the Chukchi and Beaufort seas at the time of the surveys.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for a stock is calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. An N_{MIN} for the entire stock cannot presently be determined because current reliable estimates of abundance 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, 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 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% be employed 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

Fisheries Information

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

Of the 22 federally-regulated 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 is 1.4 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 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	
Bering Sea/Aleutian Is. flatfish trawl	2010	obs data	99	0	0	0.6 (CV = 0.03)
	2011		100	1	1	
	2012		99	1	1.0	
	2013		99	0	0	
	2014		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	
Minimum total estimated annual mortality						1.4 (CV = 0.04)

[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 communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee 2016). 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 1960 (Quakenbush et al. 2011). 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). Information for 2009-2013 is available for 12 communities (Point Lay, Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills) (Table 2); but more than 50 other communities harvest bearded seals and have not been surveyed in this time period or have never been surveyed. Harvest surveys are designed to estimate harvest within the surveyed community, but because of differences in seal availability, cultural hunting practices, and environmental conditions, extrapolating harvest numbers beyond that community is not appropriate. For example, during 2009-2013, only 12 of 64 coastal communities were surveyed for bearded seals; and, of those communities, only 6 were surveyed for two or more consecutive years (Ice Seal Committee 2016). Based on the harvest data from these 12 communities (Table 2), a minimum estimate of the average annual harvest of bearded seals in 2009-2013 is 390 seals. The Ice Seal Committee is working toward a better understanding of ice seal harvest by conducting more consecutive surveys in more communities with a goal to report a statewide ice seal harvest estimate.

Table 2. Alaska bearded seal harvest estimates in 2009-2013 (Ice Seal Committee 2016).

Community	Estimated bearded seal harvest				
	2009	2010	2011	2012	2013
Point Lay				55	
Kivalina			123		
Noatak			65		
Buckland			47		
Deering			49		
Emmonak			106		
Scammon Bay			82	51	
Hooper Bay	332	148	210	212	171
Tununak	21	40	42	44	
Quinhagak		29	26	44	49
Togiak	0	0	2		
Twin Hills	0	0			
Total	353	217	752	406	220

Other Mortality

Mortality and serious injury may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. During 2010-2014, no research-related mortality or serious injury was 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).

Beginning in mid-July 2011, elevated numbers of sick or dead seals, 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, 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 USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on December 20, 2011. Disease surveillance efforts in 2012-2013 detected few new cases similar to those observed in 2011, but the UME investigation remains open for bearded seals based on continuing reports in 2013-2014 of ice seals in the Bering Strait region with patchy hair loss (alopecia). To date, no specific cause for the disease has been identified.

STATUS OF STOCK

On 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 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 total estimated annual level of human-caused mortality and serious injury is 391 bearded seals. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

HABITAT CONCERNS

The main concern about the conservation status of bearded seals stems from the likelihood that their preferred sea-ice habitats are being modified by the warming climate. Future 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. 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 activities (particularly in the outer continental shelf leasing areas), such as disturbance from vessel traffic, seismic exploration noise, or the potential for oil spills.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

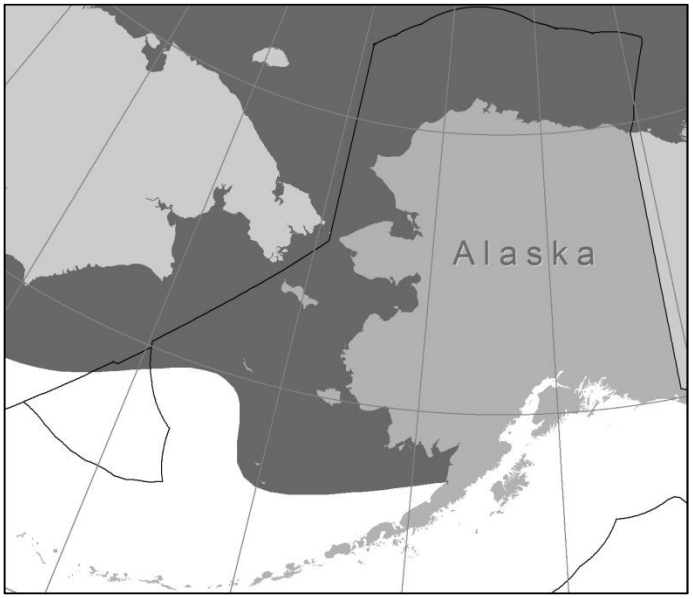

Figure 1. Approximate winter distribution of ringed seals (dark shaded area).

Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying both shorefast and pack ice (Kelly 1988a). They remain with the ice most of the year and use it as a platform for pupping and nursing in late winter to early spring, for molting in late spring to early summer, and for resting at other times of the year. This species rarely comes ashore in the Arctic; however, in more southerly portions of its range where sea or lake ice is absent during summer and fall, ringed seals are known to use isolated haul-out sites on land for molting and resting (Härkönen et al. 1998, Trukhin 2000, Kunnasranta 2001, Lukin et al. 2006). In Alaska waters, during winter and early spring when sea ice is at its maximal extent, ringed seals are abundant in the northern Bering Sea, Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort seas. They occur as far south as Bristol Bay in years of extensive ice coverage but generally are not abundant south of Norton Sound except in nearshore areas (Frost 1985). Although details of their seasonal movements have not been adequately documented, most ringed seals that winter in the Bering and Chukchi seas are thought to migrate north in spring as the seasonal ice melts and retreats (Burns 1970) and spend summers in the pack ice of the northern Chukchi and Beaufort seas, as well as in nearshore ice remnants in the Beaufort Sea (Frost 1985). During summer, ringed seals range hundreds to thousands of kilometers to forage along ice edges or in highly productive open-water areas (Harwood and Stirling 1992, Freitas et al. 2008, Kelly et al. 2010b, Harwood et al. 2015). With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted. Seals that have summered in the Beaufort Sea are thought to move west and south with the advancing ice pack, with many seals dispersing

throughout the Chukchi and Bering seas while some remain in the Beaufort Sea (Frost and Lowry 1984, Crawford et al. 2012, Harwood et al. 2012). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly et al. 2010b).

POPULATION SIZE

Ringed seal population surveys in Alaska have used various methods and assumptions, incompletely covered their habitats and range, and were conducted more than a decade ago; therefore, current, comprehensive, and reliable abundance estimates or trends for the Alaska stock are not available. Frost et al. (2004) conducted aerial surveys within 40 km of shore in the Alaska Beaufort Sea during May-June 1996-1999 and observed ringed seal densities ranging from 0.81 seals/km^2 in 1996 to 1.17 seals/km^2 in 1999. Moulton et al. (2002) conducted similar, concurrent surveys in the Alaska Beaufort Sea during 1997-1999 but reported substantially lower ringed seal densities than Frost et al. (2004). The reason for this disparity was unclear (Frost et al. 2004). Bengtson et al. (2005) conducted aerial surveys in the Alaska Chukchi Sea during May-June 1999-2000. While the surveys were focused on the coastal zone within 37 km of shore, additional survey lines were flown up to 185 km offshore. Population estimates were derived from observed densities corrected for availability bias using a haul-out model from six tagged seals. Ringed seal abundance estimates for the entire survey area were 252,488 (SE = 47,204) in 1999 and 208,857 (SE = 25,502) in 2000. Using the most recent survey estimates from surveys by Bengtson et al. (2005) and Frost et al. (2004) in the late 1990s and 2000, for the purposes of an Endangered Species Act (ESA) status review, Kelly et al. (2010a) estimated the total population in the Alaska Chukchi and Beaufort seas to be at least 300,000 ringed seals. This estimate is likely an underestimate since the Beaufort Sea surveys were limited to within 40 km from shore.

Though a reliable population estimate for the entire Alaska stock is not available, 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 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 about 170,000 ringed seals. This estimate did not account for availability bias and did not include ringed seals in the shorefast ice zone, which were surveyed using a different method. Thus, the actual number of ringed seals in the U.S. sector of the Bering Sea is likely much higher, perhaps by a factor of two or more.

Minimum Population Estimate

A minimum population estimate (N_{MIN}) for the entire stock of ringed seals cannot presently be determined because current reliable estimates of abundance are not available for the Chukchi and Beaufort seas. The 2012 Bering Sea abundance estimate by Conn et al. (2014) of 170,000, however, can be considered an N_{MIN} for only those ringed seals in the U.S. sector of the Bering Sea.

Current Population Trend

Frost et al. (2002) reported that a trend analysis based on an ANOVA comparison of observed seal densities in the central Beaufort Sea suggested marginally significant but substantial declines of 50% on shorefast ice and 31% on all ice types combined from 1985-1987 to 1996-1999. A Poisson regression model indicated highly significant density declines of 72% on shorefast ice and 43% on pack ice during the 15-year period. However, the apparent decline between the mid-1980s and the late-1990s may have been due to a difference in the timing of surveys rather than an actual decline in abundance (Frost et al. 2002, Kelly et al. 2006). As these surveys represent only a fraction of the stock's range and occurred more than a decade ago, current and reliable data on trends in population abundance for the Alaska stock of ringed seals are considered unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5,

the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Using the N_{MIN} for ringed seals in the U.S. sector of the Bering Sea, a PBR for ringed seals in this area is 5,100 (170,000 × 0.06 × 0.5) seals. 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

Fisheries Information

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

During 2010-2014, incidental mortality and serious injury of ringed seals was reported in 4 of the 22 federally-regulated commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Table 1; Breiwick 2013; MML, unpubl. data). An additional ringed seal mortality due to U.S. commercial fisheries was reported to the NMFS Alaska Region stranding network in 2011; however, because the seal was discovered during the offloading process, the resulting mean annual mortality and serious injury rate of 0.2 could not be assigned to a specific fishery (Table 2; Helker et al. 2016). Based on data from 2010 to 2014, the average annual rate of mortality and serious injury incidental to U.S. commercial fishing operations is 3.9 ringed seals (3.7 from observer data + 0.2 from stranding data).

In 2010, a ringed seal that was initially considered seriously injured due to entanglement in a subsistence salmon set gillnet in Nome, Alaska, was disentangled and released with non-serious injuries (Helker et al. 2016), so it was not included in the mean annual mortality and serious injury rate in this report.

Table 1. Summary of incidental mortality and serious injury of Alaska ringed seals due to U.S. commercial fisheries in 2010-2014 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	2010	obs data	99	0	0	2.4 (+0.2)[c] (CV = 0.02)
	2011		100	6 (+1)[a]	6.0 (+1)[b]	
	2012		99	3	3.0	
	2013		99	3	3	
	2014		99	0	0	
Bering Sea/Aleutian Is. pollock trawl	2010	obs data	86	0	0	0.6 (CV = 0.03)
	2011		98	3	3.0	
	2012		98	0	0	
	2013		97	0	0	
	2014		98	0	0	
Bering Sea/Aleutian Is. Pacific cod trawl	2010	obs data	66	0	0	0.2 (CV = 0)
	2011		60	1	1	
	2012		68	0	0	
	2013		80	0	0	
	2014		80	0	0	
Bering Sea/Aleutian Is. Pacific cod longline	2010	obs data	64	0	0	0.3 (CV = 0.61)
	2011		57	1	1.6	
	2012		51	0	0	
	2013		66	0	0	
	2014		64	0	0	

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Minimum total estimated annual mortality						3.7 (CV = 0.06)

[a]Total mortality and serious injury observed in 2011: 6 seals in sampled hauls + 1 seal in an unsampled haul.
[b]Total estimate of mortality and serious injury in 2011: 6 seals (extrapolated estimate from 6 seals observed in sampled hauls) + 1 seal (1 seal observed in an unsampled haul).
[c]Mean annual mortality and serious injury for fishery: 2.4 seals (mean of extrapolated estimates from sampled hauls) + 0.2 seals (mean of number observed in unsampled hauls).

Table 2. Summary of mortality and serious injury of Alaska ringed seals, by year and type, reported to the NMFS Alaska Region in 2010-2014 (Helker et al. 2016). 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	2010	2011	2012	2013	2014	Mean annual mortality
Unidentified commercial fishery	0	1	0	0	0	0.2
Total in commercial fisheries						0.2

Alaska Native Subsistence/Harvest Information

Ringed seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee 2016). 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 1960 (Quakenbush et al. 2011). 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). Information for 2009-2013 is available for 12 communities (Point Lay, Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills) (Table 3), but more than 50 other communities harvest ringed seals and have not been surveyed in this time period or have never been surveyed. Harvest surveys are designed to estimate harvest within the surveyed community, but because of differences in seal availability, cultural hunting practices, and environmental conditions, extrapolating harvest numbers beyond that community is not appropriate. For example, during 2009-2013, only 12 of 64 coastal communities were surveyed for ringed seals; and, of those communities, only 6 were surveyed for two or more consecutive years (Ice Seal Committee 2016). Based on the harvest data from these 12 communities (Table 3), a minimum estimate of the average annual harvest of ringed seals in 2009-2013 is 1,050 seals. The Ice Seal Committee is working toward a better understanding of ice seal harvest by conducting more consecutive surveys in more communities with a goal to report a statewide ice seal harvest estimate.

Table 3. Alaska ringed seal harvest estimates in 2009-2013 (Ice Seal Committee 2016).

Community	Estimated ringed seal harvest				
	2009	2010	2011	2012	2013
Point Lay				51	
Kivalina			16		
Noatak			3		
Buckland			26		
Deering			0		
Emmonak			56		
Scammon Bay			137	169	
Hooper Bay	889	458	674	651	667
Tununak	232	162	257	219	

Community	Estimated ringed seal harvest				
	2009	2010	2011	2012	2013
Quinhagak		163	117	140	160
Togiak	1	1	0		
Twin Hills	0	0			
Total	1,122	784	1,286	1,230	827

Other Mortality

Beginning in mid-July 2011, elevated numbers of sick or dead seals, 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, including ringed seals, bearded 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 USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on December 20, 2011. Disease surveillance efforts in 2012-2013 detected few new cases similar to those observed in 2011, but the UME investigation remains open for ringed seals based on continuing reports in 2013-2014 of ice seals in the Bering Strait region with patchy hair loss (alopecia). To date, no specific cause for the disease has been identified.

In 2011, a ringed seal mortality, due to a gunshot wound to the head, was reported to the NMFS Alaska Region stranding network (Helker et al. 2016). This seal was presumed to be a struck and lost animal from the Alaska Native subsistence hunt.

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 2013, there was one report of a mortality incidental to research on the Alaska stock of ringed seals, resulting in a mean annual mortality and serious injury rate of 0.2 ringed seals from this stock in 2010-2014 (Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

On December 28, 2012, NMFS listed Arctic ringed seals (*P. h. hispida*) and, thus, the Alaska stock of ringed seals, as threatened under the ESA (77 FR 76706). The primary concern for this population is the ongoing and anticipated loss of sea ice and snow cover 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; Kelly et al. 2010a). Because of its threatened status under the ESA, this stock was designated as depleted under the MMPA. As a result, the stock was classified as a strategic stock. On March 11, 2016, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit challenging the listing of ringed seals under the ESA (Alaska Oil and Gas Association et al. v. Pritzker, Case No. 4:14-cv-00029-RPB). The decision vacated NMFS' listing of Arctic ringed seals as a threatened species. Consequently, it is also no longer designated as depleted or 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 ringed seals in the U.S. portion of the Bering Sea is 5,100 ringed seals. The total estimated annual level of human-caused mortality and serious injury is 1,054 ringed seals. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

HABITAT CONCERNS

The main concern about the conservation status of ringed seals stems from the likelihood that their preferred sea-ice and snow habitats are being modified by the warming climate. Future scientific projections are for continued and perhaps accelerated warming (Kelly et al. 2010a). Climate models consistently project overall diminishing ice and snow cover through the 21st century with regional variation in the timing and severity of those loses. Increasing atmospheric concentrations of greenhouse gases are driving climate warming and increasing acidification of the ringed seal's habitat. Changes in ocean temperature, acidification, and ice cover threaten prey communities on which ringed seals depend. Laidre et al. (2008) concluded that on a worldwide basis ringed seals were likely to be highly sensitive to climate change based on an analysis of various life history features that could be affected by climate.

The greatest impacts to ringed seals from diminished ice cover will be mediated through diminished snow accumulation. While winter precipitation is forecasted to increase in a warming Arctic (Walsh et al. 2005), the duration of ice cover will be substantially reduced, and the net effect will be lower snow accumulation on the ice (Hezel et al. 2012). Ringed seals excavate subnivean lairs (snow caves) in drifts over their breathing holes in the ice, in which they rest, give birth, and nurse their pups for 5-9 weeks during late winter and spring (Chapskii 1940, McLaren 1958, Smith and Stirling 1975). Snow depths of at least 50-65 cm are required for functional birth lairs (Smith and Stirling 1975, Lydersen and Gjertz 1986, Kelly 1988b, Lydersen 1998, Lukin et al. 2006). Such depths typically are found only where 20-30 cm or more of snow has accumulated on flat ice and then drifted along pressure ridges or ice hummocks (Lydersen et al. 1990, Hammill and Smith 1991, Lydersen and Ryg 1991, Smith and Lydersen 1991). According to climate model projections, snow cover is forecasted to be inadequate for the formation and occupation of birth lairs within this century over the Alaska stock's entire range (Kelly et al. 2010a). Without the protection of these lairs, ringed seals—especially newborns—are vulnerable to freezing and predation (Kumlien 1879, McLaren 1958, Lukin and Potelov 1978, Smith and Hammill 1980, Lydersen and Smith 1989, Stirling and Smith 2004). Changes in the ringed seal's habitat will be rapid relative to their generation time and, thereby, will limit adaptive responses. As ringed seal populations decline, the significance of currently lower-level threats—such as ocean acidification, increases in human activities, and changes in populations of predators, prey, competitors, and parasites—may increase.

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

Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait) and oil and gas exploration activities (particularly in the outer continental shelf leasing areas), such as disturbance from vessel traffic, seismic exploration noise, or the potential for oil spills.

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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). 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 towards 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 tagged in the spring of 2005 near the eastern coast of Kamchatka spent the summer and fall throughout the Bering Sea and Aleutian Islands. However, of 72 ribbon seals satellite tagged in the central Bering Sea during 2007-2010, only 21 (29%) moved to the Bering Strait, Chukchi Sea, or Arctic Basin as the ice retreated northward. 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. These seals, and the 10 seals tagged in 2005 near Kamchatka, dispersed widely, occupying coastal areas as well as the interior 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).

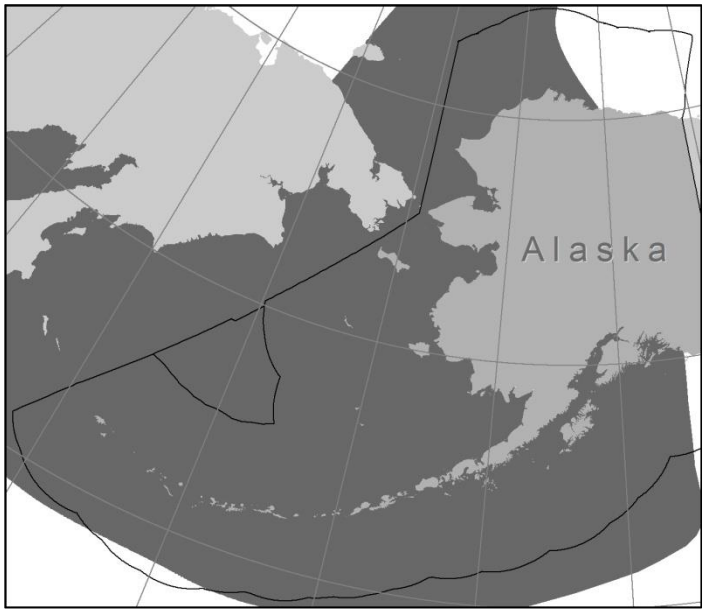

Figure 1. Approximate distribution of ribbon seals (dark shaded area) in Alaska waters. The combined summer and winter distribution is depicted.

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 splitting 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 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 (95% CI: 145,752-230,134) ribbon seals in those waters. Though this should be considered only a preliminary estimate, it is appropriate to consider this a reasonable estimate for the entire U.S. population of ribbon seals because few ribbon seals are expected to be north of the Bering Strait in the spring when these surveys were conducted. When the final analyses for both the Bering and Okhotsk seas are complete they should provide the first range-wide estimates of ribbon seal abundance.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for a 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 2012 Bering Sea abundance estimate by Conn et al. (2014) provides an N_{MIN} of 163,086 ribbon seals in this stock.

Current Population Trend

At present, 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 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% be employed 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 (163,086 × 0.06 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

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

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, incidental mortality and serious injury of ribbon seals occurred in the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands Atka mackerel trawl, and Bering Sea/Aleutian Islands pollock trawl fisheries (Table 1). The minimum estimated average annual mortality and serious injury rate incidental to U.S. commercial fisheries is 0.6 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 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; NMML, 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	obs data	99	0	0	0.2 (CV = 0.01)
	2010		99	0	0	
	2011		99	0	0	
	2012		99	1	1	
	2013		99	0	0	
Bering Sea/Aleutian Is. Atka mackerel trawl	2009	obs data	99	1	1	0.2 (CV = 0.01)
	2010		99	0	0	
	2011		99	0	0	
	2012		99	0	0	
	2013		99	0	0	

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 0 0 0 0	0.2 (CV = 0.11)
Minimum total estimated annual mortality						0.6 (CV = 0.04)

Alaska Native Subsistence/Harvest Information

Ribbon seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to Kaktovik, regularly harvest ice seals (Ice Seal Committee 2014). The Ice Seal Committee, as co-managers with NMFS, recognizes the importance of harvest information and has been collecting 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 1960. 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 information, within the last 5 years, is available for 11 communities (Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills) (Table 2), but more than 50 other communities harvest ribbon seals and have not been surveyed in the last 5 years or have never been surveyed. Harvest surveys are designed to confidently estimate harvest within the surveyed community, but because of differences in seal availability, cultural hunting practices, and environmental conditions, extrapolating harvest numbers beyond that community is misleading. For example, during the past 5 years (2009-2013), only 11 of the 64 coastal communities have been surveyed for ribbon seals and of those only 6 have been surveyed for two or more consecutive years (Ice Seal Committee 2015). Based on the harvest data from these 11 communities (Table 2), a minimum estimate of the average annual harvest of ribbon seals in 2009-2013 is 3.2 seals. The Ice Seal Committee is working toward a better understanding of ice seal harvest by conducting more consecutive surveys with the goal of being able to report a statewide ice seal harvest estimate in the future.

Table 2. Ribbon seal harvest estimates from 2009 to 2013 and the Alaska Native population for each community (Ice Seal Committee 2015).

Community	Alaska Native population (2013)	Estimated ribbon seal harvest				
		2009	2010	2011	2012	2013
Kivalina	352			0		
Noatak	514			1		
Buckland	519			0		
Deering	176			0		
Emmonak	782			0		
Scammon Bay	498			4	2	
Hooper Bay	1144	0	0	0	4	0
Tununak	342	0	0	0	0	
Quinhagak	694		2	3	0	0
Togiak	842	0	0	0		
Twin Hills	66	0	0			
Total		0	2	8	6	0

Other Mortality

Beginning in mid-July 2011, elevated numbers of sick or dead seals, 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, including ringed seals, spotted seals, bearded seals, and walrus, in northern and western Alaska. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, NOAA and USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on December 20, 2011. Disease surveillance efforts in 2012-2013 did not detect any new cases similar to those observed in 2011, but the UME investigation remains open for ice seals based on continuing reports in 2013 and 2014 of ice seals in the Bering Strait region with patchy hair loss. To date, 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 MMPA 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, with a PBR of 9,785. Because the estimated average annual level of U.S. commercial fishery-related mortality and serious injury (0.6) is less than 10% of PBR (979), it can be considered insignificant and approaching zero mortality and serious injury rate. 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 ribbon seals. The Alaska stock of ribbon seals is not considered a strategic stock.

HABITAT CONCERNS

Evidence indicates that the Arctic climate is changing significantly and that one result of the change is a reduction in the extent 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 their sea-ice habitat has been modified by the warming climate and, more so, that the scientific consensus projections are for continued and perhaps accelerated warming in the foreseeable future (Boveng et al. 2013). A second major concern, related by the common driver 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 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 activities (particularly in the outer continental shelf leasing areas), such as disturbance from vessel traffic, seismic exploration noise, and the potential for oil spills.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). In Alaska, depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea (Mackenzie River Delta) (Hazard 1988, O'Corry-Crowe et al. 1997) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). Data from satellite transmitters attached to a few whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show ranges that are relatively distinct month to month for these populations' summering areas and autumn migratory routes (e.g., Hauser et al. 2014, Citta et al. 2017). The few transmitters that lasted through the winter showed that beluga whales from these summering areas overwinter in the Bering Sea; the stocks may use separate wintering locations and probably remain separated through the winter (Suydam 2009, Citta et al. 2017).

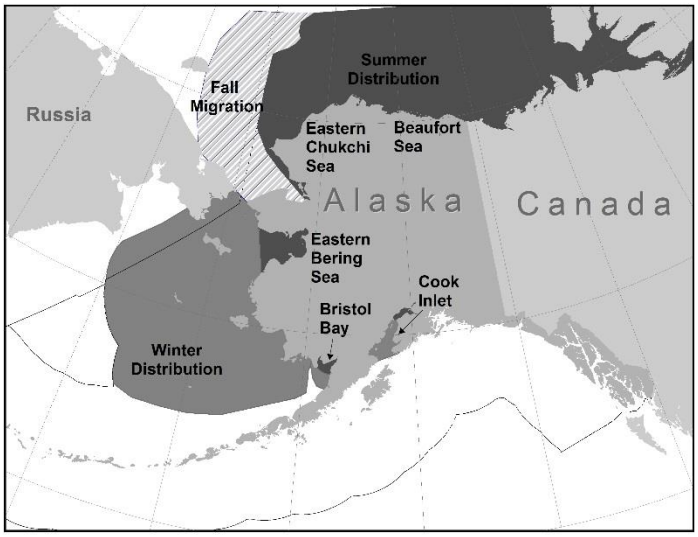

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration.

The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering and Beaufort seas. Beaufort Sea beluga whales depart from the Bering Sea in early spring, through the Chukchi Sea and into the Canadian waters of the Beaufort Sea where they remain in the summer and fall, returning to the Bering Sea in late fall. Eastern Chukchi Sea beluga whales migrate out of the Bering Sea in late spring and early summer, into the Chukchi Sea and western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. The Eastern Bering Sea stock remains in the Bering Sea but moves south near Bristol Bay in winter and returns north to Norton Sound and the mouth of the Yukon River in summer (Suydam 2009, Hauser et al. 2014, Citta et al. 2017). Beluga whales found in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012, Shelden et al. 2015) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990); 2) Population response data: distinct population trends among regions occupied in summer; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, five beluga whale stocks are recognized within U.S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 1).

POPULATION SIZE

The sources of information to estimate abundance for beluga whales in the waters of northern Alaska and western Canada have included both opportunistic and systematic observations. Duval (1993) reported an estimate of 21,000 beluga whales for the Beaufort Sea stock, similar to that reported by Seaman et al. (1985). The most recent aerial survey was conducted in July 1992 and resulted in an estimate of 19,629 beluga whales (CV = 0.229) in the

eastern Beaufort Sea (Harwood et al. 1996). To account for availability bias, a correction factor (CF), which was not data-based, has been recommended for the Beaufort Sea beluga whale stock (Duval 1993), resulting in a population estimate of 39,258 whales (19,629 × 2). A coefficient of variation (CV) for the CF is not available; however, this CF was considered negatively biased by the Alaska Scientific Review Group (SRG) considering that aerial survey CFs for this species have been estimated to be between 2.5 and 3.27 (Frost and Lowry 1995). Additionally, the 1992 surveys did not encompass the entire summer range of Beaufort Sea beluga whales (Richard et al. 2001), thus, are negatively biased.

Minimum Population Estimate

For the Beaufort Sea beluga whale stock, the minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 39,258 whales and an associated CV(N) of 0.229, N_{MIN} for this stock would be 32,453 whales. However, because the survey data are more than 8 years old, it is not considered a reliable minimum population estimate for calculating a PBR and N_{MIN} is considered unknown.

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is unavailable for the Beaufort Sea beluga whale stock. Hence, until additional data become available, the default maximum theoretical net productivity rate (R_{MAX}) for cetaceans of 4% will be used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for cetacean stocks that are thought to be stable in the presence of a subsistence harvest (Wade and Angliss 1997). However, the 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. Therefore, the PBR for this stock is considered undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Beaufort Sea beluga whales in 2011-2015 is 139 beluga whales: 47 in subsistence takes by Alaska Natives and 92 in subsistence takes by Canadian Natives.

Fisheries Information

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

There are no reports of mortality or serious injury of this stock incidental to U.S. commercial fisheries.

Alaska Native Subsistence/Harvest Information

The subsistence take of beluga whales from this stock within U.S. waters is reported by the Alaska Beluga Whale Committee (ABWC). The most recent Alaska Native subsistence harvest estimates for the Beaufort Sea beluga whale stock are provided in Table 1 (ABWC, unpubl. data, 2016). Given these data, the annual subsistence take by Alaska Native hunters averaged 47 beluga whales landed during 2011-2015.

Table 1. Summary of Beaufort Sea beluga whales landed by Alaska Native subsistence hunters in 2011-2015 (ABWC, unpubl. data, 2016). These are minimum estimates of the total number of beluga whales taken, because struck and lost data are not consistently provided.

Year	Reported total number landed
2011	42
2012	92
2013	35
2014	24
2015	43
Mean annual number landed	47

Canadian Native Subsistence/Harvest Information

The subsistence take of beluga whales within the Canadian waters of the Beaufort Sea is reported by the Fisheries Joint Management Committee (FJMC). The data are collected through on-site harvest monitoring conducted by the FJMC at Inuvialuit communities in the Mackenzie River Delta, Northwest Territories. The Canadian Inuvialuit subsistence harvest estimates for the Beaufort Sea beluga whale stock in 2011-2015 are provided in Table 2 (FJMC Beluga Monitor Program, FJMC, Inuvik, NT, Canada). Given these data, the annual subsistence take in Canada averaged 92 beluga whales in 2011-2015. Thus, the estimated mean annual subsistence take of Beaufort Sea beluga whales in U.S. and Canadian waters in 2011-2015 is 139 whales (47 + 92).

Table 2. Summary of the Canadian subsistence harvest of Beaufort Sea beluga whales in 2011-2015 (FJMC, unpubl. data).

Year	Landed	Struck and lost	Total (landed + struck and lost)
2011	98	4	102
2012	73	2	75
2013	90	2	92
2014	104	2	106
2015	82	1	83
Mean annual number taken (landed + struck and lost)			92

STATUS OF STOCK

No fishery-related mortality or serious injury has been reported for the Beaufort Sea stock of beluga whales; therefore, the mean annual U.S. commercial fishery-related mortality and serious injury rate can be considered insignificant and approaching zero mortality and serious injury rate. The total estimated annual level of human-caused mortality and serious injury for this stock is 139 beluga whales. Beaufort Sea beluga whales are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. Therefore, the Beaufort Sea beluga whale stock is classified as a non-strategic stock. At this time, it is not possible to assess the status of this stock relative to its Optimum Sustainable Population.

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

HABITAT CONCERNS

Evidence indicates that the arctic climate is changing rapidly and significantly, and one result of this change is a reduction in the extent and duration of sea ice in at least some regions (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, are sensitive to changes in arctic weather, sea-surface temperatures, and ice extent, and the concomitant effect on prey availability. There are indications that decreases in seasonal sea ice have influenced beluga whale phenology; however, Beaufort Sea beluga whales did not show a statistically significant change in the timing of their southward migration in response to changes in sea ice (Hauser et al. 2017). An offshore shift in distribution of Beaufort Sea beluga whales between an earlier sample in 1982-1985 and a later sample in 2007-2009 was attributed either to increased habitat due to more open water or potentially a response to industrial activity

(Harwood and Kingsley 2013). Decreases in seasonal sea ice may also increase the risk of killer whale predation (O'Corry-Crowe et al. 2016). There are insufficient data to make reliable predictions of the effects of arctic climate change on beluga whales; however, Laidre et al. (2008) and Heide-Jørgensen et al. (2010) concluded that on a worldwide basis beluga whales were likely to be less sensitive to climate change than other arctic cetaceans because of their wide distribution and flexible behavior. Increased human activity in the Arctic, including increased oil and gas exploration and development and increased nearshore development, has the potential to impact beluga whale habitat (Moore et al. 2000, Lowry et al. 2006). However, predicting the type and magnitude of the impacts is difficult.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). In Alaska, depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea (Mackenzie River Delta) (Hazard 1988, O'Corry-Crowe et al. 1997) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). Data from satellite transmitters attached to a few whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show ranges that are relatively distinct month to month for these populations' summering areas and autumn migratory routes (e.g., Hauser et al. 2014, Citta et al. 2017). The few transmitters that lasted through the winter showed that beluga whales from these summering areas overwinter in the Bering Sea; the stocks may use separate wintering locations and probably remain separated through the winter (Suydam 2009, Citta et al. 2017).

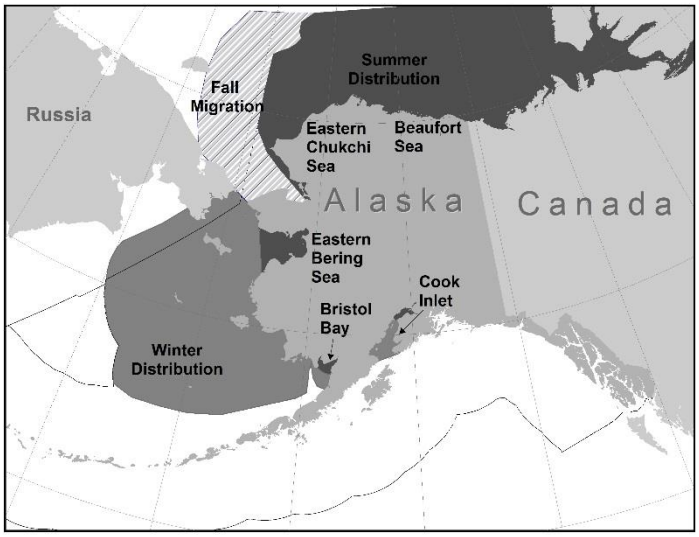

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration.

The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering and Beaufort seas. Beaufort Sea beluga whales depart from the Bering Sea in early spring, through the Chukchi Sea and into the Canadian waters of the Beaufort Sea where they remain in the summer and fall, returning to the Bering Sea in late fall. Eastern Chukchi Sea beluga whales migrate out of the Bering Sea in late spring and early summer, into the Chukchi Sea and western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. The Eastern Bering Sea stock remains in the Bering Sea but moves south near Bristol Bay in winter and returns north to Norton Sound and the mouth of the Yukon River in summer (Suydam 2009, Hauser et al. 2014, Citta et al. 2017). Beluga whales found in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012, Shelden et al. 2015) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

Eastern Chukchi Sea beluga whales move into coastal areas, including Kasegaluk Lagoon, in late June and animals are sighted in the area until about mid-July (Frost and Lowry 1990, Frost et al. 1993, Suydam et al. 2001). Data from satellite tags attached to Eastern Chukchi Sea beluga whales captured in Kasegaluk Lagoon during the summer showed these whales traveled 1,100 km north of the Alaska coastline, into the Canadian Beaufort Sea within 3 months (Suydam et al. 2001, Hauser et al. 2014). This movement indicated some overlap in distribution with the Beaufort Sea beluga whale stock during late summer. Satellite-telemetry data from 23 whales tagged during 1998-2007 suggest variation in movement patterns for different age and/or sex classes during July-September (Suydam et al. 2005). Adult males used deeper waters and remained there for the duration of the summer. All beluga whales that moved into the Arctic Ocean (north of 75°N) were males, and males traveled through 90% pack ice to reach deeper waters in the Beaufort Sea and Arctic Ocean (79-80°N) by late July/early August. Adult and immature female beluga whales remained at or near the shelf break in the Chukchi Sea. After October, only three tags continued to transmit and those whales migrated south through the eastern Bering Strait into the northern Bering Sea, remaining north of Saint Lawrence Island during the winter (Hauser et al. 2014, Citta et al. 2017). A

whale tagged in the eastern Chukchi Sea in 2007 overwintered in the waters north of Saint Lawrence Island during 2007/2008, then moved to near King Island in April and May before moving north through the Bering Strait in late May and early June (Suydam 2009).

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990); 2) Population response data: distinct population trends among regions occupied in summer; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, five beluga whale stocks are recognized within U.S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 1).

POPULATION SIZE

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

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

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

Aerial surveys were conducted as part of the Alaska Fisheries Science Center-Marine Mammal Laboratory's Aerial Surveys of Arctic Marine Mammals (ASAMM) project in the northeastern Chukchi and Alaska Beaufort seas in late June through August 2012 (Clarke et al. 2013). Line-transect analysis resulted in an estimate of 5,547 surface-visible beluga whales (CV = 0.22) in the study area (Lowry et al. 2017). Data from satellite-linked dive recorders were used to develop correction factors to account for animals that were missed because they were outside of the study area or diving too deep to be seen, resulting in a total abundance estimate of 20,752 beluga whales (CV = 0.70) (Lowry et al. 2017).

Minimum Population Estimate

For the Eastern Chukchi Sea beluga whale stock, the minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate of 20,752 and the associated coefficient of variation (CV) of 0.70, N_{MIN} for this stock is 12,194 whales.

Current Population Trend

The population trend for the Eastern Chukchi Sea beluga whale stock is unknown.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is unavailable for this beluga whale stock. Hence, until additional data become available, the default maximum theoretical net productivity rate (R_{MAX}) for cetaceans of 4% will be used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for cetacean stocks that are thought to be stable in the presence of a subsistence harvest (DeMaster 1995, Wade and Angliss 1997). Therefore, the PBR for this stock is 244 beluga whales (12,194 × 0.02 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Eastern Chukchi Sea beluga whales in 2011-2015 is 67 beluga whales: 0.2 in U.S. commercial fisheries and 67 in subsistence takes by Alaska Natives (including 0.4 incidental to Marine Mammal Protection Act (MMPA)-authorized research). Assignment of mortality and serious injury to the Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay stocks when stock is unknown, and the event occurred at a time and in an area where the three stocks could occur, may result in overestimating stock specific mortality and serious injury in federal commercial fisheries. Potential threats most likely to result in direct human-caused mortality and serious injury of this stock include entanglement in fishing gear.

Fisheries Information

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

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

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

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

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

The minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2011-2015 is 0.2 beluga whales from this stock.

Alaska Native Subsistence/Harvest Information

The subsistence take of beluga whales from the Eastern Chukchi Sea stock is provided by the Alaska Beluga Whale Committee (ABWC). The most recent subsistence harvest estimates for the stock are provided in Table 2 (ABWC, unpubl. data, 2016). The annual subsistence take by Alaska Native villages averaged 67 beluga whales landed from the Eastern Chukchi Sea stock in 2011-2015.

Table 2. Summary of Eastern Chukchi Sea beluga whales landed by Alaska Native subsistence hunters in 2011-2015 (ABWC, unpubl. data, 2016). It should be noted that the 2011 report includes takes at Kivalina (2 in 2011) and Kotzebue/Noatak (30 in 2011) which likely are from a population that is genetically distinct from the whales that comprise the Eastern Chukchi Sea beluga whale stock. These are minimum estimates of the total number of beluga whales taken, since the struck and lost data are not consistently provided.

Year	Reported total number landed
2011	64
2012	52
2013	87
2014	59
2015	72
Mean annual number landed	67

Other Mortality

Mortality and serious injury may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Two beluga whale deaths occurred incidental to research on ice seals in the Beaufort Sea in 2012 (Helker et al. 2017), resulting in a mean annual mortality and serious injury rate of 0.4 beluga whales from this stock in 2011-2015. Since these animals were subsequently used for subsistence purposes by Alaska Natives, this mortality is accounted for in the harvest data for 2012 (Table 2).

STATUS OF STOCK

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries (0.2 beluga whales) is less than 10% of the PBR (10% of PBR = 24 whales) and, thus, can be considered insignificant and approaching zero mortality and serious injury rate. The total estimated annual level of human-caused mortality and serious injury (67 beluga whales) is less than the PBR (244 whales). Eastern Chukchi Sea beluga whales are not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. Therefore, the Eastern Chukchi Sea stock of beluga whales is not classified as a strategic stock. The historical level and population trend is unknown and, given the uncertainty of the data, we are unable at this time to assess the status of this stock relative to its Optimum Sustainable Population.

There are some key uncertainties in the assessment of the Eastern Chukchi Sea stock of beluga whales. Coastal subsistence fisheries will occasionally cause incidental mortality or serious injury of a beluga whale; these incidental takes used for subsistence purposes are not always reported to the ABWC and included in the estimate of subsistence harvest for the stock.

HABITAT CONCERNS

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

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). In Alaska, depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea (Mackenzie River Delta) (Hazard 1988, O'Corry-Crowe et al. 1997) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). Data from satellite transmitters attached to a few whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show ranges that are relatively distinct month to month for these populations' summering areas and autumn migratory routes (e.g., Hauser et al. 2014, Citta et al. 2017). The few transmitters that lasted through the winter showed that beluga whales from these summering areas overwinter in the Bering Sea; the stocks may use separate wintering locations and probably remain separated through the winter (Suydam 2009, Citta et al. 2017).

