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Alaska Marine Mammal Stock Assessments, 201~~3~~4

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PREFACE

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

Each stock assessment includes, when available, a description of the stock's geographic range, a minimum population estimate, current population trends, current and maximum net productivity rates, optimum sustainable population levels and allowable removal levels, and estimates of annual human-caused mortality and serious injury through interactions with commercial fisheries and subsistence hunters. These 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, and 2010 (Allen and Angliss 2011), 2011 (Allen and Angliss 2012), ~~and~~ 2012 (Allen and Angliss 2013), and 2013 (Allen and Angliss 2014). 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 are 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 porpoises, sperm whales, humpback whales, fin whales, North Pacific right whales, and bowhead whales), were reviewed in 2012-2013. This review, and a review of other stocks, led to the revision of the following stock assessments for the 2009 document: Steller sea lions (western and eastern U.S. stocks), northern fur seal, spotted seal, bearded seal, ringed seal, ~~ribbon seal, Cook Inlet~~ beluga whales (Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet stocks), ~~narwhal,~~ AT1 transient killer whale~~(Alaska resident; northern resident; Gulf of Alaska, Aleutian Islands, and Bering Sea transient; AT1 transient; west coast transient stocks)~~, harbor porpoises (southeast Alaska, Gulf of Alaska, and Bering Sea stocks), sperm whale, ~~beaked whales (Baird's, Cuvier's, and Stejneger's),~~ western and central stocks of humpback whales, fin whale, eastern North Pacific right whale, and bowhead whale. The stock assessment reports for all stocks, however, are included in this document to provide a complete reference. Those sections of each stock assessment report containing significant changes are listed in Appendix 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 this NMFS Stock Assessment Report for your convenience.

Ideas and comments from the Alaska Scientific Review Group (SRG) have significantly improved this document from its draft form. The authors wish to express their gratitude for the thorough reviews and helpful guidance provided by the Alaska Scientific Review Group members: 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.

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

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Revised ~~06/10/2013~~06/09/2014

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). ~~The species is not known to migrate, but~~Large numbers of individuals disperse widely outside of the breeding season (late May-early July), ~~thus potentially intermixing with animals from other areas (Sease and York 2003).~~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).

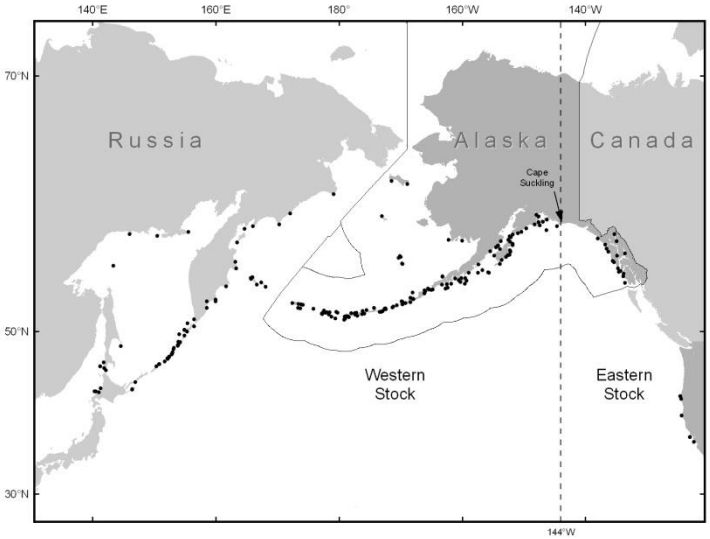

Figure 1. Approximate distribution of Steller sea lions in the North Pacific. Major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993) and active Asian haulouts and rookeries (Burkanov and Loughlin, 2005) are depicted (points). Black dashed line (144° W) indicates stock boundary (Loughlin 1997). Note: Haulouts and rookeries in British Columbia are not shown.

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 between rookeries; 2) Population response data: substantial differences in population dynamics (York et al. 1996); 3) Phenotypic data: ~~unknown~~skull morphology (Phillips et al. 2009); 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 DPS (males and females equally) and eastern DPS (almost exclusively males) across the DPS boundary.

Steller sea lions that breed in Asia are considered part of the western stock. Whereas Steller sea lions seasonally inhabit coastal waters of Japan in the winter, breeding rookeries 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/western stock split based on their analysis of nuclear microsatellite markers indicating high rates of male gene flow. Berta and Churchill (2012) concluded that a putative Asian stock is "not substantiated by microsatellite data since the Asian stock groups with the western stock". All genetic analyses (Baker et al. 2005, Harlin-Cognato et al. 2006, Hoffman et al. 2006, 2009, O'Corry-Crowe et al, 2006) confirm a strong separation between western and eastern stocks, and there may be sufficient morphological differentiation to support elevating the two recognized stocks to subspecies (Phillips et al. 2009), although a recent review by Berta and Churchill (2012) characterized that 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, while range fragmentation type events were correlated with larger effective population sizes. This work again re-inforced 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). ~~Overall, the basis for this distinctiveness of the eastern and western stocks is the overwhelming collection of morphological, ecological and behavioral, and genetic evidence for DPS differences.~~ ~~In 1998 Steller sea lion pups were first noted on Graves Rock just north of Cross Sound in Southeast Alaska in the range of the eastern stock of Steller sea lion. By 2002 the population had increased to approximately 100 pups and 50 of those pups were captured, branded, and tissue sampled in July 2002. Mitochondrial and microsatellite analysis of those samples revealed that approximately 70% of the pups had mtDNA haplotypes that were consistent with those found in the western stock (Gelatt et al. 2007). Similarly, a rookery to the south on the White Sisters Islands near northern Chichagof Island where pups were first noted in 1990 was also sampled in 2002 and approximately 45% of those pups had western stock haplotypes. Collectively, this information demonstrates that these two most recently established rookeries have been partially to predominately established by females that were born in the western stock. Movements of animals marked as pups in both stocks support these genetic results (Jemison et al., in preparation; NMML and ADFG unpublished data), with females moving from the northern Gulf of Alaska (western stock; Prince William Sound and northern Kodiak area) to breed on rookeries in northern southeast Alaska (eastern stock) with virtually no eastern stock females moving to the west.~~

In 1998, a single Steller sea lion pup was observed on Graves Rock in northern Southeast Alaska, and by 2013, pup counts had increased to 551 (DeMaster 2014). Mitochondrial and microsatellite analysis of pup tissue samples collected in 2002 revealed that approximately 70% of the pups had mtDNA haplotypes that were consistent with those found in the western stock (Gelatt et al. 2007). Similarly, a rookery to the south on the White Sisters Islands where pups were first noted in 1990 was also sampled in 2002 and approximately 45% of those pups had western stock haplotypes. Collectively, this information demonstrates that these two most recently established rookeries in northern southeast Alaska have been partially to predominately established by western stock females. Movements of animals marked as pups in both stocks support these genetic results (Jemison et al. 2013). Overall, however, the observations of marked sea lion movements corroborate the extensive genetics research findings for a strong separation between the two currently recognized stocks. Although recent colonization events in the far northern part of the eastern DPS indicate movement of western sea lions into this area, the mixed part of the range remains small (Jemison et al. 2013), and the overall discreteness of the eastern from the western stock remains distinct. Hybridization among subspecies and species along a contact zone such as now occurs near the stock boundary is not unexpected as the ability to interbreed is a primitive condition whereas reproductive isolation would be derived. In fact as stated by NMFS and FWS 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 ~~overwhelming~~ 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 ~~Bickham et al. (1996),~~ 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)~~, and others since then~~.

POPULATION SIZE

~~The most recent comprehensive estimate (pups and non-pups) of abundance of the western stock of Steller sea lions in Alaska is derived from aerial photographic surveys of non-pups conducted in June-July 2008-2012 and aerial photographic and ground-based pup counts conducted in June-July 2009-2012 (DeMaster 2011; 2012). During the 2008-2012 non-pup surveys, a total of 34,056 non-pups was counted at 269 terrestrial rookery and haulout sites; 19,593 in the Gulf of Alaska and 14,463 in the Bering Sea/Aleutian Islands. Most of the data represented in the aggregate 2008-2012 non-pup count was collected in the 2011 survey (29,705 non-pups on 114 of the largest sites). Twenty-three (23) sites in the central and western Aleutian Island were surveyed in 2012 and had a total of 1,240 non-pups. Sites that were not surveyed in 2011 or 2012 contributed less to the aggregate 2008-2012 total: 553 non-pups on 46 sites last surveyed in 2008, 152 non-pups on 1 site last surveyed in 2009, and 2,406 non-pups on 85 sites last surveyed in 2010. The composite pup count of the western stock in Alaska from 2009-2012 totaled 11,603. Most of the data represented in the aggregate 2009-2012 pup count were collected in 2011 (10,418 pups on 73 sites) and 2012 (200 pups on 5 sites), with the remainder collected in 2009 (273 pups on 6 sites) and~~

~~2010 (712 pups on 4 sites). There were 6,034 pups counted in the Gulf of Alaska and 5,569 pups counted in the Bering Sea/Aleutian Islands.~~

The most recent comprehensive aerial photographic and land-based surveys of western Steller sea lions in Alaska were conducted in 2008-2013 (Fritz et al. 2013; DeMaster 2014). An estimate of the total population size of western Steller sea lions in Alaska ~~may~~can be obtained by multiplying the best estimate of total pup production ~~(11,603)~~ by 4.5 (Calkins and Pitcher 1982)~~, which yields approximately 52,200~~. Total pup production in Alaska in 2013 was estimated to be 12,316 (95% credible interval: 11,741-12,926) using a Bayesian hierarchical model, agTrend (Johnson and Fritz in review) and 2013 survey results (DeMaster 2014), when multiplied by 4.5, yields a total population estimate of 55,422 (95% credible interval: 52,834-58,167). This is not a minimum abundance estimate since it is an extrapolated total population size from pup counts based on survival and fecundity estimates ~~in a life table. The 4.5 multiplier may not be appropriate for use in estimating the abundance of the western stock, as it is based on a life history table using vital rates (age-specific fecundity and survival) for the stable, mid-1970s population sampled in the central Gulf of Alaska.~~for an assumed stable, mid-1970s central Gulf of Alaska population (Figure 2; Calkins and Pitcher 1982) and may not be appropriate for use in estimating the abundance of the Alaskan western stock as a whole given the considerable regional variation in current trends: populations east of Samalga Pass are generally increasing, while those to the west are decreasing (Figure 2; Fritz et al. 2013; DeMaster 2014). Vital rates of Steller sea lions in the central Gulf of Alaska may have changed considerably since the mid-1970s as the population declined through the 1980s and 1990s and has been slowly increasing~~ relatively stable~~ in the 2000s (York 1994, Holmes and York 2003, Fay and Punt 2006, Pendleton et al. 2006, Winship and Trites 2006, Holmes et al. 2007, Demaster 2014). For the increasing eastern stock of Steller sea lion, Pitcher et al. (2007) showed that the multiplier could range between 4.2 and 5.2 depending on the combination of changes to survival and natality.

~~Factors that caused the population decline, particularly those that contributed to lower rates of juvenile survival, were likely quite different from those that are now affecting recovery (e.g., factors that may by impacting reproductive rates of adult females; Holmes and York 2003, Fay and Punt 2006, Winship and Trites 2006, 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 Alaska Fisheries Science Center, NMML, 7600 Sand Point Way, 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 and yields a total population abundance estimate of 27,100 Steller sea lions using the 4.5 multiplier.

An estimate of the abundance of the entire (U.S. and Russia) western stock of Steller sea lions (pups and non-pups) can be made by adding the most recent estimates of U.S. and Russian pups production~~counts~~, and multiplying by 4.5 (~~11,603~~12,316 + 6,021 = ~~17,624~~18,337 pups × 4.5), which yields ~~79,300~~82,516.

