Alaska Marine Mammal Stock Assessments, ~~2015~~2016

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

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

PREFACE

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

Each stock assessment includes, when available, a description of the stock's geographic range;~~,~~ a minimum population estimate;~~,~~ current population trends;~~,~~ current and maximum net productivity rates;~~,~~ optimum sustainable population levels and allowable removal levels;~~, and~~ estimates of annual human-caused mortality and serious injury through interactions with commercial, recreational, and subsistence fisheries, ~~and~~ takes by subsistence hunters, and other human-caused events (e.g., entanglement in marine debris, ship strikes); and habitat concerns. The~~se~~ 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), and 2015 (Muto et al. 2016). 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 (Steller sea lions, northern fur seals, bearded seals, ringed 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 ~~2014-2015~~2015-2016. This review, and a review of other stocks, led to the revision of the following stock assessments for the ~~2015~~2016 document: Western U.S. and Eastern U.S. stocks of Steller sea lions; northern fur seals; ~~Aleutian Islands, Pribilof Islands, Bristol Bay, North Kodiak, South Kodiak, Prince William Sound, Cook Inlet/Shelikof Strait, Glacier Bay/Icy Strait, Lynn Canal/Stephens Passage, Sitka/Chatham Strait, Dixon/Cape Decision, and Clarence Strait stocks of harbor seals;~~ bearded seals; ringed seals; ~~ribbon seals;~~ Cook Inlet beluga whales; narwhals; Eastern North Pacific (ENP) Alaska Resident, ENP Gulf of Alaska, Aleutian Islands, and Bering Sea Transient, and AT1 Transient stocks of killer whales; ~~Pacific white-sided dolphins;~~ Southeast Alaska, Gulf of Alaska, and Bering Sea stocks of harbor porpoise; ~~Dall's porpoise;~~ sperm whales; Western North Pacific and Central North Pacific stocks of humpback whales; fin whales; ~~minke whales;~~ North Pacific right whales, and bowhead whales. The Stock Assessment Reports for all stocks, however, are included in ~~this~~the final Stock Assessment Report document to provide a complete reference. Those sections of each Stock Assessment Report containing significant changes are listed in Appendix Table 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 walrus. Copies of the stock assessments for these species are included in Appendix 8 of the final NMFS Stock Assessment Report for your convenience.

Ideas and comments from the Alaska Scientific Review Group (SRG) have significantly improved this document from its draft form. The authors wish to express their gratitude for the thorough reviews and helpful guidance provided by the Alaska Scientific Review Group members: Karl Haflinger, Lloyd Lowry (Chair from 2012 to present), Beth Mathews, Craig Matkin, Mike Miller, Grey Pendleton, Robert Small, Kate Stafford, Robert Suydam, David Tallmon, and Kate Wynne. We would also like to acknowledge the contributions from the Communications Program of the Alaska Fisheries Science Center.

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

CONTENTS*

SPECIES	STOCK	PAGE
Pinnipeds		
Steller Sea Lion	**Western U.S.**	**1**
Steller Sea Lion	**Eastern U.S.**	**17**
Northern Fur Seal	**Eastern Pacific**	**32**
Harbor Seal	Aleutian Islands, Pribilof Islands, Bristol Bay, N. Kodiak, S. Kodiak, Prince William Sound, Cook Inlet/Shelikof Strait, Glacier Bay/Icy Strait, Lynn Canal/Stephens Passage, Sitka/Chatham Strait, Dixon/Cape Decision, Clarence Strait	
Spotted Seal	Alaska	
Bearded Seal	**Alaska**	**43**
Ringed Seal	**Alaska**	**50**
Ribbon Seal	Alaska	
Cetaceans		
Beluga Whale	Beaufort Sea	
Beluga Whale	Eastern Chukchi Sea	
Beluga Whale	Eastern Bering Sea	
Beluga Whale	Bristol Bay	
Beluga Whale	**Cook Inlet**	**60**
Narwhal	**Unidentified**	**68**
Killer Whale	**Eastern North Pacific Alaska Resident**	**73**
Killer Whale	Eastern North Pacific Northern Resident	
Killer Whale	**Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient**	**83**
Killer Whale	**AT1 Transient**	**92**
Killer Whale	West Coast Transient	
Pacific White-Sided Dolphin	North Pacific	
Harbor Porpoise	**Southeast Alaska**	**98**
Harbor Porpoise	**Gulf of Alaska**	**105**
Harbor Porpoise	**Bering Sea**	**111**
Dall's Porpoise	Alaska	
Sperm Whale	**North Pacific**	**117**
Baird's Beaked Whale	Alaska	
Cuvier's Beaked Whale	Alaska	
Stejneger's Beaked Whale	Alaska	
Humpback Whale	**Western North Pacific**	**123**
Humpback Whale	**Central North Pacific**	**134**
Fin Whale	**Northeast Pacific**	**148**
Minke Whale	Alaska	
North Pacific Right Whale	**Eastern North Pacific**	**155**
Bowhead Whale	**Western Arctic**	**164**

Appendices

Appendix 1. Summary of changes for the ~~2015~~2016 stock assessments **176**
Appendix 2. Stock summary table **177**
Appendix 3. Summary table for Alaska category 2 commercial fisheries
Appendix 4. Interaction table for Alaska category 2 commercial fisheries
Appendix 5. Interaction table for Alaska category 3 commercial fisheries
Appendix 6. Observer coverage in Alaska commercial fisheries, 1990-2009
Appendix 7. Self-reported fisheries information
Appendix 8. Stock Assessment Reports published by the U.S. Fish and Wildlife Service

*Stock Assessment Reports and Appendices revised in ~~2015~~2016 are in boldface.

Revised ~~12/30/2015~~9/12/2016

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).

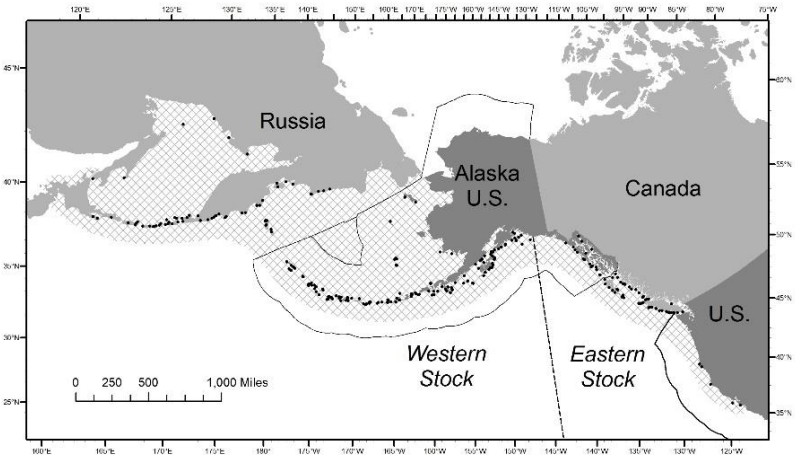

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005; S. Majewski, Fisheries 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) ~~and Phillips et al. (2009)~~ 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 ~~size (males) and shape (females) of skulls~~the length of pups (~~Phillips et al. 2009~~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 ~~d~~Distinct ~~p~~Population ~~s~~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 ~~w~~Western stock. Whereas Steller sea lions seasonally inhabit coastal waters of Japan in the winter, breeding rookeries 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 Alaskan 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/~~w~~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 ~~w~~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 ~~w~~Western and ~~e~~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. Recent 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 ~~in northern~~just north of Cross Sound in Southeast Alaska, and~~, by~~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 ~~w~~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 ~~w~~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 ~~w~~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~~s~~ 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 ~~w~~Western sea lions into this area, the mixed part of the range remains small (Jemison et al. 2013), and the overall discreteness of the ~~e~~Eastern from the ~~w~~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 ~~w~~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 2000, the abundance of the ~~w~~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). The most recent comprehensive aerial photographic and land-based surveys of ~~w~~Western Steller sea lions in Alaska were conducted ~~in 2013-2014~~during the 2014 and 2015 breeding seasons (~~DeMaster 2014,~~ Fritz et al. 2015a, 2015b). Western Steller sea lion pup and non-pup counts in Alaska in ~~2014~~2015 were estimated to be ~~12,189~~12,492 (~~90~~95% credible interval~~:~~ of ~~11,318-13,064~~11,480-13,612) and ~~37,308~~38,491 (~~34,373-40,314~~34,377-42,634), respectively, using agTrend (Johnson and Fritz 2014) and ~~2013-2014~~ survey results through 2015 (~~DeMaster 2014,~~ Fritz et al. 2015a, 2015b). 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). However, there are several factors which make using these methods problematic when applied to counts of ~~w~~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 counts of non-pup Steller sea lions in Russia were conducted in 2007-2011 and totaled ~12,700 (V. Burkanov, NMFS-AFSC-~~N~~NMML~~, 7600 Sand Point Way NE, Seattle, WA 98115,~~ pers. comm.). The most recent

estimate of pup production in Russia is available from counts conducted in 2011 and 2012, which totaled 6,021 pups. Analysis of data collected in 2013 and 2015 is ongoing and results will be included in a future Stock Assessment Report.

Minimum Population Estimate

Because of the uncertainty regarding the use of ~~the~~a pup multiplier or haulout rate to estimate N, we will use the best estimate of the total count of ~~w~~Western Steller sea lions in Alaska as the minimum population estimate (N_{MIN}). ~~The agTrend (Johnson and Fritz 2014) estimates (with 90% credible intervals) of w~~Western Steller sea lion pup and non-pup counts in ~~2014~~2015 in Alaska ~~are~~were estimated to be ~~12,189 (11,318-13,064)~~12,492 and ~~37,308 (34,373-40,314)~~38,491, respectively (Fritz et al. 2015b), which total ~~49,497~~50,983 and will be used as the minimum population estimate (N_{MIN}) for the U.S. portion of the ~~w~~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 ~~w~~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 ~~w~~Western Steller sea lions stopped in 2000-2002 (Sease and Gudmundson 2002).

Johnson and Fritz (2014) ~~developed agTrend to~~ 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 (see also Fritz et al. 2013). Using ~~agTrend with~~ data collected through ~~2014~~2015, there is strong evidence that non-pup and pup counts of ~~w~~Western stock Steller sea lions in Alaska increased at ~2% y^{-1} between 2000 and ~~2014~~2015 (Table 1; Fritz et al. 2015). However, there are strong regional differences across the range in Alaska, with positive trends east of Samalga Pass (~170°W) in the Gulf of Alaska and eastern Bering Sea and negative trends to the west in the Aleutian Islands (Table 1; Fig. 2).

~~Regional variation in trends in pup counts in 2000-2014 is similar to that of non-pups (Table 1). Overall, there is strong evidence that pup counts increased in the overall western stock in Alaska and that there is considerable regional variation west and east of Samalga Pass. West of Samalga Pass, pup counts are stable in the central Aleutian Islands but decreasing rapidly in the western Aleutian Islands. East of Samalga Pass, there is strong evidence that pup counts increased in each of the four regions.~~ Regional differences in pup trends cannot be explained by movement of pups during the breeding season. However, slower growth in pup counts in the central Gulf of Alaska than in the surrounding regions east of Samalga Pass could be due to movement of adult females out of the region (suggesting some level of permanent emigration)~~ or poor local conditions, both of which suggest~~, indicating that sea lions may have responded to meso-scale (on the order of 100s of kilometers) variability in their environment (see O'Corry-Crowe et al. 2014).

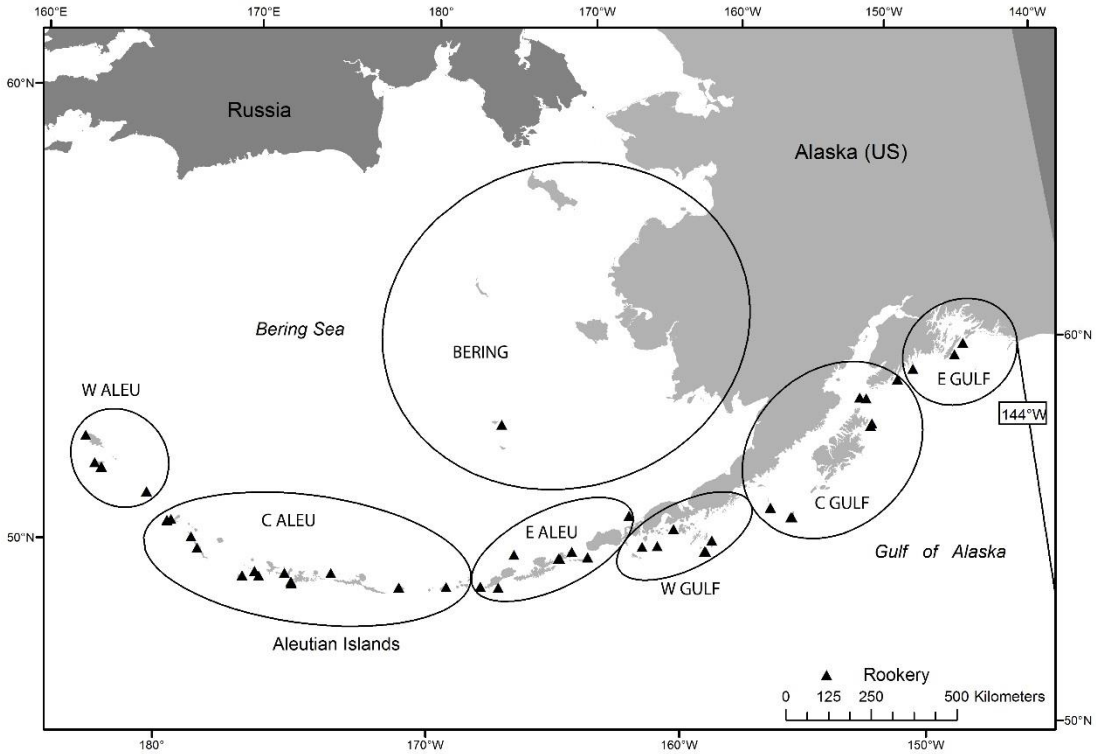

Figure 2. Regions of Alaska used for ~~w~~Western Steller sea lion population trend estimation. E GULF, C GULF, and W GULF are eastern, central, and western Gulf of Alaska regions, respectively. E ALEU, C ALEU, and W ALEU are eastern, central, and western Aleutian Islands regions, respectively.

Table 1. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in counts of ~~w~~Western Steller sea lion non-pups (adults and juveniles) and pups in Alaska, by region, for the period ~~2000-2014~~2000-2015 (Johnson and Fritz 2014~~,~~; Fritz et al. 2013, 2015a, 2015b).

		~~**Non-pups**~~				~~**Pups**~~		
~~**Region**~~	~~**Latitude Range**~~	~~**Trend**~~	~~**-95%**~~	~~**+95%**~~		~~**Trend**~~	~~**-95%**~~	~~**+95%**~~
~~Western Stock in Alaska~~	~~144°W-172°E~~	~~2.17~~	~~1.54~~	~~2.76~~		~~1.76~~	~~1.16~~	~~2.31~~
~~E of Samalga Pass~~	~~144°-170°W~~	~~3.41~~	~~2.59~~	~~4.15~~		~~3.18~~	~~2.44~~	~~3.91~~
~~Eastern Gulf of Alaska~~	~~144°-150°W~~	~~5.22~~	~~2.48~~	~~8.06~~		~~4.44~~	~~2.36~~	~~6.42~~
~~Central Gulf of Alaska~~	~~150°-158°W~~	~~2.61~~	~~1.46~~	~~3.76~~		~~2.14~~	~~0.45~~	~~3.61~~
~~E-C Gulf of Alaska~~	~~144°-158°W~~	~~3.67~~	~~2.36~~	~~5.08~~		~~2.83~~	~~1.58~~	~~4.07~~
~~Western Gulf of Alaska~~	~~158°-163°W~~	~~4.09~~	~~2.77~~	~~5.33~~		~~3.27~~	~~1.86~~	~~4.72~~
~~Eastern Aleutian Islands~~	~~163°-170° W~~	~~2.3~~	~~0.98~~	~~3.67~~		~~3.55~~	~~2.43~~	~~4.62~~
~~W of Samalga Pass~~	~~170°W-172°E~~	~~-1.22~~	~~-2.02~~	~~-0.4~~		~~-1.66~~	~~-2.46~~	~~-0.86~~
~~Central Aleutian Islands~~	~~170°W-177°E~~	~~-0.27~~	~~-1.17~~	~~0.61~~		~~-0.64~~	~~-1.56~~	~~0.23~~
~~Western Aleutian Islands~~	~~172°-177°E~~	~~-7.10~~	~~-8.66~~	~~-5.57~~		~~-8.92~~	~~-10.14~~	~~-7.53~~

		Non-pups				Pups		
Region	**Latitude Range**	**Trend**	**-95%**	**+95%**		**Trend**	**-95%**	**+95%**
Western Stock in Alaska	144°W-172°E	1.94	1.35	2.58		1.87	1.30	2.40
E of Samalga Pass	144°-170°W	3.28	2.55	4.10		3.30	2.61	3.98
Eastern Gulf of Alaska	144°-150°W	5.07	2.35	7.87		4.31	2.54	6.00
Central Gulf of Alaska	150°-158°W	2.68	1.53	3.73		2.82	1.39	4.24
Western Gulf of Alaska	158°-163°W	3.95	2.75	5.11		3.28	1.86	4.61
Eastern Aleutian Islands	163°-170°W	2.08	0.69	3.44		3.35	2.29	4.37
W of Samalga Pass	170°W-172°E	-1.82	-2.62	-0.97		-1.62	-2.45	-0.82
Central Aleutian Islands	170°W-177°E	-0.84	-1.69	0.05		-0.68	-1.58	0.23
Western Aleutian Islands	172°-177°E	-8.71	-10.65	-6.83		-8.88	-10.00	-7.73

The distribution of sightings of branded animals during the breeding season indicates an average annual net movement of adult and juvenile sea lions from the central to the eastern Gulf of Alaska~~, which~~ (Fritz et al. 2013). This could have depressed non-pup trend estimates in the ~~former~~central Gulf (2.68% y^{-1} between 2000 and 2015) and increased ~~trend estimates~~them in the ~~latter region (Fritz et al. 2013). Non-pup counts in the combined eastern-central~~ eastern Gulf (5.07% y^{-1}; ~~of Alaska region increased at 3.67% y^{-1} (2.36-5.08% y^{-1}) between 2000 and 2014~~ ~~(~~Table 1). Although less is known about inter-regional movement west of Samalga Pass, including Russia, sea lion dispersal during the breeding season may have had a smaller influence on non-pup trends here than in the eastern-central Gulf of Alaska given the much larger area over which regional non-pup (and pup) trends are declining (see discussion of Russia below).

~~Fritz et al. (2013) estimated t~~The net magnitude of ~~cross-boundary movement of~~ Steller sea lion~~s~~ movements during the breeding season between the Eastern and ~~w~~Western ~~and eastern~~ stocks ~~using transition probabilities of individually marked sea lions by sex, age, and region estimated by Jemison et al. (2013); survival rates by age, sex, and region estimated by Hastings et al. (2011) and Fritz et al. (2014); and pup production by region based on aerial surveys conducted in 2009. There was an estimated average net annual movement of only ~200 sea lions from Southeast Alaska (eastern stock) to the western stock during the breeding season. Given that only approximately 60% of sea lions are hauled out and available to be counted during breeding season aerial surveys (see summary of sightability by age and sex in Holmes et al. 2007), an average net movement of this magnitude represents a very small (<0.5%) percentage of the total count of sea lions in the western stock or Southeast Alaska~~ 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 ~~and age~~ in ~~the~~ cross-boundary movements~~, with a net increase of ~400~~: for females, ~~in Southeast Alaska (eastern stock) and~~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~~ern stock~~. ~~The~~This pattern of movement is supported by mitochondrial DNA evidence that indicated that the newest rookeries in northern Southeast Alaska (~~e~~Eastern stock) were colonized in part by ~~w~~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 2012 (V. Burkanov, NMFS-AFSC-MML, pers. comm.) indicate that overall Steller sea lion abundance in Russia~~ has continued to~~ increased back to levels observed ~~and is now similar to~~in the 1960s (~27,100 based on life table multiplier of 4.5 on the most recent total pup count of 6,021).~~ Between 1995 and 2011/2012, pup production has increased overall in Russia by 3.1% per year (V. Burkanov, pers. comm., 27 February 2013).~~ However, just as in the U.S. portion of the stock, there are significant regional differences in population trend in Russia, with increasing abundance in the Sea of Okhotsk and Kuril Islands and stable or declining trends in eastern Kamchatka, the Commander Islands, and the western Bering Sea.~~ Pup production in the combined Kuril Islands and the Sea of Okhotsk areas increased 59% between 1995 and 1997 (3,596 pups) and 2011 (5,729 pups), while non-pup counts increased 87% over the same time period (6,205 to 11,576). However, Steller sea lion population trends in eastern Kamchatka, the Commander Islands, and the western Bering Sea have been quite different. In eastern Kamchatka, pup production at the single rookery (Kozlova Cape) declined 50% between the mid-1980s (~200 pups) and 2012 (101 pups), while non-pup counts were 80% lower in 2010 than in the early 1980s. On the Commander Islands, non-pup counts increased between 1930 and the late 1970s, when the rookery became re-established. Pup production on the Commander Islands increased to a maximum of 280 in 1998 and has varied between 180 and 228 since then (through 2012). Non-pup counts on the Commander Islands also reached a maximum in 1998-1999~~

~~(mean of 880), and since then have ranged between 581 and 797 (through 2010).~~ 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.~~ The overall increase in the abundance of Steller sea lions in Russia is due entirely to recovery and increases in abundance in the Kuril Islands and Sea of Okhotsk.~~ Regions in Russia that ~~are~~have either stable or declining ~~(eastern Kamchatka, Commander Islands, and western Bering Sea) border~~counts of pups and non-pups are adjacent to regions in the U.S. ~~where sea lion trends are~~with similar trends (Aleutian Islands west of 170°W). Results from surveys conducted in 2013 and 2015 will be available soon and included in a future Stock Assessment Report.

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, 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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 ~~w~~Western stock of Steller sea lions, PBR = ~~297~~306 animals (~~49,497~~50,983 × 0.06 × 0.1).

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.

Between ~~2009 and 2013~~2010 and 2014, serious injury and mortality of ~~w~~Western Steller sea lions was observed in the following ~~7~~8 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 Atka mackerel trawl, Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands Pacific cod trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod longline, Gulf of Alaska Pacific cod trawl, Gulf of Alaska Pacific cod longline, and Gulf of Alaska sablefish longline fisheries (Table 2; Breiwick 2013).

Observers also monitored the Alaska State-managed Prince William Sound salmon drift gillnet fishery in 1990 and 1991, recording two mortalities in 1991, extrapolated to 29 (95% CI: 1-108) for the entire fishery (Wynne et al. 1992). No mortality or serious injury was observed during 1990 for this fishery (Wynne et al. 1991), resulting in a mean annual mortality rate of ~~14.5~~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.

Combining the mortality and serious injury estimates from the Bering Sea/Aleutian Islands groundfish trawl, Bering Sea/Aleutian Islands longline, Gulf of Alaska groundfish trawl, and Gulf of Alaska longline fisheries (~~16~~15) with the estimate from the Prince William Sound salmon drift gillnet fishery (15) results in an estimated mean annual mortality and serious injury rate ~~in observed fisheries~~ of ~~31~~30 sea lions from this stock in observed U.S. commercial fisheries (Table 2).

Table 2. Summary of incidental mortality and serious injury of ~~the~~ Western U.S. ~~stock of~~ Steller sea lions due to U.S. commercial fisheries in ~~2009-2013~~2010-2014 (or the most recent data available) and calculation of the mean annual mortality and serious injury rate (Wynne et al. 1991, 1992; Breiwick 2013; ~~N~~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. Atka mackerel trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~99~~ ~~99~~100 99 99 99 99	~~0~~ 1 0 0 0 0	~~0~~ 1 0 0 0 0	0.2 (CV = 0.05)
Bering Sea/Aleutian Is. flatfish trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~99~~ 99 ~~99~~100 99 99 99	~~3~~ 4 (+1)[a] 7 6 7 5	~~3.0~~ 4 (+1)[b] 7 6.0 ~~7.0~~7.1 5.0	~~5.6~~5.8 (+0.2)[c] (CV = ~~N/A~~0.01)
Bering Sea/Aleutian Is. Pacific cod trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~63~~ 66 60 68 80 80	~~0~~ 1 1 0 1 0	~~0~~ 1 1.0 0 1.9 0	0.8 (CV = ~~0.33~~0.34)
Bering Sea/Aleutian Is. pollock trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~86~~ 86 98 98 97 98	~~6~~ 5 9 7 (+1)[~~e~~d] 5 2	~~6.2~~ 8.2 9.3 7 (+1)[~~d~~e] 5.1 2.1	~~7.4~~6.3 (+0.2)[f] (CV = ~~N/A~~0.09)
Bering Sea/Aleutian Is. Pacific cod longline	2010 2011 2012 2013 2014	obs data	64 57 51 66 64	0 0 0 0 1	0 0 0 0 1.7	0.3 (CV = 0.64)
Gulf of Alaska Pacific cod longline	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~21~~ 29 ~~31~~30 13 ~~28~~29 31	~~0~~ 1 0 0 0 0	~~0~~ 1.1 0 0 0 0	0.2 (CV = ~~0.32~~0.33)
Gulf of Alaska Pacific cod trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~29~~ 31 41 25 ~~11~~10 12	~~0~~ 0 0 1 0 0	~~0~~ 0 0 1 0 0	0.2 (CV = 0)
Gulf of Alaska sablefish longline	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~16~~ 15 14 14 ~~13~~14 19	~~0~~ 0 0 1 0 0	~~0~~ 0 0 5.5 0 0	1.1 (CV = ~~0.91~~0.89)

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	0 2	0 29	15 (CV = 1.0)
Minimum total estimated annual mortality						~~31~~30 (CV = ~~0.87~~0.50)

[a]Total mortality and serious injury observed in 2010: 4 sea lions in sampled hauls + 1 sea lion in an unsampled haul.
[b]~~Since the t~~Total ~~known~~estimate of mortality and serious injury in 2010: 4 sea lions (extrapolated estimate from 4 sea lions observed in sampled hauls) + 1 sea lion (1 sea lion observed in an unsampled haul)~~ exceeds the estimated mortality and serious injury (4) for the fishery in 2010, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year~~.
[c]Mean annual mortality and serious injury for fishery: 5.8 sea lions (mean of extrapolated estimates from sampled hauls) + 0.2 sea lions (mean of number observed in unsampled hauls).
[e~~d~~]Total mortality and serious injury observed in 2012: 7 sea lions in sampled hauls + 1 sea lion in an unsampled haul.
[d~~e~~]~~Since the t~~Total ~~known~~estimate of mortality and serious injury in 2012: 7 sea lions (extrapolated estimate from 7 sea lions observed in sampled hauls) + 1 sea lion (1 sea lion observed in an unsampled haul)~~ exceeds the estimated mortality and serious injury (7) for the fishery in 2012, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year~~.
[f]Mean annual mortality and serious injury for fishery: 6.3 sea lions (mean of extrapolated estimates from sampled hauls) + 0.2 sea lions (mean of number observed in unsampled hauls).

Reports from the NMFS Alaska Region stranding ~~database~~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. ~~2015~~2016~~; Table 3~~). During the 5-year period from ~~2009 to 2013~~2010 to 2014, there were ~~six confirmed fishery-related Steller sea lion strandings in the range of the western stock. F~~five reports ~~involved~~of a Steller sea lion in poor body condition with a flasher lure hanging from its mouth and, in each case, the animal was believed to have ingested the hook (Table 3). ~~The sixth~~An additional animal ~~had a string leader line hanging out of its mouth, with a~~was hooked ~~apparently inside its mouth~~by longline gear and two animals were entangled in unidentified fishing gear. Fishery-related strandings in these unknown (commercial, recreational, or subsistence) fisheries during ~~2009-2013~~2010-2014 resulted in a~~n~~ minimum ~~estimated average~~mean annual mortality and serious injury rate of ~~1.2~~1.6 animals from this stock (Table 3). This estimate is 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 ~~w~~Western stock are known to travel to parts of Southeast Alaska to forage, and higher rates of entanglement of Steller sea lions have been observed in this area (e.g., see Raum-Suryan et al. 2009), estimates based solely on stranding reports in areas west of 144°W longitude may underestimate the total entanglement of ~~w~~Western stock animals in fishery-related and other marine debris.~~ Steller sea lions reported in the stranding database as shot are not included in this estimate, as they may have been animals that were struck and lost in the Alaska Native subsistence harvest.~~

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 ~~database~~network~~,~~ and Alaska Department of Fish and Game in ~~2009-2013~~2010-2014 (Helker et al. ~~2015~~2016).

~~**Cause of injury**~~	~~**2009**~~	~~**2010**~~	~~**2011**~~	~~**2012**~~	~~**2013**~~	~~**Mean annual mortality**~~
~~Swallowed troll gear~~	~~1~~	~~0~~	~~1~~	~~3~~	~~0*~~	~~1~~
~~Ring neck entanglement (packing band)~~	~~1~~	~~2~~	~~0~~	~~1~~	~~0*~~	~~0.8~~
~~Ring neck entanglement (unknown marine debris/gear)~~	~~0~~	~~3~~	~~1~~	~~1~~	~~0*~~	~~1~~
~~Swallowed unknown fishing gear~~	~~0~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0.2~~
~~Shot with arrow~~	~~0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0.2~~
~~Entangled in aquaculture facility net~~	~~0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0.2~~

~~*The 2013 Alaska Department of Fish and Game entanglement and flasher injury data are not included. Thus, this number is artificially low and will be revised as data become available.~~

Cause of injury	2010	2011	2012	2013	2014	Mean annual mortality
Hooked by Gulf of Alaska longline gear*	1	0	0	0	0	0.2
Hooked by Southcentral Alaska salmon troll gear*	0	1	0	0	1	0.4
Hooked by Alaska Peninsula troll gear*	0	0	0	1	0	0.2
Hooked by troll gear*	0	0	2	0	0	0.4
Entangled in unidentified fishing gear*	0	0	1	0	1	0.4
Entangled in marine debris	5	1	2	0	3	2.2
Struck by arrow	0	0	0	1	0	0.2
Entangled in commercial Kodiak salmon hatchery net	0	0	0	1	0	0.2
*Total unknown (commercial, recreational, or subsistence) fisheries						1.6
Total marine debris						2.2
Total other causes (arrow strike, entangled in hatchery net)						0.4

NMFS studies using satellite-tracking devices attached to juvenile and adult female Steller sea lions suggest that ~~they~~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~~; NMML, unpubl. data~~). 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 estimated mortality and serious injury rate incidental to U.S. commercial fisheries is ~~31~~30 Steller sea lions. The minimum average annual mortality and serious injury rate for all fisheries, ~~B~~based on observer data (~~31~~30 sea lions) for commercial fisheries and stranding data (~~1.2~~1.6 sea lions) for~~, the minimum average annual estimated mortality and serious injury rate incidental to~~ unknown (commercial, ~~and~~ recreational, or subsistence) fisheries is 32 Western Steller sea lions. Observer data ~~on~~for state fisheries ~~dates as far back as~~are from 1990-1991; however, these are the best data available to estimate takes in these fisheries. 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.

Alaska Native Subsistence/Harvest Information

Information on the subsistence harvest of Steller sea lions comes via two sources: the Alaska Department of Fish and Game (ADF&G) and the Ecosystem Conservation Office (ECO) of the Aleut Community of St. Paul. 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. Therefore, the most recent 5 years of data available (2004-2008) will be retained and used for calculating an annual mortality and serious injury estimate for all areas except St. Paul. Data from St. Paul are still being collected and will be updated with the most recent 5 -years ~~period~~of data available. The ECO collects data on the harvest in near real-time on St. Paul Island and records hunter activities within 36 hours of the harvest (~~Zavadil 2010~~Lestenkof 2011). Information on subsistence harvest levels is provided in Table 4; data from ECO (e.g., ~~Zavadil 2010~~Lestenkof 2011) are relied upon as the source of data for St. Paul Island and all

other data are from the ADF&G (e.g., Wolfe et al. 2005).~~ Data were collected on the Alaska Native harvest of Steller sea lions for seven communities on Kodiak Island in 2011; the Alaska Native Harbor Seal Commission and ADF&G estimated a total of 20 adult sea lions were harvested, with a 95% confidence range between 15 to 28 animals (Wolfe et al. 2012). This estimate does 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. No monitoring occurred on St. Paul in 2012; therefore, t~~The most recent 5 years of data from St. Paul are from ~~2008-2011 and 2013~~2010 to 2014 (Lestenkof 2011, 2012).

The mean annual subsistence take from this stock for all areas except St. Paul in 2004-2008 (172), combined with the mean annual take for St. Paul in ~~2008-2011 and 2013~~2010-2014 (29), ~~was 199~~is 201 Western Steller sea lions (Table 4).

Table 4. Summary of the subsistence harvest data for ~~the~~ Western U.S. ~~stock of~~ 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. Data from St. Paul are still being collected and will be updated with the most recent 5 years of data available (~~2008-2011 and 2013~~2010-2014).

	All areas except St. Paul Island			**St. Paul Island**	
Year	**Number harvested**	**Number struck and lost**	**Total**	**Number harvested +Number struck and lost**	**~~Total take~~**
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]	~~22[f]~~	~~158~~
2009	N/A	N/A	N/A	~~26[g]~~	~~N/A~~
2010	N/A	N/A	N/A	20~~[h]~~[f]	~~N/A~~
2011	N/A	N/A	N/A	32~~[i]~~[g]	~~N/A~~
2012	N/A	N/A	N/A	~~N/A~~24[h]	~~N/A~~
2013	N/A	N/A	N/A	34~~[j]~~[h]	~~N/A~~
2014	N/A	N/A	N/A	35[h]	
Mean annual take	136.9	35.3	172.3	~~26.8~~29	~~199~~

[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]Jones (2009); [g]Zavidil (2010);~~ ~~[h]~~[f]Lestenkof (2011); ~~[i]~~[g]Lestenkof (2012); ~~[j]~~[h]ADF&G, unpubl. ~~D~~data.

Other Mortality

Reports from the NMFS Alaska Region stranding ~~database~~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. From ~~2009 to 2013~~2010 to 2014, ~~nine~~11 animals were observed~~ with circumferential neck~~ entangled~~ments from packing bands or other unknown~~ in marine debris~~/gear~~, ~~one~~1 animal was ~~shot with~~struck by an arrow, and ~~one~~1 entangled in a~~n aquaculture facility~~commercial Kodiak salmon hatchery net (Table 3; Helker et al. 2016). The minimum mean annual mortality and serious injury rate from these sources of human interactions for ~~2009-2013~~2010-2014 is ~~2.2~~2.6 sea lions from this stock.

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 2008 and 2012, there was no reported mortality or serious injury resulting~~In 2011, there were two reports of mortality incidental ~~from~~to research on the ~~w~~Western U.S. stock of Steller sea lions (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 0.4 sea lions from this stock in 2010-2014.

STATUS OF STOCK

The current mean annual ~~level of incidental~~ U.S. commercial fishery-related mortality and serious injury rate (~~31~~30 sea lions) ~~exceeds~~is less than 10% of the PBR (10% of PBR = ~~30~~31) and, therefore, can~~not~~ be considered insignificant and approaching a zero mortality and serious injury rate. Based on available data, the total estimated annual level of ~~total~~ human-caused mortality and serious injury (~~31 (commercial fisheries) + 1.2 (unknown fisheries)~~

~~+ 199 (Alaska Native harvest) + 2.2 (entanglement in marine debris/gear and other human interaction) = 233~~236 sea lions) is below the PBR level (~~297~~306) 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. However, the population previously declined for unknown reasons that are not explained by the documented level of direct human-caused mortality and serious injury.

HABITAT CONCERNS

Many factors have been suggested as causes of the steep decline in abundance of ~~w~~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 ~~between~~since 1990 ~~and 2011~~ 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).

Table 5. Potential threats and impacts to Steller sea lion recovery and associated references. Threats and impact 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

CITATIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DeMaster, D. P. 2014. Results of Steller sea lion surveys in Alaska, June-July 2013. Memorandum to J. Balsiger, J. Kurland, B. Gerke, and L. Rotterman, NMFS Alaska Regional Office, Juneau, AK, January 27, 2014. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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

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

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

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

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

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

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

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

Fritz, L. W., R. Towell, T. S. Gelatt, D. S. Johnson, and T. R. Loughlin. 2014. Recent increases in survival of western Steller sea lions in Alaska and implications for recovery. Endang. Species Res. 26(1):13-24. DOI: 10.3354/esr00634.

Fritz, L., K. Sweeney, D. Johnson, and T. Gelatt. 2015a. Results of Steller sea lion surveys in Alaska, June-July 2014. Memorandum to D. DeMaster, J. Balsiger, J. Kurland, and L. Rotterman, January 28, 2015. Available from ~~National~~ Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Fritz, L., K. Sweeney, R. Towell, and T. Gelatt. 2015b. Results of Steller sea lion surveys in Alaska, June-July 2015. Memorandum to D. DeMaster, J. Balsiger, J. Kurland, and L. Rotterman, December 22, 2015. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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

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

Hastings, K. K., L. A. Jemison, T. S. Gelatt, J. L. Laake, G. W. Pendleton, J. C. King, A. W. Trites, and K. W. Pitcher. 2011. Cohort effects and spatial variation in age-specific survival of Steller sea lions from southeastern Alaska. Ecosphere 2(10):1-21. DOI: 10.1890/ES11-00215.1.

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

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

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

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

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

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

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

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

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

~~Jones, D. J. 2009. 2008 subsistence harvest of Steller sea lion on St. Paul Island. Memorandum for the Record, April 27, 2009, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.~~

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

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

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

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

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

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

Lestenkof, A. D. 2011. 2010 subsistence harvest of Steller sea lion on St. Paul Island. Memorandum for the Record, March 7, 2011, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.

Lestenkof, A. D. 2012. 2011 subsistence harvest of Steller sea lion on St. Paul Island. Memorandum for the Record, May 30, 2012, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks,~~.~~ ~~P~~p. 329-341. *In* A. Dizon, S. J. Chivers, and W. Perrin (eds.), Molecular genetics of marine mammals, incorporating the proceedings of a workshop on the analysis of genetic data to address problems of stock identity as related to management of marine mammals. Soc. Mar. Mammal., Spec. Rep. No. 3.

Loughlin, T. R., and A. E. York. 2000. An accounting of the sources of Steller sea lion mortality. Mar. Fish. Rev. 62(4):40-45.

Loughlin, T. R., D. J. Rugh, and C. H. Fiscus. 1984. Northern sea lion distribution and abundance: 1956-1980. J. Wildl. Manage. 48:729-740.

Maniscalco, J. M., P. Parker, and S. Atkinson. 2006. Interseasonal and interannual measures of maternal care among individual Steller sea lions (*Eumetopias jubatus*). J. Mammal. 87:304-311.

McBeath, J. 2004. Greenpeace v. National Marine Fisheries Service: Steller sea lions and commercial fisheries in the North Pacific. Alaska Law Rev. 21:1-42.

Merrick, R. L., R. Brown, D. G. Calkins, and T. R. Loughlin. 1995. A comparison of Steller sea lion, *Eumetopias jubatus*, pup masses between rookeries with increasing and decreasing populations. Fish. Bull., U.S. 93:753-758.

Merrick, R. L., and T. R. Loughlin. 1997. Foraging behavior of adult female and young-of-the-year Steller sea lions in Alaskan waters. Can. J. Zool. 75(5):776-786.

Merrick, R. L., T. R. Loughlin, and D. G. Calkins. 1987. Decline in abundance of the northern sea lion, *Eumetopias jubatus*, in 1956-86. Fish. Bull., U.S. 85:351-365.

Milette, L. L., and A. W. Trites. 2003. Maternal attendance patterns of Steller sea lions (*Eumetopias jubatus*) from stable and declining populations in Alaska. Can. J. Zool. 81:340-348.

NMFS (National Marine Fisheries Service). 1995. Status review of the United States Steller sea lion (*Eumetopias jubatus*) population. Prepared by the National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115. 61 p~~p~~.

NMFS (National Marine Fisheries Service). 2001. Endangered Species Act, Section 7 Consultation Biological Opinion and Incidental Take Statement on the Authorization of the Bering Sea/Aleutian Islands and Gulf of Alaska Groundfish Fishery Management Plan Amendments 61 and 70. NMFS Alaska Region, Protected Resources Division, Juneau, AK.

NMFS (National Marine Fisheries Service). 2008. Recovery Plan for the Steller sea lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 p~~p~~.

Nikulin, V. S., and V. N. Burkanov. 2000. Species composition of marine mammal by-catch during Japanese driftnet salmon fishery in southwestern Bering Sea. Unpubl. manuscript. 2 ~~p~~p. Available from ~~National~~ Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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

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

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

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

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

Pitcher, K. W., P. F. Olesiuk, R. F. Brown, M. S. Lowry, S. J. Jeffries, J. L. Sease, W. L. Perryman, C. E. Stinchcomb, and L. F. Lowry. 2007. Status and trends in abundance and distribution of the eastern Steller sea lion (*Eumetopias jubatus*) population. Fish. Bull., U.S. 107(1):102-115.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

~~Zavadil, P. A. 2010. 2009 subsistence harvest of Steller sea lion on St. Paul Island. Memorandum for the Record, April 2010, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK.~~

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). ~~Large numbers of i~~Individual~~s~~ 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~~ 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, 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 ~~southeastern~~Southeast Alaska (Pitcher et al. 2007).

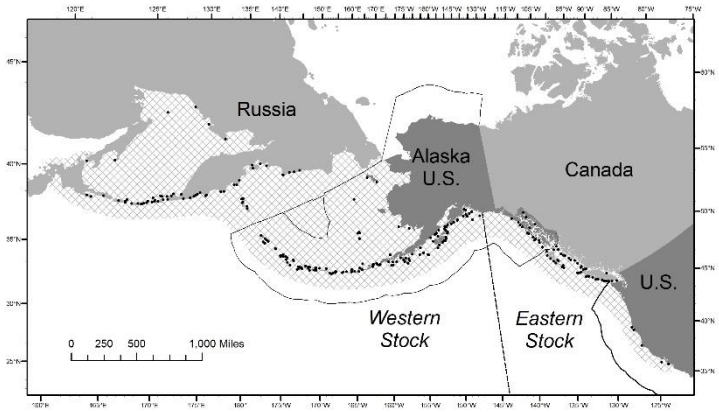

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005; S. Majewski, Fisheries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

Loughlin (1997) ~~and Phillips et al. (2009)~~ considered the following information when classifying stock structure based ~~up~~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 ~~between~~among rookeries; 2) Population response data: substantial differences in population dynamics (York et al. 1996); 3) Phenotypic data: ~~skull morphology~~differences in the length of pups (~~Phillips et al. 2009~~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 ~~e~~Eastern U.S. stock, which includes animals born east of Cape Suckling, Alaska (144°W), and a ~~w~~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 ~~w~~Western and ~~e~~Eastern stocks and there may be sufficient morphological differentiation to support elevating the two recognized stocks to subspecies (Phillips et al. 2009) ~~despite the observation that western stock haplotypes are present in substantial numbers at two northern southeast Alaska rookeries (Gelatt et al. 2007)~~. 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 ~~w~~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 ~~w~~Western stock haplotypes. Collectively, this information demonstrates that these two most recently established rookeries in northern ~~s~~Southeast Alaska have been partially to predominately established by ~~w~~Western stock females. While ~~M~~movements of animals marked as pups in both stocks support these genetic results (Jemison et al. 2013)~~.~~

~~Overall, however~~, overall the observations of marked sea lion movements corroborate the extensive genetic~~s~~ 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, ~~A~~although recent colonization events in the northern part of the eastern DPS indicate movement of ~~w~~Western sea lions into this area, the mixed part of the range remains small (Jemison et al. 2013)~~,~~ and the overall discreteness of the ~~e~~Eastern from the ~~w~~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 ~~e~~Eastern stock of Steller sea lions ~~breeds~~has historically bred on rookeries located in ~~s~~Southeast Alaska, British Columbia, Oregon, and California~~; there are no rookeries located in Washington~~. 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.~~ Calkins and Pitcher (1982) and Pitcher et al. (2007) concluded that the total Steller sea lion population abundance could be estimated by multiplying pup counts by a factor based on the birth rate, sex and age structure, and growth rate of the population.~~ The ~~most recent~~2015 estimated total ~~e~~Eastern stock pup count is ~~14,317~~19,423 (95% credible interval of 16,318-23,309)~~ and includes counts made between 2009 and 2013 (Table 1; DeMaster 2014; NMFS, Fisheries and Oceans Canada, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, unpublished data). Using pup multipliers of either 4.2 or 5.2 (Pitcher et al. 2007), the population is estimated to be within the range of 60,131 (14,317 × 4.2) and 74,448 (14,317 × 5.2). These are not minimum population estimates, since they are extrapolated from pup counts from photographs taken between 2009 and 2013, and demographic parameters estimated for an increasing (at 3.1% per year) population. The extrapolation factor varied depending on the vital rate parameter that resulted in the growth rate: as low as 4.2 if it was due to high fecundity, and as high as 5.2 if it was due to low juvenile mortality (Pitcher et al. 2007).~~ 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

~~The minimum population estimate was calculated by adding the most recent non-pup and pup counts from all sites surveyed (Table 1).~~

~~**Table 1.** Non-pup and pup counts from rookery and haulout sites of eastern Steller sea lions, by region. The most recent counts for each site were used to calculate the minimum population estimate (N_{MIN}) for the entire eastern stock, and for the U.S. portion.~~

~~**Region**~~	~~**Year**~~	~~**Non-pups**~~	~~**Pups**~~	~~**Total count**~~
~~Southeast Alaska (USA)~~	~~2013~~	~~19,101~~	~~6,741~~	~~25,842~~
~~British Columbia (Canada)~~	~~2010~~	~~17,932~~	~~5,485~~	~~23,417~~
~~Washington (USA)~~	~~2011~~	~~1,749~~	~~–~~	~~1,749~~
~~Oregon (USA)~~	~~2013~~	~~4,761~~	~~–~~	~~4,761~~
~~Oregon (USA)~~	~~2009~~	~~–~~	~~1,418~~	~~1,418~~
~~California (USA)~~	~~2011~~	~~2,108~~	~~673~~	~~2,781~~
~~Eastern stock, total~~		~~45,651~~	~~14,317~~	~~59,968~~
~~Eastern stock, U.S. portion only~~		~~27,719~~	~~8,832~~	~~36,551~~

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 minimum population estimate (N_{MIN}).~~This results in an N_{MIN} for the eastern U.S. (only) stock of Steller sea lions of 36,551 based on counts as old as 2009 for Oregon pup counts (NMFS, unpublished data) to as recent as 2013 for Oregon and southeast Alaska. Including counts in British Columbia (Canada) yields an N_{MIN} for the entire eastern stock of 59,968.~~ 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

~~The best available information~~Using agTrend, we modeled the most recent count data to estimate annual trends from 1989 to 2015. This model indicates the ~~e~~Eastern stock of Steller sea lions increased at a rate of ~~4.18~~4.76% per year (~~90~~95% confidence ~~bounds~~intervals of ~~3.71–4.62~~4.09-5.45%~~ per year~~) between ~~1979 and 2010~~1989 and 2015 based on an analysis of pup counts in California, Oregon, British Columbia, and Southeast Alaska (~~NMFS 2013~~Table 1, Fig. 2 and 3). A similar analysis of non-pup counts in the same regions plus Washington yielded an estimate of population increase of ~~2.99~~2.84% per year (95% confidence intervals of ~~2.62-3.31~~2.36-3.33%~~ per year; NMFS 2013~~). Pitcher et al. (2007) reported that the ~~e~~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 ~~e~~Eastern U.S. stock increase has been driven by growth in pup counts in all regions (NMFS 2013).