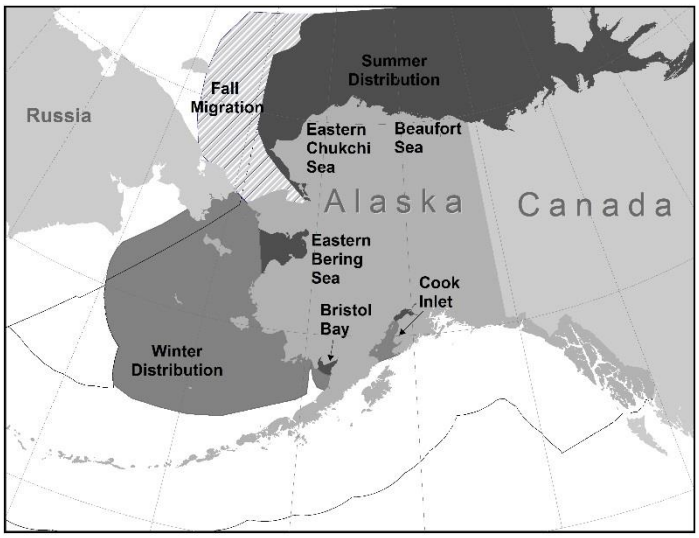

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration.

The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering and Beaufort seas. Beaufort Sea beluga whales depart from the Bering Sea in early spring, through the Chukchi Sea and into the Canadian waters of the Beaufort Sea where they remain in the summer and fall, returning to the Bering Sea in late fall. Eastern Chukchi Sea beluga whales migrate out of the Bering Sea in late spring and early summer, into the Chukchi Sea and western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. The Eastern Bering Sea stock remains in the Bering Sea but moves south near Bristol Bay in winter and returns north to Norton Sound and the mouth of the Yukon River in summer (Suydam 2009, Hauser et al. 2014, Citta et al. 2017). Beluga whales found in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012, Shelden et al. 2015) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

Two beluga whales from the Eastern Bering Sea stock were tagged with satellite transmitters in 2012 near Nome. The beluga whales moved south from Nome through ice covered shelf waters during the winter, swimming south near Hagemeister Island and the Walrus Islands in Bristol Bay, before returning to Norton Sound in the spring (Citta et al. 2017). A beluga whale tagged near Nome in September 2016 has remained in the vicinity of Nome and Norton Sound through mid-January 2017 due to low ice cover in the Bering Sea (Alaska Beluga Whale Committee, unpubl. data).

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990); 2) Population response data: distinct population trends among regions occupied in summer; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, five beluga whale stocks are recognized within U.S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 1).

POPULATION SIZE

The Alaska Beluga Whale Committee (ABWC) has been working to develop a population estimate for the Eastern Bering Sea stock since the first systematic aerial surveys of the Norton Sound/Yukon Delta region during May, June, and September 1992 and June 1993-1995 (Lowry et al. 1999). Beluga whale density estimates were calculated for the June 1992 surveys using strip-transect methods, and for the June 1993-1995 surveys using line-transect methods. Correction factors were applied to account for whales that were missed during the surveys (those below the surface and not visible and dark colored neonates). Lowry et al. (1999) concluded that the best abundance estimate for the Eastern Bering Sea stock was 17,675 beluga whales (95% CI: 9,056-34,515, not accounting for variance in correction factors), based on counts made in early June 1995. Additional aerial surveys of the Norton Sound/Yukon Delta region were conducted in June 1999 and 2000 (Lowry et al. 2017). Unlike previous survey years, in 1999 sea ice persisted in western Norton Sound resulting in a much different distribution of beluga whales, and the data were not used for population estimation. In 2000, systematic transect lines were flown covering the entire study region, and the data were analyzed using a covariate line-transect model. Results indicate 3,497 beluga whales (CV = 0.37) were seen at the surface in the study area (Lowry et al. 2017). If this estimate were doubled to correct for the proportion of whales that were diving, and thus not visible at the surface, the total abundance for the Eastern Bering Sea stock would be 6,994 beluga whales (95% CI: 3,162-15,472).

Minimum Population Estimate

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

Current Population Trend

Surveys to estimate population abundance in Norton Sound were not conducted prior to 1992. Annual estimates of population size from surveys flown in 1992-1995 and 1999-2000 have varied widely, due partly to differences in survey coverage and conditions between years. Available data do not allow an evaluation of population trend for the Eastern Bering Sea stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is unavailable for the Eastern Bering Sea stock of beluga whales. Lowry et al. (2008) estimated the rate of increase of the Bristol Bay beluga whale stock was 4.8% per year (95% CI = 2.1%-7.5%) over a 12-year period. However, until additional data become available specific to the Eastern Bering Sea stock, the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% will be used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for cetacean stocks that are thought to be stable in the presence of a subsistence harvest (Wade and Angliss 1997). However, the 2016 guidelines for preparing Stock Assessment Reports (NMFS 2016) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. Therefore, the PBR for the Eastern Bering Sea stock of beluga whales is considered undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Eastern Bering Sea beluga whales in 2011-2015 is 206 beluga whales: 0.2 in U.S. commercial fisheries and 206 in subsistence takes by Alaska Natives; however, a reliable estimate of mortality and serious injury in U.S. commercial fisheries is not available because there has never been an observer program for nearshore commercial fisheries in the eastern Bering Sea region.

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

Fisheries Information

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

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

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

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

In the nearshore waters of the Eastern Bering Sea, substantial effort occurs in commercial and subsistence fisheries, mostly for salmon and herring. The salmon fishery uses gillnet gear similar to that used in Bristol Bay, where it is known that beluga whales have been incidentally taken (Frost et al. 1984). However, there are no useful data on beluga whale incidental takes from this stock because there have never been observer programs in these commercial fisheries and there is no reporting requirement for takes in personal use fisheries. NMFS assumes that all beluga whales killed in these fisheries are used for subsistence, regardless of the method of harvest, and are reported to the ABWC. These subsistence takes are included in the Alaska Native Subsistence/Harvest Information section, below.

The minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2011-2015 is 0.2 beluga whales from this stock. However, because there has never been an observer program for state-managed nearshore commercial fisheries in the eastern Bering Sea region, a reliable estimate of the mortality and serious injury incidental to U.S. commercial fisheries is not available.

Alaska Native Subsistence/Harvest Information

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

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

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

STATUS OF STOCK

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

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

HABITAT CONCERNS

Evidence indicates that the arctic climate is changing significantly and that one result of the change is a reduction in the extent and duration of sea ice in most regions of the Arctic (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, are sensitive to changes in arctic weather, sea-surface temperatures, and ice extent, and the concomitant effect on prey availability. Decreases in seasonal sea ice may also increase the risk of killer whale predation (O'Corry-Crowe et al. 2016). It is unknown whether Eastern Bering Sea beluga whales have changed their areas of use in the winter; however, information from the Beaufort Sea and Eastern Chukchi Sea populations (Hauser et al. 2017), where tag data are more extensive, suggest that changes in timing of migration and winter distribution may have occurred. There are insufficient data to make reliable predictions of the effects of arctic climate change on beluga whales; however, Laidre et al. (2008) and Heide-Jørgensen et al. (2010) concluded that on a worldwide basis beluga whales were likely to be less sensitive to climate change than other arctic cetaceans because of their wide distribution and flexible behavior. Increased human activity in the Arctic, including increased oil and gas exploration and development and increased nearshore development, has the potential to impact habitat for beluga whales (Moore et al. 2000, Lowry et al. 2006); however, predicting the type and magnitude of the impacts is difficult.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). In Alaska, depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea (Mackenzie River Delta) (Hazard 1988, O'Corry-Crowe et al. 1997) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). Data from satellite transmitters attached to a few whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show ranges that are relatively distinct month to month for these populations' summering areas and autumn migratory routes (e.g., Hauser et al. 2014, Citta et al. 2017). The few transmitters that lasted through the winter showed that beluga whales from these summering areas overwinter in the Bering Sea; the stocks may use separate wintering locations and probably remain separated through the winter (Suydam 2009, Citta et al. 2017).

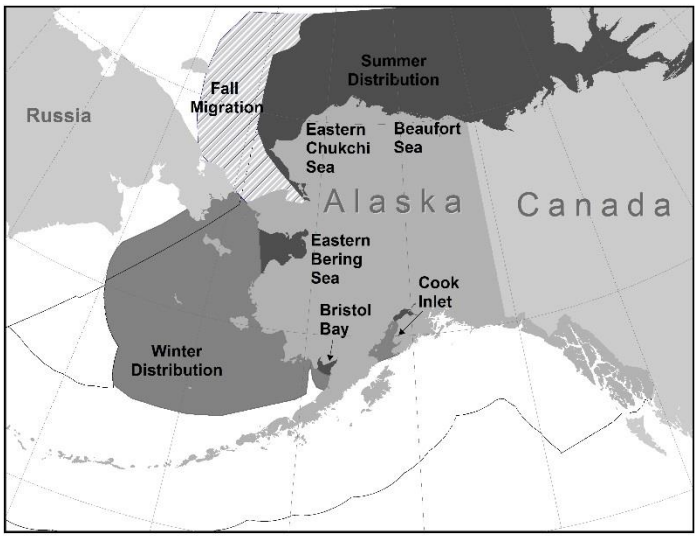

Figure 1. Approximate distribution for all five beluga whale stocks. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea stocks for autumn migration.

The Beaufort Sea and Eastern Chukchi Sea stocks of beluga whales migrate between the Bering and Beaufort seas. Beaufort Sea beluga whales depart from the Bering Sea in early spring, through the Chukchi Sea and into the Canadian waters of the Beaufort Sea where they remain in the summer and fall, returning to the Bering Sea in late fall. Eastern Chukchi Sea beluga whales migrate out of the Bering Sea in late spring and early summer, into the Chukchi Sea and western Beaufort Sea where they remain in the summer, returning to the Bering Sea in the fall. The Eastern Bering Sea stock remains in the Bering Sea but moves south near Bristol Bay in winter and returns north to Norton Sound and the mouth of the Yukon River in summer (Suydam 2009, Hauser et al. 2014, Citta et al. 2017). Beluga whales found in Bristol Bay (Quakenbush 2003; Citta et al. 2016, 2017) and Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012, Shelden et al. 2015) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

Summer movement patterns of Bristol Bay beluga whales were determined from satellite-linked tags deployed on 10 animals in the Kvichak River during 2002 and 2003 and 22 whales in the Nushagak River in 2006-2011 (Citta et al. 2016). Those whales used the shallow upper portions of Kvichak and Nushagak bays between May and August (Quakenbush 2003) and remained in the nearshore waters of Bristol Bay throughout September and October (Quakenbush and Citta 2006). Data from two beluga whales whose tags lasted into December and January showed they were in Nushagak and Kvichak bays, suggesting that some beluga whales do not leave the nearshore waters of Bristol Bay during the winter (Citta et al. 2017). Tags attached to whales in 2012, 2013, 2014, and 2016 have confirmed these movement observations (NMFS and Alaska SeaLife Center, unpubl. data; https://alaskafisheries.noaa.gov/sites/default/files/andrews_limpettagging041514.pdf).

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990); 2) Population response data: distinct population trends among regions occupied in summer; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, five beluga whale stocks

are recognized within U.S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) Eastern Bering Sea, 4) Eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 1).

POPULATION SIZE

The sources of information to estimate abundance for beluga whales in the waters of western and northern Alaska have included both opportunistic and systematic observations. Frost and Lowry (1990) compiled data collected from aerial surveys conducted between 1978 and 1987 that were specifically designed to estimate the number of beluga whales. Surveys did not cover the entire habitat of beluga whales but were directed to specific areas at the times of year when beluga whales are known to concentrate during summer. Frost and Lowry (1990) reported an estimate of 1,000-1,500 whales for Bristol Bay, similar to that reported by Seaman et al. (1985). In 1994, the abundance was estimated at 1,555 beluga whales (Lowry and Frost 1998). That estimate was based on a maximum count of 503 whales, which was corrected using radio-telemetry data for the proportion of whales that were diving and thus not visible at the surface (2.62: Frost and Lowry 1995) and for the proportion of newborns and yearlings not observed due to their small size and dark coloration (1.18: Brodie 1971). The Alaska Department of Fish and Game and the Alaska Beluga Whale Committee (ABWC) conducted aerial beluga whale surveys in Bristol Bay in 1999, 2000, 2004, and 2005, with average counts of 444, 421, 609, and 637 whales, respectively (Lowry et al. 2008). The results from the 2004 and 2005 surveys give an average count of 623 (CV = 0.25) and, using the correction values above, a population estimate of 1,926 beluga whales (623 × 2.62 × 1.18).

Minimum Population Estimate

The survey technique used for estimating the abundance of beluga whales in this stock is a direct count which incorporates correction factors for submerged whales and calves. The abundance estimate is thought to be conservative because no correction was made for whales that were at the surface but were missed by the observers (Lowry and Frost 1998). The minimum population estimate (N_{MIN}) for this beluga whale 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 estimate from the 2004 and 2005 surveys of 1,926 and the coefficient of variation (CV) of 0.25, N_{MIN} for the Bristol Bay stock is 1,565 beluga whales. However, because the survey data are more than 8 years old, it is not considered a reliable minimum population estimate for calculating a PBR, and N_{MIN} is considered unknown.

Current Population Trend

A survey program involving replicate aerial counts using standardized methods was conducted during 1993-2005. Data from 28 complete counts of Kvichak and Nushagak bays made in good or excellent survey conditions were analyzed, and results showed that the population increased by 65% over the 12-year period (Lowry et al. 2008).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The estimated rate of increase in abundance of beluga whales in Bristol Bay during 1993-2005 was 4.8% per year (95% CI = 2.1%-7.5%: Lowry et al. 2008). This estimate exceeds the default cetacean maximum net productivity rate (R_{MAX}) of 4% (Wade and Angliss 1997). It is not clear why this stock should be increasing at such a high rate, but possibilities include recovery from research kills in the 1960s, a reduction in subsistence harvests, and a delayed response to increases in salmon stocks (Lowry et al. 2008).

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. As this stock is known to be increasing (Lowry et al. 2008), the recovery factor (F_R) is 1.0 (Wade and Angliss 1997, DeMaster 1997; see discussion under PBR for the Eastern Bering Sea stock). 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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017);

however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Bristol Bay beluga whales in 2011-2015 is 25 beluga whales: 0.2 in U.S. commercial fisheries, 0.2 in subsistence fisheries, and 25 in subsistence takes by Alaska Natives. Estimates of mortality and serious injury incidental to Bristol Bay fisheries are likely to be underestimated because observers have never monitored the Bristol Bay commercial salmon set gillnet and drift gillnet fisheries, there is substantial participation in the subsistence salmon gillnet fishery in Bristol Bay but no established protocol for reporting incidental takes in non-commercial fisheries to NMFS, and beluga whales taken incidental to personal-use or commercial salmon fisheries may be used by Alaska Natives for subsistence purposes and may be reported as subsistence takes. Assignment of mortality and serious injury to the Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay stocks when stock is unknown, and the event occurred at a time and in an area where the three stocks could occur, may result in overestimating stock specific mortality and serious injury in federal commercial fisheries. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include entanglement in fishing gear.

Fisheries Information

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

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

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

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

The Bristol Bay commercial salmon set gillnet and drift gillnet fisheries combined had 2,752 active permits in 2016 (Appendix 3 of the Alaska Stock Assessment Reports). These fisheries are known to have caused mortality of beluga whales from this stock in the past (Frost et al. 1984). However, they have never been monitored by an observer program so there is no reliable information on the number of animals that have been or are being taken.

There is substantial effort in a subsistence gillnet fishery for salmon in Bristol Bay. Beluga whales are occasionally entangled and killed in this fishery, but there is no established protocol to report incidental takes in non-commercial fisheries to NMFS. In 2013, one mortality of a beluga whale in a Bristol Bay subsistence salmon gillnet was reported to the NMFS Alaska Region stranding network and the ABWC (Table 2; Helker et al. 2017). Based on this stranding report, the minimum mean annual mortality and serious injury rate due to subsistence fishery interactions in 2011-2015 is 0.2 beluga whales. However, this figure is likely an underestimate because subsistence fishermen are not required to report marine mammal takes. Also, it should be noted that in western Alaska, beluga whales taken incidental to personal-use or commercial salmon fisheries may be used by Alaska Natives for subsistence and may be included in the subsistence harvest data reported below. An additional three beluga whales that entangled in Bristol Bay subsistence salmon set gillnets (2 whales in 2013 and 1 in 2014) were

used for subsistence purposes and are included in the subsistence harvest data for 2011-2015 (Table 3; ABWC, unpubl. data; Helker et al. 2017).

A minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2011-2015 is 0.2 beluga whales from this stock; however, a reliable estimate of the mortality rate incidental to U.S. commercial fisheries is not available.

Table 2. Summary of Bristol Bay beluga whale mortality and serious injury, by year and type, reported to the Alaska Region marine mammal stranding network in 2011-2015 (Helker et al. 2017). 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**	**Mean annual mortality**
Entangled in Bristol Bay subsistence salmon gillnet	0	0	1	0	0	0.2
Minimum total annual mortality						0.2

Alaska Native Subsistence/Harvest Information

Data on the subsistence take of beluga whales from the Bristol Bay stock are provided by the ABWC. The most recent subsistence harvest estimates for this stock are provided in Table 3 (ABWC, unpubl. data, 2016). These data show the annual subsistence take by Alaska Native villages averaged 25 beluga whales landed from the Bristol Bay stock in 2011-2015.

Table 3. Summary of Bristol Bay beluga whales landed by Alaska Native subsistence hunters in 2011-2015 (ABWC, unpubl. data, 2016). These are minimum estimates for the total number of beluga whales taken, since struck and lost data are not consistently provided.

Year	**Reported total number landed**
2011	22
2012	29
2013	29
2014	26
2015	18
Mean annual number landed	25

STATUS OF STOCK

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries is 0.2 beluga whales. However, it is unknown whether this level is insignificant and approaching zero mortality and serious injury rate (i.e., less than 10% of PBR) because PBR is undetermined and a reliable estimate of the mortality and serious injury rate incidental to U.S. commercial fisheries is not available. Bristol Bay beluga whales are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. Because the population size increased at a rate above R_{MAX} from 1993 to 2005, the sum of human impacts on the population was not a concern (Lowry et al. 2008). Therefore, the Bristol Bay stock of beluga whales is not classified as a strategic stock. However, as noted previously, the estimate of fisheries-related mortality and serious injury is likely to be underestimated.

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

HABITAT CONCERNS

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). In Alaska, depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta and Norton Sound), eastern Chukchi Sea, and Beaufort Sea (Mackenzie River Delta) (Hazard 1988, O'Corry-Crowe et al. 1997) (Fig. 1). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). Data from satellite transmitters attached to a few whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show ranges that are relatively distinct month to month for these populations' summering areas and autumn migratory routes (e.g., Hauser et al. 2014, Citta et al. 2017). 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) remain in those areas throughout the year, showing only small seasonal shifts in distribution.

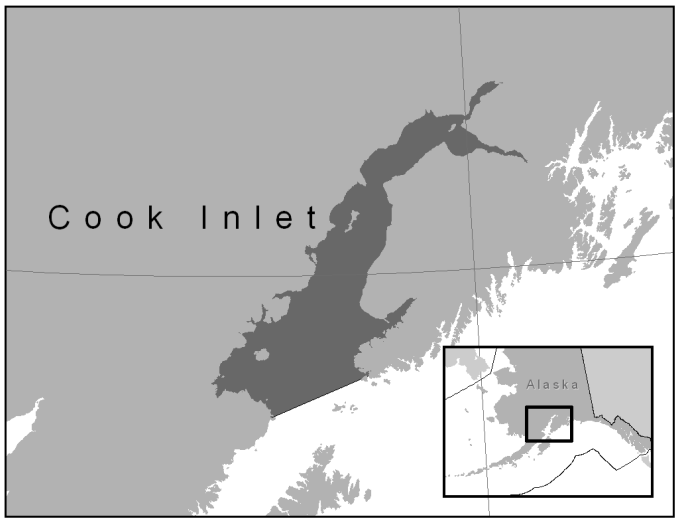

Figure 1. Approximate distribution of beluga whales in Cook Inlet.

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; 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: 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 concentrated near river mouths (Rugh et al. 2010). 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 from 1999 to 2002, satellite tags were attached to a total of 18 beluga whales in Cook Inlet to determine their distribution through the fall and winter months (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a). 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 upper inlet waters (Shelden et al. 2015a).

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 (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 that 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). Thus, Yakutat Bay beluga whales remain part of the Cook Inlet stock and designated as depleted.

POPULATION SIZE

Aerial surveys during June documenting the early summer distribution and abundance of beluga whales in Cook Inlet were conducted by NMFS each year from 1993 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 quality (Hobbs 2013).

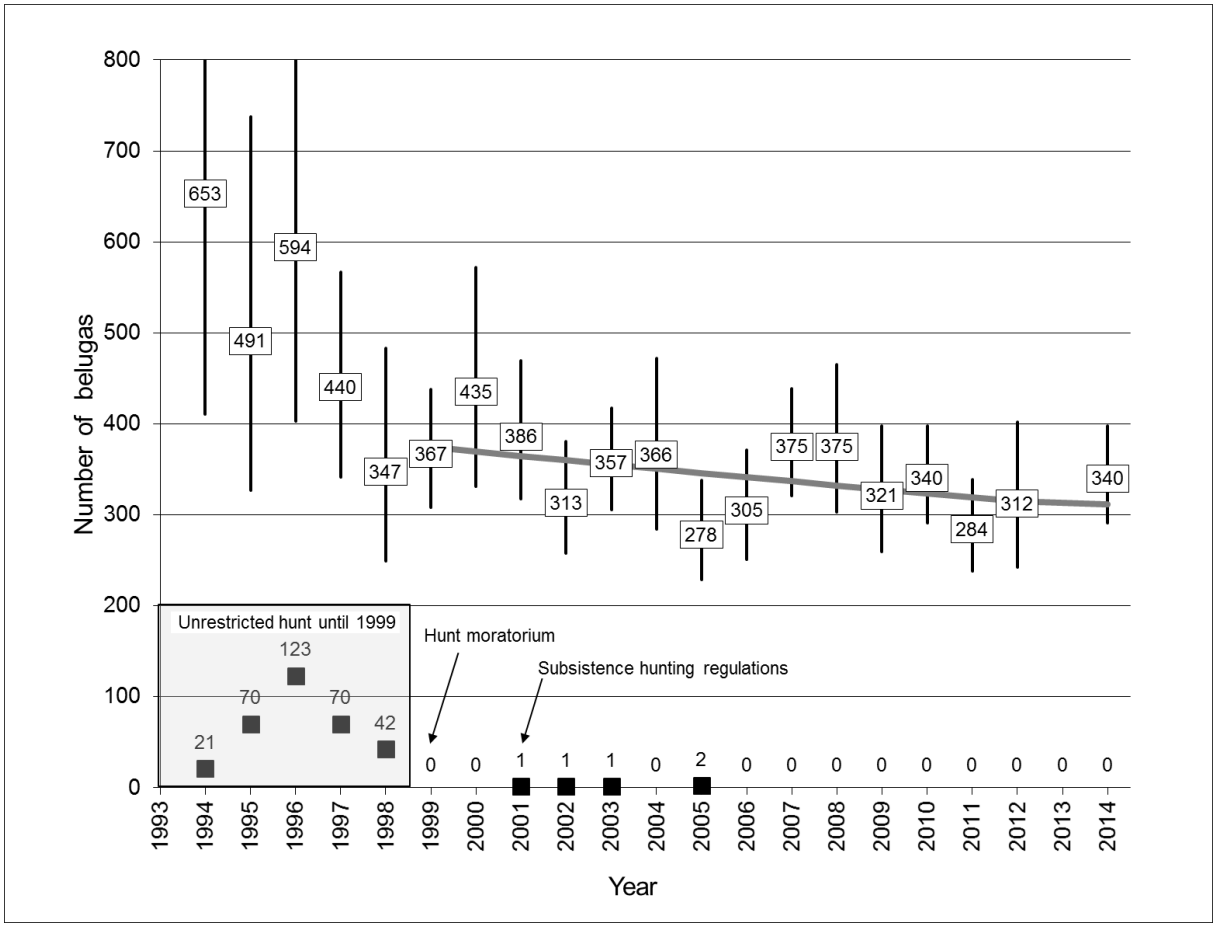

Figure 2. Annual abundance estimates of beluga whales in Cook Inlet, Alaska, 1994-2014 (Hobbs et al. 2015a, Shelden et al. 2015b). Black squares show reported removals (landed plus struck and lost) during the Alaska Native subsistence hunt. A struck and lost average was calculated by the Cook Inlet Marine Mammal Council (CIMMC) and hunters for 1996, 1997, and 1998. Black vertical bars depict plus and minus one standard error for each abundance estimate (number in box). 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 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 coefficients of variation (CVs) by almost half. The June 2014 survey resulted in a corrected estimate of 340 whales (CV = 0.08) (Shelden et al. 2015b). 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), resulting in an average abundance estimate for this stock of 312 beluga whales (CV = 0.10). An abundance estimate survey was conducted in June 2016 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, $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. Using the 3-survey average population estimate (N) of 312 whales and an associated CV(N) of 0.10, N_{MIN} for the Cook Inlet beluga whale stock is 287 beluga whales.

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate 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 beluga whales, the calculated PBR for this stock is 0.57 beluga whales (287 × 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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. No human-caused mortality or serious injury of Cook Inlet beluga whales was documented in 2011-2015. There are no observers in fisheries in Cook Inlet, 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 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 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 in his salmon set net near Kenai, Alaska. The beluga whale was dead and necropsy findings 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 beluga whales in Cook Inlet is important to one local village (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 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 and 106-553 established a moratorium on Cook Inlet beluga whale harvests except for subsistence hunts conducted under cooperative agreements between NMFS and affected Alaska Native organizations. A cooperative agreement, also referred to as a co-management agreement, was not signed in 1999, so harvest was not authorized in 1999 and 2000. Harvests from 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 beluga whales were harvested in Cook Inlet under this interim harvest plan. In August 2004, an administrative hearing was held to create a long-term harvest plan. An interim plan would have allowed up to eight whales to be harvested between 2005 and 2009 (https://alaskafisheries.noaa.gov/pr/interim-harvest-plan, accessed December 2017). Two whales were taken in 2005 and no takes were authorized in 2006 and later under this agreement. A long-term harvest plan (https://alaskafisheries.noaa.gov/pr/cib-long-term-harvest-management, accessed December 2017) established allowable harvest levels 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 changed to a biennial survey schedule after 2012, so the 5-year average abundance will now be based on either two or three surveys. Analysis in Hobbs (2013) showed that biennial rather than annual abundance surveys may lead to higher variation in harvests but is not expected to change the probability of recovery while using the algorithm that determines the allowable harvest level.

Other Mortality

Mortality related to live stranding events, where a group of beluga whales becomes stranded as the tide recedes, has been reported in Cook Inlet (Table 1). Improved record-keeping was initiated in 1994, and reports have since included the number of floating and beachcast carcasses and live stranded beluga whales (NMFS 2016; https://alaskafisheries.noaa.gov/sites/default/files/15strandings.pdf, accessed December 2017). Most whales involved in a live stranding event survive, although some deaths may be missed by observers if whales die later from live-stranding-related injuries (Vos and Shelden 2005, Burek-Huntington et al. 2015). Between 2011 and 2015, there were approximately 118 beluga whales involved in seven known live stranding events, with two deaths reported (Table 1). In 2014, necropsy results from two dead whales found in Turnagain Arm suggested the whales had recently live stranded and that the live stranding may have contributed to their deaths. No live stranding events were reported to NMFS prior to the discovery of these whales, suggesting that not all strandings are observed (Table 1). Most live strandings occur in Knik Arm or Turnagain Arm, both of which are shallow and dangerous waterways. Turnagain Arm has the largest tidal range 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 (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)
Total	24	118+ (2)

Another source of beluga whale mortality in Cook Inlet is predation by 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, 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 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 through 2015, NMFS received three reports of killer whale sightings (1 in 2011 and 2 in 2015, with one killer whale per sighting) in upper Cook Inlet but 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. Cause of death in the others was 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.

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 (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 well documented. While the early cause of the decline was likely unrestricted subsistence hunting, it is unknown what has been preventing recovery of this stock since no takes have been allowed for subsistence purposes 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.

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 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 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 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). Only 2 of 10 tagged whales spent time in offshore waters and the lower inlet in August (Shelden et al. 2015a). Numbers of whales observed during August calf index surveys conducted from 2005 to 2012 were also within the range of counts reported during the June surveys (Hobbs et al. 2015a, Shelden et al. 2015a). This 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 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 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 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 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, habitat that is most likely to be developed (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 of preferred habitat areas (Goetz et al. 2007, 2012b) is unknown. Goetz et al. (2012b) modeled habitat preferences using NMFS' 1994-2008 abundance survey data. In large areas, such as the Susitna Delta and Knik Arm, they found a high probability of beluga whale presence 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. Potential threats identified in the Cook Inlet Beluga Recovery Plan (NMFS 2016) are threats of high concern, including catastrophic events (e.g., natural disasters, spills, mass strandings), cumulative effects of multiple stressors, and noise; threats of 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 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.

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NARWHAL (*Monodon monoceros*): Unidentified Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

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

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

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

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

POPULATION SIZE

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

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for these stocks is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). However, in the absence of a reliable estimate of a minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

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

Subsistence/Native Harvest Information

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

STATUS OF STOCK

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

HABITAT CONCERNS

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

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

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

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade, 2006). Killer whales are found throughout the North Pacific. Along the west coast of North America, killer whales occur 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). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where whales 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).

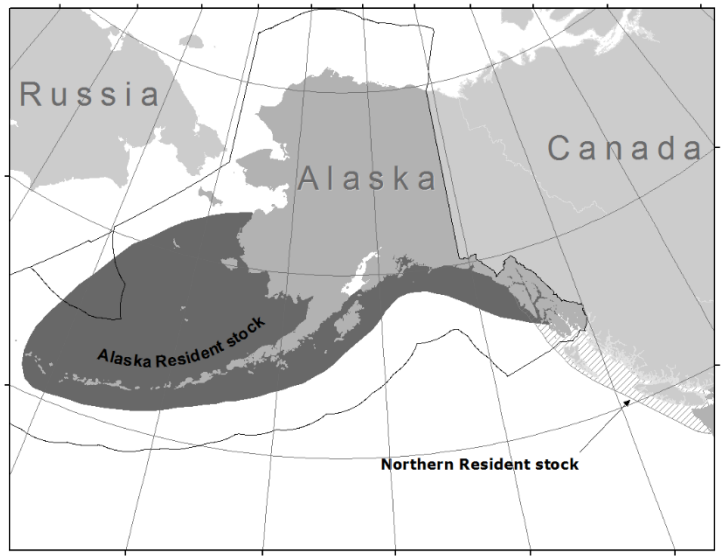

Figure 1. Approximate distribution of resident killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text).

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). 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 2012). 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.

Genetic differences have also been found between populations within the transient and resident ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Within the resident ecotype, association data were used to

describe three separate populations in the North Pacific: Southern Residents, Northern Residents, and Alaska Residents (Bigg et al. 1990; Ford et al. 1994, 2000; Dahlheim et al. 1997; Matkin et al. 1999). In previous stock assessment reports, the Alaska and Northern Resident populations were considered one stock. Acoustic data (Ford 1989, 1991; Yurk et al. 2002) and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) have now confirmed that these three units represent discrete populations. The Southern Resident population is found in summer primarily in waters of Washington state and southern British Columbia and has never been seen to associate with other resident stocks. The Northern Resident population is found in summer primarily in central and northern British Columbia. Members of the Northern Resident population have been documented in southeastern Alaska; however, they have not been seen to intermix with Alaska Residents (Fig. 1). Alaska Resident whales are found from southeastern Alaska to the Aleutian Islands and Bering Sea. Intermixing of Alaska Residents have been documented among the three areas, at least as far west as the eastern Aleutian Islands.

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. EEZ: 1) the Alaska Resident stock - occurring from southeastern Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of southeastern 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 southeastern Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast transient stock - occurring from California through southeastern 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 Stock Assessment Reports for the Alaska Region contain information concerning all the killer whale stocks except the Hawaiian and Offshore stocks.

Resident killer whales ranging from Southeastern Alaska to Kodiak Island have been observed in regular association during multipod encounters since 1984 (Matkin et al. 2010). Tagging data also indicates the range of killer whales seen in these aggregations extends from Southeastern Alaska to south of Kodiak Island (Matkin et al. 2010). Although recent studies have documented movements of Alaska Resident killer whales from the Bering Sea into the Gulf of Alaska as far north as southern Kodiak Island, none of these whales have been photographed further north and east in the Gulf of Alaska where regular photoidentification studies have been conducted since 1984 (P. Wade, pers. comm., MML-AFSC, Seattle, WA, 10 December 2012; unpublished data; Matkin et al. 2010). The resident-type killer whales encountered in western Alaska possibly belong to groups that are distinct from the groups of resident killer whales in the Gulf of Alaska because no call syllables or call patterns (sequence of syllables) between groups were found to match (Matkin et al. 2007).

POPULATION SIZE

The Alaska Resident stock includes killer whales from southeastern Alaska to the Aleutian Islands and Bering Sea. Preliminary analysis of photographic data resulted in the following minimum counts for resident killer whales belonging to the Alaska Resident stock (Note: individual whales have been matched between geographical regions and missing animals likely to be dead have been subtracted). In southeastern Alaska, 109 resident whales have been identified as of 2009 (MML and North Gulf Oceanic Society (NGOS), 3430 Main Street, Suite B1, Homer, Alaska; unpublished data). In Prince William Sound and Kenai Fjords, another 675 resident whales have been identified as of 2009 (Matkin et al. 2003; C. Matkin, North Gulf Oceanic Society, pers. comm.).

Beginning in 2001, dedicated killer whale studies were initiated by the NMFS Marine Mammal Laboratory (MML) in Alaska waters west of Kodiak Island, including the Aleutian Islands and Bering Sea. Between 2001 and 2009, using field assessments based on morphology, association data, and genetic analyses, additional resident whales were added to the Alaska Resident stock. Internal matches within the MML data set have been subtracted, resulting in a final count of western Alaska residents for 2001-2012 as 1,475 whales. Studies conducted in western Alaska by the NGOS have resulted in the collection of photographs of approximately 600 resident killer whales; however, the NGOS and MML data sets have not yet been matched so it is unknown how many of these 600 animals are included in the MML collection. Another 41 whales were identified off Kodiak between 2000 and 2003 by the NGOS. These whales are added to the total of western Alaska residents although they have not been matched to MML photographs.

MML conducted killer whale line-transect surveys for 3 years in July and August in 2001-2003. These surveys covered an area from approximately Resurrection Bay in the Kenai Fjords to the central Aleutians. The surveys covered an area from shore to 30-45 nautical miles offshore, with randomly located transects in a zigzag pattern. A total of 9,053 km of tracklines were surveyed between the Kenai Peninsula (~150°W) and Amchitka Pass

(~179ºW). A total of 41 on-effort sightings of killer whales were recorded, with an additional 16 sightings off-effort. Estimated abundance of resident killer whale from these surveys was 991 (CV = 0.52), with a 95% confidence interval of 380-2,585 (Zerbini et al. 2007).

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

Combining the counts of known resident whales gives a minimum number of 2,347 (Southeast Alaska + Prince William Sound + Western Alaska; 121 + 751 + 1,475) killer whales belonging to the Alaska Resident stock (Table 1).

Table 1. Numbers of animals in each pod of killer whales belonging to the Alaska Resident stock of killer whales. A number followed by a "+" indicates a minimum count for that pod.

Pod ID	**1999/2000 estimate (and source)**	**2001/2004 estimate (and source)**	**2005-2012 estimate (and source)**
Southeast Alaska			33 (Matkin et al. in prep.)
AF22			
AF5	49 (Dahlheim et al. 1997, Matkin et al. 1999)	61 (C. Matkin, NGOS, pers. comm.)	46 (Matkin et al. in prep.)
AG	27 (Dahlheim et al. 1997, Matkin et al. 1999)	33 (C. Matkin, NGOS, pers. comm.)	42 (Matkin et al. in prep.)
AZ	23+ (Dahlheim, AFSC-MML, pers. comm.)	23+ (Dahlheim et al. 1997)	Not seen since prior to 1997
Total, Southeast Alaska	**99+**	**117+**	**121 (excluding AZ)**
Prince William Sound	**Matkin et al. 1999**	**Matkin et al. 2003 and C. Matkin, NGOS, pers. comm.**	**Matkin et al. in prep.**
AA1	---	8	8
AA30	---	---	24
AB	25	19	20
AB25	---	10	19
AD05	---	16	22
AD16	7	4	9
AE	16	19	17
AH01		9	9
AH20		12	12
AI	7	7	8
AJ	38	42	57
AK	12	13	19
AL	---	---	23
AN10	20	27	36
AN20	assume 9	33	30
AS2	assume 20	21	31
AS30		14	19
AW		24	27
AX01	21	20	33
AX27		24	26
AX32		15	18
AX40		14	16
AX48		20	23
AY	assume 11	18	21
Unassigned to pods	138 (C. Matkin, NGOS, pers. comm.)	112	220

Pod ID	1999/2000 estimate (and source)	2001/2004 estimate (and source)	2005-2012 estimate (and source)
Total, Prince William Sound/ Kenai Fjord/ Kodiak	**341**	**501**	**751**
Western Alaska	**Dahlheim et al. 1997 and MML unpublished data[2]**	**2001/2003 MML unpublished data[2]**	**2001-2012 MML/NGOS unpublished catalog[2]**
Unassigned to pods (MML)	68+	464	1,475 (H. Fearnbach, NOAA-SWFSC, pers. comm., April 2013)
Total, Western Alaska	**68+**	**505**	**1,475**
Total, all areas	**507**	**1,123**	**2,347[1]**

[1]Although there is strong evidence (Matkin et al. 2003, 2010) the resident killer whale numbers have been increasing in the Gulf of Alaska, the bulk of the increase from the 2001-2004 counts to the 2005-2009 counts is believed to be due to the discovery of new animals, not recruitment. Animals reported here have been photographed in the 2001-2012 period. [2]Available from M. Dahlheim, Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115.

Minimum Population Estimate

The survey technique utilized for obtaining the abundance estimate of killer whales is a direct count of individually identifiable animals. Thus the minimum population estimate (N_{MIN}) for the Alaska Resident stock of killer whales based on photo-identification studies conducted between 2005-2009 is 2,084 animals (Table 1). Other estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) are not currently available. Given that researchers continue to identify new whales, the estimate of abundance based on the number of uniquely identified individuals known to be alive is likely conservative. However, the rate of discovering new resident whales within southeastern Alaska and Prince William Sound is relatively low (MML, unpublished data). Conversely, the rate of discovery of new whales in western Alaska was initially high (i.e., 2001 and 2002 field seasons). However, recent photographic data collected during 2003 and 2004 indicates that the rate of discovering new individual whales has decreased.

Using the line-transect estimate of 991 (CV = 0.52) results in an estimate of N_{MIN} (20th percentile) of 656. This is lower than the minimum number of individuals identified from photographs in recent years, so the photographic catalogue number is used for PBR calculations.

Some overlap of Northern Resident whales occur with the Alaska Resident stock in southeastern Alaska. However, information on the percentage of time that the Northern Resident stock spends in Alaska waters is unknown. However, as noted above, this minimum population estimate is considered conservative. This approach is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

Data from Matkin et al. (2003) indicate that the component of the Alaska Resident stock that summers in the Prince William Sound and Kenai Fjords area is increasing. With the exception of AB pod, which declined drastically after the *Exxon Valdez* oil spill and has not yet recovered, the component of the Alaska Resident stock in the Prince William Sound and Kenai Fjords area increased 3.2% (95% CI = 1.94 to 4.36%) per year from 1990 to 2005 (Matkin et al. 2008). Although the current minimum population count of 2,084 is higher than the last population count of 1,123, examination of only count data does not provide a direct indication of the net recruitment into the population. At present, reliable data on trends in population abundance for the entire Alaska Resident stock of killer whales are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Studies of resident killer whale pods in the Pacific Northwest resulted in estimated population growth rates of 2.92% and 2.54% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993), and 3.3% over the period 1984-2002 (Matkin et al. 2003). Until additional stock-specific data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). Thus, for the Eastern North Pacific Alaska Resident killer whale stock, PBR = 24 animals (2,347 × 0.02 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Detailed 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.

Three of the federally-regulated U.S. commercial fisheries, monitored for incidental mortality and serious injury of marine mammals by fishery observers, incurred mortality and serious injury of killer whales (unknown stock) between 2010 and 2014: the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands rockfish trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Table 1; Breiwick 2013; MML, unpubl. data).

Fishery observers have collected tissue samples from many of the killer whales that were killed incidental to U.S. commercial fisheries. Genetic analyses of samples from seven killer whales collected between 1999 and 2004 have confirmed that Alaska Resident killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands flatfish trawl (n = 3) and Bering Sea/Aleutian Islands Pacific cod longline fisheries (n = 1) and that Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands pollock trawl fishery (n = 3) (M. Dahlheim, NMFS-AFSC-MML, pers. comm., 20 February 2013). Given the overlap in the range of transient and resident stocks in Alaska waters, unless genetic samples can be collected from animals injured or killed by gear or the ship's propeller, these events are assigned to both the transient and resident stock occurring in that area. Thus, the estimated mean annual mortality and serious injury rate of one killer whale in 2010-2014 will be assigned to both the Alaska Resident and Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stocks of killer whales (Table 2; Breiwick 2013; MML, unpubl. data).