Minimum Population Estimate

Because of the uncertainty regarding the use of the pup multipler to estimate N, we will use the best estimate of the total count of western Steller sea lions in Alaska as the minimum population estimate (N_{MIN}). The agTrend (Johnson and Fritz in review) estimates (with 95% credible intervals) of western Steller sea lion pup and non-pup counts in 2013 in Alaska are 12,316 (11,741-12,926) and 36,360 (34,469-38,271), respectively, which total 48,676, ~~The 2008-2012 aggregate total count of non-pups (34,056) plus the number of pups in 2009-2012 (11,603) is 45,659,~~ and will be used as the minimum population estimate (N_{MIN}) for the U.S. portion of the western stock of Steller sea lion (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 1956-60. 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~~, Table 1~~). 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). ~~Between 1991 and 2000, overall counts of Steller sea lions at trend sites decreased 40% (Table 1), an average annual decline of 5.4% (Loughlin and York 2000). In the 1990s, counts decreased more at the western (western Aleutians; 65%) and eastern edges (eastern and central Gulf of Alaska; 56% and 42%, respectively) of the U.S. range than they did in the center (range of 24% to 6% from the central Aleutians through the western Gulf of Alaska) (Fritz et al. 2008).~~ 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. Continued declines in counts of western sea lions in Alaska in the 1990s (Sease et al. 2001) led NMFS to change the ESA listing status to endangered in 1997 (NMFS 2008). Surveys in Alaska in 2002, however, were the first to note an increase in counts, which suggested that the overall decline of western Steller sea lions stopped in 2000-2002 (Sease and Gudmundson 2002).

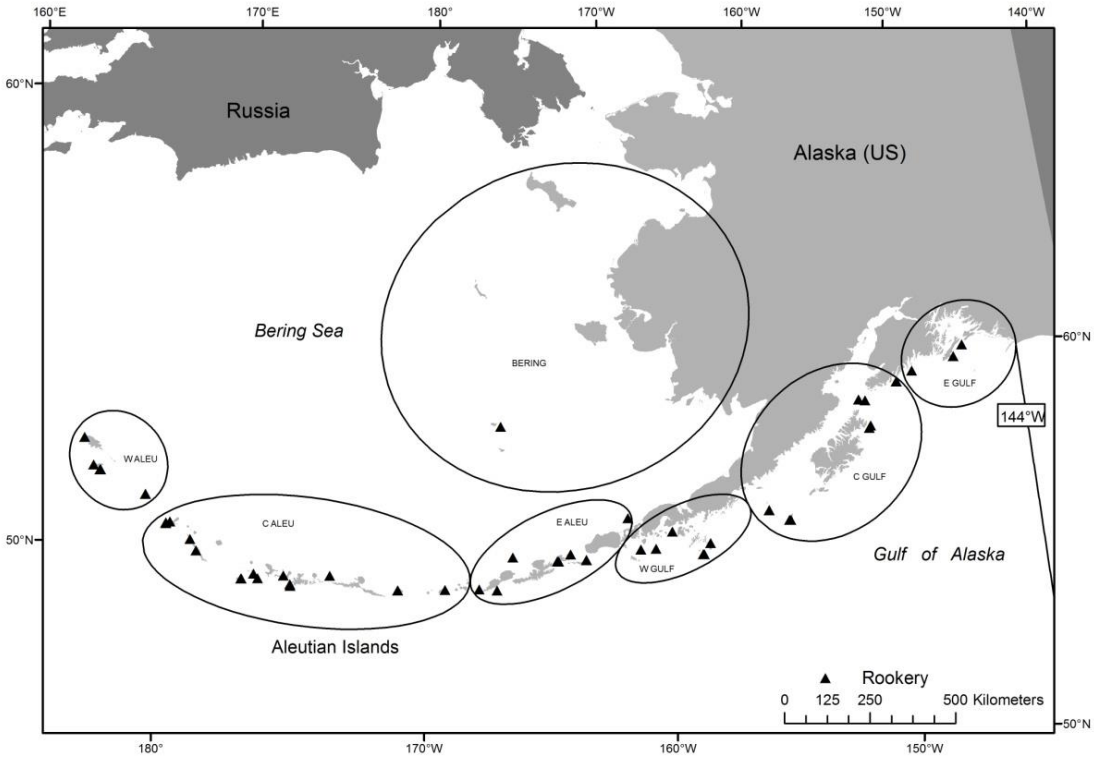

Figure 2. Regions of Alaska used for western Steller sea lion population trend estimation. E GULF, C GULF, and W GULF are eastern, central and western Gulf of Alaska regions, respectively. E ALEU, C ALEU, and W ALEU are eastern, central and western Aleutian Islands regions, respectively.

~~**Table 1.** Counts of adult and juvenile Steller sea lions observed at rookery and haulout trend sites surveyed consistently since the late 1970s by year and geographical area for the western U. S. stock (NMFS 1995, Sease et al. 2001, Fritz et al. 2008, NMFS 2008). Counts from 1976 to 1979 (NMFS 1995) were combined to produce complete regional counts that are comparable to the 1990-2008 data. Data from 2004 and 2008 reflect a 3.64% reduction from actual counts to account for improvements in survey protocol in 2004 relative to previous years (Fritz and Stinchcomb 2005).~~

~~**Area**~~	~~**late 1970s**~~	~~**1990**~~	~~**1991**~~	~~**1992**~~	~~**1994**~~	~~**1996**~~	~~**1998**~~	~~**2000**~~	~~**2002**~~	~~**2004**~~	~~**2008**~~
~~Gulf of Alaska~~	~~65,296~~	~~16,409~~	~~14,598~~	~~13,193~~	~~11,862~~	~~9,784~~	~~8,937[1]~~	~~7,995~~	~~9,087~~	~~8,993~~	~~10,931~~
~~Bering Sea/Aleutians~~	~~44,584~~	~~14,116~~	~~14,807~~	~~14,106~~	~~12,274~~	~~12.426~~	~~11,501~~	~~10,330~~	~~10,253~~	~~11,507~~	~~10,559~~
~~Total~~	~~109,880~~	~~30,525~~	~~29,405~~	~~27,299~~	~~24,136~~	~~22,210~~	~~20,438[1]~~	~~18,325~~	~~19,340~~	~~20,500~~	~~21,489~~

~~[1]Identifies 637 non-pups counted at six trend sites in 1999 in the eastern Gulf of Alaska which were not surveyed in 1998.~~

Johnson and Fritz (in ~~prep~~2014) developed agTrend to estimate~~d~~ regional and overall trends in counts of pups and non-pups in Alaska ~~western stock non-pup counts~~ using data collected at all sites with more than two non-zero counts ~~between 1990 and 2012~~, rather than relying solely on counts at 'trend' sites (see also Fritz et al. ~~in prep~~2013). ~~Their method uses data collected at a larger group of sites than those designated previously as 'trend' sites, and uses the magnitude and variance observed at each site to estimate counts for years when the site was not surveyed. A model was developed to estimate individual site-year counts for missing years and counts were summed by region and stock for each of 10,000 iterations. Regional and stock-wide trends and variances for 2000-2012 were obtained from the median and variance of the posterior predictive distribution (Table 2; Johnson and Fritz, in prep). Overall~~Using agTrend with data collected through 2013, there ~~was~~is strong evidence that non-pup counts ~~in the~~of western stock Steller sea lions in Alaska increased between 2000 and 201~~2~~3 (Table 1; DeMaster 2014)~~average rate of 1.67% y^{-1}; 95% credible interval of 1.01% y^{-1} and 2.38% y^{-1}~~). However, there ~~were~~are strong regional differences across the range in Alaska, with ~~strong evidence of a~~ positive trends east of Samalga Pass (~170°W) ~~(2.89% y^{-1}; 2.07-3.80% y^{-1})~~ and ~~strong evidence of a decreasing~~negative trends to the west (Table 1; Figure 2)~~(-1.53% y^{-1}; -2.35% y^{-1} to -0.66% y^{-1})~~.

Regional variation in trends in pup counts in 2000-2013 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 eest 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 three of the four regions, but were stable in the central Gulf of Alaska. 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 sea lions have responded to meso-scale (on the order of 100s of kms) variability in their environment.

Table 1. Trends (annual rates of change expressed as % $y^{-1}$with 95% credible interval) in counts of western Steller sea lion non-pups (adults and juveniles) and pups in Alaska, by region, for the period 2000-2012 (Johnson and Fritz, in prep).

		Non-pups				**Pups**		
Region	**Latitude Range**	**Trend**	**-95%**	**+95%**		**Trend**	**-95%**	**+95%**
Western Stock in Alaska	144°W-172°E	1.67	1.01	2.38		1.45	0.69	2.22
E of Samalga Pass	144°-170°W	2.89	2.07	3.80		--	--	--
Eastern Gulf of Alaska	144°-150°W	4.51	1.63	7.58		3.97	1.31	6.50
Central Gulf of Alaska	150°-158°W	0.87	-0.34	2.18		1.48	-0.56	3.30
E-C Gulf of Alaska	144°-158°W	2.40	0.92	3.86		--	--	--
Western Gulf of Alaska	158°-163°W	4.01	2.49	5.42		3.03	1.06	5.20
Eastern Aleutian Islands	163°-170° W	2.39	0.92	3.94		3.30	1.76	4.83
W Gulf & E Aleutians	158°-170°W	3.22	2.19	4.25				
W of Samalga Pass	170°W-172°E	-1.53	-2.35	-0.66		--	--	--
Central Aleutian Islands	170°W-177°E	-0.56	-1.45	0.43		-0.46	-1.50	0.72
Western Aleutian Islands	172°-177°E	-7.23	-9.04	-5.56		-9.36	-10.93	-7.78

The distribution of sightings of branded animals during the breeding season from 2001 to 2011 indicates an average annual net movement of sea lions from the central to the eastern Gulf of Alaska, which could have depressed trend estimates in the former and increased trend estimates in the latter region (Fritz et al. 2013), but non-pup counts in the combined eastern-central Gulf of Alaska region increased at 3.23% y^{-1} (2.00-4.50% y^{-1}) between 2000 and 2013 (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).

~~The distribution of sightings of branded animals during the breeding season from 2001 to 2011 indicates an average annual net movement of sea lions from the central to the eastern Gulf of Alaska, which could have depressed trend estimates in the former and increased trend estimates in the latter region (Fritz et al. in preparation A); non-pup counts in the combined eastern-central Gulf of Alaska region increased at 2.40% y^{-1} (0.92-3.86% y^{-1}) between 2000 and 2012. West of Samalga Pass, trends in non-pup counts between 2000 and 2012 were largely negative, and were increasingly negative to the west. Non-pup counts were essentially stable (slow decline at -0.56% y^{-1}; -1.45% y^{-1} to 0.43% y^{-1}) in the central Aleutian Islands, but there is strong evidence of a steep decline (-7.23% y^{-1}; -9.04% y^{-1} to -5.56% y^{-1}) in the western Aleutian Islands. 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. (~~in prep-A~~2013) estimated the magnitude of cross-boundary movement of Steller sea lions between the western and eastern stocks using ~~the following information:~~ transition probabilities of individually marked sea lions by sex, age and region estimated by Jemison et al. (~~in prep~~2013); survival rates by age, sex and region estimated by Hastings et al. (2011) and Fritz et al. (in ~~prep-B~~review); and pup production by region based on aerial surveys conducted in 2009~~(Fritz et al. in prep-A)~~. ~~Transition probabilities and survivorship were based on sightings of sea lions branded as pups within both stocks.~~ 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, and would have a negligible impact on non-pup trend estimates in either area. However, there were significant differences by sex and age in the cross-boundary movement, with a net increase of ~400 females in southeast Alaska (eastern stock) and a net increase of ~600 males in the western stock. The pattern of movement is supported by mitochondrial DNA evidence that indicated that the newest rookeries in northern southeast Alaska (eastern stock) were colonized in part by western females (Gelatt et al. 2007).