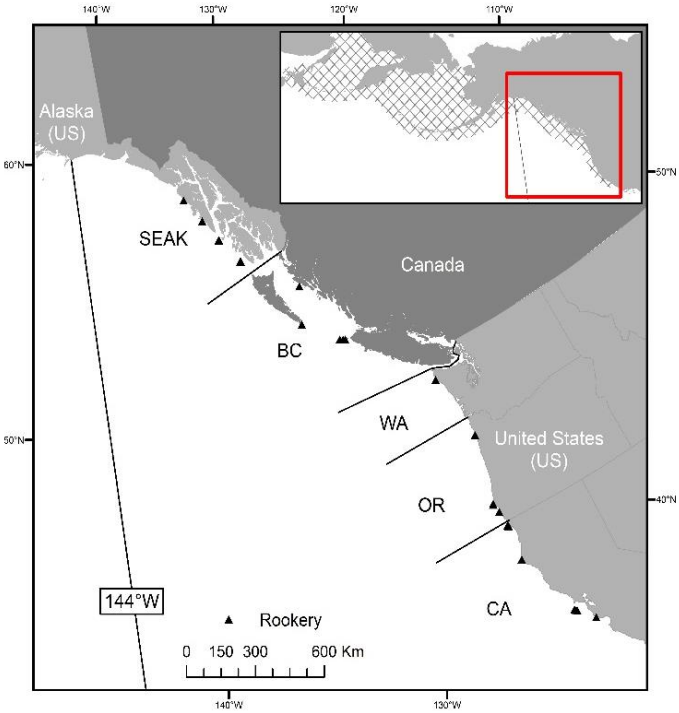

Figure 2. The Eastern Steller sea lion rookery sites by region: SEAK (Southeast Alaska), BC (British Columbia, Canada), WA (Washington State), OR (Oregon State), and CA (California State).

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.).

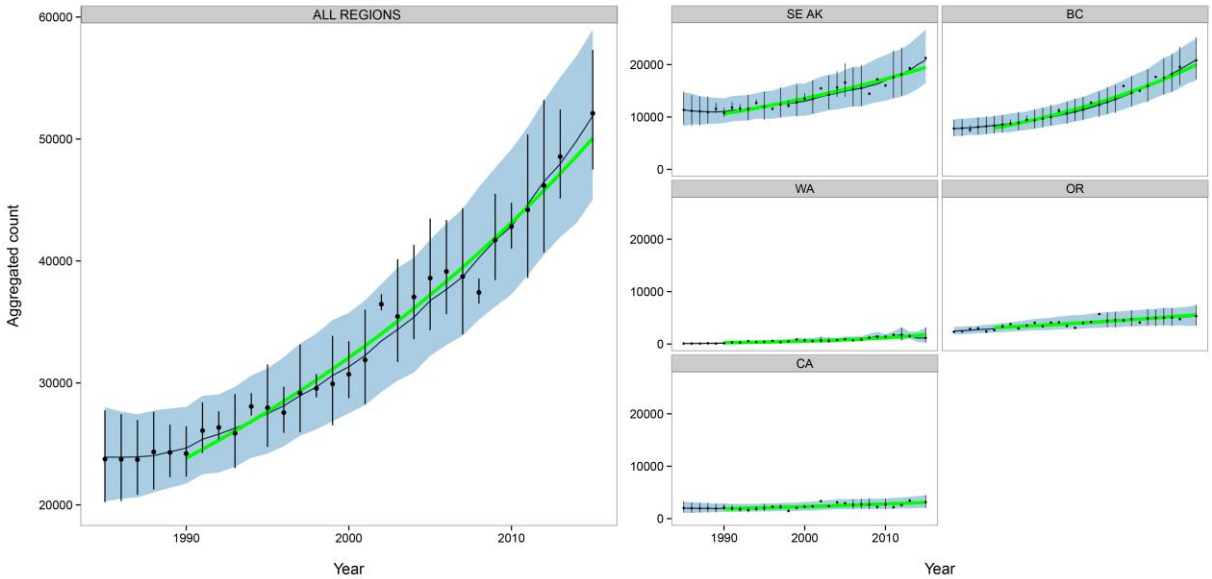

Figure 3. Estimated counts (modeled with agTrend) of Eastern Steller sea lion non-pups (adults and juveniles) for the period from 1989 to 2015, with estimated trend (green line) from 1990 to 2015 for all regions and for the five separate regions: Southeast Alaska (SEAK), British Columbia (BC), Washington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

~~Steller sea lion numbers in California, especially in southern and central California, have declined from historic numbers.~~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 ~~and~~to 1947~~,~~ but ~~have~~ subsequently declined~~ by over 50%, and were between 1,500 and 2,000 in the period 1980-2011~~. 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).~~ Counts of non-pups in California have been relatively stable, while those in Oregon and Washington have been increasing since 1990. Non-pup counts in southeast Alaska and British Columbia increased steadily between 1990 and 2013, and~~

~~comprise ~80% of the total eastern stock count (Table 2; Fig. 2).~~ Non-pup counts increased slightly from 1989 to 2015, ranging from approximately 2,000 to 3,100.

~~Fritz et al. (2013) estimated t~~The net magnitude of ~~cross-boundary movement of~~ Steller sea lion~~s~~ movements during the breeding season between the Eastern and ~~w~~Western ~~and eastern~~ stocks ~~using transition probabilities of individually marked sea lions by sex, age and region estimated by Jemison et al. (2013); survival rates by age, sex and region estimated by Hastings et al. (2011) and Fritz et al. (2014); and pup production by region based on aerial surveys conducted in 2009. There was an estimated average net annual movement of only ~200 sea lions from southeast Alaska (eastern stock) to the western stock during the breeding season. Given that only approximately 60% of sea lions are hauled out and available to be counted during breeding season aerial surveys (see summary of sightability by age and sex in Holmes et al. 2007), an average net movement of this magnitude represents a very small (<0.5%) percentage of the total count of sea lions in the western stock or southeast Alaska,~~ 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 ~~and age~~ in ~~the~~ cross-boundary movements~~, with a net increase of ~400~~; for females ~~in southeast Alaska (eastern stock) and~~, 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~~ern stock~~. ~~The~~This pattern of movement is supported by mitochondrial DNA evidence that indicated that the newest rookeries in northern ~~s~~Southeast Alaska (~~e~~Eastern stock) were colonized in part by ~~w~~Western females (Gelatt et al. 2007, O'Corry-Crowe et al. 2014).

~~**Table 2.** Counts of adult and juvenile Steller sea lions observed at consistently surveyed rookery and haulout (trend) sites by year and region for the eastern U.S. stock from 1990 through 2013*. California (CA) includes Año Nuevo, Farallon Islands, and St. George Reef. Oregon (OR) includes counts at all sites. Washington (WA) includes Split Rock Complex, Sea Lion Rock/Carroll Island, Bodelteh/Cape Alava/Guano Rock, and Tatoosh. British Columbia (BC) includes counts from all sites. Southeast Alaska (SEAK) includes counts from 24 trend sites.~~

~~**Region**~~	~~**1990**~~	~~**1991**~~	~~**1992**~~	~~**1994**~~	~~**1996**~~	~~**1998**~~	~~**2000**~~	~~**2002**~~	~~**2006**~~	~~**2008**~~	~~**2009**~~	~~**2010**~~	~~**2011**~~	~~**2013**~~
~~CA~~	~~1,329~~	~~1,163~~	~~969~~	~~1,046~~	~~1,369~~	~~1,277[1]~~	~~1,215~~	~~1,096~~			~~1,236~~		~~935~~	
~~OR~~	~~2,414~~		~~3,581~~	~~3,293~~	~~3,205~~	~~3,971~~	~~2,927~~	~~4,169~~	~~4,506~~	~~4,090~~				~~4,761~~
~~WA~~	~~89[2]~~	~~274~~	~~278~~	~~384~~	~~595~~	~~470~~	~~681~~	~~650~~	~~714~~	~~1,198~~	~~1,343~~	~~1,421~~	~~1,749~~	
~~BC~~	~~6,122[3]~~	~~--~~	~~7,378~~	~~8,104~~	~~--~~	~~9,818~~	~~--~~	~~12,122~~	~~15,721~~	~~15,061~~		~~17,932~~	~~--~~	
~~SEAK~~	~~9,149~~	~~9,294~~		~~11,524~~	~~10,778~~	~~11,117~~	~~12,412~~	~~15,138~~	~~--~~	~~13,902~~	~~16,635~~	~~15,431~~	~~--~~	~~18,595~~
~~Total~~	~~19,103~~		~~21,500[4]~~	~~24,351~~		~~26,653~~		~~33,176~~		~~35,414[5]~~		~~40,174[6]~~		

~~*Data sources for counts of adult and juvenile Steller sea lions: Merrick et al. 1992; NMFS 1995; Strick et al. 1997; Sease et al. 1999; Sease and Loughlin 1999; Sease et al. 2001; Olesiuk 2003, 2004, 2008; Brown et al. 2002; NMFS 2008, 2013; ODF&W, unpubl. data, 7118 NE Vandenberg Ave., Corvallis, OR 97330; WDF&W, unpubl. data, Marine Mammal Investigations, 7801 Phillips Road SW, Lakewood WA 98498; Point Reyes Bird Observatory, unpubl. data, 4990 Shoreline Hwy., Stinson Beach, CA 94970; NMFS, unpublished data (M. Lowry, SWFSC); DeMaster 2009, 2014.~~

~~[1] This count was conducted in 1999.~~

~~[2] This count was conducted in 1989.~~

~~[3] This count was conducted in 1987.~~

~~[4] Total includes 1991 SEAK count.~~

~~[5] Total includes 2004 CA count of 1,163.~~

~~[6] Total includes 2008 OR and 2009 CA count.~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the maximum net productivity rate~~s~~ for Steller sea lions. Pitcher et al. (2007) observed a rate of population increase of 3.1% per year for the ~~e~~Eastern stock~~,~~ but concluded this rate did not represent a maximum rate of increase. NMFS (2013) estimated that the ~~e~~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). ~~Hence, u~~Until additional data become available, it is recommended that the ~~pinniped maximum~~ theoretical maximum net productivity rate (R_{MAX}) for pinnipeds of 12% be ~~used~~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 ~~e~~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's 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's consideration of this information led to a determination that the ~~e~~Eastern population has recovered and no longer meets the definition of a "threatened" species under the ESA. ~~Per the 2013 SAR, NMFS for now will continue, under the MMPA, to consider the stock depleted; the recovery factor of 0.75 is maintained and PBR = 1,645 (36,551 × 0.06 × 0.75).~~As recently noted within the humpback whale ESA listing final rule (81 FR 62259, September 8, 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

~~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 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).

~~Between 2008 and 2012~~During 2010-2014, ~~there were~~ no incidental serious injury~~ies~~ ~~and~~or mortality~~ies~~ of ~~e~~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 ~~F~~fishery observers monitored ~~four~~three federally-regulated commercial fisheries ~~during the period from 1990 to 2005~~in 2010-2013 in which Steller sea lions from this stock were taken incidentally: the ~~California (CA)/Oregon (OR) thresher shark and swordfish drift gillnet,~~ 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).~~northern Washington (WA) marine set gillnet, and Gulf of Alaska sablefish longline fisheries. The best data available on the rates of serious injury and mortality incidental to these fisheries is presented in Table 3. There have been no observed serious injuries or mortalities incidental to the CA/OR thresher shark and swordfish drift gillnet fishery since the 1990s (Carretta 2002; Carretta and Chivers 2003, 2004). In the WA/OR/CA groundfish trawl (Pacific whiting component only) one Steller sea lion was observed killed in each year in 2000-2003. No data are available after 1998 for the northern Washington marine set gillnet fishery. Between 2005 and 2009, several Steller sea lion mortalities occurred in WA/OR/CA groundfish fisheries, including the limited trawl sector, California halibut trawl, and the at-sea hake sector, with a mean annual mortality in these fisheries of 5.71 (Jannot et al. 2011). There have been no observer reported mortalities in the Gulf of Alaska sablefish longline fishery since 2000 (Perez, unpubl. ms.; Breiwick 2013). During the 4-year period from 2007 to 2010, a total of 45 Steller sea lions mortalities occurred in fisheries operating south of 49°N latitude (2007 = 14 mortalities, 2008 = 6 mortalities, 2009 = 0 mortalities, 2010 = 25 mortalities), with an average annual take of 11.25 animals. These takes were reported as animals killed by gear; however, they could not be assigned to a particular fishery. The total mean annual mortality rate from all fisheries is 17.0 Steller sea lions (Breiwick 2013). No mortalities were reported by fishery observers monitoring drift gillnet and set gillnet fisheries in Washington and Oregon this decade; though, mortalities have been reported in the past.~~

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 ~~3~~2. Summary of incidental mortality and serious injury of Eastern U.S. Steller sea lions ~~(eastern U.S. stock)~~ due to U.S. commercial fisheries ~~from 2005 to 2009~~in 2010-2013 (Jannot et al. 2016) and calculation of the mean annual mortality and serious injury rate.~~ The most recent 5 years of available data are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. N/A indicates that data are not available. Data for observer coverage, observed mortality and estimated mortality not in parentheses are values from non-breeding season (Aug-Apr), those in parentheses are from breeding season (May-Jul). Details of how percent observer coverage is measured are included in Appendix 6.~~

Fishery name	**Years**	**Data type**	**Percent ~~O~~observer coverage**	**Observed mortality ~~(in given yrs.)~~**	**Estimated mortality ~~(in given yrs.)~~**	**Mean estimated annual mortality**
~~WA/OR/CA groundfish (limited entry trawl sector)~~	~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~	~~obs data~~	~~22 (5)~~ ~~21 (5)~~ ~~18 (4)~~ ~~20 (5)~~ ~~26 (5)~~	~~0 (0)~~ ~~0 (0)~~ ~~0 (0)~~ ~~0 (0)~~ ~~3 (1)~~	~~0 (0)~~ ~~0 (0)~~ ~~0 (0)~~ ~~0 (0)~~ ~~11.56 (--)~~	~~2.51 (CV = 0.47)~~
~~WA/OR/CA California halibut trawl~~	~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~	~~obs data~~	~~10~~ ~~13~~ ~~12~~ ~~37~~ ~~N/A~~	~~0~~ ~~0~~ ~~1~~ ~~1~~ ~~N/A~~	~~0~~ ~~0~~ ~~--~~ ~~2.68~~ ~~N/A~~	~~0.74 (CV = 0.63)~~
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)	~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~ 2010 2011 2012 2013	obs data	~~100~~ ~~98~~ ~~99~~ ~~99~~ ~~100~~ 100 100 100 100	~~0 (2)~~ ~~0 (3)~~ ~~0 (3)~~ ~~1 (0)~~ ~~0 (0)~~ 9 2 1 2	~~0 (2.99)~~ ~~0 (3.78)~~ ~~0 (4.22)~~ ~~1.3 (0)~~ ~~0 (0)~~ 9 2 1 2	~~2.46~~3.5 ~~(CV = 0.17)~~
~~Observer program~~ Minimum total estimated annual mortality						~~5.71~~14 ~~(CV = 0.23)~~

~~[a] A "--" indicates bycatch estimate is not provided due to the high coefficient of variation for that estimate.~~[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 ~~S~~strandings 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). ~~Estimates of fishery-related mortality from stranding data are considered minimum estimates because not all entangled animals strand, and not all stranded animals are found or reported.~~ 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 average annual mortality and serious injury of 30.6 sea lions with flashers, or salmon troll lures, hanging from their mouth were observed in~~

~~Southeast Alaska and northern British Columbia between 2008 and 2012.~~ 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, ~~I~~it is not clear whether ~~entanglements with hooks and flashers~~these interactions involved ~~the~~ recreational or commercial components of the ~~salmon troll~~ fishery~~y~~ies. ~~Based on guidelines presented in 77FR3233, 23 January 2012, these fishery interactions are considered "serious injuries".~~ 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.~~The average minimum annual serious injury and mortality attributed to entanglement in fishing gear, ingestion of gear other than troll gear, or other fishery related injury and mortality between 2008 and 2012 was 34.6.~~ 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). ~~These estimates are based on opportunistic reports, and actual levels of occurrence are likely higher.~~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 4~~2~~3. Summary of ~~e~~Eastern U.S. Steller sea lion mortality~~ies~~ and serious injury~~ies~~, by year and type, reported to the NMFS Alaska Region~~al Office,~~ marine mammal stranding ~~database~~network~~,~~ and ADF&G ~~for the 2008-2012 period~~in 2010-2014 (~~Allen et al. 2014,~~ Helker et al. ~~2015~~2016).

~~**Cause of Injury**~~	~~**2008**~~	~~**2009**~~	~~**2010**~~	~~**2011**~~	~~**2012**~~	~~**Mean Annual Mortality**~~
~~Dependent animal with seriously injured mother~~	~~4~~	~~1~~	~~3~~	~~1~~	~~1~~	~~2.0~~
~~Entanglement (foreign high seas gillnet)~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0~~	~~0.2~~
~~Entanglement (halibut gangion line)~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0.2~~
~~Entanglement (troll gear)~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0.2~~
~~Entanglement (unknown marine debris/gear)~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0.2~~
~~Entanglement (unknown pot fishery gear)~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0.2~~
~~Neck entanglement (fishing line)~~	~~1~~	~~0~~	~~1~~	~~1~~	~~0~~	~~0.6~~
~~Neck entanglement (longline gear)~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0.2~~
~~Neck entanglement (packing band)~~	~~5~~	~~2~~	~~4~~	~~7~~	~~5~~	~~4.6~~
~~Neck entanglement (rope)~~	~~1~~	~~0~~	~~0~~	~~0~~	~~2~~	~~0.6~~
~~Neck entanglement (rubber band)~~	~~1~~	~~1~~	~~1~~	~~1~~	~~0~~	~~0.8~~
~~Neck entanglement (unknown marine debris/gear)~~	~~25~~	~~15~~	~~19~~	~~24~~	~~17~~	~~20~~
~~Vessel strike (unknown vessel)~~	~~0~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0.2~~
~~Gunshot~~	~~0~~	~~1~~	~~2~~	~~0~~	~~15~~	~~3.0~~
~~Swallowed troll gear~~	~~38~~	~~15~~	~~42~~	~~30~~	~~28~~	~~30.6~~
~~Swallowed unknown fishing gear~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0~~	~~0.2~~
~~Swallowed unknown marine debris/gear~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0.2~~
~~Minimum total annual mortality~~						~~64.0*~~

~~*Total excludes gunshot animals from Alaska since these animals are likely already accounted for in the "struck and lost" from the Alaska Native harvest estimates.~~

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
Total recreational fisheries						0.2
*Total unknown (commercial, recreational, or subsistence) fisheries						38
Total marine debris						28
Total 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.

~~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.~~

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 ~~and~~+ 0.2 in recreational fisheries + 38 in unknown (commercial, recreational, or subsistence) fisheries ~~(both U.S. and Canadian) is 51.6 sea lions per year, based on fisheries observer data (17.0), opportunistic observations, and stranding data (34.6)~~.

Alaska Native Subsistence/~~Native~~ Harvest Information

Information on ~~T~~the subsistence harvest of Steller sea lions is provided by the ADF&G~~during 2004-2008 is summarized in Wolfe et al. (2009b)~~. The ADF&G~~During each year, data were collected through~~ 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 ~~e~~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 ~~estimating~~calculating an annual mortality and serious injury estimate. The average number of animals harvested ~~and~~plus struck ~~but~~and lost is 11 animals~~/~~ per year during this 5-year period (Table ~~5~~4). ~~No monitoring occurred in 2010 and 2011. In 2012, one animal was landed and 8 animals were struck and lost.~~

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

Table ~~5~~4. Summary of the subsistence harvest data for ~~the e~~Eastern U.S. ~~stock of~~ 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 ~~estimating~~calculating an annual mortality and serious injury estimate.

Year	~~Estimated total number taken~~	Number harvested	Number struck and lost	Estimated total number taken
2005	~~19[1]~~	0	19	19[a]
2006	~~12.6[2]~~	2.5	10.1	12.6[b]
2007	~~6.1[3]~~	0	6.1	6.1[c]
2008	~~9.7[4]~~	1.7	8.0	9.7[d]
2012	~~9~~	1	8	9[e]
Mean annual take (~~2004-2008~~2005-2008 and 2012)	~~11.3~~	1.0	10~~.2~~	11

~~[1]~~[a]Wolfe et al. (2006); ~~[2]~~[b]Wolfe et al. (2008); ~~[3]~~[c]Wolfe et al. (2009a); ~~[4]~~[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.~~ished~~ 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."

~~Strandings of~~ Steller sea lion~~s~~ mortality and serious injury ~~with~~caused by gunshot wounds ~~do occur, along with strandings of animals entangled in material that is not fishery related~~is reported to the NMFS Alaska and NMFS West Coast Regions. ~~During the period from 2008 to 2012~~During 2012-2014, ~~there was 1 reported stranding of an~~ 45 animals ~~from this stock~~ with gunshot wounds ~~in Oregon and Washington~~were reported to the NMFS West Coast Region stranding network ~~in 2010~~, resulting in a~~n~~ ~~estimated~~minimum average annual mortality and serious injury rate of ~~0.2~~15 Steller sea lions from this stock (Table 3; Helker et al. 2016). ~~This estimate is considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel).~~ An additional ~~Eighteen~~two ~~mortalities from~~ animals with gunshot wounds were reported ~~in~~to the NMFS Alaska Region in 2010~~(1 in 2009, 2 in 2010, and 15 in 2012)~~. Although it is likely that illegal shooting does

occur in Alaska, these events~~Steller sea lions reported in the Alaska stranding database as shot~~ are not included in ~~this~~the estimate of the average annual mortality and serious injury rate due to gunshot wounds ~~unless~~because it ~~was~~could not be confirmed that the deaths ~~was~~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.~~ In addition, human-related stranding data are not available for British Columbia. One Steller sea lion death attributed to vessel collision was reported to the Alaska stranding network (0.2 mean annual mortality).~~ Other ~~sources of~~ non-fishery human-~~related~~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 ~~and mortality~~ rates) ~~include ingestion of unknown marine debris/gear (0.4),~~ were due to entanglement in ~~unknown~~ marine debris~~/gear~~ (~~26.2~~27), ~~and~~ dependent pups of animals seriously injured~~ or dead mother~~ by marine debris (~~2.0~~1), entanglement in foreign gillnet (0.2), arrow strike (0.2), and explosives (0.2) (Table ~~4~~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~~ies~~ 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 2006 and 2010, there was 1 incidental mortality (2010) resulting from~~ Three mortalities occurred incidental to research on the ~~e~~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), ~~which~~ result~~s~~ing in a~~n~~ mean annual ~~average~~mortality and serious injury rate of ~~0.2~~0.6 ~~mortalities~~sea lions ~~per year~~ from this stock in 2010-2014~~(T. Adams, pers. comm., Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910; 11 January 2012). Two Steller sea lions died in 2008 in traps at Bonneville Dam, part of the lethal take program targeting California sea lions, averaging 0.4 mortalities per year.~~

The minimum mean ~~average~~ annual human-caused mortality and serious injury rate ~~of eastern Steller sea lions for~~in ~~2008-2012~~2010-2014 from sources other than fisheries ~~and~~or Alaska Native harvest is ~~29.4~~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 (~~17.0~~14 sea lions) is less than 10% of the calculated PBR (10% of PBR = ~~164~~250) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The total estimated annual level of ~~total~~ human-caused mortality and serious injury (~~51.6 (commercial and recreational fisheries) + 11.3 (subsistence) + 29.4 (other human-caused mortality) = 92.3~~108 sea lions) does not exceed the PBR (~~1,645~~2,498) for this stock. The ~~e~~Eastern U.S. stock of Steller sea lions is currently not listed under the ESA ~~but~~and is not considered "depleted" under the MMPA. ~~; therefore, t~~This stock is classified as a non-strategic stock. Because the counts of ~~e~~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 ~~w~~Western U.S. stock of Steller sea lions, there has been a sustained and robust increase in abundance of the ~~e~~Eastern U.S. stock throughout ~~most of~~ its breeding range.~~ The eastern U.S. stock is increasing throughout the northern portion of its range (Southeast Alaska and British Columbia), and is stable or increasing slowly in the central portion (Oregon through central California).~~ 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).

CITATIONS

~~Allen, B. M., V. T. Helker, and L. A. Jemison. 2014. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-274, 84 p.~~

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

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

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

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

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

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

Brown, R. F., S. D. Riemer, and B. E. Wright. 2002. Population status and food habits of Steller sea lions in Oregon. Marine Mammal Research Program, Oregon Dep~~.~~artment of Fish and Wildl~~.~~ife, Corvallis, OR~~,~~ 97330.

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

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

~~Carretta, J. V. 2002. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2001. Unpubl. doc. submitted to Int. Whal. Comm. (SC/54/SM12). 22 p.~~

~~Carretta, J. V., and S. J. Chivers. 2003. Preliminary estimates of marine mammal mortality and biological sampling of cetaceans in California gillnet fisheries for 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/55/SM3). 21 p.~~

~~Carretta J. V., and S. J. Chivers. 2004. Preliminary estimates of marine mammal mortality and biological sampling of cetaceans in California gillnet fisheries for 2003. Unpubl. doc. submitted to Int. Whal. Comm. (SC/56/SM1). 20 p.~~

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013. COSEWIC assessment and status report on the Steller sea lion *Eumetopias jubatus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Canada. xi + 54 p. Available online: www.registrelep-sararegistry.gc.ca/species/default_e.cfm. Accessed June 2016.

DeMaster, D. 2009. Aerial ~~S~~survey of Steller ~~S~~sea ~~L~~lions in Alaska, June-July 2009 and ~~U~~update on the ~~S~~status of the Western ~~S~~stock in Alaska. Memorandum to D. Mecum, K. Brix, and L. Rotterman, NMFS Alaska Regional Office, Juneau, AK, December 2, 2009. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115. Available online: http://www.afsc.noaa.gov/nmml/PDF/SSL-Survey-09-memo-11-30-09.pdf. Accessed June 2016.

DeMaster, D. 2014. Results of Steller sea lion surveys in Alaska, June-July 2013. Memorandum to J. Balsiger, J. Kurland, B. Gerke, and L. Rotterman, January 27, 2014, NMFS Alaska Regional Office, Juneau AK. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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

Fisheries and Oceans Canada. 2010. Management Plan for the Steller Sea Lion (*Eumetopias jubatus*) in Canada [Final]. Species at Risk Act Management Plan Series. Fisheries and Oceans Canada, Ottawa. vi + 69 p~~p~~.

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

Fritz, L. W., R. Towell, T. S. Gelatt, D. S. Johnson, and T. R. Loughlin. 2014. Recent increases in survival of western Steller sea lions in Alaska and implications for recovery. Endang. Species Res. 26(1):13-24. DOI: 10.3354/esr00634.

Fritz, L., K. Sweeney, R. Towell, and T. Gelatt. 2015. Results of Steller sea lion surveys in Alaska, June-July 2015. Memorandum to D. DeMaster, J. Balsiger, J. Kurland, and L. Rotterman, December 28, 2015. Available from Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Gelatt, T., A. W. Trites, K. Hastings, L. Jemison, K. Pitcher, and G. O'Corry-Crowe. 2007. Population trends, diet, genetics, and observations of Steller sea lions in Glacier Bay National Park,~~.~~ ~~-~~p. 145-149. *In* J. F. Piatt and S. M. Gende (eds.), Proc~~.~~eedings of the ~~4th~~Fourth Glacier Bay Science Symposium, October 26-28, 2004: U.S. Geological Survey Scientific Investigations Report 2007-5047.~~ Juneau, AK. October 2004.~~

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

Hastings, K.~~,~~ K., L. A. Jemison, T. S. Gelatt, J. L. Laake, G. W. Pendleton, J. C. King, A. W. Trites, and K. W. Pitcher. 2011. Cohort effects and spatial variation in age-specific survival of Steller sea lions from southeastern Alaska. Ecosphere 2(~~11~~10):1-21. DOI: 10.1890/ES11-00215.1.

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

Hoffman, J. I., K. K. Dasmahapatra, W. Amos, C. D. Phillips, T. S. Gelatt, and J. W Bickham. 2009. Contrasting patterns of genetic diversity at three different genetic markers in a marine mammal metapopulation. Mol~~ec~~. Ecol. 18(14):-2961-2978.

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

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

~~Jannot, J., E. Heery, M. A. Bellman, and J. Majewski. 2011. Estimated bycatch of marine mammals, seabirds, and sea turtles in the US west coast commercial groundfish fishery, 2002-2009. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd. E., Seattle, WA 98112.~~

Jannot, J. E., V. Tuttle, K. Somers, Y.-W. Lee, and J. McVeigh. 2016. Marine mammal, seabird and sea turtle summary of observed interactions, 2002-2014. Fisheries Observation Science, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, NMFS, Seattle, WA 98112.

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

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

LeBoeuf, B. J., K. Ono, and J. Reiter. 1991. History of the Steller sea lion population at Año Nuevo Island, 1961-1991. Southwest Fish~~.~~eries Sci~~.~~ence Center Admin. Rep. LJ-91-45C. ~~U.S. Dep. Commer., La Jolla, CA,~~ 9 p + tables + figs. Available from Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037.

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks,~~.~~ ~~P~~p. 329-341. *In* A. Dizon, S. J. Chivers, and W. Perrin (eds.), Molecular genetics of marine mammals, incorporating the proceedings of a workshop on the analysis of genetic data to address problems of stock identity as related to management of marine mammals. Soc. Mar. Mammal., Spec. Rep. No. 3.

Loughlin, T. R., D. J. Rugh, and C. H. Fiscus. 1984. Northern sea lion distribution and abundance: 1956-1980. J. Wildl. Manage. 48:729-740.

Merrick, R. L., D. G. Calkins, and D. C. McAllister. 1992. Aerial and ship-based surveys of Steller sea lions in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands during June and July 1991. U.S. Dep. Commer, NOAA Tech. Memo. NMFS-AFSC-1, 37 p.

Merrick, R. L., R. Brown, D. G. Calkins, and T. R. Loughlin. 1995. A comparison of Steller sea lion, *Eumetopias jubatus*, pup masses between rookeries with increasing and decreasing populations. Fish. Bull., U.S. 93:753-758.

NMFS (National Marine Fisheries Service). 1995. Status review of the United States Steller sea lion (*Eumetopias jubatus*) population. Prepared by the National Marine Mammal Laboratory, AFSC, NMFS~~, NOAA~~, 7600 Sand Point Way NE, Seattle, WA 98115. 61 p.

NMFS (National Marine Fisheries Service). 2008. Recovery ~~P~~plan for the Steller sea lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 p.

NMFS (National Marine Fisheries Service). 2013. Status ~~R~~review of ~~T~~the Eastern Distinct Population Segment of Steller ~~S~~sea ~~L~~lion (*Eumetopias jubatus*). 144 p.~~p~~ + ~~A~~appendices. Protected Resources Division, Alaska Region, N~~ational~~ M~~arine~~ F~~isheries~~ S~~ervice~~, 709 West 9th Street, Juneau, AK~~laska~~ 99802.

~~NOAA. 2012. Federal Register 77:3233. National Policy for Distinguishing Serious From Non-Serious Injuries of Marine Mammals. Available online: http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf.~~

O'Corry-Crowe, G., B. L. Taylor, and T. Gelatt. 2006. Demographic independence along ecosystem boundaries in Steller sea lions revealed by mtDNA analysis: implications for management of an endangered species. Can. J. Zool. 84(12):1796-1809.

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

Olesiuk, P. F. 2003. Recent trends in the abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia. NMMRC Working Paper No. 2003-11.

Olesiuk, P. F. 2004. Status of sea lions (*Eumetopias jubatus* and *Zalophus californianus*) wintering off southern Vancouver Island. NMMRC Working Paper No. 2004-03 (DRAFT).

Olesiuk, P. F. 2008. Abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia. Department of Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Research Document 2008/063. 29 p. Available online: http://www.dfo-mpo.gc.ca/csas/. Accessed June 2016.

~~Perez, M. A. Unpubl. ms. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 67 pp. Available from NMML AFSC, 7600 Sand Point Way NE, Seattle, WA 98115.~~

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

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

Pitcher, K. W., P. F. Olesiuk, R. F. Brown, M. S. Lowry, S. J. Jeffries, J. L. Sease, W. L. Perryman, C. E. Stinchcomb, and L. F. Lowry. 2007. Status and trends in abundance and distribution of the eastern Steller sea lion (*Eumetopias jubatus*) population. Fish. Bull., U.S. 107(1):102-115.

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

Sease, J. L., and T. R. Loughlin. 1999. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1997 and 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-100, 61 p.

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

Sease, J. L., J. M. Strick, R. L. Merrick, and J. P. Lewis. 1999. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-99, 43 p.

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

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

Strick, J. M., L. W. Fritz, and J. P. Lewis. 1997. Aerial and ship-based surveys of Steller sea lions (*Eumetopias jubatus*) in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands during June and July 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-71, 55 p.

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

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

Wiles, G. J. 2014. Draft Washington State periodic status review for the Steller sea lion. Washington Department of Fish and Wildlife, Olympia, WA. 35 p.

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

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

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

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

Wolfe, R. J., J. Bryant, L. Hutchinson-Scarbrough, M. Kookesh, and L.A. Sill. 2013. The subsistence harvest of harbor seals and sea lions in Southeast Alaska in 2012. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 383, Anchorage, AK.

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

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

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 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).

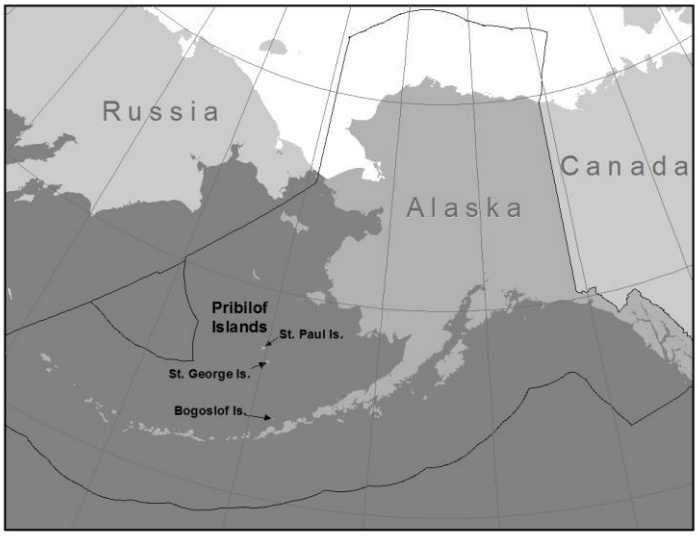

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area).

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, 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, leave the rookeries in the fall, on average around mid-November but ranging from late October to early December, and generally remain at sea for 22 months before returning to their rookery of birth. There is considerable interchange of individuals between rookeries.

Two separate stocks of northern fur seals 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~~, DeLong 1982~~); 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). Thus, an Eastern Pacific stock and a California stock are recognized. 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 different 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 4.5. Juvenile northern fur seals are pelagic and are not included in the rookery counts. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. Coefficients of variation (CVs) are unavailable for the expansion factor. As the great majority of pups are born on St. Paul and St. George Islands, pup surveys are conducted biennially on these islands. Counts 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 counts on Sea Lion Rock (~~2008~~2014), on St. Paul and St. George

Islands (mean of ~~2008,~~ 2010, ~~and~~ 2012, and 2014), and on Bogoslof Island (2011), is ~~648,534~~626,734 northern fur seals (4.47 × ~~145,086~~140,209).

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**
1992*	182,437 (8,919)	10,217 (568)	25,160 (707)	898 (N/A)	218,712 (0.041)
1994	192,104 (8,180)	12,891 (989)	22,244 (410)	1,472 (N/A)	228,711 (0.036)
1996	170,125 (21,244)	"	27,385 (294)	1,272 (N/A)	211,673 (0.10)
1998	179,149 (6,193)	"	22,090 (222)	5,096 (33)	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)

* Incorporates the 1990 estimate for Sea Lion Rock and the 1993 count for Bogoslof Island.

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 3-year mean population estimate (N) of ~~648,534~~626,734 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is ~~548,926~~530,474.

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

(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 ~~1998-2012~~1998-2014, pup production declined ~~4.84~~4.25% per year (SE = ~~0.49~~0.48%; P < 0.01) on St. Paul Island and ~~1.95~~1.42% per year (SE = ~~0.50~~0.54%; P ~~<~~= ~~0.01~~0.04) on St. George Island. The estimated pup production in ~~2012~~2014 was below the ~~1916~~1917 level on both St. Paul and St. George Islands (~~NMFS~~MML, unpubl. data). Northern fur seal pup production at Bogoslof Island has grown at an exponential rate since the 1990s (~~R. Ream, NMFS-AFSC-NMML, 7600 Sand Point Way NE, Seattle, WA 98115, pers. comm., 5 February 2009~~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 2005 and 2011, pup production at Bogoslof Island increased 9.9% per year. Incorporation of the ~~2012~~2014 estimates from the Pribilofs shows ~~an~~a small and insignificant ~~change~~decline in pup production on the Pribilof Islands since 2010. 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.

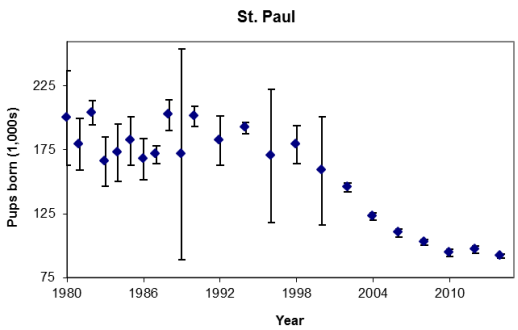

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, ~~1970-2012~~1980-2014.

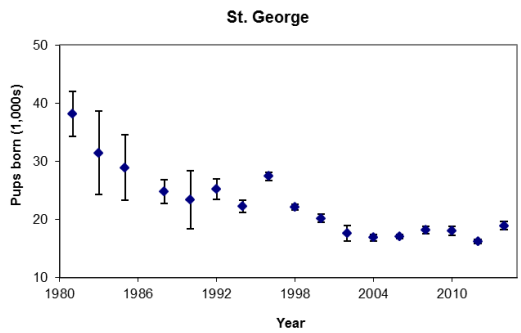

Figure 3. Estimated number of northern fur seal pups born on St. George Island, ~~1970-2012~~1980-2014.

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-~~N~~MML (retired)~~, 7600 Sand Point Way NE, Seattle, WA 98115~~, 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

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 "depleted" stocks under the MMPA (Wade and Angliss 1997). Thus, for the Eastern Pacific stock of northern fur seals, PBR = ~~11,802~~11,405 animals (~~548,926~~530,474 × 0.043 × 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.

~~Historically, northern fur seals were known to be killed incidentally by both the foreign and the joint U.S.-foreign commercial groundfish trawl fisheries (total estimate of 246 northern fur seals killed between 1978 and 1988), as well as the foreign high seas driftnet fisheries (total take estimate in 1991 was 5,200; 95% CI: 4,500-6,000) (Perez and Loughlin 1991, Larntz and Garrott 1993). These estimates are not included in the mortality and serious injury rate calculation in this Stock Assessment Report because the fisheries are no longer operative, although some low level of illegal fishing may still be occurring. Commercial net fisheries in international waters of the North Pacific Ocean have decreased significantly in recent years. The assumed level of incidental catch of northern fur seals in those fisheries, though unknown, is thought to be minimal (T. Loughlin, NMFS-AFSC-NMML (retired), 7600 Sand Point Way NE, Seattle, WA 98115, pers. comm.).~~

~~Between 2009 and 2013~~During 2010-2014, incidental mortality and serious injury of northern fur seals was observed in the following 3 fisheries of the 22 federally-regulated commercial fisheries in Alaska monitored for incidental mortality by fisheries observers: Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries. The ~~total~~ estimated mean annual ~~fishery-related~~ incidental mortality and serious injury rate in these fisheries ~~from 2009 to 2013~~in 2010-2014 is 1.1 ~~(CV = 0.23)~~ northern fur seals (Breiwick 2013; ~~N~~MML, unpubl. data; Table 2).

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 ~~the~~ Eastern Pacific ~~stock of~~ northern fur seals due to U.S. commercial fisheries in ~~2009-2013~~2010-2014 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; ~~N~~MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~99~~ 99 ~~99~~100 99 99 99	~~1~~ 0 (+1)[a] 0 0 0 1	~~1.0~~ 0 (+1)[b] 0 0 0 1	~~0.4~~0.2 (+0.2)[c] (CV = ~~N/A~~0.04)
Bering Sea/Aleutian Is. pollock trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~86~~ 86 98 98 97 98	~~0~~ 2 0 0 0 0	~~0~~ 2.0 0 0 0 0	0.4 (CV = 0.07)
Bering Sea/Aleutian Is. Pacific cod longline	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~60~~ 64 57 51 67 64	~~0~~ 1 0 0 0 0	~~0~~ 1.4 0 0 0 0	0.3 (CV = 0.52)
Minimum total estimated annual mortality						1.1 (CV = ~~0.23~~0.17)

[a]Total mortality and serious injury observed in 2010: 0 fur seals in sampled hauls + 1 fur seal in an unsampled haul.
[b]~~Since the t~~Total ~~known~~estimate of mortality and serious injury in 2010: 0 fur seals (extrapolated estimate from 0 fur seals observed in sampled hauls) + 1 fur seal (1 fur seal observed in an unsampled haul) ~~exceeds the estimated mortality and serious injury (0) for 2010, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year~~.
[c]Mean annual mortality and serious injury for fishery: 0.2 fur seals (mean of extrapolated estimates from sampled hauls) + 0.2 fur seals (mean of number observed in unsampled hauls).

Entanglement studies on the Pribilof Islands are another source of information on fishery-specific interactions with fur seals. Based on entanglement rates and sample sizes presented in Zavadil et al. (2003), an average of 1.1 fur seals ~~/~~per year on the rookeries were entangled in pieces of trawl netting and an average of 0.1 fur

seals ~~/~~per year ~~was~~were entangled in monofilament net. Zavadil et al. (2007) determined the juvenile male entanglement rate for 2005-2006 to be between 0.15 and 0.35%. The mean entanglement rate in this 2-year period for pups on St. George Island was 0.06-0.08%, with a potential maximum rate of up to 0.11% in October prior to weaning. Female entanglement rate on St. George Island increased during the course of the 2005-2006 breeding seasons, reaching a rate of 0.13% in October; this rate increase coincided with the arrival of progressively younger females on the rookery throughout the season (Zavadil et al. 2007).

Entanglements of northern fur seals have been observed on St. Paul, St. George, and Bogoslof Islands. ~~In~~Since 2011, there ~~was~~has been an increased effort to include entanglement reports in the NMFS Alaska Region stranding database. A summary of entanglements in fishing gear that were reported ~~between 2009 and 2013~~in 2010-2014 is provided in Table 3 (Helker et al. 2016).