Typically, if mortality or serious injury occurs incidental to U.S. commercial fishing, it is due to interactions with the fishing gear. However, reports indicate that observed killer whale mortality incidental to the Bering Sea/Aleutian Islands trawl fisheries often occurs due to contact with the ship's propeller (e.g., the 2010 mortality in the Bering Sea/Aleutian Islands rockfish trawl fishery).

Table 2. Summary of incidental mortality and serious injury of Alaska Resident killer whales due to U.S. commercial fisheries in 2010-2014 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. N/A indicates that data are not available.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	2010	obs data	99	0	0	0.4 (+0.2)[c] (CV = 0)
	2011		100	0	0	
	2012		99	0 (+1)[a]	0 (+1)[b]	
	2013		99	2	2	
	2014		99	0	0	
Bering Sea/Aleutian Is. rockfish trawl	2010	obs data	99	1	1	0.2 (CV = 0)
	2011		99	0	0	
	2012		100	0	0	
	2013		99	0	0	
	2014		99	0	0	

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. Pacific cod longline	2010 2011 2012 2013 2014	obs data	64 57 51 66 64	0 0 0 (+1)[d] 0 0	0 0 0 (+1)[e] 0 0	0 (+0.2)[f] (CV = N/A)
Minimum total estimated annual mortality						1 (CV = 0)

[a]Total mortality and serious injury observed in 2012: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[b]Total estimate of mortality and serious injury in 2012: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 1 whale (1 whale observed in an unsampled haul).
[c]Mean annual mortality and serious injury for fishery: 0.4 whales (mean of extrapolated estimates from sampled hauls) + 0.2 whales (mean of number observed in unsampled hauls).
[d]Total mortality and serious injury observed in 2012: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[e]Total estimate of mortality and serious injury in 2012: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 1 whale (1 whale observed in an unsampled haul).
[f]Mean annual mortality and serious injury for fishery: 0 whales (mean of extrapolated estimates from sampled hauls) + 0.2 whales (mean of number observed in unsampled hauls).

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2010-2014 is one Alaska Resident killer whale, based on observer data (Table 2).

Subsistence/Native Harvest Information

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

Other Mortality

During the 1992 killer whale surveys conducted in the Bering Sea and western Gulf of Alaska, 9 of 182 (4.9%) individual whales in 7 of the 12 (58%) pods encountered had evidence of bullet wounds (Dahlheim and Waite 1993). The relationship between wounding due to shooting and survival is unknown. In Prince William Sound, the pod responsible for most of the fishery interactions experienced a high level of mortality: between 1986 and 1991, 22 whales out of a pod of 37 (59%) disappeared (Matkin et al. 1994). The cause of death for these whales is unknown, but it may be related to gunshot wounds or effects of the *Exxon Valdez* oil spill (Dahlheim and Matkin 1994). It is unknown who was responsible for shooting at killer whales.

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

Other Issues

Killer whales are known to depredate longline catches in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003, 2006; Sigler et al. 2003) and in the Gulf of Alaska (Sigler et al. 2003, Perez 2006). In addition, there have been many reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (Perez 2006). Resident killer whales are most likely to be involved in such fishery interactions since these whales are known to be fish eaters.

Fisheries observers report that large groups of killer whales in the Bering Sea follow vessels for days at a time, actively consuming the processing waste (NMFS-AFSC, Fishery Observer Program, unpubl. data). On some vessels, the waste is discharged in the vicinity of the vessel's propeller (NMFS, unpubl. data); consumption of the processing waste in the vicinity of the propeller may be the cause of the propeller-caused mortalities of killer whales in the trawl fisheries.

STATUS OF STOCK

The Eastern North Pacific Alaska Resident stock of killer whales is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. The minimum abundance estimate for the Alaska Resident stock is likely underestimated because researchers continue to encounter new whales in the

Gulf of Alaska and western Alaska waters. Because the population estimate is likely to be conservative, the PBR is also conservative.

Based on currently available data, a minimum estimate of the mean annual mortality and serious injury rate due to U.S. commercial fisheries (1 whale) is less than 10% of the PBR (10% of PBR = 2.4) and, therefore, is considered to be insignificant and approaching zero mortality and serious injury rate. A minimum estimate of the total annual level of human-caused mortality and serious injury (1 whale) is not known to exceed the PBR (24). Therefore, the Eastern North Pacific Alaska Resident stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

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KILLER WHALE (*Orcinus orca*): Eastern North Pacific
Northern Resident 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. Along the west coast of North America, killer whales occur along the entire Alaskan 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). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where whales 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, resident type whales identified in Prince William Sound have been observed in southeastern Alaska and lower Cook Inlet. (Matkin et al. 2010) Movements of transient type 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).

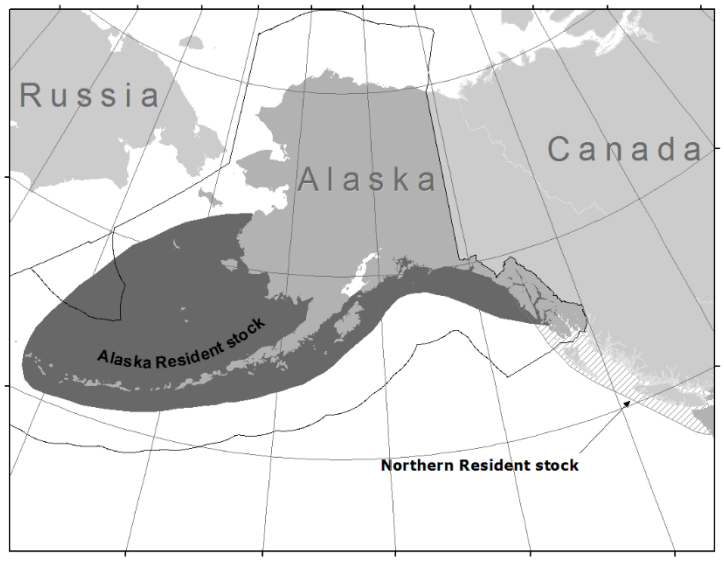

Figure 1. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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). 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 2012). 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.

Genetic differences have also been found between populations within the 'transient' and 'resident' ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Within the resident ecotype, association data were initially used to describe three separate communities in the North Pacific (Bigg et al. 1990; Ford et al. 1994, 2000; Matkin et al. 1999). The Southern Resident population is found in summer primarily in waters of Washington state and southern British Columbia. The Northern Resident population is found in summer primarily in central and northern British Columbia. Alaska resident whales are found in marine waters of southern and southwestern Alaska. Acoustic data (Ford 1989, 1991; Yurk et al. 2002) and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) have confirmed that these three units represent discrete populations.

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. EEZ: 1) the Alaska Resident stock - occurring from southeastern Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of southeastern 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 southeastern Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast transient stock - occurring from California through southeastern 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 Stock Assessment Reports for the Alaska Region contain information concerning all the killer whale stocks except the Hawaiian and Offshore stocks.

The Eastern North Pacific Northern Resident stock is a transboundary stock, and includes killer whales that frequent British Columbia, Canada and southeastern Alaska (Dahlheim et al. 1997; Ford et al. 2000). They have been seen infrequently in Washington state waters.

POPULATION SIZE

Photo-identification studies since 1970 (Ford et al. 2000) have catalogued every individual belonging to the Eastern North Pacific Northern Resident stock (note that individual whales that have been matched between geographical regions and missing animals likely to be dead have been subtracted). In 1998, the photo catalog included 216 whales (Ford et al. 2000). The photo-identification catalogue was updated in 2011 summarizing individual identifications made between 1974 and 2010. At the conclusion of the 2010 field season, the population was composed of three clans representing a total of 261 whales (plus four missing and possibly dead). The population is twice the size it was in 1974, representing an average annual increase of 2.1% (Ellis et al. 2011).

Table 1. Numbers of animals in each pod of killer whales belonging to the Eastern North Pacific Northern Resident stock of killer whales.

British Columbia	Ford et al. 1994	Ford et al. 2000	Ellis et al. 2011
A1	15	16	22
A4	11	11	16
A5	12	13	13
B1	9	7	6*
C1	13	14	17*
D1	7	12	12
H1	8	9	5
I1	10	8	18*
I2	7	2	3
I18	19	16	24
G1	28	29	34*
G12	11	13	16
I11	18	22	26
I31	10	12	10
R1	23	29	38
W1	3	3	1
Total	**204**	**216**	**261**

Note: * indicates that one whale may be missing/ dead

Minimum Population Estimate

The technique used for estimating abundance of killer whales is a direct count of individually identifiable animals. Other estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) are not currently available. Because this population has been studied for such a long time, each individual is well documented, and except for births, no new individuals are expected to be discovered. Therefore, the estimated population size of 261 animals can also serve as a minimum count of the population.

Thus, the minimum population estimate (N_{MIN}) for the Northern Resident stock of killer whales is 261 animals, which includes animals found in Canadian waters (see PBR Guidelines (Wade and Angliss 1997) regarding the status of migratory transboundary stocks). This approach is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1996). Information on the percentage of time animals typically encountered in Canadian waters spend in U. S. waters is unknown.

Current Population Trend

From the mid 1970s to the mid 1990s, the northern resident killer whale population grew steadily at an annual rate of 2.6% (i.e., from 122 whales in 1974 to 218 in 1997). A decline was reported during the 1998 -2001 period at a rate of 7%. That period coincided with a significant reduction in Chinook salmon (Ford et al. 2010). Then after 2001, the growth was positive with the population increasing at an average rate of 3.1% per year (2001 – 2010). At the end of the 2010 field season, 261 whales were catalogued. This represents an average annual increase of 2.1% over the 36-year time series (Ellis et al. 2011).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Studies of northern 'resident' killer whale pods in British Columbia and Washington waters resulted in estimated population growth rates of 2.92% and 2.54% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993). Analyses of photographic data collected from 1974 through 2010 indicated a population growth from 122 individuals to 261 whales. This represents an average annual increase of 2.1% over the 36-year period (Ellis et al. 2011). The period from 2001 to 2010 was a period of maximum growth for this population when it grew at an average rate of 3.1% per year. Therefore, the maximum net productivity rate (R_{MAX}) is estimated to be 3.1% (Ellis et al. 2011, Olesiuk et al. 2005).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). Thus, for the Eastern North Pacific Northern Resident killer whale stock, PBR = 1.96 animals (261 × 0.015 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

All Canadian trawl and longline fisheries are monitored by observers or video; salmon net fisheries are not observed (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013). The interaction of resident killer whales with the sablefish longline fishery accounts for a large proportion of the commercial fishing/killer whale interactions in Alaska waters. Such interactions have not been reported in Canadian waters where sablefish are taken via a pot fishery. Interactions have been reported between northern resident killer whales in the British Columbia halibut longline and salmon troll fisheries (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013). Since 1990, there have been no reported fishery-related strandings or bycatch of killer whales in Canadian waters. However, in 1994, one killer whale was reported to have contacted a salmon gillnet but did not entangle (Guenther et al. 1995).

Subsistence/Native Harvest Information

Killer whales are not harvested for subsistence in Alaska or Canada.

Other Mortality

Collisions of killer whales with vessels occur occasionally. One mortality of a northern resident killer whale (C21) in Prince Rupert, BC was reported in 2006 (Williams and O'Hara 2010). The shooting of killer whales in Canadian waters has been a concern in the past. However, in recent years the Canadian portion of the stock has been researched so extensively that evidence of bullet wounds would have been noticed if shooting was prevalent (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

Other Issues

In U.S. waters, there is considerable interaction between killer whales and fisheries aside from incidental take. Interactions between killer whales and longline vessels, specifically predation by killer whales on sablefish catch, have been well documented (Dahlheim 1988, Yano and Dahlheim 1995, Sigler et al. 2002). In Canada, northern resident killer whales have been reported to depredate fish from both commercial salmon trollers and recreational sportfishers, as well as halibut longliners. Most reports occur in the northern half of the coast, especially Dixon Entrance, and early in the season (April to June), although some are scattered throughout the summer (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 3 December 2012).

STATUS OF STOCK

The Northern Resident killer whale stock is not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. In 2001, the Committee on the Status of Endangered Wildlife in Canada designated northern resident killer whales in British Columbia as "threatened" and listed in Schedule 1 of the Species at Risk Act (SARA) for Canada. Resident killer whales in British Columbia are considered to be at risk based on their small population size, low reproductive rate, and the existence of a variety of anthropogenic threats that have the potential to prevent recovery or to cause further declines (DFO, 2008). Monitoring of fisheries in BC over the past decade has been quite extensive and likely at the same level as in U.S. waters. No incidental killer whale mortalities from fishery interactions have been reported or observed (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013).

Based on currently available data, the estimated annual U. S. commercial fishery-related mortality level is zero, which does not exceed 10% of the PBR (0.20) and therefore is considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (0) is not known to exceed the PBR (2.0). Therefore, the eastern North Pacific Northern Resident stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population size are currently unknown.

HABITAT CONCERNS

Ford et al. (2005) showed that a sharp drop in coast-wide Chinook salmon abundance during the late 1990s was correlated with a significant decline in resident whale survival. They noted that the whales' preference for chinook salmon is likely due to this species' relatively large size, high lipid content and, unlike other salmonids, its year-round presence in the whales' range. They further note that resident killer whales may be especially dependent on chinook during winter, when this species is the primary salmonid available in coastal waters, and the whales may be subject to nutritional stress leading to increased mortality if the quantity and/or quality of this prey resource declines.

Vessel traffic, particularly increased whale-watching activity, is another potential concern for this stock.

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade 2006). Killer whales are found throughout the North Pacific. Along the west coast of North America, killer whales occur 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). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where whales 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, 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 2012). 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.

Until recently, transient killer whales in Alaska had only been studied intensively 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 populations of transients which were never found in association with one another, the so-called "Gulf of Alaska" transients and "AT1" transients. Gulf of Alaska transients are documented throughout the Gulf of Alaska, including occasional sightings in Prince William Sound. AT1 transients are primarily seen in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with Gulf of Alaska transients. Recently, on one occasion, members of the Gulf of Alaska transient population were seen in association with the transient killer whales that range from California to southeastern Alaska, the West Coast Transients, which are identified by a unique mtDNA haplotype (Matkin et al. 2012). Photographs have identified 14 out of 217 whales considered "outer coast" transients in British Columbia that were also photographed in Alaska waters and considered Gulf of Alaska transients (Matkin et al. 2012, Ford et al. 2013). Transients that are 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 stock have been found to share a single mtDNA haplotype that is not found in the other stocks. Additionally, all three populations have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found between these stocks by Saulitis (1993) and Saulitis et al. (2005). 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 communities are considered discrete from the West Coast Transients.

Biopsy samples from the eastern Aleutians and south side of the end of the Alaska Peninsula have produced the same haplotypes as killer whales in the northern Gulf of Alaska; however, nuclear DNA analysis strongly suggest they belong to a separate population (Parsons et al. 2013). Samples from the central Aleutian Islands and Bering Sea have identified mtDNA haplotypes not found in Gulf of Alaska transients, suggesting additional population structure in western Alaska. At this time 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 are observed in the northern Bering Sea and Beaufort Sea that have the physical characteristics of transient type whales, but little is known about these whales.

In summary, within the transient ecotype, association data (Ford et al. 1994, Ford and Ellis 1999, Matkin et al. 1999), acoustic data (Saulitis 1993, Ford and Ellis 1999) 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 (Fig. 1).

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. EEZ: 1) the Alaska Resident stock - occurring from southeastern Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of southeastern 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 southeastern Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast Transient stock - occurring from California through southeastern 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 Stock Assessment Reports for the Alaska Region contain information concerning all the killer whale stocks except the Hawaiian and Offshore stocks.

In recent years, a small number of the Gulf of Alaska transients (identified by genetics and association) have been seen in southeastern Alaska; previously only West Coast Transients had been seen in southeastern Alaska. Therefore, the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock occupies a range that includes all of the U.S. EEZ in Alaska, though few individuals from this population have been seen in southeastern Alaska.

POPULATION SIZE

In January 2004 the North Gulf Oceanic Society (NGOS) and the Marine Mammal Laboratory (MML) held a joint workshop to match identification photographs of transient killer whales from this population. That analysis of photographic data resulted in the following minimum counts for transient killer whales belonging to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock. In the Gulf of Alaska (east of the Shumagin Islands), 82 whales were identified by NGOS, including whales from Matkin et al. (1999) as well as whales identified in subsequent years (but not including whales identified as part of the AT1 population). MML identified 43 whales

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

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

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

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

Minimum Population Estimate

The 20th percentile of the line transect survey estimate is 167. The 20th percentile of the mark-recapture estimates of 345 is ~303. A total count of 587 individual whales have been identified in the photograph catalogues from the Gulf of Alaska (Matkin et al. in prep.) and from western Alaska (NGOS/MML 2012). The photograph catalogue estimate of transient killer whales is a direct count of individually identifiable animals. However, the number of catalogued whales does not necessarily represent the number of live animals. Some animals may have died, but whales cannot be presumed dead if not resighted because long periods of time between sightings are common for some transient animals. The catalogue for the western area used data only from 2001-2012, decreasing the potential bias from using whales that may have died prior to the end of the time period. However, given that researchers continue to identify new whales and the entire range has not been surveyed, the estimate of abundance based on the number of uniquely identified individuals catalogued is likely conservative. The catalogue count is slightly higher than the 20 th percentile of the mark-recapture estimates, in part because it included data from areas such as Prince William Sound and the Bering Sea that were outside the survey area.

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

Current Population Trend

Recently Matkin et al. (2012) analyzed photographic data collected since 1984 and determined Gulf of Alaska transients in the northern Gulf of Alaska have had stable numbers. At present, reliable data on trends in population abundance for the Aleutian Islands and Bering Sea portion of this stock of killer whales are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Studies of resident killer whale pods in the Pacific Northwest resulted in estimated population growth rates of 2.92% and 2.54% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993). Until stock-specific data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{Max} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status with a mortality rate CV $\geq$ 0.80 (Wade and Angliss 1997). Thus, for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale stock, PBR = 5.87 animals (587 × 0.02 × 0.5). Although only a few individuals have been observed in Canadian waters, the proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Detailed 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.

Three of the federally-regulated U.S. commercial fisheries, monitored for incidental mortality and serious injury of marine mammals by fishery observers, incurred serious injury and mortality of killer whales (unknown stock) in 2010-2014: the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands rockfish trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Table 1; Breiwick 2013; MML, unpubl. data).

Fishery observers have collected tissue samples from many of the killer whales that were killed incidental to U.S. commercial fisheries. Genetic analyses of samples from seven killer whales collected between 1999 and 2004 have confirmed that Alaska Resident killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands flatfish trawl (n = 3) and Bering Sea/Aleutian Islands Pacific cod longline fisheries (n = 1) and that Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands pollock trawl fishery (n = 3) (M. Dahlheim, NMFS-AFSC-MML, pers. comm., 20 February 2013). Given the overlap in the range of transient and resident stocks in Alaska waters, unless genetic samples can be collected from animals injured or killed by gear or the ship's propeller, these events are assigned to both the transient and resident stock occurring in that area. Thus, the estimated mean annual mortality and serious injury rate of one killer whale in 2010-2014 will be assigned to both the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and the Alaska Resident stocks of killer whales (Table 1).

Typically, if mortality or serious injury occurs incidental to U.S. commercial fishing, it is due to interactions with the fishing gear. However, reports indicate that observed killer whale mortality incidental to Bering Sea/Aleutian Islands trawl fisheries often occurs due to contact with the ship's propeller (e.g., the 2010 mortality in the Bering Sea/Aleutian Islands rockfish trawl fishery).

Table 1. Summary of incidental mortality and serious injury of Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whales due to U.S. commercial fisheries in 2010-2014 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. N/A indicates that data are not available.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	2010	obs data	99	0	0	0.4 (+0.2)[c] (CV = 0)
	2011		100	0	0	
	2012		99	0 (+1)[a]	0 (+1)[b]	
	2013		99	2	2	
	2014		99	0	0	
Bering Sea/Aleutian Is. rockfish trawl	2010	obs data	99	1	1	0.2 (CV = 0)
	2011		99	0	0	
	2012		100	0	0	
	2013		99	0	0	
	2014		99	0	0	
Bering Sea/Aleutian Is. Pacific cod longline	2010	obs data	64	0	0	0 (+0.2)[f] (CV = N/A)
	2011		57	0	0	
	2012		51	0 (+1)[d]	0 (+1)[e]	
	2013		66	0	0	
	2014		64	0	0	
Minimum total estimated annual mortality						1 (CV = 0)

[a]Total mortality and serious injury observed in 2012: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[b]Total estimate of mortality and serious injury in 2012: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 1 whale (1 whale observed in an unsampled haul).
[c]Mean annual mortality and serious injury for fishery: 0.4 whales (mean of extrapolated estimates from sampled hauls) + 0.2 whales (mean of number observed in unsampled hauls).
[d]Total mortality and serious injury observed in 2012: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[e]Total estimate of mortality and serious injury in 2012: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 1 whale (1 whale observed in an unsampled haul).
[f]Mean annual mortality and serious injury for fishery: 0 whales (mean of extrapolated estimates from sampled hauls) + 0.2 whales (mean of number observed in unsampled hauls).

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2010-2014 is one Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale, based on observer data (Table 1).

Subsistence/Native 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 (Table 1).

Other Issues

Killer whales are known to depredate longline catches in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003, 2006; Sigler et al. 2003) and in the Gulf of Alaska (Sigler et al. 2003, Perez 2006). In addition, there have been many reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (Perez 2006). However, resident killer whales are most likely to be involved in such fishery interactions since these whales are known to be fish eaters.

STATUS OF STOCK

The Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. Based on currently available data, a minimum estimate of the mean annual mortality and serious injury rate due to U.S. commercial fisheries (1 whale) is greater than 10% of the PBR (10% of PBR = 0.6) and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. A minimum estimate of the total annual level of human-caused mortality and serious injury (1 whale) is less than the PBR (5.9). Therefore, the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

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

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 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, 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 Beaufort Sea have physical characteristics of transient-type whales, but little is known about these whales. 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).

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), though 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, six of the seven whales were photographed 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 $\leq$1969), AT3 (male, born 1984), AT4 (female, born $\leq$1974), AT9 (female, born $\leq$1965), AT10 (male, born 1980), and AT18 (female, born $\leq$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 remains at seven whales (C. Matkin, North Gulf Oceanic Society, pers. comm., 27 September 2016). 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). 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 7 whales in 2015, 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 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). 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 whales ($7 \times 0.02 \times 0.1$).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. No human-caused mortality or serious injury of AT1 Transient killer whales was reported in 2011-2015. 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 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. State-managed commercial fisheries prosecuted 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. Several subsistence fisheries (salmon, halibut, non-salmon finfish, and shellfish) also occur within this area, and no incidental mortality or serious injury of AT1 killer whales has been reported for these fisheries.

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, 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 (0) 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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade, 2006). Killer whales are found throughout the North Pacific. Along the west coast of North America, killer whales occur along the entire Alaskan 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). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where whales 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 killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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 2012). 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.

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. EEZ: 1) the Alaska Resident stock - occurring from southeastern Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of southeastern 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 southeastern Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring

mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast transient stock - occurring from California through southeastern 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 Stock Assessment Reports for the Alaska Region contain information concerning all the killer whale stocks except the Hawaiian and Offshore stocks.

Until recently, transient killer whales in Alaska had only been studied intensively 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 populations of transients which were never found in association with one another, the so-called 'Gulf of Alaska' transients and 'AT1' transients. Gulf of Alaska' transients are documented throughout the Gulf of Alaska, including occasional sightings in Prince William Sound. AT1 transients are primarily seen in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with 'Gulf of Alaska' transients. Recently members of the Gulf of Alaska transient population have been seen in association with the transient killer whales that range from California to southeastern Alaska, the west coast transients, which are identified by a unique mtDNA haplotype. Recent data have identified 14 out of 217 whales considered "outer coast" transients in British Columbia as photographed in Alaskan waters and considered Gulf of Alaska transients (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' stock have been found to share a single mtDNA haplotype that is not found in the other communities. 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, as Saulitis (1993) and 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 communities are considered discrete from the 'west coast' transients.

Biopsy samples from the eastern Aleutians and south side of the end of the Alaska Peninsula have produced the same haplotypes as killer whales in the northern Gulf of Alaska, however nuclear DNA analysis strongly suggest they belong to a separate population (Parsons et al. 2013). Samples from the central Aleutian Islands and Bering Sea have identified mtDNA haplotypes not found in Gulf of Alaska transients, suggesting additional population structure in western Alaska. At this time, 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 are observed in the northern Bering Sea and Beaufort Sea that have the physical characteristics of transient type whales, but little is known about these whales.

In summary, within the transient ecotype, association data (Ford et al. 1994, Ford and Ellis 1999, Matkin et al. 1999), acoustic data (Saulitis 1993, Ford and Ellis 1999) and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000, Parsons et al. 2013) confirm that at least three communities of transient whales exist and represent three discrete populations: 1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, 2) AT1 transients, and 3) West Coast transients.

Most of the transient whales photographed in the inland waters of Southeast Alaska share the west coast transient haplotype and have been seen in association with British Columbia/Washington State transients. Transients most often seen off California have also share the West Coast Transient (WCT) haplotype and have been observed in association with transients in Washington and British Columbia. The West Coast Transient Stock is therefore considered to include transient killer whales from California through southeastern Alaska. However, it should be noted that Fisheries and Oceans Canada recently decided to exclude whales from California from their assessment of the "West Coast Transient (WCT) Population" (DFO 2007). They noted that 100 or so transient killer whales identified off the central coast of California (Black et al. 1997) were in the past considered to be an extension of this population because of acoustical similarities and occasional mixing with WCT individuals in BC waters (Ford and Ellis 1999), but that a recent reassessment indicated that the available evidence was insufficient to warrant inclusion of those whales in the WCT population (DFO 2010). Canadian researchers have now identified 46 individual whales in British Columbia that are known from California (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013). They also noted that the Gulf of Alaska transients are seen occasionally within the range of WCTs (in southeastern Alaska and off British Columbia) but have only been observed to travel in association with WCTs on one occasion (DFO 2007, Matkin et al. 2012). For the purposes of this stock assessment report, the West Coast Transient Stock continues to include animals that occur in California, Oregon, Washington, British Columbia and southeastern Alaska.

POPULATION SIZE

The west coast transient stock is a trans-boundary stock, including killer whales from British Columbia. Preliminary analysis of photographic data resulted in the following minimum counts for 'transient' killer whales belonging to the west coast transient stock. Over the time series from 1975 to 2012, 521 individual transient killer whales have been identified. Of these, 217 are considered part of the poorly known "outer coast" subpopulation and 304 belong to the well-known "inner coast" population. However of the 304, the number of whales currently alive is not certain (see Ford et al. 2013). A recent mark-recapture estimate that does not include the "outer coast" subpopulation or whales from California for the west coast transient population resulted in an estimate of 243 (95% probability interval = 180-339) in 2006 (DFO 2009). This estimate applies to the population of west coast transient whales that occur in the inside waters of southeastern Alaska, British Columbia, and northern Washington. Given that the California transient numbers have not been updated since the publication of the catalogue in 1997 (Black et al. 1997), the total number of transient killer whales reported above should be considered as a minimum count for the west coast transient stock.

Minimum Population Estimate

The abundance estimate of killer whales is a direct count of individually identifiable animals. However, the number of cataloged whales does not necessarily represent the number of live animals. Some animals may have died, but whales can not be presumed dead if not resighted because long periods of time between sightings are common for some 'transient' animals. The connection of the outer coast whales with the west coast transient population of inshore waters is not well established, and the photographic catalogue from California has not been updated in 15 years. Estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) that include the "outer coast" whales are not currently available. Thus, the minimum population estimate (N_{MIN}) for the West Coast Transient stock of killer whales is derived from the recent mark-recapture analysis for West Coast transient population whales from the inside waters of Alaska and British Columbia of 243 whales (95% probability interval = 180-339) in 2006 (DFO 2009), which includes animals found in Canadian waters (see PBR Guidelines regarding the status of migratory trans-boundary stocks, Wade and Angliss 1997). Information on the percentage of time animals typically encountered in Canadian waters spend in U.S. waters is unknown. However, as noted above, this minimum population estimate is considered conservative. This approach is consistent with previous recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

Recent analyses of the inshore west coast transient population indicate that this segment grew rapidly from the mid-1970s to mid-1990s as a result of a combination of high birth rate, survival, as well as greater immigration of animals into the nearshore study area (DFO 2009). The rapid growth of the west coast transient population in the mid-1970s to mid-1990s coincided with a dramatic increase in the abundance of the whales' primary prey, harbor seals, in nearshore waters. Population growth began slowing in the mid-1990s and has continued to slow in recent years (DFO 2009). Given population estimates are based on photo identification of individuals and considered minimum estimates, no reliable estimate of trend is available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Analyses in DFO (2009) estimated a rate of increase of about 6% per year in this population from 1975 to 2006, but this included recruitment of non-calf whales into the population, at least in the first half of the time period, interpreted as either a movement of some whales into nearshore waters from elsewhere, or from better spatial sampling coverage. The population increased at a rate of approximately 2% for the second half of the time period, when recruitment of new individuals was nearly exclusively from new-born individuals (DFO 2009). Studies of 'resident' killer whale pods in the Pacific Northwest resulted in estimated population growth rates of 2.92% and 2.54% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993) and an observed growth rate of 3.1% was observed in northern resident killer whales and used in calculations of R_{MAX} for that stock. However, until additional data become available for this stock of transient type killer whales, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net

productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status with a mortality rate CV = 0.80 (Wade and Angliss 1997). Thus, for the West Coast Transient killer whale stock, PBR = 2.4 animals (243 × 0.02 × 0.5). The proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, Pacific Biological Station, Canada, pers. comm.)

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

NMFS observers monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 1994 to 2003 (Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, Carretta 2002, Carretta and Chivers 2003, Carretta and Chivers 2004). The observed mortality in this fishery, in 1995, was a transient whale as determined by genetic testing (S. Chivers, NMFS-SWFSC, pers. comm.). Overall entanglement rates in the California/Oregon thresher shark/swordfish drift gillnet fishery dropped considerably after the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders (Barlow and Cameron 1999). Because the California/Oregon thresher shark/swordfish drift gillnet fishery is observed and has not incurred incidental serious injuries or mortalities of killer whales between 1999-2003, the estimate of fishery-related take for this fishery is zero. Thus, the mean annual mortality rate for this stock is zero. Additional fisheries that could interact with the Eastern North Pacific Transient stock of killer whales are listed in Appendix 3.

The estimated minimum mortality rate incidental to recently monitored U.S. commercial fisheries is zero animals per year.

All Canadian trawl and longline fisheries are monitored by observers or video; salmon net fisheries are not observed (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013). The sablefish longline fishery accounts for a large proportion of the commercial fishing/killer whale interactions in Alaska waters. However, transient killer whales typically are not involved in these interactions. Resident killer whales are well documented to interact with the longline fishery. Such interactions have not been reported in Canadian waters where sablefish are taken via a pot fishery. Canada has a Marine Mammal Response Network to track human interaction incidents such as entanglements (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013). Since 1990, there have been no reported fishery-related strandings of killer whales in Canadian waters. In 1994, one killer whale was reported to have contacted a salmon gillnet, but it did not entangle (Guenther et al. 1995).

Subsistence/Native Harvest Information

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

Other Mortality

The shooting of killer whales in Canadian waters has been a concern in the past. However, in recent years there have been no reports of shooting incidents in Canadian waters. In fact, the likelihood of shooting incidents involving 'transient' killer whales is thought to be minimal since commercial fishermen are most likely to observe 'transients' feeding on seals or sea lions instead of interacting with their fishing gear (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

Collisions with boats are another source of mortality. Killer whales interacting with trawl vessels are occasionally struck by the propeller; there were 4 incidents of mortality and serious injury in the Bering Sea/Aleutian Islands flatfish trawl and Bering Sea/ Aleutian Islands rockfish trawl fisheries between 2007-2011. Stock identification for these occurrences is unknown; however, this area is outside of the known range for this stock. There have been no reported mortalities of killer whales from this stock due to vessel collisions.

STATUS OF STOCK

The West Coast transient killer whale stock is not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. In 2001, the Committee on the Status of Endangered Wildlife in Canada designated west coast transient killer whales in British Columbia as "threatened" under the Species at Risk Act (SARA) for Canada. Human-caused mortality may have been underestimated, primarily due to a lack of information on Canadian fisheries, and that the minimum abundance estimate is considered conservative (because researchers continue to encounter new whales and provisionally classified whales from Southeast Alaska and off the coast of California were not included), resulting in a conservative PBR estimate. Based on currently available data, the estimated annual U. S. commercial fishery-related mortality level (0) does not exceed 10% of the PBR (0.2) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (0 animals per year) does not exceed the PBR (2.4). Therefore, the West Coast Transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population (OSP) level are currently unknown.

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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 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).

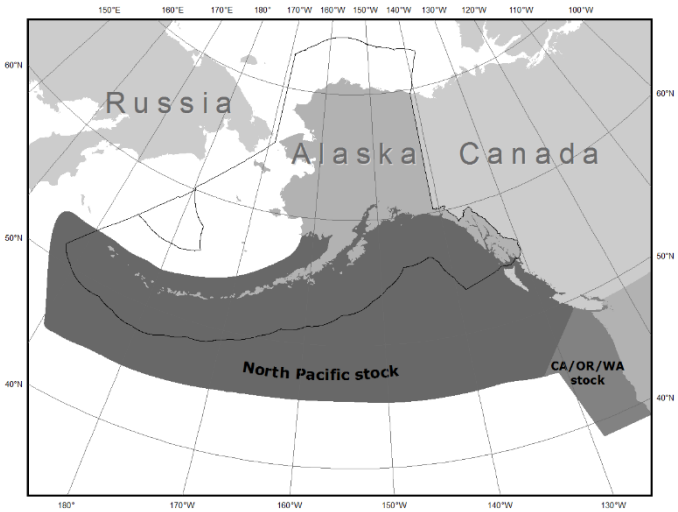

Figure 1. Approximate distribution of Pacific white-sided dolphins in the eastern North Pacific (dark shaded areas).

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, though 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 (Buckland et al. 1993). The Buckland et al. (1993) abundance estimate, 931,000 (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 Alaskan 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 (95% CI: 868-265,000) Pacific white-sided dolphins in the Gulf of Alaska based on a single sighting of 20 animals. 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, off Port Moller (R. Hobbs, NMFS-AFSC-NMML, pers. comm.).

Minimum Population Estimate

Historically, the minimum population estimate (N_{MIN}) for this stock was 26,880, 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 stock is unknown.

Current Population Trend

At present, there is no reliable information on trends in abundance for this stock of Pacific white-sided dolphins.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate 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 net productivity rate (R_{MAX}) was based. Thus, it is recommended that the cetacean maximum net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks 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) recommend that abundance estimates older than 8 years no longer be used to calculate a PBR level. 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. Thus, the PBR for this stock is undetermined (NMFS 2005).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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 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 incidental to observed U.S. commercial fisheries was reported between 2009 and 2013 (Breiwick 2013; NMML, unpubl. data).

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 to 2013, no human-caused mortality or serious injury of Pacific white-sided dolphins was reported to the NMFS Alaska Region stranding database (Helker et al. 2015).

STATUS OF STOCK

Pacific white-sided dolphins are not designated as "depleted" under the MMPA 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. Because the PBR for Pacific white-sided dolphins is undetermined, the level of human-caused mortality and serious injury relative to PBR is unknown and the level of annual U.S. commercial fishery-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.

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).

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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, 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).

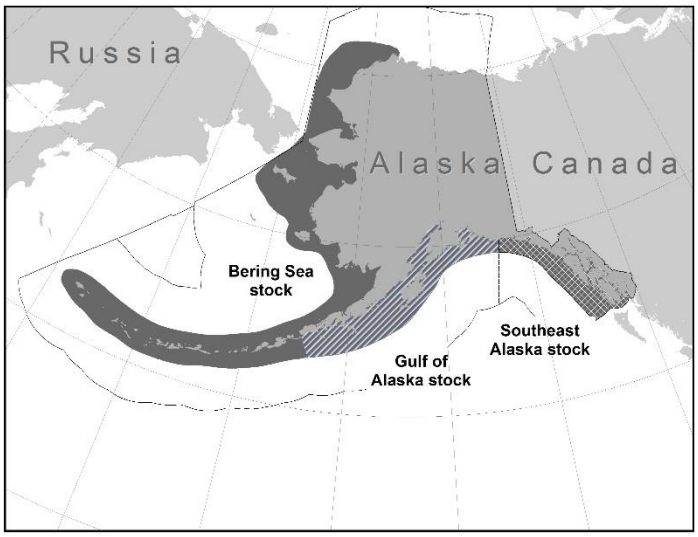

Figure 1. Approximate distribution of harbor porpoise in Alaska waters.

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, 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 = 0.162) (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 = 0.242) in the coastal and inside waters of Southeast Alaska (Hobbs and Waite 2010).

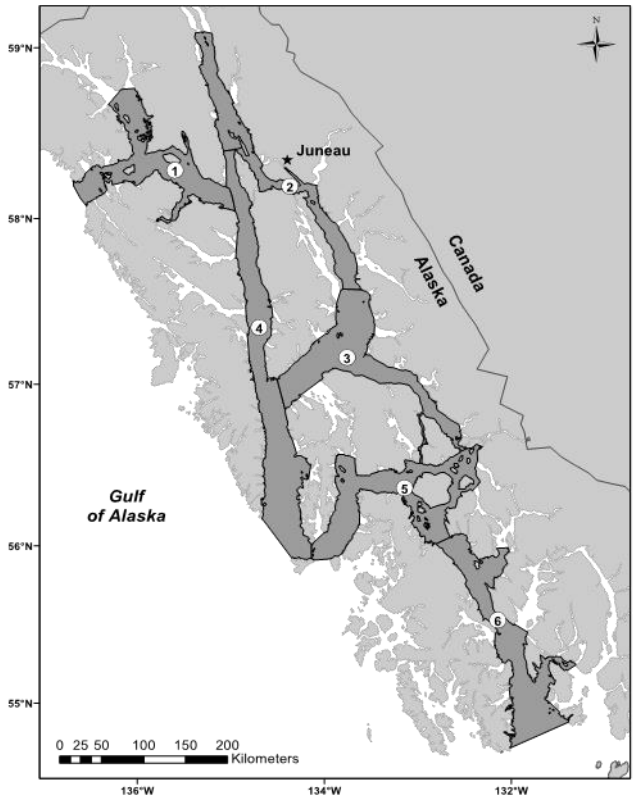

Figure 2. Survey strata defined for line-transect survey effort allocation in Southeast Alaska (as illustrated in Fig. 1 of Dahlheim et al. 2015).

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 not been computed for these surveys. Therefore, these 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 aerial surveys is 1,996 porpoise calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. 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 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 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 N_{MINs} of 359 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 (based on the 2010-2012 abundance estimate for harbor porpoise in the inland waters of Southeast Alaska), PBR is 8.9 harbor porpoise (896 × 0.02 × 0.5).

Based on text above related to prospective stocks, we have also calculated 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) and 5.1 harbor porpoise (N = 577; CV = 0.14; N_{MIN} = 513), respectively.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Southeast Alaska harbor porpoise 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 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 (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 (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, 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 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.

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).

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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, 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).

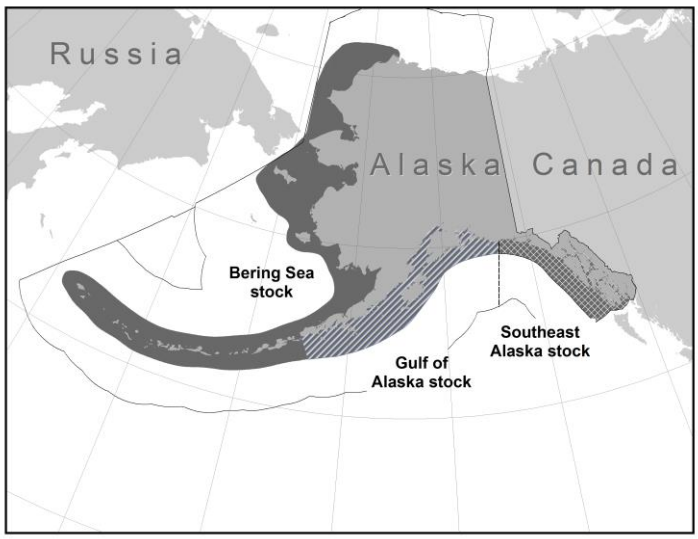

Figure 1. Approximate distribution of harbor porpoise in Alaska waters.