~~Regional variation in trends in pup counts in 2000-2012 is similar to that of non-pup counts (Johnson and Fritz, in preparation; Table 2). Overall, there is strong evidence that pup counts in the western stock in Alaska increased (1.45% y^{-1}; 0.69-2.22% y^{-1}). Pup counts declined steeply in the western Aleutian Islands (-9.36% y^{-1}; -10.93% y^{-1} to -7.78% y^{-1}), but were stable (declining slowly) in the central Aleutian Islands (-0.46 % y^{-1}; -1.50% y^{-1} to 0.72% y^{-1}). As with non-pup counts, there is a west-east cline in pup trends in the central Aleutians, with declining counts in the western central Aleutians (RCA 2: -4.83% y^{-1} [-7.32% y^{-1} to -2.04% y^{-1}]; RCA 3: -1.74% y^{-1} [-3.37% y^{-1} to -0.13% y^{-1}]) and stable (slowly increasing) counts in the eastern central Aleutians (RCA 4: 2.56% y^{-1} [0.15% y^{-1} to 5.39% y^{-1}]; RCA 5: 0.45% y^{-1} [-1.48% y^{-1} to 2.48% y^{-1}]). In three of the four regions east of Samalga Pass (eastern Aleutian Islands, and eastern and western Gulf of Alaska), there is strong evidence that pup counts increased (all >3% y^{-1}), but were stable (increasing slowly; 1.48% y^{-1} [0.56% y^{-1} to 3.30% y^{-1}]) in the central Gulf of Alaska. 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 sea lions have responded to meso-scale (on the order of 100s of kms) variability in their environment.~~

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, pers. comm.) indicates that overall Steller sea lion abundance in Russia has continued to increase and is now similar to the 1960s (27,100 based on life table multiplier of 4.5 on the most recent total pup count). Between 1995 and 2011/12, pup production has increased overall in Russia by 3.1% per year (Vladimir 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. Pup production in the combined Kuril Islands and the Sea of Okhotsk areas increased 59% between 1995-97 (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, 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 Commanders increased to a maximum of 280 in 1998 and has varied between 180 and 228 since then (through 2012). Non-pup counts on the Commanders also reached a ~~recent~~ maximum in 1998-99 (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 either stable or declining (eastern Kamchatka, Commander Islands and the western Bering Sea) border regions in the United States where sea lion trends are similar (Aleutian Islands west of 170W).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of 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 Endangered Species Act (Wade and Angliss 1997). Thus, for the U.S. portion of the western stock of Steller sea lions, PBR = ~~274~~292 animals (~~45,659~~48,676 × 0.06 × 0.1).

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

~~Until 2003, there were six different federally regulated commercial fisheries in Alaska that could have interacted with Steller sea lions. These fisheries were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these 6 fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska.~~ Between ~~2007-2011~~2008-2012, there were incidental serious injuries and mortalities of western Steller sea lions observed in the following 8 fisheries of the 22 federally regulated commercial fisheries in Alaska monitored for incidental mortality 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, ~~and~~ Gulf of Alaska Pacific cod trawl, Gulf of Alaska Pacific cod longline, and Gulf of Alaska sablefish longline (Table 2a).

Observers also monitored the Prince William Sound salmon drift gillnet fishery in 1990 and 1991, recording 2 mortalities in 1991, extrapolated to 29 (95% CI: 1-108) kills for the entire fishery (Wynne et al. 1992). No mortalities were observed during 1990 for this fishery (Wynne et al. 1991), resulting in a mean kill rate of 14.5 (CV = 1.0) animals per year for 1990 and 1991. In 1990, observers boarded 300 (57.3%) of the 524 vessels that fished in the Prince William Sound salmon drift gillnet fishery, monitoring a total of 3,166 sets, or roughly 4% of the estimated number of sets made by the fleet. In 1991, observers boarded 531 (86.9%) of the 611 registered vessels and monitored a total of 5,875 sets, or roughly 5% of the estimated sets made by the fleet (Wynne et al. 1992). The Alaska Peninsula and Aleutian Islands salmon drift gillnet fishery was also monitored during 1990 (roughly 4% observer coverage) and no Steller sea lion mortalities were observed. It is not known whether these incidental mortality levels are representative of the current incidental mortality levels in these fisheries.

An observer program for the Cook Inlet salmon set and drift gillnet fisheries was implemented in 1999 and 2000 in response to the concern that there may be significant numbers of marine mammal injuries and mortalities that occur incidental to these fisheries. Observer coverage in the Cook Inlet drift gillnet fishery was 1.75% and 3.73% in 1999 and 2000, respectively. The observer coverage in the Cook Inlet set gillnet fishery was 7.3% and 8.3% in 1999 and 2000, respectively (Manly 2006). There were no mortalities of Steller sea lions observed in the set or drift gillnet fisheries in either 1999 or 2000 (Manly 2006). An observer program conducted for a portion of the Kodiak drift gillnet fishery in 2002 did not observe any serious injuries or mortalities of Steller sea lions, although Steller sea lions were frequently observed in the vicinity of the gear (Manly et al. 2003).

Combining the mortality estimates from the Bering Sea groundfish trawl and Gulf of Alaska longline fisheries presented above (~~15.1~~17.0) with the mortality estimate from the Prince William Sound salmon drift gillnet fishery (14.5) results in an estimated mean annual mortality rate in the observed fisheries of ~~29.6~~31.5 (CV = ~~0.49~~0.46) sea lions per year from this stock (Table 2).

Table 2. Summary of incidental mortality of Steller sea lions (western U. S. stock) due to fisheries from ~~2007~~2008 through ~~2011~~2012 (or most recent data available) and calculation of the mean annual mortality rate (Breiwick 2013). Mean annual mortality in brackets represents a minimum estimate from stranding data. The most recent 5 years of available data, or best available information, are used in the mortality for a particular fishery. N/A indicates that data are not available. Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	**Years**	**Data type**	**Observer coverage**	**Observed mortality (in given yrs.)**	**Estimated mortality (in given yrs.)**	**Mean annual mortality**
Bering Sea/Aleutian Is. Atka mackerel trawl	~~2007~~	obs	~~94~~	~~0~~	~~0~~	0.20
	2008	data	100	0	0	(CV = 0.05)
	2009		99	0	0	
	2010		100	1	1.0	
	2011		100	0	0	
	2012		100	0	0	
Bering Sea/Aleutian Is. flatfish trawl	~~2007~~	obs	~~72~~	~~3 (+1)*~~	~~3.7 (4)**~~	~~6.0~~6.41
	2008	data	100	11	11.0	(CV = ~~0.03~~0.01)
	2009		100	3	3.0	
	2010		100	4 (+1)*	4.0 (+1)**	
	2011		100	7	7.0	
	2012		100	6	6.0	
Bering Sea/Aleutian Is. Pacific cod trawl	~~2007~~	obs	~~53~~	~~1 (+2)*~~	~~1.0 (3)**~~	~~1.0~~0.4
	2008	data	59	0	0	(CV = ~~0.07~~0.06)
	2009		63	0	0	
	2010		66	1	1.0	
	2011		60	1	1.0	
	2012		68	0	0	
Bering Sea/Aleutian Is. pollock trawl	~~2007~~	obs	~~85~~	~~2~~	~~2.0 (+1)~~[1]	~~7.36~~8.18
	2008	data	85	8	10.1	(CV = ~~0.11~~0.09)
	2009		86	6	6.2	
	2010		86	5	8.2	
	2011		98	9	9.3	
	2012		98	7	7.0	
Gulf of Alaska Pacific cod longline	~~2007~~	obs	~~20~~	~~0~~	~~0~~	0.54
	2008	data	15	1	1.6	(CV = 0.39)
	2009		21	0	0	
	2010		28	1	1.1	
	2011		30	0	0	
	2012		13	0	0	

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Gulf of Alaska Pacific cod trawl	2008 2009 2010 2011 2012	obs data	15 29 31 41 25	0 0 0 0 1	0 0 0 0 1.0	0.2 (CV = 0.0)
Gulf of Alaska sablefish longline	2008 2009 2010 2011 2012	obs data	16 16 15 14 14	0 0 0 0 1	0 0 0 0 5.5	1.1 (CV = 0.91)
Prince William Sound salmon drift gillnet	1990-1991	obs data	4-5%	0 2	0 29	14.5 (CV = 1.0)
Prince William Sound salmon set gillnet	1990	obs data	3%	0	0	0
Alaska Peninsula/Aleutian Islands salmon drift gillnet	1990	obs data	4%	0	0	0
Cook Inlet salmon set gillnet[1]	1999-2000	obs data	2-5%	0 0	0, 0	0
Cook Inlet salmon drift gillnet[1]	1999-2000	obs data	2-5%	0 0	0, 0	0
Kodiak Island salmon set gillnet	2002	obs data	6.0%	0	0	0
Minimum total annual mortality						~~29.6~~31.5 (CV = ~~0.49~~0.46)

~~[1] Animal reported to Alaska Regional Office stranding program; however, it was not documented in the Observer Program data. This observation is being added to the estimated mortality since it is not accounted for in the extrapolated value (Table 2b).~~
[~~2~~1] Data from the 1999 Cook Inlet observer program are preliminary.
*Total mortalities observed in unsampled hauls.
**Total mortalities observed in sampled and unsampled hauls is in parentheses. In cases where the total known mortality exceeds the estimated mortality for a fishery in given year, the sum of observed mortalities (both in sampled and unsampled hauls) will be used as a minimum estimate for that year.

Reports from the NMFS stranding database of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality data. During the 5-year period from ~~2007~~2008 to ~~2011~~2012, there were ~~four~~six confirmed fishery-related Steller sea lion strandings in the range of the western stock. ~~Two~~Five sightings involved a Steller sea lion that was reported to be in bad body condition and observed with a flasher lure hanging from its mouth; it was believed to have ingested the hook (Table 3). ~~One animal was found on a Bering Sea/ Aleutian Islands pollock trawl vessel while offloading the catch, which was not accounted for in the estimated mortality for this fishery, and a~~Another ~~with~~had a string leader line hanging out its mouth with a hook apparently inside the mouth. Fishery-related strandings during ~~2007-2011~~2008-2012 resulted in an estimated annual mortality of ~~0.8~~1.2 animals from this stock. This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found or reported. Steller sea lions reported in the stranding database as shot are not included in this estimate, as they may result from animals struck and lost in the Alaska Native subsistence harvest.

Table 3. Summary of western Steller sea lion mortalities and serious injuries by year and type reported to the NMFS Alaska Regional Office, marine mammal stranding database, and Alaska Department of Fish and Game for the ~~2007-2011~~2008-2012 period (Allen et al. 2014, Allen ~~and Helker~~et al. in prep).

Cause of Injury	~~2007~~	2008	2009	2010	2011	2012	Mean Annual Mortality
Swallowed troll gear	~~0~~	0	1	0	1	3	~~0.4~~ 1

~~Caught in BSAI pollock trawl~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
~~Gaff puncture wound~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~		~~0.2~~
Ring neck entanglement (packing band)		5	1	2	0	1	1.8
Ring neck entanglement (unknown marine debris / gear)	~~0~~	~~0~~ 1	~~0~~	~~1~~ 3	~~0~~ 1	1	~~0.2~~ 1.2
Swallowed unknown fishing gear	~~0~~	0	0	1	0	0	0.2

Minimum total annual mortality	~~1.2~~ 4.2

NMFS studies using satellite tracking devices attached to Steller sea lions suggest that they rarely go beyond the U.S. Exclusive Economic Zone into international waters. Given that the high-seas gillnet fisheries have been prohibited and other net fisheries in international waters are minimal, the probability that Steller sea lions are taken incidentally in commercial fisheries in international waters is very low. NMFS concludes that the number of Steller sea lions taken incidental to commercial fisheries in international waters is insignificant.