Three northern fur seals entangled in commercial Bering Sea/Aleutian Islands halibut longline gear and nine northern fur seals entangled in commercial Bering Sea/Aleutian Islands trawl gear were reported to the NMFS Alaska Region stranding network in 2010-2014, resulting in minimum mean annual mortality and serious injury rates of 0.6 and 1.8 fur seals, respectively, in these fisheries (Table 3; Helker et al. 2016).

An additional seven 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, and 1 in 2014) and unidentified net (1 each in 2011 and 2012); however, since these animals were disentangled and released with non-serious injuries (Helker et al. 2016), they were not included in the mean annual mortality and serious injury rate for 2010-2014.

The total mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2010-2014 is 3.5 northern fur seals (1.1 from observer data + 2.4 from stranding data).

The minimum mean annual mortality and serious injury rate due to entanglement in ~~trawl gear (0.4),~~ fishing line (0.2), pot gear (0.2), gillnet (0.2), and unidentified fishing net (~~0.6~~0.8) in Alaska waters in ~~2009-2013~~2010-2014 is 1.4 northern fur seals (Table 3; Helker et al. 2016). 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. More thorough reporting of events has occurred since 2011, and ~~T~~there is significantly higher observation effort on the rookeries during the years of pup production (even years) than during odd numbered years, so this difference in the level of effort ~~should be taken into consideration with~~most likely affects estimates of entanglement based on opportunistic reports.

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 ~~Between 2009 and 2013~~2010-2014, ~~two~~ three northern fur seal entanglements in trawl gear occurred off the ~~Oregon~~U.S. west coast in December through May~~during this time period: one in an unknown fishing net in February 2009 and one in trawl gear in April 2011~~ (Carretta et al. ~~2015~~2016), resulting in an average annual mortality and serious injury rate of ~~0.4~~0.6 Eastern Pacific northern fur seals in these waters (Table 3). 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 (Carretta et al. ~~2015~~2016); therefore, it was not included in the mean annual mortality and serious injury rate for 2010-2014.

Table 3. Summary of mortality and serious injury of ~~the~~ Eastern Pacific ~~stock of~~ northern fur seals, by year and type, reported to the NMFS Alaska Region (Helker et al. ~~2015~~2016) and NMFS U.S. West Coast Region (Carretta et al. ~~2015~~2016)~~,~~ marine mammal stranding ~~databases~~networks~~,~~ in ~~2009-2013~~2010-2014. 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**~~	~~**2009**~~	~~**2010**~~	~~**2011**~~	~~**2012**~~	~~**2013**~~	~~**Mean annual mortality**~~
~~Entanglement (unknown fishing net)~~	~~1[a]~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0.4~~
~~Entanglement (unknown marine debris/gear)~~	~~3[a]~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0.8~~
~~Entanglement (trawl gear)~~	~~0~~	~~0~~	~~1[a]~~	~~0~~	~~0~~	~~0.2~~
~~Neck entanglement (fishing line)~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0~~	~~0.2~~
~~Neck entanglement (fishing net)~~	~~0~~	~~0~~	~~0~~	~~2~~	~~0~~	~~0.4~~
~~Neck entanglement (packing band)~~	~~0~~	~~0~~	~~2~~	~~0~~	~~0~~	~~0.4~~

~~Cause of injury~~	~~2009~~	~~2010~~	~~2011~~	~~2012~~	~~2013~~	~~Mean annual mortality~~
~~Neck entanglement (pot gear)~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0~~	~~0.2~~
~~Neck entanglement (trawl gear)~~	~~0~~	~~0~~	~~2~~	~~0~~	~~0~~	~~0.4~~
~~Neck entanglement (unknown marine debris/gear)~~	~~0~~	~~0~~	~~8~~	~~3~~	~~1~~	~~2.4~~
~~Power plant entrainment~~	~~0~~	~~0~~	~~0~~	~~1[a]~~	~~0~~	~~0.2~~
~~Sum of 2011, 2012 M/SI events[b]~~			~~15~~	~~8~~		~~12~~

Cause of injury	2010	2011	2012	2013	2014	Mean annual mortality
Entangled in commercial Bering Sea/Aleutian Is. halibut longline gear	0	0	0	0	3	0.6
Entangled in commercial Bering Sea/Aleutian Is. trawl gear	0	2	1	0	6	1.8
Entangled in Bering Sea crab pot gear*	0	1	0	0	0	0.2
Entangled in Bering Sea/Aleutian Is. monofilament hook and line gear*	0	1	0	0	0	0.2
Entangled in gillnet*	0	0	0	0	1	0.2
Entangled in unidentified net*	0	0	3	0	1	0.8
Entangled in trawl gear*	0	1[a]	0	0	2[a]	0.6
Entangled in marine debris	0	10	4	1	11	5.2
Entrained in power plant intake	0	0	1[a]	0	0	0.2
Sum of 2011, 2012, and 2014 events[b]		15	9		24	16
Total commercial fisheries						2.4
*Total unknown (commercial, recreational, or subsistence) fisheries						2.0
Total marine debris						5.2
Total other sources (power plant entrainment)						0.2

[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.
[b]An increase in the number of reports is not necessarily an indication of an increase in occurrence of entanglements but rather is a reflection of more thorough reporting of these events in the NMFS Alaska Region stranding database as of 2011. The average of the sum of mortality/serious injury (M/SI) events reported in 2011, ~~and~~ 2012, and 2014 may be a more accurate number of annual M/SI for management purposes due to more thorough reporting for those years.

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 total of 113 sub-adult males and one female were harvested on St. George in 2009 (Lekanof 2009).~~ Only juvenile males were harvested in 2010; no females were reported as accidentally killed. A single female was killed during the harvest on St. Paul Island in 2011 (Lestenkof et al. 2011).~~.~~ ~~O~~one female was killed on St. George Island in 2012 (Lekanof 2013), ~~and~~ three females were killed on St. Paul ~~Island~~ in 2013 (Lestenkof et al. 2014).~~.~~ and four females were killed on St. Paul (Melovidov et al. 2014) and one was killed on St. George (Kashevarof 2014b) in 2014. During the inaugural pup harvest on St. George Island in 2014, 54 pups were killed (M. Williams, NMFS, Alaska Regional Office, Anchorage, AK, pers. comm). ~~Between 2009 and 2013~~During 2010-2014, ~~there was~~ an ~~annual~~ average of ~~432~~426 northern fur seals were harvested each year in the subsistence harvest on the Pribilof Islands (Table 4).

Table 4. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands in ~~2009-2013~~2010-2014.

Year	St. Paul	St. George	Total harvested
~~2009~~	~~341[a]~~	~~114[b]~~	~~455~~
2010	357[~~e~~a]	78[~~d~~b]	435
2011	323[~~e~~c]	120[~~f~~d]	443
2012	383[~~g~~e]	64[~~h~~f]	447
2013	301[~~i~~g]	80[~~j~~h]	381
2014	266[i]	158[j, k]	424
Mean annual take (~~2009-2013~~2010-2014)			~~432~~426

~~[a]Zavadil (2009); [b]Lekanof (2009);~~ [~~e~~a]Zavadil et al. (2011); [~~d~~b]Merculief (2010); [~~e~~c]Lestenkof et al. (2011); [~~f~~d]Merculief (2011); [~~g~~e]Lestenkof et al. (2012); [~~h~~f]Lekanof (2013); [~~i~~g]Lestenkof et al. (2014); [~~j~~h]Kashevarof (2014a); [i]Melovidov et al. (2014); [j]Kashevarof (2014b); [k]M. Williams, NMFS, Alaska Regional Office, Anchorage, AK, pers. comm.

Other Mortality

Intentional killing of northern fur seals by commercial fishers, sport fishers, and others may occur, but the magnitude of that mortality is unknown. Such shooting has been illegal since the species was designated as "depleted" in 1988.

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 ~~packing bands (0.4 in Alaska waters) and unknown~~ marine debris ~~or gear (3.2: 2.6~~ in Alaska waters ~~+ 0.6 in Oregon waters)~~ in 2010-2014 is ~~3.6~~5.2 Eastern Pacific northern fur seals ~~in 2009-2013~~ (Table 3; Helker et al. 2016). ~~An additional mean annual mortality and serious injury rate of 0.2 Eastern Pacific northern fur seals occurred in 2009-2013 due to~~ A northern fur seal mortality in 2012 due to entrainment in the cooling water system of a California power plant ~~in 2012~~resulted in an additional mean annual mortality and serious injury rate of 0.2 Eastern Pacific northern fur seals in 2010-2014 (Table 3; Carretta et al. ~~2015~~2016).

An additional 14 northern fur seals that were initially considered seriously injured due to entanglement in marine debris (3 in 2011, 7 in 2012, and 4 in 2014) were disentangled and released with non-serious injuries (Helker et al. 2016); therefore, these animals were not included in the mean annual mortality and serious injury rate for 2010-2104.

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 2008 and 2012, there was~~ In 2009, a single mortality resulted~~ing~~ from research on the Eastern Pacific stock of northern fur seals ~~in 2009~~, for an average annual mortality and serious injury rate of 0.2 northern fur seals in 2008-2012 (NMFS, Office of Protected Resources, Division of Permits and Conservation, ~~Office of Protected Resources, NMFS, 1315 East-West Highway,~~ Silver Spring, MD ~~20910~~). Mortality and serious injury of northern fur seals also occurred during a research groundfish bottom trawl survey in Alaska waters in 2009 (Helker et al. 2015) and a research trawl survey in California waters in 2009 (Carretta et al. 2015), resulting in an average annual mortality and serious injury rate of 0.4 northern fur seals in 2008-2012. The total combined mean annual mortality and serious injury rate ~~of northern fur seals~~ from marine mammal (0.2) and fisheries (0.4) research activities is 0.6 northern fur seals per year in 2008-2012.

STATUS OF STOCK

Based on currently available data, the minimum estimate~~d~~ of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (~~1.1~~3.5 fur seals) is less than 10% of the calculated PBR (10% of PBR = ~~1,180~~1,140) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The total estimated annual level of ~~total~~ human-caused mortality and serious injury (~~1.1 (commercial fisheries) + 1.8 (unknown fisheries) + 432 (Alaska Native harvest) + 0.6 (research activities) + 3.6 (marine debris/gear) + 0.2 (power plant entrainment) = 439~~438 fur seals) does not exceed the PBR (~~11,802~~11,405) 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) and there was no compelling

evidence that carrying capacity (K, assumed to be 1.8 million animals) had changed substantially since the late 1950s. The Eastern Pacific stock of northern fur seals is classified as a strategic stock because it is designated as "depleted" under the MMPA.~~ This stock will remain designated as "depleted" until population levels reach at least the lower limit of its Optimum Sustainable Population (estimated at 60% of K: 1,080,000).~~

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 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). 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). Call et al. (2008) 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.

Fishing effort displaced by Steller sea lion protection measures may have moved to areas important to fur seals; recent 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). From 1982 to 2002, 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 the relative distribution of pollock fishery effort in summer on the eastern Bering Sea shelf. Adult female fur seals 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 ~~have an effect on~~be affecting abundance and productivity of fur seals breeding in Alaska.

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

CITATIONS

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

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

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

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

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

Carretta, J. V., M. M. Muto, S. Wilkin, J. Greenman, K. Wilkinson, M. DeAngelis, J. Viezbicke, D. Lawson, J. Rusin, and J. Jannot. 2015. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2009-2013. U.S. Dep. Commer. NOAA Tech. Memo NMFS-SWFSC-548, 108 p.

Carretta, J. V., M. M. Muto, S. Wilkin, J. Greenman, K. Wilkinson, M. DeAngelis, J. Viezbicke, and J. Jannot. 2016. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-554, 101 p.

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

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

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

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

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

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

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

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

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

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

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

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

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

Larntz, K., and R. Garrott. 1993. Analysis of 1991 bycatch of selected mammal species in the North Pacific neon squid driftnet fishery. Final Contract Report prepared for NMFS. 68 p~~p~~. + appendices.

~~Lekanof, P. A. 2009. The subsistence harvest of northern fur seals on St. George Island in 2009. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK. 8 pp.~~

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

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

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

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

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

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Report to NMFS Alaska Region. 98 p~~p~~. Available online: https://alaskafisheries.noaa.gov/sites/default/files/1999-2000cookinlet.pdf. Accessed ~~December 2015~~June 2016.

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

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

Merculief, A. 2010. The subsistence harvest of northern fur seals on St. George Island in 2010. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, AK. 8 p~~p~~.

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

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

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

Perez, M. A., and T. R. Loughlin. 1991. Incidental catch of marine mammals by foreign-directed and joint-venture fishing vessels in the U.S. EEZ of the North Pacific, 1973-1988. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-104, 57 p.

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

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

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

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

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

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

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

Towell, R., and R. Ream. 2012. 2011 northern fur seal pup production estimate on Bogoslof Island, Alaska. Available online: http://www.afsc.noaa.gov/nmml/PDF/BogPupMem11_final.pdf. Accessed June 2016.

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

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

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

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

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

~~Zavadil, P. A. 2009. 2009 subsistence fur seal harvest on St. Paul Island. Memorandum for the Record, December 2009. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 2 pp.~~

Zavadil, P. A., A. D. Lestenkof, M. T. Williams, and S. A. MacLean. 2003. Assessment of northern fur seal entanglement in marine debris on St. Paul Island, Alaska in 2002. Unpubl. report available from the Aleut Community of St. Paul Island, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 12 p~~p~~.

Zavadil, P. A., B. W. Robson, A. D. Lestenkof, R. Holser, and A. Malavansky. 2007. Northern fur seal entanglement studies on the Pribilof Islands in 2006. 56 p~~p~~. Available online: http://doc.nprb.org/web/research/research%20pubs/outside_publications/733_entanglement.pdf. Accessed ~~December 2015~~June 2016.

Zavadil, P. A., P. M. Lestenkof, S. M. Zachaorf, and P. I. Melovidov. 2011. The subsistence harvest of sub-adult northern fur seals on St. Paul Island, Alaska in 2010. Memorandum for the Record, January 2011. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, AK. 2 p~~p~~.

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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).

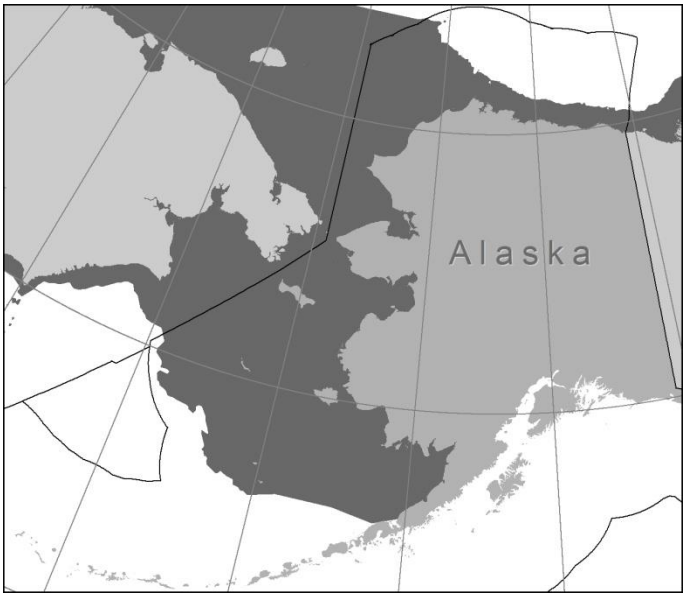

Figure 1. Approximate distribution of bearded seals (dark shaded area) in Alaska. The combined summer and winter distribution are depicted.

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, ~~and that~~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~~ and~~–2000 along the Alaskan coast indicate that bearded seals are typically more abundant 20-100 nmi from shore than within 20 nmi ~~of~~from shore, ~~with the exception of~~except for high concentrations nearshore to the south of Kivalina (Bengtson et al. 2000, 2005; Simpkins et al. 2003). Many ~~of the~~ 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 ~~from~~ in December~~ to~~–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 ~~of~~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 ~~those~~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 ~~reliable~~ 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 ~~partial~~ 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 (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 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Using the ~~partial~~ N_{MIN} calculated for bearded seals in the Bering Sea, a ~~partial~~ 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, ~~because~~this is not an ~~reliable~~ estimate of ~~minimum abundance~~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 ~~or~~and Beaufort seas~~), the PBR for this stock is unknown~~.

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. ~~Between 2009 and 2013~~During 2010-2014, incidental mortality and serious injury ~~and mortality~~ of bearded seals occurred in three ~~of these~~ 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 ~~1.2~~1.4 bearded seals, based exclusively on observer data.

Table 1. Summary of incidental mortality and serious injury of ~~the~~ Alaska ~~stock of~~ bearded seals due to U.S. commercial fisheries ~~from 2009 to 2013~~in 2010-2014 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; ~~N~~MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. pollock trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~86~~ 86 98 98 97 98	~~1~~ 0 (+1)[a] 0 1 0 1	~~1.0~~ 0 (+1)[b] 0 1.0 0 1.0	~~0.6~~0.4 (+0.2)[c] (CV = ~~N/A~~0.11)
Bering Sea/Aleutian Is. flatfish trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~99~~ 99 ~~99~~100 99 99 99	~~0~~ 0 1 1 0 1	~~0~~ 0 1~~.0~~ 1.0 0 1	~~0.4~~0.6 (CV = 0.03)
Bering Sea/Aleutian Is. Pacific cod trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~63~~ 66 60 68 80 80	~~0~~ 0 0 0 1 0	~~0~~ 0 0 0 1 0	0.2 (CV = 0)
Minimum total estimated annual mortality						~~1.2~~1.4 (CV = ~~0.03~~0.04)

[a]Total mortality and serious injury observed in 2010: 0 seals in sampled hauls + 1 seal in an unsampled haul.
[b]~~Since the t~~Total ~~known~~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) ~~exceeds the estimated mortality and serious injury (0) for the fishery in 2010, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year~~.
[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 ~~Kaktovik~~the Beaufort Sea, 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~~ collected~~ing~~ it since 2008, ~~as~~when funding and ~~available~~ personnel have allowed. Annual household survey results ~~are~~ compiled in a statewide harvest report ~~that~~ include~~s~~ historical ice seal harvest information back to 1960 (Quakenbush et al. 2011). This report is used to determine where and how often harvest information ~~has been~~was collected and where ~~efforts need~~ to ~~be~~ focus~~ed~~ in the future (Ice Seal Committee 2014). ~~Current i~~Information ~~, within the last 5 years,~~for 2009-2013 is available for ~~11~~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 ~~the last 5 years~~this time period 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~~not appropriate. For example, during ~~the past 5 years (~~2009-2013~~)~~, only ~~11~~12 of ~~the~~ 64 coastal communities ~~have been~~were surveyed for bearded seals; and, of those communities, only 6 ~~have been~~were surveyed for two or more consecutive years (Ice Seal Committee 2015). Based on the harvest data from these ~~11~~12 communities (Table 2), a minimum estimate of the average annual harvest of bearded seals in 2009-2013 is ~~379~~441 seals. The Ice Seal Committee is working toward a better understanding of ice seal harvest by conducting more consecutive surveys in more communities with ~~the~~a goal ~~of being able~~ to report a statewide ice seal harvest estimate ~~in the future~~.

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

Community	Alaska Native population (2013)	Estimated bearded seal harvest				
		2009	2010	2011	2012	2013
Point Lay					55	
Kivalina	352			123	117	
Noatak	514			65	57	
Buckland	519			47	42	
Deering	176			49	42	
Emmonak	782			106		
Scammon Bay	498			82	51	
Hooper Bay	1,144	332	148	210	~~212~~213	171
Tununak	342	21	40	42	44	
Quinhagak	694		29	26	44	49
Togiak	842	0	0	2		
Twin Hills	66	0	0			
Total		353	217	752	~~351~~665	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. ~~Between~~During 2007~~ and~~-2011, one mortality resulted from research on the Alaska stock of bearded seals (in 2007), which result~~s~~ed in an average annual mortality and serious injury rate of 0.2 bearded seals from this stock (Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910, 11 January 2012).

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 bearded seals, ringed seals, spotted seals, and walrus~~, and a few bearded seals,~~ in northern and western Alaska. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, ~~NOAA~~NMFS and USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on December 20, 2011. Disease surveillance efforts in 2012-2013 ~~did not~~ detected ~~any~~few new cases similar to those observed in 2011, but the UME investigation remains open for ~~ice~~bearded seals based on continuing reports in 2013~~ and~~-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 December 28, 2012, NMFS listed the Beringia DPS and, thus, the Alaska Stock of bearded seals, as "threatened" under the Endangered Species Act (ESA) (77 FR 76740). Because of its "threatened" status under the ESA, this stock was designated as "depleted" under the MMPA and was classified as a strategic stock.~~ On July 25, 2014, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit ~~challenging~~that challenged ~~the~~ listing ~~of~~ 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 ~~level of~~mean annual U.S. commercial fishery-related mortality and serious injury rate that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. A ~~partial~~ PBR for only those bearded seals that overwinter and breed in the U.S.

portion of the Bering Sea~~, however,~~ is 8,210 bearded seals. The total estimated annual level of human-caused mortality and serious injury ~~based on commercial fisheries observer data (1.2), the most recent MMPA permit records (0.2), and a minimum estimate of the Alaska Native harvest (379)~~ is ~~380~~443 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 ~~has been~~are being modified by the warming climate. ~~and, more so, that the~~Future scientific projections are for continued and perhaps accelerated warming ~~in the foreseeable future~~ (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 ~~coastal regions in the vicinity of~~at onshore haul-out sites ~~on shore~~ (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 ~~of~~for the future conservation status of each bearded seal ~~species segment~~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 ~~of~~in the Gulf of Anadyr and in the area between St. Lawrence Island and the Bering Strait. ~~In June~~Suitable ice in June in the Bering Sea~~, suitable ice~~ 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 ~~carbon dioxide~~CO_2 in the atmosphere, may ~~impact~~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.

CITATIONS

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

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

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

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

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

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

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

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

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

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

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

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

Fay, F. H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea,~~.~~ ~~P~~p. 383-399. *In* D. W. Hood and E. J. Kelley (eds.), Oceanography of the Bering Sea. Institute of Marine Science, Hakodate, Japan.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Society for Marine Mammalogy, Lawrence, KS. 231 p~~p~~.

Scheffer, V. B. 1958. Seals, Sea Lions and Walruses: A Review of the Pinnipedia. Stanford University Press, Palo Alto, CA. 179 ~~pp~~p.

Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. L. Bengtson. 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. Polar Biol. 26:577-586.

Smith, T. G. 1981. Notes on the bearded seal, *Erignathus barbatus*, in the Canadian Arctic. Department of Fisheries and Oceans, Arctic Biological Station, Can. Tech. Rep. Fish. Aquat. Sci. No. 1042. 49 ~~pp~~p.

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

RINGED SEAL (~~*Phoca*~~*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.~~hoca~~ h.~~ispida~~ hispida* in the Arctic Ocean and Bering Sea; *P.~~hoca~~ h.~~ispida~~ ochotensis* in the Sea of Okhotsk and northern Sea of Japan; *P.~~hoca~~ h.~~ispida~~ botnica* in the northern Baltic Sea; *P.~~hoca~~ h.~~ispida~~ lagodensis* in Lake Ladoga, Russia; and *P.~~hoca~~ h.~~ispida~~ 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). ~~but suggest gene flow from the Arctic to the Baltic as well as w~~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).~~; however,~~ ~~t~~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.~~hoca~~ h.~~ispida~~ hispida*) that occurs within the U.S. Exclusive Economic Zone ~~(EEZ)~~ of the Beaufort, Chukchi, and Bering seas (Fig. 1).

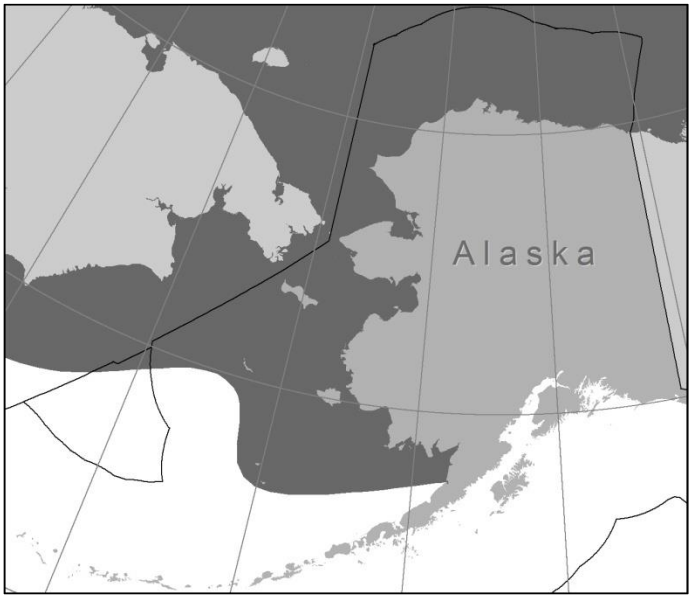

Figure 1. Approximate winter distribution of ringed seals (dark shaded area).~~ The combined summer and winter distribution are depicted.~~

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 ~~in contact~~ 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, ~~it is thought that~~ 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. ~~and s~~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). ~~Many~~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, ~~had~~ incompletely ~~coverage of~~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. ~~Burns and Harbo (1972) conducted aerial surveys along the North Slope of Alaska (between Point Lay and Kaktovik) during June 1970, and reported a minimal estimate of 11,612 ringed seals in areas of shorefast ice. Frost and Lowry (1984) produced a rough estimate of 40,000 ringed seals in the Alaska Beaufort Sea during winter and spring by applying an assumed correction factor for availability bias (i.e., for seals not hauled out at the time of the surveys) to the average density observed from 7 years of aerial surveys in the Alaska and Yukon Beaufort Sea and extrapolating over the entire area of the continental shelf. Their estimate during summer of 80,000 ringed seals was based on the assumption that this population doubles as seals from the Bering and Chukchi seas move in with the receding ice edge. Based on an analysis of surveys conducted during the 1970s, Frost (1985) estimated 1 to 1.5 million ringed seals in Alaska waters, of which 250,000 were estimated in shorefast ice. These estimates were considered conservative when compared with polar bear predation rates (Frost 1985); however, details of the analysis were not published. Frost et al. (1988) reported detailed methods and results of surveys conducted in the Alaska Chukchi and Beaufort seas during May-June 1985-1987. Survey effort was directed towards shorefast ice within 20 nmi of shore, though some areas of adjacent pack ice were also surveyed, and estimates were based on observed densities extrapolated over estimates of available habitat without correcting for availability bias. In the Chukchi Sea, total numbers of hauled out ringed seals in shorefast ice ranged from 18,400 ± 1,700 in 1985 to 35,000 ± 3,000 in 1986. The 1987 estimate of 20,200 ± 2,300 was similar to 1985. In the Beaufort Sea, the estimated number of ringed seals hauled out within the 20-m depth contour ranged from 9,800 ± 1,800 in 1985 to 13,000 ± 1,600 in 1986. The 1987 estimate (19,400 ± 3,700) was considerably higher but may have included seals that had moved in from other areas as the ice began to break up (Frost et al. 1988).~~ 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- ~~and~~ 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. ~~The estimates from 1999 and 2000 in the Chukchi Sea only covered a portion of this stock's range and were conducted over a decade ago.~~ 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 ~~of the species~~, Kelly et al. (2010a) estimated the total population in the Alaska Chukchi and Beaufort seas to be at least 300,000 ringed seals. ~~, which Kelly et al. (2010a) state~~ This estimate is likely an underestimate since the Beaufort Sea surveys were limited to within 40 km ~~of~~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 ~~During April-May in 2012 and 2013, U.S. and Russian researchers conducted comprehensive and synoptic aerial abundance and distribution surveys of ice-associated seals in the Bering and Okhotsk seas (Moreland et al. 2013). Preliminary analysis of the U.S. surveys, which included only a small subset of the 2012 data, produced an estimate of~~ about 170,000 ringed seals ~~in the U.S. EEZ of the Bering Sea in late April (Conn et al. 2014)~~. This estimate ~~does~~did not account for availability bias~~,~~ and did not include ringed seals in the shorefast ice zone, which were surveyed using a different method. ~~t~~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. ~~The full data sets are currently being processed and analyzed to provide abundance estimates for bearded, spotted, ribbon, and ringed~~

~~seals in the Bering and Okhotsk seas. Similar surveys in the Chukchi and Beaufort seas are planned for the near future, pending funding.~~

Minimum Population Estimate

~~The estimate of 300,000 ringed seals presented in Kelly et al. (2010a) is based on estimates from surveys by Bengtson et al. (2005) and Frost et al. (2004) in the late 1990s and 2000. This estimate is likely an underestimate, as it is based on surveys of a portion of the range, and is more than 8 years old. A reliable estimate of N_{MIN} for the total population in the Alaska Chukchi and Beaufort sea regions is not available.~~An 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 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 ~~over~~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). ~~Since the data used to produce the abundance estimate presented in Kelly et al. (2010a) are more than 8 years old, and no reliable N_{MIN} is available, PBR is undetermined.~~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 seals (170,000 × 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.

~~Between 2009 and 2013~~During 2010-2014, incidental mortality and serious injury ~~and mortality~~ 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 ~~2009 to 2013~~2010 to 2014, the average annual rate of mortality and serious injury incidental to U.S. commercial fishing operations is ~~4.1~~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 ~~the~~ Alaska ~~stock of~~ ringed seals due to U.S. commercial fisheries ~~from 2009 to 2013~~in 2010-2014 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; ~~N~~MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~99~~ 99 ~~99~~100 99 99 99	~~1~~ 0 6 (+1)[a] 3 3 0	~~1.0~~ 0 6.0 (+1)[b] 3.0 3~~.0~~ 0	~~2.8~~2.4 (+0.2)[c] (CV = ~~N/A~~0.02)
Bering Sea/Aleutian Is. pollock trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~86~~ 86 98 98 97 98	~~1~~ 0 3 0 0 0	~~1.0~~ 0 3.0 0 0 0	~~0.8~~0.6 (CV = 0.03)
Bering Sea/Aleutian Is. Pacific cod trawl	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~63~~ 66 60 68 80 80	~~0~~ 0 1 0 0 0	~~0~~ 0 1~~.0~~ 0 0 0	0.2 (CV = 0)
Bering Sea/Aleutian Is. Pacific cod longline	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~60~~ 64 57 51 ~~67~~66 64	~~0~~ 0 1 0 0 0	~~0~~ 0 1.6 0 0 0	0.3 (CV = 0.61)
Minimum total estimated annual mortality						~~4.1~~3.7 (CV = ~~0.17~~0.06)

[a]Total mortality and serious injury observed in 2011: 6 seals in sampled hauls + 1 seal in an unsampled haul.
[b]~~Since the t~~Total ~~known~~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) ~~exceeds the estimated mortality and serious injury (6.0) for the fishery in 2011, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year~~.
[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 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 ~~Kaktovik~~the Beaufort Sea, 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~~ collected~~ing~~ it since 2008, ~~as~~when funding and ~~available~~ personnel have allowed. Annual household survey results ~~are~~ compiled in a statewide harvest report ~~that~~ include~~s~~ historical ice seal harvest information back to 1960 (Quakenbush et al. 2011). This report is used to determine where and how often harvest information ~~has been~~was collected and where ~~efforts need~~ to ~~be~~ focus~~ed~~ in the future (Ice Seal Committee 2014). ~~Current i~~Information~~,~~ ~~within the last 5 years~~for 2009-2013~~,~~ is available for ~~11~~12 communities (Point Lay, Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills) (Table ~~2~~3), but more than 50 other communities harvest ringed seals and have not been surveyed in ~~the last 5 years~~this time period 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~~not appropriate. For example, during ~~the past 5 years (~~2009-2013~~)~~, only ~~11~~12 of ~~the~~ 64 coastal communities ~~have been~~were surveyed for ringed seals; and, of those communities, only 6 ~~have been~~were surveyed for two or more consecutive years (Ice Seal Committee 2015). Based on the harvest data from these ~~11~~12 communities (Table ~~2~~3), a minimum estimate of the average annual harvest of ringed seals in 2009-2013 is ~~1,040~~1,058 seals. The Ice Seal Committee is working toward a better understanding of ice seal harvest by conducting more consecutive surveys in more communities with ~~the~~a goal ~~of being able~~ to report a statewide ice seal harvest estimate ~~in the future~~.

Table ~~2~~3. Alaska ~~R~~ringed seal harvest estimates ~~from~~in 2009~~- to~~-2013 and the Alaska Native population for each community (Ice Seal Committee 2015).

Community	Alaska Native population (2013)	Estimated ringed seal harvest				
		2009	2010	2011	2012	2013
Point Lay					51	
Kivalina	352			16	15	
Noatak	514			3	2	
Buckland	519			26	23	
Deering	176			0	0	
Emmonak	782			56		
Scammon Bay	498			137	169	
Hooper Bay	1,144	889	458	674	651	667
Tununak	342	232	162	257	219	
Quinhagak	694		163	117	140	160
Togiak	842	1	1	0		
Twin Hills	66	0	0			
Total		1,122	784	1,286	~~1,179~~1,270	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 ~~of Alaska~~. By December 2011, there were more than 100 cases of affected pinnipeds, including ringed seals, bearded seals, spotted seals, ~~bearded seals,~~ and walruses, in northern and western Alaska. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, ~~NOAA~~NMFS and 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~~ringed seals based on continuing reports in 2013~~- and~~-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.

~~Between 2009 and 2013~~In 2011, ~~one~~a ringed seal mortality, due to a gunshot wound to the head, was reported to the NMFS Alaska Region stranding ~~database~~network (Helker et al. ~~2015~~2016). This seal~~,~~ was

presumed~~ably~~ to be a struck and lost animal from the Alaska Native subsistence hunt~~, had skin lesions consistent with those seen in animals considered part of the multi-species Northern Pinniped 2011 Unusual Mortality Event~~.

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.~~hoca~~ h.~~ispida~~ 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 the Arctic ringed seals as a "threatened" species. Consequently, it is also no longer designated as "depleted" or classified as a strategic stock. ~~Since PBR is undetermined, it is not possible to determine whether direct human-caused mortality and serious injury exceeds PBR and it is not known whether the current annual level of incidental U.S. commercial fishery-related mortality and serious injury (4.1) exceeds 10% of the PBR. However, mortality and serious injury occurring incidental to commercial fishing is likely small.~~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 ~~average~~ annual level of human-caused mortality and serious injury ~~based on commercial fisheries observer data (4.1) and a minimum estimate of the Alaska Native harvest (1,040)~~ is ~~1,044~~1,062 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 sea-ice and snow habitats have 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 (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).~~, and~~ ~~s~~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.

CITATIONS

Amano, M., A. Hayano, and N. Miyazaki. 2002. Geographic variation in the skull of the ringed seal, *Pusa hispida*. J. Mammal. 83:370-380.

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

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

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

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

~~Burns, J. J., and S. J. Harbo. 1972. An aerial census of ringed seals, northern coast of Alaska. Arctic 25:279-290.~~

Chapskii, K. K. 1940. The ringed seal of western seas of the Soviet Arctic (The morphological characteristic, biology and hunting production).~~.~~ ~~P~~p. 147. *In* N. A. Smirnov (ed.), Proceedings of the Arctic Scientific Research Institute, Chief Administration of the Northern Sea Route. Izd. Glavsevmorputi, Leningrad, Moscow. (Translated from Russian by the Fisheries Research Board of Canada, Ottawa, Canada, Translation Series No. 1665, 147 p~~p~~.)

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

Crawford, J. A., K. J. Frost, L. T. Quakenbush, and A. Whiting. 2012. Different habitat use strategies by subadult and adult ringed seals (*Phoca hispida*) in the Bering and Chukchi seas. Polar Biol. 35:241-255.

Davis, C. S., I. Stirling, C. Strobeck, and D. W. Coltman. 2008. Population structure of ice-breeding seals. Mol~~ec~~. Biol. 17:3078-3094.

Fedoseev, G. A. 1975. Ecotypes of the ringed seal (*Pusa hispida* Schreber, 1777) and their reproductive capabilities. Biology of the Seal. Proceedings of a Symposium held in Guelph, 14-17 August 1972. Rapports et Proces-verbaux des Réunions. Conseil International pour l'Éxploration de la Mer. 169:156-160.

Finley, K. J., G. W. Miller, R. A. Davis, and W. R. Koski. 1983. A distinctive large breeding population of ringed seals (*Phoca hispida*) inhabiting the Baffin Bay pack ice. Arctic 36:162-173.

Freitas, C., K. M. Kovacs, R. A. Ims, M. A. Fedak, and C. Lydersen. 2008. Ringed seal post-moulting movement tactics and habitat selection. Oecologia 155:193-204.

Frost, K. J. 1985. The ringed seal (*Phoca hispida*).~~.~~ ~~P~~p. 79-87. *In* J. J. Burns, K. J. Frost, and L. F. Lowry (eds.), Marine Mammal~~s~~ Species Accounts. Alaska Department of Fish and Game, Juneau, AK.

Frost, K. J., and L. F. Lowry. 1984. Trophic relationships of vertebrate consumers in the Alaskan Beaufort Sea.~~.~~ ~~P~~p. 381-401. *In* P. W. Barnes, D. M. Schell, and E. Reimnitz (eds.), The Alaskan Beaufort Sea: ~~–~~ Ecosystems and Environments. Academic Press, Inc., New York, NY.

Frost, K. J., L. F. Lowry, J. R. Gilbert, and J. J. Burns. 1988. Ringed seal monitoring: relationships of distribution and abundance to habitat attributes and industrial activities. Final Report Contract No. 84-ABC-00210 submitted to U.S. Dep. Interior, Minerals Management Service, Anchorage, AK. 101 p~~p~~.

Frost, K. J., L. F. Lowry, G. Pendleton, and H. R. Nute. 2002. Monitoring distribution and abundance of ringed seals in northern Alaska. OCS Study MMS 2002-04. Final Report from the Alaska Department of Fish and Game, Juneau, AK, for U.S. Minerals Management Service, Anchorage, AK. 66 p~~p~~. + appendices.

Frost, K. J., L. F. Lowry, G. Pendleton, and H. R. Nute. 2004. Factors affecting the observed densities of ringed seals, *Phoca hispida*, in the Alaskan Beaufort Sea, 1996-99. Arctic 57:115-128.

Hammill, M. O., and T. G. Smith. 1991. The role of predation in the ecology of the ringed seal in Barrow Strait, Northwest Territories, Canada. Mar. Mammal Sci. 7:123-135.

Härkönen, T., O. Stenman, M. Jüssi, I. Jüssi, R. Sagitov, and M. Verevkin. 1998. Population size and distribution of the Baltic ringed seal (*Phoca hispida botnica*),~~.~~ ~~P~~p. 167-180. *In* M. P. Heide-Jørgensen and C. Lydersen (eds.), Ringed Seals in the North Atlantic. NAMMCO Scientific Publications, Vol. 1, Tromsø, Norway.

Harwood, L. A., and I. Stirling. 1992. Distribution of ringed seals in the southeastern Beaufort Sea during late summer. Can. J. Zool. 70(5):891-900.

Harwood, L. A., T. G. Smith, and J. C. Auld. 2012. Fall migration of ringed seals (*Phoca hispida*) through the Beaufort and Chukchi seas, 2001-02. Arctic 65:35-44.

Harwood, L. A., T. G. Smith, J. C. Auld, H. Melling, and D. J. Yurkowski. 2015. Seasonal movements and diving of ringed seals, *Pusa hispida*, in the western Canadian Arctic, 1999-2001 and 2010-11. Arctic 68(2):193-209.

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

Hezel, P. J., X. Zhang, C. M. Bitz, B. P. Kelly, and F. Massonnet. 2012. Projected decline in spring snow depth on Arctic sea ice caused by progressively later autumn open ocean freeze-up this century. Geophys. Res. Lett. 39:L17505.

Hyvärinen, H., and M. Nieminen. 1990. Differentiation of the ringed seal in the Baltic Sea, Lake Ladoga and Lake Saimaa. Finnish Game Res. 47:21-27.

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

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

Kelly, B. P. 1988a. Ringed seal, *Phoca hispida*,~~.~~ ~~P~~p. 57-75. *In* J. W. Lentfer (ed.), Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, DC.

Kelly, B. P. 1988b. Locating and characterizing ringed seal lairs and breathing holes in coordination with surveys using forward looking infra-red sensors. Fisheries and Oceans Freshwater Institute Final Report. 17 p~~p~~.

Kelly, B. P., O. H. Badajos, M. Kunnasranta, and J. Moran. 2006. Timing and re-interpretation of ringed seal surveys. Coastal Marine Institute University of Alaska Fairbanks, Final Report. 60 p~~p~~.

Kelly, B. P., M. Ponce, D. A. Tallmon, B. J. Swanson, and S. K. Sell. 2009. Genetic diversity of ringed seals sampled at breeding sites; implications for population structure and sensitivity to sea ice loss. University of Alaska Southeast, North Pacific Research Board 631 Final Report. 28 p~~p~~.

Kelly, B. P., J. L. Bengtson, P. L. Boveng, M. F. Cameron, S. P. Dahle, J. K. Jansen, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010a. Status review of the ringed seal (*Phoca hispida*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-212, 250 p.

Kelly, B. P., O. H. Badajos, M. Kunnasranta, J. R. Moran, M. Martinez-Bakker, D. Wartzok, and P. Boveng. 2010b. Seasonal home ranges and fidelity to breeding sites among ringed seals. Polar Biol. 33:1095-1109.

King, J. E. 1983. Seals of the World. 2nd edition. British Museum (Natural History), London. 240 p~~p~~.

Kumlien, L. 1879. Mammals,~~.~~ ~~P~~p. 55-61. *In* Contributions to the Natural History of Arctic America Made in Connection with the Howgate Polar Expedition 1877-78. Government Printing Office, Washington, DC.

Kunnasranta, M. 2001. Behavioural biology of two ringed seal (*Phoca hispida*) subspecies in the large European lakes Saimaa and Ladoga. Ph.D. Diss., University of Joensuu, Joensuu, Finland. 86 p~~p~~.

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

Lukin, L. R., and V. A. Potelov. 1978. Living conditions and distribution of ringed seal in the White Sea in the winter. Soviet J. Mar. Biol. 4:684-690.

Lukin, L. P., G. N. Ognetov, and N. S. Boiko. 2006. Ecology of the ringed seal in the White Sea. UrO RAN, Ekaterinburg, Russia. 165 p~~p~~. (Translated from Russian by the Baltic Fund for Nature (BFN), State University of St. Petersburg, Russia.)

Lydersen, C. 1998. Status and biology of ringed seals (*Phoca hispida*) in Svalbard.~~.~~ ~~P~~p. 46-62. *In* M. P. Heide-Jørgensen and C. Lydersen (eds.), Ringed Seals in the North Atlantic. NAMMCO Scientific Publications, Vol. 1. Tromsø, Norway.

Lydersen, C., and I. Gjertz. 1986. Studies of the ringed seal (*Phoca hispida* Schreber 1775) in its breeding habitat in Kongsfjorden, Svalbard. Polar Res. 4:57-63.

Lydersen, C., and M. Ryg. 1991. Evaluating breeding habitat and populations of ringed seals *Phoca hispida* in Svalbard fjords. Polar Rec. 27:223-228.

Lydersen, C., and T. G. Smith. 1989. Avian predation on ringed seal *Phoca hispida* pups. Polar Biol. 9:489-490.

Lydersen, C., P. M. Jensen, and E. Lydersen. 1990. A survey of the Van Mijen Fiord, Svalbard, as habitat for ringed seals, *Phoca hispida*. Holarctic Ecol. 13:130-133.

Martinez-Bakker, M. E., S. K. Sell, B. J. Swanson, B. P. Kelly, and D. A. Tallmon. 2013. Combined genetic and telemetry data reveal high rates of gene flow, migration, and long-distance dispersal potential in Arctic ringed seals (*Pusa hispida*). PLOS ONE 8:e77125.

McLaren, I. A. 1958. The biology of the ringed seal (*Phoca hispida* Schreber) in the eastern Canadian Arctic. Bull. Fish. Res. Board Can. 118:97.

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

Moulton, F. D., W. J. Richardson, T. L. McDonald, R. E. Elliott, and M. T. Williams. 2002. Factors influencing local abundance and haulout behavior of ringed seals (*Phoca hispida*) on landfast ice of the Alaskan Beaufort Sea. Can. J. Zool. 80:1900-1917.

Müller-Wille, L. L. 1969. Biometrical comparison of four populations of *Phoca hispida* Schreb. in the Baltic and White Seas and Lakes Ladoga and Saimaa. Commentationes Biologicae Societas Scientiarum Fennica 31:1-12.

Nyman, T., M. Valtonen, J. Aspi, M. Ruokonen, M. Kunnasranta, and J. U. Palo. 2014. Demographic histories and genetic diversities of Fennoscandian marine and landlocked ringed seal subspecies. Ecol. Evol. 4:3420-3434.

Ognev, S. I. 1935. Mammals of the U.S.S.R. and Adjacent Countries. Vol. 3. Carnivora. Glavpushnina NKVT, Moscow, Russia. 641 p~~p~~. (Translated from Russian by the Israel Program for Scientific Translations, Jerusalem, Israel. 741 p~~p~~.)

Palo, J. 2003. Genetic diversity and phylogeography of landlocked seals. Dissertation. University of Helsinki, Helsinki, Finland. 29 p~~p~~.