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, 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 for observer perception bias and one to correct for porpoise availability/visibility at the surface. The 1998 survey resulted in an abundance estimate for the Gulf of Alaska harbor porpoise stock of 10,489 porpoise (CV = 0.115) (Hobbs and Waite 2010), which includes a correction factor (1.372; CV = 0.066) 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 for aerial surveys of harbor porpoise in Puget Sound to be 2.96 (CV = 0.180); 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. The estimated corrected abundance estimate from the 1998 survey is 31,046 porpoise (10,489 × 2.96 = 31,046; CV = 0.214) (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), which was based on surveys 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, N_{MIN} for the Gulf of Alaska stock of harbor porpoise is 25,987 (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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Gulf of Alaska harbor porpoise 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 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 (Breiwick 2013; MML, unpubl. data). 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, 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, 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 = 1.0)
Cook Inlet salmon set gillnet	1999 2000	obs data	0.16-1.1 0.34-2.7	0 0	0 0	0
Kodiak Island salmon set gillnet	2002 2005	obs data	6.0 4.9	2 2	32 39	36 (CV = 0.68)
Minimum total estimated annual mortality						72 (CV = 0.44)

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, one Gulf of Alaska harbor porpoise mortality in a commercial salmon drift gillnet near Kenai, Alaska, was reported to the NMFS Alaska Region stranding network

and five mortalities in Kodiak Island salmon set gillnet were reported through the Marine Mammal Authorization Program (Helker et al. 2017). However, all of these events are accounted for in the extrapolated estimates (derived from Alaska Marine Mammal Observer Program observer data) of annual mortality and serious injury occurring in the commercial Cook Inlet salmon drift gillnet fishery and commercial Kodiak Island salmon set gillnet fishery (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 (Table 2; Helker et al. 2017). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and should be considered a minimum because not all entangled animals strand and not 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 (Helker et al. 2017). 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**	**Mean annual mortality**
Entangled in unidentified net*	0	0	0	1	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 observer placements in all of the salmon and herring fisheries operating within the range of this stock. However, 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 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 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.

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).

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HARBOR PORPOISE (*Phocoena phocoena*): Bering Sea Stock

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

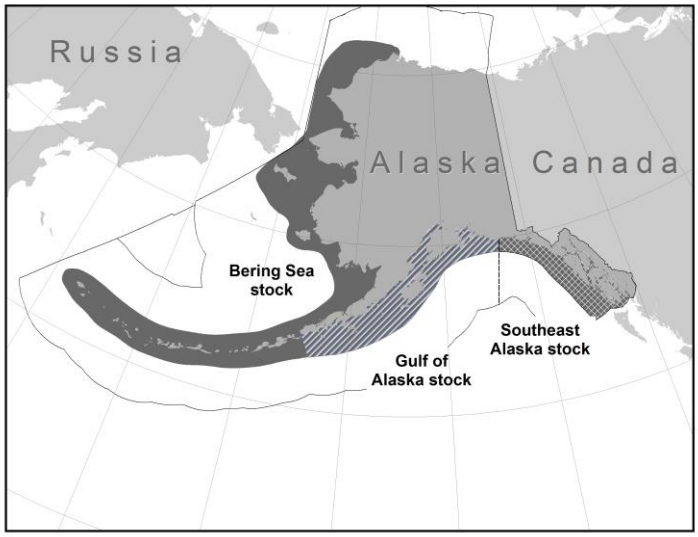

Figure 1. Approximate distribution of harbor porpoise in Alaska waters.

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, 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 not counted because they were not observed and one to correct for porpoise availability/visibility at the surface. The 1999 survey resulted in an observed abundance estimate for the Bering Sea harbor porpoise stock of 16,289 (CV = 0.132: Hobbs and Waite 2010), which includes the perception bias correction factor (1.337; CV = 0.062) obtained during the survey using an independent belly window observer. Laake et al. (1997) estimated the availability bias for aerial surveys of harbor porpoise in Puget Sound to be 2.96 (CV = 0.180); 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 = 0.223). 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 (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 harbor porpoise and no correction factors are available, the abundance estimates are not used to calculate a population estimate.

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 0.223, N_{MIN} for the Bering Sea stock of harbor porpoise is 40,039 (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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Bering Sea harbor porpoise in 2011-2015 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 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 Bering Sea harbor porpoise was observed incidental to U.S. federal commercial fisheries during 2011-2015 (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), 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 (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 a minimum because not all entangled animals strand and not 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 observer placements in all of the salmon and herring fisheries operating within the range of this stock.

In 2012, one harbor porpoise entangled in a subsistence salmon gillnet in Nome, Alaska (Helker et al. 2017), resulting in a minimum average annual mortality and serious injury rate of 0.2 harbor porpoise due to subsistence fishery interactions in 2011-2015 (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 (Helker et al. 2017). 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	Mean annual mortality
Entangled in Kotzebue commercial salmon set gillnet	0	0	1	0	0	0.2
Entangled in Nome subsistence salmon gillnet	0	1	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.

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, 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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dall's porpoise are widely distributed across the entire North Pacific Ocean (Fig. 1). They are found over the continental shelf adjacent to the slope and over deep (2,500+ m) oceanic waters (Hall 1979). They have been sighted throughout the North Pacific as far north as 65°N (Buckland et al. 1993) and as far south as 28°N in the eastern North Pacific (Leatherwood and Fielding 1974). The only apparent distribution gaps in Alaska waters are upper Cook Inlet and the shallow eastern flats of the Bering Sea. Throughout most of the eastern North Pacific they 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).

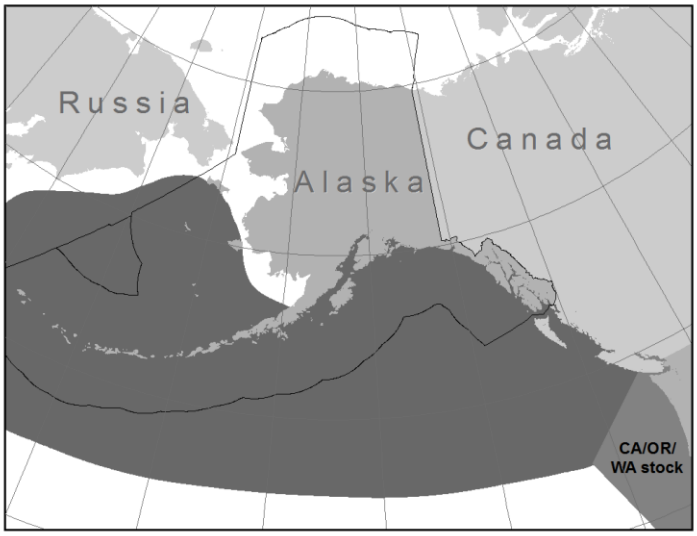

Figure 1. Approximate distribution of Dall's porpoise in Alaska waters (dark shaded area).

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 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).

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, 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 genetics 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 recognized in Alaskan 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 (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 (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. Surveys for this stock are more than 8 years old, consequently there are no reliable abundance data for the 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 of the survey was completed 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 estimate was 35,303 (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 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). They are also uncorrected for potential biases from responsive movements (ship attraction) and 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 the abundance estimate is based on data older than 8 years, the N_{MIN} is considered unknown.

Current Population Trend

At present, 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 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% be employed for the Alaska stock of Dall's porpoise (Wade and Angliss 1997). However, based on life-history analyses in Ferrero and Walker (1999), Dall's porpoise reproductive strategy is not consistent with the delphinid pattern on which the default R_{MAX} for cetaceans is based. In contrast to the delphinids, Dall's porpoise mature earlier and reproduce annually which suggest 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 that abundance estimates older than 8 years no longer be used to calculate a PBR level; thus, because the abundance estimate for this stock is more than 8 years old, the N_{MIN} is unknown and therefore the PBR level is undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

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.

The Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery was monitored 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).

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 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 (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; NMML, 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)
SE Alaska salmon drift gillnet (Districts 6, 7, 8)	2012 2013	obs data	6.4 6.6	1 0	18 0	9 (CV = 1.0)
AK Peninsula/Aleutian Is. salmon drift gillnet	1990	obs data	4	1	28	28 (CV = 0.585)
Minimum total estimated annual mortality						38 (CV = 0.498)

From 2009 to 2013, no mortality or serious injury of Dall's porpoise was reported to the NMFS Alaska Region stranding database (Helker et al. 2015).

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 MMPA 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 the most recent abundance estimate is more than 8 years old. Because the PBR is undetermined, the annual level of U.S. commercial fishery-related mortality and serious injury that 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.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

The sperm whale is one of the most widely distributed marine mammal species, perhaps exceeded in its global range only by the killer whale (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 at least the late 1960s (Ivashchenko and Clapham 2015).

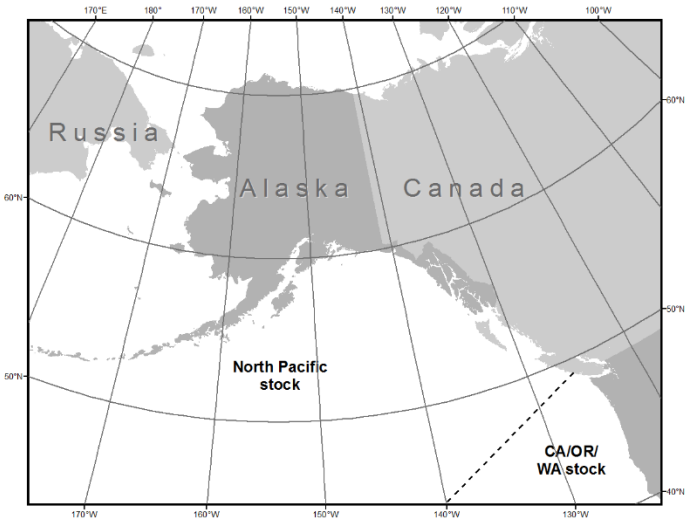

Figure 1. The approximate distribution of sperm whales in the North Pacific Ocean includes deep waters south of 62°N to the equator.

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 given to sperm whales in the 1960s can, if rediscovered, provide useful information on historical movements. Mizroch and Rice (2013) examined 261 Discovery mark 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 176 sperm whales from 1962 to 1969 off southern California and northern Baja California (Mizroch and Rice 2013). Seven of those marked whales were recovered in locations ranging from offshore California, Oregon, and British Columbia to the western Gulf of Alaska. A male whale marked by Canadian researchers moved from near Vancouver Island, British Columbia, to the Aleutian Islands near Adak. A whale marked by Soviet researchers moved from coastal Michoacán, mainland Mexico, to a location about 1,300 km offshore of Washington State. Marking 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) 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. The authors also found no indication from marking 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 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 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) suggests that this structure should be reviewed and updated to reflect current data. 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; caution should be exercised in interpreting published estimates. The abundance of sperm whales in the North Pacific was reported to be 1,260,000 prior to exploitation, which by the late 1970s was estimated 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 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.

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 available.

Minimum Population Estimate

At this time, it is not possible to produce a reliable estimate of minimum abundance for this stock.

Current Population Trend

No current estimate of abundance exists for this stock; therefore, 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 is not available for the North Pacific stock of sperm whales. Hence, until additional data become available, the cetacean maximum 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.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. A minimum estimate of the total annual level of human-caused mortality and serious injury for North Pacific sperm whales in 2011-2015 is 3.7 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 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, 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) 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 sperm whales in U.S. commercial fisheries in 2011-2015 (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 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. Pacific halibut longline	2011	obs data	16	0	0	1.5 (CV=0.91)
	2012		1.8	0	0	
	2013		13	0	0	
	2014		11	0	0	
	2015		14	0.75	7.3	
Gulf of Alaska sablefish longline	2011	obs data	14	0	0	1.9 (+0.3)[e] (CV = 0.63)
	2012		14	1.5	3.4	
	2013		14	0.75 (+0.75)[a]	6.2 (+0.75)[b]	
	2014		19	0 (+0.75)[c]	0 (+0.75)[d]	
	2015		20	0	0	
Minimum total estimated annual mortality						3.7 (CV = 0.53)

[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]Mean annual mortality and serious injury for fishery: 1.9 whales (mean of extrapolated estimates from sampled hauls) + 0.3 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 (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 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 to 2015, one suspected human-related sperm whale mortality was reported to the NMFS Alaska Region stranding network (Helker et al. 2017). 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 in the West Yakutat and East Yakutat/Southeast Alaska areas (Perez 2006, Hanselman et al. 2008). 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.

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 whales in U.S. commercial fisheries. Because the PBR is unknown, it is not known if this minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate (3.7 whales) can be considered insignificant and approaching zero mortality and serious injury rate.

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.

HABITAT CONCERNS

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

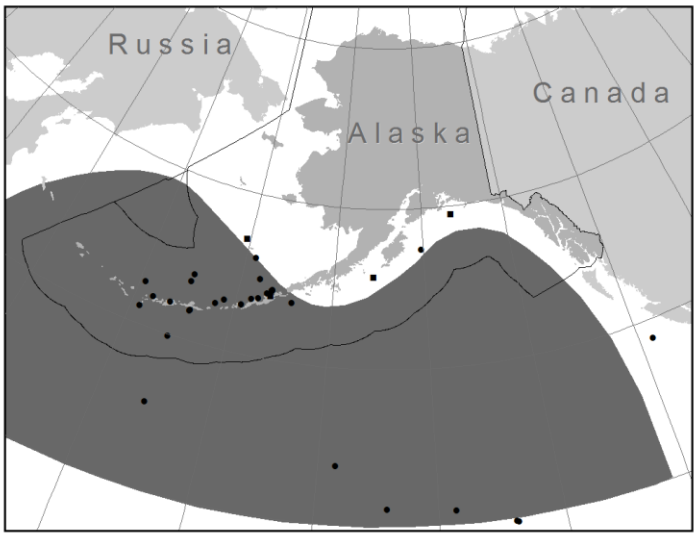

Figure 1. Approximate distribution of Baird's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted. (Forney and Brownell 1996, Moore et al. 2002, NMFS unpublished data). Note: Distribution updated based on Kasuya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

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

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for these stocks is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). However, in the absence of a reliable estimate of minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Subsistence/Native Harvest Information

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

Other Mortality

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

STATUS OF STOCK

Baird's beaked whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are currently not available. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered

insignificant and approaching zero mortality and serious injury rate is unknown. However, the estimated annual rate of human-caused mortality and serious injury seems minimal for this stock. Thus, the Alaska stock of Baird's beaked whale is not classified as strategic.

Habitat concerns

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

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Revised 5/15/2013

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

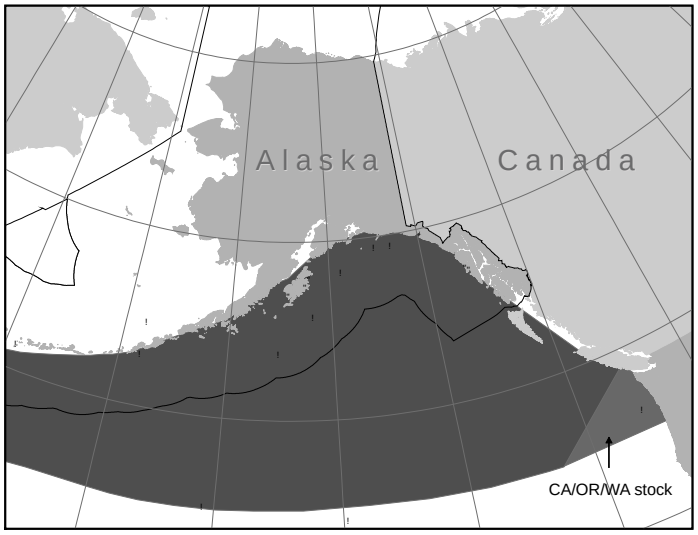

Figure 1. Approximate distribution of Cuvier's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted (Forney and Brownell 1996, NMFS unpublished data).

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

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). However, in the absence of a reliable estimate of minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Subsistence/Native Harvest Information

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

Other Mortality

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

STATUS OF STOCK

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

Habitat concerns

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

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Revised 2/11/2013

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

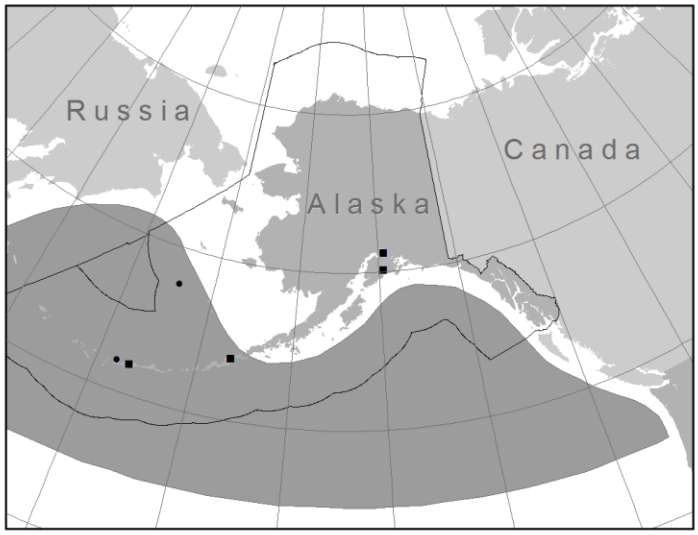

Figure 1. Approximate distribution of Stejneger's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted (Walker and Hanson 1999, NMFS unpublished data).

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

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status (Wade and Angliss 1997). However, in the absence of a reliable estimate of minimum abundance, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Subsistence/Native Harvest Information

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

STATUS OF STOCK

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

Habitat concerns

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

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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.

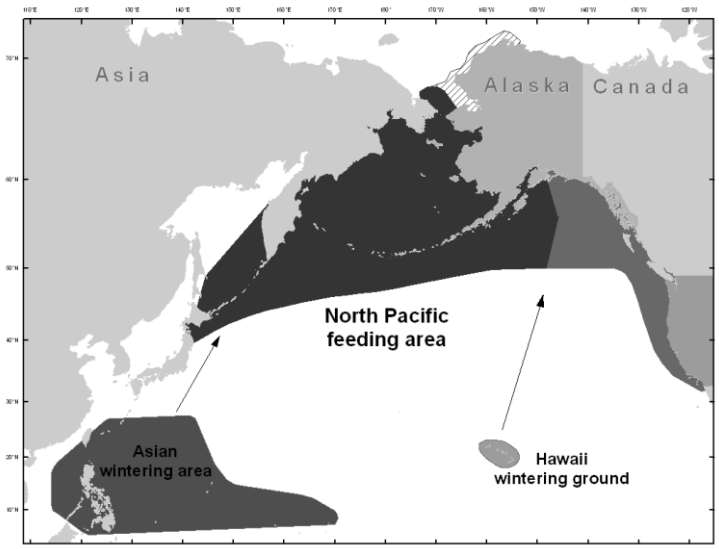

Figure 1. Approximate distribution of humpback whales in the western North Pacific (dark shaded areas). Feeding and wintering grounds are presented above (see text). Area within the hash lines is a probable distribution area based on sightings in the Beaufort Sea (Hashagen et al. 2009). See Figure 1 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 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 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 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 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, 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 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. Confidence limits or coefficients of variation (CVs) have not yet been 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, point estimates of abundance for Asia ranged from 938 to 1,107 (for 2004-2006), but no associated CV has yet been 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 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.

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 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, 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 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 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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Western North Pacific humpback whales in 2011-2015 is 3.2 whales: 0.8 in U.S. commercial fisheries, 0.4 in recreational fisheries, 0.6 in unknown (commercial, recreational, or subsistence) fisheries, 0.8 in marine debris, and 0.6 due to other causes (ship strikes and entanglement in a ship's ground tackle); 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 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.

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 U.S. commercial fisheries 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 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	obs data	98 98 97 98 99	0 1 0 0 0	0 1.0 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 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 Marine Mammal Authorization Program in 2011-2015 (Table 2; Helker et al. 2017). 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 (Table 2). Mortality and serious injury in events that occurred in the area where the two stocks overlap is 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 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 a minimum because not all entangled animals strand and not 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 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 (Table 2; Helker et al. 2017). 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, 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 humpback whales (Table 2; Helker et al. 2017).

The minimum average annual mortality and serious injury rate due to interactions with all fisheries in 2011-2015 is 1.8 Western North Pacific humpback whales (0.8 in commercial fisheries + 0.4 in recreational fisheries + 0.6 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 Marine Mammal Authorization Program in 2011-2015 (Helker et al. 2017). 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).

Cause of injury	**2011**	**2012**	**2013**	**2014**	**2015**	**Mean annual mortality**
Entangled in Kodiak Island commercial salmon purse seine gear	0	1[a]	0	0	0	0.2
Entangled in Kodiak Island commercial salmon set gillnet	0	0	0	0	0.75	0.2
Entangled in Bering Sea/Aleutian Is. commercial pot gear	0	0	0	0	1	0.2
Entangled in Gulf of Alaska recreational Dungeness crab pot gear	0	0	0	0	0.75	0.2
Entangled in Gulf of Alaska recreational shrimp pot gear	0	0	0	0	0.75	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	0.2

Cause of injury	2011	2012	2013	2014	2015	Mean annual mortality
Entangled in gillnet*	0.75	0	0	0	0	0.2
Entangled in marine debris	2.5	0.75	0	0.75	0	0.8
Entangled in ship's ground tackle	0	0	1	0	0	0.2
Ship strike	0	1.2	0	1	0	0.4
Total in commercial fisheries						0.6
Total in recreational fisheries						0.4
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.6
Total in marine debris						0.8
Total due to other sources (entangled in ship's ground tackle, ship strike)						0.6

[a]Marine Mammal Authorization Program 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, 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.

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 (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 for large whales in the western Gulf of Alaska; however, no specific cause for the increased mortality has been identified.

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 Western North Pacific humpback whales in 2011-2015 (Table 2; Helker et al. 2017). Ship strikes and other interactions with vessels unrelated to fisheries resulted in a minimum mean annual mortality and serious injury rate of 0.6 humpback whales from this stock in 2011-2015, based on ship strikes (0.4) and entanglement in a ship's ground tackle (0.2) reported to the NMFS Alaska Region stranding network (Table 2; Helker et al. 2017). Because all of these events occurred in the area where the stocks overlap, the mortality and serious injury is 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 a minimum because not all entangled animals strand and not all stranded animals are found, reported, or have the cause of death determined.

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). From 1961 to 1971, 6,793 humpback whales were killed illegally by the U.S.S.R. 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.

STATUS OF STOCK

The total estimated annual level of human-caused mortality and serious injury of 3.2 Western North Pacific humpback whales is more than 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).

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).

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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 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.

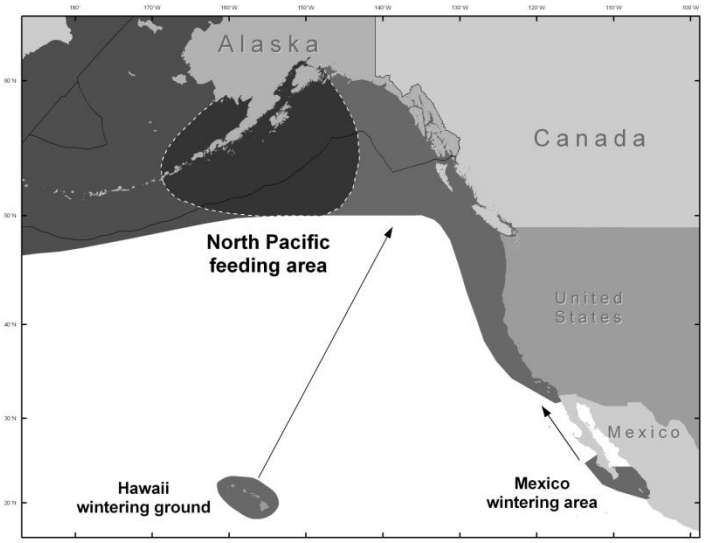

Figure 1. Approximate distribution of humpback whales in the eastern North Pacific (dark shaded areas). Feeding and wintering areas are presented above (see text). Area within the dotted line is known to be an area where the Central North Pacific and Western North Pacific stocks overlap. See Figure 1 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, 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 (Calambokidis et al. 2008), this is still 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 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 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. 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 (Calambokidis et al. 2008), 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. 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, though 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 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 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 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. 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, PBR is calculated to be 83 whales (7,890 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 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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Central North Pacific humpback whales in 2011-2015 is 25 whales: 8.5 in U.S. commercial fisheries, 0.7 in recreational fisheries, 0.3 in subsistence fisheries, 8.8 in unknown (commercial, recreational, or subsistence) fisheries, 2.8 in marine debris, and 4.4 due to other causes (ship strikes and entanglement in a ship's ground tackle); 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 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 (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 one in the Hawaii deep-set longline fishery in 2014, resulting in mean annual mortality and serious injury rates of 0.2 and 0.9 whales, respectively, in these fisheries in 2011-2015 (Table 1; Bradford and Forney 2017; NMFS-PIFSC, unpubl. data).

In 2012 and 2013, the Alaska Marine Mammal Observer Program placed observers on independent vessels in the state-managed Southeast Alaska salmon drift gillnet fishery to assess mortality and serious injury of marine mammals. Areas around and adjacent to Wrangell and Zarembo Islands (ADF&G Districts 6, 7, and 8) were observed during the 2012-2013 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 (1 serious injury in 2014 in District 13B, 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 Marine Mammal Authorization Program in 2011-2015 (Table 2; Helker et al. 2017). 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 1.7 humpback whales in 2011-2015 (Table 2). Mortality and serious injury in events that occurred in the area where the two stocks overlap is 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 a minimum because not all entangled animals strand and not 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 (or the most recent data available) is 8.5 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 Hawaii (Table 1: 1.1) and on reports, in which the commercial fishery is confirmed, to the NMFS Alaska Region stranding network (Table 2: 1.7).

Table 1. Summary of incidental mortality and serious injury of Central North Pacific humpback whales due to U.S. commercial fisheries in 2011-2015 (or the most recent data available) and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; Bradford and Forney 2017; Manly 2015; NMFS-PIFSC, unpubl. data; 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	obs data	98	0	0	0.2 (CV = 0.16)
	2012		98	1	1.0	
	2013		97	0	0	
	2014		98	0	0	
	2015		99	0	0	
Southeast Alaska salmon drift gillnet (Districts 6, 7, 8)	2012	obs data	6.4	0	0	5.5 (CV = 1.0)
	2013		6.6	1	11	
Hawaii shallow-set longline	2011	obs data	100	1[b]	0.75[b]	0.2
	2012		100	0	0	
	2013		100	0	0	
	2014		100	0	0	
	2015		100	0	0	
Hawaii deep-set longline	2011	obs data	20	0	0	0.9 (CV = 2.1)
	2012		20	0	0	
	2013		20	0	0	
	2014		20	1	5	
	2015		20	0	0	

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Minimum total estimated annual mortality					Bering Sea/Aleutian Is.:	0.2
					Southeast Alaska:	5.5
					Hawaii:	1.1
					Total:	6.8
						(CV = 0.88)

[a]Mortality and serious injury in this fishery is 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 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 a minimum because not all entangled animals strand and not 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 (Table 2; Helker et al. 2017). 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 halibut longline gear were reported to the NMFS Alaska Region in 2011-2015, resulting in a minimum mean annual mortality and serious injury rate of 0.3 humpback whales in this fishery (Table 2; Helker et al. 2017). 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 is 8.8 humpback whales in 2011-2015: 2.2 reported to the NMFS Alaska Region stranding network (Table 2; Helker et al. 2017) and 6.6 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 is 18 Central North Pacific humpback whales (8.5 in commercial fisheries + 0.7 in recreational fisheries + 0.3 in subsistence fisheries + 8.8 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 Marine Mammal Authorization Program in 2011-2015 (Helker et al. 2017). Injury events lacking detailed 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).

Cause of injury	2011	2012	2013	2014	2015	Mean annual mortality
Entangled in Kodiak Island commercial salmon purse seine gear	0	1[a, b]	0	0	0	0.2
Entangled in Southeast Alaska commercial salmon purse seine gear	0	0	0.75[a]	0	0.75	0.3
Entangled in Kodiak Island commercial salmon set gillnet	0	0	0	0	0.75[b]	0.2

Cause of injury	2011	2012	2013	2014	2015	Mean annual mortality
Entangled in Prince William Sound commercial salmon drift gillnet	0	0	0	0	1.5	0.3
Entangled in Southeast Alaska commercial salmon drift gillnet (District 13B)	0	0	0	0.75[a]	0	0.2
Entangled in Bering Sea/Aleutian Is. commercial pot gear	0	0	0	0	1[b]	0.2
Entangled in Southeast Alaska commercial pot gear	0	0	0	0	1.5	0.3
Entangled in Gulf of Alaska recreational Dungeness crab pot gear	0	0	0	0	0.75[b]	0.2
Entangled in Gulf of Alaska recreational shrimp pot gear	0	0	0	0	0.75[b]	0.2
Entangled in Southeast Alaska subsistence halibut longline gear	0	0.75	0	0	0.75	0.3
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	0.2
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	0.5
Entangled in Southeast Alaska unidentified net*	0	0	0	0	1.5	0.3
Entangled in gillnet*	0.75[b]	1	0	0	0	0.4
Entangled in unidentified net*	0	0	0.75	0	0	0.2
Entangled in marine debris[c]	5.5	0.75	1.5	4.5	1.75	2.8
Entangled in ship's ground tackle	0	0	1[b]	0	0	0.2
Ship strike[d]	2	2.6	0.14	4.52	2.8	2.4
Total in commercial fisheries						1.7
Total in recreational fisheries						0.4
Total in subsistence fisheries						0.3
*Total in unknown (commercial, recreational, or subsistence) fisheries						2.2
Total in marine debris						2.8
Total due to other sources (entangled in ship's ground tackle, ship strike)						2.6

[a]Marine Mammal Authorization Program fisherman self report.
[b]Mortality and serious injury assigned to both the Central North Pacific (CNP) and Western North Pacific (WNP) stocks.
[c]Marine debris mortality and serious injury (prorated values) assigned to both the CNP and WNP stocks: 2.5 whales in 2011; 0.75 in 2012; and 0.75 in 2014.
[d]Ship strike mortality and serious injury (prorated values) assigned to both the CNP and WNP stocks: 1.2 whales in 2012 and 1 in 2014.

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 (Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data).

Cause of injury	2011	2012	2013	2014	2015	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	0.2
Entangled in Alaska shrimp pot gear*	0	0	0	1	0	0.2
Entangled in Alaska king crab, tanner crab, or finfish pot gear*	0	0	0	0.75	0	0.2
Entangled in longline gear*	0	0	1	1	0	0.4
Entangled in unidentified fishing gear*	3.25	4.25	5.25	6.25	7.75	5.4
Ship strike	1.72	1.72	3.56	1	1.2	1.8
Total in recreational fisheries						0.3
*Total in unknown (commercial, recreational, or subsistence) fisheries						6.6
Total due to other sources (ship strike)						1.8

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.

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 (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 for large whales in the western Gulf of Alaska; however, no specific cause for the increased mortality has been identified.

Entanglements in marine debris reported to the NMFS Alaska Region stranding network account for a minimum mean annual mortality and serious injury rate of 2.8 Central North Pacific humpback whales in 2011-2015 (Table 2; Helker et al. 2017).

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) and ship strikes reported in Hawaii (Table 3: 1.8) in 2011-2015 is 4.4 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). 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 protected in 1965, but illegal catches by the U.S.S.R. continued until 1972 (Ivashchenko et al. 2007). From 1961 to 1971, 6,793 humpback whales were killed illegally by the U.S.S.R. 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.

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 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 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 (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.

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). 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.

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FIN WHALE (*Balaenoptera physalus*): Northeast Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the U.S. waters in the Pacific Ocean, fin whales are found seasonally off the coast of North America and in the Bering Sea during the summer (Fig. 1). Information on seasonal fin whale distribution has been gleaned from the 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 detected in the southeast Bering Sea using an instrument moored there, from April 2006 through April 2007, which showed peaks in fin whale call detections 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 fin whale stocks may feed in the Bering Sea, but call data collected in 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).

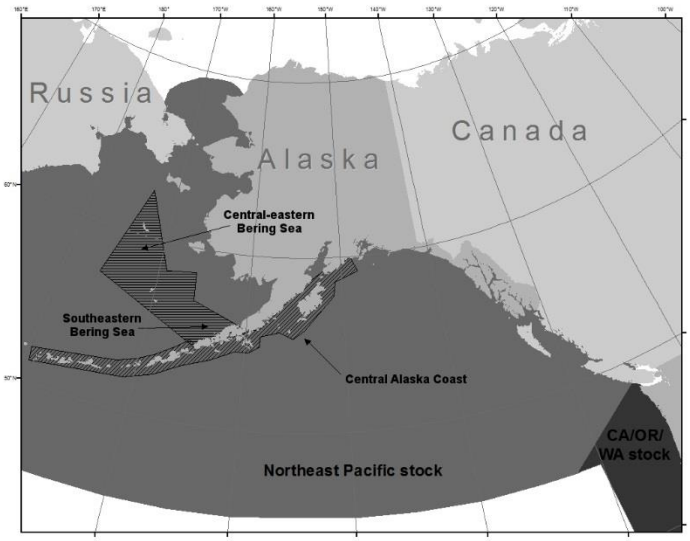

Figure 1. Approximate distribution of fin whales in the eastern North Pacific. Striped areas indicate where vessel surveys occurred in 1999-2010 (Moore et al. 2002; Friday et al. 2012, 2013) and 2001-2003 (Zerbini et al. 2006).

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 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 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. Discovery mark recoveries (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, Discovery mark recoveries, and opportunistic sightings data and found evidence that suggests 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 whale 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. Even though no data are available to make these corrections, 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 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 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. However, this apparent rate of increase in abundance 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 into the study area rather than actual population trends.

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 is unavailable for the Northeast Pacific fin whale stock. Hence, until additional data become available, the cetacean maximum 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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Northeast Pacific fin whales in 2011-2015 is 0.4 whales: 0.2 in U.S. commercial fisheries and 0.2 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 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). 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 (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 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 (Helker et al. 2017). 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	Mean annual mortality
Entangled in ground tackle of commercial mechanical jig fishing vessel	0	1	0	0	0	0.2
Ship strike	0	0	0	1	0	0.2
Total in commercial fisheries						0.2
Total due to other causes (ship strike)						0.2

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 reported taken 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 (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 for large whales in the western Gulf of Alaska; however, no specific cause for the increased mortality has been identified.

A fin whale mortality due to a ship strike in Alaska waters in 2014 was reported to the NMFS Alaska Region stranding network (Helker et al. 2017), resulting in a mean annual mortality and serious injury rate of 0.2 fin whales due to ship strikes in 2011-2015 (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 whales) does not exceed the calculated PBR (5.1 whales), and 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).

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.

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MINKE WHALE (*Balaenoptera acutorostrata*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the North Pacific, 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 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).

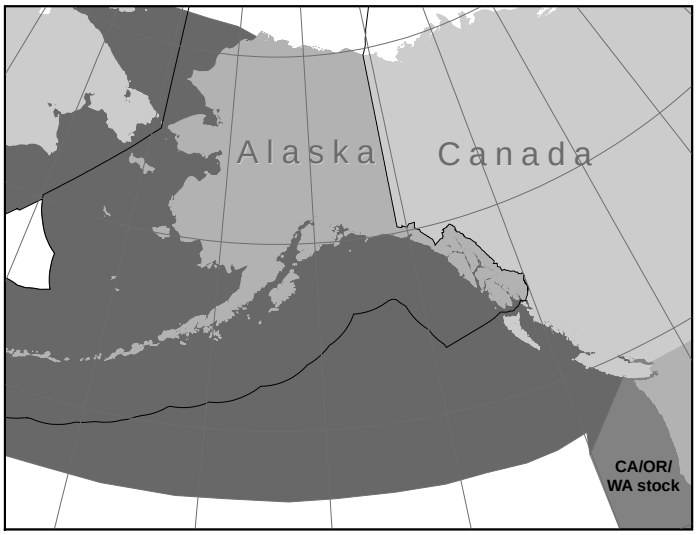

Figure 1. Approximate distribution of minke whales in the eastern North Pacific (dark shaded areas).

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 offshore Gulf of Alaska surveys for cetaceans in 2009 and 2013 that a population estimate for this species in this area could not be determined (Rone et al. 2010, 2014).

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. 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, 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 net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. Given the status of this stock is unknown, the appropriate recovery factor 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

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 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, no mortality or serious injury of minke whales occurred in observed U.S. commercial fisheries in 2009-2013.

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.

Other Mortality

From 2009 to 2013, no human-related mortality or serious injury of minke whales was reported to the NMFS Alaska Region stranding database (Helker et al. 2015).

STATUS OF STOCK

Minke whales are not designated as "depleted" under the MMPA 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. Because minke whales are considered common in the waters off Alaska and, because the number of human-related removals is currently thought to be minimal, this stock is presumed to not be a 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 annual U.S. commercial fishery-related mortality and serious injury that can be considered insignificant and approaching zero mortality and serious injury rate is unknown.

HABITAT CONCERNS

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

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NORTH PACIFIC RIGHT WHALE (*Eubalaena japonica*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

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).

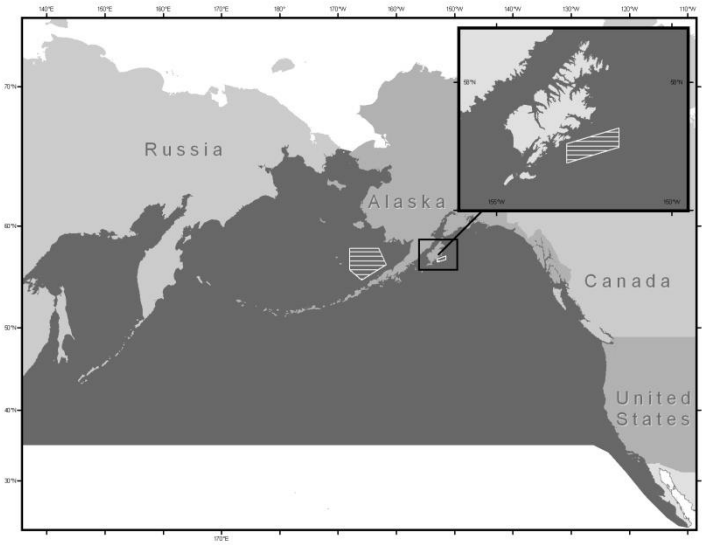

Figure 1. Approximate historical distribution of North Pacific right whales in the North Pacific (dark shaded area). Striped areas indicate northern right whale critical habitat (71 FR 38277, 6 July 2006).

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 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. 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 southeast 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).

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). 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.

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). 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).

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 individual whales from the eastern North Pacific. From 2008 to 2013, 16 individual right whales were photographically identified, some repeatedly (Clapham et al. 2013, Ford et al. 2016). This includes 8 individuals photographed in 2008 (all in the Bering Sea), 7 in 2009 (Bering Sea), 2 in 2010 (1 in the Bering Sea, 1 off Kodiak), 2 in 2011 (Bering Sea), 1 in 2012 (Gulf of Alaska), and 2 in 2013 (both off British Columbia). These numbers

include four individuals that were tracked with satellite-monitored radio tags in the Bering Sea in 2008 or 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 photo-identification 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.

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 relatively 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 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 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). 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 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 of 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 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 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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. No human-caused mortality or serious injury of Eastern North Pacific right whales was reported in 2011-2015; 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 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.

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). No other incidental takes of right whales are known to have occurred in the North Pacific, although two photographs from the 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).

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, 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). 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. There appear to be more males than females in the population and the observed calving rate is very low, so the calculated PBR level is likely biased. 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*.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984, Moore and Reeves 1993). For management purposes, four stocks of bowhead whales 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 (Figs. 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 (IWC 2008).

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) 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 bowhead whales are found in

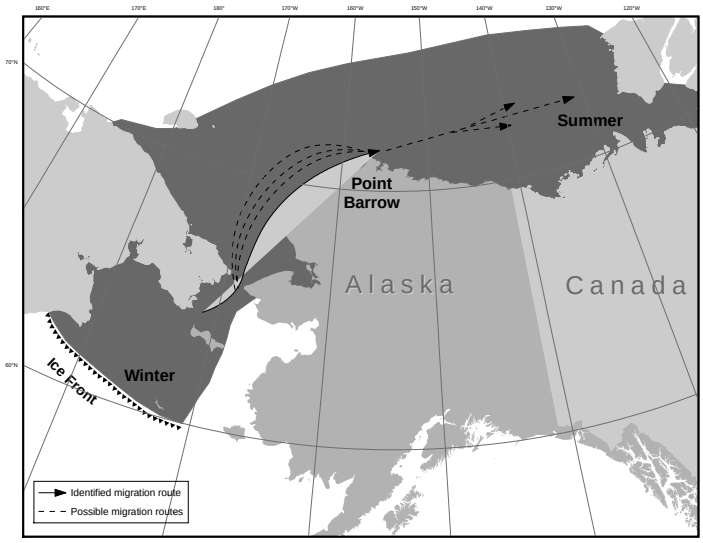

Figure 1. Dark areas depict the approximate distribution of the Western Arctic stock of bowhead whales. The spring migration represented here by lines and arrows follows a route from the Bering Sea wintering area to the Beaufort Sea summering area, mostly along a coastal tangent that constricts somewhat as it goes east past Point Barrow.