The minimum estimated mortality rate incidental to U. S. commercial fisheries is ~~29.6~~31.5 sea lions per year. Based on observer data (~~29.6~~31.5) and stranding data (~~0.8~~1.2), the minimum estimated mortality rate incidental to commercial and recreational fisheries, as well as other marine debris, is ~~30.4~~32.7. Observer data on state fisheries dates as far back as 1990; 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 making the estimated mortality likely an ~~minimum~~ underestimate of the actual mortality level.

Subsistence/Native Harvest Information

Information on the subsistence harvest of Steller sea lions comes via two sources: the Alaska Department of Fish and Game (ADFG) and the Ecosystem Conservation Office (ECO) of the Aleut Community of St. Paul. The ADFG conducted systematic interviews with hunters and users of marine mammals in approximately 2,100 households in about 60 coastal communities within the range of the Steller sea lion in Alaska (Wolfe et al. 2005). 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 collected. Data are being collected periodically in subareas. Therefore, the most recent 5-years of data (2004-2008) will be retained and used for estimating an annual mortality estimate for all areas except St. Paul. Data from St. Paul are still being collected and will be updated with the most recent 5-year period 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 et al. 2010). Information on subsistence harvest levels is provided in Table 4; data from ECO (e.g., Zavadil et al. 2010) are relied upon as the source of data for St. Paul Island and all other data are from the ADFG (e.g., Wolfe et al. 2005). Data were collected on Alaska Native harvest of Steller sea lions for 7 communities on Kodiak Island for 2011; the Alaska Native Harbor Seal Commission and ADFG 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 2004-2008.

The mean annual subsistence take from this stock over the 5-year period from 2004 through 2008, combined with the mean take over the 2007-2011 period from St. Paul, was 199 Steller sea lions/year (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 collected. Therefore, the most recent 5-years of data (2004-2008) will be retained and used for estimating an annual mortality estimate for all areas except St. Paul. Data from St. Paul are still being collected and will be updated with the most recent 5-year period available (2007-2011).

	All areas except St. Paul Island			**St. Paul Island**	
Year	**Number harvested**	**Number struck and lost**	**Total**	**Number harvested + struck and lost**	**Total take**
2004	136.8	49.1	185.9[1]		
2005	153.2	27.6	180.8[2]		

2006	114.3	33.1	147.4[3]		
2007	165.7	45.2	210.9[4]	34[8]	245
2008	114.7	21.6	136.3[5]	22[9]	158
2009	N/A	N/A	N/A	26[10]	N/A
2010	N/A	N/A	N/A	20[9]	N/A
2011	N/A	N/A	N/A	32[10]	N/A
Mean annual take	136.9	35.3	172.3	26.8	199

[1]Wolfe et al. 2005; [2]Wolfe et al. 2006; [3]Wolfe et al. 2008; [4]Wolfe et al. 2009a; [5]Wolfe et al. 2009b; ~~[6,7]~~ [8]Lestenkof et al. 2008, [9]Jones 2009, [10]Zavidil 2010, [9]Lestenkof 2011, [10]Lestenkof 2012.

Other Mortality

Reports from the NMFS stranding database of Steller sea lions entangled in marine debris or with injuries caused by other types of human interaction are another source of mortality data. During the 5-year period from ~~2007~~2008 to ~~2011~~2012, ~~one~~ 15 animals were observed with circumferential neck entanglements from packing bands or other unknown marine debris~~, animal possessed a circumferential neck entanglement of unknown marine debris, and presented with a gaff puncture wound~~ (Table 3). The mean annual mortality and serious injury from other sources of human interactions for ~~2007-2011~~2008-2012 is ~~0.4~~3.0.

~~Illegal shooting of sea lions was thought to be a potentially significant source of mortality prior to the listing of sea lions as "threatened" under the U.S. Endangered Species Act (ESA) in 1990. Such shooting has been illegal since the species was listed as threatened. (Note: the 1994 Amendments to the MMPA made intentional lethal take of any marine mammal illegal except for subsistence take by Alaska Natives or where imminently necessary to protect human life). Records from NMFS enforcement indicate that there were two cases of illegal shootings of Steller sea lions in the Kodiak area in 1998, both of which were successfully prosecuted (NMFS, Alaska Enforcement Division). There have been no cases of successfully prosecuted illegal shootings between 1999 and 2003 (NMFS, Alaska Enforcement Division).~~

Mortalities 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 ~~2006-2010~~2008-2012, there was a total of 0 mortalities resulting from research on the western stock of Steller sea lions (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

The current annual level of incidental U. S. commercial fishery-related mortality (~~29.6~~31.5) exceeds 10% of the PBR (~~27~~29) and, therefore, cannot be considered insignificant and approaching a zero mortality and serious injury rate. Based on available data, the estimated annual level of total human-caused mortality and serious injury (~~29.6~~31.5 [commercial fisheries] + ~~0.8~~4.2 [unknown fisheries and marine debris] + 199 [Alaska Native harvest] + ~~0.4~~3.0 [other human-interaction] = ~~229.8~~237.7) is below the PBR level (~~274~~292) for this stock. The western U. S. stock of Steller sea lion 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 level of direct human-caused mortality.

Demographic criteria for down- and de-listing western Steller sea lions under the ESA are based primarily on population trend estimates rather than absolute abundance thresholds (NMFS 2008). This is due to the uncertainties related to estimating total population size based on a life table (e.g., a multiplier of total pup production) or using a proportion hauled out to estimate animals at sea during surveys. For down-listing to threatened status, the western stock in Alaska should have had a significantly positive trend in abundance for 15 years (beginning in 2000), trends in 5 of the 7 sub-regions (three each in the Aleutian Islands and Gulf of Alaska plus all of Russia) should be consistent with the overall Alaska western stock trend, and no two adjacent sub-regions should have significant negative abundance trends. Using data collected through 2012, Fritz et al. (2013) concluded that the western stock in Alaska may be on a trajectory to satisfy the first demographic criterion for down-listing if the overall counts continue to increase through 2015. The second and third demographic criteria, however, involve regional population performance, which has varied across the range. The western stock may satisfy the second criterion if counts in the eastern, central and western Gulf of Alaska, eastern Aleutian Islands, and Russia (overall) continue to increase through 2015, but satisfying the third criterion by 2015 will likely depend on an improvement in central Aleutian Island trends.

Habitat Concerns

~~The decline in the western U. S. stock of Steller sea lion caused a change in the listing status of the stock in 1997 from "threatened" to "endangered" under the U. S. Endangered Species Act of 1973. Survey data collected since 2000 indicate that the decline continues in the central and western Aleutian Islands but that regional populations east of Samalga Pass have increased or are stable.~~ Many factors have been suggested as causes of the steep decline in abundance of western Steller sea lions observed in the 1980s, including~~(e.g.,~~ competitive effects of fishing, environmental change, disease, killer whale predation, incidental take, illegal and legal shooting (Atkinson et al. 2008; NMFS 2008). ~~Decreases in rates of survival, particularly for juveniles, were associated with the steep 1980s declines (Holmes et al. 2007). Factors causing direct mortality were likely the most important. The slowing of the decline in the 1990s, and the periods of increase and stability observed between 2000 and 2008 were associated with increases in survival of both adults and juveniles, but also with continuation of a chronic decline in reproductive rate that may have been initiated in the early 1980s (Pitcher et al. 1998, Holmes et al. 2007). Nutritional stress related to competition with commercial fisheries or environmental change, along with predation by killer whales, have been identified as potentially important threats to recovery (NMFS 2008). Additional p~~Potential threats to Steller sea lion recovery are shown in Table 5. A number of management actions have been implemented between 1990 and 2011 to promote the recovery of the western U. S. stock of Steller sea lions, including 3 nautical mile (nmi) no-entry zones around rookeries, prohibition of shooting at or near sea lions, and regulation of fisheries for sea lion prey species (e.g., walleye pollock, Pacific cod and Atka mackerel; see reviews by Fritz et al. 1995; McBeath 2004; Atkinson et al. 2008; NMFS 2008).

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

~~A number of management actions were implemented between 1990 and 1998 to promote the recovery of the western U. S. stock of Steller sea lions, including 3 nautical mile (nmi) no-entry zones around rookeries, prohibition of groundfish trawling within 10-20 nmi of certain rookeries, and spatial and temporal allocation of Gulf of Alaska pollock and Aleutian Island Atka mackerel total allowable catch. In 2000, NMFS issued a Biological Opinion (BO) on effects of the groundfish fisheries in the Bering Sea/Aleutian Islands and Gulf of Alaska regions on listed species. In this BO, NMFS determined that the continued prosecution of the groundfish fisheries as described in the Fishery Management Plan for Bering Sea/Aleutian Islands Groundfish and in the Fishery Management Plan for Gulf of Alaska Groundfish was likely to jeopardize the continued existence of the western population of Steller sea lion and to adversely modify critical habitat. NMFS also identified several other factors that could contribute to the decline of the population, including a shift in the large-scale weather regime and~~

~~predation. To avoid jeopardy, NMFS identified a Reasonable and Prudent Alternative that included components such as 1) adoption of a more precautionary rule for setting "global" harvest limits, 2) extension of 3 nmi protective zones around rookeries and haulouts not currently protected, 3) closures of many areas around rookeries and haulouts to 20 nmi, 4) establishment of four seasonal and area catch limits, and 5) establishment of a procedure ("fishing in proportion to biomass") for setting seasonal catch limits on removal levels in critical habitat based on the biomass of the target species residing in critical habitat.~~

~~In 2001, NMFS developed a programmatic SEIS to consider the impacts on Steller sea lions of different management regimes for the Alaska groundfish fisheries. A committee composed of 21 members from fishing groups, processor groups, Alaska communities, environmental advocacy groups, and NMFS representatives met to recommend conservation measures for Steller sea lions and to develop a "preferred alternative" for the SEIS. Although consensus was not reached, a "preferred alternative" was identified and included in the SEIS. The preferred alternative included complicated, area-specific management measures (e.g., area restrictions and closures) designed to reduce direct and indirect interactions between the Atka mackerel, pollock, and Pacific cod fisheries and Steller sea lions, particularly in waters within 10 nmi of haulouts and rookeries. The suite of conservation measures, which were implemented in 2002, were developed after working with the: 1) State of Alaska to explore whether there are potential adverse effects of state fisheries on Steller sea lions, and 2) the North Pacific Fishery Management Council (Council) to further minimize overcapitalization of fisheries and concentration of fisheries in time and space. The 2002 suite of conservation measures also removed the broad prohibition of fishing with trawl gear within 10 (or 20) nmi of rookeries in the western stock in U.S. waters, and did not apply the "fishing in proportion to biomass" procedure for regulating seasonal catch for the three Steller sea lion prey species in the same manner as was initially applied in the 2000 BO. All Steller sea lion fishery management measures were reviewed in a programmatic, status quo ESA Biological Opinion on the effects of groundfish fisheries on listed species released in December 2010 (NMFS 2010). NMFS concluded that the groundfish fisheries in the Bering Sea/Aleutian Islands area and in the Gulf of Alaska, as managed in 2010 were likely to jeopardize the continued existence (recovery) and adversely modify the critical habitat of the western stock of Steller sea lion. In 2011, NMFS implemented interim final measures (reasonable and prudent alternatives to the status quo suite of fishery management regulations) that mitigate jeopardy and adverse modification: closure of the western Aleutian Islands region (170° 177°E) to directed fishing for Atka mackerel and Pacific cod, and additional measures in the central Aleutian Islands (170°W 177°E) to reduce catches of Atka mackerel and Pacific cod in critical habitat and disperse the fisheries temporally and spatially. The state of Alaska, along with some members of the groundfish fishing industry, challenged the conclusions of the 2010 Biological Opinion, the rationale for the measures enacted as part of the interim final rule (IFR), and the process that NMFS undertook to follow the National Environmental Policy Act (NEPA). The Court rejected the plaintiffs' ESA claims (upheld the 2010 Biological Opinion), but granted a summary judgment on their NEPA claims, requiring NMFS to complete an Environmental Impact Statement (EIS) by March 2014 that will consider alternatives to the IFR measures that will also mitigate jeopardy and adverse modification. NMFS, in collaboration with its partners at the North Pacific Fishery Management Council, is currently (in 2013) preparing an EIS for Steller sea lion protective measures in the Aleutian Islands, as well as a new ESA Biological Opinion that will also be finalized by March 2014. Any changes to Aleutian Island groundfish fishery regulations to manage fishery-Steller sea lion interactions would be enacted no sooner than January 2015.~~

CITATIONS

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

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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 Review. 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. ~~In review~~2013. North Pacific marine mammal bycatch estimation methodology and results, 2007-2011. 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. rep., U.S. Fish and Wildlife Service. Alaska Maritime National Wildlife Refuge, P.O. Box 5251, NSA Adak, FPO Seattle, WA 98791.