Palo, J. U., H. S. Mäkinen, E. Helle, O. Stenman, and R. Väinölä. 2001. Microsatellite variation in ringed seals (*Phoca hispida*): genetic structure and history of the Baltic Sea population. Heredity 86:609-617.

Palo, J. U., H. Hyvärinen, E. Helle, H. S. Mäkinen, and R. Väinölä. 2003. Postglacial loss of microsatellite variation in the landlocked Lake Saimaa ringed seal. Conserv. Genet. 4:117-128.

Quakenbush, L., J. Citta, and J. Crawford. 2011. Biology of the ringed seal (*Phoca hispida*) in Alaska, 1960–2010. Final Report to NMFS. Arctic Marine Mammal Program, Alaska Department of Fish and Game, Fairbanks, AK. 72 p.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Society for Marine Mammalogy, Lawrence, KS. 231 p~~p~~.

Smith, T. G., and M. O. Hammill. 1980. A survey of the breeding habitat of ringed seals and a study of their behavior during the spring haul-out period in southeastern Baffin Island. Addendum to the Final Report to the Eastern Arctic Marine Environmental Studies (EAMES) project. Department of Fisheries and Oceans, Arctic Biological Station, Canadian Manuscript Report of Fisheries and Aquatic Sciences, No. 1561. 47 p~~p~~.

Smith, T. G., and C. Lydersen. 1991. Availability of suitable land-fast ice and predation as factors limiting ringed seal populations, *Phoca hispida*, in Svalbard. Polar Res. 10:585-594.

Smith, T. G., and I. Stirling. 1975. The breeding habitat of the ringed seal (*Phoca hispida*). The birth lair and associated structures. Can. J. Zool. 53:1297-1305.

Stirling, I., and T. G. Smith. 2004. Implications of warm temperatures, and an unusual rain event for the survival of ringed seals on the coast of southeastern Baffin Island. Arctic 57:59-67.

Trukhin, A. M. 2000. Ringed seal on the eastern coast of Sakhalin Island.~~.~~ ~~P~~p. 4. *In* V. M. Belkovich, A. N. Boltunov, and I. V. J. Smelova (eds.), Marine Mammals of the Holarctic. 2000. Materials from the International Conference, Archangel, Russia. Pravda Severa. (Translated from Russian by Olga Romanenko, 4 p~~p~~.)

Valtonen, M., J. Palo, M. Ruokonen, M. Kunnasranta, and T. Nyman. 2012. Spatial and temporal variation in genetic diversity of an endangered freshwater seal. Conserv. Genet. 13:1231-1245.

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

Walsh, J. E., O. Anisimov, J. O. M. Hagen, T. Jakobsson, J. Oerlemans, T. D. Prowse, V. Romanovsky, N. Savelieva, M. Serreze, A. Shiklomanov, I. Shiklomanov, and S. Solomon. 2005. Section 6.2. Precipitation and evapotranspiration,. Pp. 184-189. *In* Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK.

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, ~~D~~depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet (north of the East and West Forelands), Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta~~,~~ and Norton Sound), eastern Chukchi Sea (including Kotzobue Sound), and Beaufort Sea (Mackenzie River Delta) (Hazard 1988). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). Satellite transmitters on whales from the Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea stocks show monthly home ranges that are relatively distinct among these populations' summering areas and autumn migratory routes (e.g., Hauser et al. 2014). Beluga whales satellite-tagged in Bristol Bay (Quakenbush 2003~~, http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.bristolbaybeluga~~) and Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a) remained in those respective areas throughout the year, i.e., they are non-migratory.

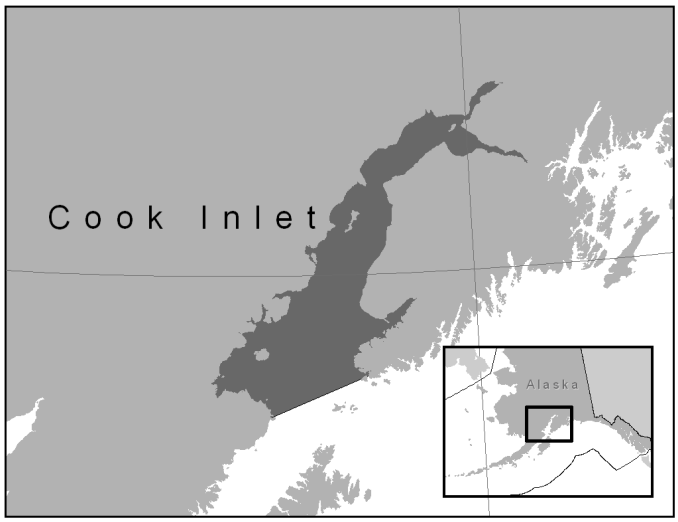

Figure 1. Approximate distribution of beluga whales in Cook Inlet.

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 ~~between~~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 ~~well-known~~fully determined; however, there is evidence that ~~some~~most whales in this population inhabit upper Cook Inlet year-round (Hansen and Hubbard 1999, Rugh et al. 2004, Lammers et al. 2013, Shelden et al. 2015a, Castellote et al. 2015). During summers from 1999 to 2002, satellite tags were attached to a total of ~~15~~18 beluga whales to determine their distribution through the fall and winter months (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a). Tags on four of these whales transmitted for only a few days and transmissions stopped in September for another whale (Shelden et al. 2015a). Ten tags transmitted whale locations from ~~August to December~~September through November and, of those, three transmitted into January, ~~four tags deployed on males transmitted~~three into March, and one into late May (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 ~~conducted~~ in the northern Gulf of Alaska between 1936 and 2000 found only ~~31~~28 beluga whale sightings~~ among 23,000 marine mammal 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. ~~2006~~2015) are regularly observed in Yakutat Bay. ~~Although not included in the Cook Inlet Distinct Population Segment (DPS), as listed under the Endangered Species Act (ESA), NMFS regulations under the Marine Mammal Protection Act (MMPA) (50 CFR 216.15) include the beluga whales occupying Yakutat Bay as part of the depleted~~

~~Cook Inlet stock (75 FR 12498, 16 March 2010).~~Based on genetic analyses, traditional ecological knowledge (TEK), and observations by fishers and others 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). Notice-and-comment rulemaking procedures would be required to change ~~this~~the NMFS regulatory definition under the MMPA. ~~Until such procedures are completed~~Thus, Yakutat Bay beluga whales remain designated as "depleted" and part of the Cook Inlet stock.

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). ~~In 2013,~~ NMFS changed to a biennial survey schedule after detailed analysis showed that there would be ~~no~~little reduction in assessment quality (Hobbs 2013).

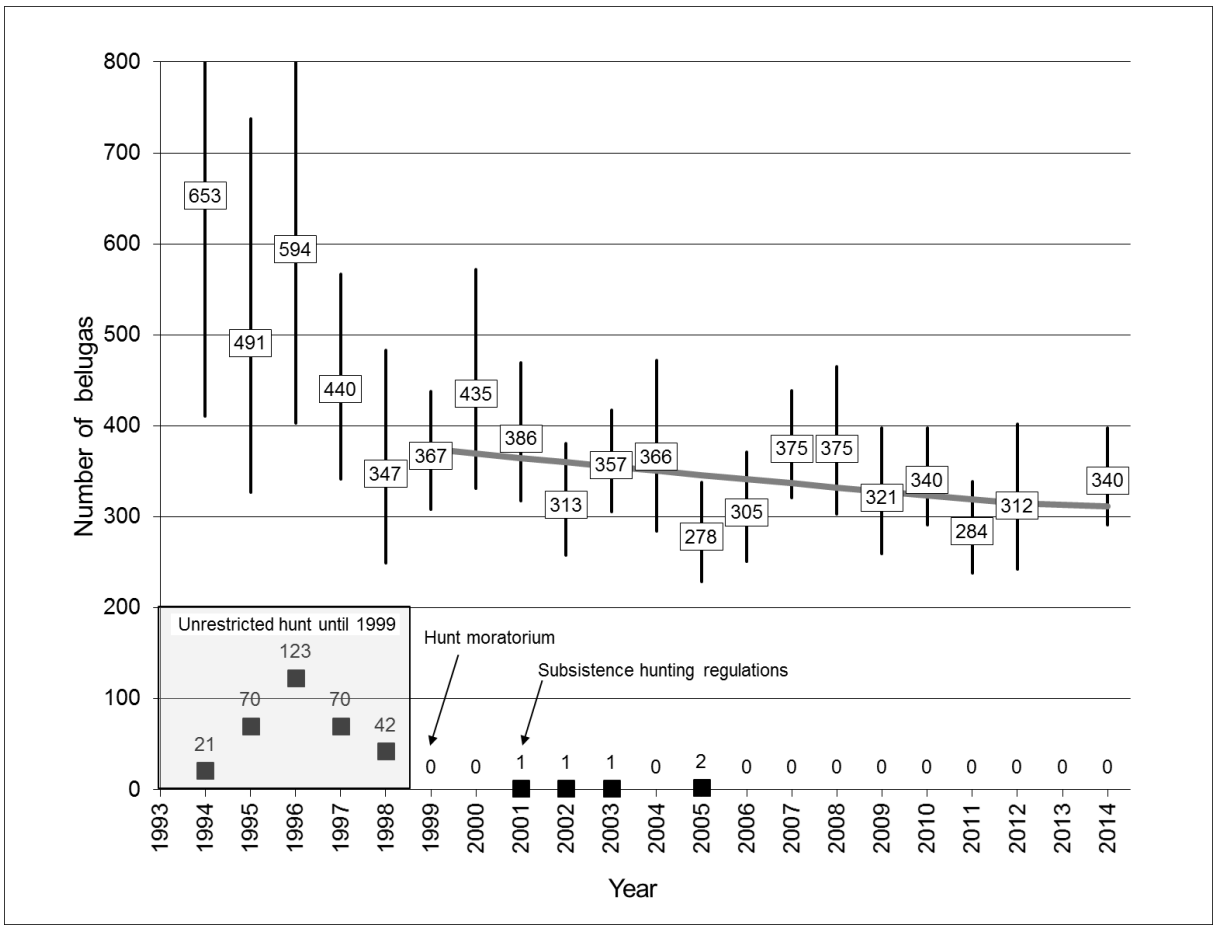

Figure 2. Annual abundance estimates of beluga whales in Cook Inlet, Alaska, ~~1994-2012~~1994-2014 (Hobbs et al. 2015a, Shelden et al. 2015b). Black squares show reported removals (landed plus struck and lost) during the Alaska Native subsistence hunt. A struck and lost average was calculated by the Cook Inlet Marine Mammal Council (CIMMC) and hunters for 1996, 1997, and 1998. Black ~~V~~vertical bars depict plus and minus one standard error for each abundance estimate (box label). From 1999 to ~~2012~~2014, the rate of decline (red trend line) ~~has been~~is ~~-1.60~~1.3% per year (with a 97% probability that the growth rate is declining), while the 10-year trend (~~2002-2012~~2004-2014) ~~has been~~is ~~-0.6~~ -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 CVs by almost half. The June ~~2012~~2014 survey resulted in an estimate of ~~312~~340 whales (CV = ~~0.13~~0.08) (~~Hobbs et al. 2015~~Shelden et al. 2015b). This estimate is more than the estimate of ~~284~~312 beluga whales for ~~2011~~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 ~~2011~~2012 to ~~2012~~2014. Annual abundance estimates based on aerial surveys of Cook Inlet beluga whales during the most recent 3-~~year~~survey period were ~~340 (2010),~~ 284 (2011), ~~and~~ 312 (2012), and 340 (2014), resulting in an average abundance estimate for this stock of 312 (CV = 0.10) beluga whales. The ~~most recent annual~~next abundance estimate survey ~~was conducted in~~is planned for June ~~2014~~2016 ~~and is currently undergoing analyses~~.

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-~~year~~survey average population estimate (N) of 312 ~~animals~~whales and an associated CV(N) of 0.10, N_{MIN} for the Cook Inlet beluga whale stock is 280 beluga whales.

Current Population Trend

The corrected annual abundance estimates for the period 1994-~~2012~~2014 are shown in Figure 2. From 1999 to ~~2012~~2014, the rate of decline was ~~-1.60~~1.3% (SE = ~~0.75~~0.7%) per year, with a 97% probability that the growth rate is declining (i.e., less than zero), while the 10-year trend (2004-2014) is -0.4% per year (with a 76% probability of declining) (~~Hobbs et al. 2015~~Shelden et al. 2015b).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently 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% is recommended to be employed for this stock (Wade and Angliss 1997). This figure is similar to the 4.8% annual increase that has been documented for the Bristol Bay beluga whale stock (Lowry et al. 2008).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized MMPA, the PBR was defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. In past Stock Assessment Reports for this stock, from 1998 through 2005, NMFS calculated a value for PBR. Given the low abundance relative to historical estimates and low known levels of human-caused mortality since 1999, this stock should have begun to grow at or near its maximum productivity rate (2-6%), but for unknown reasons the Cook Inlet beluga whale stock is not increasing. Because this stock does not meet the assumptions inherent to the use of the PBR, NMFS has decided it would not be appropriate to calculate a maximum number that may be removed while allowing the population to achieve its Optimum Sustainable Population. Thus, the PBR for this stock is undetermined.

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.

The estimated minimum average annual mortality and serious injury rate incidental to U.S. commercial fisheries is unknown, although probably low, because only one known beluga whale mortality due to fishery interaction has been reported in the past 10 years.

One entanglement in a subsistence fishery was reported to the NMFS Alaska Region~~al Office~~ on May 7, 2012 by~~.~~ ~~A~~a fisherman report~~ed~~ing a juvenile beluga whale entangled in his salmon fishing 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 ~~has been~~is important to one local village (Tyonek) and the Alaska Native subsistence hunter community in Anchorage. Between 1993 and ~~1999~~1998, the annual subsistence take ranged from ~~30~~17 to more than ~~100~~123 animals (Fig. 2), ~~not~~ including beluga whales struck ~~but~~and lost (~~Mahoney and Shelden 2000~~NMFS 2015).

Following a significant decline in Cook Inlet beluga whale abundance estimates between 1994 and 1998, 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. ~~These~~A cooperative agreement~~s~~, also referred to as a co-management agreement~~s~~, ~~were~~was not signed in 1999~~, 2004, and 2007~~, so ~~no~~ 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. ~~This~~An interim plan would have allowed up to ~~8~~eight whales to be harvested between 2005 and 2009 (https://alaskafisheries.noaa.gov/pr/interim-harvest-plan, accessed June 2016). Two whales were taken in 2005 and no takes were authorized in 2006 and later under this agreement. ~~Under the~~A long-term harvest plan (https://alaskafisheries.noaa.gov/pr/cib-long-term-harvest-management, accessed June 2016)~~,~~ established allowable harvest levels ~~are established~~ 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. ~~Because~~Under the long-term harvest plan, the 5-year average abundance during the first review period 2003-2007 was 336 whales~~(i.e., below 350 whales)~~, ~~no~~ harvest ~~was~~would not have been 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 is not allowed for the current 5-year period 2013-2017.

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 ~~dead~~beachcast carcasses and live stranded beluga whales (NMFS 2015). Most whales involved in a live stranding event ~~probably~~ survive, although some ~~mortalities~~deaths may be missed by observers if whales die later from live stranding-related injuries (Vos and Shelden 2005, Burek-Huntington et al. 2015). ~~In 2012~~Between 2009 and 2014, there were ~~38~~approximately 300 whales involved in ~~three~~10 known live stranding events, with ~~no~~four ~~mortalities~~deaths reported (Table 1). ~~There were no live stranding events reported to NMFS in 2013.~~ In 2014, ~~at least 76 whales were involved in a single live stranding event in Eagle Bay in Knik Arm. That same year,~~ necropsy results from two dead whales found ~~near Kincaid Park along~~in Turnagain Arm suggested the whales had recently live stranded, and that the live stranding may have contributed to their deaths.~~, although~~ ~~n~~No live stranding events were reported to NMFS in the period 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 2009-2014 (NMFS~~, unpubl. data~~ 2015).

Year	Beachcast carcasses	Number of beluga whales per live stranding event (number of associated known or suspected ~~mortalities~~resulting deaths)
2009	4	16-21 (0)
2010	5	11(0), 2(0)
2011	3	2(0)
2012	3	12(0), 23(0), 3(0)
2013	5	0
2014	10	76 (0), unknown (2)
Total	30	145-150 (2)

Another source of beluga whale mortality in Cook Inlet is ~~killer whale~~ predation by mammal-eating killer whales. Killer whale sightings were not well documented and ~~appear to be~~were likely rare in the upper inlet prior to the mid-1980s. From 1982 through 2014, 29 killer whale sightings in upper Cook Inlet (north of East and West Foreland) were reported to NMFS~~ 29 times,~~. 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. ~~and 9-11~~Between 9 and 12 beluga whale ~~mortalities~~deaths during this time were suspected to be a direct result of killer whale predation (NMFS 2015). 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 2014, NMFS ~~has~~ received no reports of killer whale sightings in upper Cook Inlet or possible predation attempts.

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 the period of 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. ~~2015~~2016).

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 cause of death.

STATUS OF STOCK

The Cook Inlet beluga whale stock was designated as "depleted" under the MMPA (65 FR 34590, May 21, 2000), and on October 22, 2008, NMFS listed Cook Inlet beluga whales as "endangered" under the ESA (73 FR 62919, October 22, 2008). Therefore, the Cook Inlet beluga whale stock is considered a strategic stock. There are no ~~fisheries~~ observers on fisheries in Cook Inlet and there have been no voluntary reports of beluga whale mortalities in U.S. commercial fisheries. The mean ~~A~~annual mortality and serious injury rate for commercial fisheries is likely low, although the incompleteness of the data for commercial fisheries operating within the range of Cook Inlet beluga whales is a concern for this small population.~~ NMFS convened a Recovery Team to aid in the development of a Recovery Plan for the Cook Inlet beluga whales; the Recovery Team's draft plan was submitted to NMFS in March 2013. NMFS intends to release a draft Recovery Plan for public review and comment in 2015, in advance of finalizing the Recovery Plan for Cook Inlet beluga whales .~~

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 20180, 11 April 2011). Based on available information from aerial surveys, tagged whales, and opportunistic sightings, beluga whales remain within the inlet year-round. Since 2000, most whales have been found in the upper inlet north of East and West Foreland ~~not only~~

during the summer months (Rugh et al. 2010) ~~but~~and in the fall as well (Rugh et al. 2004), with tagged whales travelling between the lower and upper inlet and offshore waters >10 m deep during the winter (Hobbs et al. 2005, Goetz et al. 2012a, Shelden et al. 2015a, Castellote et al. 2015). ~~It is unknown if~~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. With the limited range of this stock, Cook Inlet beluga whales are vulnerable to human-induced or natural perturbations within their preferred habitat. 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. ~~Additional effects~~Threats that have the potential to impact this stock and its habitat include the following: changes in prey availability due to natural environmental variability, ocean acidification, and commercial fisheries; climatic changes affecting habitat; predation by killer whales; contaminants; noise; ship strikes; waste management; urban runoff; construction projects; and physical habitat modifications that may occur as Cook Inlet becomes increasingly urbanized (Moore et al. 2000, Lowry et al. 2006, Hobbs et al. 2015b). Planned projects that may alter the physical habitat of Cook Inlet include highway improvements; mine construction and operation; oil and gas exploration and development; and expansion and improvements to ports.

CITATIONS

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

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

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

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

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

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

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

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

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

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

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

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

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

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

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

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

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

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

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

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

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

Lowry, L. F., K. J. Frost, A. Zerbini, D. DeMaster, and R. R. Reeves. 2008. Trend in aerial counts of beluga or white whales (*Delphinapterus leucas*) in Bristol Bay, Alaska, 1993-2005. J. Cetacean Res. Manage. 10:201-207.

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

Mahoney, B. A., and K. E. W. Shelden. 2000. Harvest history of belugas, *Delphinapterus leucas*, in Cook Inlet, Alaska. Mar. Fish. Rev. 62(3):124-140.

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

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

NMFS (National Marine Fisheries Service). 2015. Draft recovery plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). NOAA, National Marine Fisheries Service, Alaska Regional Office, Protected Resources Division, Juneau, AK. 274 p.

O'Corry-Crowe, G. E., A. E. Dizon, R. S. Suydam, and L. F. Lowry. 2002. Molecular genetics studies of population structure and movement patterns in a migratory species: the beluga whale, *Delphinapterus leucas*, in the western neoarctic.~~–~~ ~~P~~p. 464. *In* C. J. Pfeiffer (ed.), Molecular and Cell Biology of Marine Mammals. Kreiger Publishing Company, Malabar, FL.

~~O'Corry-Crowe, G., W. Lucey, C. Bonin, E. Henniger, and R. Hobbs. 2006. The ecology, status, and stock identify of beluga whales, *Delphinapterus leucas*, in Yakutat Bay, Alaska. Report to the U.S. Marine Mammal Commission. 22 pp.~~

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

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

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

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

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

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

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

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

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

Shelden, K. E. W., C. L. Sims, L. Vate Brattström, K. T. Goetz, and R. C. Hobbs. 2015b. Aerial surveys of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2014. AFSC Processed Report 2015-03, 55 p. Available online: http://www.afsc.noaa.gov/Publications/ProcRpt/PR2015-03.pdf. Accessed June 2016.

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

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

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)~~Narwhals typically inhabit waters of the Arctic Ocean. They are common~~While large aggregations are found in ~~the~~eastern Arctic waters~~ of Nunavut, Canada, west Greenland, and in the European Arctic; however~~, they rarely occur in the western Arctic, namely the East Siberian, Bering, Chukchi, and Beaufort ~~S~~seas (COSEWIC 2004). The three recognized narwhal populations ~~of narwhals~~ are based on ~~summer distribution~~geographic separation: Baffin Bay, Hudson Bay, and ~~e~~East Greenland (DFO 1998a, 1998b; COSEWIC 2004). The Baffin Bay population ~~of narwhals~~ summers in the waters ~~of~~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 ~~e~~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,~~;~~ ~~p~~Populations are defined for management purposes, and these designated populations may actually consist of several populations (COSEWIC 2004). Population definition based on molecular genetic~~s~~ 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 ~~A~~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 ~~observation~~any data ~~of~~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 ~~of the~~ 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 ~~on~~ a sighting of two male narwhals ~~that occurred~~ northwest of King Island in the Bering Sea~~, just south of the Bering Strait~~, during a systematic scientific survey. Sightings have occurred in Russian waters of the northern Chukchi Sea~~ in Russian waters~~ (~~Reeves and Tracey 1980,~~ Yablokov and Bel'kovich 1968, Reeves and Tracey 1980). George and Suydam (unpubl. ms.) summarized observations from Alaska Native hunters during eight sightings ~~events~~ of narwhals in the Chukchi and Beaufort ~~S~~seas between 1989 and 2008. Of these records, seven ~~were~~ sightings ~~of~~were live animals totaling 11-12 individuals; one record was ~~a report~~ of a beachcast narwhal tusk at Cape Sabine. Four of the seven live narwhal sightings ~~of live animals~~ consisted of mixed groups of belugas and narwhals (George and Suydam, unpubl. ms.).~~ It is believed that these incidental sightings of narwhals occurring in the Beaufort, Chukchi, and Bering seas are whales from the Baffin Bay population that are known to move into the Canadian Arctic Archipelago and as far north and west as ice conditions will permit (COSEWIC 2004).~~

Several narwhal specimens ~~of narwhals~~ 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 ~~dead~~ on the beach of Kiwalik Bay (Kotzebue Sound), another was initially sighted alive at the mouth of the Caribou River in Nelson Lagoon (~~on the~~ Alaska Peninsula) but later died, and a third specimen ~~of~~was only a ~~narwhal~~ tusk ~~was~~ found on ~~the~~a beach ~~at~~near Wainwright, on the Chukchi Sea. ~~Murie (1936) reported on a single tusk that was found on a sandbar at Cape Chibukak, St. Lawrence Island.~~

~~Narwhal in Alaska are thought to originate from a Canadian population, but there is no available method to verify this.~~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

~~**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

There are no U.S. commercial fisheries operating within the normal range of ~~the~~ narwhals in Alaska. There are no observer program records of narwhal mortalities incidental to commercial fisheries in Alaska. The estimated annual mortality rate incidental to 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 ~~size~~ 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 serious injury or mortality of narwhals in Alaska, ~~so~~therefore, the ~~level of~~ mortality and serious injury ~~and mortality~~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).

CITATIONS

Anderson, R. M. 1947. Catalogue of Canadian recent mammals. Bull. Natl. Mus. Canada, Biol. Ser.~~,~~ No. 31: vi + 238.

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

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

Bee, J. W.~~,~~ and E. R. Hall. 1956. Mammals of northern Alaska on the Arctic slope. Univ. Kansas Mus. Nat. Hist., Misc. Publ. No. 8~~,~~. 309 p~~p~~.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2004. COSEWIC assessment and update status report on the narwhal, *Monodon monoceros*, in Canada. Committee on the Status of Endangered Wildlife in Canada~~,~~. Ottawa. vii + 50 p~~p~~. Available online: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_narwhal_e.pdf ~~(www.sararegistry.gc.ca/status/status_e.cfm)~~. Accessed June 2016.

de March, B. G. E., L. D. Maiers, and D. Tenkula. 2001. A preliminary analysis of the molecular genetics of narwhal (*Monodon monoceros*) samples collected from Canadian and adjacent waters from 1982 to 2000. Canada/Greenland Joint Commission on the Management and Conservation of Narwhal and Beluga (JCNB), Scientific Working Group, Quqetarsuaq, Greenland, May 9-13, 2001. Document No. SWG-2001-10.

de March, B. G. E., D. A. Tenkula, and L. D. Postma. 2003. Molecular genetics of narwhal (*Monodon monoceros*) from Canada and West Greenland (1982-2001). ~~Canada~~ Department of Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Research Document 2003/080~~:~~. 23 p.

DFO (~~[Canada.~~ Department of Fisheries and Oceans Canada~~]~~). 1998a. Hudson Bay narwhal. ~~Canada~~ Department of Fisheries and Oceans Canada, Central and Arctic Region, DFO Sci. Stock Status Rep. E5-44.~~:~~ 5 p.

DFO (~~[Canada.~~ Department of Fisheries and Oceans Canada~~]~~). 1998b. Baffin Bay narwhal. ~~Canada~~ Department of Fisheries and Oceans Canada, Central and Arctic Region, DFO Sci. Stock Status Rep. E5-43.~~:~~ 5 p.

Dietz, R., M. P. Heide-Jørgensen, E. Born, and C. M. Glahder. 1994. Occurrence of narwhals (*Monodon monoceros*) and white whales (*Delphinapterus leucas*) in East Greenland. Medd. Grønl. Biosci. 39:69-86.

Dietz, R., M. P. Heide-Jørgensen, P. R. Richard, and M. Acquarone. 2001. Summer and fall movements of narwhals (*Monodon monoceros*) from northeastern Baffin Island towards northern Davis Strait. Arctic 54:244-261.

~~Dietz, R., M.P. Heide-Jørgensen, E. Born, and C.M. Glahder. 1994. Occurrence of narwhals (*Monodon monoceros*) and white whales (*Delphinapterus leucas*) in East Greenland. Medd. Grønl. Biosci. 39:69-86.~~

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

Dufresne, F. 1946. Alaska's ~~a~~Animals and ~~f~~Fishes. ~~New York:~~ A. S. Barnes, New York. xviii + 297 p~~p~~.

Geist, O. W., J. L. Buckley, and R. H. Manville. 1960. Alaskan records of the narwhal. J. Mammal.~~, Vol.~~ 41(~~, No.~~ 2):-250-253.

George, J. C., and R. Suydam~~, R.~~ ~~u~~Unpubl. manuscript. Recent observations of narwhal in the Chukchi and Beaufort Seas by local hunters. 13 January 2009. 3 p~~p~~. Available from ~~National~~ Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115~~)~~.

Gjertz, I. 1991. The narwhal, *Monodon monoceros*, in the Norwegian High Arctic. Mar. Mammal Sci. 7:402-408.

Heide-Jørgensen, M. P., and K. L. Laidre. 2004. Declining open water refugia for top predators in Baffin Bay and adjacent waters. Ambio 33(8):488-495.

Heide-Jørgensen, M. P., P. Richard, M. Ramsay, and S. Akeeagok. 2002. Three recent ice entrapments of arctic cetaceans in West Greenland and the eastern Canadian High Arctic. NAMMCO Scientific Publications 4:143-148. DOI: 10.7557/3.2841.

Heide-Jørgensen, M. P., R. Dietz, K. L. Laidre, P. R. Richard, J. Orr, and H. C. Schmidt. 2003. The migratory behaviour of narwhals (*Monodon monoceros*). Can. J. Zool. 81:1298-1305.

Higdon, J. W., and S. H. Ferguson. 2014. History of narwhal aerial surveys and abundance estimates in the Canadian Arctic. Working Paper NAMMCO/SC/21-JCNB/SWG/2014-JWG/09 presented at NAMMCO/JCNB Joint Working Group on narwhals and belugas, 10-12 March 2014, Copenhagen, Denmark.

Huey, L. M. 1952. An Alaskan record of the narwhal. J. Mammal. 33:496.

Jefferson, T. A., L. Karkzmarski, K. Laidre, G. O'Corry-Crowe, R. Reeves, L. Rojas-Bracho, E. Secchi, E. Slooten, B. D. Smith, J. Y. Wang, and K. Zhou. 2012. *Monodon monoceros*. The IUCN Red List of Threatened Species. Version 2014.2.

Koski, W. R., and R. A. Davis. 1994. Distribution and numbers of narwhals (*Monodon monoceros*) in Baffin Bay and Davis Strait. Medd. Grønl. Biosci. 39:15-40.

Kovacs, K. M., and C. Lydersen. 2008. Climate change impacts on seals and whales in the North Atlantic Arctic and adjacent shelf seas. Sci. Prog. 91(Pt. 2):117-150.

Laidre, K. L., and M. P. Heide-Jørgensen. 2005a. Arctic sea ice trends and narwhal vulnerability. Biol. Conserv. 121:509-517.

Laidre, K. L., and M. P. Heide-Jørgensen. 2005b. Winter feeding intensity of narwhals (*Monodon monoceros*). Mar. Mammal Sci. 21:45-57.

Laidre, K. L., M. P. Heide-Jørgensen, R. Dietz, R. C. Hobbs, and O. A. Jørgensen. 2003. Deep-diving by narwhals, *Monodon monoceros*: differences in foraging behavior between wintering areas? Mar. Ecol. Prog. Ser. 261:269-281.

Laidre, K. L., M. P. Heide-Jørgensen, O. A. Jørgensen, and M. A. Treble. 2004a. Deep ocean predation by a high arctic cetacean. ICES J. Mar. Sci. 61(3):430-440.

Laidre, K. L., M. P. Heide-Jørgensen, M. L. Logsdon, R. C. Hobbs, P. Heagerty, R. Dietz, O. A. Jørgensen, and M. A. Treble. 2004b. Seasonal habitat associations of narwhals in the high Arctic. Mar. Biol. 145:821-831.

Laidre, K. L., M. P. Heide-Jørgensen, and J. Orr. 2006. Reactions of narwhals, *Monodon monoceros*, to killer whale, *Orcinus orca*, attacks in the eastern Canadian Arctic. Can. Field-Nat. 120:457-465.

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

Laidre, K. L., M. P. Heide-Jørgensen, W. Ermold, and M. Steele. 2010. Narwhals document continued warming of southern Baffin Bay. J. Geophys. Res. 115:C10049.

Laidre K. L., and M. P. Heide-Jørgensen. 2011. Life in the lead: extreme densities of narwhals in the offshore pack ice. Mar. Ecol. Prog. Ser. 423:269-278.

Laidre K. L., M. P. Heide-Jørgensen, H. Stern, and P. Richard. 2012. Unusual sea ice entrapments and delayed autumn ice-up timing reinforce narwhal vulnerability to climate change. Polar Biol. 35(1):149-154.

Laidre, K. L., H. Stern, K. M. Kovacs, L. Lowry, S. E. Moore, E. V. Regehr, S. H. Ferguson, Ø. Wiig, P. Boveng, R. P. Angliss, E. W. Born, D. Litovka, L. Quakenbush, C. Lydersen, D. Vongraven, and F. Ugarte. 2015. Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century. Conserv. Biol. 29(3):724-737.

Ljungblad, D. K., S. E. Moore, and D. R. Van Schoik. 1983. Aerial surveys of endangered whales in the Beaufort, ~~E~~eastern Chukchi and ~~N~~northern Bering Seas, 1982. NOSC Technical Document 605. 110 p~~p~~ ~~plus~~+ app~~x~~endix.

Lydersen, C., A. R. Martin, I. Gjertz, and K. M. Kovacs. 2007. Satellite tracking and diving behaviour of sub-adult narwhals (*Monodon monoceros*) in Svalbard, Norway. Polar Biol. 30:437-442.

MacFarlane, R. 1905. Notes on mammals collected and observed in the northern Mackenzie River District, Northwest Territories of Canada. Proc. U.S. Nat. Mus.~~,~~ 28:673-764.

Murdoch, J. 1898. The animals known to the Eskimos of Northwestern Alaska. Amer. Nat.~~,~~ 32:719-734.

Murie, O. J. 1936. Notes on the mammals of St. Lawrence Island, Alaska~~.~~, p. 337-326. *In* Archaeological Excavations at Kukulik, St. Lawrence Island, Alaska. Univ. Alaska, Misc. Publ.~~,~~ 2~~: 337-346~~.

Nelson, E. W., and F. W. True. 1887. Mammals of northern Alaska. Pt. 2, p. 227-293. ~~in~~*In* Report upon natural history collections made in Alaska between the years 1877 and 1881 by Edward W. Nelson. Arctic Publ. No. 3, Signal Service, U.S. Army~~; pp. 227-293.~~

Noongwook, G., The Native Village of Savoonga, The Native Village of Gambell, H. P. Huntington, ~~H.P.,~~ and J. C. George~~, J.C.~~ 2007. Traditional knowledge of the bowhead whale (*Balaena mysticetus*) around St. Lawrence Island, Alaska. Arctic 60 (1):47-54.

~~NOAA. 2012. Federal Register 77:3233. National Policy for Distinguishing Serious From Non-Serious Injuries of Marine Mammals. http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf.~~

Palsbøll, P. J., M. P. Heide-Jørgensen, and R. Dietz. 1997. Genetic studies of narwhals, *Monodon monoceros*, from West and East Greenland. Heredity 78:-284-292.

Ray, P. H., and J. Murdoch. 1885. Report of the International Polar Expedition to Point Barrow, Alaska. Government Printing Office, Washington~~,~~. 695 p~~p~~.

Reeves, R. R., and S. Tracey~~, S~~. 1980. *Monodon monoceros*. Mamm. Species~~,~~ 127:1-7~~, 5 figs~~.

Richard, P. 1991. Abundance and distribution of narwhals (*Monodon monoceros*) in northern Hudson Bay. Can. J. Fish. Aquat. Sci. 48:276-283.

Scammon, C. M. 1874. The ~~m~~Marine ~~m~~Mammals of the ~~n~~Northwestern ~~c~~Coast of North America, ~~d~~Described and ~~i~~Illustrated: ~~t~~Together with an ~~a~~Account of the American ~~w~~Whale ~~f~~Fishery. ~~New York:~~ G. P. Putnam's Sons, New York. 319 p~~p~~.

Turner, L. M. 1886. Contributions to the natural history of Alaska; results of investigations made chiefly in the Yukon District and the Aleutian Islands. Arctic Publ. No. 2, Signal Service, U.S. Army.~~; pp. 1~~ 226 p.

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

Yablokov A. V., and V. M. Bel'kovich. 1968. Cetaceans of the ~~a~~Arctic; their proper utilization and conservation. Probl. of the North, Nat. Res. Council, Ottawa~~,~~ 11:199-218.

Revised ~~6/10/2013~~9/12/2016

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 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).

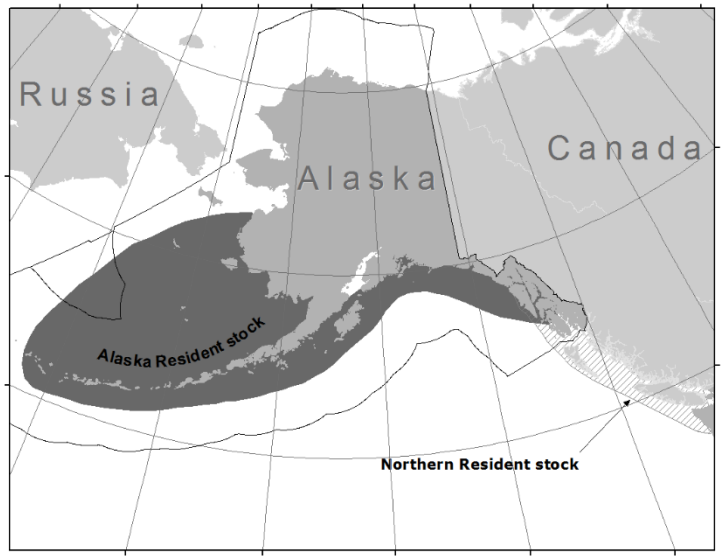

Figure 1. Approximate distribution of resident killer whales in the eastern North Pacific (shaded areas). The distribution of ~~the eastern North Pacific R~~resident and ~~T~~transient killer whale stocks in the eastern North Pacific ~~are~~ largely overlap~~ping~~ (see text).

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; Matkin et al. 1999; Dahlheim et al. 1997). 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. 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., ~~N~~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 (~~N~~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 ~~National~~ Marine Mammal Laboratory (~~N~~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 ~~N~~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 ~~N~~MML data sets have not yet been matched so it is unknown how many of these 600 animals are included in the ~~N~~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 ~~N~~MML photographs.

~~N~~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 95% confidence interval of 380-2585 (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-~~N~~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 ~~N~~MML unpublished data[2]**	**2001/2003 ~~N~~MML unpublished data[2]**	**2001-2012 ~~N~~MML/NGOS unpublished catalog[2]**
Unassigned to pods (~~N~~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, ~~National~~ Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105.

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 (~~N~~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 Alaskan 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 = ~~23.4~~24 animals (2,347 × 0.02 × 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

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 previous assessments, there were six different commercial fisheries in Alaska that could have had incidental serious injuries or mortalities of killer whales and were observed. In 2004, the definitions of these commercial fisheries were changed to reflect target species; this new definition has resulted in the identification of 22 observed fisheries that use trawl, longline, or pot gear. Of these fisheries, there were t~~Three of the federally-regulated U.S. commercial fisheries, monitored for incidental mortality and serious injury of marine mammals by fishery observers, ~~that~~ incurred serious injury~~ies or~~ and mortality~~ies~~ of killer whales (~~any~~unknown stock) between ~~2007 and 2011~~2010 and 2014: ~~–~~the Bering Sea/Aleutian Islands flatfish trawl, ~~the~~ Bering Sea/Aleutian Islands rockfish trawl, and ~~the~~ Bering Sea/Aleutian Islands ~~Greenland turbot~~Pacific cod longline fisheries (Table 1; Breiwick 2013; MML, unpubl. data).

~~Over the past few years,~~ Fishery observers have collected tissue samples ~~of~~from many of the killer whales that were killed incidental to U.S. commercial fisheries. Genetic~~s~~ analyses of samples from seven killer whales collected between 1999 and ~~-~~2004 have confirmed that Alaska ~~r~~Resident killer~~s~~ whale~~s~~ ~~are occasionally killed~~mortality occurred incidental ~~ly in~~to the Bering Sea/Aleutian Islands flatfish trawl (n = 3) and ~~the~~ Bering Sea/Aleutian Islands Pacific cod longline fisheries (n = 1) ~~. Also during this period, 3~~and that Gulf of Alaska, Aleutian Islands, and Bering Sea ~~t~~Transient killer whale ~~s from the GOA/AI/BS stock were killed~~mortality occurred incidental to the Bering Sea/Aleutian Islands pollock trawl fishery (n = 3) (M. Dahlheim, ~~pers. comm., National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105;~~NMFS-AFSC-MML, pers. comm., 20 February 2013). ~~Photo identification of an entangled male killer whale confirmed the single whale killed incidental to the BSAI Greenland turbot longline was a resident whale (ID = AK218), an animal known since 1993 (Dahlheim 1997; M. Dahlheim, pers. comm., National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105; 20 February 2013). However, g~~Given the overlap in the range of ~~the~~ 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 ~~estimated level of serious injury and~~ mortality and serious injury rate of ~~Alaska resident killer whales is 0.9/~~one killer whale per year ~~(CV = 0.17)~~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 serious injury and mortality occurs incidental to U.S. commercial fishing, it is due to interactions with the fishing gear. However, reports indicate that observed killer whale mortality~~ies~~ incidental to the Bering Sea/Aleutian Islands ~~flatfish~~ trawl fishery~~y~~ies 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 ~~r~~Resident ~~stock of~~ killer whales due to U.S. commercial fisheries ~~from 2007 to 2011~~in 2010-2014 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data). ~~Details of how~~Methods for calculating percent observer coverage ~~is measured is included~~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 ~~O~~observer coverage**	**Observed mortality ~~(in given yrs.)~~**	**Estimated mortality ~~(in given yrs.)~~**	**Mean estimated annual mortality**
Bering Sea/Aleutian Is. flatfish trawl	~~2007~~ ~~2008~~ ~~2009~~ 2010 2011 2012 2013 2014	obs data	~~72~~ ~~100~~ ~~100~~ ~~100~~99 100 99 99 99	~~0~~ ~~1~~ ~~1*~~ 0 0 0 (+1)[a] 2 0	~~0~~ ~~1.0~~ ~~1.0~~ 0 0 0 (+1)[b] 2 0	0.4 (+0.2)[c] (CV = ~~0.02~~0)
Bering Sea/Aleutian Is. rockfish trawl	~~2007~~ ~~2008~~ ~~2009~~ 2010 2011 2012 2013 2014	obs data	~~88~~ ~~98~~ ~~99~~ ~~100~~99 ~~100~~99 100 99 99	~~0~~ ~~0~~ ~~0~~ 1 0 0 0 0	~~0~~ ~~0~~ ~~0~~ 1~~.0~~ 0 0 0 0	0.2 (CV = ~~N/A~~0)
~~BSAI Greenland turbot longline~~	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~	~~obs data~~	~~64~~ ~~74~~ ~~74~~ ~~59~~ ~~59~~	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~1.5~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0.3 (CV = 0.570.61)~~
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 ~~E~~estimated ~~total~~ annual mortality						~~0.9~~1 (CV = ~~0.17~~0)

~~*One record originally reported as a killer whale "killed by prop" was rejected due to insufficient documentation to confirm the event (B. M. Allen, National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105; 20 February 2013).~~

[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).

~~The~~A minimum estimate~~d minimum~~ of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries ~~recently monitored~~in 2010-2014 is ~~0.9~~one ~~animals~~Alaska Resident killer whale ~~per year~~, based ~~exclusively~~ 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 ~~has~~ experienced a high level of mortality: between 1986 and 1991, 22 whales out of a pod of 37 (59%) ~~are missing and considered dead~~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 ~~is~~was responsible for shooting at killer whales.

There have been no obvious bullet wounds observed on killer whales during ~~recent~~ surveys in the Bering Sea and western Gulf of Alaska (J. Durban, ~~NMML~~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 ~~on~~ longline catches in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003, 2006; Sigler et al. ~~2002~~2003~~; Perez 2006~~) and in the Gulf of Alaska (Sigler et al. ~~2002~~2003, Perez 2006). In addition, there ~~are~~have been many reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (Perez 2006). ~~However, the 'r~~Resident~~' stock of~~ killer whales ~~is~~are most likely to be involved in such fishery interactions since these whales are known to be fish eaters~~, while 'transient' whales have only been observed feeding on marine mammals~~.

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~~, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115~~). On some vessels, the waste is discharged in the vicinity of the vessel's propeller (NMFS, unpubl.~~ished~~ 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 ~~e~~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 Alaskan waters. Because the population estimate is likely to be conservative, the PBR is also conservative.

Based on currently available data, ~~the~~a minimum estimate~~d~~ of the mean annual mortality and serious injury rate due to U.S. commercial fisheries~~y related mortality level~~ (~~0.9~~1 whale) is less than 10% of the PBR (10% of PBR = ~~2.3~~2.4) and, therefore, is considered to be insignificant and approaching zero mortality and serious injury rate. ~~The~~A minimum estimate~~d~~ of the total annual level of human-caused mortality and serious injury (~~0.9~~1 whale~~animals per year~~) is not known to exceed the PBR (~~23.4~~24). Therefore, the ~~e~~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 ~~size~~ are currently unknown.

CITATIONS

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

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

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

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

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

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Southwest Fisheries Science Center Administrative Report LJ-97-11, 25 p. Available from ~~Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271~~SWFSC, NMFS, 8901 La Jolla Shores Drive, La Jolla, CA ~~92038~~92037. ~~25 pp.~~

Barrett-Lennard, L. G. 2000. Population structure and mating patterns of killer whales (*Orcinus orca*) as revealed by DNA analysis. Ph.D. ~~Thesis~~Diss., University of British Columbia, Vancouver, BC, Canada~~,~~. 97 p~~p~~.

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

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

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

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

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

Committee on Taxonomy. 2012. List of marine mammal species and subspecies. Society for Marine Mammalogy, www.marinemammalscience.org, consulted on 12 December 2012.

Dahlheim, M. E. 1988. Killer whale (*Orcinus orca*) depredation on longline catches of sablefish (*Anoplopoma fimbria*) in Alaskan waters. NWAFC Processed Report 88-14, 31 p. Available online: http://www.afsc.noaa.gov/Publications/ProcRpt/PR%2088-14.pdf. Accessed June 2016.