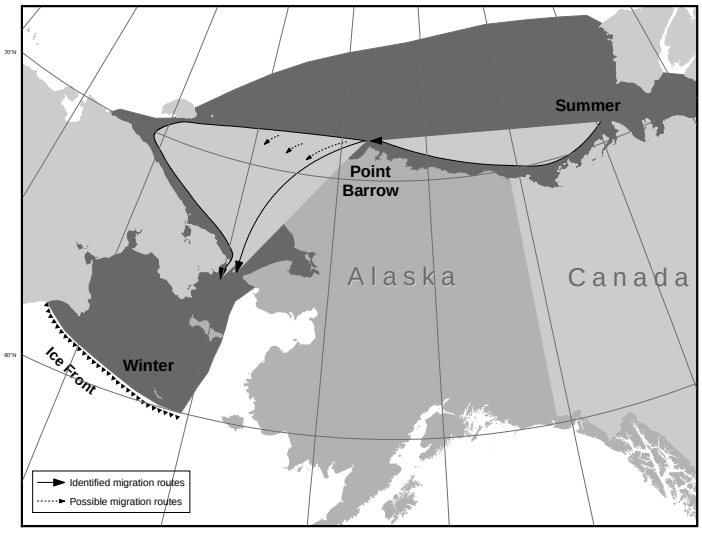

Figure 2. Dark areas depict the approximate distribution of the Western Arctic stock of bowhead whales. The fall migration is represented here by lines and arrows showing generalized routes used to travel from the Beaufort Sea (summering area) to the Bering Sea (wintering area).

the western Beaufort, Chukchi, and Bering seas in summer, and these are thought to be a part of the expanding Western Arctic stock (Rugh et al. 2003; Clarke et al. 2013, 2014, 2015; 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 the coast of Alaska, generally in the shear zone between the shorefast ice and the mobile pack ice. During summer, most of the population is in relatively ice-free waters in the southeastern 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 have had relatively high sighting rates of bowhead whales, including cows with calves and feeding animals (Clarke et al. 2013, 2014, 2015). During the autumn migration through the Beaufort Sea, bowhead whales generally select shelf waters (Citta et al. 2015). 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 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 2010a; Quakenbush et al. 2010a, 2010b; Okkonen et al. 2011; Clarke et al. 2012, 2013, 2014, 2015; Citta et al. 2015). Bowhead whales have also been observed feeding during the summer in the northeastern Chukchi Sea (Clarke and Ferguson 2010b).

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 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). 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 a revised abundance estimate based on sight-resight data (Mocklin et al. 2012, Vate Brattström et al. 2016).

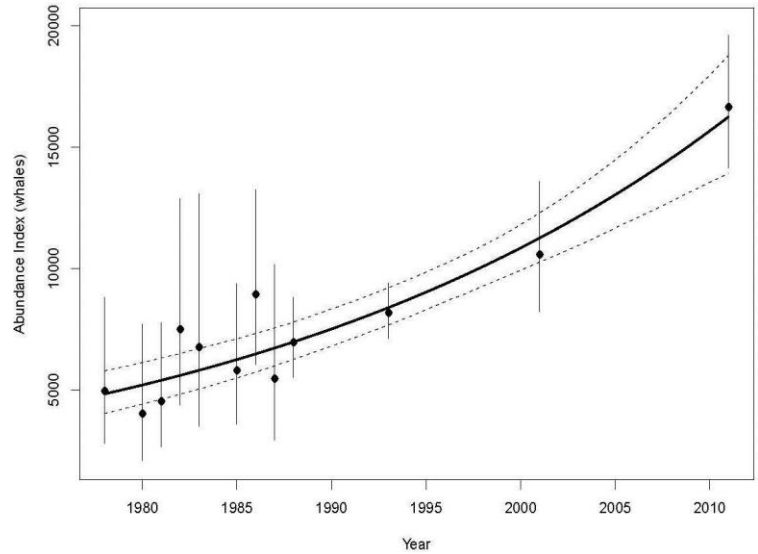

Figure 3. Abundance estimates for the Western Arctic stock of bowhead whales, 1978-2011 (Givens et al. 2013), as computed from ice-based counts, acoustic data, and aerial transect data collected during bowhead whale spring migrations past Point Barrow, Alaska.

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) of 16,820 and its associated coefficient of variation CV(N) of 0.052, 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). 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.

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 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, a strike limit of 67 (plus up to 15 previously unused strikes) is permitted each year. This quota includes an allowance of five animals per year to be taken by Chukotka Natives in Russia. 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 information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Western Arctic bowhead whales in 2011-2015 is 43 whales: 0.2 in U.S. commercial fisheries and 43 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 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.

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 gear in the Bering Sea. Most entanglement injuries occurred on the peduncle and were rare 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 is 0.2 bowhead whales (Table 2; Helker et al. 2017); 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 a minimum because not all entangled animals are found, reported, or have the cause of death determined.

Table 2. Summary of mortality and serious injury of Western Arctic bowhead whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network in 2011-2015 (Helker et al. 2017). 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	Mean annual mortality
Entangled in Bering Sea/Aleutian Is. commercial blue king crab pot gear	0	0	0	0	1	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 ranged from 8 to 55 whales (Suydam and George 2012; Suydam et al. 2012, 2013, 2014, 2015; 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 Barrow landing the most whales (n = 590) and Shaktoolik landing only one. Alaska Natives landed 38 whales in 2011 (Suydam et al. 2012), 55 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). 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, 39 of 49 whales struck were landed, resulting in an efficiency of 80% (Suydam et al. 2016). Suydam et al. (2016) reported that the current mean efficiency, from 2006 through 2015, is 75.3%.

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). The average annual subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2011 through 2015 is 43 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 the Aerial Survey of Arctic Marine Mammals (ASAMM) project in 2015 had clear evidence of killer whale predation (rake marks, missing jaw/tongue) (Suydam et al. 2016).

With increasing ship traffic and oil and gas 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 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. The total annual level of human-caused mortality and serious injury (43 whales) is not known to exceed the PBR (161) nor the IWC annual maximum strike limit (67). 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 and the southern range of the population does overlap with commercial pot fisheries. 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. 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 oil and gas development in the Arctic has led to an increased risk 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.

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Appendix 1. Summary of substantial changes to the 2017 stock assessments (last revised 12/30/2017). An 'X' indicates sections where the information presented has been updated since the 2016 stock assessments were released. Stock Assessment Reports for those stocks in boldface were updated in 2017.

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)						
Ringed seal (Alaska)						
Ribbon seal (Alaska)						
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**
Killer whale (West Coast Transient)						
Pacific white-sided dolphin (North Pacific)						
Harbor porpoise (Southeast Alaska)	**X**	**X**		**X**		**X**
Harbor porpoise (Gulf of Alaska)	**X**		**X**	**X**	**X**	**X**
Harbor porpoise (Bering Sea)	**X**	**X**	**X**	**X**		**X**
Dall's porpoise (Alaska)						
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**
Humpback whale (Central North Pacific)		**X**		**X**	**X**	**X**
Fin whale (Northeast Pacific)	**X**	**X**	**X**	**X**		**X**
Minke whale (Alaska)						
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). Stock Assessment Reports for those stocks in boldface were updated in 2017. 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]**		**53,303**	**2016**	**0.12**	**0.1**	**320**	**31**	**204**	**241**	**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**	**0.2**	**539,638**	**2015**	**0.086**	**0.5**	**11,602**	**3.2**	**425**	**436**	**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	390	391	NS
Ringed seal	Alaska	[b]		[b]	2013	0.12	0.5	[b]	3.9	1,050	1,054	NS
Ribbon seal	Alaska	184,000		163,086	2013	0.12	1.0	9,785	0.6	3.2	3.8	NS
Beluga whale	**Beaufort Sea**	**39,258**	**0.229**	**N/A**	**1992**	**0.04**	**1.0**	**UNDET**	**0**	**139**	**139**	**NS**

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
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**	**0.10**	**287**	**2014**	**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**	**0.04**	**0.1**	**0**	**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	0.04	1.0	UNDET	38	0	38	NS
Sperm whale	**North Pacific**	**N/A**		**N/A**		**0.04**	**0.1**	**N/A**	**3.7**	**0**	**3.7**	**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**	**S**
Humpback whale	**Central North Pacific - entire stock**	**10,103**	**0.300**	**7,890**	**2006**	**0.07**	**0.3**	**83**	**8.5**	**0**	**25**	**S**
Fin whale	**Northeast Pacific**	**[b]**	**[b]**	**[b]**	**2013**	**0.04**	**0.1**	**[b]**	**0.2**	**0**	**0.4**	**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**	**43**	**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). Notice of continuing effect of list of fisheries.

Fishery (area, target species, and gear type)	Mngmt	Active Permits/Vessels[1]	Soak time	Landings per day	Sets per day	Season duration	Fishery trends (2012-2016)
AK Southeast salmon drift gillnet	State	451	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	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	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	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	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	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	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	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	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	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	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]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.

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Appendix 4. Interaction table for Alaska **Category 2** commercial fisheries (last revised 12/30/2016). Notice of continuing effect of list of fisheries.

Fishery Name (area, target species, and gear type)	Mngmt	Active Permits/Vessels[1]	Observer data[2]	Species recorded as taken incidentally in this fishery (records dating back to 1988)	Data type
AK Southeast salmon drift gillnet	State	451	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	2007 - 2008	harbor seal, harbor porpoise (obs), humpback whale, gray whale (stranding)	logbook, observer, stranding
AK Prince William Sound salmon drift gillnet	State	529	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	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	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	2002, 2005	harbor seal, harbor porpoise, sea otter, Steller sea lion	observer, logbook
AK Peninsula/Aleutian Islands salmon drift gillnet	State	150	1990-1991	northern fur seal, harbor seal, harbor porpoise, Dall's porpoise (obs)	observer, logbook
AK Peninsula/Aleutian Islands salmon set gillnet	State	108	never observed	Steller sea lion, harbor porpoise, northern sea otter	logbook
AK Bristol Bay salmon drift gillnet	State	1,811	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	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	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]For state-managed fisheries, this is the number of active permits in 2016 and for federally-managed fisheries, this is the number of active vessels participating in the fishery in 2015.
[2]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.

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Appendix 5. Interaction table for Alaska **Category 3** commercial fisheries (last revised 12/30/2016). Notice of continuing effect of list of fisheries.

Fishery name (area, target species, and gear type)	Mngmt	Active Permits/Vessels[1]	Observer data[2]	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	never observed	humpback whale	stranding
AK Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	State	1184	never observed	harbor porpoise	n/a
AK roe herring and food/bait herring gillnet	State	426	never observed	none documented	none
AK salmon purse seine	State	442	never observed	harbor seal, gray whale (Eastern North Pacific)	logbook
AK salmon beach seine	State	23	never observed	none documented	none
AK roe herring and food/bait herring purse seine	State	331	never observed	none documented	none
AK roe herring and food/bait herring beach seine	State	8	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	never observed	humpback whale	stranding
AK Kodiak salmon purse seine	State	324	never observed	humpback whale	stranding
AK Southeast salmon purse seine	State	293	never observed	none documented	none
AK miscellaneous finfish purse seine	State	9	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	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	none documented	observer
AK Gulf of Alaska rockfish longline	Federal	13	2013	none documented	observer
AK Gulf of Alaska Pacific cod longline	Federal	95	2013	Steller sea lion (Western U.S.)	observer
AK Gulf of Alaska sablefish longline	Federal	281	2013	Steller sea lion, sperm whale	observer
AK Bering Sea, Aleutian Islands Greenland turbot longline	Federal	3	2013	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	none documented	observer
AK Bering Sea, Aleutian Islands sablefish longline	Federal	16	2013	none documented	observer
AK halibut longline/set line (state and federal waters)	State	878	2013	Steller sea lion	self-reports
AK octopus/squid longline	State	8	never observed	none documented	none
AK shrimp otter and beam trawl (statewide and Cook Inlet)	State	28	never observed	none documented	none
AK Gulf of Alaska flatfish trawl	Federal	21	2013	northern elephant seal, harbor seal	observer
AK Gulf of Alaska Pacific cod trawl	Federal	54	2013	Steller sea lion (Western U.S.), harbor seal	observer
AK Gulf of Alaska pollock trawl	Federal	63	2013	Steller sea lion (Western U.S.), fin whale, northern elephant seal, Dall's porpoise	observer
AK Gulf of Alaska rockfish trawl	Federal	37	2013	none documented	observer
AK Bering Sea, Aleutian Islands Atka mackerel trawl	Federal	14	2013	ribbon seal, Steller sea lion (Western U.S.), northern elephant seal	observer
AK Bering Sea, Aleutian Islands Pacific cod trawl	Federal	64	2013	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	never observed	none documented	none
AK Bering Sea, Aleutian Islands Pacific cod pot	Federal	116	2013	possible harbor seal	observer
AK Bering Sea, Aleutian Islands crab pot	State	248	never observed	gray whale (Eastern North Pacific)	stranding

Fishery name (area, target species, and gear type)	Mngmt	Active Permits/Vessels[1]	Observer data[2]	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
AK Gulf of Alaska crab pot	State	271	never observed	humpback whale	stranding
AK Gulf of Alaska Pacific cod pot	Federal	116	2013	harbor seal, gray whale (Eastern North Pacific)	observer, stranding
AK Southeast Alaska crab pot	State	375	never observed	humpback whale	stranding
AK Southeast Alaska shrimp pot	State	210	never observed	humpback whale	stranding
AK octopus/squid pot	State	15	never observed	none documented	none
AK snail pot	State	1	never observed	none documented	none
AK Aleutian Islands sablefish pot	Federal	2	2013	humpback whale	observer
AK Bering Sea sablefish pot	Federal	3	2013	humpback whale	observer
AK statewide miscellaneous finfish pot	State	201	never observed	none documented	none
AK shrimp pot, except Southeast AK	State	141	never observed	none documented	none
AK North Pacific halibut handline and mechanical jig	State	71	never observed	none documented	none
AK miscellaneous finfish handline and mechanical jig	State	572	never observed	none documented	none
AK herring spawn on kelp pound net	State	291	never observed	none documented	none
AK Southeast herring roe/food/bait pound net	State	0	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	never observed	none documented	none
AK urchin and other fish/shellfish (hand pick/dive)	State	214	never observed	none documented	none
AK commercial passenger fishing vessel	State	1006	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	never observed	none documented	none

[1]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]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.

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.

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Appendix 6. Percent observer coverage in Alaska commercial fisheries 1990-2015 (last revised 12/30/2017).

Fishery name[1]	Method for calculating observer coverage[2]	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
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
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
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
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						23
GOA rockfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	51.4	49.8	50.2	51.0	37.2	48.4	74.1	51.4	49.1	88	87	91						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
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
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
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
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
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

Fishery name[1]	Method for calculating observer coverage[2]	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
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
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
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
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
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
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
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
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
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
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
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[1]	Method for calculating observer coverage[2]	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
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.
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.
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.
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.
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.
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.
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.
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.

[1]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.

[2]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.

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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.

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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

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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.

Appendix 8. Stock Assessment Reports published by the U.S. Fish and Wildlife Service.

POLAR BEAR (*Ursus maritimus*): Chukchi/Bering Seas Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Polar bears are circumpolar in their distribution in the northern hemisphere. They occur in several largely discrete stocks or populations (Harington 1968). Polar bear movements are extensive and individual activity areas are enormous (Garner *et al.* 1990, Amstrup *et al.* 2000). The parameters used by Dizon *et al.* (1992) to classify stocks based on the phylogeographic approach were considered in the determination of stock separation in Alaska. Several polar bear stocks are known to be shared between countries (Amstrup *et al.* 1986, Amstrup and DeMaster 1988). Lentfer hypothesized that in Alaska two stocks exist, the Southern Beaufort Sea (SBS) and the Chukchi/Bering seas (CBS), based upon: (a) variations in levels of heavy metal contaminants of organ tissues (Lentfer 1976, Lentfer and Galster 1987); (b) morphological characteristics (Manning 1971, Lentfer 1974, Wilson 1976); (c) physical oceanographic features which segregate the Chukchi Sea and Bering Sea stock from the Beaufort Sea stock (Lentfer 1974); and (d) movement information collected from mark and recapture studies of adult female bears (Lentfer 1974, 1983) (Figure 1). Information on contaminants (Woshner *et al.* 2001, Evans 2004a, Evans 2004b, Kannan *et al.* 2005, Smithwick *et al.* 2005, Verreault *et al.* 2005, Muir *et al.* 2006, Smithwick *et al.* 2006, Kannan *et al.* 2007, Rush *et al.* 2008) and movement data using satellite collars (Amstrup *et al.* 2004, Amstrup *et al.* 2005) continue to support the presence of these two stocks.

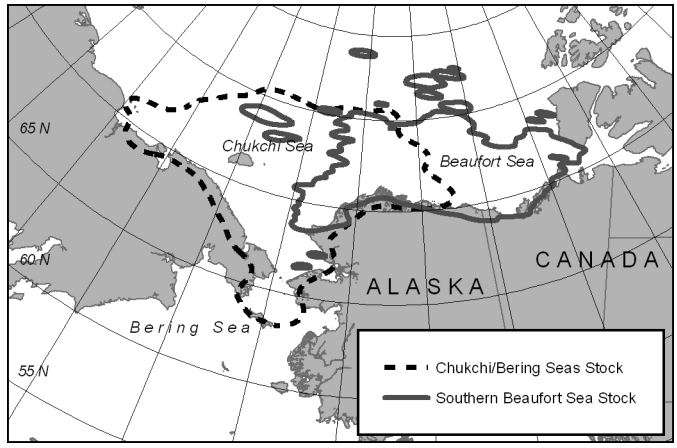

Figure 1. Map of the Southern Beaufort Sea and the Chukchi/Bering seas polar bear stocks.

The CBS population is widely distributed on the pack ice in the Chukchi Sea and northern Bering Sea and adjacent coastal areas in Alaska and Russia. The northeastern boundary of the Chukchi/Bering seas stock is near the Colville Delta in the central Beaufort Sea (Garner *et al.*1990, Amstrup 1995, Amstrup *et al.* 2005) and the western boundary is near Chauniskaya Bay in the Eastern Siberian Sea. The boundary between the Eastern Siberian Sea stock and the Chukchi Sea stock is designated based on movements of adult female polar bears captured in the Bering and Chukchi seas region. Female polar bears initially captured and radio collared on Wrangel Island exhibited no movement into the Eastern Siberian Sea, while female polar bears captured and radio collared in the Eastern Siberian Sea, exhibited only limited short term movement into the western Chukchi Sea (Garner *et al.* 1990). The Chukchi/Bering seas stock extends into the Bering Sea and its southern boundary is determined by the annual extent of pack ice (Garner *et al.* 1990). Adult female polar bears captured from the Southern Beaufort Sea stock may make seasonal movements into the Chukchi Sea in an area of overlap located between Point Hope and Colville Delta, centered near Point Lay (Garner *et al.* 1990, Garner *et al.* 1994, Amstrup 1995, Amstrup *et al.* 2002, Amstrup *et al.* 2005). Probabilistic distribution information for zones of overlap between the Chukchi/Bering seas and the Southern Beaufort Sea population exist (Amstrup *et al.* 2004, Amstrup *et al.* 2005). Telemetry data indicate that these bears, marked in the Beaufort Sea, spend about 25% of their time in the northeastern Chukchi Sea, whereas females captured in the Chukchi Sea spend only 6% of their time in the Beaufort Sea (Amstrup 1995). Average activity areas of females in the Chukchi/Bering seas from 1986–1988 (244,463 km^2, range 144,659–351,369 km^2) (Garner *et al.* 1990) were more extensive than the Beaufort Sea from 1983– 1985 (96,924 km^2, range 9,739–269,622 km^2) (Amstrup 1986) or from 1985–1995 (166,694 km^2, range 14,440–616,800 km^2) (Amstrup *et al.* 2000). Radio collared adult females spent a greater proportion of their time in the Russian region than in the American region (Garner *et al.* 1990). Historically polar bears ranged as far south as St. Matthew Island (Hanna 1920) and the Pribilof Islands (Ray 1971) in the Bering Sea.

Analysis of mitochondrial DNA indicates little differentiation of the Alaska polar bear stocks (Cronin *et al.* 1991, Scribner *et al.* 1997, Cronin *et al.* 2006). Using 16 highly variable micro-satellite loci, Paetkau *et al.* (1999) determined that polar bears throughout the arctic (19 populations) are genetically similar. Genetically, polar bears in the southern Beaufort Sea differed more from polar bears in the Chukchi/Bering seas than from polar bears in the northern Beaufort Sea (Paetkau *et al.* 1999).

While genetically similar, demographic and movement data of the CBS population, indicates a high degree of site fidelity, suggesting that the stocks should be managed separately (Amstrup 2000, Amstrup *et al.* 2000, Amstrup *et al.* 2001a, Amstrup *et al.* 2002, Amstrup *et al.* 2004, Amstrup *et al.* 2005).

Past management has consistently distinguished between the southern Beaufort Sea and the Chukchi/Bering seas stocks. The Inuvialuit of the Inuvialuit Game Council (IGC), Northwest Territories, and the Inupiat of the North Slope Borough (NSB), Alaska, polar bear management agreement for the Southern Beaufort Sea stock was based on stock boundaries described previously (Brower *et al.* 2002, Nageak *et al.* 1991, Treseder and Carpenter 1989) and reaffirmed by the information in this stock assessment report.

POPULATION SIZE

Polar bears typically occur at low densities throughout their circumpolar range (DeMaster and Stirling 1981). It has been difficult to obtain a reliable population estimate for this population due to the vast and inaccessible nature of the habitat, movement of bears across international boundaries, logistical constraints of conducting studies in Russian territory, and budget limitations (Amstrup and DeMaster 1988, Garner *et al.* 1992, Garner *et al.* 1998, Evans *et al.* 2003). The Chukchi Sea population is estimated to comprise 2,000 animals, based on extrapolation of aerial den surveys (Lunn *et al.* 2002). Estimates of the population have been derived from observations of dens and aerial surveys (Chelintsev 1977, Stishov 1991a, Stishov 1991b, Stishov *et al.* 1991); however, these estimates (see below) have wide confidence intervals and are considered to be of little value for management and cannot be used to evaluate status and trends for this population.

Minimum Population Estimate

A reliable population estimate for the Chukchi/Bering seas stock currently does not exist. Lentfer, in the Administrative Law Judge (ALJ) proceeding to waive the Marine Mammal Protection Act of 1972 (MMPA) moratorium on taking and return management to the State of Alaska (ALJ 1977), estimated the size of the Chukchi/Bering seas population stock (Wrangel Island to western Alaska) at 7,000, and Chapman estimated the Alaska population (both stocks) at 5,550 to 5,700 (ALJ 1977). Lentfer and Chapman's estimates (ALJ 1977), however, were not based on rigorous statistical analysis of population data and variance estimates could not be calculated. Amstrup *et al.* (1986) estimated densities (1976–129 km^2/bear, 1981–211 km^2/bear) based on mark and recapture of 266 polar bears near Cape Lisburne on the Chukchi Sea, but a population estimate for the Chukchi Sea was not developed at that time. An August 2000 aerial survey of polar bears in the Eastern Chukchi Sea resulted in density estimates of (0.00748 bear/km^2, or 147 km^2/bear, C.V. = 0.38) (Evans *et al.* 2003). A population estimate was not derived from this density since the study area included only a portion of the total area used by the population.

Amstrup and DeMaster (1988) estimated the Alaska population (both stocks) at 3,000 to 5,000 animals based on densities calculated previously by Amstrup *et al.* (1986). The area that the estimate applied to and the variance associated with the estimate were not provided for in the 1988 population estimate (Amstrup and DeMaster 1988). A crude population estimate for the Chukchi/Bering seas stock of 1,200 to 3,200 animals was derived by subtracting the Beaufort Sea population estimate of 1,800 animals (Amstrup 1995) from the total Alaska statewide estimate of 3,000 to 5,000 (Amstrup and DeMaster 1988). The IUCN Polar Bear Specialist Group (IUCN 2006) estimated this population to be approximately 2,000 animals based on extrapolation of multiple years of denning data for Wrangel Island, assuming that 10% of the population dens annually as adult females. However, confidence in this estimate is low due to the lack of current denning estimates and reliable data with measurable levels of precision (IUCN 2006). Nonetheless, an N_{MIN} of 2,000 is the best available information we have at this time.

Current Population Trend

Prior to the 20th century, when Alaska's polar bears were hunted primarily by Alaskan Natives, both stocks probably existed at near carrying capacity (K). The size of the Beaufort Sea stock declined substantially in the late 1960's and early 1970's (Amstrup *et al.* 1986) due to excessive sport harvest. Similar declines could have occurred in the Chukchi Sea, although there are no population data to support this assumption. Since passage of the MMPA, the southern Beaufort Sea population grew during the late 1970's and 1980's and then stabilized during the 1990's (Amstrup *et al.* 2001b). Based on demographic data 2001 to 2006, the overall population growth rate in the Southern Beaufort Sea population declined approximately 0.3% per year (Hunter *et al.* 2007). Until 1992 it is likely that the Chukchi/Bering seas stock mimicked the growth pattern and later stability of Southern Beaufort Sea stock, since both

stocks experienced similar management and harvest histories. However, since 1992 the CBS population has faced different stressors than the SBS population. These include increased harvest in Russia (150 – 250 bears/yr) (Kochnev 2006, Ovsyanikov 2006, Eduard Zdor personal communication) and greater loss of summer sea ice habitat from global warming (Overland and Wang 2007), which suggest that using the growth rate for the Southern Beaufort Sea may not be applicable. The status of the Chukchi/Bering seas stock was listed as data deficient (Aars *et al.* 2006) due to the lack of abundance estimates with measurable levels of precision. The population is believed to be declining and the status relative to historical levels is believed to be reduced based on harvest levels that were demonstrated to be unsustainable in the past.

MAXIMUM NET PRODUCTIVITY RATES

Polar bears are long lived, mature at a relatively old age, have an extended breeding interval, and have small litters (Lentfer *et al.* 1980, DeMaster and Stirling 1981). Population/stock specific data to estimate R_{MAX} are not available for the Chukchi/Bering seas polar bear stock. The Southern Beaufort Sea is one of four polar bear populations with long-term data sets and as it overlaps with the Chukchi/Bering seas stock using the default value for R_{MAX} for the Southern Beaufort Sea seems reasonable as it is based on empirical data. Survival rates for the Southern Beaufort Sea stock (Regehr *et al.* 2006), which can be used in a Leslie matrix model, suggest that under optimal conditions and in the absence of human perturbations the population could increase at a rate of between 4 and 6%. Amstrup (1995) projected an annual intrinsic growth rate (including natural mortality but not human-caused mortality) of 6.03% for the Southern Beaufort Sea stock using a Leslie type matrix of recapture data. Since the Chukchi/Bering seas area is one of the most productive areas in the Arctic using the 6.03% for the Chukchi/Bering seas polar bear stock seems reasonable.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

Under the 1994 reauthorized MMPA, the potential biological removal (PBR) level is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $(N_{MIN})(½\ R_{MAX})(F_R)$. Wade and Angliss (1997) recommend a default recovery factor (F_R) of 0.5 for a threatened population or when the status of a population is unknown. We used 0.5 as the recovery factor since reliable population estimates to assess population trends are not available. In the following calculation: $(N_{MIN})(½\ R_{MAX})(F_r)$ = PBR (Wade and Angliss 1997) the minimum population estimate, N_{MIN} was 2,000; the maximum rate of increase R_{MAX} was 6.03%; and the recovery factor F_R was 0.50. Therefore, the PBR level for the Chukchi/Bering seas stock is 30 bears per year. However, confidence in these numbers is low due to dated and extrapolated population information and, therefore, the PBR value has little utility for management purposes.

ANNUAL HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities. Consequently, the total fishery mortality and serious injury rate for the Chukchi/Bering seas stock is zero.

Alaska Native Subsistence Harvest

Historically, polar bears have been killed for subsistence, handicrafts, and recreation. Based on records of skins shipped from Alaska for 1925–53, the estimated annual statewide harvest averaged 120 bears, taken primarily by Native hunters. Recreational hunting by non-native sports hunters using aircraft was common from 1951–72, increasing statewide annual harvest to 150 during 1951–60 and to 260 during 1960–72 (Amstrup *et al.* 1986, Schliebe *et al.* 1995). Hunting by non-Natives has been prohibited since 1973 when provisions of the MMPA went into effect. This reduced the mean annual statewide harvest for both populations to 98 during 1980–2007 (SD=40; range 48–242) (USFWS unpublished data). The annual harvest from the Chukchi/Bering seas stock was 92/year in the 1980s, 49/year in the 1990s, and 43/year in the 2000s. More recently, the 2003−2007 average Alaska harvest for the Chukchi/Bering seas stock in Alaska was 37 and the sex ratio was 66M:34F.

Under the MMPA, an exemption was made for Alaska Natives living in coastal communities to allow them to hunt polar bears for subsistence and making of handicrafts provided that the hunt was not done in a wasteful manner. Recently, harvest levels by Alaska Natives from the Chukchi/Bering seas stock have been declining (Figure 2). The sex ratio of known-sex bears harvested since 1980 has remained relatively consistent at 66% males and 34% females (Schliebe *et al.* 2006).

The number of unreported kills in Alaska since 1980 to the present time is approximately 7% based on: (a) tagging information; (b) interviews with local hunters; and (c) law enforcement investigations. No user agreement, similar to that between the Inuvialuit and Inupiat for the Beaufort Sea stock, exists for the Bering/Chukchi stock. Harvest levels are not limited at this time.

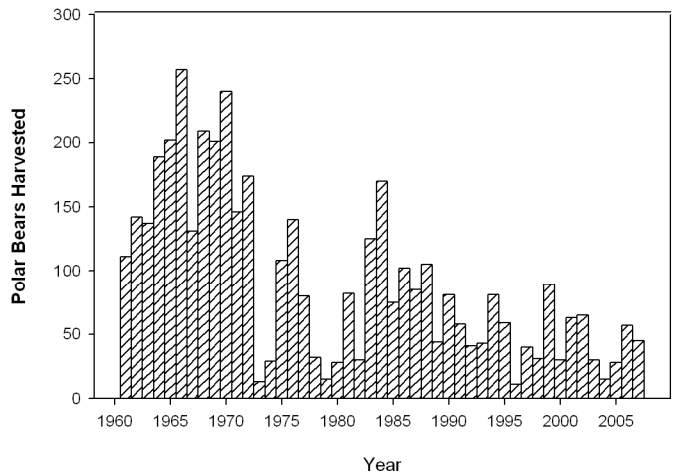

Figure 2. Annual Alaska polar bear harvest from the Chukchi/Bering Seas stock, 1961-2007.

Other Removals

Russia prohibited all hunting of polar bears in 1956 in response to perceived population declines caused by over-harvest. In Russia, only a small number of animals, less than 3–5 per year, were removed for placement in zoos prior to 1986 (Uspenski 1986) and a few were killed in defense of life. No bears were taken for zoos or circuses from 1993 to 1995 (Belikov 1998). The occurrence of increased takes of problem bears in Chukotka was acknowledged in 1992, and Belikov (1993) estimated that up to 10 problem bears were killed annually in all of the Russian Arctic. Increased illegal hunting of polar bears in the Russian Arctic was also recognized to have begun in 1992. While the magnitude of the illegal harvest in Russia from the Chukchi/Bering seas stock is unquantified, reports indicate that a substantial number of bears, 150–250/yr (Kochnev 2006), or alternatively 120–150/yr (Eduard Zdor pers. comm.), are being harvested. Combining the reported Chukotka harvest with the documented Alaska harvest indicates that up to 200 bears may have been harvested from this population in many years. Harvest levels similar to these are believed to have caused population depletion by the early 1970s. Belikov *et al.* (2006) indicated that the current level of poaching in Russia poses a serious threat to the population. No serious injuries, other than the mortalities discussed here, have been reported for the Chukchi/Bering seas stock.

No orphaned cubs from the Alaskan Chukchi/Bering seas stock were placed in zoos since 2002. Illegal harvest has not been detected in Alaska. Oil and gas exploration in the Bering/Chukchi region of Alaska, began again in 2006, primarily during the open water season has resulted in minimal interaction with polar bears; there was no evidence of mortality or serious injury.

STATUS OF STOCK

Polar bears in the Chukchi/Bering seas stock are currently classified as depleted under the MMPA and listed as threatened under the U.S. Endangered Species Act of 1973 (ESA) as amended. Reliable estimates of the minimum population, PBR level, and human-caused mortality or serious injury in Chukotka are currently not available

The ongoing level of the subsistence hunting in western Alaska and Chukotka is a concern. There is no incidental mortality or serious injury of polar bear in any U.S. commercial fishery. The primary concerns for this population are habitat loss resulting from climate change, potential over-harvest, human activities including industrial activities occurring within the near-shore environment, and potential effects of contaminants on nutritionally stressed populations. The Chukchi/Bering seas polar bear stock is designated as a strategic stock because the population is listed as threatened under the ESA.

Conservation Issues and Habitat Concerns

Oil and Gas Exploration

In 2008, the Minerals Management Service held an oil and gas lease sale for offshore blocks in the eastern Chukchi Sea. Polar bears from Chukchi/Bering seas stock seasonally use the shallow, productive, ice-covered waters of the eastern Chukchi Sea for feeding, breeding, and movements. The Fish and Wildlife Service (USFWS) works to monitor and mitigate potential impacts of oil and gas activities on polar bears through incidental take regulations (ITR) as authorized under the Marine Mammal Protection Act. Activities operating under these regulations must adopt measures to: ensure that the total of such incidental taking of polar bears remains negligible; minimize impacts to their habitat; and ensure no unmitigable adverse impact on their availability for Alaska Native subsistence use. ITR also

specify monitoring requirements that provide a basis for evaluating potential impacts of current and future activities on marine mammals.

Climate Change

Polar bears evolved over thousands of years to life in a sea ice environment. They depend on the sea ice-dominated ecosystem to support essential life functions. Sea ice provides a platform for hunting and feeding, for seeking mates and breeding, for movement to terrestrial maternity denning areas and occasionally for maternity denning, for resting, and for long-distance movements. The sea ice ecosystem supports ringed seals, the primary prey for polar bears, and other marine mammals that are also part of their prey base.

Sea ice is rapidly diminishing throughout the Arctic and large declines in optimal polar bear habitat have occurred in the Southern Beaufort and Chukchi Seas between the two time periods, 1985–1995 and 1996–2006 (Durner et al 2009). In addition, it is predicted that the greatest declines in 21st century optimal polar bear habitat will occur in Chukchi and Southern Beaufort Seas (Durner *et al.* 2009a). Patterns of increased temperatures, earlier onset of and longer melting periods, later onset of freeze-up, increased rain-on-snow events, and potential reductions in snowfall are occurring. In addition, positive feedback systems (i.e., the sea-ice albedo feedback mechanism) and naturally occurring events, such as warm water intrusion into the Arctic and changing atmospheric wind patterns, can operate to amplify the effects of these phenomena. As a result, there is fragmentation of sea ice, a dramatic increase in the extent of open water areas seasonally, reduction in the extent and area of sea ice in all seasons, retraction of sea ice away from productive continental shelf areas throughout the polar basin, reduction of the amount of heavier and more stable multi-year ice, and declining thickness and quality of shore-fast ice (Parkinson et al 1999, Rothrock *et al.* 1999, Comiso 2003, Fowler *et al.* 2004, Lindsay and Zhang 2005, Holland *et al.* 2006, Comiso 2006, Serreze *et al.* 2007, Stroeve *et al.* 2008).

The Chukchi/Bering seas and the Southern Beaufort Sea population stocks are currently experiencing the initial effects of changes in sea ice conditions (Rode *et al.* 2007, Regehr *et al.* 2007, Hunter *et al.* 2007). These populations are vulnerable to large-scale dramatic seasonal fluctuations in ice movements, decreased abundance and access to prey, and increased energetic costs of hunting. The USFWS is working on measures to protect polar bears and their habitat.

Subsistence Harvest

Past differences in management regimes between the United States and Russia have made coordination of studies on the shared Alaska-Chukotka polar bear population difficult. In the former Soviet Union, hunting of polar bears was banned nationwide in 1956. Recently, Russia's ability to enforce that ban has been difficult due to logistical and financial constraints. In Alaska, subsistence hunting of polar bears by Alaska Natives is currently unrestricted under section 101(b) of the MMPA provided that the take is for subsistence purposes or creating authentic articles of Alaska Native handicrafts and conducted in a non-wasteful manner. While several joint research and management projects have been successfully undertaken in the past between the United States and Russia, today comparable efforts are either no longer occurring or are unilateral in scope.

The bilateral "Agreement between the United States and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population (Agreement)" was signed by the governments of the United States and the Russian Federation on October 16, 2000, with subsequent advice and consent provided by the U.S. Senate. Among other provisions the Agreement recognizes the needs of Native people to harvest polar bears for subsistence purposes and includes provisions for developing sustainable harvest limits, allocation of the harvest between jurisdictions, and compliance and enforcement. Each jurisdiction is entitled to up to one-half of a harvest limit to be determined by a future the joint Commission. The Agreement reiterates requirements of the 1973 multi-lateral agreement and includes restrictions on harvesting denning bears, females with cubs, or cubs less than one year old, and prohibitions on the use of aircraft, large motorized vessels, and snares or poison for hunting polar bears.

On January 12, 2007, President Bush signed into law H.R. 5946, the "Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006." This Act includes Title X implementing the Agreement. This action allows for the establishment of the commission and development of enforceable harvest management agreements. The Russian Federation and the United States have completed documents necessary to implement the Agreement within Russia and the United States. The USFWS is currently developing recommendations for the Bilateral Commission that will direct research and establish sustainable and enforceable harvest limits needed to address current potential population declines due to over-harvest of the population.

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POLAR BEAR (*Ursus maritimus*): Southern Beaufort Sea Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Polar bears are circumpolar in their distribution in the northern hemisphere. They occur in several largely discrete stocks or populations (Harington 1968). Polar bear movements are extensive and individual activity areas are enormous (Garner et al. 1990, Amstrup et al. 2000). The parameters used by Dizon et al. (1992) to classify stocks based on the phylogeographic approach were considered in the determination of stock separation in Alaska. Several polar bear stocks are known to be shared between countries (Amstrup et al. 1986, Amstrup and Demaster 1988). Lentfer hypothesized that two Alaska stocks exist, the Southern Beaufort Sea, and the Chukchi/Bering Seas, based upon: (a) variations in levels of heavy metal contaminants of organ tissues (Lentfer 1976, Lentfer and Galster 1987); (b) morphological characteristics (Manning 1971; Lentfer 1974; Wilson 1976); (c) physical oceanographic features which segregate stocks (Lentfer 1974) and; (d) movement information collected from mark and recapture studies of adult female bears (Lentfer 1983) (Figure 1). Information on contaminants (Woshner et al. 2001, Evans 2004a, Evans 2004b, Kannan et al. 2005, Smithwick et al. 2005, Verreault et al. 2005, Muir et al. 2006, Smithwick et al. 2006, Kannan et al. 2007, Rush et al. 2008) and movement data using satellite collars (Amstrup et al. 2004, Amstrup et al. 2005) continue to support the existence of these two stocks.

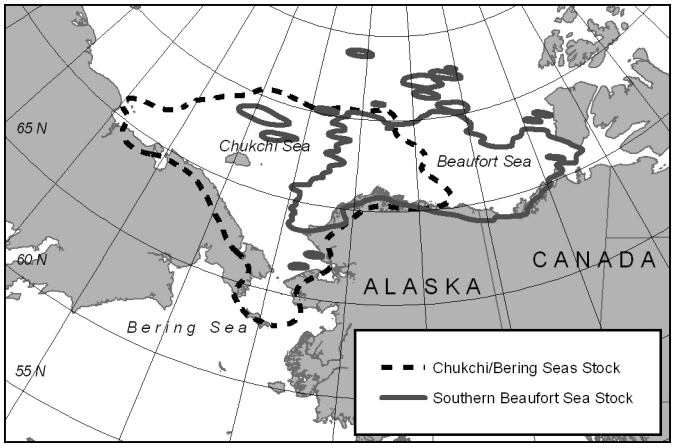

Figure 1. Map of the Southern Beaufort Sea and the Chukchi/ Bering seas polar bear stocks.

Amstrup et al. (2000) demonstrated that the eastern boundary of the Southern Beaufort Sea stock occurs south of Banks Island and east of the Baillie Islands, Canada. The bears in the Northern Beaufort Sea and Southern Beaufort Sea populations spend the summer on pack ice and move toward the coast during fall, winter, and spring (Durner et al. 2004). The range of the two populations previously overlapped extensively in the vicinity of the Baille Islands, Canada (Amstrup 2000) but recent data no longer support this degree of overlap (Amstrup et al. 2005). Recent analysis of polar bear movements using satellite telemetry from 2000 to 2006 (Amstrup et al. 2004, Amstrup et al. 2005), capture and recapture data (Regehr et al. 2006, Stirling et al. 2007), and harvest information suggest that the eastern population boundary has shifted westward to near the village of Tuktoyaktuk, Canada. The assignment of this new boundary could be adjusted somewhat based on local management considerations; however, it will probably necessitate a downward readjustment of the population size of the Southern Beaufort Sea stock to correspond with the smaller geographic area. The proposed boundary change is under consideration and has not been accepted by the parties to the Polar Bear Management Agreement for the Southern Beaufort Sea between the Inuvialuit Game Council of Canada and the North Slope Borough of Alaska. For the purposes of this report, we continue to use the previously published boundaries for the Southern Beaufort Sea population delineated by Amstrup et al. (2000). The western boundary is near Point Hope. An extensive area of overlap between the Southern Beaufort Sea stock and the Chukchi/Bering seas stock occurs between Point Barrow and Point Hope, centered near Point Lay (Garner et al. 1990, Garner et al. 1994, Amstrup et al. 2000). The southern boundary of the Northern Beaufort Sea stock in the Canadian Arctic was delineated by Bethke et al. (1996). Telemetry data indicates that adult female polar bears marked in the Southern Beaufort Sea spend about 25% of their time in the northeastern Chukchi Sea, whereas females captured in the Chukchi Sea spend only 6% of their time in the Southern Beaufort Sea (Amstrup 1995). However, polar bears are not dispersed evenly throughout their range. To access ringed and bearded seals, polar bears in the Southern Beaufort Sea concentrate in shallow waters less that 300 m deep over the continental shelf and in areas with >50% ice cover (Stirling et al. 1999, Durner et al. 2004, Durner et al. 2006a, Durner et al. 2009). Polar bears from this population have historically denned on both the sea ice and land. Thinning of the sea ice in recent years has caused a decline in the number of polar bears denning on the sea ice. Fischbach et al. (2007) found that the proportion of dens on the pack ice declined from 62% from 1985—1994 to 37% in 1998-2004. The main terrestrial denning areas for the Southern Beaufort Sea population in Alaska occur on the barrier islands from Barrow to Kaktovik and along coastal areas up

to 25 miles inland including the Arctic National Wildlife Refuge to Peard Bay, west of Barrow (Amstrup and Gardner 1994, Amstrup 2000, Durner et al. 2001, Durner et al. 2006b).