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

Calkins, D. G. 1985. Steller sea lion entanglement in marine debris. Pp. 308-314 *In* R. S. Shomura and H. O. Yoshida (editors), 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., E. Becker, T. R. Spraker, and T. R. Loughlin. 1994. Impacts on Steller sea lions. Pp. 119-139 *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez*. Academic Press, N.Y.

~~DeMaster, D. P. 2009. Aerial Survey of Steller Sea Lions in Alaska, June-July 2009 and Update on the Status of the Western Stock in Alaska. Memorandum to D. Mecum, K. Brix and L. Rotterman, December 2, 2009. Available AFSC, National Marine Mammal Laboratory, NOAA, NMFS 7600 Sand Point Way NE, Seattle WA 98115.~~

~~DeMaster, D. P. 2011. Results of Steller sea lion surveys in Alaska, June-July 2011. Memorandum to J. Balsiger, K. Brix, L. Rotterman, and D. Seagars, December 5, 2011. Available AFSC, National Marine Mammal Laboratory, NOAA, NMFS 7600 Sand Point Way NE, Seattle WA 98115.~~

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, January 27, 2014. Available AFSC, National Marine Mammal Laboratory, NOAA, 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. V. 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.

Fay, G. and A. E. Punt 2006. Modeling spatial dynamics of Steller sea lions (*Eumetopias jubatus*) using maximum likelihood and Bayesian methods: evaluating causes for population decline. Sea Lions of the World. S. K. A. A.W. Trites, D.P. DeMaster, L.W. Fritz, T.S. Gelatt, L.D. Rea, and K.M. Wynne Fairbanks, AK, Alaska Sea Grant College Program. AK-SG-06-01: 405-433.

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. 103:501-515.

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

Fritz, L. W., R. C. Ferrero, et al. 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. 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. 103:501-515.~~

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., and C. Stinchcomb. 2005. Aerial, ship and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in the western stock in Alaska, June and July 2003 and 2004. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-153, 56 p.~~

~~Fritz, L. W., K. Sweeney, C. Gudmundson, T. Gelatt, M. Lynn and W. Perryman. 2008. Survey of Adult and Juvenile Steller Sea Lions, June-July 2008. Memorandum to the Record, NMFS Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle WA 98115. http://www.afsc.noaa.gov/nmml/pdf/SSLNon-Pups2008memo.pdf.~~

Fritz, L., K.Sweeney, D. Johnson, M. Lynn, and J. Gilpatrick. ~~In prep A~~2013. Aerial and ship-based Ssurveys 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~~XXX~~, ~~YY~~91 p.

Fritz, L., R. Towell, T. S. Gelatt, and T. R. Loughlin. In ~~prep. B~~review. Temporal and regional changes in the survival of western Steller sea lions in Alaska. Endangered Species Review.

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

Harlin-Cognato, A., Bickham, J. W., Loughlin, T. R., and Honeycutt, R. L. 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(11): 1-21.

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

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

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

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*). Molec. Ecol. 15:2821-2832.

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

Holmes, E. E., and A. E. York. 2003. Using age structure to detect impacts on threatened populations case study using Steller sea lions. Conserv. Biol. 17:1794-1806.

Jemison, L. A., G. W. Pendleton, L. W. Fritz, K. K. Hastings, J. M. Maniscalco, A. W. Trites, and T. S. Gelatt. ~~In prep~~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. ~~In prep~~2014. agTrend: a Bayesian approach for estimating trends of aggregated abundance. Methods in Ecology and Evolution. 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, Alaska.

Kucey, L. 2005. Human disturbance and the hauling out behaviour of Steller sea lions (*Eumetopias jubatus*). M.Sc. thesis, University of British Columbia, Vancouver. 67 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 Program AK-SG-06-01.

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, Alaska.

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, Alaska.

Lestenkof, A. D., P. A. Zavadil, and D. J. Jones. 2008. 2007 subsistence harvest of Steller sea lion on St. Paul Island. Memorandum for the Record, March 4, 2008, Aleut Community of St. Paul, Tribal Government, Ecosystem Conservation Office. St. Paul Island, Pribilof Islands, Alaska.

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Pp. 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.

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.

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. Draft report to NMFS Alaska Region. 83 p.

Manly, B. F. J., A. S. Van Atten, K. J. Kuletz, and C. Nations. 2003. Incidental catch of marine mammals and birds in the Kodiak Island set gillnet fishery in 2002. Final report to NMFS Alaska Region. 91 p.

McBeath, J. 2004. Greenpeace v. National Marine Fisheries Service: Steller Sea Lions and Commercial Fisheries in the North Pacific. Alaska Law. Rev. 21: 1.

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.

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.

~~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 61and 70. NMFS Alaska Region, Protected Resources Division, Juneau, AK.~~

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

National Marine Fisheries Service. 2010. 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 61and 70. NMFS Alaska Region, Protected Resources Division, Juneau, AK.
http://www.fakr.noaa.gov/protectedresources/stellers/esa/biop/final/biop1210_chapters.pdf

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 pp. Available, National Marine Mammal Laboratory, AFSC, 7600 Sand Point Way, NE, Seattle, WA 98115.

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.

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. Canadian Journal of Zoology 84:1796-1809.

Pendleton, G. W., K. W. Pitcher, et al. 2006. Survival of Steller sea lions in Alaska: a comparison of increasing and decreasing populations. Can. J. Zool. 84(8): 1163-1172.

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

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. Occasional 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., D. G. Calkins, and G. W. Pendleton. 1998. Reproductive performance of female Steller sea lions: an energetics-based reproductive strategy? Can. J. Zool. 76:2075-2083.

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, 54p.

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.

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.

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, et al. 2012. Effects of research disturbance on the behavior and abundance of Steller sea lions (Eumetopias jubatus) at two rookeries in Alaska. Mar. Mamm. Sci. 28(1): E58-E74.

Winship, A. J. and A. W. Trites 2006. Risk of extirpation of Steller sea lions in the Gulf of Alaska and Aleutian Islands: a population viability analysis based on alternative hypotheses for why sea lions declined in western Alaska. Mar. Mamm. Sci. 22(1): 124-155.

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. Fish and Game, Juneau, AK, Subsistence Div. Tech. 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. Fish and Game, Juneau, AK, Subsistence Div. Tech. 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. Fish and Game, Juneau, AK, Subsistence Div. Tech. Paper No. 347. Juneau, AK.

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 Dep. Fish and Game, Juneau, AK, Subsistence Div. Tech. 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 Dep. Fish and Game, Juneau, AK, Subsistence Div. Tech. Paper No. 319. 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 Dep. Fish and Game, Juneau, AK, Subsistence Div. Tech. 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 Rept. NMFS/NOAA Contract 50ABNF000036. 65 pp. 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 Rept. NMFS/NOAA Contract 50ABNF000036. 53 pp. NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

York, A. E. 1994. The population dynamics of northern sea lions, 1975-1985. Marine Mammal Science 10(1): 38-51.

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

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, Alaska.

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. 3). ~~The species is not known to migrate, but~~Large numbers of individuals disperse widely outside of the breeding season (late May-early July), ~~thus potentially intermixing with animals from other areas (Sease and York 2003).~~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). 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 Alaska (Pitcher et al. 2007).

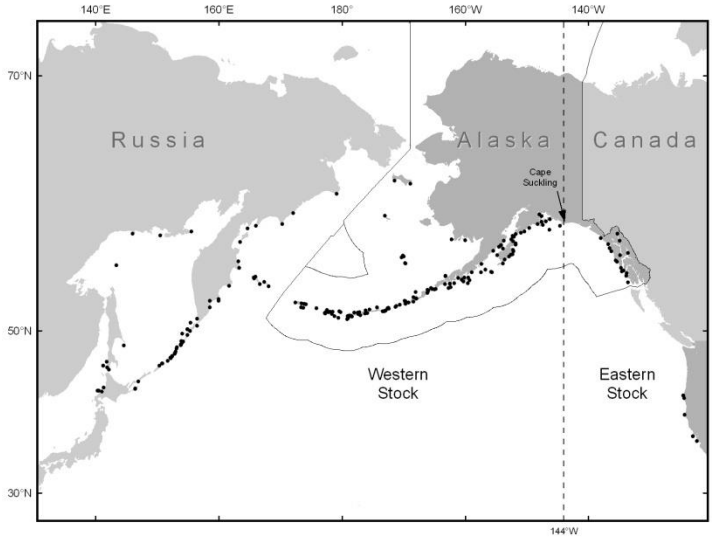

Figure 3. Approximate distribution of Steller sea lions in the North Pacific. Major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993) and active Asian haulouts and rookeries (Burkanov and Loughlin, 2005) are depicted (points). Black dashed line (144° W) indicates stock boundary (Loughlin 1997). Note: Haulouts and rookeries in British Columbia are not shown.

Loughlin (1997) and Phillips et al. (2009) considered the following information when classifying stock structure based upon 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 rookeries; 2) Population response data: substantial differences in population dynamics (York et al. 1996); 3) Phenotypic data: ~~unknown~~skull morphology (Phillips et al. 2009); 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. 3).

~~Steller sea lions that breed in Asia have been considered part of the western stock since the two stocks were first delineated in 1997. Since then, analyses of genetic data differ in their interpretation of separation between Asian and Alaskan sea lions. In Asian waters, Steller sea lions seasonally inhabit coastal waters of Japan in the winter, but breeding rookeries are currently only located in Russia (Burkanov and Loughlin 2005). 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 sea lions west of there in an Asian stock. However, Hoffman et al. (2006) did not support this split based on analysis of nuclear microsatellite markers indicating high rates of male gene flow.~~ All genetic analyses confirm a strong separation between western and eastern stocks and there may be sufficient morphological differentiation to support elevating the two recognized stocks to subspecies (Phillips et al. 2009) despite the observation that western stock haplotypes are present in substantial numbers at two northern southeast Alaska rookeries (Gelatt et al. 2007).

In 1998, a single Steller sea lion pup was observed on Graves Rock just north of Cross Sound in Southeast Alaska, and within 15 years (2013), pup counts had increased to 551 (DeMaster 2014). Mitochondrial and microsatellite analysis of pup tissue samples collected in 2002 revealed that approximately 70% of the pups had

mtDNA haplotypes that were consistent with those found in the western stock (Gelatt et al. 2007). Similarly, a rookery to the south on the White Sisters Islands where pups were first noted in 1990 was also sampled in 2002 and approximately 45% of those pups had western stock haplotypes. Collectively, this information demonstrates that these two most recently established rookeries in northern southeast Alaska have been partially to predominately established by western stock females. Movements of animals marked as pups in both stocks support these genetic results (Jemison et al.,2013).