~~Dahlheim, M. E. 1997. A photographic catalog of killer whales, *Orcinus orca*, from the Central Gulf of Alaska to the Southeastern Bering Sea. NOAA Technical Report, NMFS 131, 54 pp.~~

~~Dahlheim, M. E. 1988. Killer whale (*Orcinus orca*) depredation on longline catches of sablefish (*Anoplopoma fimbria*) in Alaskan waters. NWAFC Processed Report 88-14, 31 pp. (Available online: http://www.afsc.noaa.gov/Publications/ProcRpt/PR%2088-14.pdf).~~

Dahlheim, M. E., and C.O. Matkin. 1994. Assessment of injuries to Prince William Sound killer whales, p. 163-171. *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez*. Academic Press, Inc., San Diego, CA.

Dahlheim, M. E., and J. M. Waite. 1993. Abundance and distribution of killer whales (*Orcinus orca*) in Alaska in 1992. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

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

~~Dahlheim, M. E., and C.O. Matkin. 1994. Assessment of injuries to Prince William Sound killer whales. Pp. 163-171 *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez*. Academic Press, Inc., San Diego, CA.~~

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

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

DeMaster, D. P. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group, Anchorage, Alaska. 20 p~~p~~. + appendices. ~~(~~Available ~~upon request~~ from ~~National Marine Mammal Laboratory~~Alaska Fisheries Science Center, 7600 Sand Point Way~~,~~ NE, Seattle, WA 98115~~)~~.

Ford, J. K. B. 1989. Acoustic behaviour of resident killer whales (*Orcinus orca*) off Vancouver Island, British Columbia. Can. J. Zool. 67(3):727-745.

Ford, J. K. B. 1991. Vocal traditions among resident killer whales (*Orcinus orca*) in coastal waters of British Columbia. Can. J. Zool. 69(6):1454-1483.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Matkin, C. O., G. Ellis, L. Barrett-Lennard, H. Yurk, E. Saulitis, D. Scheel, P. Olesiuk, and G. Ylitalo. 2003. Photographic and acoustic monitoring of killer whales in Prince William Sound and Kenai Fjords. *Exxon Valdez* Oil Spill Restoration Project 030012, Final Report, North Gulf Oceanic Society, 60920 Mary Allen Ave, Homer, AK 99603. 118 p.

Matkin, C. O, L. Barrett-Lennard, H. Yurk, D. Ellifrit, and A. Trites. 2007. Ecotypic variation and predatory behavior of killer whales *Orcinus orca*~~,~~ in the Eastern Aleutian Islands, Alaska. Fish.~~eries~~ Bull.~~etin~~, U.S. 105:74-87.

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

Matkin, C. O., G. Ellis, D. Herman, E. Saulitis, R. Andrews, A. Gaylord, and H. Yurk. 2010. Monitoring, ~~T~~tagging, ~~A~~acoustics, ~~F~~feeding ~~H~~habits and ~~R~~restoration of ~~K~~killer ~~W~~whales in Prince William Sound/Kenai Fjords 2003-2009. EVOS Trustee Council -Restoration Project 090742 Final Report, North Gulf Oceanic Society, Homer, Alaska.

Matkin, C. O., G. Ellis, D. Herman, E. Saulitis, R. Andrews, and A. Gaylord. In prep. Monitoring, ~~T~~tagging, ~~F~~feeding ~~H~~habits and ~~R~~restoration of ~~K~~killer ~~W~~whales in Prince William Sound/Kenai Fjords 2010-2012. EVOS Trustee Council Restoration Project 10100742 Final Report, North Gulf Oceanic Society, Homer, Alaska.

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

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

~~Matkin, C. O., G. Ellis, L. Barrett-Lennard, H. Yurk, E. Saulitis, D. Scheel, P. Olesiuk, and G. Ylitalo. 2003. Photographic and Acoustic Monitoring of Killer Whales in Prince William Sound and Kenai Fjords. *Exxon Valdez* Oil Spill Restoration Project 030012, Final Report. North Gulf Ocean Society, 60920 Mary Allen Ave, Homer AK, 99603. 118 pp.~~

~~Matkin C. O., Saulitis E. L., Ellis G. M., Olesiuk P., Rice S. D. 2008. Ongoing population level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Mar. Ecol. Prog. Ser. 356: 269281.~~

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

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

~~NOAA. 2012. Federal Register 77:3233. National Policy for Distinguishing Serious From Non-Serious Injuries of Marine Mammals. http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf.~~

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

Perez, M. A. 2003. Compilation of marine mammal-fisheries interaction data from the domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-138,~~.~~ 145 p.

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

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

Sigler, M. F., C. R. Lunsford, J. T. Fujioka, and S. A. Lowe. ~~2002~~2003. Alaska ~~S~~sablefish ~~A~~assessment for ~~2003~~2004. *In* Stock ~~A~~assessment and ~~F~~fishery ~~E~~evaluation ~~R~~report for the ~~G~~groundfish ~~F~~fisheries of the Bering Sea/Aleutian Islands ~~R~~regions. North Pacific~~.~~ Fishery~~.~~ Management~~.~~ Council, Anchorage, AK, Section ~~5:229-294~~3:223-292.

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

Yano, K., and M. E. Dahlheim. 1995. Killer whale, *Orcinus orca*, depredation on longline catches of bottomfish in the southeastern Bering Sea and adjacent waters. Fish. Bull., U.S. 93:355-372.

Yurk, H., L. Barrett Lennard, J. K. B. Ford, and C. O. Matkin. 2002. Cultural transmission within maternal lineages: vocal clans in resident killer whales in southern Alaska. Anim. Behav. 63:1103-1119.

Zerbini, A. N., J. M. Waite, J. Durban, R. LeDuc, M. E. Dahlheim and P. R. Wade. 2007. Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling. Mar. Biol. 150(5):1033-1045.

Revised ~~6/10/2013~~9/12/2016

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 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, 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).

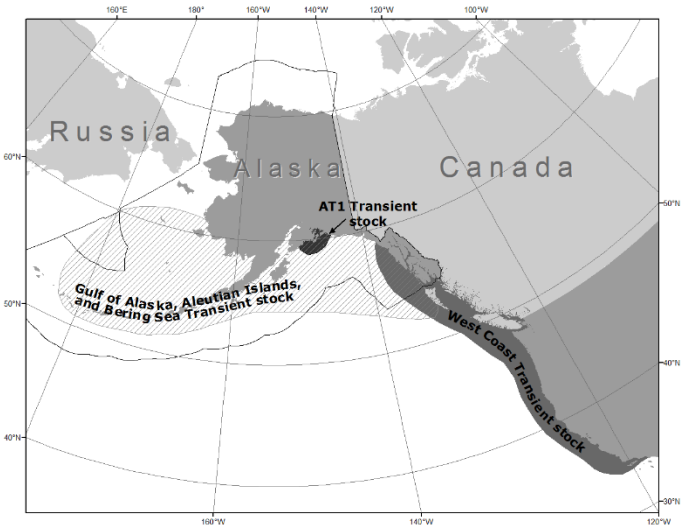

Figure 1. Approximate distribution of transient killer whales in the eastern North Pacific (shaded areas). The distribution of ~~the eastern North Pacific~~ ~~R~~resident and ~~T~~transient killer whale stocks in the eastern North Pacific ~~are~~ largely overlap~~ping~~ (see text).

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 Alaskan waters and considered Gulf of Alaska transients (Matkin et al. 2012, Ford et al. 2013). Transients that 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. ~~in prep.~~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.

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 ~~National~~ Marine Mammal Laboratory (~~N~~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). ~~N~~MML identified 43 whales and 11 matches were found between the NGOS and ~~N~~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/~~N~~MML catalogue (NGOS/~~N~~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 catalogs of this stock.

~~N~~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 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 (~~N~~MML/NGOS 2012). The photograph catalogue estimate of transient 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 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 cataloged is likely conservative. The catalogue count is slightly higher than the 20 th percentile of the mark-recapture estimates, in part because in 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 ≥ 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, 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

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 previous assessments, there were six different federal commercial fisheries in Alaska that could have had incidental serious injuries or mortalities of killer whales and were observed. In 2004, the definitions of these fisheries were changed to reflect target species; these new definitions have resulted in the identification of 22 observed fisheries that use trawl, longline, or pot gear. Of these fisheries, there were t~~Three of the federally-regulated U.S. commercial fisheries, monitored for incidental mortality and serious injury of marine mammals by fishery observers, ~~which~~ incurred serious injury and mortality of killer whales (~~any~~unknown stock) ~~between 2007 and 2011~~in 2010-2014: the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands rockfish trawl, and ~~the~~ Bering Sea/Aleutian Islands ~~Greenland turbot~~Pacific cod longline fisheries (Table 1; Breiwick 2013; MML, unpubl. data).

~~Over the past few years,~~Fishery observers have collected tissue samples ~~of~~from many of the killer whales ~~which~~that were killed incidental to U.S. commercial fisheries. Genetic~~s~~ analyses of samples from seven killer whales collected between 1999~~-~~ and 2004 have confirmed that Alaska ~~r~~Resident killer~~s~~ whale~~s~~ ~~are occasionally killed~~mortality occurred incidental~~ly in~~to the Bering Sea/Aleutian Islands flatfish trawl (n = 3) and ~~the~~ Bering Sea/Aleutian Islands Pacific cod longline fisheries (n = 1)~~; during this period, 3~~ and that Gulf of Alaska, Aleutian Islands, and Bering Sea ~~t~~Transient killer whale~~s from the GOA/AI/BS stock were killed~~ mortality occurred incidental to the Bering Sea/Aleutian Islands pollock trawl fishery (n = 3) (M. Dahlheim, ~~pers. comm., National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98105;~~NMFS-AFSC-MML, pers. comm., 20 February 2013). ~~Photo-identification of an entangled male killer whale confirmed the single whale killed incidental to the BSAI Greenland turbot longline was a resident whale (ID = AK218), an animal known since 1993 (Dahlheim 1997; M. Dahlheim, pers. comm., National Marine Mammal~~

~~Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105; 20 February 2013). However, g~~Given the overlap in the range of ~~the~~ 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 ~~estimated level of serious injury and~~ mortality and serious injury rate of ~~Alaska resident killer whales for 2007-2011 is 0.6/~~one killer whale per year ~~(CV = 0.02)~~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 serious injury and mortality 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 ~~(Gulf of Alaska, Aleutian Islands, Bering Sea transient stock)~~ 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). ~~Mean annual takes are based on 2007-2011 data. Details of how~~Methods for calculating percent observer coverage ~~is measured is included~~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 ~~O~~observer coverage**	**Observed mortality ~~(in given yrs.)~~**	**Estimated mortality ~~(in given yrs.)~~**	**Mean estimated annual mortality**
Bering Sea/Aleutian Is. flatfish trawl	~~2007~~ ~~2008~~ ~~2009~~ 2010 2011 2012 2013 2014	obs data	~~72~~ ~~100~~ ~~100~~ ~~100~~99 100 99 99 99	~~0~~ ~~1~~ ~~1*~~ 0 0 0 (+1)[a] 2 0	~~0~~ ~~1.0~~ ~~1.0*~~ 0 0 0 (+1)[b] 2 0	0.4 (+0.2)[c] (CV = ~~0.02~~0)
Bering Sea/Aleutian Is. rockfish trawl	~~2007~~ ~~2008~~ ~~2009~~ 2010 2011 2012 2013 2014	obs data	~~88~~ ~~98~~ ~~99~~ ~~100~~99 ~~100~~99 100 99 99	~~0~~ ~~0~~ ~~0~~ 1 0 0 0 0	~~0~~ ~~0~~ ~~0~~ 1~~.0~~ 0 0 0 0	0.2 (CV = ~~N/A~~0)
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 ~~E~~estimated ~~total~~ annual mortality						~~0.6~~1 (CV = ~~0.02~~0)

~~*One record originally reported as a killer whale "killed by prop" was rejected due to insufficient documentation to confirm the event (B. M. Allen, National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105; 20 February 2013).~~

[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 ~~are another~~may be an occasional source of mortality or serious injury of killer whales. ~~One mortality due to a ship strike occurred in 1998, when~~ For example, a killer whale ~~was~~ struck ~~by a~~the propeller of a vessel in the Bering Sea/Aleutian Islands ~~groundfish~~rockfish trawl fishery in 2010 (Table 1).

Other Issues

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

STATUS OF STOCK

The Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea ~~t~~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, ~~the~~a minimum estimate~~d~~ of the mean annual mortality and serious injury rate due to U.S. commercial fisheries~~y related mortality level~~ (~~0.6~~1 whale) is ~~equal to~~greater than 10% of the PBR (10% of PBR = 0.6) and, therefore, ~~is~~cannot be considered to be insignificant and approaching zero mortality and serious injury rate. ~~The~~A minimum estimate~~d~~ of the total annual level of human-caused mortality and serious injury (~~0.6~~1 ~~animals~~whale~~ per year~~) is less than the PBR (5.9). Therefore, the Gulf of Alaska, Aleutian Islands, and Bering Sea ~~t~~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.

CITATIONS

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

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

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

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

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

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Southwest Fisheries Science Center Administrative Report LJ-97-11, 25 p. Available from ~~Southwest Fisheries Science Center~~SWFSC, ~~National Marine Fisheries Service~~NMFS, ~~P.O. Box 271,~~ 8901 La Jolla Shores Drive, La Jolla, CA ~~92038~~92037. 25 p~~p~~.

Barrett-Lennard, L. G. 2000. Population structure and mating patterns of killer whales as revealed by DNA analysis. ~~Doctoral thesis~~Ph.D. Diss.,- Univ~~.~~ersity of British Columbia, Vancouver, BC, Canada.

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

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

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

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

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

Committee on Taxonomy. 2012. List of marine mammal species and subspecies. Society for Marine Mammalogy, www.marinemammalscience.org, consulted on 12 December 2012.

Dahlheim, M. E. 1988. Killer whale (*Orcinus orca*) depredation on longline catches of sablefish (*Anoplopoma fimbria*) in Alaskan waters. NWAFC Processed Rep. 88-14, 31 p~~p~~. ~~(~~Available online: http://www.afsc.noaa.gov/Publications/ProcRpt/PR%2088-14.pdf~~)~~. Accessed June 2016.

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

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

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

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

Durban, J., D. Ellifrit~~, D.~~, M. Dahlheim~~, M.~~, J. Waite~~, J.~~, C. Matkin~~, C.~~, L. Barrett-Lennard~~, L.~~, G. Ellis~~, G.~~, R. Pitman~~, R.~~, R. LeDuc~~, R~~, and P. R. Wade~~, P.R.~~ 2010. Photographic mark-recapture analysis of clustered mammal-eating killer whales around the Aleutian Islands and Gulf of Alaska. Mar. Biol. 157:1591-1604.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Matkin, C. O., L. G. Barrett-Lennard, H. Yurk, D. Ellifrit, and A. W. Trites. 2007. Ecotypic variation and predatory behavior among killer whales (*Orcinus orca*) off the eastern Aleutian Islands, Alaska. Fish. Bull., U.S. 105:74-87.

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

Matkin, C. O., G. M. Ellis, E. L. Saulitis, and R. D. Andrews. In prep. Monitoring, ~~T~~tagging, ~~F~~feeding ~~H~~habits, and ~~R~~restoration of ~~K~~killer ~~W~~whales in Prince William Sound/Kenai Fjords 2010-2012. Final ~~r~~Report to the EVOS Trustee Council~~.~~, North Gulf Oceanic Society, Homer, Alaska.

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

~~Matkin C. O., L. G. Barrett-Lennard, H. Yurk, D. Ellifrit, A. W. Trites. 2007. Ecotypic variation and predatory behavior among killer whales (*Orcinus orca*) off the eastern Aleutian Islands, Alaska. Fish. Bull., U.S. 105: 74-87.~~

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

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

NGOS-/~~N~~MML (North Gulf Oceanic Society/Marine Mammal Laboratory). 2012. A ~~W~~working ~~C~~catalogue of ~~W~~western ~~T~~transients in Alaska. North Gulf Oceanic Society, Homer, Alaska, and ~~National~~ Marine Mammal Laboratory/NOAA, Seattle, WA. ~~(~~Available electronically by request~~)~~.

~~NOAA. 2012. Federal Register 77:3233. National Policy for Distinguishing Serious From Non-Serious Injuries of Marine Mammals. http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf.~~

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

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

Perez, M. A. 2003. Compilation of marine mammal-fisheries interaction data from the domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-138,~~.~~ 145 p~~p~~.

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

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

Saulitis, E. L. 1993. The behavior and vocalizations of the "AT" group of killer whales (*Orcinus orca*) in Prince William Sound, Alaska. MS thesis, University of Alaska, Fairbanks.

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

Sigler, M. F., C. R. Lunsford, J. T. Fujioka, and S. A. Lowe. 2003. Alaska sablefish assessment for 2004. *In* Stock ~~A~~assessment and ~~F~~fishery ~~E~~evaluation ~~R~~report for the ~~G~~groundfish ~~F~~fisheries of the Bering Sea/Aleutian Islands ~~R~~regions. North Pacific~~.~~ Fishery~~.~~ Management~~.~~ Council, Anchorage, AK, Section 3:223-292.

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

Yano, K., and M. E. Dahlheim. 1995. Killer whale, *Orcinus orca*, depredation on longline catches of bottomfish in the southeastern Bering Sea and adjacent waters. Fish. Bull., U.S. 93:355-372.

Zerbini, A. N., J. M. Waite, J. Durban, R. LeDuc, M. E. Dahlheim, and P. R. Wade. 2007. Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling. Mar. Biol. 150(5):1033-1045.

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. Along the west coast of North America, seasonal and year-round occurrence of killer whales has been noted 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). 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 ~~2012~~2016). 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, 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 ~~Stock Assessment Reports for the Alaska Region contain information concerning all the killer whale stocks except 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 re-sighted 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 methods, all 22 individuals in the AT1 Transient population were censused for the first time in 1984 (Leatherwood et al. 1984). All 22 AT1s 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 AT1s (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 genetically assigned AT1 stranded whale found in 2003 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 whale missing for at least 4 years has ever been resighted and all 15 missing whales are presumed dead (Matkin et al. 2008). In ~~2014~~2015, all seven whales (AT2, AT3, AT4, ~~and~~ AT6, AT9, AT10, and AT18) were observed by researchers from the North Gulf Oceanic Society~~; AT9, AT10, and AT18 were not seen in 2014. Although the absence of sightings of these three whales is of some concern, they are a matriline that is typically closely associated and may not have been encountered during research cruises. Their absence may be linked to their time spent around glaciers, which are not routinely surveyed. At this time, they are not considered to be dead~~. Therefore, the population estimate as of the summer of ~~2014~~2015 remains at seven whales (C. Matkin, North Gulf Oceanic Society, pers. comm., ~~21 March 2014~~20 October 2015). 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 is seven whales (Matkin et al. 2008). 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 minimum population estimate 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 ~~2014~~2015, a decline of 68%. Most of the mortalities apparently occurred in 1989-1990.

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 2.9% 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, 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 0.1, as the stock is considered "depleted" under the MMPA and there has been no recruitment into the stock since 1984. Thus, for the AT1 killer whale stock, PBR = 0 ~~animals~~whales (7 × 0.02 × 0.1).

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.

The known range of the AT1 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 incur incidental serious injury or mortality of AT1 killer whales. Several subsistence fisheries (salmon, halibut, non-salmon finfish, and shellfish) also occur within this area, and no reports of incidental serious injury or mortality 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. ~~One mortality due to a ship strike occurred in 1998 when~~For example, a killer whale struck the propeller of a vessel in the Bering Sea/Aleutian Islands ~~groundfish~~rockfish trawl fishery in 2010; however, this mortality did not involve a whale from the AT1 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 ~~1991~~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; 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 ~~U.S. commercial fishery related~~ mortality and serious injury ~~level~~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 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.

CITATIONS

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

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

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

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

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

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

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

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

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

Committee on Taxonomy. ~~2012~~2016. List of marine mammal species and subspecies. Society for Marine Mammalogy, www.marinemammalscience.org, consulted ~~on 12 December 2012~~June 2016.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Revised ~~12/30/2015~~9/12/2016

HARBOR PORPOISE (*Phocoena phocoena*): Southeast Alaska Stock

NOTE – ~~December 2015~~September 2016: In areas outside of Alaska, studies of harbor porpoise distribution have indicated that stock structure is likely more fine~~ly~~-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 (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). 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).

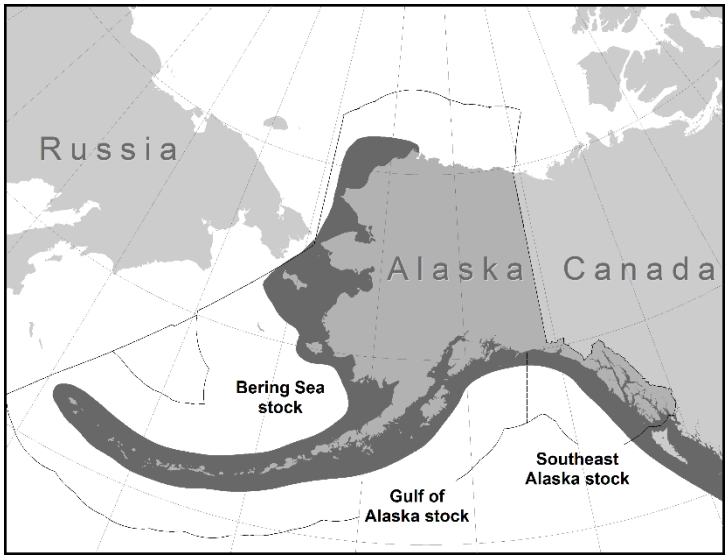

Figure 1. Approximate distribution of harbor porpoise in Alaska waters (dark shaded area).

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 ~~significant genetic~~ differences ~~for three of the six pair-wise comparisons~~ 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 ~~unknown~~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). 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 (SAR). Incidental takes from commercial fisheries within a small region (e.g., Wrangell and Zarembo Islands area) are of concern because ~~they could~~of the potential impact on undefined localized stocks of harbor porpoise~~ which could go easily undetected unless stock structure is identified~~. ~~The Alaska Scientific Review Group concurred that available data were insufficient to justify recognizing three biological stocks of harbor porpoise in Alaska instead of only one; however, it did not recommend against the establishment of three management units in Alaska (DeMaster 1996, 1997).~~

Accordingly, from the above information, three harbor porpoise stocks in Alaska were ~~recommended~~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 ~~the northern border of British Columbia~~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

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 ~~National~~ Marine Mammal Laboratory (~~N~~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 (CV = 0.162) porpoise (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 (3,766 × 2.96; CV = 0.242) harbor porpoise in the coastal and inside waters of Southeast Alaska (Hobbs and Waite 2010).

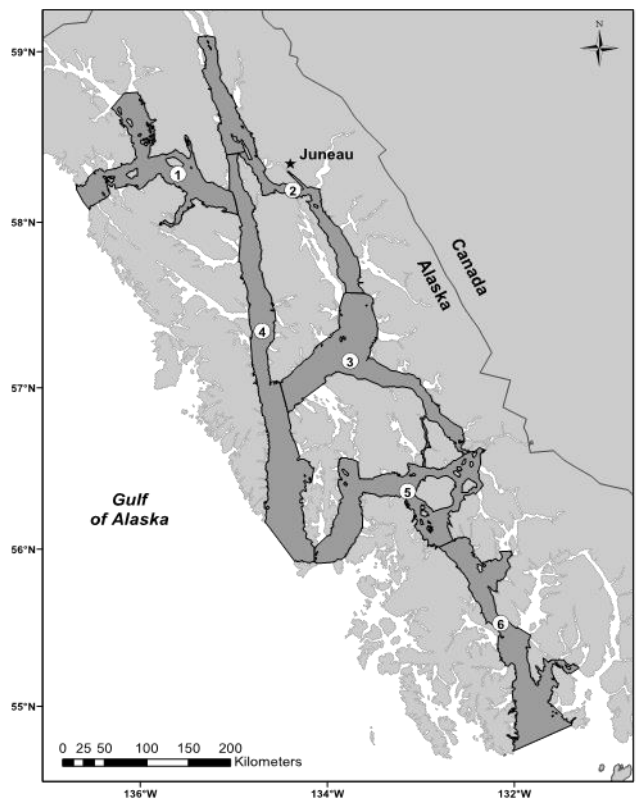

Figure 2. Survey strata defined for line-transect survey effort allocation in Southeast Alaska (as illustrated in Fig. 1 of Dahlheim et al. 2015).

In 1991, researchers initiated harbor porpoise studies aboard the NOAA ship *John N. Cobb* with broad survey coverage through~~out~~ 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 ~~S~~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. ~~Although~~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. Previous studies reported no evidence of seasonality for harbor porpoise occupying the inland waters of Southeast Alaska. Thus, ~~we opted to analyze~~only data collected during the summer season ~~only~~were analyzed, given the broader spatial coverage and the greater number of surveys ~~completed for this season~~ (i.e., ~~representing~~ 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 ~~A~~abundance ~~estimates~~of harbor porpoise ~~for~~in inland waters of Southeast Alaska ~~were~~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) ~~in 1991-1993~~ 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. ~~(the probability of detection directly on the track-line) and, t~~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 et al. 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 (CV = 0.12) harbor porpoise in the northern inland waters (including Cross Sound, Icy Strait, Glacier Bay, Lynn Canal, Stephens Passage, and Chatham Strait) and 577 (CV = 0.14) harbor porpoise 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 conservative.

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 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, ~~because~~ these survey data are now more than 8 years old~~, the N_{MIN} is considered unknown and PBR cannot be determined~~. Using ~~T~~the 2010-2012 abundance estimate for harbor porpoise occupying the inland waters of Southeast Alaska of 975 (~~95% CI = 857-1,109~~CV = 0.10), N_{MIN} is 896 harbor porpoise. However, since the abundance estimate represents ~~a small~~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. ~~Therefore, this number would not be an accurate estimate of N_{MIN} for the entire stock of Southeast Alaska harbor porpoise.~~ Although harbor porpoise in the ~~Wrangell and Zarembo Islands area~~northern and southern regions of the inland waters of Southeast Alaska have not been determined to be ~~a~~ subpopulations or stocks, ~~a~~ PBR calculations for ~~this~~these areas ~~of the inland waters of Southeast Alaska~~ may provide a frame of reference for comparison to ~~the~~ harbor porpoise takes in the portion of the Southeast Alaska salmon drift gillnet fishery~~,~~ that was monitored in 2012-2013~~, which partially overlaps this area~~. We used ~~the~~ pooled 2010-2012 abundance estimates of 398 (CV = 0.12; assumes g(0) = 1) for the northern region and ~~526~~577 (CV = ~~0.15~~0.14; assumes g(0) = 1) for the ~~Wrangell and Zarembo Islands area~~southern region (Dahlheim et al. 2015) to calculate ~~an~~ N_{MIN}s of ~~463~~359 and 513, respectively, for ~~this area of~~the concentrations of harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska. ~~The porpoise survey area for which the abundance estimate and N_{MIN} were calculated (Area 5: Dahlheim et al. 2015) partially overlaps~~ ADF&G Districts ~~6 and 8, which are two of the three 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. ~~Dahlheim et al. (2015) also provide information sufficient to calculate an N_{MIN} for the concentrations of harbor porpoise in the northern and southern regions of the inland waters of Southeast Alaska; this will be provided in a future draft SAR.~~

Current Population Trend

The abundance of harbor porpoise ~~for~~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 for the range of the Southeast Alaska harbor porpoise stock of 5,568. 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 ~~for the~~surveyed in 1997 ~~survey~~ 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 ~~(Zerbini et al. 2011), thus~~and highlighted~~ing~~ 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 ~~still~~ unclear why ~~the population estimate fluctuation for~~ a negative trend in harbor porpoise numbers was detected in inland waters of Southeast Alaska ~~occurred~~in 1991-2010 and reversed thereafter (Dahlheim et al. 2015). ~~When examined on a more regional scale~~Regionally, abundance was relatively constant in ~~Glacier Bay~~the northern region of the inland waters of Southeast Alaska throughout the survey period~~. In contrast~~, while declines were documented ~~for~~in the southern region~~Wrangell and Zarembo Islands area; an area where net fisheries occur~~ (Dahlheim et al. 2015).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not currently available for the Southeast Alaska stock of harbor porpoise. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate of 4% be employed (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 cetacean stocks with unknown population status (Wade and Angliss 1997). ~~The SAR guidelines (Wade and Angliss 1997) 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 (NMFS 2005).~~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 (896 × 0.02 × 0.5). However, 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. ~~A putative~~These PBR ~~level~~ calculations ~~for the Wrangell and Zarembo Islands area of the inland waters of Southeast Alaska~~ may provide a frame of reference for the observed takes of harbor porpoise in ~~this area~~the portion of the Southeast Alaska salmon drift gillnet fishery that was monitored in 2012-2013.~~ However, some of the observed takes in this fishery were outside of the area for which this putative PBR level is calculated. This PBR calculation, b~~Based on the pooled 2010-2012 abundance estimates ~~of 526 (CV = 0.15)~~ and ~~its~~ corresponding N_{MINs}~~ of 463~~, the PBR calculations for the ~~Wrangell and Zarembo Islands area~~northern and southern regions of the inland waters of Southeast Alaska~~, is 4.6~~are 3.6 (N = 398; CV = 0.12; N_{MIN} = 359) and 5.1 (N = 577; CV = 0.14; N_{MIN} = 513) harbor porpoise, respectively.

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.

~~Until 2003, there were three different federally regulated commercial fisheries in Alaska that could have interacted with the Southeast Alaska stock of harbor porpoise. As of 2003, changes in fishery definitions in the MMPA List of Fisheries resulted in separating the Gulf of Alaska (GOA) groundfish fisheries into many 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 responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. These fisheries (GOA Pacific cod longline, Pacific halibut longline, rockfish longline, and sablefish longline) were monitored for incidental mortality by fishery observers from 2009 to 2013,~~

~~although observer coverage has been very low in the offshore waters of Southeast Alaska (Appendix 6; Breiwick 2013; NMML, unpubl. data).~~ No mortality or serious injury of harbor porpoise from the Southeast Alaska stock has been observed ~~from this stock of harbor porpoise~~ incidental to U.S. federal commercial groundfish fisheries in Alaska in 2010-2014 (Breiwick 2013; MML, unpubl. data). ~~There is no consistent observer coverage for fisheries operating within the inside waters of Southeast Alaska. A reliable estimate of the mortality and serious injury rate incidental to commercial fisheries is currently unavailable because of the limited observer placements in Southeast Alaska fisheries. Therefore, it is unknown whether the mortality and serious injury rate is insignificant.~~

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 ~~observed~~ mortality~~y~~ies and serious injur~~y~~ies 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).

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, ~~we expect~~ this ~~to be~~is a minimum estimate of mortality for the fishery.

Table 1. Summary of incidental mortality and serious injury of harbor porpoise from the Southeast Alaska stock due to U.S. commercial fisheries in ~~2009-2013~~2010-2014 (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 SARs.

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)
SE 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)

~~Two~~One harbor porpoise mortality~~ies,~~ due to entanglement in a Yakutat salmon set gillnet~~s~~, ~~were~~was reported to the NMFS Alaska Region~~, one each~~ in ~~2009 and~~ 2010 (Helker et al. 2016); however, the AMMOP mean estimated annual mortality for the fishery accounts for ~~these~~this mortality~~ies~~ (Table 1).

~~A harbor porpoise mortality, due to entanglement in a subsistence king salmon set gillnet, was reported to the NMFS Alaska Region in 2009, resulting in an estimated minimum mean annual mortality and serious injury rate of 0.2 harbor porpoise in this fishery from 2009 to 2013 (Table 2).~~

~~**Table 2.** Summary of incidental mortality and serious injury of the Southeast Alaska stock of harbor porpoise, by year and type, reported to the NMFS Alaska Region, marine mammal stranding database, in 2009-2013 (Helker et al. 2015). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.~~

~~**Cause of injury**~~	~~**2009**~~	~~**2010**~~	~~**2011**~~	~~**2012**~~	~~**2013**~~	~~**Mean annual mortality**~~
~~Caught in Yakutat subsistence king salmon set gillnet~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0.2~~

A complete estimate of the total mortality and serious injury incidental to U.S. commercial fisheries is unavailable for this stock because not all salmon and herring fisheries have been observed. However, the minimum mean annual mortality and serious injury rate incidental to U.S. fisheries in 2010-2014 is estimated as 34 harbor porpoise.

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 MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. ~~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 total estimated annual level of human-caused mortality and serious injury ~~based on observer data (34) and stranding data (0.2) is~~for Southeast Alaska harbor porpoise (34 ~~harbor~~ porpoise) ~~from this stock~~exceeds the calculated PBR (8.9 porpoise), and 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). However, the calculated PBR is considered unreliable for the entire stock because it is based on estimates from surveys of only a portion (the inside waters of Southeast Alaska) of the range of this stock as currently designated. Because the abundance estimates are more than 8 years old (with the exception of the 2010-2012 abundance estimates provided for the inland waters of Southeast Alaska~~ and for the Wrangell and Zarembo Islands area~~) and the frequency of incidental mortality and serious injury in U.S. commercial fisheries throughout Southeast Alaska is not known, the Southeast Alaska stock of harbor porpoise is classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

HABITAT CONCERNS

Harbor porpoise are mostly found ~~in waters less than 100 m deep and they often concentrate~~ in nearshore areas and inland waters, including bays, tidal areas, and river mouths (Dahlheim et al. 2000, 2009, 2015; Hobbs and Waite 2010). As a result, harbor porpoise are vulnerable to physical modifications of nearshore habitats resulting from urban and industrial development (including waste management and nonpoint source runoff) and activities such as construction of docks and other over-water structures, filling of shallow areas, dredging, and noise (Linnenschmidt et al. 2013).

CITATIONS

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

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

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

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

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

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

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

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

~~DeMaster, D. P. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group. Anchorage, Alaska. 20 pp. + appendices. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

~~DeMaster, D. P. 1997. Minutes from the fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

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

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

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

Manly, B. F. J. 2009. Incidental catch of marine mammals and birds in the Yakutat salmon set gillnet fishery, 2007 and 2008. Final Report to NMFS Alaska Region. 96 p~~p~~.
Available online: https://alaskafisheries.noaa.gov/sites/default/files/yakutat07-08.pdf. Accessed ~~December 2015~~June 2016.

Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in districts 6, 7, and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 pp. Available online: https://alaskafisheries.noaa.gov/sites/default/files/incidentaltakes2012-2013.pdf. Accessed ~~December 2015~~June 2016.

NMFS (National Marine Fisheries Service). 2005. Revisions to guidelines for assessing marine mammal stocks. 24 p~~p~~. Available online: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf. Accessed ~~December 2015~~June 2016.

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

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

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

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

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

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

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

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

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

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

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

NOTE – ~~December 2015~~September 2016: In areas outside of Alaska, studies of harbor porpoise distribution have indicated that stock structure is likely more fine~~ly~~-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 (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).

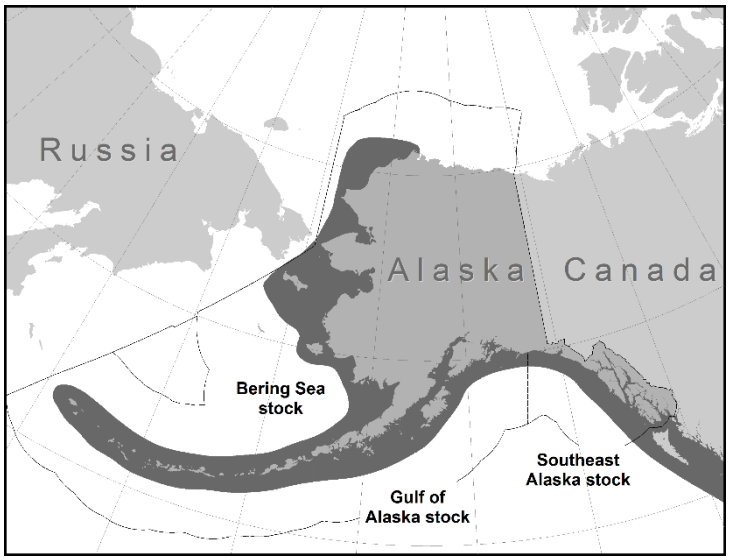

Figure 1. Approximate distribution of harbor porpoise in Alaska waters (dark shaded area).

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 ~~significant genetic~~ differences ~~for three of the six pair-wise comparisons~~ 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 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 ~~unknown~~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). ~~The Alaska Scientific Review Group concurred that available data were insufficient to justify recognizing three biological stocks of harbor porpoise in Alaska instead of only one; however, it did not recommend against the establishment of three management units in Alaska (DeMaster 1996, 1997).~~ Accordingly, from the above information, three harbor porpoise stocks in Alaska were ~~identified~~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 ~~the northern border of British Columbia~~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 ~~Sutwik~~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 (CV = 0.115) animals (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 (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 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

At present, 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 currently available for the Gulf of Alaska stock of harbor porpoise. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate of 4% be employed (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 cetacean stocks with unknown population status (Wade and Angliss 1997). However, the 2005 revisions to the SAR guidelines (Wade and Angliss 1997) 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 (NMFS 2005).

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.

~~Prior to 2003, three different federally managed commercial fisheries operating within the range of the Gulf of Alaska stock of harbor porpoise were monitored by NMFS observers for incidental take: the Gulf of Alaska groundfish trawl, longline, and pot fisheries. As of 2003, changes in fishery definitions in the MMPA List of Fisheries resulted in separating these 3 Gulf of Alaska (GOA) fisheries into 10 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.~~ No incidental mortality or serious injury of the Gulf of Alaska stock of harbor porpoise was observed in ~~these~~U.S. commercial groundfish fisheries in 2010-2014 (MML, unpubl. data). Observers ~~also~~ monitoring~~ed~~ the State of Alaska-managed Prince William Sound salmon drift gillnet fishery in 1990 and 1991~~,~~ recorded~~ing~~ 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 (CV = 0.60) ~~animals~~porpoise when averaged over 1990 and 1991 (Table 1; Wynne et al. 1991, 1992)~~ (Table 1)~~. 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 the 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. ~~Two h~~Harbor porpoise mortality~~ies~~ ~~were~~ observed in this fishery (2 each in both 2002 and 2005) (Manly 2007)~~, which~~ extrapolates to an estimated mean annual mortality and serious injury rate of 36 harbor porpoise (Table 1).

Table 1. Summary of incidental mortality and serious injury of ~~the~~ Gulf of Alaska ~~stock of~~ 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 2.7	0 0	0 0	0
Kodiak Island 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. ~~Between 2009 and 2013~~In 2013, one Gulf of Alaska harbor porpoise mortality, due to entanglement in a commercial salmon drift gillnet near Kenai, Alaska~~ in 2013~~, was reported to the NMFS Alaska Region stranding ~~database~~network (Helker et al. ~~2015~~2016). However, this event is accounted for in the extrapolated estimate (derived from Alaska Marine Mammal Observer Program (AMMOP) observer data) of annual mortality and serious injury occurring in the commercial Cook Inlet salmon drift 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 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 2010-2014 (Table 2; Helker et al. 2016).

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 2010-2014 (Helker et al. 2016). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	**2010**	**2011**	**2012**	**2013**	**2014**	**Mean annual mortality**
Entangled in unidentified net*	0	0	0	0	1	0.2
*Total 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 because of the absence of observer placements in all salmon and herring fisheries. However, 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 ~~is 72 harbor porpoise (Table 1)~~ + 0.2 in unknown fisheries).

Alaska Native Subsistence/Harvest Information

Porpoise in the Gulf of Alaska were hunted by prehistoric societies in Kodiak, 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 MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Because the PBR is undetermined, it is unknown if the minimum estimate of the mean annual ~~level of~~ U.S. commercial fishery-related mortality and serious injury rate (72 porpoise) ~~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 72 harbor porpoise. Because the most recent abundance estimate is more than 8 years old and information on incidental harbor porpoise mortality and serious injury in commercial fisheries is not complete, the Gulf of Alaska stock of harbor porpoise is classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

HABITAT CONCERNS

Harbor porpoise are mostly found ~~in waters less than 100 m in depth and they often concentrate~~ in nearshore areas, bays, tidal areas, and river mouths (Dahlheim et al. 2000, Hobbs and Waite 2010). As a result, harbor porpoise are vulnerable to physical modifications of nearshore habitats resulting from urban and industrial development (including waste management and nonpoint source runoff) and activities such as construction of docks and other over-water structures, filling of shallow areas, dredging, and noise (Linnenschmidt et al. 2013).

CITATIONS

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

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

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

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

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

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

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

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

~~DeMaster, D. P. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group. Anchorage, Alaska. 20 pp. + appendices. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

~~DeMaster, D. P. 1997. Minutes from the fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

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

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

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

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

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Final Report to NMFS Alaska Region. 98 p~~p~~. Available online: https://alaskafisheries.noaa.gov/sites/default/files/1999-2000cookinlet.pdf. Accessed ~~December 2015~~June 2016.

Manly, B. F. J. 2007. Incidental take and interactions of marine mammals and birds in the Kodiak Island salmon set gillnet fishery, 2002 and 2005. Final Report to NMFS Alaska Region. 221 p~~p~~. Available online: https://alaskafisheries.noaa.gov/sites/default/files/kodiakreport02_05.pdf. Accessed ~~December 2015~~June 2016.

NMFS (National Marine Fisheries Service). 2005. Revisions to guidelines for assessing marine mammal stocks. 24 p~~p~~. Available online: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf. Accessed ~~December 2015~~June 2016.

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

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

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

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

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

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

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

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

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

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

Revised ~~12/30/2015~~9/12/2016

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

NOTE – ~~December 2015~~September 2016: In areas outside of Alaska, studies of harbor porpoise distribution have indicated that stock structure is likely more fine~~ly~~-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 (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).

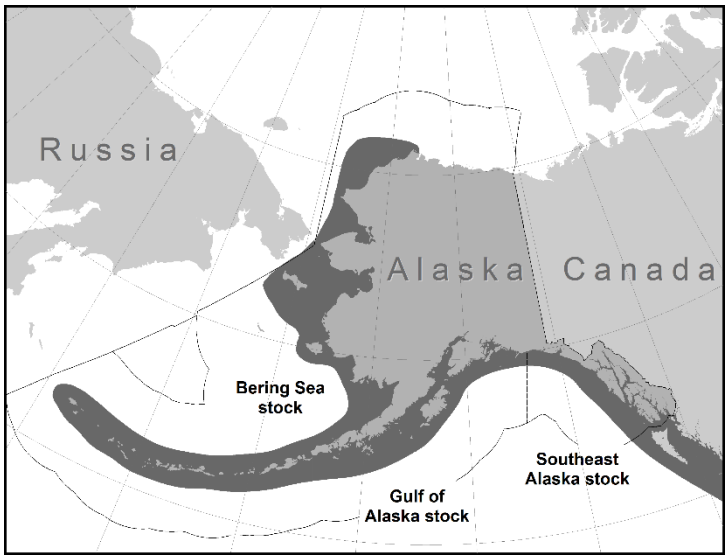

Figure 1. Approximate distribution of harbor porpoise in Alaska waters (dark shaded area).

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 ~~significant genetic~~ differences ~~for three of the six pair-wise comparisons~~ 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 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 ~~unknown~~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). ~~The Alaska Scientific Review Group concurred that available data were insufficient to justify recognizing three biological stocks of harbor porpoise in Alaska instead of only one; however, it did not recommend against the establishment of three management units in Alaska (DeMaster 1996, 1997).~~ Accordingly, from the above information, three harbor porpoise stocks in Alaska were ~~identified~~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 ~~the northern border of British Columbia~~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 this second correction factor, the corrected abundance estimate is 48,215 (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 ~~either~~ 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 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

~~The abundance of harbor porpoise in Bristol Bay was estimated in 1991 and 1999. The 1991 estimate was 10,946 (Dahlheim et al. 2000). The 1999 estimate of 48,215 is higher than the 1991 estimate (Hobbs and Waite 2010). However, there are some key differences between surveys which complicate direct comparisons. Transect lines were substantially more dense in 1999 than in 1991 and large numbers of porpoise were observed in 1999 in an area which was not surveyed intensely in 1991 (compare sightings in northeast Bristol Bay depicted in Figure 5 in Hobbs and Waite (2010) with Figure 4 in Dahlheim et al. 2000). In addition, the use of a second correction factor for the 1999 estimate confounds direct comparison. The density of harbor porpoise resulting from the 1999 surveys was still substantially higher than that from 1991 (Dahlheim et al. 2000), but it is unknown whether the increase in density is a result of a population increase or a result of survey design. Thus, at present, t~~There is no reliable information on current 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 ~~currently~~ not available for this stock of harbor porpoise. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate of 4% be employed (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 cetacean stocks with unknown population status (Wade and Angliss 1997). However, the 2005 revisions to the Stock Assessment Report guidelines (Wade and Angliss 1997) 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 (NMFS 2005). Therefore, the PBR for this stock is considered undetermined.

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.