In response to changes in the sea ice characteristics and declines in sea ice habitat over the continental shelf during the summer and late fall, some polar bears have changed distribution to search for seals and to access the remains of subsistence harvested bowhead whales (Schliebe et al. 2008). It is expected that changes in the distribution and movements may occur with increasing frequency in the future (Durner et al. 2009, Schliebe et al. 2008) Polar bears may also become more nutritionally stressed due to global climate changes in the Arctic (Stirling and Parkinson 2006) and, thus, continued monitoring is required to document these changes.

Analysis of mitochondrial DNA and microsatellite DNA loci indicates little differentiation of the Alaska polar bear stocks (Cronin et al. 1991, Scribner et al. 1997, Cronin et al. 2006). Using 16 highly variable micro satellite loci, Paetkau et al. (1999) determined that polar bears throughout the arctic (19 populations) were genetically very similar. Genetically, polar bears in the Southern Beaufort Sea differed more from polar bears in the Chukchi/Bering Seas than from polar bears in the Northern Beaufort Sea (Paetkau et al. 1999, Thiemann et al. 2008). While genetically similar, demographic and movement data indicates a high degree of site fidelity, suggesting that the stocks should be managed separately (Amstrup 2000, Amstrup et al. 2000, Amstrup et al. 2001a, Amstrup et al. 2002, Amstrup et al. 2004, Amstrup et al. 2005).

POPULATION SIZE

Polar bears occur at low densities throughout their circumpolar range (DeMaster and Stirling 1981). They are long lived, mature late, have an extended breeding interval, and have small litters (Lentfer et al. 1980, DeMaster and Stirling 1981, Amstrup 2003). Accurate population estimates for the Alaskan populations have been difficult to obtain because of low population densities, inaccessibility of the habitat, movement of bears across international boundaries, and budget limitations (Amstrup and DeMaster 1988, Garner et al. 1992). Research on the Southern Beaufort Sea population began in 1967 and is one of only four polar bear populations with long term (>20 yrs) data.

Amstrup et al. (1986) estimated the Southern Beaufort Sea stock at 1,778 (S.D. $\pm$ 803; C.V. = 0.45) during the 1972-83 period. Amstrup (1995) estimated the Southern Beaufort Sea stock near 1,480 animals in 1992. Amstrup (USGS unpublished data) using data for the 1986-98 period (excluding 4 unsampled years), estimated the population at 2,272 in 2001. This total population estimate was based on as estimate of 1,250 females (C.V. = 0.17) and a sex ratio of 55% females (Amstrup et al. 2001b). The population estimate of 1,526 (95% CI =1211−1841; C.V. = 0.106) (Regehr et al. 2006), which is based on open population capture-recapture data collected from 2001 to 2006, is considered the most current and valid population estimate.

Minimum Population Estimate

N_{MINn} is calculated as follows $N/\exp(0.842 * (\ln(1+CV(N)^2))^{1/2})$ and is 1,397 bears for population size of 1,526 and C.V. of 0.106. This population estimate applies to an area that extends from Pt. Barrow in the west, east to the Baillie Islands in Canada.

Current Population Trend

Prior to the 20th century, when Alaska's polar bears were hunted primarily by Natives, both the Chukchi/Bering seas and Southern Beaufort Sea stocks probably existed near carrying capacity (K). Once harvest by non-Natives became common in the Southern Beaufort Sea in the early 1960s, the size of these stocks declined substantially (Amstrup et al. 1986, Amstrup 1995). Since passage of the Marine Mammal Protection Act (MMPA) in 1972, both Alaska polar bear stocks seem to have increased; this is based on: (a) mark and recapture data; (b) observations by Natives and residents of coastal Alaska and Russia; (c) catch per unit effort indices (USGS unpublished data); (d) reports from Russian scientists (Uspenski and Belikov 1991); and (e) harvest statistics on the age structure of the population. Recapture data from the stock indicated a population growth rate of 2.4% from 1981 to 1992 (Amstrup 1995).

The Southern Beaufort Sea stock experienced little or no growth during the 1990's (Amstrup et al. 2001b). Declining survival, recruitment, and body size (Regehr et al. 2006, Regehr et al. 2007), and low growth rates (λ) during years of reduced sea ice during the summer and fall (2004 and 2005), and an overall declining growth rate of 3% per year from 2001-2005 (Hunter et al. 2007) indicates that the Southern Beaufort Sea population is now declining.

MAXIMUM NET PRODUCTIVITY RATES

Population/stock specific data to estimate R_{MAX} are not available for the stock. Taylor et al. (1987) estimated the sustainable yield of the female component of the population at < 1.6% per annum. The following information is used to understand the R_{MAX} determination. From 1981-92, when the population was increasing, vital rates of polar bears in the Southern Beaufort Sea were as follows: average age of sexual maturity (females) was 6 years; average COY litter size was 1.67; average reproductive interval was 3.68 years; and average annual natural mortality (nM), which varies by age class, ranged from 1-3% for adults (Amstrup 1995).

Amstrup (1995) projected an annual intrinsic growth rate (including natural mortality but not human-caused mortality) of 6.03% for the Southern Beaufort Sea stock using a Leslie type matrix of recapture data. This analysis mimics a life history scenario where environmental resistance is low and survival high.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

Under the 1994 reauthorized MMPA, the potential biological removal (PBR) level is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $(N_{MIN})(\frac{1}{2} R_{MAX})(F_R)$. Wade and Angliss (1997) recommend a default recovery factor (F_R) of 0.5 for a threatened population or when the status of a population is unknown. In the following calculation: $(N_{MIN})(\frac{1}{2} R_{MAX})(F_r)$ = PBR (Wade and Angliss 1997) the minimum population estimate, N_{MIN} was 1,397; the maximum rate of increase R_{MAX} was 6.03%; and the recovery factor F_R was 0.5. Therefore, the PBR level for the Southern Beaufort Sea stock is 22 bears per year.

ANNUAL HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities. Consequently, the total fishery mortality and serious injury rate for the Southern Beaufort Sea stock is zero.

Alaska Native Subsistence Harvest

Historically, polar bears have been killed for subsistence, handicrafts, and recreation (sport hunting). Based upon records of skins shipped from Alaska, the estimated annual statewide harvest (both stocks) for 1925−53 averaged 120 bears taken primarily by Native hunters. Sport hunting using aircraft was common from 1951−72, increasing annual harvest in Alaska to 150 during 1951-60 and to 260 during 1960−72 (Amstrup et al. 1986; Schliebe et al.1995). The annual harvest for the Southern Beaufort Sea stock was 81/year from 1960−1972. Although polar bear hunting was prohibited by the MMPA, an exemption was made for Alaska Natives living in coastal communities to allow them to hunt polar bears for subsistence and making of handicrafts provided that the hunt was not done in a wasteful manner. The cessation of sport hunting in 1972 reduced the mean annual combined harvest for both Alaskan stocks to 98 during 1980−2007 (SD=40; range 48−242) (USFWS unpublished data). The annual harvest from the Southern Beaufort Sea was 39/year in the 1980s, 33/year in the 1990s, and 32/year in the 2000s. More recently, the 2003−2007 average Alaska harvest for the Southern Beaufort Sea in Alaska was 33 and the sex ratio was 67M:33F. During the same time period the average Canadian harvest for the Southern Beaufort Sea was 21.0 and the sex ratio was 45M:55F. The combined average annual Alaska and Canada harvest during the past five years was 53.6. Figure 2 illustrates the annual Alaska polar bear harvest and trend for the Southern Beaufort Sea stock from 1961−2007. No serious injuries, other than the mortalities discussed here, have been reported for the Southern Beaufort Sea stock.

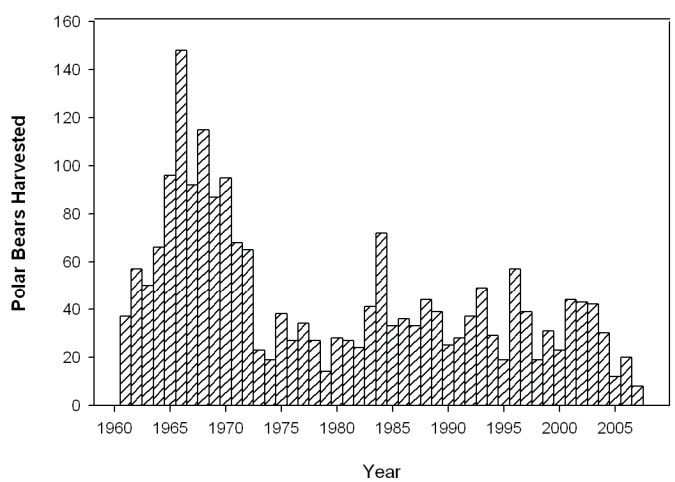

Figure 2. Annual Alaska polar bear harvest from the Southern Beaufort Sea stock, 1961-2007.

During the 1980−2007 period the Alaska harvest from the Southern Beaufort Sea accounted for 34% of the total Alaska kill (annual mean=33 bears) with the remaining 66% occurring in the Chukchi Sea. The sex ratio of the harvest from 1980−2007 in the Southern Beaufort Sea was 69M:31F.

Other Removals

Orphaned cubs are occasionally removed from the wild and placed in zoos; no cubs were placed into public display facilities during the past five years. One bear died as a result of research mortality and two bears were euthanized during the last five years. Activities operating under "incidental take" regulations, associated with the oil and gas industry, have the potential to impact polar bears and their habitat. During the past five years no lethal takes related to industrial activities of polar bears have occurred. Three lethal takes related to oil and gas activities have been documented in the Southern Beaufort Sea: one at an offshore drilling site in the Canadian Beaufort Sea (1968); one bear at the Stinson site in the Alaska Beaufort Sea (1990); and one bear that ingested ethylene glycol stored at an offshore island in the Alaska Beaufort Sea (1988). In 1993, a polar bear was killed at the Oliktok remote radar defense site when it broke into a residence and severely mauled a worker.

STATUS OF STOCK

The Southern Beaufort Sea Stock is currently classified as depleted under the MMPA and listed as threatened under the U.S. Endangered Species Act of 1973 (ESA), as amended. The primary concerns for this population are loss of the sea ice habitat due in part to climate changes in the Arctic, potential overharvest, and current and proposed human activities including industrial activities occurring in the nearshore and offshore environment. Recent data on the vital rates, population estimate, and growth rates for the Southern Beaufort Sea suggests that this population stock is declining. Because of its status as a threatened species under the ESA, the Southern Beaufort Sea population is designated as a strategic stock.

Conservation Issues and Habitat Concerns

Oil and Gas Exploration

The Minerals Management Service (MMS) (2004) estimated an 11 percent chance of a marine spill greater than 1,000 barrels in the Beaufort Sea from the Beaufort Sea Multiple Lease Sale in Alaska. Amstrup et al. (2006) evaluated the potential effects of a hypothetical 5,912-barrel oil spill (the largest spill thought possible from a pipeline spill) on polar bears from the Northstar offshore oil production facility in the southern Beaufort Sea, and found that there is a low probability that a large number of bears (i.e., 25–60) might be affected by such a spill. For the purposes of this scenario, it was assumed that a polar bear would die if it came in contact with the oil. Amstrup et al. (2006) found that 0–27 bears could potentially be oiled during the open water conditions in September; and from 0–74 bears in mixed ice conditions during October. If such a spill occurred, particularly during the broken ice period, the impact of the spill could be significant to the Southern Beaufort Sea polar bear population (Amstrup et al. 2006, 65 FR 16828; March 30, 2000). At the time that Amstrup did this analysis, the sustainable harvest yield per year for the Southern Beaufort Sea polar bear population, based on a stable population size of 1,800 bears, was estimated to be 81.1 bears (1999–2000 to 2003–2004) (Lunn et al. 2005). For the same time period, the average harvest was 58.2 bears, leaving an additional buffer of 23 bears that could have been removed from the population. Therefore, an oil spill that resulted in the death of greater than 23 bears, which was possible based on the range of oil spill-related mortalities from the previous analysis, could have had population level effects for polar bears in the southern Beaufort Sea. However, the harvest figure of 81 bears may no longer be sustainable for the Southern Beaufort Sea population so, given the average harvest rate cited above, fewer than 23 oil spill-related mortalities could result in a population decline or increase the time required for recovery.

The Fish and Wildlife Service (USFWS) works to monitor and mitigate potential impacts of oil and gas activities on polar bears through incidental take regulations (ITR) as authorized under the Marine Mammal Protection Act. Activities operating under these regulations must adopt measures to: ensure that the total taking of polar bears remains negligible; minimize impacts to their habitat; and ensure no unmitigable adverse impact on their availability for Alaska Native subsistence use. ITR also specify monitoring requirements that provide a basis for evaluating potential impacts of current and future activities on marine mammals.

Climate Change

Polar bears evolved over thousands of years to life in a sea ice environment. They depend on the sea ice-dominated ecosystem to support essential life functions. Sea ice provides a platform for hunting and feeding, for seeking mates

and breeding, for movement to terrestrial maternity denning areas and occasionally for maternity denning, for resting, and for long-distance movements. The sea ice ecosystem supports ringed seals, the primary prey for polar bears, and other marine mammals that are also part of their prey base.

Sea ice is rapidly diminishing throughout the Arctic and large declines in optimal polar bear habitat have occurred in the Southern Beaufort and Chukchi Seas between the two time periods, 1985–1995 and 1996–2006 (Durner et al. 2009). In addition, it is predicted that the greatest declines in 21st century optimal polar bear habitat will occur in Chukchi and Southern Beaufort Seas (Durner et al. 2009). Patterns of increased temperatures, earlier onset of and longer melting periods, later onset of freeze-up, increased rain-on-snow events, and potential reductions in snowfall are occurring. In addition, positive feedback systems (i.e., the sea-ice albedo feedback mechanism) and naturally occurring events, such as warm water intrusion into the Arctic and changing atmospheric wind patterns, can operate to amplify the effects of these phenomena. As a result, there is fragmentation of sea ice, a dramatic increase in the extent of open water areas seasonally, reduction in the extent and area of sea ice in all seasons, retraction of sea ice away from productive continental shelf areas throughout the polar basin, reduction of the amount of heavier and more stable multi-year ice, and declining thickness and quality of shore-fast ice (Parkinson et al 1999, Rothrock et al. 1999, Comiso 2003, Fowler et al. 2004, Lindsay and Zhang 2005, Holland et al. 2006, Comiso 2006, Serreze et al. 2007, Stroeve et al. 2008).

The Chukchi/Bering Seas and the Southern Beaufort Sea population stocks are currently experiencing the initial effects of changes in sea ice conditions (Rode et al. 2007, Regehr et al. 2007, Hunter et al. 2007). These populations are vulnerable to large-scale dramatic seasonal fluctuations in ice movements, decreased abundance and access to prey, and increased energetic costs of hunting. The USFWS is working on measures to protect polar bears and their habitat.

Subsistence Harvest

Recognition that the polar bears in the southern Beaufort Sea were shared between Canada and the Alaska led to the development of the Polar Bear Management Agreement for the Southern Beaufort Sea between the Inuvialuit of the Inuvialuit Game Council (IGC), Canada and the Inupiat of the North Slope Borough (NSB) Alaska in 1988 (Nageak et al. 1991, Treseder and Carpenter 1989, Prestrud and Stirling 1994, Brower et al. 2002). Since initiation of this local user agreement in 1988, the combined Alaska/Canada mean harvest from this stock has been 56.9 bears per year (1988-2007). The harvest in Canada is limited primarily to Native hunters and is regulated by a quota system (Prestrud and Stirling 1994, Brower et al. 2002). Canada has a well regulated and controlled harvest, which has resulted in accurate harvest reporting, strict controls on the harvest, and efficient monitoring and enforcement. The harvest management system in Alaska is voluntary and is less efficient overall than the Canadian system (Brower et al 2002).

The calculation of a PBR level for the Southern Beaufort Sea stock is required by the MMPA even though the subsistence harvest quota is managed under the authority of the Polar Bear Agreement between the NSB and the IGC. Accordingly, the quota from the Board of Commissioners for the Polar Bear Agreement takes precedence over the PBR estimate for the purposes of managing the Alaska Native subsistence harvest from this stock. The Southern Beaufort Sea population is currently thought to be declining; therefore, overharvest could hasten the decline or prevent and/or slow the recovery. Analysis is currently underway to evaluate the effects of different harvest levels on the population dynamics of the Southern Beaufort Sea population.

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PACIFIC WALRUS (*Odobenus rosmarus divergens*):

Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The family Odobenidae is represented by a single modern species, *Odobenus rosmarus,* of which two subspecies are generally recognized: the Atlantic walrus (*O. r. rosmarus*) and the Pacific walrus (*O. r. divergens*). The two subspecies occur in geographically isolated populations. The Pacific walrus is the only stock occurring in United States waters and considered in this account.

Pacific walruses range throughout the continental shelf waters of the Bering and Chukchi Seas, occasionally moving into the East Siberian Sea and the Beaufort Sea (Figure 1). During the summer months most of the population migrates into the Chukchi Sea; however, several thousand animals, primarily adult males, aggregate near coastal haulouts in the Gulf of Anadyr, Russia; Bering Strait, and Bristol Bay, Alaska. During the winter breeding season walruses are found in three concentration areas of the Bering Sea where open leads, polynyas, or thin ice occur (Fay *et al.* 1984, Garlich-Miller *et al.* 2011a). While the specific location of these groups varies annually and seasonally depending upon the extent of the sea ice, generally one group occurs near the Gulf of Anadyr, another south of St. Lawrence Island, and a third in the southeastern Bering Sea south of Nunivak Island into northwestern Bristol Bay. However, Pacific walruses

are currently managed as a single panmictic population. Scribner *et al.* (1997) found no difference in mitochondrial and nuclear DNA among walruses sampled shortly after the breeding season from four areas of the Bering Sea (Gulf of Anadyr, Koryak Coast, Southeast Bering Sea, and St. Lawrence Island).

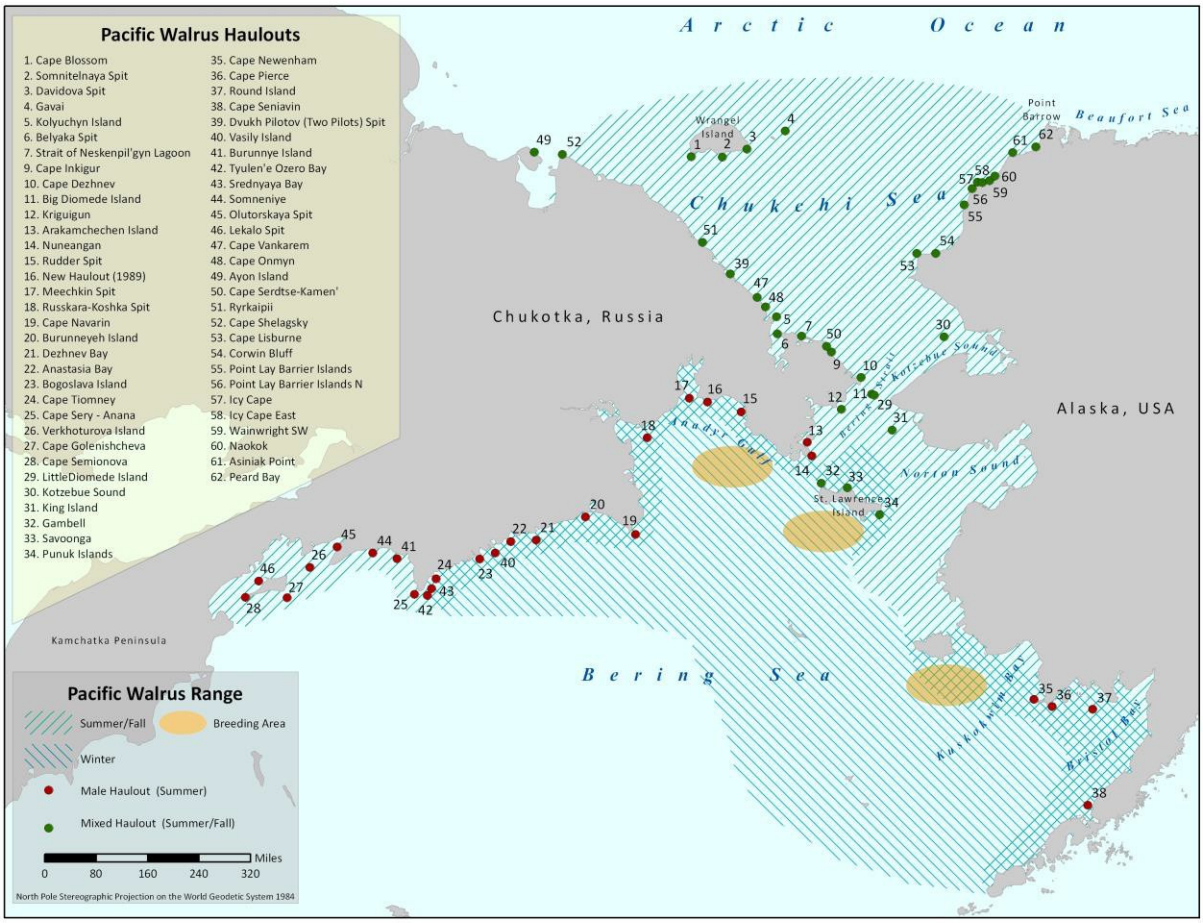

Figure 1. Seasonal distribution, breeding areas, and coastal haulouts of Pacific walruses in the Bering and Chukchi Seas. Modified from Smith 2010.

Pacific walruses typically use sea-ice as a resting platform between feeding dives, as a

birthing substrate, for shelter from storms, isolation from predators, and passive transportation (Fay 1982). Historically, the summer distribution of walruses in the Chukchi Sea occurred primarily on sea ice over the continental shelf from the Alaska to Chukotka coasts with large numbers of animals near Hanna Shoal in the United States and Wrangel Island in the Russian Federation. A few animals would be observed utilizing haulouts along both the Alaska and Chukotka coasts, particularly in the fall. While the overall geographic range of Pacific walruses has not changed, over the past decade the number of walruses coming to shore along the coastline of the Chukchi Sea in both Alaska and Chukotka has increased from the hundreds to thousands to greater than 100,000 (Kavry *et al.* 2008, Garlich-Miller *et al.* 2011*a*, Jay *et al.* 2011). Additionally, adult female and young walruses are arriving at these coastal haulouts as much as a month earlier and staying at the coastal haulouts a week or two longer. In fall 2007, 2009, 2010, and 2011 large walrus aggregations (3,000 to 20,000) were observed along the Alaska coast (Garlich-Miller *et al*. 2011*a*). This increased use of coastal haulouts is a function of the loss of summer sea ice over the continental shelf (Garlich-Miller *et al.* 2011*a*). Summer sea-ice extent in the Chukchi Sea has decreased by about 12% per decade (NSIDC 2012); retreating off the shallow continental shelf and remaining only over deep Arctic Ocean waters where walruses cannot reach the benthos to feed. Declines in Chukchi Sea ice extent, duration, and thickness are projected to continue in a linear fashion into the foreseeable future (Douglas 2010).

POPULATION SIZE

The size of the Pacific walrus population has never been known with certainty. Based on large sustained harvests in the 18th and 19th centuries, Fay (1982) speculated that the pre-exploitation population was represented by a minimum of 200,000 animals. Since that time, population size has fluctuated markedly in response to varying levels of human exploitation (Fay *et al*. 1989). Large-scale commercial harvests reduced the population to 50,000 to 100,000 animals in the mid-1950s (Fay *et al.* 1997). The population is believed to have increased rapidly in size during the 1960s and 1970s in response to reductions in hunting pressure (Fay *et al.* 1989).

Between 1975 and 1990, aerial surveys were carried out by the United States and Russia at five-year intervals, producing mean population estimates ranging from 201,039 to 234,020 animals with 95% confidence intervals that include zero (Table 1). The estimates generated from these surveys are considered minimum values and because of the large associated variances they are not suitable for detecting population trends (Hills and Gilbert 1994, Gilbert *et al.* 1992). Further, these earlier figures largely underestimate the population because they were not adjusted for walruses in the water, a proportion of the population that may be as high as 65 to 87 percent (Born and Knutsen 1997, Gjertz *et al*. 2001, Jay *et al*. 2001, Born *et al*. 2005, Acquarone *et al*. 2006, Lydersen *et al*. 2008) and, because walrus tend to aggregate in large closely packed groups when hauled out on ice or land, it was difficult to obtain accurate counts of animals observed. Efforts to survey the Pacific walrus population were suspended at that time due to unresolved problems with survey methods, which produced population estimates with unknown bias and unknown or large variances that severely limited their utility (Gilbert *et al.* 1992, Gilbert 1999).

An international workshop on walrus survey methods in 2000 concluded that it would not be possible to obtain a population estimate with adequate precision for tracking trends using the existing aerial survey methods and any feasible amount of survey effort (Garlich-Miller and Jay 2000). Two major problems were identified: (1) accurately counting walruses in large groups, and (2) accounting for walruses in the water that were not available to be counted. Remote sensing systems were viewed as having great potential to address the first problem (Udevitz *et al.* 2001) as well as being able to sample larger areas per unit of time (Burn *et al*. 2006). To address the second problem U.S. Geological Survey (USGS) scientists developed satellite transmitters that recorded the haul-out status (in water or out) of individual walruses, which was used to estimate the proportion of animals in the water and correct walrus counts (Udevitz *et al.* 2009). These technological advances led to a joint United States-Russian Federation survey in March and April of 2006. This survey effort was timed to occur when the majority of Pacific walrus were hauled out on sea ice habitats across the continental shelf of the Bering Sea in order to capture as much of the population as possible.

The goal of the 2006 survey was to estimate the size of the Pacific walrus population (Speckman *et al.* 2011). However, some areas known to be important to walruses were not surveyed in 2006 because of poor weather and therefore the 2006 estimate is also considered to be an underestimate. The number of Pacific walruses within the area surveyed in 2006 was estimated at 129,000 with a 95% confidence interval of 55,000 to 507,000 (Speckman *et al.* 2011).

Table 1. Point estimates (95% confidence interval) of Pacific walrus population size, 1975-2006 from cooperative United States – Russian aerial surveys and original references.

Year	Population Estimate	References
1975	221,350 (–20,000-480,000)[a]	Gol'tsev 1976, Estes and Gilbert 1978, Estes and Gol'tsev 1984
1980	246,360 (–20,000-540,000)[a]	Johnson *et al.* 1982, Fedoseev 1984
1985	234,020 (–20,000-510,000)[a]	Gilbert 1986, 1989a, 1989b; Fedoseev and Razlivalov 1986
1990	201,039 (–19,000-460,000)[a]	Gilbert *et al.* 1992
2006	129,000 (55,000-507,000)	Speckman *et al*. 2011

[a]95% confidence intervals are from Figure 1 in Hills and Gilbert (1994).

Minimum Population Estimate

Under section 3(27) of the Marine Mammal Protection Act (MMPA), a "minimum population estimate" is defined as "an estimate of the number of animals in a stock that (A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information and (B) provides reasonable assurance that the stock size is equal to or greater than the estimate." The estimate derived from the joint United States-Russian Federation survey conducted in March and April 2006 (Speckman *et al*. 2011) represents the minimum population estimate for the Pacific walrus. Because the 2006 survey used the most advanced technologies developed to address the problems identified in earlier aerial survey methods and was timed to capture as much of the population as possible (see above discussion under **POPULATION SIZE**), the survey's estimate of 129,000 individuals, with a 95%

confidence interval of 55,000 to 507,000 (Speckman *et al*. 2011), constitutes the best available scientific information on the size of the Pacific walrus population, taking into account the precision and variability associated with such estimates on abundance. The estimate from the 2006 survey is also negatively biased (Speckman *et al*. 2011), which provides reasonable assurance that the walrus population size is greater.

Current Population Trend

The 2006 estimate is lower than previous estimates of Pacific walrus population size (Table 1) and is known to be biased low to an unknown degree (Garlich-Miller *et al.* 2011*a*). However, estimates of population size from 1975 to the present (Table 1) are not directly comparable (Fay *et al.* 1997, Gilbert 1999) because of differences in survey methods, timing of surveys, and segments of the population surveyed. Therefore, while these estimates do not provide a good basis for inference with respect to population trends, there is other evidence supporting the hypothesis that the Pacific walrus population has declined from a peak in the late 1970s and 1980s.

Walrus researchers in the 1970s and 1980s were concerned that the population had reached or exceeded carrying capacity, and predicted that density-dependent mechanisms would begin to cause a decrease in population size (Fay and Stoker 1982b, Fay *et al*. 1986, Sease 1986, Fay *et al*. 1989). Estimates of demographic parameters from the late 1970s and 1980s support the idea that population growth was slowing (Fay and Stoker 1982a, Fay *et al*. 1986, Fay *et al*. 1989). Garlich-Miller *et al*. (2006) found that the median age of first reproduction for female walruses decreased in the 1990s, which is consistent with a reduction in density-dependent pressures. In addition, data on calf/cow ratios collected from harvested animals is consistent

with a population peak in the late 1970s (i.e., low estimates in the late 1970s and 1980s) and subsequent population decline, and indicates that the population is currently below carrying capacity (MacCracken 2012).

The current working hypothesis, based on the available data, is that commercial and subsistence harvests prior to the 1960s limited the population; adoption of harvest quotas in the 1960s resulted in a population increase until the carrying capacity (about 300,000; according to Fay *et al.* (1997)) was reached in the 1970 to 1980s and productivity began to decline. The subsequent lack of harvest quotas in the United States beginning in 1979 and the reduced productivity levels resulted in another population decline, and the population is once again likely limited primarily by subsistence harvest, although other factors such as haulout mortalities may also be important (Udevitz et al. 2013). Garlich-Miller *et al*. (2011*a*) predicted that changing sea ice dynamics will result in further population declines in the future, but could not specify the magnitude or rate of decline. Given the suite of challenges associated with walrus aerial surveys, many of which cannot be overcome (e.g., poor weather, extensive area, estimate imprecision), it is clear that new approaches to evaluate population status and trend need to be explored. The U.S. Fish and Wildlife Service (Service) is developing a project to test the feasibility of genetic mark-recapture methods to estimate population size and trend. The successful development of a repeatable, unbiased, and precise estimate of population size will greatly facilitate our walrus conservation efforts including those directed at harvest management (USFWS 1994).

MAXIMUM NET PRODUCTIVITY RATES

Estimates of net productivity rates for walrus populations have ranged from 3 to 13% per

year with most estimates between 5-10% (Chapskii 1936; Mansfield 1959; Krylov 1965, 1968; Fedoseev and Gol'tsev 1969; Sease 1986; DeMaster 1984; Sease and Chapman 1988; Fay *et al.* 1997). Chivers (1999) developed an individual age-based model of the Pacific walrus population using published estimates of survival and reproduction. The model yielded a maximum population growth rate (R_{MAX}) of 8%, which we use as the maximum net productivity rate in this assessment. Empirical estimates of age-specific survival rates for free ranging walruses are not available.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) of a marine mammal stock is defined in the MMPA as the maximum number of animals, not including natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population. The PBR is the product of the following factors: (A) the minimum population estimate of the stock, (B) one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size, and (C) a recovery factor between 0.1-1.0 (MMPA §3(20)). Mathematically, PBR = N_{MIN} x 0.5 R_{MAX} x F_R; where N_{MIN} is minimum populations size, R_{MAX} the net productivity rate, and F_R a recovery factor. The F_R for the Pacific walrus is 0.5 (NMFS 2005) because the population is a candidate for listing under the U.S. Endangered Species Act of 1973, as amended (ESA) (USFWS 2011). The net productivity rate is estimated as 0.08 (Chivers 1999). Therefore, for the Pacific walrus population:

$$N_{MIN} = 129{,}000$$

$$R_{MAX} = 0.08$$

$$F_R = 0.5$$

$$PBR = (129{,}000 \times [0.5*0.08]*0.5) = 2{,}580$$

HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Human Caused Mortalities

Subsistence Harvest

Over the past 60 years the Pacific walrus population has sustained estimated annual harvest removals ranging from 3,184 to 16,127 animals (mean = 6,440; Figure 2). Harvest levels since 2006 are 5 to 68% lower than this long-term average. It is not known whether recent reductions in harvest levels reflect changes in walrus abundance or hunting opportunities, but hunters consistently state that more frequent and severe storms are affecting hunting effort (EWC 2003, Oozeva *et al.* 2004). Other factors affecting harvest levels included: 1) the cessation of Russian commercial walrus harvests after 1990; and 2) changes in political, economic, and social conditions of subsistence hunters in Alaska and Chukotka.

The Service uses the average annual harvest over the past five years as an estimate of current harvest levels in the United States and Russia. Total U.S. annual harvest is estimated using data collected by direct observation in selected communities and through the statewide regulatory Marking, Tagging, and Reporting Program. The two sources of data are combined to calculate annual reporting compliance and to correct for any unreported harvest. Total U.S. subsistence harvest is estimated as the sum of reported and estimated unreported harvests. Harvest estimates in Russia were collected through both an observer program and a reporting program instituted by the Russian Federation.

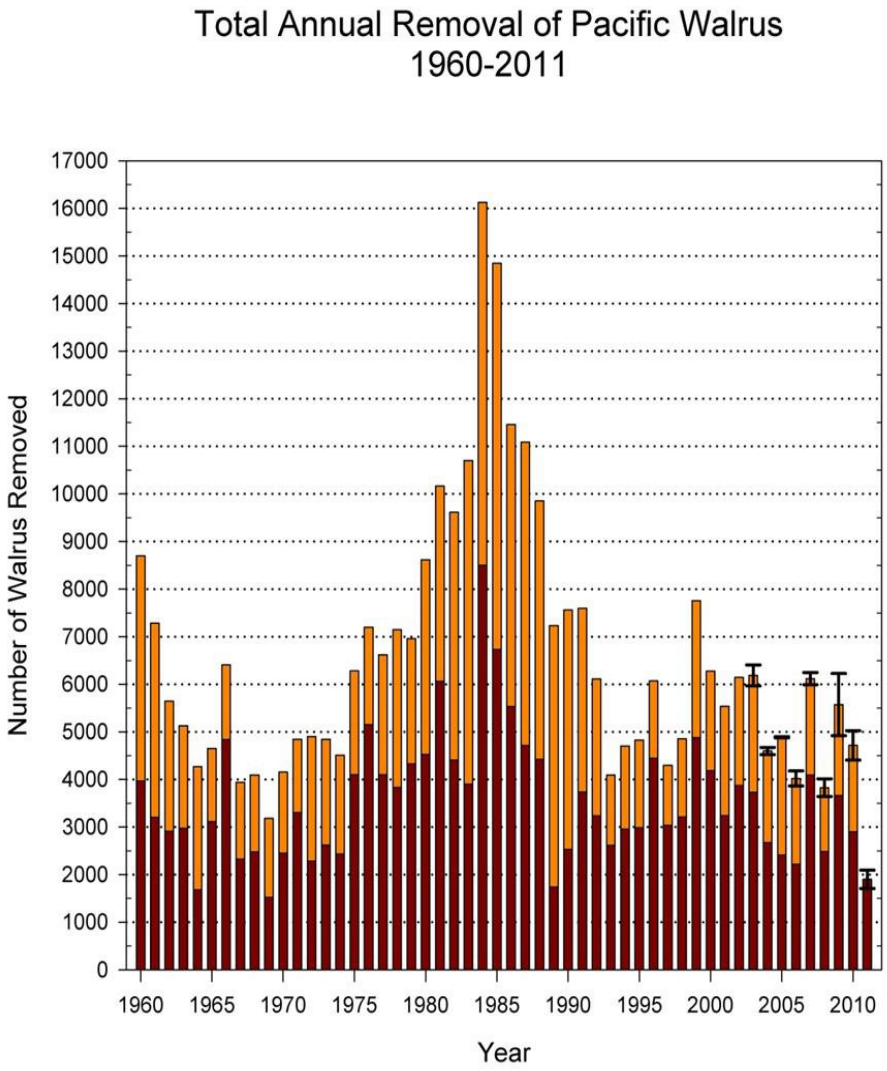

Figure 2. Total annual harvest removals for the Pacific walrus population from 1960 to 2011. Error bars for 2003-2011 denote the standard error around the estimate. Russian data for 2011 not included.

Using data collected between 1952 and 1972, Fay *et al*. (1994) estimated that 42% of

walruses that were shot at were lost after being hit. All walruses that have been shot with a firearm are either killed immediately or assumed to be mortally wounded; however, they are often not retrievable if they die in the water and sink or if they are wounded and escape (Fay *et al.* 1994). We recognize that hunting equipment and techniques have improved since Fay *et al.* (1994) published their estimate; however, that estimate is still the best available. We therefore multiply the estimated harvest by 1.42 to adjust for walruses shot but not retrieved (i.e., struck and lost), resulting in a more accurate estimate of total number of walruses harvested.

Harvest mortality levels from 2006 to 2010 are estimated at 3,828 to 6,119 walruses per year (Table 2). The sex-ratio of the reported U.S. walrus harvest over this time period was 1.3:1 males to females. The sex-ratio of the reported Russian walrus harvest was 3.1:1 males to females based on harvest information collected by ChukotTINRO from 1999 to 2009 (Kochnev 2010).

Impacts of climate change on future subsistence harvests of walruses are difficult to predict (Holversrud 2008). Changes in walrus distribution, abundance, and health; sea ice characteristics and distribution; length and timing of the hunting season; and weather and sea state during the hunting season can all influence hunting success. Recent harvests are lower than historic levels and more frequent storms during the traditional hunting season, which limit hunting opportunities, appear to be a contributing factor. Holversrud (2008) predicted that climate change would result in a decline in the subsistence harvest of marine mammals. Garlich-Miller *et al*. (2011a) predicted that walrus harvest levels would remain relatively stable. Since 2006, the estimated total removal of walruses has fluctuated from year to year by an average of 3%, but is highly variable (e.g., 2006 to 2007, a 52% increase; and 2007 to 2008, a 60% decline).

Although fewer walruses are currently being harvested overall, of those animals harvested more are being harvested earlier in the spring and earlier in the winter than during the previous 20 years demonstrating that hunters will likely adapt to changing hunting and sea ice conditions. Harvest levels must be assessed within the context of the best available information on walrus population size, weather and climate, and political, economic, and social conditions of subsistence hunters in Alaska and Chukotka. Garlich-Miller et al. (2011a) assumed that summer sea ice loss would result in a reduced walrus population over time and that subsistence harvests could become unsustainable if not reduced in concert with any decline in the population. The recent adoption of trip limit ordinances by the Native Villages of Gambell and Savoonga and the acquisition of a Tribal Wildlife Grant to ensure administration of those ordinances is a positive development in this arena.

Table 2. Mean (standard error) harvest of Pacific walruses, 2006-2010. Russian harvest information was provided by ChukotTINRO and the Russian Agricultural Department. United States harvest information was collected by the U.S. Fish and Wildlife Service, and adjusted for unreported walruses using a mark-recapture method. Total harvest includes a struck and lost factor of 42% (Fay *et al*. 1994).

Year	Total harvest	United States harvest	Russian harvest
2006	4,022(157)	1,286(91)	1,047
2007	6,119(127)	2,376(74)	1,173
2008	3,828(185)	1,442(107)	778
2009	5,547(654)	2,123(379)	1,110
2010	4,716(308)	1,682(178)	1,053
Five year mean	4,852(346)	1,782(200)	1,032(67)

Cooperative Agreements have been developed annually between the Service and the Eskimo Walrus Commission since 1997 to facilitate the participation of subsistence hunters in activities related to the conservation and management of the walrus in Alaska. This co-management process is on-going. Ensuring that harvest levels remain sustainable is a goal shared by subsistence hunters and resource managers in the United States and Russian Federation. Achieving this management goal will require continued investments in co-management relationships, harvest monitoring programs, international coordination, and research.

Fisheries Related Mortalities and Injuries

A complete list of fisheries and marine mammal interactions is published annually by the National Oceanic and Atmospheric Administration (NOAA)-Fisheries, the most recent of which was published on August 29, 2013 (NOAA 2013). Pacific walruses occasionally interact with trawl and longline gear of groundfish fisheries. No data are available on incidental catch of walruses in fisheries operating in Russian waters, although trawl and longline fisheries are known to operate there. In Alaska each year, fishery observers monitor a percentage of commercial fisheries and report injury and mortality of marine mammals incidental to these operations. Overall, 13 fisheries, with observers, operate in Alaska within the range of the Pacific walrus in the Bering Sea, and could potentially interact with them.