Overall, however, the observations of marked sea lion movements corroborate the extensive genetics research findings for a strong separation between the two currently recognized stocks. Although recent colonization events in the northern part of the eastern DPS indicate movement of western sea lions into this area, the mixed part of the range remains small (Jemison et al. 2013), and the overall discreteness of the eastern from the western stock remains distinct. Hybridization among subspecies and species along a contact zone such as now occurs near the stock boundary is not unexpected as the ability to interbreed is a primitive condition whereas reproductive isolation would be derived. In fact as stated by NMFS and FWS in a 1996 response to a previous comment regarding stock discreteness policy (61 FR 47222), "*The Services do not consider it appropriate to require absolute reproductive isolation as a prerequisite to recognizing a distinct population segment*" or stock. The fundamental concept overlying this distinctiveness is the collection of morphological, ecological and behavioral, and genetic evidence for stock differences initially described by Bickham et al. (1996) and Loughlin (1997), and supported by Baker et al. (2005), Harlin-Cognato et al. (2006), Hoffman et al. (2006; 2009), O'Corry-Crowe et al, (2006), and Phillips et al. (2009; 2011).

POPULATION SIZE

The eastern stock of Steller sea lions breeds on rookeries located in southeast Alaska, British Columbia, Oregon, and California; there are no rookeries located in Washington. Counts of pups on rookeries conducted near the end of the birthing season are nearly complete counts of pup production. 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 pup counts available by region are 7,462 in 2009 for southeast Alaska (DeMaster 2009), 5,485 in 2010 for British Columbia (Olesiuk pers. comm., Dept. Fisheries and Oceans Canada, 04 December 2012; NMFS 2012), 1,418 in 2009 for Oregon (NMFS, unpublished data), and 673 in 2011 for California (NMFS unpublished data).~~ The most recent total eastern stock pup count is 14,317 and includes counts made between 2009 and 2013 (Table 6; 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 ~~63,160~~60,131 (~~15,038~~14,317 × 4.2) and ~~78,198~~74,448 (~~15,038~~14,317 × 5.2). These are not minimum population estimates, since they are extrapolated from pup counts from photographs taken ~~in 2009-2011~~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 were due to high fecundity, and as high as 5.2 if it were due to low juvenile mortality (Pitcher et al. 2007).

Minimum Population Estimate

The minimum population estimate was calculated by adding the most recent non-pup and pup counts from all sites surveyed (Table 6).

Table 6. 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)	2009	16,985	7,462	24,447
British Columbia (Canada)	2010	17,996	5,485	23,481
Washington (USA)		1,749	--	1,749
Oregon (USA)	2008	4,090	--	4,090
Oregon (USA)	2009	--	1,418	1,418
California (USA)	2011	2,108	673	2,781
~~N_{MIN} (entire eastern stock)~~Eastern		45,651	14,317	~~57,966~~59,968

stock, total				
~~N_{MIN} (U.S. portion of eastern stock)~~Eastern stock, U.S. portion only		27,719	8,832	~~34,485~~36,551

This results in an N_{MIN} for the eastern U. S. (only) stock of Steller sea lions of ~~34,485~~36,551 based on counts as old as ~~2008~~2009 for ~~sea lions hauled out in~~ Oregon pup counts (~~Oregon Dept. of Fish and Wildlife~~NMFS, unpublished data) to as recent as ~~2011~~2013 for Oregon and southeast Alaska~~sites in Washington and California~~. Including counts in British Columbia (Canada) yields an N_{MIN} for the entire eastern stock of ~~57,966~~59,968. These counts are considered minimum estimates of population size because they have not been corrected for animals at sea.

Current Population Trend

The best available information indicates the eastern stock of Steller sea lion increased at a rate of 4.18% per year (90% confidence bounds of 3.71 - 4.62% per year) between 1979 and 2010 based on an analysis of pup counts in California, Oregon, British Columbia and Southeast Alaska (NMFS 2013~~Eastern DPS Status review~~). A similar analysis of non-pup counts in the same regions plus Washington yielded an estimate of population increase of 2.99% per year (2.62-3.31% per year; NMFS 2013~~Eastern DPS Status review~~). Pitcher et al. (2007) reported that the eastern U.S. stock increased at a rate of 3.1% per year during a 25-year time period from 1977-2002; however, they used a slightly different method to estimate population growth than the methods reported in NMFS (~~2012~~2013). The eastern U.S. stock increase has been driven by growth in pup counts in all regions (NMFS ~~2012~~2013).

Steller sea lion numbers in California, especially in southern and central California, have declined from historic numbers. ~~C~~Non-pup counts in California ~~between 1927 and 1947~~ ranged between 4,000 and 6,000 ~~non-pups~~ with no apparent trend from 1927 and 1947, but have subsequently declined by over 50%, and were between 1,500 and 2,000 ~~non-pups during~~in the period 1980-2011. At Año Nuevo Island off central California, a steady decline in abundance~~ground counts started around~~began in 1970, and there was an 85% reduction in the breeding population by 1987 (LeBoeuf et al. 1991). Counts of non-pups ~~at trend sites~~ in California have been relatively stable, while those in Oregon and Washington have been increasing since ~~the~~ 1990.~~; n~~ Non-pup counts in southeast Alaska and British Columbia ~~have~~ increased steadily between 1990 and 2013, and comprise ~80% of the total eastern stockcount~~ more rapidly~~ (Table 7, Fig. 4).

Fritz et al. (2013) estimated the magnitude of cross-boundary movement of Steller sea lions between the 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. (in review); 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, and would have a negligible impact on non-pup trend estimates in either area. However, there were significant differences by sex and age in the cross-boundary movement, with a net increase of ~400 females in southeast Alaska (eastern stock) and a net increase of ~600 males in the western stock. The pattern of movement is supported by mitochondrial DNA evidence that indicated that the newest rookeries in northern southeast Alaska (eastern stock) were colonized in part by western females (Gelatt et al. 2007).

Table 7. 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 ~~2011~~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		~~17,996~~ 17,932	--	

Region	1990	1991	1992	1994	1996	1998	2000	2002	2006	2008	2009	2010	2011	2013
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~~; NMFS 2012~~.

[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 maximum net productivity rates for Steller sea lions. Pitcher et al. (2007) observed a rate of population increase of 3.1% per year for the eastern stock, but concluded this rate did not represent a maximum rate of increase. NMFS (~~2012~~2013) estimated that the eastern stock increased at rates of 4.18% per year using pup counts, and 2.99% per year using non-pup counts between 1979 and 2009. Hence, until additional data become available, it is recommended that the pinniped maximum theoretical net productivity rate (R_{MAX}) of 12% be used for this stock (Wade and Angliss 1997).

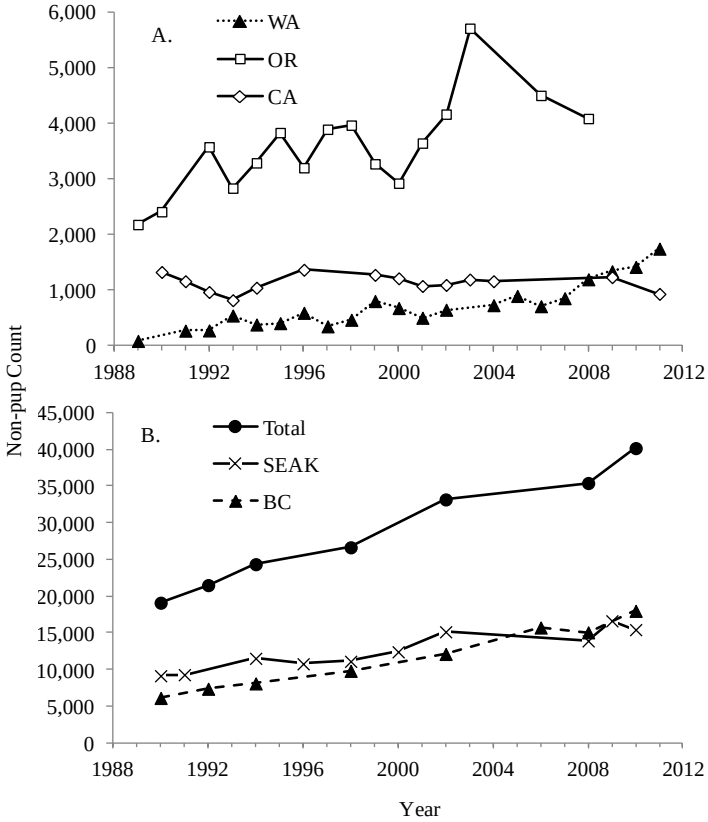

Figure 4. Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites by region throughout the range of the eastern U.S. stock, 1990-~~2011~~2013. Data from Oregon and British Columbia include all sites. Region abbreviations and data are in Table 4. (A.) CA, OR, and WA. (B.) BC, SEAK, and Total Eastern stock.

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. On 4 December 2013, the eastern stock of Steller sea lion was removed from the list of 'threatened' species under the Endangered Species Act (ESA; 78 FR 66140). 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 eastern population has recovered and no longer meets the definition of a threatened species under the ESA. Based on the stock's delisting, its extended 30-yr period of population increase at > 3% y^{-1}, and the fact that its current abundance is the highest that can be documented in the last 100 years, NMFS is evaluating whether the eastern stock of Steller sea lion is within its optimum sustainable population, is not depleted, and is not a strategic stock as defined in the MMPA. If so, and the stock is no longer considered depleted, the PBR recovery factor would be ~~is~~ changed to 1.0 (recovery factor for a stock within its OSP)~~. This approach is consistent with recommendations of the Alaska Scientific~~

~~Review Group. Thus, for the eastern (U.S. portion only) stock of Steller sea lions,~~ and PBR = 2,193 (36,551 × 0.06 × 1.0). This approach is consistent with recommendations of the Alaska Scientific Review Group. If the stock is considered depleted, and the recovery factor of 0.75 is maintained, PBR = 1,645 (36,551 × 0.06 × 0.75).

~~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} × 0.5R_{MAX} × F_R. The default recovery factor (F_R) for stocks listed as "threatened" under the Endangered Species Act (ESA) is 0.5 (Wade and Angliss 1997). However, in 2012 NMFS proposed removing the eastern stock of Steller sea lion from the list of threatened and endangered species. As such, the recovery factor is set at 0.75, midway between 0.5 (recovery factor for a "threatened" stock) and 1.0 (recovery factor for a stock within its optimal sustainable population level; OSPL). This approach is consistent with recommendations of the Alaska Scientific Review Group since it has not been determined if the eastern stock of Steller sea lion is within its OSPL. Thus, for the eastern (U.S. portion only) stock of Steller sea lions, PBR = 1,552 animals (34,485 × 0.06 × 0.75). If this stock is considered to be within its OSPL, PBR = 2,069 (34,485 × 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

~~Until 2003, there were six different federally regulated commercial fisheries in Alaska that could have interacted with Steller sea lions and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these 6 fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska.~~ Between 2008-2012, there were no incidental serious injuries and mortalities of eastern Steller sea lions observed in the 22 federally regulated commercial fisheries in Alaska monitored for incidental mortality by fisheries observers.

Fishery observers monitored four commercial fisheries during the period from 1990 to 2005 in which Steller sea lions from this stock were taken incidentally: the California (CA)/Oregon (OR) thresher shark and swordfish drift gillnet, WA/OR/CA groundfish trawl, 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 8. There have been no observed serious injuries or mortalities incidental to the CA/OR thresher shark and swordfish drift gillnet fishery since the 1990s ~~in recent years~~ (Carretta 2002, Carretta and Chivers 2003, Carretta and Chivers 2004). In the WA/OR/CA groundfish trawl (Pacific whiting component only) one Steller sea lion was observed killed in each year in 2000-03. No data are available after 1998 for the northern Washington marine set gillnet fishery. Between 2005-2009, 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 since 2000 (Perez unpubl. ms.; Breiwick 2013). During the 4-year period from 2007-2010, 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.