~~Prior to 2003, three different federally managed commercial fisheries operating within the range of the Bering Sea stock of harbor porpoise were monitored for incidental take by NMFS observers during 1990-1998: the Bering Sea/Aleutian Islands groundfish trawl, longline, and pot fisheries. As of 2003, changes in fishery definitions in the MMPA List of Fisheries resulted in separating these fisheries into 12 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 Bering Sea harbor porpoise was observed ~~in these~~incidental to U.S. commercial fisheries during ~~2009-2013~~2010-2014 (Breiwick 2013; ~~N~~MML, unpubl. data).

One harbor porpoise mortality due to entanglement in a commercial salmon gillnet in Kotzebue, Alaska, was reported to the NMFS Alaska Region stranding ~~database~~network in 2013 (Table 1; Helker et al. ~~2015~~2016), resulting in a minimum average annual mortality and serious injury rate of 0.2 Bering Sea harbor porpoise in U.S. commercial fisheries in ~~2009-2013~~2010-2014 (Table 1). ~~However, a reliable~~A complete estimate of the total mortality and serious injury rate incidental to U.S. commercial fisheries is currently unavailable because of the absence of observer placements in all of the salmon and herring fisheries. ~~Therefore, it is unknown whether the mortality and serious injury rate is insignificant.~~

In 2012, one harbor porpoise entangled in a subsistence salmon gillnet in Nome, Alaska (Helker et al. ~~2015~~2016), resulting in a minimum average annual mortality and serious injury rate of 0.2 harbor porpoise due to subsistence fishery interactions in ~~2009-2013~~2010-2014 (Table 1).

Table 1. Summary of incidental mortality and serious injury of ~~the~~ Bering Sea ~~stock of~~ harbor porpoise, by year and type, reported to the NMFS Alaska Region~~,~~ marine mammal stranding ~~database~~network~~,~~ in ~~2009-2013~~2010-2014 (Helker et al. ~~2015~~2016). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	**~~2009~~**	**2010**	**2011**	**2012**	**2013**	**2014**	**Mean annual mortality**
Entangled in Kotzebue commercial salmon set gillnet	~~0~~	0	0	0	1	0	0.2
Entangled in Nome subsistence salmon gillnet	~~0~~	0	0	1	0	0	0.2
Total commercial fisheries							0.2
Total 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 MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Because the PBR is undetermined, the ~~annual level of~~mean annual U.S. commercial fishery-related mortality and serious injury rate that can be considered insignificant and approaching zero mortality and serious injury rate is unknown; a minimum estimate of the current rate (from stranding data) is 0.2 harbor porpoise; however, most of the fisheries likely to interact with this stock of harbor porpoise have never been monitored. ~~The~~A minimum estimate of ~~mean~~the total annual level of human-caused mortality and serious injury ~~(0.2 from commercial fisheries + 0.2 from subsistence fisheries)~~ is 0.4 harbor porpoise; however, the estimated annual level of human-caused mortality and serious injury relative to PBR is unknown. Because the abundance estimates are more than 8 years old and information on incidental mortality and serious injury in commercial fisheries is sparse, the Bering Sea stock of harbor porpoise is classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

HABITAT CONCERNS

Harbor porpoise are ~~mostly~~ found ~~in waters less than 100 m in depth~~over the shelf waters of the southeastern Bering Sea (Dahlheim et al. 2000, Hobbs and Waite 2010). ~~As a result~~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.

CITATIONS

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

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

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

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

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

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

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

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

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

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

~~DeMaster, D. P. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group. Anchorage, Alaska. 20 pp. + appendices. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

~~DeMaster, D. P. 1997. Minutes from the fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. Available from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.~~

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

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

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

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

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

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

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

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

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

NMFS (National Marine Fisheries Service). 2005. Revisions to guidelines for assessing marine mammal stocks. 24 p~~p~~. Available online: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf. Accessed ~~December 2015~~June 2016.

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

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

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

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

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

Suydam, R. S., and J. C. George. 1992. Recent sightings of harbour porpoises, *Phocoena phocoena*, near Point Barrow, Alaska. Can. Field-Nat. 106(4):489-492.

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

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

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

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

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, 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).

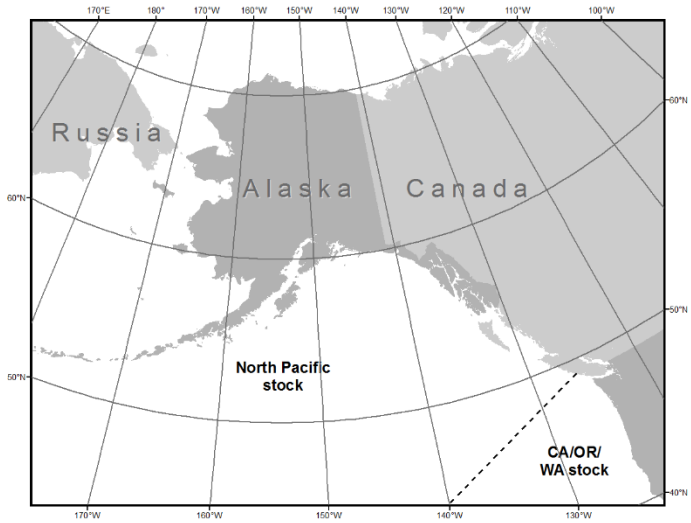

Figure 1. The approximate distribution of sperm whales in the North Pacific includes deep waters south of 62°N to the equator.

Sperm whales feed primarily on medium-sized to large-sized squids but also take substantial quantities of large demersal and mesopelagic sharks, skates, and fishes (Rice 1989). In the North Pacific, sperm whales are distributed widely (Fig. 1), with the northernmost boundary extending from Cape Navarin (62°N) to the Pribilof Islands (Omura 1955). 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, in the western Bering Sea and in the western Aleutian Islands. Mizroch and Rice (2013) also showed female movements into the Gulf of Alaska and western Aleutians. Males are found in the summer 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 ~~National~~ Marine Mammal Laboratory (MML) in the summer months between 2001 and 2010 have found sperm whales to be the most frequently sighted large cetacean in the coastal waters around the central and western Aleutian Islands (~~N~~MML, unpubl. data). Acoustic surveys detected the presence of sperm whales year-round in the Gulf of Alaska, although they appear to be more common in summer than in winter (Mellinger et al. 2004). These seasonal detections are consistent with the hypothesis that sperm whales move to higher latitudes in summer and to lower latitudes in winter (Whitehead and Arnbom 1987).

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 waters 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. Similar extensive movements have also been demonstrated by recent 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). 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) also analyzed whaling data and found that males and females 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. Their analyses of marking and whaling data indicate that there are no apparent divisions between

separate demes or stocks within the North Pacific. Analysis of Soviet catch data by Ivashchenko et al. (2014) showed broad agreement with these results, although a sharp division was evident at Amchitka Pass in the Aleutians, with mature males to the east and males and family groups to the west, including in the Commander Islands. 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.

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~~s~~ studies indicate the possibility of a "somewhat" discrete U.S. coastal stock (Mesnick et al. 2011). For management purposes, the International Whaling Commission (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. ~~New i~~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 estimates of the abundance of sperm whales in the North Pacific are considered unreliable, and 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 were not provided. These estimates include whales from the California/Oregon/Washington stock, for which a separate abundance estimate is currently available (see 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 recent estimate exists for other areas, including for the central or western North Pacific.

Although Kato and Miyashita (1998) believe their estimate to be positively biased, their analysis suggested 102,112 (CV = 0.155) sperm whales in the western North Pacific. The number of sperm whales occurring within 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 ~~at this time~~, and there are no available estimates for numbers of sperm whales in Alaska waters, 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, as a current estimate of abundance is not available.

Current Population Trend

No current estimate of abundance exists for this stock; therefore, reliable information on trends in abundance for this stock is currently not available (Braham 1992).

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 sperm whales. 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 at this time (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 0.1, the value for cetacean stocks which are classified as "endangered" (Wade and Angliss 1997). However, because a reliable estimate of minimum abundance (N_{MIN}) is currently not available, the PBR for this stock is unknown.

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.

~~Between 2009 and 2013~~In 2010-2014, there were ~~four~~five serious injuries of sperm whales observed in the Gulf of Alaska sablefish longline fishery (two each in 2012 and 2013 and one in 2014). Each of these injuries was prorated to a value of 0.75, resulting in an average annual observed mortality and serious injury rate of ~~0.8~~2.2 sperm whales in U.S. commercial groundfish fisheries in ~~2009-2013~~2010-2014 (Table 1; ~~Helker et al. 2015~~Breiwick 2013; MML, unpubl. data). ~~Extrapolations based on observer effort are not available at this time.~~

Table 1. Summary of incidental mortality and serious injury of North Pacific sperm 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). 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
Gulf of Alaska sablefish longline	2010 2011 2012 2013 2014	obs data	15 14 14 14 19	0 0 1.5 0.75 (+0.75)[a] 0 (+0.75)[c]	0 0 3.4 6.2 (+0.75)[b] 0 (+0.75)[d]	1.9 (+0.3)[e] (CV = 0.63)
Minimum total estimated annual mortality						2.2 (CV = 0.63)

[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 ~~the Second~~ 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 further 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 (IWC, Bureau of International Whaling Statistics (BIWS) catch data, February 2008 version, unpubl.). 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 ~~new information indicates~~ 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.).~~ It should be noted that the reliability of data concerning large pelagic catches of sperm whales by Japan in the North Pacific is unknown, but analysis of length distribution data suggests at least some degree of systematic misreporting (Cooke et al. 1983). Thus, studies that use Japanese data to assess the North Pacific distribution of this species, including by sex, should be interpreted with caution.~~ 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) is known to be unreliable because of falsified catch information from both the Japanese coastal and pelagic fisheries (Kasuya 1999, Ivashchenko and Clapham 2015).

From ~~2009 to 2013~~2010 to 2014, one suspected human-related sperm whale mortality was reported to the NMFS Alaska Region stranding ~~database~~network (Helker et al. ~~2015~~2016). 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 predation 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). Undamaged catches may also occur when sperm whales are present; in these cases, sperm whales apparently feed off the 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 currently 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 currently not available, although the total estimated annual ~~rate~~level of human-caused mortality and serious injury (2.2 whales) seems minimal for this stock. Because the PBR is unknown, it is not known if the ~~level of~~mean annual U.S. commercial fishery-related mortality and serious injury rate (2.2 whales) ~~that~~ can be considered insignificant and approaching zero mortality and serious injury rate~~ is unknown~~.

HABITAT CONCERNS

~~There are no known habitat issues that are of particular concern for this stock. However, p~~Potential habitat concerns for this stock include elevated levels of sound from anthropogenic sources (e.g., shipping, military ~~sonars~~exercises), possible changes in prey distribution and quality with climate change, entanglement in fishing gear, ship strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes), and oil and gas activities.

CITATIONS

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

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

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

Braham, H. 1992. Endangered whales: status update. Working document presented at A Workshop on the Status of California Cetacean Stocks (SOCCS/14). 35 p~~p~~. + tables. Available from ~~N~~MML, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

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

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

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

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

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

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

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

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

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

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

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

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

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

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

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

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

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

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

Omura, H. 1955. Whales in the northern part of the North Pacific. Norsk~~.~~ Hvalfangst-tidende 44(6):323-345.

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

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

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

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

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

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

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

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

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

~~**NOTE – December 2015: NMFS has conducted a global Status Review of humpback whales (Bettridge et al. 2015) and has proposed revisions to the ESA listing of the species (80 FR 22303, April 21, 2015).**~~

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 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.

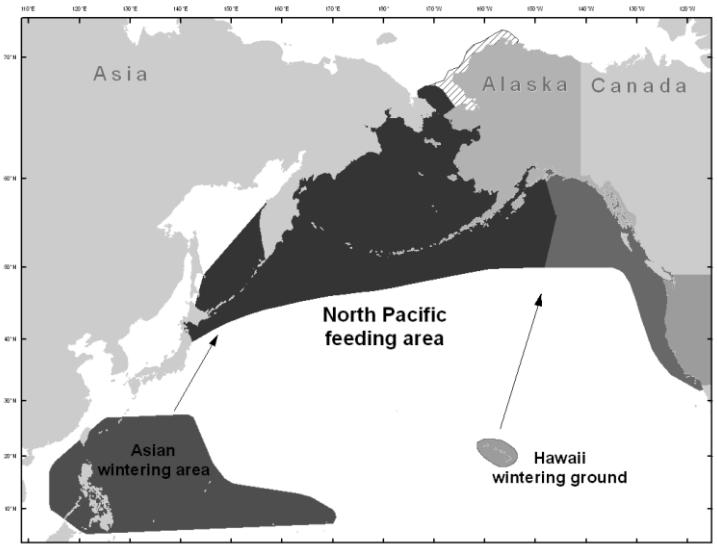

Figure 1. Approximate distribution of humpback whales in the western North Pacific (dark shaded areas). Feeding and wintering grounds are presented above (see text). Area within the hash lines is a probable distribution area based on sightings in the Beaufort Sea (Hashagen et al. 2009). See Figure 1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

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.

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 ~~to~~and as far north as southern British Columbia in summer/fall (Calambokidis et al. 1989, Steiger et al. 1991, Calambokidis et al. 1993); 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.

Information from the SPLASH project ~~mostly~~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.~~ and~~ 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).~~ This suggests a need for some modification to the current view of winter breeding populations. After a Status Review under the Endangered Species Act (ESA), NMFS has proposed designating four Distinct Population Segments (DPSs) of humpback whales in the North Pacific: Western North Pacific, Hawaii, Mexico, and Central America (https://www.federalregister.gov/articles/2015/04/21/2015-09010/endangered-and-threatened-species-humpback-whale-megaptera-novaeangliae-identification-of-14). If this proposed rule results in the designation of DPSs in the North Pacific, a parallel revision of Marine Mammal Protection Act (MMPA) population structure in the North Pacific will be considered.~~

The winter distribution of humpback whales in the Western stock includes several island chains in the western North Pacific. In the Ogasawara Islands, humpback 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.

~~A relevant finding from t~~The SPLASH project ~~is~~also found that whales from the Aleutian Islands and Bering Sea, and perhaps ~~also~~ the Gulf of Anadyr and the Chukotka Peninsula on the west side of the Bering Strait in Russia~~ and the Bering Sea~~, have an unusually low resighting rate in winter areas compared to whales from other feeding areas. ~~One explanation for this result could be~~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. ~~Indeed, humpback whales have been found to occur in the Northwestern Hawaiian Islands, though apparently at relatively low density (Johnston et al. 2007), but no other areas with high densities of humpback whales are known between the Hawaiian main islands and Ogasawara.~~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 (Johnson 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 humpbacks 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-~~N~~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, 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

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 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, because this population is growing (Calambokidis et al. 2008), this is still a valid minimum population estimate.

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): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. 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.

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, it is recommended that 7% be employed as the maximum net productivity rate (R_{MAX}) for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized 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 0.1, 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

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.

~~Between 2009 and 2013~~During 2010-2014, ~~there were two known~~ mortality~~ies~~, and serious injury of humpback whales occurred in the Bering Sea/Aleutian Islands pollock trawl fishery (1 each in 2010 and 2012) and ~~one in~~ the Bering Sea/Aleutian Islands flatfish trawl fishery (1 in 2010) (Table 1; Breiwick 2013; MML, unpubl. data). Since the stock identification of these whales is unknown, and the events occurred within the area where the Western North Pacific and Central North Pacific stocks are known to overlap, the mortality in these fisheries is assigned to both stocks of humpback whales. The ~~minimum~~estimated average annual mortality and serious injury rate from observed U.S. commercial fisheries is 0.6 ~~humpbacks from the~~ Western North Pacific ~~stock~~humpback whales in ~~2009-2013~~2010-2014 (Table 1).

Table 1. Summary of incidental mortality and serious injury of ~~the~~ Western North Pacific ~~stock of~~ humpback whales due to observed U.S. commercial fisheries ~~from 2009 to 2013~~in 2010-2014 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; ~~N~~MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports. 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[a]	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~99~~ 99 ~~99~~100 99 99 99	~~0~~ 0 (+1)[b] 0 0 0 0	~~0~~ 0 (+1)[c] 0 0 0 0	0 (+0.2)[d] (CV = N/A)
Bering Sea/Aleutian Is. pollock trawl[a]	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~86~~ 86 98 98 97 98	~~0~~ 1 0 1 0 0	~~0~~ 1.0 0 1.0 0 0	0.4 (CV = ~~0.68~~0.09)
Minimum total estimated annual mortality						0.6 (CV = ~~0.45~~0.09)

[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 identification is unknown and the two stocks overlap within the area of operation of the fishery.
[b]Total mortality and serious injury observed in 2010: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[c]~~Since the t~~Total ~~known~~estimate of mortality and serious injury in 2010: 0 whales (extrapolated estimate from 0 whales observed in sampled hauls) + 1 whale (1 whale observed in an unsampled haul~~) exceeds the estimated mortality and serious injury (0) for the fishery in 2010, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year~~.
[c]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).

One entanglement in the ground tackle of a commercial Pacific cod jig fishery vessel in Kodiak, Alaska, was reported to the NMFS Alaska Region stranding network in 2013 (Table 2; Helker et al. ~~2015~~2016). Since observer data are not available for this fishery, this mortality results in a minimum mean annual mortality and serious injury rate of 0.2 humpback whales in ~~2009-2013~~2010-2014 (Table 2) and, since the event occurred in the area where the two stocks overlap, the mortality is assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales.

The estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries is 0.8 Western North Pacific humpback whales (0.6 based on observed fisheries + 0.2 based on stranding data)~~ Western North Pacific humpback whales~~; 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.~~ However, very few stranding reports are received from areas west of Kodiak.~~ The ~~estimated~~minimum mean annual mortality and serious injury rate from fishery-related gear entanglements and interactions reported to the NMFS Alaska Region stranding ~~database~~network in ~~2009-2013~~2010-2014, in which the events have not been attributed to a specific fishery listed on the MMPA List of Fisheries (76 FR 73912; 29 November 2011), is ~~0.4~~0.6 humpbacks (Table 2; Helker et al. 2016). Since these events occurred in the area where the two stocks overlap, this mortality is assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales. These estimates are considered a minimum because not all entangled animals strand and not all stranded animals are found, reported, or have the cause of death determined.

One additional humpback whale, initially considered seriously injured due to entanglement in Gulf of Alaska/Kodiak Dungeness crab pot gear, was disentangled in Alaska waters in 2012 and released with non-serious injuries (Helker et al. 2016); therefore, it was not included in the mean annual mortality and serious injury rate for 2010-2014. Since this event occurred in the area where the two stocks overlap, this injury was also assigned to the Central North Pacific stock.

The ~~estimated~~minimum average annual mortality and serious injury rate due to interactions with all fisheries in ~~2009-2013~~2010-2014 is ~~1.2~~1.4 Western North Pacific humpback whales (0.8 in commercial fisheries + ~~0.4~~0.6 in unknown fisheries)~~ Western North Pacific humpback whales~~.

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 ~~database~~network in ~~2009-2013~~2010-2014 (Helker et al. ~~2015~~2016). Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NOAA (2012). All events occurred within the area of known overlap between the Western North Pacific and Central North Pacific humpback whale stocks. Since the stock identification is unknown, the mortality and serious injury is reflected in both Stock Assessment Reports. 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. (~~2015~~2016).

~~Cause of injury~~	~~2009~~	~~2010~~	~~2011~~	~~2012~~	~~2013~~	~~Mean annual mortality~~
~~Entangled in ground tackle of commercial cod jig vessel~~	~~0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0.2~~
~~Entangled in unspecified pot gear~~	~~0~~	~~0~~	~~0.75~~	~~0~~	~~0~~	~~0.2~~
~~Entangled in unspecified set net gear~~	~~0~~	~~0~~	~~0.75~~	~~0~~	~~0~~	~~0.2~~
~~Ship strike (charter)~~	~~0~~	~~0~~	~~0~~	~~0.2~~	~~0~~	~~0.04~~
~~Ship strike (whale watch)~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0.2~~

~~Cause of injury~~	~~2009~~	~~2010~~	~~2011~~	~~2012~~	~~2013~~	~~Mean annual mortality~~
~~Entangled in unknown marine debris/gear~~	~~0.75~~	~~0~~	~~2.5~~	~~0.75~~	~~0~~	~~0.8~~

Cause of injury	2010	2011	2012	2013	2014	Mean annual mortality
Entangled in ground tackle of Kodiak commercial Pacific cod jig vessel	0	0	0	1	0	0.2
Entangled in Bering Sea pot gear*	0	0.75	0	0	0	0.2
Entangled in Prince William Sound shrimp pot gear*	0	0	0	0	1	0.2
Entangled in gillnet*	0	0.75	0	0	0	0.2
Entangled in marine debris	0	2.5	0.75	0	0.75	0.8
Ship strike	0	0	1.2	0	1	0.4
Total commercial fisheries						0.2
*Total unknown (commercial, recreational, or subsistence) fisheries						0.6
Total marine debris						0.8
Total other sources (ship strike)						0.4

Brownell et al. (2000) compiled records of bycatch in Japanese and Korean commercial fisheries between 1993 and 2000. During the period 1995-1999, there were six humpback whales indicated as "bycatch." In addition, two strandings were reported during this period. Furthermore, analysis of four samples from meat found in markets indicated that humpback whales are 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 much higher. An analysis of entanglement rates from photographs collected for SPLASH 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 ~~are~~were no reported takes of humpback whales from this stock by Native subsistence hunters in Alaska or Russia in ~~2009-2013~~2010-2014.

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 June 2016). On August 20, 2015, NMFS declared an Unusual Mortality Event for large whales in the western Gulf of Alaska; however, to date, no specific cause for the increased mortality has been identified.

Other sources of human-caused mortality and serious injury include ship strikes and entanglement in ~~unknown~~ marine debris~~/gear~~. The minimum mean annual mortality and serious injury rate of ~~one~~1.2 Western North Pacific humpback whales ~~per year~~ in ~~2009-2013~~2010-2014 is based on ship strikes (~~0.2~~0.4) and entanglement in ~~unknown~~ marine debris~~/gear~~ (0.8) reported to the NMFS Alaska Region stranding ~~database~~network (Table 2; Helker et al. 2016). Since these events occurred in the area where the stocks overlap, this mortality is assigned to both the Western North Pacific and Central North Pacific stocks of humpback whales.

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 the Queen Charlotte Islands, and other takes in earlier years may have gone unrecorded.

STATUS OF STOCK

~~NMFS recently concluded a global humpback whale Status Review (Bettridge et al. 2015).~~ The total estimated ~~mean~~ annual level of human-caused mortality and serious injury ~~rate~~ of ~~2.2~~2.6 ~~(1.2 from fishery related interactions + 1 from other interactions)~~ Western North Pacific humpback whales is less than the calculated conservative 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~~: Brownell et al. 2000~~). ~~The humpback whale is listed as "endangered" under the Endangered Species Act and, therefore, designated as "depleted" under the MMPA.~~The humpback whale ESA listing final rule (81 FR 62259, September 8, 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 necessarily 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, NMFS 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 whale is classified as a strategic stock.~~ The status of this stock relative to its Optimum Sustainable Population is currently unknown.~~

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 in fishing gear, 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)~~, as well as oil and gas activities in the Chukchi and Beaufort seas~~.

CITATIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final Report for Contract AB133F-03-RP-00078, U.S. Dep. Commer., Western Administrative Center, Seattle, WA. Available online: http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-Report-May08.pdf. Accessed ~~December 2015~~June 2016.

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

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

Clarke, J. T., C. L. Christman, A. A. Brower, and M. C. Ferguson. 2013a. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2012. Annual Report, OCS Study BOEM 2013-00117. ~~National~~ Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-6349.

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

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

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

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

Doroshenko, N. V. 2000. Soviet catches of humpback whales (*Megaptera novaeangliae*) in the North Pacific,~~.~~ ~~P~~p. 96-103. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet whaling data (1949-1979). Center for Russian Environmental Policy, Marine Mammal Council, Moscow.

Fleming, A., and J. Jackson. 2011. Global review of humpback whales (*Megaptera novaeangliae*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-474, 206 p.

Hashagen, K. A., G. A. Green,~~,~~ and B. Adams. 2009. Observations of humpback whales, *Megaptera novaeangliae*, in the Beaufort Sea, Alaska. Northwest. Nat. 90:160-162.

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

Hill, M. C., E. M. Oleson, S. Baumann-Pickering, A. M. VanCise, A. D. Ligon, A. R. Bendlin, A. C. Ü, J. S. Trickey, and A. L. Bradford. 2016. Cetacean monitoring in the Mariana Islands Range Complex, 2015. Prepared for the U.S. Pacific Fleet Environmental Readiness Office. PIFSC Data Report DR-16-01. 36 p. + appendix.

Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell, Jr. (eds.). 2007. Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-175, 36 p. (Translation: Y. V. Ivashchenko) + appendix.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish. Rev. 46(4):30-37.

Johnston, D. W., M. E. Chapla, L. E. Williams, and D. K. Mattila. 2007. Identification of humpback whale wintering habitat in the Northwestern Hawaiian Islands using spatial habitat modeling. Endang. Species Res. 3:249-257.

Melnikov, V. V. 2000. Humpback whales *Megaptera novaeangliae* off Chukchi Peninsula. Russ. J. Oceanogr. 4:844-849.

Miyashita, T. 2006. Cruise report of the sighting survey in the waters east of the Kuril Islands and the Kamchatka Peninsula in 2005. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/NPM5).

Mizroch, S. A., and D. W. Rice. 2007. Distribution and movements of humpback whales (*Megaptera novaeangliae*) in the North Pacific Ocean. Presented at the 17th Biennial Conference on the Biology of Marine Mammals, Cape Town, South Africa.

Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, and O. von Ziegesar. 2004. Estimating the adult survival rate of central North Pacific humpback whales. J. Mammal. 85(5):963-972.

Mobley, J. M., S. Spitz, R. Grotefendt, P. Forestell, A. Frankel, and G. Bauer. 2001. Abundance of humpback whales in Hawaiian waters: Results of 1993-2000 aerial surveys. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary. 16 p~~p~~.

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. Tokyo 12:33-89.

Nemoto, T. 1959. Food of baleen whales with reference to whale movements. *S*ci. Rep. Whales Res. Inst. 14**:**149-290.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results.~~,~~ ~~P~~p. 172-191. *In* K. S. Norris (ed.), Whales, Dolphins and Porpoises. University of California Press, Berkeley, CA.

NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf. Accessed ~~December 2015~~June 2016.

Ohsumi, S., and Y. Masaki. 1975. Japanese whale marking in the North Pacific, 1963-1972. Bull. Far Seas Fish. Res. 12:171-219.

Omura, H., and S. Ohsumi. 1964. A review of Japanese whale marking in the North Pacific to the end of 1962, with some information on marking in the Antarctic. Norsk Hvalfangst-Tidende 4:90-112.

Perry, A., C. S. Baker, and L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. Rep. Int. Whal. Comm. (Special Issue 12):307-317.

Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation and numbers.~~,~~ Appendix 4.~~,~~ ~~P~~p. 29-44. *In* K. S. Norris and R. R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. U.S. Dep. Commer., Nat. Tech. Info. Serv. PB-280 794. Springfield, VA.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Soc. Mar. Mammal. Spec. Publ. No. 4.

Springer, A. M., G. B. van Vliet, J. F. Piatt, and E. M. Danner. 2006. Whales and whaling in the North Pacific Ocean and Bering Sea: oceanographic insights and ecosystem impacts, ~~P~~p. 245-261. *In* J. A. Estes, R. L. Brownell, Jr., D. P DeMaster, D. F. Doak, and T. M. Williams (eds.), Whales, Whaling and Ocean Ecosystems~~,~~. University of California Press. 418 p~~p~~.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mammal Sci. 7:306-310.

Tomlin, A. G. 1967. Mammals of the USSR and adjacent countries. Vol. 9. Cetacea. Israel Program for Scientific Translations No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 p~~p~~. (Translation of Russian text published in 1957.)

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

Witteveen, B. H., J. M. Straley, O. von Ziegesar, D. Steel, and C. S. Baker. 2004. Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska. Can. J. Zool. 82:1352-1359.

Zenkovich, B. A. 1954. Vokrug sveta za kitami, Vol. Gosudarstvennoe Izdatel'stvo Geograficheskoi Literatury, Moscow.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53(11):1772-1790.

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

~~**NOTE – December 2015: NMFS has conducted a global Status Review of humpback whales (Bettridge et al. 2015) and has proposed revisions to the ESA listing of the species (80 FR 22303, April 21, 2015).**~~

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 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.

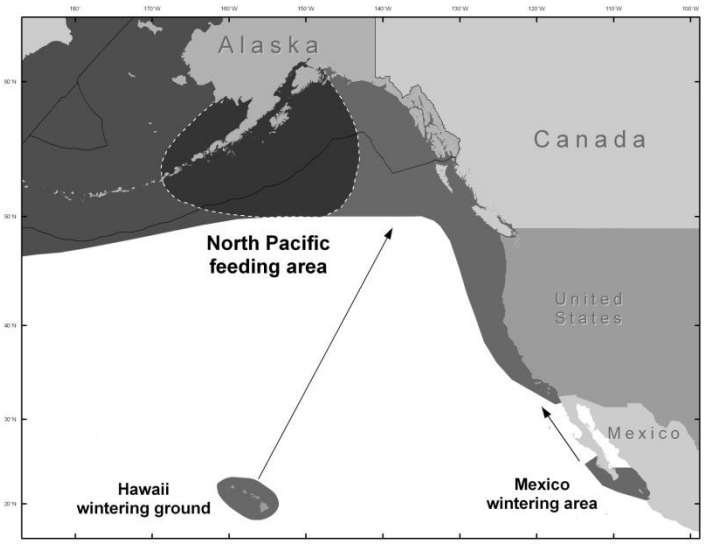

Figure 1. Approximate distribution of humpback whales in the eastern North Pacific (dark shaded areas). Feeding and wintering areas are presented above (see text). Area within the dotted line is known to be an area where the Central North Pacific and Western North Pacific stocks overlap. See Figure 1 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 ~~to~~and as far north as southern British Columbia in summer/fall (Calambokidis et al. 1989, Steiger et al. 1991, Calambokidis et al. 1993); 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.

Information from the SPLASH project ~~mostly~~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.~~ and~~ 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).~~ This suggests a need for some modification to the current view of winter/breeding populations. After a Status Review under the Endangered Species Act (ESA), NMFS has proposed designating four Distinct Population Segments (DPSs) of humpback whales in the North Pacific: Western North Pacific, Hawaii, Mexico, and Central America (https://www.federalregister.gov/articles/2015/04/21/2015-09010/endangered and threatened species humpback whale megaptera novaeangliae identification of 14). If this proposed rule results in the designation of DPSs in the North Pacific, a parallel revision of Marine Mammal Protection Act (MMPA) population structure in the North Pacific will be considered.~~

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 (Johnson 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.

~~A relevant finding from the SPLASH project is that whales from the Aleutian Islands, and perhaps also the Gulf of Anadyr in Russia and the Bering Sea, have an unusually low resighting rate in winter areas compared to whales from other feeding areas. One explanation for this result could be 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 and Hawaiian Islands), and the Northwestern Hawaiian Islands. Indeed, humpback whales have been found to occur in the Northwestern Hawaiian Islands, though apparently at relatively low density (Johnston et al. 2007), but no other areas with high densities of humpback whales are known between the Hawaiian main islands and Ogasawara. Which stock that whales found in these locations would belong to is currently unknown.~~

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 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.

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 Shumigan 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). ~~In the northern British Columbia region (primarily near Langara Island), 275 humpback whales were photo-identified from 1992 to 1998 (G. Ellis, Pacific Biological Station, pers. comm.). As of 2003, approximately 850-1,000 humpback whales had been identified in British Columbia (J. Ford, Department of Fisheries and Oceans, Canada, pers. comm.)~~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.

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 Shumigan 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% ~~per year~~ (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 from the Central North Pacific humpback whale stock, it is recommended that 7% be employed as the maximum net productivity rate (R_{MAX}) for this stock.

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized 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 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). A recovery factor of 0.3 is used in calculating the PBR 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 animals (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. ~~One possibility would be to revise stock structure to be consistent with summer feeding aggregations, as has been done for the North Atlantic population of humpback whales. If this were to occur, possible groupings could be Southeast Alaska/northern British Columbia, Gulf of Alaska, and Aleutian Islands/Bering Sea.~~ Just for information purposes, PBR calculations are completed here for the~~se~~ 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

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 2004, there were four different federally regulated commercial fisheries in Alaska that occurred within the range of the Central North Pacific humpback whale stock that were monitored for incidental mortality and serious injury by fishery observers. As of 2004, changes in fishery definitions in the MMPA List of Fisheries have resulted in separating these 4 fisheries into 17 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~~2010 and 2014, ~~there was one known incidental~~mortality and serious injury ~~and mortality~~ of ~~a~~ humpback

whales occurred in the Bering Sea/Aleutian Islands flatfish trawl fishery (1 in 2010) and ~~two in~~ the Bering Sea/Aleutian Islands pollock trawl fishery (1 each in 2010 and 2012) (Table 1; Breiwick 2013; ~~N~~MML, unpubl. data). Since the stock identification of these whales is unknown, and the events occurred within the area where the Central North Pacific and Western North Pacific stocks are known to overlap, the mortality in these fisheries is assigned to both stocks of humpback whales. ~~One~~Two Central North Pacific humpback whales were injured in Hawaii longline fisheries in 2010-2014: one in the Hawaii shallow~~-~~-set longline fishery in 2011 ~~is~~ (prorated at 0.75 under the injury determination guidelines for large whales, since the severity of its injury is unknown) and one in the Hawaii deep-set longline fishery in 2014 (Table 1; Bradford and Forney 2014; NMFS-PIFSC, unpubl. data).

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 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 for the fishery.

Humpback whale mortality and serious injury due to entanglement in the commercial Southeast Alaska salmon drift gillnet fishery was reported to the NMFS Alaska Region stranding network in 2010-2014. Prorated values for serious injuries resulted in a total of 3 whales in 2010, 0.75 whales in 2011, 1.75 whales in 2012~~ (1 whale), and~~ 0.75 whales in 2013~~ (1.75 whales)~~, and 2.5 whales in 2014 (Helker et al. ~~2015~~2016); however, this mortality and serious injury is accounted for by the AMMOP observer data for this fishery (in Table 1). One entanglement in the ground tackle of a commercial Pacific cod jig fishery vessel in Kodiak, Alaska, was also reported to the NMFS Alaska Region in 2013 (Table 2; Helker et al. ~~2015~~2016). Since observer data are not available for this fishery, this mortality results in a minimum mean annual mortality and serious injury rate of 0.2 humpback whales in ~~2009-2013~~2010-2014 (Table 2) and, since the event occurred in the area where the two stocks overlap, the mortality is assigned to both the Central North Pacific and Western North Pacific stocks of humpback whales.

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 2010-2014 is ~~6.5~~7.4 humpback whales, based on observer data from Alaska (Table 1: 0.6 in the federal groundfish fisheries + 5.5 in the state-managed Southeast Alaska salmon drift gillnet fishery~~: Table 1~~) and Hawaii (Table 1: ~~0.2~~1.1~~: Table 1~~) and on reports, in which the commercial fishery is confirmed, to the NMFS Alaska Region stranding ~~database~~network (Table 2: 0.2~~: Table 2~~).

Table 1. Summary of incidental mortality and serious injury of ~~the~~ Central North Pacific ~~stock of~~ humpback whales due to observed U.S. commercial fisheries ~~from 2009 to 2013~~in 2010-2014 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; Bradford and Forney 2014; Manly 2015; NMFS-PIFSC, unpubl. data; ~~N~~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[a]	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~99~~ 99 ~~99~~100 99 99 99	~~0~~ 0 (+1)[b] 0 0 0 0	~~0~~ 0 (+1)[c] 0 0 0 0	0 (+0.2)[d] (CV = N/A)
Bering Sea/Aleutian Is. pollock trawl[a]	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~86~~ 86 98 98 97 98	~~0~~ 1 0 1 0 0	~~0~~ 1.0 0 1.0 0 0	0.4 (CV = ~~0.68~~0.09)

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
SE A~~K~~laska salmon drift gillnet (Districts 6, 7, 8)	2012 2013		6.4 6.6	0 1	0 11	5.5 (CV = 1.0)
H~~I~~awaii shallow-~~-~~set longline	~~2009~~ 2010 2011 2012 2013 2014	obs data	~~100~~ 100 100 100 100 100	~~0~~ 0 1~~d~~[e] 0 0 0	~~0~~ 0 0.75~~d~~[e] 0 0 0	0.2
Hawaii deep-set longline	2010 2011 2012 2013 2014	obs data	20 20 20 20 20	0 0 0 0 1	0 0 0 0 5	0.9 (CV = 2.1)
Minimum total estimated annual mortality					Bering Sea/Aleutian Is.: SE ~~AK~~Alaska: ~~HI~~Hawaii: Total:	0.6 5.5 ~~0.2~~1.1 ~~6.3~~7.2 (CV = ~~0.88~~0.86)

[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 identification is unknown and the two stocks overlap within the area of operation of the fishery.
[b]Total mortality and serious injury observed in 2010: 0 whales in sampled hauls + 1 whale in an unsampled haul.
[c]~~Since the t~~Total ~~known~~estimate of mortality and serious injury in 2010: 0 whales (extrapolated estimate from 0 whales observed in ~~monitored~~sampled hauls) + 1 whale (1 whale observed in an ~~unmonitored~~unsampled haul) ~~exceeds the estimated mortality and serious injury (0) for the fishery in 2010, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year~~.
[d]Mean annual mortality and serious injury for fishery: 0 whales (mean of extrapolated estimates from sampled hauls) + 0.2 whales (mean of number observed in unsampled hauls).
[~~d~~e]A humpback was entangled and cut free with trailing gear. Due to the unknown configuration of the entanglement, this injury ~~is being~~was prorated with a value of 0.75 (Bradford and Forney 2014).

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. ~~The mean annual mortality and serious injury rate from entanglements in recreational gear is 0.7 humpback whales: 0.4 in recreational shrimp pot gear reported to the NMFS Alaska Region in 2009-2013 (Table 2; Helker et al. 2015) and 0.3 in recreational troll fisheries reported to the NMFS Pacific Islands Region in 2008-2012 (Table 3; Bradford and Lyman 2015).~~One whale with a serious injury (prorated at 0.75 under the injury determination guidelines for large whales) entangled in subsistence Southeast Alaska halibut longline gear was reported to the NMFS Alaska Region in 2012, resulting in a minimum mean annual mortality and serious injury rate of 0.2 humpback whales in 2010-2014 in this fishery (Table 2; Helker et al. 2016). 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 2010-2014 (Table 3; Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data). Based on events that have not been attributed to a specific fishery listed on the MMPA List of Fisheries (76 FR 73912; 29 November 2011), the ~~estimated~~minimum mean annual mortality and serious injury rate from ~~fishery-related~~ gear entanglements in unknown (commercial, recreational, or subsistence) fisheries is ~~7.1~~7.7 humpback whales in 2010-2014: ~~2.5~~1.7 reported to the NMFS Alaska Region stranding ~~database~~network ~~in 2009-2013~~ (Table 2; Helker et al. ~~2015~~2016) and ~~4.6~~6 reported to the NMFS Pacific Islands Region stranding ~~database~~network ~~in 2008-2012~~ (Table 3; Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data). These estimates are considered a minimum because not all entangled animals strand and not all stranded animals are found, reported, or cause of death determined.

Five humpback whales that were initially considered seriously injured due to entanglement in Southeast Alaska commercial Dungeness crab pot gear (1 in 2010), Southeast Alaska crab pot gear (1 in 2011 and 1 in 2012), Southeast Alaska shrimp pot gear (1 in 2011), and Gulf of Alaska/Kodiak Island Dungeness crab pot gear (1 in

2012) were disentangled in Alaska waters and released with non-serious injuries (Helker et al. 2016). Since the 2012 event occurred in the area where the two stocks overlap, this injury was also assigned to the Western North Pacific stock. Three additional whales that were initially considered seriously injured due to entanglement in Hawaii crab pot gear (1 in 2013) and unidentified fishing gear (1 each in 2013 and 2014) were disentangled in Hawaii waters and released with non-serious injuries (NMFS-PIFSC, unpubl. data). None of the whales released with non-serious injuries in Alaska or Hawaii waters were included in the mean annual mortality and serious injury rate for 2010-2014.

The minimum average annual ~~estimate of~~ mortality and serious injury rate due to interactions with all fisheries in 2010-2014 is ~~14~~16 Central North Pacific humpbacks (~~6.5~~7.4 ~~from~~in commercial fisheries + 0.2 in subsistence fisheries + ~~0.7~~0.3 ~~from~~in recreational fisheries + ~~7.1~~7.7 ~~from~~in unknown fisheries) ~~Central North Pacific humpbacks~~.

Table 2. Summary of mortality and serious injury of Central North Pacific humpback whales reported to the NMFS Alaska Region marine mammal stranding ~~database~~network in ~~2009-2013~~2010-2014 (Helker et al. ~~2015~~2016). 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. (~~2015~~2016).

~~**Cause of injury**~~	~~**2009**~~	~~**2010**~~	~~**2011**~~	~~**2012**~~	~~**2013**~~	~~**Mean annual mortality**~~
~~Entangled in ground tackle of commercial cod jig vessel~~	~~0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0.2~~
~~Entangled in unknown gillnet gear~~	~~0.75~~	~~3~~	~~0.75~~	~~1.75~~	~~0~~	~~1.3~~
~~Entangled in recreational shrimp pot gear~~	~~1.75~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0.4~~
~~Entangled in unspecified crab gear~~	~~0~~	~~0~~	~~0.75~~	~~0~~	~~0~~	~~0.2~~
~~Entangled in unspecified longline gear~~	~~0~~	~~0~~	~~0.75~~	~~0.75~~	~~0~~	~~0.3~~
~~Entangled in unspecified pot gear~~	~~0~~	~~1.5~~	~~0.75~~	~~0~~	~~0~~	~~0.5~~
~~Entangled in unspecified set net gear~~	~~0~~	~~0~~	~~0.75~~	~~0~~	~~0~~	~~0.2~~
~~Ship strike (charter)~~	~~0.76~~	~~0~~	~~0~~	~~0.2~~	~~0~~	~~0.2~~
~~Ship strike (pilot vessel)~~	~~0~~	~~0~~	~~0~~	~~0.2~~	~~0~~	~~0.04~~
~~Ship strike (unknown)~~	~~0.36~~	~~4~~	~~2~~	~~1.2~~	~~0.14~~	~~1.5~~
~~Ship strike (whale watch)~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0.2~~
~~Unknown marine debris/gear entanglement~~	~~2.25~~	~~2.25~~	~~5.5~~	~~0.75~~	~~2.25~~	~~2.6~~

Cause of injury	**2010**	**2011**	**2012**	**2013**	**2014**	**Mean annual mortality**
Entangled in ground tackle of Kodiak commercial Pacific cod jig vessel	0	0	0	1	0	0.2
Entangled in subsistence SE Alaska halibut longline gear	0	0	0.75	0	0	0.2
Entangled in Bering Sea pot gear*	0	0.75	0	0	0	0.2
Entangled in Prince William Sound shrimp pot gear*	0	0	0	0	1	0.2
Entangled in SE Alaska longline gear*	0	0.75	0	0	0	0.2
Entangled in SE Alaska golden king crab pot gear*	0	0.75	0	0	0	0.2
Entangled in SE Alaska pot gear*	1.5	0	0	0	0	0.3
Entangled in gillnet*	0	0.75	1	0	0	0.4

Cause of injury	2010	2011	2012	2013	2014	Mean annual mortality
Entangled in unidentified net*	0	0	0	0.75	0	0.2
Entangled in marine debris	2.25	5.5	0.75	1.5	4.5	2.9
Ship strike	4	2	2.6	0.14	4.52	2.7
Total commercial fisheries						0.2
Total subsistence fisheries						0.2
*Total unknown (commercial, recreational, or subsistence) fisheries						1.7
Total marine debris						2.9
Total other sources (ship strike)						2.7

Table 3. Summary of mortality and serious injury of Central North Pacific humpback whales reported to the NMFS Pacific Islands Region stranding ~~database~~network in ~~2008-2012~~2010-2014 (Bradford and Lyman 2015; NMFS-PIFSC, unpubl. data).

Cause of injury	~~2008~~	~~2009~~	2010	2011	2012	2013	2014	Mean annual mortality
Entangled in recreational troll gear	~~0~~	~~0~~	0	1.5	0	0	0	0.3
Entangled in A~~K~~laska king crab pot gear*	~~0~~	~~0~~	0	0.75	0	0	0	0.2
Entangled in A~~K~~laska tanner crab pot gear*	~~0~~	~~0~~	0	0	1	0	0	0.2
Entangled in A~~K~~laska shrimp pot gear*	~~0~~	~~1~~	0	0	0	0	1	0.2
~~Entangled in HI crab pot gear~~	~~0~~	~~0.75~~	~~0~~	~~0~~	~~0~~			~~0.2~~
Entangled in Alaska king crab, tanner crab, or finfish pot gear*			0	0	0	0	0.75	0.2
Entangled in longline gear*			0	0	0	1	1	0.4
Entangled in ~~unknown~~unidentified fishing gear*	~~1.75~~	~~4.75~~	5	3.25	4.25	5.25	6.25	~~3.8~~4.8
Ship strike	~~5.04~~	~~1.4~~	2.0	1.72	1.72	3.56	1	~~2.4~~2
Total recreational fisheries								0.3
*Total unknown (commercial, recreational, or subsistence) fisheries								6
Total other sources (ship strike)								2

However, these estimates of serious injury and mortality 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 unreliable. 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 have been reported.