Mortalities

Incidental mortality during 2006-2010 was observed in only one fishery, the Bering Sea/Aleutian Island flatfish non-pelagic trawl (Table 3); which, according to NOAA-Fisheries is

a Category II Commercial Fishery with an estimated 34 vessels and/or persons participating. Observer coverage for this fishery averaged 88% during 2006-2010. The mean number of observed mortalities was one walrus per year, with a range of zero to three (Table 3). The total estimated annual fishery-related incidental mortality in Alaska was two walruses per year. We consider fishery related mortality to be insignificant.

Table 3. Summary of incidental mortality of Pacific walruses in the Bering Sea/Aleutian Islands flatfish trawl fishery from 2006-2010 and estimated mean annual mortality. Data provided by the National Marine Fisheries Service.

Year	Observer coverage (%)	Observed mortality	Estimated mortality	95% CI
2006	68	2	3	1 – 6
2007	72	1	3	1 – 5
2008	100	1	1	0.6 – 1.4
2009	100	0	0	
2010	100	2	2	1 – 3
Five year mean(SE[a])	88(7)	1(0.4)	2(0.6)	

[a]standard error.

Injuries

No incidental injury was observed during this time period; therefore, annual serious injury is estimated to be zero.

Other Removals

Between 2006-2011, satellite transmitters were affixed to 348 walruses, and collections of skin and blubber samples with biopsy darts were attempted from 183 walruses. No mortalities or serious injuries were directly associated with those research activities. However, in 2011,

walruses at the Point Lay, Alaska haulout cleared the beach as USGS researchers, ferried by local guides, boated past resulting in the death of one calf (Jay 2012).

Up to 52 orphaned walrus calves were captured in Russia and placed on public display between 2006-2010. In addition, 3 calves were found on the beach near Barrow, Alaska in 2012 and taken into captivity. Based on this information, about 19 (standard error = 17) walruses per year were removed from the wild due to other human activities.

Total Estimated Human-Caused Mortality and Serious Injury

The average (standard error) total annual human-caused mortality or removal is 4,873 (346) walruses (2 due to fisheries interactions, 4,852 due to harvest, and 19 due to other human activities). There is no evidence that levels of human-caused serious injury are significant at this point.

Mortalities at coastal haulouts are due to several natural sources (poor condition, old age, injuries, predation, etc.) and occur at all haulouts at an unknown background level. Mortalities due to human caused stampedes also occur but are hard to quantify – most events are observed after the fact (Fay and Kelley 1980, Fischbach *et al.* 2009), some may go undetected, and carcasses can be redistributed during storms and consumed by predators. In 2007, more than 3,200 haulout mortalities were attributed to disturbance events along the Russian coast, but none were noted in Alaska. In 2008, few haulout mortalities were observed (0 in the United States, 165 in Russia) as remnant ice in the Chukchi Sea allowed walruses to stay offshore. In 2009, 131 calves were apparently trampled in a disturbance event at Icy Cape, Alaska (Fischbach *et al.* 2009) and another 53 were reported from other locations in Alaska with 453 counted in Russia. In 2010, 680 carcasses were counted at four haulouts in Russia (A. Kochnev, pers. comm.) and

less than 200 were observed at Point Lay, Alaska (USFWS, unpubl. data). In 2011, 376 carcasses were counted in Russia (A. Kochnev, pers. comm.) and about 100 carcasses were found at the Point Lay haulout (USFWS, unpubl. data). Haulout management programs in Russia and the United States may be a successful management tool in reducing disturbance related mortalities compared to the extreme event in 2007.

STATUS OF STOCK

Pacific walrus are not designated as depleted under the MMPA; however, we have determined that listing the Pacific walrus as endangered or threatened under the ESA is warranted, but precluded by higher priority listing actions (USFWS 2011). Based on the best available information, the estimated incidental mortality and serious injury related to commercial fisheries (two walruses per year) is less than one percent of PBR and therefore can be considered insignificant and approaching a zero mortality and serious injury rate. However, the total human-caused removals exceed the PBR of 2,580. Therefore, the Pacific walrus is classified as a strategic stock.

EMERGING CONSERVATION ISSUES

A status review for the Pacific walrus was completed in 2011 in response to the ESA listing petition (Garlich-Miller *et al.* 2011*a*, and is available at: *http://alaska.fws.gov/fisheries/mmm/walrus/pdf/review_2011.pdf*. That review provides a comprehensive analysis of the stressors currently affecting the Pacific walrus population. The major findings of that analysis have been incorporated into this document in the appropriate

sections. Readers should refer to Garlich-Miller *et al.* (2011*a*) for additional information on topics not covered by this stock assessment report.

Chukchi Coast Haulout Use

Over the past decade, the number of walruses coming to shore in summer and fall along the coastline of the Chukchi Sea in both Alaska and Russia has increased (Kavry *et al.* 2008, Garlich-Miller *et al.* 2011*a*) coincident with the earlier and more extensive melting of sea ice. In fall 2007, 2009, 2010, and 2011, large aggregations of females and young (about 3,000 to 30,000) were observed along the Alaska coast. An area of concern is the amount of walrus prey within the foraging range of coastal haulouts (Garlich-Miller *et al*. 2011*a*). As more walruses use coastal haulouts more frequently and for longer periods each year, prey populations could be depleted. Malnourished walruses have been reported from Chukotka (Ovsyanikov *et al*. 2008, A.A. Kochnev personal communication) and they are also regularly observed in Alaska (Garlich-Miller *et al.* 2011a); however, the majority of walruses observed at fall haulouts in Alaska in 2010 and 2011 were in good physical condition.

Ocean Acidification

The effect of ocean acidification (OA) on walrus prey is another issue of concern because lower pH levels can interfere with invertebrate shell formation and erode existing shells. No information is available about potential impacts on specific walrus prey species. Uncertainty regarding the general effects of ocean acidification has been summarized by the National Research Council (2010:1): "The major changes in ocean chemistry caused by increasing atmospheric CO_2 are well understood and can be precisely calculated, despite some uncertainty resulting from biological feedback processes. However, the direct biological effects of ocean

acidification are less certain and will vary among organisms, with some coping well and others not at all." Consequently, although we recognize that effects to calcifying organisms that are important prey items for Pacific walruses may occur in the foreseeable future from ocean acidification, we do not know which species may be able to adapt and thrive, which may decline, or the ability of the walrus to depend on alternative prey items. The prey base of walrus includes over 100 taxa of benthic invertebrates from all major phyla (Sheffield and Grebmeier 2009). Although walruses are highly adapted for obtaining bivalves, they also have the potential to switch to other prey items if bivalves and other calcifying invertebrate populations decline. Whether other prey items would fulfill walrus nutritional needs over their life span is unknown (Sheffield and Grebmeier 2009), and there also is uncertainty about the extent to which other suitable non-bivalve prey might be available, due to uncertainty about the effects of ocean acidification and the effects of ocean warming.

Subsistence Harvest

Recent subsistence harvests are lower than historic levels due to a faster spring migration and more frequent severe storms that have limited hunting opportunities during the spring migration (Kapsch *et al.* 2010). Garlich-Miller *et al.* (2011*a*) predicted that walrus harvest levels would remain relatively stable as hunters adapt to changing hunting conditions, but that summer sea ice loss will result in a reduced walrus population over time, and therefore subsistence harvests could become unsustainable if not reduced similarly. The Service, in cooperation with the Russian Federation, has a comprehensive harvest monitoring program in place that provides detailed information on harvest trends and characteristics. We will continue to cooperatively monitor harvest levels into the future, a key component to maintaining a sustainable harvest.

Oil and Gas Exploration

In 2008, the Minerals Management Service (now the Bureau of Ocean Energy Management) held an oil and gas lease sale for offshore blocks in the eastern Chukchi Sea. In 2009, 2010, and 2011 a number of seismic surveys were conducted in the lease sale area. A significant portion of the Pacific walrus population migrates into the Chukchi Sea region each summer, and the shallow, productive, ice covered waters of the eastern Chukchi Sea are considered particularly important habitat for female walruses and their dependent young. The Hanna Shoal area seems to be particularly attractive to walruses summering in the Chukchi Sea likely due to both high prey abundance and shallow waters. The Service works to monitor and mitigate potential impacts of oil and gas activities on walruses through Incidental Take Regulations (ITR) as authorized under the MMPA. Entities operating under these regulations must adopt measures to ensure that impacts to walruses remain negligible, minimize impacts to their habitat, and ensure no unmitigable adverse impact on their availability for Alaska Native subsistence use. These regulations also specify monitoring requirements that provide a basis for evaluating potential impacts of current and future activities on marine mammals. The current ITRs were renewed in 2013 for another five years. The Service included a thorough analysis of the monitoring data collected in association with previous ITRs when it issued the current ITRs.

The Service (2011) concluded that at current levels, oil and gas exploration posed a relatively minor threat to the Pacific walrus population. However, we noted that a large oil spill could significantly impact the population depending on timing, location, amount and type of oil, efficacy of response efforts, etc.; the current ITRs also provided special considerations to limit potential impacts to walrus utilizing the Hanna Shoal area.

International Commercial Shipping

As summer sea ice melts earlier in the year and the open water extends further north, opportunities for commercial shipping through the arctic increase (Garlich-Miller *et al.* 2011*a*). Transits through the Bering Strait increased significantly between 2009 and 2010 (M. Williams, pers. comm.) and are currently outpacing regulatory efforts to define shipping channels, seasons of use, and mitigation measures to reduce ship strikes, etc. Commercial shipping is expected to increase in the future, but several scenarios are possible depending on economics and international regulatory efforts. Shipping is not currently impacting the Pacific walrus population and not expected to be a major source of mortality in the future.

Disease

During summer and fall 2011, about 130 ringed seals (*Pusa hispida*) were found on the beaches on northwest Alaska with skin lesions and hair loss suggestive of a viral infection. About 48% of those seals were found dead and the others were lethargic. During September 2011, 6% of the walruses at the Point Lay haulout had similar skin lesions, but were otherwise in good physical condition. The majority of affected walruses were subadults and some of those had healed lesions, indicating that the disorder is not necessarily fatal. However, a number of dead calves at the haulout had both skin lesions and signs of trampling trauma (Garlich-Miller *et al.* 2011*b*) and the ultimate cause of death is not known at this time.

In December 2011, the National Marine Science Fisheries (NMFS) declared the seal mortalities an unusual mortality event (UME) and, with the Service concurrence, included walrus in the UME, due to the similarities of the lesions. No causative agent has been identified and it is not known if the same agent is infecting both species. The symptoms appear to be less severe in

walruses than in ringed seals in terms of prevalence and mortalities. Sampling of Pacific walrus' tissues and comprehensive laboratory analyses is continuing as part of the UME investigation.

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Revised: April 2014

NORTHERN SEA OTTER (*Enhydra lutris kenyoni*):

Southeast Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters occur in nearshore coastal waters of the U.S. along the North Pacific Rim from the Aleutian Islands to California. The species is most commonly observed within the 40-meter (m) (approximately 12.2 feet) depth contour because the animals require frequent access to benthic foraging habitat in subtidal and intertidal zones (Reidman and Estes 1990). Sea otters are not migratory and generally do not disperse over long distances, although movements of tens of kilometers (km) (tens of miles [mi]) are common (Garshelis and Garshelis 1984). Annual home range sizes of adult sea otters are relatively small, with male territories ranging from 4 to 11 square kilometers (km^2) (approximately 10.5 to 28.5 square miles [mi^2]) and adult female home ranges from a few to 24 km^2 (approximately 62 mi^2) (Garshelis and Garshelis 1984; Ralls *et al*. 1988; Jameson 1989). Due to their benthic foraging, sea otter distribution is largely limited by their ability to dive to the sea floor (Bodkin *et al*. 2004).

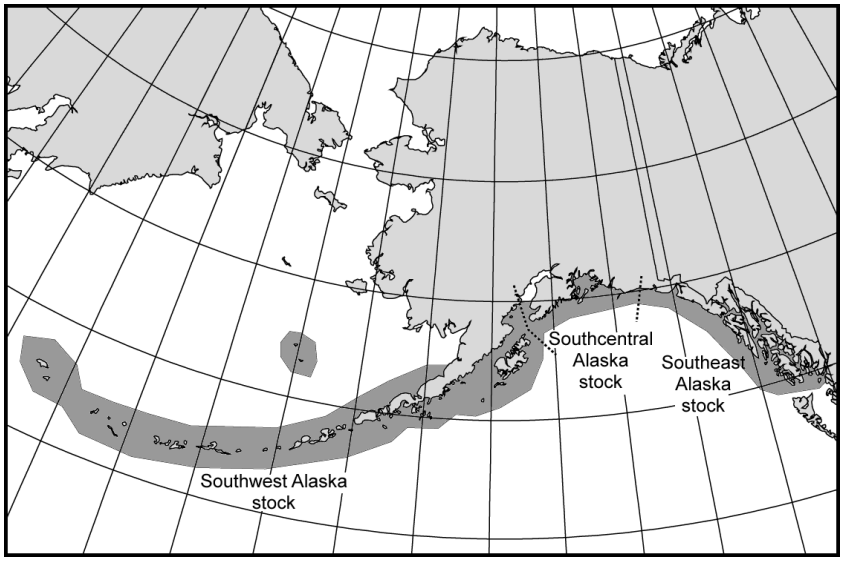

Figure 1. Approximate distribution and stock boundaries of northern sea otters in Alaska waters (shaded area).

The spatial scale at which sea otter populations are managed remains an important, although largely unexplored issue (Bodkin and Ballachey 2010) deserving further study. Bodkin and Ballachey (2010) used models of sea otter mortality to show that range-wide reductions and extirpations during the commercial fur trade of the 18th and 19th centuries occurred not simply because of excessive harvest, but because the harvest was not allocated proportional to the abundance and distribution of sea otters. This process of serial depletion was facilitated by the relatively sedentary nature of sea otters. To reduce the risk of overexploitation, sea otters must be managed on a spatial scale compatible with their well-known behavioral and reproductive biology (Bodkin and Monson 2002), incorporating traits such as home range and movements. These proposed scales for management are much smaller than the currently recognized stocks.

Gorbics and Bodkin (2001) applied the phylogeographic approach of Dizon *et al.* (1992) and used the best available data at the time to identify three sea otter stocks in Alaska: Southeast, Southcentral, and Southwest. The ranges of these stocks are defined as follows: (1) Southeast

Alaska stock extends from Dixon Entrance to Cape Yakataga; (2) Southcentral Alaska stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai Peninsula coast, and Kachemak Bay; and (3) Southwest Alaska stock includes the Alaska Peninsula and Bristol Bay coasts, and the Aleutian, Barren, Kodiak, and Pribilof Islands (Figure 1). This stock assessment report is focused on the Southeast stock of sea otters in Alaska.

POPULATION SIZE

Historically, sea otters occurred across the North Pacific Rim, ranging from Hokkaido, Japan, through the Kuril Islands, the Kamchatka Peninsula, the Commander Islands, the Aleutian Islands, peninsular and south coastal Alaska, and south to Baja California, Mexico (Kenyon 1969). In the early 1700s, the worldwide population was estimated to be between 150,000 (Kenyon 1969) and 300,000 individuals (Johnson 1982). Prior to large-scale commercial exploitation, indigenous peoples of the North Pacific hunted sea otters. Although it appears that harvests may have periodically led to local reductions of sea otters (Simenstad *et al.* 1978), the species remained abundant throughout its range until the mid-1700s. Following the arrival in Alaska of Russian explorers in 1741, extensive commercial harvest of sea otters over the next 150 years resulted in the near extirpation of the species. When sea otters were afforded protection by the International Fur Seal Treaty in 1911, probably fewer than 2,000 animals remained in thirteen remnant colonies (Kenyon 1969).

Although population recovery began following legal protection, no remnant colonies of sea otters existed in Southeast Alaska. As part of efforts to re-establish sea otters in portions of their historical range, otters from Amchitka Island and Prince William Sound were translocated

to other areas (Jameson *et al.* 1982). These translocation efforts met with varying degrees of success. From 1965 to 1969, 412 otters (89% from Amchitka Island in southwest Alaska, and 11% from Prince William Sound in southcentral Alaska) were translocated to six sites in southeast Alaska (Jameson *et al.* 1982). In the first 20 years following translocation, these populations increased in numbers and expanded their range (Pitcher 1989).

Nearly all of the current population estimates for the Southeast Alaska stock were developed using the aerial survey methods of Bodkin and Udevitz (1999). The lone exception was a survey of the outer coastline from the western boundary of the stock at Cape Yakataga to Cape Spencer conducted by U.S. Geological Survey (USGS) in 2000. Thirty-two otters were estimated to be in that area (coefficient of variation [CV]=0.378). In 2005, the U.S. Fish and Wildlife Service (Service) surveyed Yakutat Bay (estimate number of otters [N]=1,582; CV=0.33; Gill and Burn 2007). In 2010, the Service surveyed the southern half (Kuiu and Kupreanof Islands south to the Canadian border) of Southeast Alaska (SSE) (N=12,873; CV=0.18; Gill and Burn unpublished data). The northern half (Admiralty and Baranof Islands north to Glacier Bay) of Southeast Alaska (NSE) was surveyed by the Service in 2011 (N=2,717; CV=0.22; Gill and Burn unpublished data). Glacier Bay (GB) National Park (NSE) was not included in the 2011 survey as USGS had separate plans to conduct replicate surveys in the Bay in 2012 to add to a long-term data set for the National Park (NP). The estimate from that 2012 survey is N=8,508; CV=0.20 (Esslinger *et al.* 2013). The most recent population estimates for the Southeast Alaska stock are presented in Table 1, which shows a total estimate of 25,712 sea otters for the stock.

Table 1. Abundance estimates for the Southeast Alaska stock of northern sea otters.

Survey Area	Year	Unadjusted count	Adjusted Estimate	CV	N_{MIN}	Reference
North Gulf of Alaska	2000	15	32	0.38	24	USGS unpublished data
Glacier Bay (NP)	2012		8,508	0.20	7,201	Esslinger, Bodkin, & Weitzman (2013)
Northern Southeast Alaska (NSE)	2011		2,717	0.22	2,270	Gill and Burn unpublished data
Southern Southeast Alaska (SSE)	2010		12,873	0.18	11,099	Gill and Burn unpublished data
Yakutat Bay	2005		1,582	0.33	1,203	Gill and Burn (2007)
Current Total			**25,712**		**21,798**	
2008 SAR Total			10,563		9,136	

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the Potential Biological Removal Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{1/2})$. The N_{MIN} for each survey area is presented in Table 1. The estimated N_{MIN} for the entire Southeast Alaska stock is 21,798 sea otters.

Current Population Trend

The trend for this stock of sea otters has generally been one of growth (Pitcher 1989, Agler *et al.* 1995, Esslinger and Bodkin 2009). Comparing the current population estimate with that of the previous stock assessment reports suggests that this growth trend is continuing. The estimated population size (25,712) of this stock currently is more than double what was

estimated in the previous (2008) stock assessment report (10,563). However, it is important to note that the population estimate published in the 2008 stock assessment report was based on survey data from 2002 and 2003. Therefore, we can only conclude that the Southeast population stock has doubled since 2003.

The 2010-2011 survey followed the same Bodkin and Udevitz (1999) methods as the 2002-2003 survey effort (Esslinger and Bodkin 2009) so results of those two surveys can be directly compared. In addition, all surveys in the GBNP time series followed the Bodkin and Udevitz (1999) method. The Service's 2010 survey of SSE showed an average annual increase of 12% per year over the last seven years and the Service's 2011 survey of NSE Alaska (minus GBNP) showed an average annual increase of 4% per year over the last nine years. The USGSs' survey of GBNP showed an average annual increase of 20% per year over the last six years. If we include the 2012 GBNP estimate with the estimate for the 2011 NSE Alaska the growth rate is about 14% per year in NSE Alaska which is in line with the growth rate for SSE Alaska. Hence, the northern and southern portions of Southeast Alaska appear to be growing at the same average annual rate; between 12-14% per year.

When compared to SSE, the sea otter population has also not appreciably expanded its range in NSE outside of GBNP since 2002 (Esslinger and Bodkin 2009, Gill and Burn unpublished data). However, otters have occupied appreciable new habitat in SSE since 2003 (Esslinger and Bodkin 2009, Gill and Burn unpublished data). There appear to be two major areas of expansion in SSE; otters have moved in large numbers along the northwest coast of Kuiu Island up into Keku Strait and then animals from this area have crossed Frederick Sound to the

southern tip of Admiralty Island, and finally otters have expanded northward from the Barrier Islands through Tlevak Strait.

Sea otter abundance in Yakutat Bay has also increased, by an estimated 14.6% per year, over the last decade, likely through reproduction, although some amount of immigration cannot be ruled out (Gill and Burn 2007). During this process, otters appear to have expanded their range to include the western shores of Yakutat Bay.

Based on this information the current population trend for the Southeast Alaska stock is increasing.

MAXIMUM NET PRODUCTIVITY RATE

Estes (1990) estimated a population growth rate of 17 to 20% per year for northern sea otter populations expanding into unoccupied habitat in the Aleutian Islands, southeast Alaska, British Columbia, Washington State, and central California. Although maximum productivity rates (R_{MAX}) have not been measured through much of the sea otter's range in Alaska, in the absence of more detailed information, the rate of 20% calculated by Estes (1990) is considered the best available estimate of R_{MAX}. The Service's 2010 survey of SSE and 2011 survey of NSE shows a current growth rate of 12% and 4% respectively per year (minus GBNP). The USGS' 2012 survey of GBNP shows a current growth rate of 20% per year. Combining the data from NSE AK indicates that area is growing at a rate of 14% per year which compares to the rate of 12% per year in SSE AK. Consequently, we estimate the current net productivity rate for the entire Southeast Alaska population stock to be between 12-14% per year.

POTENTIAL BIOLOGICAL REMOVAL

Under the Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as *the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population.* Potential biological removal is the product of the minimum population estimate (N_{MIN}), one-half the maximum theoretical net productivity rate, and a recovery factor (F_R): PBR = N_{MIN} x 0.5 R_{MAX} x F_R. The recovery factor for this stock is 1.0 (Wade and Angliss 1997) as population levels have been stable or increasing with a known human take. Thus, for the Southeast stock of sea otters, PBR = 2,179 animals (21,798 x 0.5(0.2) x 1.0).

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

A complete list of fisheries and marine mammal interactions is published annually by the National Oceanic and Atmospheric Administration (NOAA) Fisheries, the most recent of which was published on August 29, 2013 (78 FR 53336). Fisheries that have been known to interact with sea otters in the Southwest and Southcentral Alaska stocks do occur in Southeast Alaska, specifically the Southeast Alaska salmon drift gillnet (474 vessels) and the Yakutat salmon set gillnet (167 participants) fisheries. Sea otters are also known to interact with pot fisheries in California (Hatfield *et al*. 2011); in Southeast Alaska, there are 415 crab pot fishery participants and 274 shrimp pot participants. There are also 243 miscellaneous finfish pot fishery participants across the entire state (numbers are not available for specific areas). Available information

suggests that fisheries using other types of gear, such as trawl, longline, and purse seine, are less likely to have interactions with sea otters across their entire range in Alaska due to either the areas where such fisheries operate (i.e., outside of sea otter habitat), the specific gear used (i.e., otters are not going to tangle or get trapped in a longline), or both.

Although commercial fisheries in Alaska have observer programs that monitor and report injury and mortality of marine mammals incidental to their operations, a reliable estimate of the levels of commercial fisheries incidental mortality and serious injury relative to the southeast sea otter stock cannot be made because observer coverage is not sufficient and data are not collected consistently over time. Of the observer programs in operation within the stock, no incidents of sea otter incidental take were observed in trawl, longline, or pot groundfish fisheries in Southeast Alaska from 1989 to 2010 (Perez 2003, Perez 2006, Perez 2007, Manly 2009, Bridget Mansfield 2011 personal communication). However, there has been no observer effort to document by-catch in the salmon set or drift gillnet fisheries or in the crab or shrimp pot fisheries in Southeast Alaska. Hatfield *et al*. (2011) contend that significant sea otter mortality from pot fishery by-catch might easily go undetected, even when seemingly high levels of observer effort exist.

An additional source of information on the number of sea otters killed or injured incidental to commercial fishery operations in Alaska is found in fisher self-reports required of vessel owners by NOAA Fisheries. From 1990 to 1993, self-reported fisheries data showed no sea otter kills or injuries in Southeast Alaska. Self-reports were incomplete for 1994 and not available for 1995 or 1996. Between 1997 and 2010, there were no records of incidental take of sea otters by commercial fisheries in this region. Credle *et al.* (1994) considered fisher self-reports to be a minimum estimate of incidental take as these data are most likely negatively

biased. Indeed, anecdotal observations have been reported to the Service within the last five years suggesting that sea otters do interact with crab pots in Southeast Alaska. As sea otters reoccupy portions of their former habitat in Southeast Alaska, co-occurrence with pot fisheries will increase and so will the likelihood of mortalities or serious injury.

Information is insufficient to determine whether or not the total fishery mortality and serious injury for the Southeast Alaska stock of the northern sea otter is insignificant and is approaching a zero mortality and serious injury rate.

Oil Spills

Activities associated with exploration, development, and transport of oil and gas resources can adversely impact sea otters and nearshore coastal ecosystems in Alaska. Sea otters rely on air trapped in their fur for conserving body heat and buoyancy. Contamination with oil drastically reduces the insulative value of the pelage, and consequently, sea otters are among the marine mammals most likely to be detrimentally affected by contact with oil. It is believed that sea otters can survive low levels of oil contamination (< 10% of body surface), but that greater levels (>25%) will lead to death (Costa and Kooyman 1981, Siniff *et al.* 1982). Vulnerability of sea otters to oiling was demonstrated by the 1989 *Exxon Valdez* oil spill in Prince William Sound. Total estimates of mortality caused by the spill for the Prince William Sound area vary from 750 (range 600-1,000) (Garshelis 1997) to 2,650 (range 500-5,000) (Garrot *et al.* 1993) otters. Statewide, it is estimated that 3,905 sea otters (range 1,904-11,257) died in Alaska as a result of the spill (DeGange *et al.* 1994), but none of these were from the Southeast Alaska stock.

There is currently no oil and gas development in Southeast Alaska. Tankers carrying oil south from the Trans-Alaska Pipeline typically travel offshore of Southeast Alaska. Information

on oil spills compiled by the Alaska Department of Environmental Conservation from 2006 to 2010 indicates that there were no reported spills of crude oil in Southeast Alaska. In addition to spills that may occur in association with the development, production, and transport of crude oil, each year numerous spills of non-crude oil products in the marine environment occur from ships and shore facilities throughout Southeast Alaska. During that same time period, there was an average of 133 spills each year, ranging in size from less than 1 and up to 17,800 gallons (approximately 4 to 64,600 liters). The vast majority of these spills were small, with a mean size of 46 gallons (1,748 liters), and there is no indication that these small-scale spills have had an impact on the Southeast Alaska stock of northern sea otters at the population level.

Subsistence/Native Harvest Information

The MMPA exempts Alaska Natives from the prohibition on take of marine mammals, provided such taking is not wasteful and is done for subsistence use or for creating and selling authentic handicrafts or clothing. According to the Service's Law Enforcement records from 2006 to 2010, individuals were prosecuted for unlawful possession, transport, or sale of 208 sea otter hides or skulls taken within the range of the Southeast Alaska stock. During the same time period, there was one prosecution for unlawful take of a single sea otter hide. Data for subsistence harvest of sea otters in Southeast Alaska are collected by a mandatory Marking, Tagging and Reporting Program administered by the Service since 1988. Figure 2 provides a summary of subsistence harvest information for the Southeast stock from 1989 to 2010. The mean reported annual subsistence take during the past five complete calendar years (2006-2010) was 447 animals. This is an increase from the annual average of 322 sea otters hunted during the previous five-year period. Reported age composition from 2006 to 2010 was the same as the

previous five years; 83% adults, 14% subadults, and 3% pups. Reported sex composition from 2006 to 2010 was also the same as the previous five years; 72% males, 27% females, and 1% of unknown sex.

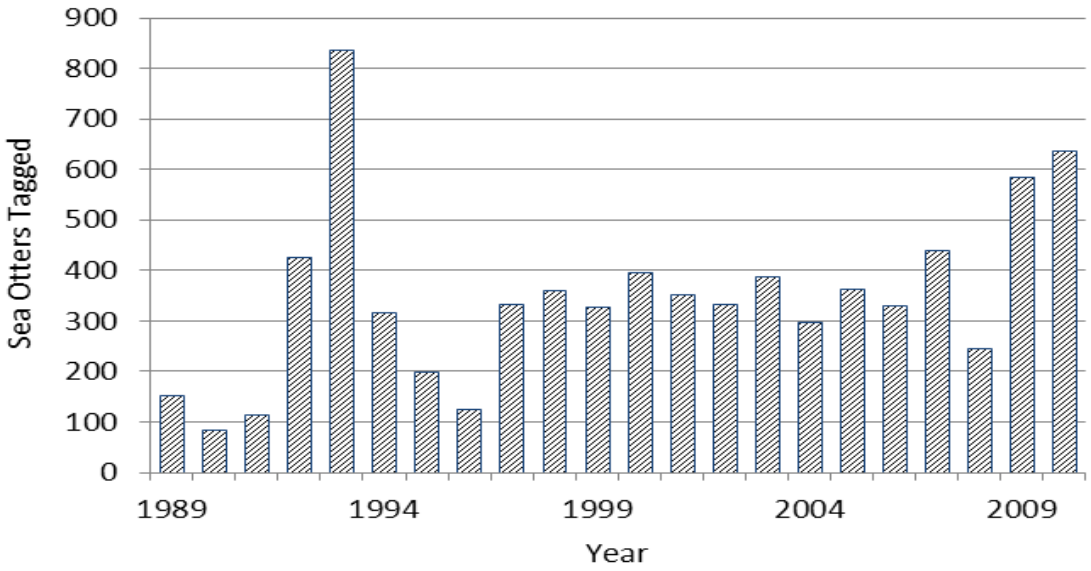

Figure 2. Reported subsistence harvest of northern sea otters from the Southeast Alaska stock, 1989 to 2010.

Research and Public Display

In the past five years, no sea otters were removed from the Southeast Alaska stock for public display. In 2011, 93 sea otters were captured and released for scientific research in the Southeast Alaska stock; the Service captured and released 31 sea otters in the Keku Strait region and the USGS captured and released 62 sea otters in Cross Sound and off of southern Baranof Island. There were no mortalities and serious injuries reported from either of these research efforts.

Other Factors

Since 2002 the Service has undertaken a health and disease study of northern sea otters from all three Alaskan stocks. On average, the Service conducts about 100 necropsies a year on sea otter carcasses to determine cause of death, disease incidence and status of general health parameters. Boat strike is a recurring cause of death across all three stocks. However, it has been determined in most of these cases that although trauma was the ultimate cause of death, there was a contributing factor, such as disease or biotoxin exposure, which incapacitated the animal and made it more vulnerable to boat strike.

In August 2006, the Working Group on Marine Mammal Unusual Mortality Events reviewed information provided by the Service, and declared that a dramatic increase in sea otter strandings in Kachemak Bay, in the Southcentral Alaska stock, since 2002 constituted an Unusual Mortality Event (UME) in accordance with section 404 of the MMPA. The disease that typifies this UME is caused by a *Streptococcus infantarius* infection and has been observed over a broad geographic range in Alaska, including a few cases from Southeast Alaska; however, the majority of cases have come from Kachemak Bay in the Southcentral Alaska stock. It is not clear if the observed stranding pattern is representative of overall sea otter mortality, or an artifact of having a well-developed stranding network in the Kachemak Bay area. The Service will continue to work with NOAA Fisheries and the Alaska SeaLife Center to develop the infrastructure for a statewide marine mammal stranding network in Alaska.

STATUS OF STOCK

The known level of direct human-caused mortality within the Southeast Alaska stock does not exceed the PBR level, and the Southeast Alaska stock is neither listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act of 1973, as amended, nor is it likely to be listed as such in the foreseeable future. The known level of direct human-caused mortality is 447 otters per year. It would require an annual rate of human-caused mortality from additional hunting or fisheries interactions of 1,733 more otters per year for the total amount of direct human-caused mortality to exceed PBR for this stock. Despite uncertainties regarding fishery mortality, we believe that it is unlikely this level is occurring at present. Therefore, the Southeast Alaska stock of the northern sea otter is classified as non-strategic. In addition, although the Service does not currently know the OSP for this stock, based on the known population level and our estimate of growth and considering the known level of human-caused mortality, we have determined that this stock is increasing and that human-caused mortality and serious injury is not likely to cause the stock to be reduced or to decrease its growth rate. Therefore, we would not expect the current level of human-caused mortality and serious injury to cause this stock to be reduced below its plausible OSP.

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Revised: April 2014

NORTHERN SEA OTTER (*Enhydra lutris kenyoni*):

Southcentral Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters occur in nearshore coastal waters of the U.S. along the North Pacific Rim from the Aleutian Islands to California. The species is most commonly observed within the 40-meter (approximately 12.2 feet [ft]) depth contour because the animals require frequent access to benthic foraging habitat in subtidal and intertidal zones (Reidman and Estes 1990). Sea otters are not migratory and generally do not disperse over long distances, although movements of tens of kilometers (km) (tens of miles [mi]) are common (Garshelis and Garshelis 1984). Annual home range sizes of adult sea otters are relatively small, with male territories ranging from 4 to 11 square kilometers (km^2) (approximately 10.5 to 28.5 square miles[mi^2]) and adult female home ranges from a few to 24 km^2 (approximately 62 mi^2) (Garshelis and Garshelis 1984; Ralls *et al*. 1988; Jameson 1989). Due to their benthic foraging, sea otter distribution is largely limited by their ability to dive to the sea floor (Bodkin *et al*. 2004).

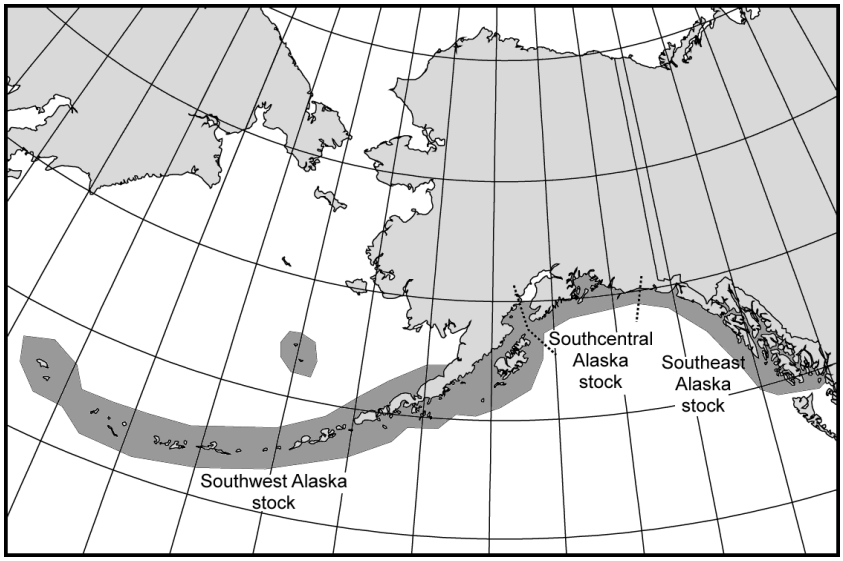

Figure 1. Approximate distribution and stock boundaries of northern sea otters in Alaska waters (shaded area).

The spatial scale at which sea otter populations are managed remains an important, although largely unexplored issue (Bodkin and Ballachey 2010) deserving further study. Bodkin and Ballachey (2010) used models of sea otter mortality to show that range-wide reductions and extirpations during the commercial fur trade of the 18th and 19th centuries occurred not simply because of excessive harvest, but because the harvest was not allocated proportional to the abundance and distribution of sea otters. This process of serial depletion was facilitated by the relatively sedentary nature of sea otters. To reduce the risk of overexploitation, sea otters must be managed on a spatial scale compatible with their well-known behavioral and reproductive biology (Bodkin and Monson 2002), incorporating traits such as home range and movements. These proposed scales for management are much smaller than the currently recognized stocks.

Gorbics and Bodkin (2001) applied the phylogeographic approach of Dizon *et al.* (1992) and used the best available data at the time to identify three sea otter stocks in Alaska: Southeast, Southcentral, and Southwest. The ranges of these stocks are defined as follows: (1) Southeast

Alaska stock extends from Dixon Entrance to Cape Yakataga; (2) Southcentral Alaska stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai Peninsula coast, and Kachemak Bay; and (3) Southwest Alaska stock includes the Alaska Peninsula and Bristol Bay coasts, and the Aleutian, Barren, Kodiak, and Pribilof Islands (Figure 1). This stock assessment report is focused on the Southcentral stock of sea otters in Alaska.

POPULATION SIZE

Historically, sea otters occurred across the North Pacific Rim, ranging from Hokkaido, Japan, through the Kuril Islands, the Kamchatka Peninsula, the Commander Islands, the Aleutian Islands, peninsular and south coastal Alaska, and south to Baja California, Mexico (Kenyon 1969). In the early 1700s, the worldwide population was estimated to be between 150,000 (Kenyon 1969) and 300,000 individuals (Johnson 1982). Prior to large-scale commercial exploitation, indigenous peoples of the North Pacific hunted sea otters. Although it appears that harvests may have periodically led to local reductions of sea otters (Simenstad *et al.* 1978), the species remained abundant throughout its range until the mid-1700s. Following the arrival in Alaska of Russian explorers in 1741, extensive commercial harvest of sea otters over the next 150 years resulted in the near extirpation of the species. When sea otters were afforded protection by the International Fur Seal Treaty in 1911, probably fewer than 2,000 animals remained in thirteen remnant colonies (Kenyon 1969). Population recovery began following legal protection. As part of efforts to re-establish sea otters in portions of their historical range, otters from Amchitka Island and Prince William Sound were translocated to other areas in the

1960s and 1970s, including to southeast Alaska (Jameson *et al.* 1982). Sea otters have since recolonized much of their historical range in Alaska.

The most recent abundance estimates for survey areas within the Southcentral Alaska stock are presented in Table 1. Estimates for Kenai Fjords and Kachemak Bay have been updated since the previous stock assessment report. In 2008, an aerial survey using the methods described in Bodkin and Udevitz (1999) was conducted within Kachemak Bay, resulting in an estimate of 3,596 sea otters (CV = 0.50; USFWS unpublished data). This method included a survey-specific correction factor to account for undetected animals. A 2010 aerial survey using the Bodkin-Udevitz method in Kenai Fjords National Park resulted in an estimate of 1,322 sea otters (CV = 0.37; Coletti *et al*. 2011). Eastern lower Cook Inlet was surveyed as part of a larger area in 2002, yielding an estimate of 962 sea otters (CV = 0.54; Bodkin *et al*. 2003b) for the areas not covered in 2008 and 2010.

In 2003, an aerial survey of Prince William Sound resulted in an abundance estimate of 11,989 sea otters (CV = 0.18; Bodkin *et al.* 2003a). Finally, an aerial survey of the northern Gulf of Alaska coastline flown in 2000 provided a minimum uncorrected count of 198 sea otters between Cape Hinchinbrook and Cape Yakataga (USGS unpublished data). Applying a correction factor of 2.16 (CV = 0.38) for this observer conducting sea otter aerial surveys produces an adjusted estimate of 428 (CV = 0.38).

The most recent population estimates for survey areas within the Southcentral Alaska stock are presented in Table 1. Combining the adjusted estimates for these areas results in a total estimate of 18,297 sea otters for the Southcentral Alaska stock.

Table 1. Population estimates for the Southcentral Alaska stock of northern sea otters. The previous stock assessment report (SAR) total is from 2008.

Survey Area	Year	Unadjusted Estimate	Adjusted Estimate	CV	N_{MIN}	Reference
Cook Inlet, Kachemak Bay excluded	2002		962	0.54	629	Bodkin *et al.* (2003b)
Kachemak Bay	2008		3,596	0.50	2,416	USFWS unpublished data
Kenai Fjords	2010		1,322	0.37	978	Coletti *et al.* (2011)
Prince William Sound	2003		11,989	0.18	10,324	Bodkin *et al.* (2003a)
North Gulf of Alaska	2000	198	428	0.38	314	USGS unpublished data
Current Total			**18,297**		**14,661**	
Previous SAR Total			15,090		12,774	

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the Potential Biological Removal Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{1/2})$. The N_{MIN} for each survey area is presented in Table 1. The estimated N_{MIN} for the Southcentral Alaska stock is 14,661 sea otters.

Current Population Trend

All surveys analyzed for trends in abundance used methods described in Bodkin and Udevitz (1999), including use of a survey-specific correction factor to account for undetected animals, with the exception of the survey in the North Gulf of Alaska. Aerial surveys in Kachemak Bay in 2002, 2007, and 2008, indicated that the population is increasing, with an

estimated annual rate of increase between 2002 and 2008 of 26% per year (USGS unpublished data, USFWS unpublished data). This rate slightly exceeds the estimated maximum productivity rates (R_{MAX}) for the species (see below). Immigration from other areas (Cook Inlet, Kenai Fjords) may have contributed to the observed increase in sea otter numbers in Kachemak Bay.