Table 8. Summary of incidental mortality of Steller sea lions (eastern U. S. stock) due to commercial fisheries from 2005 to 2009 and calculation of the mean annual mortality 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 is included in Appendix 6.

Fishery name	**Years**	**Data type**	**Observer coverage**	**Observed mortality (in given yrs.)**	**Estimated mortality (in given yrs.)**	**Mean 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 (at-sea hake sector)	2005 2006 2007 2008 2009	Obs data	100 98 99 99 100	0 (2) 0 (3) 0 (3) 1 (0) 0 (0)	0 (2.99) 0 (3.78) 0 (4.22) 1.3 (0) 0 (0)	2.46 (CV = 0.17)
Observer program total						5.71 (CV = 0.23)

[1] A "—" indicates bycatch estimate not provided due to the high coefficient of variation for that estimate.

Strandings of Steller sea lions provide additional information on fishery-related mortality. 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. ~~A total of 148 observations of Steller sea lions with flashers hanging from their mouth were reported in Southeast Alaska and northern British Columbia between 2007 and 2011 (Raum-Suryan et al. 2009; pers. comm., Lauri Jemison, Steller Sea Lion Program, Alaska Department of Fish and Game, 1255 West 8th Street, P.O. Box 115526, Juneau, AK 99811; 03 January 2013; Allen and Helker in prep; Table 5b) indicating an average rate of hook ingestion of 29.6 per year.~~An average annual mortality and serious injuries of 30.6 sea lions were observed with flashers, or salmon troll lures, hanging from their mouth in Southeast Alaska and northern British Columbia between 2008-2012. It is not clear whether entanglements with hooks and flashers involved the recreational or commercial component of the salmon troll fishery. Based on guidelines presented in 77FR3233, 23 January 2012, these fishery interactions are considered "serious injuries". The average minimum annual serious injury and mortality attributed to entanglement in fishing gear~~ and~~, ingestion of gear other than troll gear, or other fishery-related injury and mortality between ~~2007-2011~~2008-2012 was ~~1.6~~34.6. ~~There were 3 fishery related strandings of Steller sea lions in Washington, Oregon, or California between 2007 and 2011, all occurring in 2010, resulting in a mean annual mortality of 0.6.~~ These estimates are based on opportunistic reports, and actual levels of occurrence are likely higher.

Table 9. Summary of eastern Steller sea lion mortalities and serious injuries by year and type reported to the NMFS Alaska Regional Office, marine mammal stranding database, and ADF&G for the ~~2007-2011~~2008-2012 period (Allen et al. 2014, Allen ~~and Helker~~ et al. in prep).

Cause of Injury	**~~2007~~**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean Annual Mortality**
Dependent animal with seriously injured mother	~~0~~	~~2~~ 4	~~0~~ 1	~~0~~ 3	~~0~~ 1	1	~~0.4~~ 2.0
Entanglement (foreign high seas gillnet)	~~0~~	0	0	1	0	0	0.2
Entanglement (halibut gangion line)	~~0~~	0	0	0	1	0	0.2

Entanglement (troll gear)	~~1~~	1	0	0	0	0	0.2
Entanglement (unknown marine debris / gear)	~~0~~	1	0	0	0	0	0.2
Entanglement (unknown pot fishery gear)	~~0~~	1	0	0	0	0	0.2
~~Ring n~~Neck entanglement (fishing line)	~~0~~	~~0~~ 1	0	1	1	0	~~0.4~~ 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
~~Ring n~~Neck entanglement (unknown marine debris / gear)	~~1~~	~~5~~ 25	~~0~~ 15	~~2~~ 19	~~3~~ 24	17	~~2.2~~ 20
Vessel strike (unknown vessel)	~~1~~	0	1	0	0	0	~~0.4~~ 0.2
Gunshot	~~0~~	0	1	2	0	15	~~0.6~~ 3.0
Swallowed troll gear	~~12~~	38	15	42	30	28	~~29.6~~ 30.6
Swallowed unknown fishing gear	~~0~~	0	0	1	0	0	0.2
Swallowed unknown marine debris / gear	~~0~~	1	0	0	0	0	0.2

Minimum total annual mortality	~~35.2*~~64.0*

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

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 mortality rate incidental to commercial and recreational fisheries (both U.S. and Canadian) is ~~49~~51.6 sea lions per year, based on fisheries observer data (17.0), opportunistic observations , and stranding data (~~29.6 + 1.6 + 0.6 = 31.8~~34.6).

Subsistence/Native Harvest Information

The subsistence harvest of Steller sea lions during 2004-2008 is summarized in Wolfe et al. (2009b). During each year, data were collected through 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. Approximately 16 of the interviewed communities lie within the range of the eastern U.S. stock. As of 2009, data on community subsistence harvests are no longer being consistently collected. Therefore, the most recent 5-years of data (~~2004~~2005-2008 and 2012) will be ~~retained and~~ used for estimating an annual mortality estimate. The average number of animals harvested and struck but lost is 11 animals/year (Table 10). 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 10. Summary of the subsistence harvest data for the eastern stock of Steller sea lions, ~~2004~~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 (~~2004~~2005-2008 and 2012) will be retained and used for estimating an annual mortality estimate.

Year	Estimated total number taken	Number harvested	Number struck and lost
~~2004~~	~~12~~[1]	~~5~~	~~7~~
2005	19[21]	0	19

Year	Estimated total number taken	Number harvested	Number struck and lost
2006	12.6[~~3~~2]	2.5	10.1
2007	6.1[~~4~~3]	0	6.1
2008	9.7[~~5~~4]	1.7	8.0
2012	9	1	8
Mean annual take (2004-2008)	~~11.9~~11.3	~~1.8~~1.0	~~10.0~~10.2

[~~1~~ ~~Wolfe et al. 2005;~~ ~~2~~1 Wolfe et al. 2006; ~~3~~2 Wolfe et al. 2008; ~~4~~3 Wolfe et al. 2009a; ~~5~~4Wolfe et al. 2009b.

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 (Table 5). 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 (DFO unpublished 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 lions with gunshot wounds do occur, along with strandings of animals entangled in material that is not fishery-related. During the period from ~~2007~~2008 to ~~2011~~2012, there ~~were 3~~was 1 reported strandings of an animal~~s~~ from this stock with gunshot wounds in Oregon and Washington~~, 2 in 2007 and 1~~ in 2010, resulting in an estimated annual mortality of ~~0.6~~0.2 Steller sea lions. This estimate is considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel). ~~Three~~Eighteen mortalities from gunshots were reported in Alaska (1 in 2009~~ and~~, 2 in 2010, and 15 in 2012).~~; however,~~ Although it is likely that illegal shooting does occur in Alaska, Steller sea lions reported in the Alaska stranding database as shot are not included in this estimate~~, as they may result~~ unless it was confirmed that the death was due to illegal shooting and not already accounted for in the eastimate of ~~from~~ animals struck and lost in the Alaska Native subsistence harvest. In addition, human-related stranding data are not available for British Columbia. ~~Two~~One Steller sea lion ~~mortalities~~death attributed to vessel collision~~s were~~was reported to the Alaska stranding network (~~0.4~~0.2 mean annual mortality). Other sources of non-fishery human-related serious injury and mortality include ingestion of unknown marine debris/ gear (~~0.2~~0.4), entanglement in unknown marine debris/ gear (~~2.2 + 0.2 = 2.4~~26.2), and dependent of a serious injured or dead mother (~~0.4~~2.0) (Table 5b).

Mortalities 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 research on the eastern stock of Steller sea lions, which results in an annual average of 0.2 mortalities per year from this stock (Tammy 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 mean average human-caused mortality and serious injury of eastern Steller sea lions for ~~2007-2011~~2008-2012 from sources other than fisheries and Alaska Native harvest is ~~4.2~~29.4. ~~based on OR/WA gunshot (0.6), ingestion of unknown marine debris/ gear (0.2), vessel collision (0.4), unknown marine debris/ gear entanglement (2.4), dependent of a seriously injured mother (0.4), and research mortality (0.2).~~

STATUS OF STOCK

Based on currently available data, the minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock (17.0) is less than 10% of the calculated PBR (10% of PBR = 164 or 219~~155 or 207~~) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The estimated annual level of total human-caused mortality and serious injury (~~49~~51.6 (commercial and recreational fisheries) + ~~11.9~~11.3 (subsistence) + ~~4.2~~29.4 (other human-caused mortality) = ~~65.1~~92.3) does not exceed the PBR

(~~1,552 or 2,069~~1,645 or 2,193) for this stock. The eastern U.S. stock of Steller sea lion is currently not listed ~~as "threatened"~~ under the ESA~~, and therefore designated as "depleted" under the MMPA.~~ As a result, this stock is not classified as a strategic stock.~~ The eastern stock of Steller sea lion is being considered for removal from listing under the ESA by NMFS (NMFS 2008, NMFS 2012), based in part on its consistent increase in abundance since the mid 1970s. On June 29, 2010, NMFS initiated a review of the eastern Distinct Population Segment population status to reassess the listing classification under the ESA (75 FR 37385). On August 30, 2010, NMFS received a petition to delist the eastern DPS from the States of Washington and Oregon; and on September 1, 2010, the Secretary of Commerce received a petition to delist this DPS from the State of Alaska. NMFS Alaska Region Protected Resources Division prepared a draft status review to address the petitions to delist the eastern DPS and is prepared to issue a final de-listing decision in late 2013.~~ Although counts of eastern Steller sea lions have~~the stock size has~~ steadily increased over a 30+ year period and may indicate that this stock is within its OSP, no determination of its~~, the~~ status ~~of this stock~~ relative to OSP has been made~~its Optimum Sustainable Population size is unknown~~. ~~The overall estimated annual rates of increase of 3.1% (Pitcher et al. 2007), 2.99%, and 4.18% (NMFS 2012) of the eastern U. S. stock has been consistent and long-term, and may indicate that this stock is reaching OSP size.~~However, it is highly likely that this stock is within or above OSP.

Habitat Concerns

Unlike the western U. S. stock of Steller sea lion, there has been a sustained and robust increase in abundance of the eastern U. S. stock throughout ~~almost~~most of its breeding~~entire~~ 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 (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). ~~A revised Recovery Plan reviewing current threats to the eastern and western U.S. stocks and proposing actions and guidelines for recovery was released by NMFS in March 2008 (NMFS 2008) and a status review will be released by NMFS in late 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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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.

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

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. Fish and Wildl., Corvallis, OR, 97330.

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.

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

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.

DeMaster, D. 2009. Aerial Survey of Steller Sea Lions in Alaska, June-July 2009 and Update on the Status of the Western Stock in Alaska. Memorandum to D. Mecum, K. Brix and L. Rotterman, NMFS Alaska Regional Office, Juneau AK. NMFS Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle WA 98115. http://www.afsc.noaa.gov/nmml/PDF/SSL-Survey-09-memo-11-30-09.pdf

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, NMFS Alaska Regional Office, Juneau AK. NMFS Alaska Fisheries Science Center, 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 pp.

Gelatt, T., A. W. Trites, K. Hastings, L. Jemison, K. Pitcher, G. O'Corry-Crowe. 2007. Population trends, diet, genetics, and observations of Steller sea lions in Glacier Bay National Park. Proc. 4th Glacier Bay Science Symposium. Juneau, AK. October 2004.

Hoffman, J., K. Dasmahapatra, et al. 2009. Contrasting patterns of genetic diversity at three different genetic markers in a marine mammal metapopulation. Molecular Ecology 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.

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.

Jemison, L. A., G. W. Pendleton, et al. 2013. Inter-Population Movements of Steller Sea Lions in Alaska with Implications for Population Separation. PLoS One 8(8): e70167.

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

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Pp. 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.

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.