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 June 2016). On August 20, 2015, NMFS declared an Unusual Mortality Event for large whales in the western Gulf of Alaska; however, to date, no specific cause for the increased mortality has been identified.

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 reported in Alaska~~ in 2009-2013~~ (~~1.9:~~ Table 2: 2.7) and Hawaii~~ in 2008-2012~~ (~~2.4:~~ Table 3: 2) in 2010-2014 is ~~4.3~~4.7 humpback whales. Most ship strikes of humpbacks are reported from Southeast Alaska; however, there are also reports from the ~~s~~South~-~central and Kodiak areas of Alaska (Helker et al. ~~2015~~2016). 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. Entanglements in ~~unknown~~ marine debris~~/gear~~ reported to the NMFS Alaska Region account for a~~n~~ ~~estimated~~minimum ~~average~~mean annual mortality and serious injury rate of ~~2.6~~2.9 Central North Pacific humpbacks in ~~2009-2013~~2010-2014 (Table 2; Helker et al. 2016).

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 the Queen Charlotte Islands, 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 densit~~y~~ies 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 ~~mean~~ annual level of human-caused mortality and serious injury ~~rate~~ for the entire Central North Pacific stock (~~21~~24 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 (~~6.5~~7.4 whales) is less than 10% of the calculated PBR for the entire stock (10% of PBR = 8.3) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. ~~The humpback whale is listed as "endangered" under the ESA and, therefore, designated as "depleted" under the MMPA.~~The humpback whale ESA listing final rule (81 FR 62259, September 8, 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 necessarily 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, NMFS 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. However, the status of the entire stock relative to its Optimum Sustainable Population is unknown.

HABITAT CONCERNS

This stock is the focus of a large whale-watching industry in its wintering grounds (Hawaii) and a growing whale-watching industry in its 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 impact of whale watching. Additional concerns have been raised in Hawaii about the impact 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 (www.whalesense.org, accessed June 2016). The growth of the whale-watching industry, however, is an ongoing concern as preferred habitats may be abandoned if disturbance levels are too high. Other potential concerns include elevated levels of sound from anthropogenic sources (e.g., shipping, military sonars), possible changes in prey distribution with climate change, entanglement in fishing gear, ship strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes), and oil and gas activities.

CITATIONS

Baker, C. S., L. M. Herman, A. Perry, W. S. Lawton, J. M. Straley, A. A. Wolman, G. D. Kaufman, H. E. Winn, J. D. Hall, J. M. Reinke, and J. Ostman. 1986. Migratory movement and population structure of humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. Mar. Ecol. Prog. Ser. 31:105-119.

Baker, C. S., A. Perry, and L. M. Herman. 1987. Reproductive histories of female humpback whales (*Megaptera novaeangliae*) in the North Pacific. Mar. Ecol. Prog. Ser. 41:103-114.

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

Baker, C. S., J. M. Straley, and A. Perry. 1992. Population characteristics of individually identified humpback whales in southeastern Alaska: summer and fall 1986. Fish. Bull., U.S. 90:429-437.

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

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

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

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

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

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

Bradford, A. L., and K. A. Forney. 2014. Injury determinations for cetaceans observed interacting with Hawaii and American Samoa longline fisheries during 2008-2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-PIFSC-41, 38 p. + appendices.

Bradford, A. L., and E. Lyman. 2015. Injury determinations for humpback whales and other cetaceans reported to NOAA Response Networks in the Hawaiian Islands during 2007-2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-PIFSC-45, 29 p.

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

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

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

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

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

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final Report for Contract AB133F-03-RP-00078. 58 p~~p~~.
Available online: http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-Report-May08.pdf. Accessed ~~December 2015~~June 2016.

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

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

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

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

Doroshenko, N. V. 2000. Soviet catches of humpback whales (*Megaptera novaeangliae*) in the North Pacific,~~.~~ ~~P~~p. 96-103. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet ~~w~~Whaling ~~d~~Data (1949-1979), Center for Russian Environmental Policy, Marine Mammal Council, Moscow.

Fleming, A., and J. Jackson. 2011. Global review of humpback whales (*Megaptera novaeangliae*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-474, 206 p.

Ford J. K. B., A. L. Rambeau, R. M. Abernethy, M. D. Boogaards, L. M. Nichol, L. D. and Spaven. 2009. An assessment of the potential for recovery of humpback whales off the Pacific coast of Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/015. iv + 33 p.

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

Hill, M. C., E. M. Oleson, S. Baumann-Pickering, A. M. VanCise, A. D. Ligon, A. R. Bendlin, A. C. Ü, J. S. Trickey, and A. L. Bradford. 2016. Cetacean monitoring in the Mariana Islands Range Complex, 2015. Prepared for the U.S. Pacific Fleet Environmental Readiness Office. PIFSC Data Report DR-16-01. 36 p. + appendix.

Ivashchenko, Y. V., P. J. Clapham, and R. L. Brownell, Jr. (eds.). 2007. Scientific reports of Soviet whaling expeditions, 1955-1978. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-175, 36 p. (Translation: Y. V. Ivashchenko) + appendix.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish. Rev. 46:30-37.

Johnston, D. W., M. E. Chapla, L. E. Williams, and D. K. Mattila. 2007. Identification of humpback whale wintering habitat in the Northwestern Hawaiian Islands using spatial habitat modeling. Endang. Species Res. 3:249-257.

Manly, B. F. J. 2015. Incidental takes and interactions of marine mammals and birds in districts 6, 7 and 8 of the Southeast Alaska salmon drift gillnet fishery, 2012 and 2013. Final Report to NMFS Alaska Region. 52 p~~p~~. Available online: https://alaskafisheries.noaa.gov/sites/default/files/incidentaltakes2012-2013.pdf. Accessed ~~December 2015~~June 2016.

Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, and O. von Ziegesar. 2004. Estimating the adult survival rate of central North Pacific humpback whales. J. Mammal. 85(5):963-972.

Mobley, J. M., S. Spitz, R. Grotefendt, P. Forestell, A. Frankel, and G. Bauer. 2001. Abundance of humpback whales in Hawaiian waters: results of 1993-2000 aerial surveys. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary. 16 p~~p~~.

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

Neilson, J. L., C. M. Gabriele, A. S. Jensen, K. Jackson, and J. M. Straley. 2012. Summary of reported whale-vessel collisions in Alaskan waters. J. Mar. Biol. 2012: Article ID 106282. 18 p~~p~~. DOI: 10.1155/2012/106282.

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. Tokyo 12:33-89.

Nemoto, T. 1959. Food of baleen whales with reference to whale movements. Sci. Rep. Whales Res. Inst. 14:149-290.

NOAA. 2012. Federal Register 77:3233. National policy for distinguishing serious from non-serious injury of marine mammals. Available online: http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf. Accessed ~~December 2015~~June 2016.

Perry, A., C. S. Baker, and L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. Rep. Int. Whal. Comm. (Special Issue 12):307-317.

Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation and numbers.~~,~~ Appendix 4.~~,~~ ~~P~~p. 29-44. *In* K. S. Norris and R. R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. U.S. Dep. Commer., Natl. Tech. Info. Serv. PB-280794. Springfield, VA.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. Soc. Mar. Mammal. Spec. Publ. No. 4.

Springer, A. M., G. B. van Vliet, J. F. Piatt, and E. M. Danner. 2006. Whales and whaling in the North Pacific Ocean and Bering Sea: oceanographic insights and ecosystem impacts, ~~P~~p. 245-261. *In* J. A. Estes, R. L. Brownell, Jr., D. P. DeMaster, D. F. Doak, and T. M. Williams (eds.), Whales, Whaling and Ocean Ecosystems. University of California Press. 418 p~~p~~.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mammal Sci. 7:306-310.

Straley, J. M. 1994. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. Master's Thesis, University of Alaska - Fairbanks, Fairbanks, AK 99775. 121 p~~p~~.

Straley, J. M., C. M. Gabriele, and C. S. Baker. 1995. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska,. ~~P~~p. 229-237. *In* D. R. Engstrom (ed.), Proceedings of the Third Glacier Bay Science Symposium, 1993. National Park Service, Anchorage, AK.

Straley, J. M., C. M. Gabriele, and T. J. Quinn II. 2009. Assessment of mark recapture models to estimate the abundance of a humpback whale feeding aggregation in Southeast Alaska. J. Biogeogr. 36:427-438.

Taylor, B. L., M. Scott, J. Heyning, and J. Barlow. 2003. Suggested guidelines for recovery factors for endangered marine mammals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-354, 6 p.

Tomlin, A. G. 1967. Mammals of the USSR and Adjacent Countries. Vol. 9. Cetacea. Israel Program for Scientific Translations No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 p~~p~~. (Translation of Russian text published in 1957.)

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

Waite, J. M., M. E. Dahlheim, R. C. Hobbs, S. A. Mizroch, O. von Ziegesar-Matkin, J. M. Straley, L. M. Herman, and J. Jacobsen. 1999. Evidence of a feeding aggregation of humpback whales (*Megaptera novaeangliae*) around Kodiak Island, Alaska. Mar. Mammal Sci. 15:210-220.

Witteveen, B. H., J. M. Straley, O. von Ziegesar, D. Steel, and C. S. Baker. 2004. Abundance and mtDNA differentiation of humpback whales (*Megaptera novaeangliae*) in the Shumagin Islands, Alaska. Can. J. Zool. 82:1352-1359.

Zenkovich, B. A. 1954. Vokrug sveta za kitami, Vol. Gosudarstvennoe Izdatel'stvo Geograficheskoi Literatury, Moscow.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off Western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53(11):1772-1790.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the U.S. waters in the Pacific Ocean, fin whales are found seasonally off the coast of North America and in the Bering Sea during the summer (Fig. 1). Recent 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 high rates of fin whale calling along the U.S. Pacific coast beginning in August/September and lasting 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 ~~S~~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 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 head northwest from August to October. They speculate that some fin whales may migrate northward 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 in July through October from 2007 through 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).

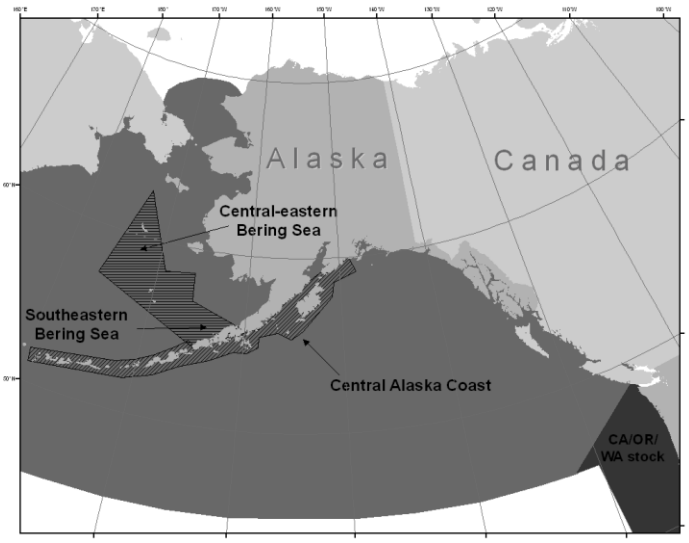

Figure 1. Approximate distribution of fin whales in the eastern North Pacific (dark shaded areas). Striped areas indicate where vessel surveys occurred in 1999-2000 (Moore et al. 2002) and 2001-2003 (Zerbini et al. 2006).

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 (EBS) 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).

Based on historical whaling data, fin whales were found to range 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 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 sighting surveys 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 have been recorded each year from 2007 to 2010 in August and September on bottom-mounted hydrophones 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 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 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 isolated though may intermingle 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) 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 substantially 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

Reliable estimates of current and historical abundance for the entire Northeast Pacific fin whale stock are currently not available. Two studies provide some 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 echo-integrated trawl survey for walleye pollock which determined the survey area and timing. The surveys included from 789 km to 3,752 km of effort depending on the year and whether the entire area was surveyed for cetaceans. Results of the surveys in 2002, 2008, and 2010, years when the entire pollock area was surveyed, 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). These estimates are considered provisional because they have not been corrected for animals missed on the trackline, animals submerged when the ship passed, and responsive movement; no data are currently available to make these corrections. However, they are expected to be robust as previous studies have shown that only small correction factors are needed for this species (Barlow 1995). This estimate cannot be used as an estimate of the entire Northeast Pacific stock of fin whales because it is based on a survey in only a small part of the stock's purported range.

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 (95% CI: 1,142-2,389) fin whales occurred in the area.

Minimum Population Estimate

Although the full range of the Northeast Pacific stock of fin whales in Alaska~~n~~ 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 into the Bering Sea 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 (Stabeno et al. 2012, Friday et al. 2013), making it possible that whales could be double counted when estimates from different years are summed (Moore et al. 2002). Therefore, our best provisional estimate of the fin whale population west and north of the Kenai Peninsula in U.S. waters would be 1,368, the greater of the minimum estimates from the 2008 and 2010 surveys (Friday et al. 2013). ~~This is a minimum estimate for the entire stock because it was estimated from surveys which covered only a small portion of the range of this stock. This is considered a minimum estimate for a portion of the range of this stock; therefore, the N_{MIN} for the entire stock is unknown.~~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 1,368 from the 2010 surveys and the associated CV(N) of 0.34 results in an N_{MIN} of 1,036 whales. However, this is an under-estimate 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 the period 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 for the first trend year (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.

Friday et al. (2013) estimated a 14% (95% CI: 1.0-26.5%) annual rate of change in abundance of fin whales during the period from 2002 to 2010. However, this apparent rate of change in abundance is higher than most plausible estimates of rates of change 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 apparent rate of change in abundance in the study area is due at least in part to changes in distribution and not just to changes in overall population size. Friday et al. (2013) found that 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.

Moore and Barlow (2011) analyzed trends in fin whale abundance from 1991 to 2008 from surveys conducted off California and 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 the period 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. A reliable estimate of the maximum net productivity rate is currently unavailable for the Northeast Pacific fin whale stock. 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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 1,368 (CV = 0.34) from the 2010 surveys and the associated N_{MIN} of 1,036, PBR is calculated to be 2.1 fin whales (1,036 × 0.02 × 0.1). However, because ~~an~~the estimate of minimum abundance is ~~not available~~for only a small portion of the stock's purported range, the calculated PBR ~~level~~is considered unreliable for the entire Northeast Pacific fin whale stock~~ is undetermined~~.

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.

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. ~~2015~~2016). Since 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 ~~2009-2013~~2010-2014 in this fishery (Table 1).

Table 1. Summary of mortality and serious injury of ~~the~~ Northeast Pacific ~~stock of~~ fin whales, by year and type, reported to the NMFS Alaska Region~~,~~ marine mammal stranding ~~database~~network~~,~~ in ~~2009-2013~~2010-2014 (Helker et al. ~~2015~~2016). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	**~~2009~~**	**2010**	**2011**	**2012**	**2013**	**2014**	**Mean annual mortality**
~~Ship strike~~	~~1~~	~~1~~	~~0~~	~~0~~	~~0~~		~~0.4~~
Entangled in ground tackle of commercial mechanical jig fishing vessel	~~0~~	0	0	1	0	0	0.2
Ship strike		1	0	0	0	1	0.4
Total commercial fisheries							0.2
Total other causes (ship strike)							0.4

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska and Russia have not been reported to take fin whales from this stock.

Other Mortality

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 June 2016). On August 20, 2015, NMFS declared an Unusual Mortality Event for large whales in the western Gulf of Alaska; however, to date, no specific cause for the increased mortality has been identified.

Between 1911 and 1985, 49,936 fin whales were reported ~~killed~~taken in commercial whaling operations throughout the North Pacific (Mizroch et al. 2009), although newly revealed information about illegal Soviet catches indicates that the Soviets over-reported catches of about 1,200 fin whales, presumably to hide catches of other protected species (Doroshenko 2000). Fin whale mortality due to ship strikes in Alaska waters (one each in ~~2009 and~~ 2010 and 2014) has also been reported to the NMFS Alaska Region stranding database (Helker et al. ~~2015~~2016), resulting in a mean annual mortality and serious injury rate of 0.4 fin whales due to ship strikes in ~~2009-2013~~2010-2014 (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 currently not available. The total estimated annual ~~rate~~level of human-caused mortality and serious injury for ~~this stock~~Northeast Pacific fin whales ~~is~~ (0.6 whales) ~~based on takes incidental to U.S. commercial fisheries (0.2) and ship strikes (0.4)~~does not exceed the calculated PBR (2.1 whales), and the mean annual rate of U.S. commercial fishery-related mortality and serious injury (0.2 whales) is less that 10% of the calculated PBR (10% of PBR = 0.21). ~~Because the PBR is undetermined, 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.~~ However, the calculated PBR is considered unreliable for the entire stock because it is based on an estimate from surveys of only a small portion of the stock's purported range.

HABITAT CONCERNS

~~Potential impacts on fin whale habitat include possible changes in prey distribution with climate change, range extension, and increased shipping in higher latitudes with changes in sea ice coverage, as well as oil and gas activities in the Chukchi and Beaufort seas.~~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/gas activities in the Chukchi and Beaufort seas. Ocean warming may increase the frequency of algal blooms that produce biotoxins known to be associated with large whale mortality. However, few or no data are available to assess the likelihood or extent of such impacts.

CITATIONS

Aerts, L. A. M., A. Kirk, C. Schudel, B. Watts, P. Seiser, A. Mcfarland, and K. Lomac-Macnair. 2012. Marine mammal distribution and abundance in the northeastern Chukchi Sea, July-October 2008-2011. Report prepared by LAMA Ecological for ConocoPhillips Alaska, Inc., Shell Exploration and Production Company and Statoil USA E&P, Inc. 69 p~~p~~.

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

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar. Mammal Sci. 22(2):446-464.

Clarke, J., K. Stafford, S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26(4):136-149. DOI: 10.5670/oceanog.2013.81.

Crance, J. L., C. L. Berchok, J. Bonnel, and A. M. Thode. 2015. Northeasternmost record of a North Pacific fin whale (*Balaenoptera physalus*) in the Alaskan Chukchi Sea. Polar Biol. 38:1767-1773.

Delarue, J., B. Martin, D. Hannay, and C. Berchok. 2013. Acoustic occurrence and affiliation of fin whales detected in the northeastern Chukchi Sea, July to October 2007–2010. Arctic 66(2):159-172.

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

Doroshenko, N. V. 2000. Soviet whaling for blue, gray, bowhead and right whales in the North Pacific Ocean, 1961-1979.~~.~~ ~~P~~p. 96-103. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet ~~w~~Whaling ~~d~~Data (1949-1979). Center for Russian Environmental Policy, Marine Mammal Council, Moscow.

Forney, K. A., and R. L. Brownell. 1996. Preliminary report of the 1994 Aleutian Island marine mammal survey. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/48/O11). 15 p~~p~~.

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

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

Fujino, K. 1960. Monogenetic and marking approaches to identifying sub-populations of the North Pacific whales. Sci. Rep. Whales Res. Inst. Tokyo 15:84-142.

Funk, D. W., D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.). 2010. Joint monitoring program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 506 p~~p~~. + appendices.

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The fin whale, *Balaenoptera physalus*. Mar. Fish. Rev. 46(4):20-24.

Mizroch, S. A., D. Rice, D. Zwiefelhofer, J. Waite, and W. Perryman. 2009. Distribution and movements of fin whales in the North Pacific Ocean. Mammal Rev. 39(3):193-227.

McDonald, M. A., and C. G. Fox. 1999. Passive acoustic methods applied to fin whale population density estimation. J. Acoust. Soc. Am. 105(5):2643-2651.

Mobley, J. R., Jr., M. Smultea, T. Norris, and D. Weller. 1996. Fin whale sighting north of Kaua'i, Hawai'i. Pac. Sci. 50(2):230-233.

Moore, J. E., and J. Barlow. 2011. Bayesian state-space model of fin whale abundance trends from a 1991–2008 time series of line-transect surveys in the California Current. J. Applied Ecol. 48:1195-1205.

Moore, S. E., K. M. Stafford, M. E. Dahlheim, C. G. Fox, H. W. Braham, J. J. Polovina, and D. E. Bain. 1998. Seasonal variation in reception of fin whale calls at five geographic areas in the North Pacific. Mar. Mammal Sci. 14(3):617-627.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. C. Hobbs. 2000. Provisional estimates of mysticete whale abundance on the central Bering Sea shelf. J. Cetacean Res. Manage. 2(3):227-234.

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

Moore, S. E., K. M. Stafford, D. K. Mellinger, and C. G. Hildebrand. 2006. Listening for large whales in the offshore waters of Alaska. BioScience 56(1):49-55.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific.~~.~~ ~~P~~p. 170-195. *In* W. E. Schevill (ed.), The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Shallenberger, E. W. 1981. The status of Hawaiian cetaceans. Final report for MMC Contract MM7AC028. Natl. Tech. Info. Ser. PB82-109398.

Širović, A., L. N. Williams, S. M. Kerosky, S. M. Wiggins, and J. A. Hildebrand. 2013. Temporal separation of two fin whale call types across the eastern North Pacific. Mar. Biol. 160:47-57.

Širović, A., A. Rice, E. Chou, J. A. Hildebrand, S. M. Wiggins, and M. A. Roch. 2015. Seven years of blue and fin whale call abundance in the Southern California Bight. Endang. Species Res. 28: 61-76.

Soule, D. C., and W. S. D. Wilcock. 2013. Fin whale tracks recorded by a seismic network on the Juan de Fuca Ridge, Northeast Pacific Ocean. J. Acoust. Soc. Am. 133(3):1751-1761.

Springer, A. M., C. P. McRoy, and M. V. Flint. 1996. The Bering Sea green belt: shelf-edge processes and ecosystem production. Fish. Oceanogr. 5:205-223.

Stabeno, P., S. Moore, J. Napp, M. Sigler, and A. Zerbini. 2012. Comparison of warm and cold years on the southeastern Bering Sea shelf and some implications for the ecosystem. Deep-Sea Res. II 65-70:31-45.

Stafford, K. M., D. K. Mellinger, S. E. Moore, and C. G. Fox. 2007. Seasonal variability and detection range modeling of baleen whale calls in the Gulf of Alaska, 1999-2002. J. Acoust. Soc. Amer. 122(6):3378-3390.

Stafford, K. M., S. E. Moore, P. J. Stabeno, D. V. Holliday, J. M. Napp, and D. K. Mellinger. 2010. Biophysical ocean observation in the southeastern Bering Sea. Geophys. Res. Lett. 37:L02606. DOI: 10.1029/2009GL040724.

Thompson, P. O., and W. A. Friedl. 1982. A long term study of low frequency sound from several species of whales off Oahu, Hawaii. Cetology 45:1-19.

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

Watkins, W. A., M. A. Daher, G. M. Reppucci, J. E. George, D. L. Martin, N. A. DiMarzio, and D. P. Gannon. 2000. Seasonality and distribution of whale calls in the North Pacific. Oceanography 13(1):62-67.

Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53(11):1772-1790.

Zerbini, A. N., P. J. Clapham, and P. R. Wade. 2010. Assessing plausible rates of population growth in humpback whales from life-history data. Mar. Biol. 157:1225-1236.

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 north of 35°N and occasionally as far south as 20°N (Fig. 1; Scarff 1986, 1991~~; Fig. 1~~), recent 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. Following large illegal catches (primarily from 1962 to -1968) by the U.S.S.R. (Ivashchenko and Clapham 2012, Ivashchenko et al. 2013), only 82 sightings of right whales in the entire eastern North Pacific were reported from 1962 to 1999, with the majority of these occurring in the Bering Sea and adjacent areas of the Aleutian Islands (Brownell et al. 2001). Additional sightings have been reported as far south as central Baja California and as far east as Yakutat Bay and Vancouver Island in the eastern North Pacific, as far south as Hawaii in the central North Pacific, and as far north as the ~~sub-Arctic~~subarctic waters of the Bering Sea and Sea of Okhotsk in the summer (Herman et al. 1980; Rowntree et al. 1980; Berzin and Doroshenko 1982; Salden and Mickelsen 1999; Brownell et al. 2001; J. Ford, Department of Fisheries and Oceans, BC, Canada, pers. comm., 28 October 2013). However, most right whale sightings in the past 20 years have occurred in the southeastern Bering Sea, with a few in the Gulf of Alaska, near Kodiak, Alaska (Waite et al. 2003; Shelden et al. 2005; Wade et al. 2011a, 2011b).

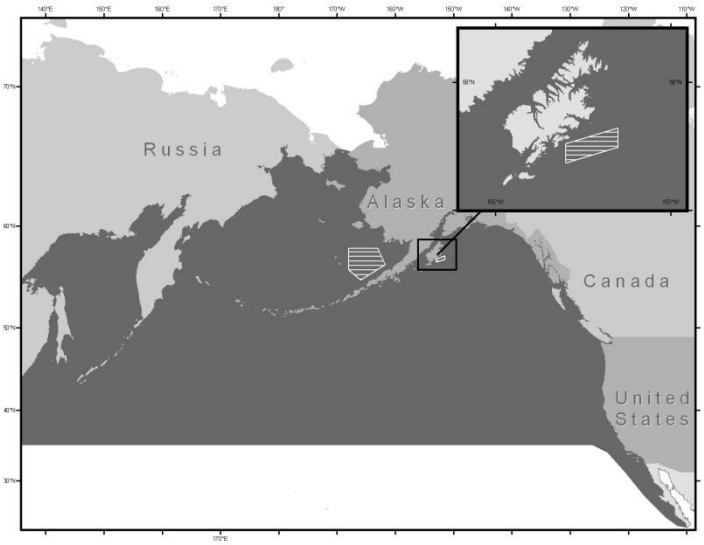

Figure 1. Approximate historical distribution of North Pacific right whales in the eastern North Pacific (dark shaded area). Striped areas indicate northern right whale critical habitat (71 FR 38277, 6 July 2006).

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 (~~Salden and Michelsen 1999,~~ 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 2011 to 2014 of the northern Bering Sea revealed detections of calls matching the North Pacific right whale up call criterion in late winter (Wright 2015), suggesting that North Pacific right whales may occur in the northern Bering Sea during winter months. 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 recent 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 because there is some chance they were bowhead whale calls; further analysis is underway to clarify which species are making these calls (Wright 2015).

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 recent years~~ in a portion of the southeastern Bering Sea (Fig. 1) where right whales have been observed most summers since 1996 (Goddard and Rugh 1998, Rone et al. 2012). North Pacific right whales are 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 and the northern Gulf of Alaska starting in 2000 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 deployed from 2007 to ~~2013~~the present time have not ~~yet~~ been fully analyzed, but ~~they~~2012-2013 data indicate the presence of right whales in the southeastern Bering Sea ~~almost year-round~~in July-January, with a peak in ~~August~~September and a sharp decline in detections ~~in early January~~by mid-November (C.~~atherine~~ Berchok, NMFS-AFSC-~~N~~MML~~, 7600 Sand Point Way NE, Seattle, WA 98115~~, unpubl. data; Wright 2015). ~~Use of this habitat may intensify in mid-summer through early fall based on higher monthly and daily call detection rates.~~ 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 ~~have~~were not ~~been~~ 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 recent 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 ~~has been conducted~~ 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 Barnabas Canyon area from NOAA surveys in August 2004, 2005, and 2006 (A. Zerbini, NMFS-AFSC-~~N~~MML~~, 7600 Sand Point Way NE, Seattle, WA 98115~~, unpubl. data). A single right whale was reported in Pasagshak Bay by a kayaker in May of 2010, and one was sighted in December 2011 by humpback whale researchers in Uganik Bay (A. Kennedy, NMFS-AFSC-~~N~~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 2009-2014. Similarly, gunshot calls were detected at Umnak Pass in July-September on a recorder deployed in 2009 (Wright 2015). ~~More recently~~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. ~~2014~~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 (B. Rone, NMFS-AFSC-MML, unpubl. data). Right whales were acoustically detected twice on the shelf, 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 (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, or whether cultural memory of its existence has been lost, is currently unknown. The sightings and acoustic detection of right whales in coastal waters east of Kodiak indicate at least occasional continuing 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.

In recent years, 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 (J. Ford, Department of Fisheries and Oceans, BC, Canada, pers. comm., 26 October 2013). Two right whale calls were detected on a bottom-mounted hydrophone off the Washington Coast on 29 June 2013. No right whale calls were detected in previous years at this site (Širović et al. ~~2014~~2015).

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 former U.S.S.R. made ~~I~~illegal catches of an estimated ~~681~~772 total right whales in the eastern and western North Pacific, with the majority (662) killed between 1962 and 1968. 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 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 14 years, starting in 1996 (Goddard and Rugh 1998), have invalidated this view (Wade et al. 2006). 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 Okhotsk Sea.

There were several sightings of North Pacific right whales in the mid-1990s, which renewed interest in conducting dedicated surveys for this species that included the collection of photo-~~ID~~identifications and biopsies. Right whales can be individually identified by photographs of the unique callosity patterns on their heads. In April 1996, a right whale was sighted off Maui (Salden and Mickelsen 1999), and that same animal was identified 119 days later and 4,111 km north (in the Bering Sea); this represents the first high- to low-latitude match of a North Pacific right whale (Kennedy et al. 2011). The Maui sighting in April was the first documented sighting of a right whale in Hawaiian waters since 1979 (Herman et al. 1980, Rowntree et al. 1980) and, even though the photographic match confirms that Bering Sea animals occasionally travel south, there is little reason to believe that either Hawaii or tropical Mexico have ever been anything except extra-limital habitats for this species (Brownell et al. 2001).

A group of 3-4 right whales, that may have included a juvenile animal, was sighted in western Bristol Bay, southeastern Bering Sea, in July 1996 (Goddard and Rugh 1998). In July 1997, a group of 4-5 individuals was encountered one evening in Bristol Bay, followed by a second sighting of 4-5 whales the following morning in approximately the same location (Tynan 1999). During dedicated surveys in July 1998, July 1999, and July 2000, 5, 6, and 13 right whales were again found in the same general region of the southeastern Bering Sea (LeDuc et al. 2001). 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 southeast 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 a near-real-time 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. From 2007 to 2011, 12 individual right whales were seen (some individuals were seen many times over all survey years).

Photographic and genotype 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 only recently processed and~~ were unavailable and not included in the Wade et al. (2011a) abundance estimate (A. Kennedy, NMFS-AFSC-~~N~~MML, pers. comm., 21 September 2011).

The photo-identification catalogue, for purposes of abundance estimation, was restricted to aerial or left-side oblique photographs of good or excellent photo quality. After this restriction, there were a total of 18 unique individuals identified from photographs of callosity patterns and scars from 1998 to 2008, with 10 resightings across years involving 5 individuals.

Another seven individuals were observed in the summer of 2009, and one individual was seen in the summer of 2010 (A. Kennedy, NMFS-AFSC-~~N~~MML, pers. comm., 3 November 2010). Four individuals were seen in the summer of 2011 (B. Rone, NMFS-AFSC-~~N~~MML, pers. comm., 7 October 2012). The two sightings noted above of right whales (one in June and one in October) in British Columbia waters in 2013 were the first sightings of this species in this region in decades. Comparisons with the photo-identification catalogue curated at the ~~National~~ Marine Mammal Laboratory showed that neither individual had been previously photographed elsewhere. Whether this indicates 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 2002, only two sightings of right whales occurred in the Gulf of Alaska: an opportunistic sighting in March 1979 near Yakutat Bay in the eastern Gulf (Shelden et al. 2005) and a sighting during an aerial survey for harbor porpoise in July 1998 south of Kodiak Island, Alaska (Waite et al. 2003). Both sightings occurred in shelf waters less than 100 m deep. However, from 2004 to 2006, four sightings of right whales occurred in the Barnabus Trough region on Albatross Bank, south of Kodiak Island, Alaska (Wade et al. 2011b). Sightings of right whales occurred at locations within the trough with the highest density of zooplankton, as measured by active-acoustic backscatter. Photo-identification (of two whales) and genotyping (of one whale) failed to reveal a match to Bering Sea right whales. 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. The survey conducted off Kodiak in the summer of 2015 made two acoustic (and no visual) detections of right whales (B. Rone, NMFS-AFSC-MML, unpubl. data).

In recent decades, the only detections of right whales in pelagic waters of the Gulf of Alaska came from passive acoustic recorders. These detections of calls were exceptionally rare; instruments in seven widespread locations detected right whale calls from only two of the locations on only 6 days out of a total of 80 months of recordings (Mellinger et al. 2004) and on only 5 days out of a total of 70 months of recordings from the five deep-water stations. The calls were heard at the deep-water station in the Gulf of Alaska ~500 km southwest of Kodiak Island on 5 days in August and September of 2000, but no calls were detected from four other instruments deployed in deep water farther east during 2000 and 2001 (Mellinger et al. 2004). Calls classified as "probable" right whales were detected from an instrument deployed on the shelf at the location of the aerial visual detection on Albatross Bank on 6 September 2000 (Waite et al. 2003), but no calls were detected from two instruments deployed at the base of the continental slope off Albatross Bank just northeast of Barnabus Trough (Mellinger et al. 2004, Munger et al.

2008). Twenty sonobuoy deployments in 2004 throughout the Gulf of Alaska resulted in the detection of right whale calls only in Barnabus Trough, near the location of the visual sightings mentioned above (Wade et al. 2011b). Right whale up-calls were detected far offshore in the Gulf of Alaska in 2013 on a bottom-mounted recorder at Quinn Seamount during a total of 3 hours on 2 days (21 June and 3 August 2013). Right whale down calls were detected during 50 hours from 27 July to 5 September 2013 (Širović et al. ~~2014~~2015). The lack of detection of right whales from passive acoustic recorders does not provide indisputable evidence there were no right whales in the area, as the whales may not always vocalize or their calls may not always be detected by the automatic algorithms used or the call type targeted for detection. Until very recently, only a single call type, the "up call" was used to automatically detect right whales. The "gunshot" call has recently been identified as another candidate for right whale detections (Stafford et al. 2010, Rone et al. 2012). 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 >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 lack 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 at least the monitored pelagic areas today. 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) ~~have not~~ detected ~~right whales other than the~~a single ~~detection~~right whale near Kodiak Island ~~by~~ (Waite et al. ~~(~~2003) and two acoustic detections from the *Reuben Lasker* survey in August 2015 (B. Rone, NMFS-AFSC-MML, unpubl. data). 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 population. However, with the exception of the August 2015 study off Kodiak, there has been virtually no survey coverage of the offshore waters in which right whales commonly occurred during historical and recent whaling periods (Townsend 1935, Ivashchenko and Clapham 2012).

Minimum Population Estimate

The minimum estimate of abundance of Eastern North Pacific right whales is ~~25.7~~26 based on the 20th percentile of the photo-identification estimate of 31 (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 from 1997 to 2011 (LeDuc et al. 2012).

Current Population Trend

No estimate of trend in abundance is currently available.

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 low observed calving rate of this population, this rate is likely to be unrealistically high.

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 0.1, 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 ~~25.7~~26 based on the mark-recapture estimate of 31 (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, because the Eastern North Pacific right whale population is far below historical levels and considered to include ~~less~~fewer than 30 mature females, the calculated value for PBR is considered unreliable.

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.

Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989 (Kornev 1994), which was presumably from the ~~w~~Western North Pacific population. No other incidental takes of right whales are known to have occurred in the North Pacific, although one photograph from the catalogue shows potential fishing gear entanglement (A. Kennedy, NMFS-AFSC-~~N~~MML, pers. comm., 21 September 2011). The right whale photographed on 25 October 2013 off British Columbia and northern Washington State, showed potential fishing gear entanglement (J. Ford, Department of Fisheries and Oceans, BC, Canada, pers. comm., 28 October 2013). 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). 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 the North Atlantic right whale stock (Waring et al. 2004).

There are no records of mortality or serious injury of Eastern North Pacific right whales in any U.S. fishery. ~~Thus, the estimated annual mortality and serious injury rate incidental to U.S. commercial fisheries approaches zero whales per year from this stock. Therefore, the annual human-caused mortality and serious injury level is considered to be insignificant and approaching a zero mortality and serious injury rate.~~Overall, given the remote nature of the known and likely habitats of North Pacific right whales, it is very unlikely that any mortality in this population would be observed. Consequently, it is possible that the current absence of reported deaths in this stock is not a reflection of the true situation.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska and Russia are not reported to take 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 at this time. There is concern regarding the effects of increased shipping through ~~A~~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 in this population would be observed. Consequently, it is possible that the current absence of reported deaths 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 MMPA. 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 ~~rate~~level of human-caused mortality and serious injury is considered minimal 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 which 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 International Whaling Commission 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.

HABITAT CONCERNS

NMFS conducted an analysis of right whale distribution in historical times and in 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, although photographs of right whales taken to date have shown no evidence of entanglement scars. 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 current 2012-2017 national lease schedule by the Bureau of Ocean Energy Management, and there are no residual active leases from past sales. On December 16, 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." Thus, oil and gas leasing in federal waters in this area is not likely for the foreseeable future.

CITATIONS

Baumgartner, M. F., N. Lysiak, H. Carter Esch, A. N. Zerbini, C. L. Berchok, and P. J. Clapham. 2013. Associations between North Pacific right whales and their zooplanktonic prey in the southeastern Bering Sea. Mar. Ecol. Prog. Ser. 490: 267-284.

Berzin, A. A., and N. V. Doroshenko. 1982. Distribution and abundance of right whales in the North Pacific. Rep. Int. Whal. Comm. 32:381-383.

Braham, H. W., and D. W. Rice. 1984. The right whale, *Balaena glacialis*. Mar. Fish. Rev. 46(4):38-44.

Brownell, R. L., P. J. Clapham, T. Miyashita, and T. Kasuya. 2001. Conservation status of North Pacific right whales. J. Cetacean Res. Manage. (Special Issue 2):269-286.

Clapham, P. J., C. Good, S. E. Quinn, R. R. Reeves, J. E. Scarff, and R. L. Brownell, Jr. 2004. Distribution of North Pacific right whales (*Eubalaena japonica*) as shown by 19th and 20th century whaling catch and sighting records. J. Cetacean Res. Manage. 6(1):1-6.

Clapham, P. J., K. E. W. Shelden, and P. R. Wade. 2006. Review of information relating to possible critical habitat for Eastern North Pacific right whales.~~.~~ ~~P~~p. 1-27. *In* P. J. Clapham, K. E. W. Shelden, and P. R. Wade (eds.), Habitat requirements and extinction risks of Eastern North Pacific right whales. AFSC Processed Report 2006-06, Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.

Cole, T. V. N., D. L. Hartley, and R. M. Merrick. 2005. Mortality and serious injury determinations for large whale stocks along the eastern seaboard of the United States, 1999-2003. U.S. Dep. Commer., NOAA, National Marine Fisheries Service, NEFSC Ref. Doc. 05-08, 20 p. Available from National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Davis, K., S. Milne, M. Wood, and C. Voigtlander. 2011. L-DEO Shillington Aleutian Cruise – *Langseth* PSO & PAM Weekly Summary Report 17 July 2011 - 23 July 2011. 13 p~~p~~.

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

Doroshenko, N. V. 2000. Soviet whaling for blue, gray, bowhead and right whales in the North Pacific Ocean, 1961-1979.~~.~~ ~~P~~p. 96-103. *In* A. V. Yablokov, and V. A. Zemsky (eds.), Soviet ~~w~~Whaling ~~d~~Data (1949-1979). Center for Russian Environmental Policy, Marine Mammal Council, Moscow.

Goddard, P. C., and D. J. Rugh. 1998. A group of right whales seen in the Bering Sea in July 1996. Mar. Mammal Sci. 14(2):344-349.

Herman, L. M., C. S. Baker, P. H. Forestell, and R. C. Antinoja. 1980. Right whale, *Balaena glacialis*, sightings near Hawaii: a clue to the wintering grounds? Mar. Ecol. Prog. Ser. 2:271-275.

IWC (International Whaling Commission). 2001. Report of the workshop on the comprehensive assessment of right whales: a worldwide comparison. J. Cetacean Res. Manage. (Special Issue 2):1-60.

Ivashchenko, Y. V., and P. J. Clapham. 2012. Soviet catches of right whales *Eubalaena japonica* and bowhead whales *Balaena mysticetus* in the North Pacific Ocean and the Okhotsk Sea. Endang. Species Res. 18:201-217.

Ivashchenko, Y. V., R. L. Brownell, Jr., and P. J. Clapham. 2013. Soviet whaling in the North Pacific: revised catch totals. J. Cetacean Res. Manage. 13:59-71.

Josephson, E., T. D. Smith, and R. R. Reeves. 2008a. Historical distribution of right whales in the North Pacific. Fish Fish. 9:155-168.

Josephson, E. A., T. D. Smith, and R. R. Reeves. 2008b. Depletion within a decade: the American 19th-century North Pacific right whale fishery.~~.~~ ~~P~~p. 133-147. *In* D. J. Starkey, P. Holm, and M. Barnard (eds.), Oceans Past: Management Insights from the History of Marine Animal Populations. Earthscan, London.

Kennedy, A. S., D. R. Salden, and P. J. Clapham. 2011. First high- to low-latitude match of an Eastern North Pacific right whale (*Eubalaena japonica*). Mar. Mammal Sci. 28(4):E539-E544. DOI: 10.1111/j.1748-7692.2011.00539.x.

Kornev, S. I. 1994. A note on the death of a right whale (*Eubalaena glacialis*) off Cape Lopakta (Kamchatka). Rep. Int. Whal. Comm. (Special Issue 15):443-444.

LeDuc, R. 2004. Report of the results of the 2002 survey for North Pacific right whales. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-357, 58 p.

LeDuc, R. G., W. L. Perryman, J. W. Gilpatrick, Jr., J. Hyde, C. Stinchcomb, J. V. Carretta, and R. L. Brownell, Jr. 2001. A note on recent surveys for right whales in the southeastern Bering Sea. J. Cetacean Res. Manage. (Special Issue 2):287-289.

LeDuc, R. G., B. L. Taylor, K. Martien, K. M. Robertson, R. L. Pitman, J. C. Salinas, A. M. Burdin, A. S. Kennedy, P. R. Wade, P. J. Clapham, and R. L. Brownell, Jr. 2012. Genetic analysis of right whales in the eastern North Pacific confirms severe extinction risk. Endang. Species Res. 18:163-167.

Mellinger, D. K., K. M. Stafford, S. E. Moore, L. Munger, and C. G. Fox. 2004. Detection of North Pacific right whale (*Eubalaena japonica*) calls in the Gulf of Alaska. Mar. Mammal Sci. 20:872-879.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. C. Hobbs. 2000. Provisional estimates of mysticete whale abundance on the central Bering Sea shelf. J. Cetacean Res. Manage. 2(3):227-234.

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

Munger, L. M., and J. A. Hildebrand. 2004. Final Report: Bering Sea right whales: acoustic recordings and public outreach. North Pacific Research Board Grant Report T-2100.

Munger, L. M., S. M. Wiggins, S. E. Moore, and J. A. Hildebrand. 2008. North Pacific right whale (*Eubalaena japonica*) seasonal and diel calling patterns from long-term acoustic recordings in the southeastern Bering Sea, 2000-2006. Mar. Mammal Sci. 24(4):795-814.

Nuka Research and Planning Group, LLC. 2014a. Aleutian Islands risk assessment project; recommending an optimal response system for the Aleutian Islands: summary report. 51 p~~p~~.

Nuka Research and Planning Group, LLC. 2014b. Summary of large vessel transits of Unimak Pass in 2012. Aleutian Islands Risk Assessment Phase B.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific.~~.~~ ~~P~~p. 170-195. *In* W. E. Schevill (ed.), The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Rone, B. K., C. L. Berchok, J. L. Crance, and P. J. Clapham. 2012. Using air-deployed passive sonobuoys to detect and locate critically endangered North Pacific right whales. Mar. Mammal Sci. 28:E528-E538.

Rosenbaum, H. C., R. L. Brownell, M. W. Brown, C. Schaeff, V. Portway, B. N. White, S. Malik, L. A. Pastene, N. J. Patenaude, C. S. Baker, M. Goto, P. B. Best, P. J. Clapham, P. Hamilton, M. Moore, R. Payne, V. Rowntree, C. T. Tynan, J. L. Bannister, and R. DeSalle. 2000. World-wide genetic differentiation of *Eubalaena*: questioning the number of right whale species. Mol. Ecol. 9(11):1793-1802.

Rowntree, V., J. Darling, G. Silber, and M. Ferrari. 1980. Rare sighting of a right whale (*Eubalaena glacialis*) in Hawaii. Can. J. Zool. 58:308-312.

Salden, D. R., and J. Mickelsen. 1999. Rare sightings of a North Pacific right whale (*Eubalaena glacialis*) in Hawaii. Pac. Sci. 53:341-345.

Scarff, J. E. 1986. Historic and present distribution of the right whale (*Eubalaena glacialis*) in the eastern North Pacific south of 50°N and east of 180°W. Rep. Int. Whal. Comm. (Special Issue 10):43-63.

Scarff, J. E. 1991. Historic distribution and abundance of the right whale, *Eubalaena glacialis*, in the North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan from the Maury Whale Charts. Rep. Int. Whal. Comm. 41:467-487.

Shelden, K. E. W., S. E. Moore, J. M. Waite, P. R. Wade, and D. J. Rugh. 2005. Historic and current habitat use by North Pacific right whales *Eubalaena japonica* in the Bering Sea and Gulf of Alaska. Mammal Rev. 35:129-155.