Aerial surveys in Kenai Fjords National Park in 2002, 2007, and 2010, had relatively high standard errors, but indicated overall that the population is stable and may be increasing (Coletti *et al.* 2011). Annual aerial surveys of sea otter abundance in western Prince William Sound from 1993 to 2009 (except for 2001 and 2006) identified a significant increase in abundance between 2001 and 2009 at this scale, with an average annual rate of increase from 1993 to 2009 of 2.6% (Bodkin *et al.* 2011). This trend is interpreted as strong evidence of a trajectory toward recovery of sea otter populations in Prince William Sound affected by the 1989 *Exxon Valdez* oil spill (Bodkin *et al.* 2011). Our best assessment is that the overall trend in abundance for this stock appears to be increasing at this time.

MAXIMUM NET PRODUCTIVITY RATE

Estes (1990) estimated a population growth rate of 17 to 20% per year for four northern sea otter populations expanding into unoccupied habitat. Although maximum productivity rates (R_{MAX}) have not been measured throughout much of the sea otter's range in Alaska, in the absence of more detailed information, the rate of 20% calculated by Estes (1990) is considered the best available estimate of R_{MAX}. There is insufficient information available to estimate the current net productivity rate for this population stock.

POTENTIAL BIOLOGICAL REMOVAL

Under the Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as *the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population.* Potential biological removal is the product of the minimum population estimate (N_{MIN}), one-half the maximum theoretical net productivity rate, and a recovery factor (F_R): PBR = N_{MIN} x 0.5 R_{MAX} x F_R. The recovery factor for this stock is 1.0 (Wade and Angliss 1997) as population levels have remained stable with a known human take. Thus, for the Southcentral stock of sea otters, PBR = 1,466 animals (14,661 x 0.5 (0.2) x 1.0).

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

A complete list of fisheries and marine mammal interactions is published annually by the National Oceanic and Atmospheric Administration (NOAA) Fisheries, the most recent of which was published on August 29, 2013 (78 FR 53336). Numerous fisheries exist within the range of the Southcentral Alaska stock of northern sea otters. Two have been identified as interacting with this stock, the Prince William Sound drift gillnet fishery with an estimated 537 vessels and/or persons participating, and the Cook Inlet salmon set gillnet fishery, with an estimated 738 participants. Additional salmon drift gillnet fisheries occur in Cook Inlet, with 589 vessels; however, with the exception of Kachemak Bay, all of the fishing effort involving salmon drift and set gillnet fisheries in Cook Inlet occurs north of the range of sea otters from the Southcentral

Alaska stock (Manly 2006). Additional salmon set gillnet fisheries occur in Prince William Sound (30 participants).

While much of the salmon set gillnet effort in Cook Inlet occurs north of the range of sea otters, interactions between sea otters and fisheries are reported from the Kachemak Bay region. In July 2009, five sea otters with slashed throats were found dead on a Seldovia beach. They were believed to have been killed after being captured in a set gillnet. In July 2011, a female and pup were successfully released from a set gillnet in the Homer area. Interactions with set gillnet gear also have been observed in the Kodiak and Prince William Sound areas within the ranges of the Southwest and Southcentral Alaska stocks. Available information suggests that fisheries using other types of gear, including trawl, longline, and purse seine, appear to be less likely to have interactions with northern sea otters due to either the areas where such fisheries operate, or the specific gear used, or both.

Although commercial fisheries in Alaska have observer programs that monitor and report injury and mortality of marine mammals incidental to their operations, a reliable estimate of the levels of commercial fisheries incidental mortality and serious injury relative to the Southcentral sea otter stock cannot be made because observer coverage is not sufficient and data are not collected consistently over time. No incidents of sea otter incidental take have been observed in trawl, longline, or pot groundfish fisheries in southcentral Alaska from 1989 to 2010 (NOAA unpublished data). Sea otters are known to interact with pot fisheries in California, however, and it is possible that observer effort for pot fisheries in Alaska has been too low to detect sea otter bycatch (Hatfield *et al.* 2011). In addition to the fisheries listed above, observers monitored the Cook Inlet set gillnet and drift gillnet fisheries from 1999 to 2000 (Manly 2006). The observer

coverage during both years was approximately 2 to 5%. No mortalities or injuries of sea otters were reported by fisheries observers for the Cook Inlet set gillnet and drift gillnet fisheries for this period. On several occasions, sea otters were observed within 10 meters (approximately 33 ft) of gillnet gear, but did not become entangled. No other fisheries operating in the region of the Southcentral Alaska stock were monitored by observer programs from 1992 through 2010. Prior to the implementation of the NOAA Fisheries observer program, studies were conducted on sea otter interactions with the drift net fisheries in western Prince William Sound from 1988 to 1990, and no mortalities were observed (Wynne 1990, Wynne *et al.* 1991).

An additional source of information on the number of sea otters killed or injured incidental to commercial fishery operations in Alaska is found in fisher self-reports required of vessel owners by NOAA Fisheries. In 1990, fisher self-report records show one mortality and four injuries due to gear interaction, and three injuries due to deterrence in the Prince William Sound drift gillnet fishery. Self-reports were not available for 1994 and 1995. Credle *et al.* (1994) considered fisher self-reports to be a minimum estimate of incidental take as these data are most likely negatively biased.

In summary, between 2006 and 2010, there were five records of incidental take of sea otters by commercial fisheries within the range of the Southcentral stock, and, therefore, the estimated mean annual mortality and serious injury reported for the 5-year period from 2006 to 2010 is one. Observer coverage for fisheries within the range of the Southcentral stock of sea otters has been absent in some fisheries and low in others, particularly with respect to the set and drift gillnet fisheries that are recognized as interacting with this stock, and current estimates of sea otter bycatch are not available. Self-reporting is not sufficiently reliable to replace observer

effort. Additionally, assessment of injury and mortality in sea otters that interact with fisheries is difficult. Information is, therefore, insufficient to determine whether or not the total fishery mortality and serious injury for the Southcentral Alaska stock of the northern sea otter is insignificant and is approaching a zero mortality and serious injury rate.

Oil Spills

Activities associated with exploration, development, and transport of oil and gas resources can adversely impact sea otters and nearshore coastal ecosystems in Alaska. Sea otters rely on air trapped in their fur for warmth and buoyancy. Contamination with oil drastically reduces the insulative value of the pelage, and consequently, sea otters are among the marine mammals most likely to be detrimentally affected by contact with oil. It is believed that sea otters can survive low levels of oil contamination (<10% of body surface), but that greater levels (>25%) will lead to death (Costa and Kooyman 1981, Siniff *et al.* 1982). Vulnerability of sea otters to oiling was demonstrated by the 1989 *Exxon Valdez* oil spill in Prince William Sound. Total estimates of mortality for the Prince William Sound area vary from 750 (range 600 to 1,000; Garshelis 1997) to 2,650 otters (range 500 to 5,000; Garrot *et al.* 1993). Statewide, it is estimated that 3,905 sea otters (range 1,904 to 11,257) died in Alaska as a result of the spill (DeGange *et al.*1994). At present, although abundance of sea otters in some oiled areas of Prince William Sound remains below pre-spill estimates, evidence from ongoing studies suggests that sea otters numbers are increasing, a trend interpreted as evidence of a trajectory toward recovery of spill-affected sea otter populations in western Prince William Sound (Bodkin *et al.* 2002, Stephensen *et al.* 2001, Bodkin *et al.* 2011, Monson *et al.* 2011).

Within the range of the Southcentral Alaska sea otter stock, oil and gas development and production occurs only in Cook Inlet. As of 2011, 16 offshore oil platforms operated in Cook Inlet, and two more are slated to begin operations in 2012. A Federal lease sale in Cook Inlet may be held in 2012 to 2017, if industry interest is sufficient. Tankering of North Slope crude oil occurs regularly through the waters of Prince William Sound with no major oil spills since the *Exxon Valdez*. While the catastrophic release of oil has the potential to take large numbers of sea otters, there is no evidence that other effects (such as disturbance) associated with routine oil and gas development and transport have had a direct impact on the Southcentral Alaska sea otter stock.

Information on oil spills compiled by the Alaska Department of Environmental Conservation from 2006 to 2010 indicates that an average of four spills of crude oil occurred each year in the marine environment within the range of the Southcentral Alaska stock of sea otters. Crude oil spills ranged in size from less than 4 liters to 760 liters (approximately 1 gallon to 200 gallons), with a mean size of about 41.8 liters (approximately 11 gallons). In addition to spills directly associated with the development, production, and transport of crude oil, each year numerous spills of non-crude oil products in the marine environment occur from ships and shore facilities throughout Southcentral Alaska. During the same time period and area, there was an average of about 62 spills of non-crude oil per year, ranging in size from less than 4 to 24,320 liters (approximately 1 to 6,400 gallons). The majority of the non-crude oil spills were small, with a mean size of about 380 liters (100 gallons) and a median size of 4 liters (approximately one gallon). There is no indication that these small-scale spills have an impact on the Southcentral Alaska stock of northern sea otters.

Subsistence/Native Harvest Information

The MMPA exempts Alaska Natives from the prohibition on take of marine mammals, provided such taking is not wasteful and is done for subsistence use or for creating and selling authentic handicrafts or clothing. According to the U.S. Fish and Wildlife Service's (Service) Law Enforcement records from 2006 to 2010, individuals were prosecuted for unlawful possession, transport, or sale of 14 sea otter hides or skulls taken within the range of the Southcentral Alaska stock. Data for subsistence harvest of sea otters in southcentral Alaska are collected by a mandatory Marking, Tagging and Reporting Program administered by the Service since 1988. Figure 2 provides a summary of subsistence harvest information for the Southcentral stock from 1989 to 2010. The mean reported annual subsistence take during the past five complete calendar years (2006 to 2010) was 293 animals. Reported age composition during this period was 93% adults, 6% subadults, and 1% pups. Sex composition during the past five years was 72% males, 23% females, and 5% of unknown sex. The majority of the harvest over the past five years has occurred in northern and eastern Prince William Sound.

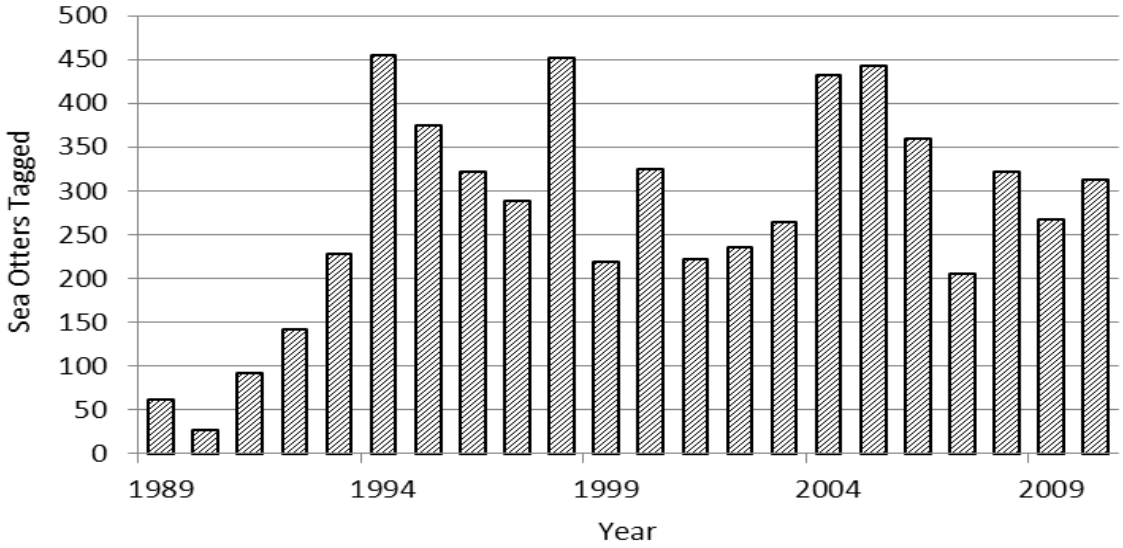

Figure 2. Reported subsistence harvest of northern sea otters from the Southcentral Alaska stock, 1989 to 2010.

Research and Public Display

During 2006 to 2010, four orphaned sea otter pups from the Southcentral Alaska stock were captured, rehabilitated, and placed for public display. During the same time period, 142 sea otters were captured and released for scientific research in Prince William Sound. There were no reported injuries and/or mortalities related to these activities.

Other Factors

In August 2006, the Working Group on Marine Mammal Unusual Mortality Events reviewed information provided by the Service and declared that a dramatic increase in sea otter strandings since 2002 constituted an Unusual Mortality Event (UME) in accordance with Section 404 of the MMPA. The disease complex that typifies this UME is caused by a *Streptococcus infantarius* infection and has been observed over a broad geographic range in Alaska, with the majority of cases identified from Kachemak Bay in the Southcentral Alaska stock. The dramatic

increase of sea otter strandings in Kachemak Bay is now thought to be due to a rapidly increasing otter population in the bay combined with more community effort to report strandings. Testing and analysis are still being conducted to pinpoint the cause of this leading source of mortality. However, it is thought that the *Streptococcus infantarius* infection may be the result of immunosuppression due to an emerging virus in the Alaska population. At this time it is unclear what impact this has had, or will have, on the population.

Since 2002, the Service has undertaken a health and disease study of northern sea otters from all three Alaskan stocks. On average, the Service conducts about 100 necropsies a year on sea otter carcasses to determine cause of death, disease incidence, and status of general health parameters. Boat strike is a recurring cause of death across all three stocks. However, it has been determined in most of these cases that although trauma was the ultimate cause of death, there was a contributing factor, such as disease or biotoxin exposure, which incapacitated the animal and made it more vulnerable to boat strike.

STATUS OF STOCK

The known level of direct human-caused mortality within the Southcentral Alaska stock does not exceed the PBR level, and the Southcentral Alaska stock is neither listed as "depleted" under the MMPA nor listed as "threatened" or "endangered" under the U. S. Endangered Species Act of 1973, as amended. The known level of direct human-caused mortality is 293 otters per year. It would require an annual rate of fisheries-associated mortality and serious injury of over 1,170 otters per year for the total amount of direct human-caused mortality to exceed PBR for this stock. Despite uncertainties regarding fisheries mortality and serious injury, we believe that

it is unlikely this level of take is occurring at present. Therefore, the Southcentral Alaska stock of the northern sea otter is classified as non-strategic. In addition, although the Service does not currently know the OSP for this stock, based on the known population level and our estimate of growth and considering the known level of human-caused mortality, we have determined that this stock is increasing and that human-caused mortality and serious injury is not likely to cause the stock to be reduced or to decrease its growth rate. Therefore, we would not expect the current level of human-caused mortality and serious injury to cause this stock to be reduced below its plausible OSP.

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Revised: April 2014

NORTHERN SEA OTTER (*Enhydra lutris kenyoni*):

Southwest Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters occur in nearshore coastal waters of the U.S. along the North Pacific Rim from the Aleutian Islands to California. The species is most commonly observed within the 40-meter (approximately 12.2 feet) depth contour because the animals require frequent access to benthic foraging habitat in subtidal and intertidal zones (Reidman and Estes 1990). Sea otters are not migratory and generally do not disperse over long distances, although movements of tens of kilometers (tens of miles) are common (Garshelis and Garshelis 1984). Annual home range sizes of adult sea otters are relatively small, with male territories ranging from 4 to 11 square kilometers (km^2) (approximately 10.5 to 28.5 square miles [mi^2]) and adult female home ranges from a few to 24 km^2 (approximately 62 mi^2) (Garshelis and Garshelis 1984; Ralls *et al*. 1988; Jameson 1989). Due to their benthic foraging, sea otter distribution is largely limited by their ability to dive to the sea floor (Bodkin *et al.* 2004).

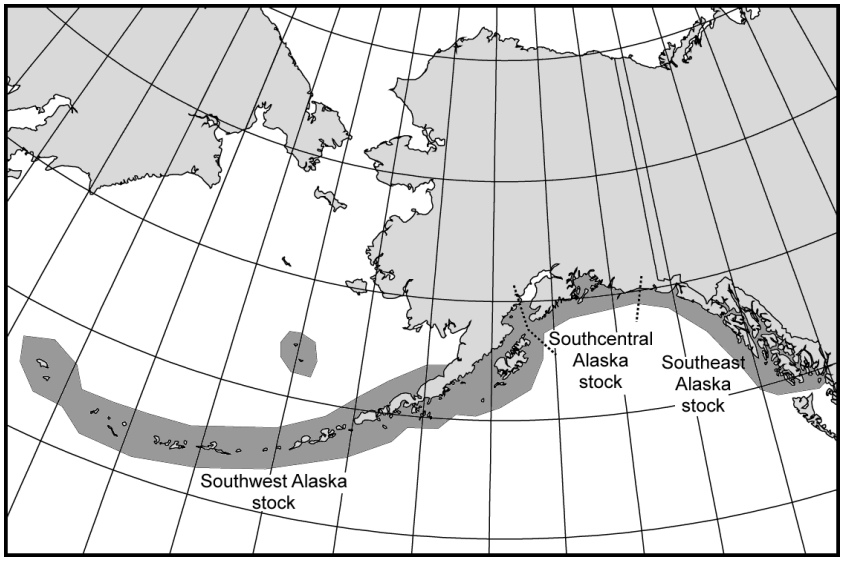

Figure 1. Approximate distribution and stock boundaries of northern sea otters in Alaska waters (shaded area).

The spatial scale at which sea otter populations are managed remains an important, although largely unexplored issue (Bodkin and Ballachey 2010) deserving further study. Bodkin and Ballachey (2010) used models of sea otter mortality to show that range-wide reductions and extirpations during the commercial fur trade of the 18th and 19th centuries occurred not simply because of excessive harvest, but because the harvest was not allocated proportional to the abundance and distribution of sea otters. This process of serial depletion was facilitated by the relatively sedentary nature of sea otters. To reduce the risk of overexploitation, sea otters must be managed on a spatial scale compatible with their well-known behavioral and reproductive biology (Bodkin and Monson 2002), incorporating traits such as home range and movements. These proposed scales for management are much smaller than the currently recognized stocks.

Gorbics and Bodkin (2001) applied the phylogeographic approach of Dizon *et al.* (1992) and used the best available data at the time to identify three sea otter stocks in Alaska: Southeast, Southcentral, and Southwest. The ranges of these stocks are defined as follows: (1) Southeast

Alaska stock extends from Dixon Entrance to Cape Yakataga; (2) Southcentral Alaska stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai Peninsula coast, and Kachemak Bay; and (3) Southwest Alaska stock includes the Alaska Peninsula and Bristol Bay coasts, and the Aleutian, Barren, Kodiak, and Pribilof Islands (Figure 1). This stock assessment report is focused on the Southwest stock of sea otters in Alaska.

POPULATION SIZE

Historically, sea otters occurred across the North Pacific Rim, ranging from Hokkaido, Japan, through the Kuril Islands, the Kamchatka Peninsula, the Commander Islands, the Aleutian Islands, peninsular and south coastal Alaska, and south to Baja California, Mexico (Kenyon 1969). In the early 1700s, the worldwide population was estimated to be between 150,000 (Kenyon 1969) and 300,000 individuals (Johnson 1982). Prior to large-scale commercial exploitation, indigenous peoples of the North Pacific hunted sea otters. Although it appears that harvests may have periodically led to local reductions of sea otters (Simenstad *et al.* 1978), the species remained abundant throughout its range until the mid-1700s. Following the arrival in Alaska of Russian explorers in 1741, extensive commercial harvest of sea otters over the next 150 years resulted in the near extirpation of the species. When sea otters were afforded protection by the International Fur Seal Treaty in 1911, probably fewer than 2,000 animals remained in thirteen remnant colonies (Kenyon 1969). Population recovery began following legal protection. As part of efforts to re-establish sea otters in portions of their historical range, otters from Amchitka Island and Prince William Sound were translocated to other areas in the

1960s and 1970s, including to southeast Alaska (Jameson *et al.* 1982). Sea otters have since recolonized much of their historical range in Alaska.

The most recent abundance estimates for survey areas within the Southwest Alaska stock are presented in Table 1. The estimate for the Katmai area has been added since the previous stock assessment report. Aerial surveys along the shorelines of the Aleutian Islands in April 2000 resulted in a count of 2,442 sea otters in the nearshore waters (Doroff *et al.* 2003). Comparison of aerial and skiff survey counts at six islands in 2000 was used to calculate a correction factor of 3.58 for this aerial survey, which resulted in an adjusted population estimate of 8,742 sea otters (CV= 0.22; Doroff *et al.* 2003).

In May 2000, a survey of offshore areas along the north Alaska Peninsula from Unimak Island to Cape Seniavin produced an abundance estimate of 4,728 sea otters (CV= 0.33; Burn and Doroff 2005). A similar survey of offshore areas along the south Alaska Peninsula from False Pass to Pavlov Bay conducted in summer 2001 resulted in a population estimate of 1,005 sea otters (CV= 0.81; Burn and Doroff 2005). Although a correction factor to account for sightability was not calculated during this survey, Evans *et al.* (1997) used a similar twin-engine aircraft flying at the same altitude and air speed to calculate a correction factor of 2.38 (CV = 0.09). Using this correction factor produced adjusted estimates of 11,253 (CV = 0.34) and 2,392 (CV = 0.82) for the north and south Alaska Peninsula offshore areas, respectively.

Table 1. Population estimates for the Southwest Alaska stock of northern sea otters. The previous stock assessment report (SAR) total is from 2008.

Survey Area	Year	Unadjusted Estimate	Adjusted Estimate	CV	N_{min}	Reference
Aleutian Islands	2000	2,442	8,742	0.22	7,309	Doroff *et al*. (2003)
North Alaska Peninsula	2000	4,728	11,253	0.34	8,535	Burn and Doroff (2005)
South Alaska Peninsula - Offshore	2001	1,005	2,392	0.82	1,311	Burn and Doroff (2005)
South Alaska Peninsula - Shoreline	2001	2,651	6,309	0.09	5,865	Burn and Doroff (2005)
South Alaska Peninsula - Islands	2001	402	957	0.09	889	Burn and Doroff (2005)
Unimak Island	2001	42	100	0.09	93	USFWS unpublished data
Kodiak Archipelago	2004		11,005	0.19	9,361	USFWS unpublished data
Katmai	2008		7,095	0.13	6,362	Coletti *et al*. (2009)
Kamishak Bay	2002		6,918	0.32	5,340	Bodkin *et al*. (2003)
Current Total			**54,771**		**45,064**	
Previous SAR Total			47,676		38,703	

In 2001, aerial surveys along the shoreline of the south Alaska Peninsula from Seal Cape to Cape Douglas recorded 2,651 sea otters (Burn and Doroff 2005). Additional aerial surveys of the south Alaska Peninsula island groups (Sanak, Caton, and Deer Islands, and the Shumagin and Pavlov Island groups) and a survey of Unimak Island, recorded 402 otters for the south Alaska Peninsula island groups and 42 animals for Unimak Island. Applying the same correction factor

of 2.38 from Evans *et al.* (1997) produced adjusted estimates of 6,309 (CV = 0.09), 957 (CV = 0.09) and 100 (CV = 0.09) for the south Alaska Peninsula shoreline, south Alaska Peninsula islands, and Unimak Island, respectively.

An aerial survey of the Kodiak Archipelago conducted in 2004 resulted in an estimate of 11,005 sea otters (CV = 0.19; USFWS unpublished data). The methods used in this survey follow those of Bodkin and Udevitz (1999), which include the calculation of a survey-specific correction factor for animals undetected by observers. An aerial survey of Katmai National Park in 2009, also using the Bodkin-Udevitz method, resulted in an estimate of 7,095 sea otters (CV = 0.13; Coletti *et al.* 2009). Finally, an aerial survey of Kamishak Bay and western Cook Inlet conducted in June 2002 resulted in an estimate of 6,918 sea otters (CV = 0.32; Bodkin *et al.* 2003). This survey also used the methods of Bodkin and Udevitz (1999).

Combining the adjusted estimates for these areas, as summarized in Table 1, results in a total estimate of 54,771 sea otters for the Southwest Alaska stock. This estimated population size for the Southwest Alaska stock is slightly higher than in the 2008 stock assessment report due to the addition of an estimate for Katmai, which was surveyed in 2009 for the first time.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the Potential Biological Removal Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{1/2})$. The N_{MIN} for each survey area is presented in Table 1. The estimated N_{MIN} for the entire Southwest Alaska stock is 45,064 sea otters.

Current Population Trend

In spring 2000, the U.S. Fish and Wildlife Service (Service) repeated an aerial survey that had previously been conducted in 1992 and observed widespread declines throughout the Aleutian Islands, with the greatest decreases occurring in the central Aleutians. The uncorrected count for the area was 2,442 animals, indicating that sea otter populations had declined 70% since 1992 (Doroff *et al.* 2003). Burn *et al.* (2003) estimated that the sea otter population in the Aleutians in 2000 may have been reduced to less than 10% of the carrying capacity for the area. With the exception of the Kodiak Archipelago, which was surveyed in 2004, there have been no new large-scale abundance surveys for sea otters in southwest Alaska since the stock assessment report of August 2002.

On-going efforts to monitor trends in abundance include repeated skiff surveys at selected islands (index sites) in the Aleutian Islands. A Bayesian state-space trend analysis (Clark and Bjornstad 2004) developed using all available data compiled from skiff surveys around five islands in the western Aleutian Islands from 1993 to 2003 indicated that the population trends during this time period were strongly negative, with an average rate of decline of approximately 20% per year (USFWS 2013b, USGS unpublished data). Population trends changed during the period 2003 to 2011, with an average growth rate of approximately 0. Some variation in trends was evident but the trends were consistent among islands. These results suggest that population trends have stabilized in the western Aleutian Islands over the last 5 to 8 years, although there is still no evidence of recovery (USFWS 2013a, USFWS 2013b, USGS unpublished data).

Unlike in the Aleutian Islands and along the western Alaska Peninsula, sea otters in other areas within the range of the Southwest stock do not appear to have undergone a population

decline over the past 20 years. Sea otter numbers in the Kodiak Archipelago, the Alaska Peninsula coast from Castle Cape to Cape Douglas, and Kamishak Bay in lower western Cook Inlet are stable and may be increasing (Coletti *et al.* 2009, Estes *et al*. 2010, USFWS 2013a, USGS unpublished data).

The estimated population size for the Southwest Alaska stock is slightly higher than in the previous stock assessment report due to the addition of Katmai, which was surveyed in 2009 for the first time. However, the overall sea otter population size in southwest Alaska has declined by more than 50% since the mid-1980s, and there is no evidence of recovery. Although current numbers are well below historical levels, the overall population trend for the Southwest Alaska stock is believed to have stabilized.

MAXIMUM NET PRODUCTIVITY RATE

Estes (1990) estimated a population growth rate of 17 to 20% per year for four northern sea otter populations expanding into unoccupied habitat. Although maximum productivity rates (R_{MAX}) have not been measured throughout much of the sea otter's range in Alaska, in the absence of more detailed information, the rate of 20% calculated by Estes (1990) is considered the best available estimate of R_{MAX}. There is insufficient information available to estimate the current net productivity rate for this population stock.

POTENTIAL BIOLOGICAL REMOVAL

Under the Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as *the maximum number of animals, not including natural mortalities, that may*

be removed from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population. The potential biological removal is the product of the minimum population estimate (N_{MIN}), one-half the maximum theoretical net productivity rate, and a recovery factor (F_R): PBR = N_{MIN} x 0.5 R_{MAX} x F_R. In August 2005, sea otters in southwest Alaska were listed as a threatened distinct population segment (DPS) under the Endangered Species Act of 1973, as amended (70 FR 46366; August 9, 2005) (ESA). Although Wade and Angliss (1997) provide a default recovery factor of 0.5 as a guideline for threatened species, a lower value may be considered appropriate in the case of a declining population. Therefore, for the Southwest Alaska stock, which has experienced a decline, we are taking a more conservative approach and have set the recovery factor at the default value for an endangered species (0.1). The calculated PBR for this stock is 450 sea otters per year (45,064 x 0.5 (0.2) x 0.1).

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

A complete list of fisheries and marine mammal interactions is published annually by the National Oceanic and Atmospheric Administration (NOAA) Fisheries, the most recent of which was published on August 29, 2013 (78 FR 53336). Numerous fisheries exist within the range of the Southwest Alaska stock of northern sea otters, with the only one identified as interacting with this stock being the Kodiak salmon set gillnet fishery, with an estimated 188 vessels and/or persons participating. Additional salmon set gillnet fisheries occur in Bristol Bay (982 participants) and the Alaska Peninsula/Aleutian Islands (114 participants). Although no interactions with salmon drift gillnets have been identified for this stock, interactions have been

observed in Prince William Sound with the Southcentral Alaska stock. Salmon drift gillnet fisheries occur in Bristol Bay (1,863 vessels) and the Alaska Peninsula/Aleutian Islands (162 vessels). Although both salmon set and drift gillnet fisheries occur in Cook Inlet, most of the fishing effort for these gillnet fisheries occurs north of the range of sea otters from the Southwest Alaska stock. Available information suggests that fisheries using other types of gear, including trawl, longline, and purse seine, appear to be less likely to have interactions with northern sea otters due to either the areas where such fisheries operate, or the specific gear used, or both.

Although commercial fisheries in Alaska have observer programs that monitor and report injury and mortality of marine mammals incidental to their operations, a reliable estimate of the levels of commercial fisheries incidental mortality and serious injury relative to the Southwest sea otter stock cannot be made because observer coverage is not sufficient and data are not collected consistently over time. Observer data were summarized from 1989 to 2010 (Perez 2003, Perez 2006, Perez 2007, NOAA unpublished data) for Bering Sea, Aleutian Islands, and Gulf of Alaska trawl, longline, and pot groundfish fisheries. During this period, no sea otters were taken in any trawl or longline fisheries. In 1992, a total of eight sea otters were observed caught in the Pacific cod pot fishery in the Aleutian Islands. Observer records indicate that those takes occurred in nearshore waters that had been closed to fishing. This explains why no additional take of sea otters was observed in legal pot fisheries, which took place in other areas, through 2010 (Perez 2006, Perez 2007, NOAA unpublished data). Sea otters are known to interact with pot fisheries in California, and it is possible that observer effort for pot fisheries in Alaska has been too low to detect sea otter bycatch (Hatfield *et al.* 2011).

The NOAA Fisheries conducted a marine mammal observer program for the Kodiak salmon set gillnet fishery during the 2002 and 2005 fishing seasons. This fishery has a seasonal component, occurring only during the summer months. In 2002, four entanglement events were observed in this fishery (Manly *et al.* 2003). Two of these events required intervention to untangle the otter from the net, and the other two were able to escape by themselves. In none of these instances was there any sign of external injuries. The sea otter by-catch in this fishery was estimated at 62 otters during the 2002 fishing season. Although no serious injuries or mortalities were observed in this small sample size of observed entanglements, it is reasonable to assume that some of these otters may have suffered injury as a result of entanglement in set gillnet fisheries. In fact, there was one self-report of an otter killed during the 2002 fishing season. Results from the 2005 Kodiak salmon set gillnet fishery indicate entanglement of one otter that subsequently released itself from the net, although it was not clear if this was a sea otter or river otter (Manly 2007). Assuming that this animal was a sea otter, the total by-catch in this fishery would be estimated at 28 animals during the 2005 season. Based on these results, it would appear that although entanglement of sea otters does occur in this fishery, the rate of mortalityor serious injury is low.

An additional source of information on the number of sea otters killed or injured incidental to commercial fishery operations in Alaska are fisher self-reports required of vessel owners by NOAA Fisheries. In 1997, fisher self-reports indicated one sea otter caught in the Bering Sea and Aleutian Island groundfish trawl fishery; however, it is unclear if the animal was alive when caught. Credle *et al.* (1994) considered fisher self-reports to be a minimum estimate of incidental take as these data are most likely negatively biased. Observer coverage for fisheries

within the range of the Southwest stock of sea otters has been absent in some fisheries and low in others, particularly with respect to the set and drift gillnet fisheries that are recognized as interacting with this stock, and current estimates of sea otter bycatch are not available. Self-reporting is not sufficiently reliable to replace observer effort. Additionally, assessment of injury and mortality in sea otters that interact with fisheries is difficult. Information is, therefore, insufficient to determine whether or not the total fishery mortality and serious injury for the Southwest Alaska stock of the northern sea otter is insignificant and is approaching a zero mortality and serious injury rate.

Oil Spills

Activities associated with exploration, development, and transport of oil and gas resources can adversely impact sea otters and nearshore coastal ecosystems in Alaska. Sea otters rely on air trapped in their fur for warmth and buoyancy. Contamination with oil drastically reduces the insulative value of the pelage, and consequently sea otters are among the marine mammals most likely to be detrimentally affected by contact with oil. It is believed that sea otters can survive low levels of oil contamination (<10% of body surface), but that greater levels (>25%) will lead to death (Costa and Kooyman 1981, Siniff *et al.* 1982). Vulnerability of sea otters to oiling was demonstrated by the 1989 *Exxon Valdez* oil spill in Prince William Sound. Estimates of mortality for the Prince William Sound area vary from 750 otters (range 600 to 1,000; Garshelis 1997) to 2,650 otters (range 500 to 5,000; Garrott *et al.* 1993). Statewide, 3,905 sea otters (range 1,904 to 11,257) were estimated to have died in Alaska as a result of the spill (DeGange *et al.* 1994). At present, although abundance of sea otters in some oiled areas of Prince William Sound remains below pre-spill estimates, evidence from ongoing studies suggests

that sea otters numbers in this area are increasing, a trend interpreted as strong evidence of a trajectory toward recovery of spill-affected sea otter populations in western Prince William Sound (Bodkin *et al.* 2002, Stephensen *et al.* 2001, Bodkin *et al.* 2011).

Within the range of the Southwest Alaska sea otter stock, oil and gas development and production occurs only in Cook Inlet. As of 2011, 16 offshore oil platforms operated in Cook Inlet, and two more are slated to begin operations in 2012. A Federal lease sale in lower Cook Inlet is planned for the fall of 2013. Although the amount of oil transported in southwest Alaska is relatively small, the *Exxon Valdez* oil spill demonstrated that spilled oil can travel long distances and take large numbers of sea otters far from the point of initial release. The grounding in 2004 of the freighter *Selendang Ayu* on Unalaska Island, within the range of this stock, released 1,219,800 liters (approximately 321,000 gallons) of non-crude oil and caused at least two sea otter mortalities (USFWS unpublished data). While the catastrophic release of oil has the potential to take large numbers of sea otters, there is no evidence that other effects (such as disturbance) associated with routine oil and gas development and transport have had a direct impact on the Southwest Alaska sea otter stock.

Information on oil spills compiled by the Alaska Department of Environmental Conservation from 2006 to 2010 indicates that there were no reported spills of crude oil in southwest Alaska during that time period. In addition to spills that may occur in association with the development, production, and transport of crude oil, each year numerous spills of non-crude oil products in the marine environment occur from ships and shore facilities throughout southwest Alaska. During that same time period, an average of 64 non-crude oil spills occurred each year, ranging in size from less than 4 to 551,000 liters (approximately1 to 145,000 gallons).

The majority of these spills were small, with a mean size of about 3,500 liters (approximately 921 gallons) and a median size of 15 liters (approximately 2 gallons). There is no indication that these small-scale spills have an impact on the Southwest Alaska stock of northern sea otters.

Subsistence/Native Harvest Information

The MMPA exempts Alaska Natives from the prohibition on take of marine mammals, provided such taking is not wasteful and is done for subsistence use or for creating and selling authentic handicrafts or clothing. In addition, section 10(e) of the ESA allows for take of listed species for primarily subsistence purposes under certain circumstances. According to the Service's Law Enforcement records, there were no prosecutions from 2006 to 2010 for unlawful take, possession, transport, or sale of sea otters or sea otter hides taken within the range of the Southwest Alaska stock. Data for subsistence harvest of sea otters in southwest Alaska are collected by a mandatory Marking, Tagging and Reporting Program administered by the Service since 1988. Figure 2 provides a summary of harvest information for the Southwest stock from 1989 through 2010. The mean reported annual subsistence take during the past five complete calendar years (2006-2010) was 76 animals. Reported age composition during this period was 84% adults, 12% subadults, 1% pups, and 3% unknown. Sex composition during the past five years was 77% males, 19% females, and 4% unknown. The majority of this harvest (83%) comes from the Kodiak Archipelago; areas within the stock that show signs of continued population declines have little to no record of subsistence harvest.

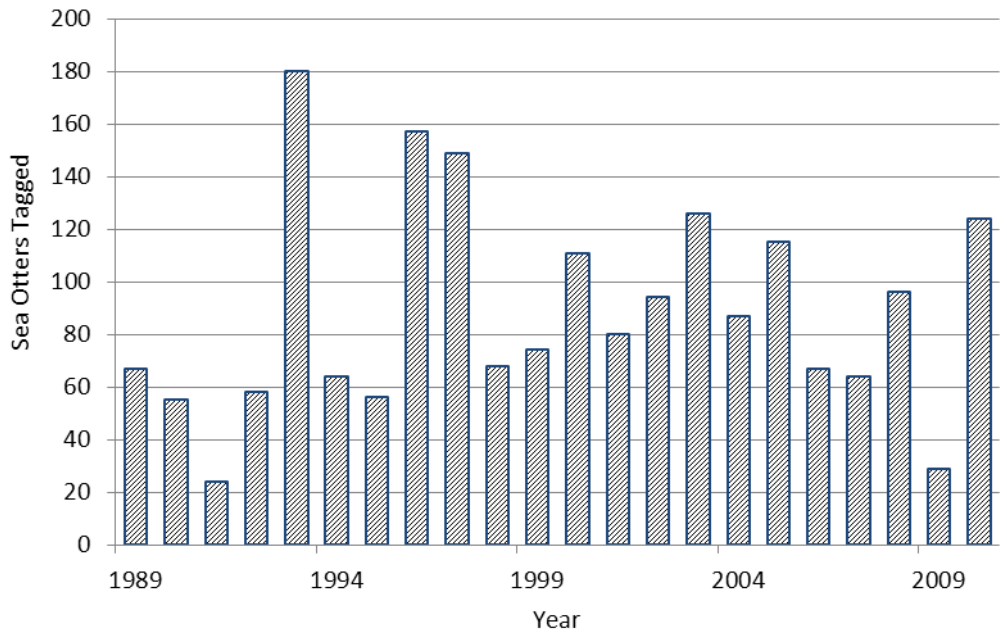

Figure 2. Reported subsistence harvest of northern sea otters from the Southwest Alaska stock, 1989-2010.

Research and Public Display

During 2006 to 2010, one orphaned sea otter pup from the Southwest Alaska stock was captured, rehabilitated, and placed for public display. During this period, a total of 65 otters were live-captured from this stock and released for research purposes. The captures occurred in the vicinities of Kukak Bay (Katmai National Park and Preserve coast), Unga Island (Shumagin Island group), and Dolgoi Island (Pavlov Island group). There were no reported injuries and/or mortalities related to these activities.

Other Factors

Each year, several thousand commercial vessels of varying sizes traverse the North Pacific Great Circle Route between North America and Asia, carrying a variety of cargoes. Vessels generally pass through the Aleutian Islands twice, through Unimak Pass to the east and

near Buldir Island to the west. A risk assessment for the area concluded that while a majority of the vessel traffic along the Great Circle Route passes through the region without making any port calls, accidents involving these vessels have the potential to significantly and adversely impact coastal and marine ecosystems, economies, and human activities in the region (Aleutian Islands Risk Assessment Project Management Team 2011). Previous vessel accidents in the Aleutian Islands have resulted in loss of cargo, oil spills, and loss of life. The remoteness, limited infrastructure, and severe weather of the region often limit the potential to mitigate or respond to incidents. Overall, both the total number of accidents and the total risk of a bunker oil spill in the region are predicted to increase (Aleutian Islands Risk Assessment Project Management Team 2011).

Since 2002 the Service has undertaken a health and disease study of northern sea otters from all three Alaskan stocks. On average, the Service conducts about 100 necropsies a year on sea otter carcasses to determine cause of death, disease incidence and status of general health parameters. Boat strike is a recurring cause of death across all three stocks. However, it has been determined in most of these cases that although trauma was the ultimate cause of death, there was a contributing factor, such as disease or biotoxin exposure, which incapacitated the animal and made it more vulnerable to boat strike.

In August 2006, the Working Group on Marine Mammal Unusual Mortality Events reviewed information provided by the Service, and declared that a dramatic increase in sea otter strandings since 2002 constituted an Unusual Mortality Event (UME) in accordance with section 404 of the MMPA. The disease that typifies this UME is caused by a *Streptococcus infantarius* infection and has been observed over a broad geographic range in Alaska, including a few cases

from southwest Alaska; however, the majority of cases have come from Kachemak Bay in the Southcentral Alaska stock. It is not clear if the observed stranding pattern is representative of overall sea otter mortality, or an artifact of having a well-developed stranding network in the Kachemak Bay area. The Service will continue to work with NOAA Fisheries and the Alaska Sea Life Center to develop the infrastructure for a State-wide marine mammal stranding network in Alaska.

STATUS OF STOCK

On August 9, 2005, the Southwest Alaska DPS of the northern sea otter was listed as "threatened" under the ESA, and it is, therefore, classified as a strategic stock under the MMPA.

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