Širović, A., S. C. Johnson, L. K. Roche, L. M. Varga, S. M. Wiggins, and J. A. Hildebrand. ~~2014~~2015. North Pacific right whales (*Eubalaena japonica*) recorded in the northeastern Pacific Ocean in 2013. Mar. Mammal Sci. 31(2):800-807. DOI: 10.1111/mms.12189.

Stafford, K. M., and D. K. Mellinger. 2009. Analysis of acoustic and oceanographic data from the Bering Sea, May 2006 – April 2007. North Pacific Research Board Final Report, NPRB Project No. 719. 24 p~~p~~.

Stafford, K. M., S. E. Moore, P. J. Stabeno, D. V. Holliday, J. M. Napp, and D. K. Mellinger. 2010. Biophysical ocean observation in the southeastern Bering Sea. Geophys. Res. Lett. 37(2). DOI: 10.1029/2009GL040724.

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

Tynan, C. 1999. Redistribution of cetaceans in the southeast Bering Sea relative to anomalous oceanographic conditions during the 1997 El Niño.~~–~~ ~~P~~p. 115-117. *In* H. J. Freeland, W. T. Peterson, and A. Tyler (eds.), Proceedings of the 1998 science board symposium on the impacts of the 1997/98 El Niño event on the North Pacific Ocean and its marginal seas. PICES Scientific Report No. 10, North Pacific Marine Science Organization (PICES), Sydney, BC, Canada.

Wada, S. 1973. The ninth memorandum on the stock assessment of whales in the North Pacific. Rep. Int. Whal. Comm. 23:164-169.

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

Wade, P. R., M. P. Heide-Jørgensen, K. Shelden, J. Barlow, J. Carretta, J. Durban, R. LeDuc, L. Munger, S. Rankin, A. Sauter, and C. Stinchcomb. 2006. Acoustic detection and satellite tracking leads to discovery of rare concentration of endangered North Pacific right whales. Biol. Lett. 2:417-419.

Wade, P. R., A. Kennedy, R. LeDuc, J. Barlow, J. Carretta, K. Shelden, W. Perryman, R. Pitman, K. Robertson, B. Rone, J. C. Salinas, A. Zerbini, R. L. Brownell, Jr., and P. Clapham. 2011a. The world's smallest whale population. Biol. Lett. 7:83-85.

Wade, P. R., A. De Robertis, K. Hough, R. Booth, A. Kennedy, R. LeDuc, L. Munger, J. Napp, K. E. W. Shelden, S. Rankin, O. Vasquez, and C. Wilson. 2011b. Rare detections of North Pacific right whales in the Gulf of Alaska, with observations of their potential prey. Endang. Species Res. 13:99-109.

Waite, J. M., K. Wynne, and D. K. Mellinger. 2003. Documented sighting of a North Pacific right whale in the Gulf of Alaska and post-sighting acoustic monitoring. Northwest. Nat. 84:38-43.

Waring, G. T., R. M. Pace, J. M. Quintal, C. P. Fairfield, and K. Maze-Foley (eds.). 2004. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2003. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NE-182, 287 p.

Wolniakowski, K. U., J. Wright, G. Folley, and M. R. Franklin. 2011. Aleutian Islands Risk Assessment Project. Phase A Summary Report. 58 p~~p~~._____ Available online: http://www.aleutiansriskassessment.com/documents/110826AIRA_SummaryReportvFINALlr.pdf. Accessed ~~December 2015~~June 2016.

Wright, D. L. 2015. Simultaneous identification of four mysticete species in the Bering Sea using passive acoustic monitoring increase confidence in acoustic identification of the critically endangered North Pacific right whale (*Eubalaena japonica*). Final Report, International Fund for Animal Welfare. 63 p.

Zerbini, A. N., M. F. Baumgartner, A. S. Kennedy, B. K. Rone, P. R. Wade, and P. J. Clapham. 2015. Space use patterns of the endangered North Pacific right whale (*Eubalaena japonica*) in the Bering Sea. Mar. Ecol. Prog. Ser. 532:269-281. DOI: 10.3354/meps11366.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984, Moore and Reeves 1993). For management purposes, four stocks of bowhead whales have been recognized worldwide by the International Whaling Commission (IWC 2010). Small stocks, comprised of only a few ~~tens to a few~~ hundred~~s of~~ 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 ~~recent~~ 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

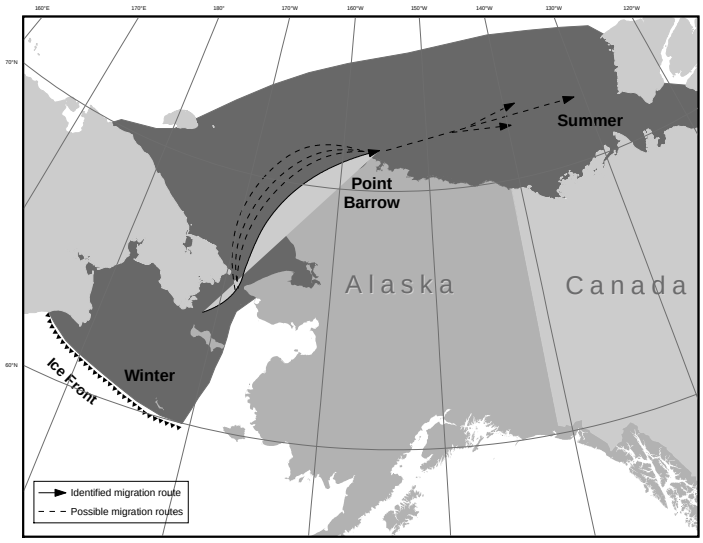

Figure 1. Dark areas depict the approximate distribution of the Western Arctic stock of bowhead whales. The spring migration represented here by lines and arrows follows a route from the Bering Sea wintering area to the Beaufort Sea summering area, mostly along a coastal tangent that constricts somewhat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

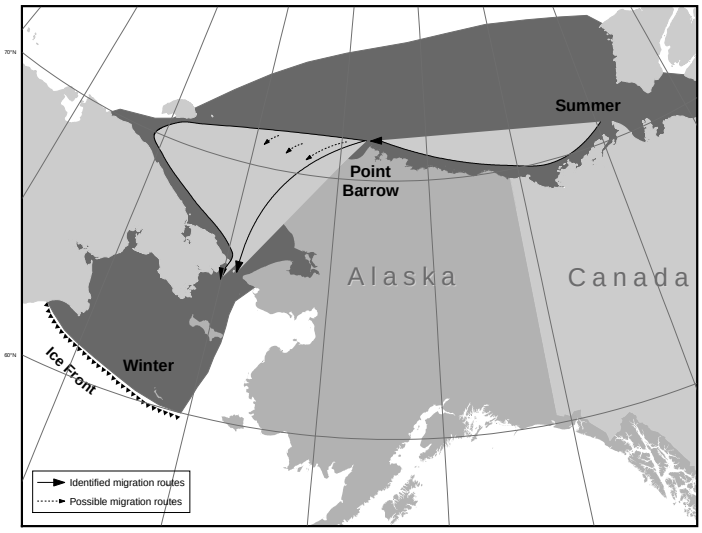

Figure 2. Dark areas depict the approximate distribution of the Western Arctic stock of bowhead whales. The fall migration is represented here by lines and arrows showing generalized routes used to travel from the Beaufort Sea (summering area) to the Bering Sea (wintering area).

al. 2015). Some bowhead whales are found in 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; ~~N~~MML, unpubl. data, available online: http://www.afsc.noaa.gov/nmml/cetacean/bwasp/flights_2014.php, accessed ~~December 2015~~June 2016). During the autumn migration through the Beaufort Sea, bowhead whales select shelf waters in all but "heavy ice" conditions, when they select slope habitat (Moore 2000). Heavy ice years in ~~the~~ autumn in the Beaufort Sea are becoming less common because of ~~the retreat of Arctic sea ice~~climate change and the resulting trend of delayed seasonal sea ice formation and dramatic reduction in volume of multi-year ice. In winter in the Bering Sea, bowhead whales often use areas with ~100% sea-ice cover, even when polynas 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; ~~N~~MML, unpubl. data, available online: http://www.afsc.noaa.gov/nmml/cetacean/bwasp/flights_2014.php, accessed ~~December 2015~~June 2016). 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 (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 (9,190-13,950; 5th and 95th percentiles, respectively) bowhead whales in 1848 at the start of commercial whaling.

Since 1978, systematic counts of bowhead whales have been conducted from sites on sea ice near Point Barrow during the whales' spring migration (Krogman et al. 1989). These counts have been corrected for whales missed due to distance offshore (since the mid-1980s, using acoustical 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

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. (2013).

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	16,892 (0.058)

(estimated as a function of visibility, number of observers, and distance offshore~~;~~. Zeh et al. 1993). A summary of the resulting abundance estimates is provided in Table 1 and Figure 3. 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. Attempts to count migrating whales near Point Barrow in 2009 and 2010 were unsuccessful due to sea-~~-~~ice conditions (IWC 2010, George et al. 2011) but were successful in 2011.~~ The ice-based abundance estimate in 2001 was 10,545 (CV = 0.128) (updated from George et al. 2004 by Zeh and Punt 2004). The 2011 ice-based abundance estimate was 16,892 (95% CI: 15,074-18,928) (Givens et al. 2013).~~

Bowhead whales were identified from aerial photographs taken in 1985 and 1986, and the results were used in a sight-resight analysis. This approach provided estimates of 4,719 (95% CI: 2,382-9,343; SE 1,696) to 7,022 (95% CI: 4,701-12,561; SE 2,017), depending on the model used (daSilva et al. 2000). These population estimates and their associated error ranges are comparable to the estimates obtained from the combined ice-based visual and acoustic data for 1985 (6,039; 95% CI: 2,286-9,792; SE 1,915) and 1986 (7,734; 95% CI: 4,892-10,576; SE 1,450; Raftery and Zeh 1998). Aerial photographs provided another sampling of the bowhead whale population in 2003 and 2004. Sight-resight results provided estimates of 8,250 whales (95% CI: 3,150-15,450) in 2001 (Schweder et al. 2009) and 12,631 whales (95% CI: 7,900-19,700) in 2004 (Koski et al. 2010), which are consistent with trends in abundance estimates made from ice-based counts. 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).

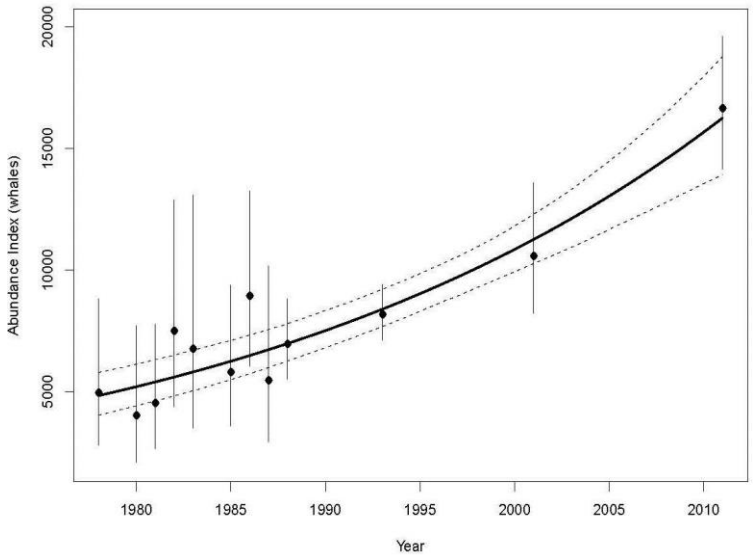

Figure 3. Abundance estimates for the Western Arctic stock of bowhead whales, 1978-2011 (Givens et al. 2013), as computed from ice-based counts, acoustic ~~locations~~data, and aerial transect data collected during bowhead whale spring migrations past Point Barrow, A~~K~~laska.

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 16,892 and its associated CV(N) of 0.058, N_{MIN} for the Western Arctic stock of bowhead whales is 16,091.

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 = 2.8-4.7%) from 1978 to 2011, during which time abundance tripled from approximately 5,000 to approximately 16,000 whales (Givens et al. 2013). 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

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the 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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. 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~~p. 27-28). Thus, PBR = 161 animals (16,091 × 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) ~~could be taken~~is permitted each year. This quota includes an allowance of five animals 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

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 ~~rope~~line or net entanglement have been reported from whales taken in the subsistence hunt (Philo et al. 1993). George et al. (2015b) 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).~~Further, a thorough reexamination of bowhead harvest records is ongoing and there are preliminary indications that entanglements or scarring attributed to ropes may include over 20 cases (C. George, Department of Wildlife Management, North Slope Borough, pers. comm.).~~

There are no observer program records of bowhead whale mortality incidental to U.S. commercial fisheries in Alaska. However, some bowhead whales have ~~historically~~ had interactions with crab pot gear and fishing nets. 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 (Table 2; Suydam et al. 2011~~; Table 2~~), 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. More recently, Citta et al. (2014) found that the distribution of satellite-tagged bowhead whales in the Bering Sea spatially and temporally overlapped areas where commercial pot fisheries occurred and noted the potential risk of entanglement in lost gear. The minimum estimated average annual mortality and serious injury rate in U.S. commercial fisheries in ~~2009-2013~~2010-2014 is 0.2 bowhead whales; however, the actual rate is currently unknown.

Table 2. Summary of mortality and serious injury of ~~the~~ Western Arctic ~~stock of~~ bowhead whales, by year and type, reported to the NMFS Alaska Region~~,~~ marine mammal stranding ~~database~~network~~,~~ in ~~2009-2013~~2010-2014 (Helker et al. ~~2015~~2016). Only cases of mortality and serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of injury	**~~2009~~**	**2010**	**2011**	**2012**	**2013**	**2014**	**Mean annual mortality**
Entangled in ~~unspecified~~commercial pot gear	~~0~~	1	0	0	0	0	0.2
Total 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 number of kills in any one year has ranged between 14 and 72. The maximum number of ~~takes~~strikes per year is set by ~~the~~a quota~~,~~ which is ~~itself~~ determined by ~~the~~ subsistence needs and ~~the~~bowhead whale abundance and trend estimates (Stoker and Krupnik 1993). Suydam and George (2012) summarized Alaskan 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 ~~31 whales in 2009 (Suydam et al. 2010),~~ 45 whales in 2010 (Suydam et al. 2011), 38 in 2011 (Suydam et al. 2012), 55 in 2012 (Suydam et al. 2013), ~~and~~ 46 in 2013 (George and Suydam 2014, Suydam et al. 2014), and 38 in 2014 (Suydam et al. 2015). 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 2014, 38 of 53 whales struck were landed, resulting in an efficiency of 72% (Suydam et al. 2015). ~~and~~ Suydam et al. (~~2014~~2015) reported that the current mean efficiency, from ~~2004 to 2013~~2005 through 2014, is ~~77~~76.5%.

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, ~~and~~ 2012, or 2014 (IWC 2011, Ilyashenko 2013, Ilyashenko and Zharikov 2015), 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 ~~2009 to 2013~~2010 through 2014 was 44 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). ~~It is~~ Woodby and Botkin (1993) estimated that the pelagic whaling industry harvested 18,684 whales from this stock ~~(Woodby and Botkin 1993)~~. 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 ~~E~~estimates ~~of mortality~~ 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 orca/killer whale injuries and another 10 had possible injuries (George et al. 2015b). A higher rate of killer whale rake mark scars occurred during 2002-2012 than in the previous decade. George et al. (2015b) 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.

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. 2015b). 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 = 16.1) and, therefore, can be considered to be insignificant. The ~~average~~total annual level of human-caused mortality and serious injury (44 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 ~~in recent years~~; the estimate of 16,892 from 2011 is between 31% and 170% of the pre-exploitation abundance of ~~(estimates ranging roughly from~~ 10,000 to 55,000~~), and this stock~~

~~may now be approaching its carrying capacity (~~ 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 ~~(ESA)~~ and is therefore also designated as "depleted" under the MMPA.

HABITAT CONCERNS

Vessel traffic in ~~A~~arctic waters is increasing, largely due to an increase in oil and gas activities and 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 in bowhead whale habitat, including oil spills~~ and other pollutants~~. Also of concern is noise produced by ~~the increased number of~~ seismic surveys and ~~increased~~ 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) and that bowhead whales often avoid sound sources associated with~~the presence of an~~ active drilling ~~rig~~ (Schick and Urban 2000) ~~or~~and seismic operations (Miller et al. 1999)~~ may cause bowhead whales to avoid the activity~~. 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, more recent 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). More recent studies have similarly 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~~n~~ 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). ~~This apparent tolerance, however, should not be interpreted to~~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 ~~so highly~~sufficiently motivated to ~~stay in a productive~~continue feeding in a given area ~~that they remain in an area with~~despite noise-induced stress ~~levels that could cause adverse~~or physiological effects~~. They could be experiencing increased stress by staying in a location with very loud noise~~ (MMS 2008). A ~~recent~~ 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. 1996).

~~Another concern for bowhead whales and other Arctic species is climate change, which is affecting high northern latitudes more than elsewhere.~~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 ~~C~~climate model projections for the next 50-100 years~~, produced by global climate models,~~ consistently show ~~a~~ pronounced warming over the Arctic, accelerated sea-ice loss, and continued permafrost degradation (IPCC 2007, USGS 2011, Jeffries et al. ~~2014~~2015). Within the Arctic, some of the largest changes are ~~expected~~projected to occur in the Bering, Beaufort, and Chukchi seas (Chapman and Walsh 2007, Walsh 2008). Ice-associated animals, ~~such as~~including the bowhead whale, may be sensitive to changes in ~~A~~arctic weather, sea-surface temperatures, ~~or~~ 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 ~~predictions~~projections of the effects of ~~A~~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. (2015a) 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. (2015a) speculated that sea ice loss has positive effects on secondary trophic production within the Western

Arctic bowhead whale's summer feeding region. ~~This, together with high calf production in recent years, suggests that the stock is presently tolerating recent trends in declining seasonal sea-ice coverage, volume, and duration.~~

CITATIONS

Ashjian, C. J., S. R. Braund, R. G. Campbell, J. C. George, J. Kruse, W. Maslowski, S. E. Moore, C. R. Nicolson, S. R. Okkonen, B. F. Sherr, E. B. Sherr, and Y. H. Spitz. 2010. Climate variability, oceanography, bowhead whale distribution, and Iñupiat subsistence whaling near Barrow, Alaska. Arctic 63(2):179-194.

Bachmann, L., Ø. Wiig, M. P. Heide-Jørgensen, K. L. Laidre, L. D. Postma, L. Dueck, and P. J. Palsbøl. 2010. Genetic diversity in Eastern Canadian and Western Greenland bowhead whales (*Balaena mysticetus*). Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG26). 6 p~~p~~.

Blackwell S. B, C. S. Nations, T. L. McDonald, A. M. Thode, D. Mathias, K. H. Kim, C. R. Greene, Jr., and A. M. Macrander 2015. Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds. PLOS ONE 10(6):e0125720. DOI: 10.1371/journal.pone.0125720.

Braham, H. W. 1984. The bowhead whale, *Balaena mysticetus*. Mar. Fish. Rev. 46(4):45-53.

Braham, H. W., M. A. Fraker, and B. D. Krogman. 1980. Spring migration of the Western Arctic population of bowhead whales. Mar. Fish. Rev. 42(9-10):36-46.

Bockstoce, J. R., and J. J. Burns. 1993. Commercial whaling in the North Pacific sector.~~.~~ ~~P~~p. 563-577. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Bockstoce, J. R., D. B. Botkin, A. Philp, B. W. Collins, and J. C. George. 2007. The geographic distribution of bowhead whales (*Balaena mysticetus*) in the Bering, Chukchi, and Beaufort ~~S~~seas: evidence from whaleship records, 1849-1914. Mar. Fish. Rev. 67(3):1-43.

Boertmann, D., L. A. Kyhn, L. Witting, and M. P. Heide-Jorgensen. 2015. A hidden getaway for bowhead whales in the Greenland Sea. Polar Biol. 38(8):1315-1319. DOI: 10.1007/s00300-015-1695-y.

Brandon, J., and P. R. Wade. 2004. Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/56/BRG20). 32 p~~p~~.

Brandon, J., and P. R. Wade. 2006. Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales using Bayesian model averaging. J. Cetacean Res. Manage. 8(3):225-239.

Burns, J. J., J. J. Montague, and C. J. Cowles (eds.). 1993. The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2. 787 p~~p~~.

Chapman, W. L., and J. E. Walsh. 2007. Simulations of ~~A~~arctic temperature and pressure by global coupled models. J. Climate 20:609-632.

Citta, J. J., J. J. Burns, L. T. Quakenbush, V. Vanek, J. C. George, R. J. Small, M. P. Heide-Jørgensen, and H. Brower. 2014. Potential for bowhead whale entanglement in cod and crab pot gear in the Bering Sea. Mar. Mammal Sci. 30(2):445-459. DOI: 10.1111/mms.12047.

Citta, J. J., L. T. Quakenbush, S. R. Okkonen, M. L. Druckenmiller, W. Maslowski, J. Clement-Kinney, J. C. George, H. Brower, R. J. Small, C. J. Ashjian, L. A. Harwood, and M. P. Heide-Jørgensen. 2015. Ecological characteristics of core-use areas used by Bering-Chukchi-Beaufort (BCB) bowhead whales, 2006-2012. Prog. Oceanogr. 136:201-222.

Clark, C. W., S. Mitchell, and R. Charif. 1994. Distribution and behavior of the bowhead whale, *Balaena mysticetus*, based on preliminary analysis of acoustic data collected during the 1993 spring migration off Point Barrow, Alaska. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/46/AS19). 24 p~~p~~.

Clarke, J. T., and M. C. Ferguson. 2010a. Aerial surveys for bowhead whales in the Alaskan Beaufort Sea: BWASP update 2000-2009 with comparisons to historical data. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG14).

Clarke, J. T., and M. C. Ferguson. 2010b. Aerial surveys of large whales in the northeastern Chukchi Sea, 2008-2009, with review of 1982-1991 data. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG13).

Clarke, J. T., C. L. Christman, A. A. Brower, and M. C. Ferguson. 2012. Distribution and relative abundance of marine mammals in the Alaskan Chukchi and Beaufort seas, 2011. Annual Report, OCS Study BOEM 2012-009. ~~National~~ Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-6349.

Clarke, J. T., C. L. Christman, A. A. Brower, and M. C. Ferguson. 2013. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2012. Annual Report, OCS Study BOEM 2013-00117. ~~National~~ Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-6349.

Clarke, J. T., A. A. Brower, C. L. Christman, and M. C. Ferguson. 2014. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2013. Annual Report, OCS Study BOEM 2014-018. ~~National~~ Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-6349.

Clarke, J. T., A. A. Brower, M. C. Ferguson, A. S. Kennedy, and A. L. Willoughby. 2015. Distribution and relative abundance of marine mammals in the eastern Chukchi and western Beaufort seas, 2014. Annual Report, OCS Study BOEM 2015-040. Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-6349.

Cosens, S. E., H. Cleator, and P. Richard. 2006. Numbers of bowhead whales (*Balaena mysticetus*) in the eastern Canadian Arctic, based on aerial surveys in August 2002, 2003 and 2004. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/BRG7). 19 p~~p~~.

daSilva, C. Q., J. Zeh, D. Madigan, J. Laake, D. Rugh, L. Baraff, W. Koski, and G. Miller. 2000. Capture-recapture estimation of bowhead whale population size using photo-identification data. J. Cetacean Res. Manage. 2(1):45-61.

Davies, J. R. 1997. The impact of an offshore drilling platform on the fall migration path of bowhead whales: a GIS-based assessment. Unpubl. MS Thesis, Western Washington University, Bellingham, WA. 51 p~~p~~.

Dueck, L. P., M. P. Heide-Jørgensen, M. V. Jensen, and L. D. Postma. 2006. Update on investigations of bowhead whale (*Balaena mysticetus*) movements in the eastern Arctic, 2003-2005, based on satellite-linked telemetry. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/BRG5). 17 p~~p~~.

Funk, D. W., R. Rodrigues, D. S. Ireland, and W. R. Koski. 2010. Summary and assessment of potential effects on marine mammals,~~.~~ Chapter 11. *In* D. W. Funk, D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.), Joint monitoring program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL, Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc., and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 506 p~~p~~. + appendices.

George, J. C., and R. S. Suydam. 2014. Update on characteristics of bowhead whale (*Balaena mysticetus*) calves. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG20Rev). 7 p~~p~~.

George, J. C., L. Philo, K. Hazard, D. Withrow, G. Carroll, and R. Suydam. 1994. Frequency of killer whale (*Orcinus orca*) attacks and ship collisions based on scarring on bowhead whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort Seas stock. Arctic 47(3):247-55.

George, J. C., J. Zeh, R. Suydam, and C. Clark. 2004. Abundance and population trend (1978-2001) of Western Arctic bowhead whales surveyed near Barrow, Alaska. Mar. Mammal Sci. 20:755-773.

George, J. C., C. Nicolson, S. Drobot, J. Maslanik, and R. Suydam. 2006. Sea ice density and bowhead whale body condition preliminary findings. Poster presented to the Society for Marine Mammalogy, San Diego, CA.

George, J. C., S. E. Moore, and R. Suydam. 2007. Summary of stock structure research on the Bering-Chukchi-Beaufort Seas stock of bowhead whales 2003-2007. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/59/BRG3). 15 p~~p~~.

George, J. C., G. H. Givens, J. Herreman, R. A. Delong, B. Tudor, R. Suydam, and L. Kendall. 2011. Report of the 2010 bowhead whale survey at Barrow with emphasis on methods for matching sightings from paired independent observations. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/63/BRG3). 14 p~~p~~.

George, J. C., M. L. Druckenmiller, K. L. Laidre, R. Suydam, and B. Person. 2015a. Bowhead whale body condition and links to summer sea ice and upwelling in the Beaufort Sea. Prog. Oceanogr. 136: 250-262.

George, J. C., G. Sheffield, D. J. Reed, B. Tudor, and R. Suydam. 2015b. Evidence of injuries from line entanglements, killer whales, and ship strikes on Bering-Chukchi-Beaufort Sea bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66a/HIM10). 14 p.

Givens, G. H., S. L. Edmondson, J. C. George, R. Suydam, R. A. Charif, A. Rahaman, D. Hawthorne, B. Tudor, R. A. DeLong, and C. W. Clark. 2013. Estimate of 2011 abundance of the Bering-Chukchi-Beaufort Seas bowhead whale population. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65a/BRG1). 30 p~~p~~.

Greene, C. R., Jr., W. J. Richardson, and N. S. Altman. 1998. Bowhead whale call detection rates versus distance from airguns operating in the Alaskan Beaufort Sea during fall migration, 1996. J. Acoust. Soc. Am. 104:1826. DOI: 10.1121/1.423473.

Harris, R. E., T. Elliot, and R. A. Davis. 2007. Results of mitigation and monitoring program, Beaufort Span 2-D marine seismic program, open water season 2006. LGL, Ltd., LGL Report TA4319-1, Report from LGL, Ltd., King City, Ont., for GX Technol., Houston, TX. 48 p~~p~~.

Heide-Jørgensen, M. P., K. L. Laidre, M. V. Jensen, L. Dueck, and L. D. Postma. 2006. Dissolving stock discreteness with satellite tracking: bowhead whales in Baffin Bay. Mar. Mammal Sci. 22:34-45.

Heide-Jørgensen, M. P., K. L. Laidre, Ø. Wiig, and L. Dueck. 2010. Large scale sexual segregation of bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG23). 13 p~~p~~.

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

Helker, V. T., M. M. Muto, and L. A. Jemison. 2016. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2010-2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-315, 89 p. DOI: 10.7289/V5/TM-AFSC-315.

Huntington, H. P., R. Daniel, A. Hartsig, K. Harun, M. Heiman, R. Meehan, G. Noongwook, L. Pearson, M. Prior-Parks, M. Robards, and G. Stetson. 2015. Vessels, risks, and rules: planning for safe shipping in Bering Strait. Marine Policy 51:119-127.

Ilyashenko, V. U. 2013. Aboriginal harvest of gray and bowhead whales in the Russian federation in 2008 – 2012. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65a/BRG24). 2 p~~p~~.

Ilyashenko, V., and K. Zharikov. 2014. Aboriginal harvest of gray and bowhead whales in the Russian federation in 2013. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG3). 1 p~~p~~.

Ilyashenko, V., and K. Zharikov. 2015. Aboriginal subsistence whaling in the Russian federation in 2014. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66a/BRG07). 5 p.

IPCC (Intergovernmental Panel on Climate Change). 2007. The physical science basis summary for policymakers. Fourth Assessment Report of the IPCC. United Nations, Geneva, Switzerland. Available online: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf. Accessed ~~December 2015~~June 2016.

IWC (International Whaling Commission). 2003. Report of the fourth workshop on the development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). J. Cetacean Res. Manage. 5(Suppl.):489-497.

IWC (International Whaling Commission). 2008. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 10(Suppl.):150-166.

IWC (International Whaling Commission). 2009. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 11(Suppl.):169-192.

IWC (International Whaling Commission). 2010. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 11(Suppl. 2):154-179.

IWC (International Whaling Commission). 2011. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 12(Suppl.):168-184.

IWC (International Whaling Commission). 2012. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 13(Suppl.):154-174.

Jeffries, M. O., J. Richter-Menge, and J. E. Overland (eds.). ~~2014~~2015. Arctic report card ~~2014~~2015. Available online: http://www.arctic.noaa.gov/reportcard. Accessed ~~December 2015~~June 2016.

Jorde, P. E., T. Schweder, J. W. Bickham, G. H. Givens, R. Suydam, D. Hunter, and N. C. Stenseth. 2007. Detecting genetic structure in migrating bowhead whales off the coast of Barrow, Alaska. Mol. Ecol. 16:1993-2004.

Koski, W., J. Zeh, J. Mocklin, A. R. Davis, D. J. Rugh, J. C. George, and R. Suydam. 2010. Abundance of Bering-Chukchi-Beaufort bowhead whales (*Balaena mysticetus*) in 2004 estimated from photo-identification data. J. Cetacean Res. Manage. 11(2):89-99.

Krogman, B., D. Rugh, R. Sonntag, J. Zeh, and D. Ko. 1989. Ice-based census of bowhead whales migrating past Point Barrow, Alaska, 1978-1983. Mar. Mammal Sci. 5:116-138.

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

Ljungblad, D. K., B. Würsig, S. L. Swartz, and J. M. Keene. 1988. Observations on the behavioral responses of bowhead whales (*Balaena mysticetus*) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic 41(3):183-194.

Lowry, L. F., G. Sheffield, and J. C. George. 2004. Bowhead whale feeding in the Alaskan Beaufort Sea, based on stomach contents analyses. J. Cetacean Res. Manage. 6(3):215-223.

Marquette, W. M., and J. R. Bockstoce. 1980. Historical shore-based catch of bowhead whales in the Bering, Chukchi, and Beaufort seas. Mar. Fish. Rev. 42(9-10):5-19.

Miller, G. W., R. E. Elliott, W. R. Koski, V. D. Moulton, and W. J. Richardson. 1999. Whales,~~.~~ ~~P~~p. 5-1 to 5-109. *In* W. J. Richardson (ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Report TA2230–3. Report from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and National Marine Fisheries Service, Anchorage, AK, and Silver Spring, MD. 390 p~~p~~.

Miller, G. W., V. D. Moulton, R. A. Davis, M. Holst, P. Millman, A. MacGillivray, and D. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001-2002,~~.~~ ~~P~~p. 511-542. *In* S. L. Armsworthy, P. J. Cranford, and K. Lee (eds.), Offshore Oil and Gas Development Effects Monitoring/Approaches and Technologies. Battelle Press, Columbus, OH.

MMS (Minerals Management Service). 2008. Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas Lease Sales 209, 212, 217, and 221, Draft Environmental Impact Statement: U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, MMS 2008-055, November. Available online: http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/2008-055-vol2.pdf. Accessed ~~December 2015~~June 2016.

Mocklin, J., J. C. George, M. Ferguson, L. Vate Brattström, V. Beaver, B. Rone, C. Christman, A. Brower, B. Shea, and C. Accardo. 2012. Aerial photography of bowhead whales near Barrow, Alaska, during the 2011 spring migration. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/64/BRG3). 9 p~~p~~.

Moore, S. E. 2000. Variability in cetacean distribution and habitat section in the Alaskan Arctic, autumn 1982-91. Arctic 53(4):448-460.

Moore, S. E., and R. R. Reeves. 1993. Distribution and movement,~~.~~ ~~P~~p. 313-386. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Okkonen, S. R., C. J. Ashjian, R. G. Campbell, J. Clarke, S. E. Moore, and K. D. Taylor. 2011. Satellite observations of circulation features associated with the Barrow area bowhead whale feeding hotspot. Remote Sensing Environ. 115:2168-2174.

Philo, L. M., E. B. Shotts, and J. C. George. 1993. Morbidity and mortality,~~.~~ ~~P~~p. 275-312. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Postma, L. D., L. P. Dueck, M. P. Heide-Jørgensen, and S. E. Cosens. 2006. Molecular genetic support of a single population of bowhead whales (*Balaena mysticetus*) in Eastern Canadian Arctic and Western Greenland waters. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/58/BRG4). 15 p~~p~~.

Quakenbush, L. T., R. J. Small, and J. J. Citta. 2010a. Satellite tracking of Western Arctic bowhead whales. Unpubl. report submitted to the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE 2010-033).

Quakenbush, L. T., J. J. Citta, J. C. George, R. J. Small, and M. P. Heide-Jørgensen. 2010b. Fall and winter movements of bowhead whales (*Balaena mysticetus*) in the Chukchi Sea and within a potential petroleum development area. Arctic 63(3):289-307.

Raftery, A., and J. Zeh. 1998. Estimating bowhead whale population size and rate of increase from the 1993 census. J. Am. Stat. Assoc. 93:451-463.

Richardson, W. J. 1995. Documented disturbance reactions,~~.~~ ~~P~~p. 241-324. *In* W. J. Richardson, C. R. Greene, C. I. Malme, and D. H. Thomson (eds.), Marine Mammals and Noise. Academic Press, San Diego, CA.

Richardson, W. J., and C. I. Malme. 1993. Man-made noise and behavioral responses,~~.~~ ~~P~~p. 631-700. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Richardson, W. J., B. Würsig, and C. R. Greene, Jr. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. J. Acoust. Soc. Am. 79(4):1117-1128.

Richardson, W. J., R. A. Davis, C. R. Evans, D. K. Ljungblad, and P. Norton. 1987. Summer distribution of bowhead whales, *Balaena mysticetus*, relative to oil industry activities in the Canadian Beaufort Sea, 1980-84. Arctic 40(2):93-104.

Richardson, W. J., G. W. Miller, and C. R. Greene, Jr. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. J. Acoust. Soc. Am. 106(4, Pt. 2):2281.

Ross, W. G. 1993. Commercial whaling in the North Atlantic sector.~~.~~ ~~P~~p. 511-561. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Rugh, D., D. DeMaster, A. Rooney, J. Breiwick, K. Shelden, and S. Moore. 2003. A review of bowhead whale (*Balaena mysticetus*) stock identity. J. Cetacean Res. Manage. 5(3):267-279.

Rugh, D., W. Koski, J. George, and J. Zeh. 2009. Inter-year re-identification of bowhead whales during their spring migration past Barrow, Alaska, 1984-1994. J. Cetacean Res. Manage. 10(3):195-200.

Schick, R. S., and D. L. Urban. 2000. Spatial components of bowhead whale (*Balaena mysticetus*) distribution in the Alaskan Beaufort Sea. Can. J. Fish. Aquat. Sci. 57:2193-2200.

Schweder, T., D. Sadykova, D. Rugh, and W. Koski. 2009. Population estimates from aerial photographic surveys of naturally and variably marked bowhead whales. J. Agric. Biol. Environ. Stat. 15(1):1-19.

Shelden, K. E. W., and D. J. Rugh. 1995. The bowhead whale (*Balaena mysticetus*): status review. Mar. Fish. Rev. 57(3-4):1-20.

Shpak, O. V., I. G. Meschersky, A. N. Chichkina, D. M. Kuznetsova, A. Y. Paramonov, and V. V. Rozhnov. 2014. New data on the Okhotsk Sea bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG17). 5 p.

Stoker, S. W., and I. I. Krupnik. 1993. Subsistence whaling.~~.~~ ~~P~~p. 579-629. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Suydam, R., and J. C. George. 2012. Preliminary analysis of subsistence harvest data concerning bowhead whales (*Balaena mysticetus*) taken by Alaskan Natives, 1974 to 2011. Unpubl. doc submitted to Int. Whal. Comm. Scientific Committee (SC/64/AWMP8). 13 p~~p~~.

~~Suydam, R., J. C. George, C. Rosa, B. Person, C. Hanns, and G. Sheffield. 2010. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2009. Unpubl. doc. submitted to Int. Whal. Comm. (SC/62/BRG18). 7 pp.~~

Suydam, R., J. C. George, B. Person, C. Hanns, and G. Sheffield. 2011. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2010. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/63/BRG2). 7 p~~p~~.

Suydam, R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2012. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2011. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/64/BRG2). 8 p~~p~~.

Suydam R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2013. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2012. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65a/BRG19). 7 p~~p~~.

Suydam, R., J. C. George, B. Person, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2014. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2013. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/65b/BRG8). 10 p~~p~~.

Suydam, R., J. C. George, B. Person, D. Ramey, C. Hanns, R. Stimmelmayr, L. Pierce, and G. Sheffield. 2015. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2014. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/66a/BRG6). 9 p.

Taylor, B., R. LeDuc, J. C. George, R. Suydam, S. Moore, and D. Rugh. 2007. Synthesis of lines of evidence for population structure for bowhead whales in the Bering-Chukchi-Beaufort region. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/59/BRG35). 12 p~~p~~.

USGS (U.S. Geological Survey). 2011. An evaluation of the science needs to inform decisions on Outer Continental Shelf energy development in the Chukchi and Beaufort seas. L. Holland-Bartels and B. Pierce (eds.), Alaska: U.S. Geological Survey Circular 1370. 278 p~~p~~.

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

Walsh, J. E. 2008. Climate of the ~~A~~arctic marine environment. Ecol. Appl. 18(2)Suppl.:S3-S22. DOI: 10.1890/06-0503.1.

Wiig, Ø., L. Bachmann, N. Øien, K. M. Kovacs, and C. Lydersen. 2009. Observations of bowhead whales (*Balaena mysticetus*) in the Svalbard area 1940-2008. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/61/BRG2). 5 p~~p~~.

Wiig, Ø., L. Bachmann, M. P. Heide-Jørgensen, K. L. Laidre, L. D. Postma, L. Dueck, and P. J. Palsbøl. 2010. Within and between stock re-identification of bowhead whales in Eastern Canada and West Greenland. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/62/BRG25). 7 p~~p~~.

Wiig, Ø., M. P. Heide-Jørgensen, C. Lindqvist, K. L. Laidre, P. J. Palsbøll, and L. Bachmann. 2011. Population estimates of mark and recaptured genotyped bowhead whales (*Balaena mysticetus*) in Disko Bay, West Greenland. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/63/BRG18). 4 p~~p~~.

Woodby, D. A., and D. B. Botkin. 1993. Stock sizes prior to commercial whaling, ~~. P~~p. 387-407. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

Zeh, J. E., and A. E. Punt. 2004. Updated 1978-2001 abundance estimates and their correlations for the Bering-Chukchi-Beaufort Seas stock of bowhead whales. Unpubl. doc. submitted to Int. Whal. Comm. Scientific Committee (SC/56/BRG1). 10 p~~p~~.

Zeh, J. E., C. W. Clark, J. C. George, D. E. Withrow, G. M. Carroll, and W. R. Koski. 1993. Current population size and dynamics, ~~. P~~p. 409-489. *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Appendix 1. Summary of changes to the ~~2015~~2016 stock assessments (last revised ~~12/30/2015~~9/12/2016). An 'X' indicates sections where the information presented has been updated since the ~~2014~~2015 stock assessments were released. Stock Assessment Reports for those stocks in boldface were updated in 2016.

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

Appendix 2. Stock summary table (last revised ~~12/30/2015~~9/12/2016). Stock ~~a~~Assessment ~~r~~Reports for those stocks in boldface were updated in ~~the 2015~~2016 ~~stock assessments~~. 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 for details).

Species	Stock	N_{EST}	CV	N_{MIN}	Year of last survey	R_{MAX}	F_R	PBR	Commer. fishery mort.	Native subsist. mort.	Total mort.	Status
Steller sea lion	**Western U.S.**	**~~49,497~~ 50,983**		**~~49,497~~ 50,983**	**~~2014~~2015**	**0.12**	**0.1**	**~~297~~306**	**~~31~~30**	**~~199~~201**	**~~233~~ 236**	**S**
Steller sea lion	**Eastern U.S.**	**~~60,131-74,448~~ 71,562**		**~~36,551~~ 41,638**	**~~2013~~2015**	**0.12**	**~~0.75~~ 1.0**	**~~1,645~~ 2,498**	**~~51.6~~[a]14**	**~~11.3~~11**	**~~92.3~~ 108**	**~~S~~NS**
Northern fur seal	**Eastern Pacific**	**~~648,534~~ 626,734**	**0.2**	**~~548,926~~ 530,474**	**~~2012~~2014**	**0.086**	**0.5**	**~~11,802~~ 11,405**	**~~1.1~~3.5**	**~~432~~426**	**~~439~~ 438**	**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

Species	Stock	N_{EST}	CV	N_{MIN}	Year of last survey	R_{MAX}	F_R	PBR	Commer. fishery mort.	Native subsist. mort.	Total mort.	Status
Spotted seal	Alaska	460,268		391,000	2012	0.12	0.5	11,730	1.5	5,265	5,267	NS
Bearded seal	**Alaska**	**~~N/A~~[a]**		**~~N/A~~[a]**	**2013**	**0.12**	**0.5**	**~~N/A~~[a]**	**~~1.2~~1.4**	**~~379~~441**	**~~380~~ 443**	**NS**
Ringed seal	**Alaska**	**~~N/A~~[a]**		**~~N/A~~[a]**	**2013**	**0.12**	**0.5**	**~~UNDET~~ [a]**	**~~4.1~~3.9**	**~~1,040~~ 1,058**	**~~1,044~~ 1,062**	**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	0.23	32,453	1992	0.04	1.0	649	0	166	166	NS
Beluga whale	Eastern Chukchi Sea	3,710	N/A	~~UNK~~ N/A	1991	0.04	1.0	UNDET	0	57.4	57.4	NS
Beluga whale	Eastern Bering Sea	19,186	0.32	~~UNK~~ N/A	2000	0.04	1.0	UNDET	0	181	181	NS
Beluga whale	Bristol Bay	2,877	0.2	2,467	2005	0.048	1.0	59	0.2	24	24.2	NS
Beluga whale	**Cook Inlet**	**312**	**0.10**	**280**	**2014**	**0.04**	**0.1**	**UNDET**	**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[b]**	**N/A**	**2,347**	**2012**	**0.04**	**0.5**	**~~23.4~~24**	**~~0.9~~1**	**0**	**~~0.9~~1**	**NS**
Killer whale	Eastern North Pacific Northern Resident (British Columbia)	261[b]	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[b]**	**N/A**	**587**	**2012**	**0.04**	**0.5**	**5.9**	**~~0.6~~1**	**0**	**~~0.6~~1**	**NS**
Killer whale	**AT1 Transient**	**7[b]**	**N/A**	**7**	**~~2014~~2015**	**0.04**	**0.1**	**0**	**0**	**0**	**0**	**S**
Killer whale	West Coast Transient	243[b]	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**	**~~11,146~~[a]**	**~~0.242~~[a]**	**~~N/A~~[a]**	**~~1997~~2012**	**0.04**	**0.5**	**~~UNDET~~ [a]**	**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**	**~~0.8~~2.2**	**0**	**~~0.8~~2.2**	**S**

Species	Stock	N_{EST}	CV	N_{MIN}	Year of last survey	R_{MAX}	F_R	PBR	Commer. fishery mort.	Native subsist. mort.	Total mort.	Status
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**	**~~2.2~~2.6**	**S**
Humpback whale	**Central North Pacific - entire stock**	**10,103**	**0.300**	**7,890**	**2006**	**0.07**	**0.3**	**83**	**~~6.5~~7.4**	**0**	**~~21~~24**	**S**
Fin whale	**Northeast Pacific**	**~~N/A~~[a]**	**~~N/A~~[a]**	**~~N/A~~[a]**	**2010**	**0.04**	**0.1**	**~~UNDET~~[a]**	**0.2**	**0**	**0.6**	**S**
Minke whale	Alaska	N/A		N/A		0.04	0.5	N/A	0	0	0	NS
North Pacific right whale	**Eastern North Pacific**	**31**	**0.226**	**~~25.7~~26**	**2013**	**0.04**	**0.1**	**0.05**	**0**	**0**	**0**	**S**
Bowhead whale	**Western Arctic**	**16,892**	**0.058**	**16,091**	**2011**	**0.04**	**0.5**	**161**	**0.2**	**44**	**44**	**S**

~~C.F. = correction factor; CV C.F. = CV of correction factor; Comb. CV = combined CV;~~ Status: S = Strategic, NS = Not Strategic.

[a]~~Includes entanglements from recreational or subsistence fisheries.~~
[a]See text in Stock Assessment Report.
[b]N(est) based on counts of individual animals identified from photo-identification catalogs. Surveys for abundance estimates of these stocks are conducted infrequently.