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

~~National Marine Fisheries Service. 2012. (Draft) Status Review of The Eastern Distinct Population Segment of Steller Sea Lion (*Eumetopias jubatus*). 106pp + Appendices. Protected Resources Division, Alaska Region, National Marine Fisheries Service, 709 West 9th St, Juneau, Alaska 99802.~~

National Marine Fisheries Service. 2013. Status Review of The Eastern Distinct Population Segment of Steller Sea Lion (*Eumetopias jubatus*).144pp + Appendices. Protected Resources Division, Alaska Region, National Marine Fisheries Service, 709 West 9th St, Juneau, Alaska 99802.

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.

O'Corry-Crowe, G., B. L. Taylor, et al. 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.

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. http://www.dfo-mpo.gc.ca/csas/.

Olesiuk, P. F., and A. W. Trites. 2003. Steller sea lions. Status Report submitted 16 September 2003 to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Dep. Fisheries and Oceans Canada, Science Branch, Pacific Biological Station, Nanaimo, BC. V9R 5K6. 42 p.

Perez, M. A. Unpubl. ms. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 67 pp. Available 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.

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. 107(1):102-115.

Raum-Suryan, K. L., Jemison, L. A., Pitcher, K. W. 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., 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. Mamm. 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 pp.

Trujillo, R. G., Loughlin, T. R., Gemmell, N. J., Patton, J. C., Bickham, J. W. 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 pp.

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. Fish and Game, Juneau, AK, Subsistence Div. Tech. 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. Fish and Game, Juneau, AK, Subsistence Div. Tech. 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. Fish and Game, Juneau, AK, Subsistence Div. Tech. Paper No. 347. Juneau, AK.

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 Dep. Fish and Game, Juneau, AK, Subsistence Div. Tech. 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 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. Pp. 259-292 *In* D. R. McCullough (ed.), Metapopulations and wildlife conservation. Island Press, Covelo, California.

Revised ~~05/30/2013~~02/05/2014

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. 5) 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, and on San Miguel Island off southern California (Lander and Kajimura 1982; NMFS 1993). 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).

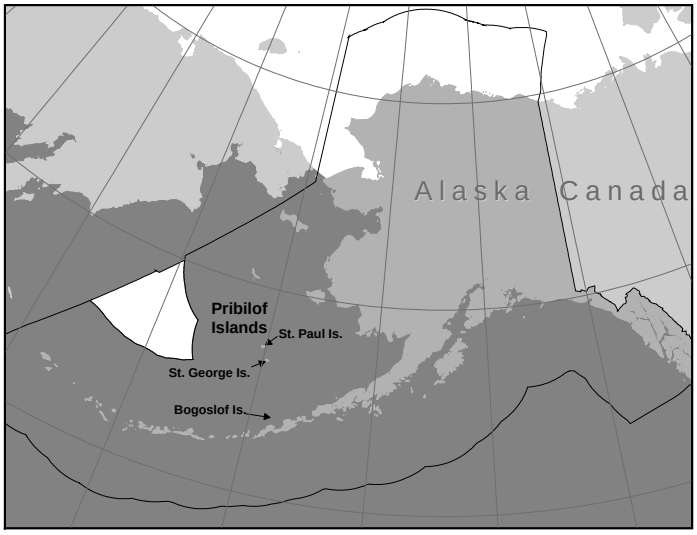

Figure 5. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

During the reproductive season, adult males usually are on shore during the 4- month period from May-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, 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 between 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 Dizon et al. (1992) phylogeographic approach: 1) distribution: continuous during non-breeding season and discontinuous during the breeding season, high natal site fidelity (Baker et al. 1995; DeLong 1982); 2) population response: substantial differences in population dynamics between 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 (Dickerson et al. 2010, Ream 2002). Thus, an Eastern Pacific stock and a San Miguel Island stock are recognized. The San Miguel Island stock is reported separately in the Stock Assessment Reports for the 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. ~~Currently,~~ 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 11). The most recent estimate for the number of fur seals in the Eastern Pacific stock, based on pup counts ~~from 2008~~ on Sea Lion Rock (2008), ~~from 2010~~ on St. Paul and St.

George Islands (mean of 2008, 2010 and 2012), and ~~from 2011~~ on Bogoslof Island (2011), is ~~639,545~~648,534 (~~4.5 × 142,121~~4.47 × 145,086).

Table 11. 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 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)

* 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) 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 (DeMaster 1998). N_{MIN} is calculated using Equation 1 from the 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 ~~639,545~~648,534 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is ~~541,317~~548,919.

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. 6; 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. 7). During 1998-~~2010~~2012, pup production declined ~~5.42~~4.84% per year (SE = ~~0.34~~0.49%; P < 0.01) on St. Paul Island and ~~2.09~~1.95% per year (SE = ~~0.69~~0.50%; P ~~= 0.03~~ < 0.01) on St. George Island. The estimated pup production in ~~2010~~2012 was below the 1916 level on both St. Paul and St. George Islands (NMFS unpubl. data). Northern fur seal pup production at Bogoslof Island has grown at an exponential rate since the 1990s. (R. Ream, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, 5 February 2009). 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 ~~2010~~2012 estimates from the Pribilofs ~~suggests that the decline has not stopped, and show that the overall abundance estimate is strongly influenced by the continued rapid decline in pup production at St. Paul Island~~shows an insignificant change 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.

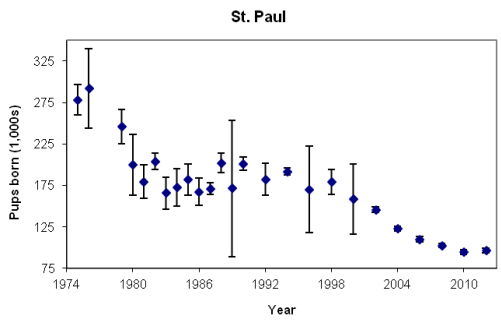

Figure 6. Estimated number of northern fur seal pups born on St. Paul Island, 1970-~~2010~~2012.

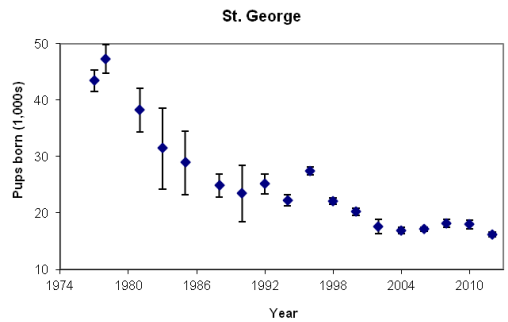

Figure 7. Estimated number of northern fur seal pups born on St. George Island, 1970-~~2010~~2012.

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, unpubl. data, National Marine Mammal Laboratory (retired), 7600 Sand Point Way NE, Seattle, WA 98115), 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 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 depleted stocks under the MMPA (Wade and Angliss 1997). Thus, for the Eastern Pacific stock of northern fur seals, PBR = ~~11,638~~11,802 animals (~~541,317~~548,919 × 0.043 × 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

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 rate calculation in this SAR 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, pers. comm., National Marine Mammal Laboratory (retired), 7600 Sand Point Way NE, Seattle, WA 98115).

~~In 2003, changes in fishery definitions in the List of Fisheries resulted in separating 6 federally regulated fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change did not represent a change in fishing effort, but provided 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 2008-2012, there were incidental serious injuries and mortalities of western Steller sea lions 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, Bering Sea/Aleutian Islands Pacific cod longline (Table 8). The total estimated annual fishery-related incidental mortality in these fisheries from ~~2007-2011~~2008-2012 is ~~4.6~~1.7 (CV = 0.58) (Table 12).

Observer programs for five Alaska state commercial fisheries have not documented any takes of fur seals. In 1990 and 1991, observers monitored the Prince William Sound salmon drift gillnet fishery and recorded no mortalities of northern fur seals. In 1990, observers were on board 300 of the 524 vessels that fished in the Prince William Sound salmon drift gillnet fishery, monitoring a total of 3,166 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). In 1991, observers were on board 531 of the 611 registered vessels and monitored a total of 5,875 sets, or roughly 5% of the estimated sets made by the fleet (Wynne et al. 1992). During 1990, observers also were on board 59 of the 154 vessels participating in the Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery, monitoring a total of 373 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). More recently, observer programs have been conducted in the Cook Inlet salmon set and drift gillnet fisheries (Manly 2006) and in a portion of the Kodiak set gillnet fishery (Manly 2007). Observer coverage in the Cook Inlet drift gillnet fishery was 1.8% and 3.7% in 1999 and 2000, respectively. The observer coverage in the Cook Inlet set gillnet fishery was 7.3% and 8.3% in 1999 and 2000, respectively (Manly 2006). Observer coverage in the Kodiak set gillnet fishery was 6.0% (2002) and 4.9% (2005) of the fishing permit days. No serious injuries or mortalities of northern fur seals were observed during the course of any observer program.

Table 12. Summary of incidental mortality of northern fur seals from the eastern Pacific stock due to commercial fisheries from ~~2007~~2008 through ~~2011~~2012 and calculation of the mean annual mortality rate (Breiwick 2013). Details of how percent observer coverage is measured are included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Islands flatfish trawl	~~2007~~	obs	~~72~~	~~0~~	~~0~~	0.82
	2008	data	100	2	2.1	(CV = 0.11)
	2009		100	1	1.0	
	2010		100	0 (+1)*	0 (1)**	
	2011		100	0	0	
	2012		100	0	0	

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Islands pollock trawl	~~2007~~ 2008 2009 2010 2011 2012	obs data	~~85~~ 85 86 86 98 98	~~3~~ 1 0 2 0 0	~~14.6~~ 1.0 0 2.0 0 0	~~3.52~~0.61 (CV = ~~0.73~~0.06)
Bering Sea/Aleutian Islands Pacific cod longline	~~2007~~ 2008 2009 2010 2011 2012	obs data	~~63~~ 63 61 64 57 51	~~0~~ 0 0 1 0 0	~~0~~ 0 0 1.4 0 0	0.28 (CV = ~~0.51~~0.52)
Minimum total annual mortality						~~4.62~~1.71 (CV = ~~0.58~~0.11)

*Total mortalities observed in unsampled hauls.
**Total mortalities observed in sampled and unsampled hauls. Since the total known mortality (1) exceeds the estimated mortality (0) for 2010, the sum of actual mortalities observed (1) will be used as a minimum estimate for that year.

The estimated minimum annual mortality rate incidental to commercial fisheries is ~~4.6~~1.7 fur seals per year based on observer data. There are several fisheries that are known to interact with northern fur seals and have not been observed (Appendices 4 and 5). Thus, the estimated mortality rate is likely ~~a minimum~~ an underestimate of the actual mortality level. However, the large stock size makes it unlikely that unreported mortalities from those fisheries would be a significant source of mortality for the stock.

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/year on the rookeries were entangled in pieces of trawl netting and an average of 0.1 fur seal/year was entangled in monofilament net. Zavadil et al. (2007) determined the juvenile male entanglement rate for 2005-2006 to be between 0.15-0.35%. 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 2011, there was an increased effort to include entanglement reports in the Alaska Regional Office stranding database. A summary of circumferential neck entanglements of marine debris and fishing gear between ~~2007-2011~~2008-2012 is provided in Table 13. Twenty~~-four~~ Northern fur seals with circumferential neck entanglements were reported to the stranding network between ~~2007-2011~~2008-2012~~; nine were disentangled and released with non-serious injuries, thus no longer counted as serious injuries~~. The mean annual mortality and serious injury rate due to circumferential neck entanglement from trawl gear (0.4), fishing line (0.2), pot gear (0.2), and unknown fishing gear (~~0.2~~0.8) is ~~1.0~~1.6 for the ~~2007-2011~~2008-2012 period. These entanglements cannot be assigned to a specific fishery, and it is unknown whether commercial, recreational, or Alaska Native subsistence fisheries are the source of the fishing debris. 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 estimates of entanglement based on opportunistic reports.

Table 13. Summary of Northern fur seal, eastern Pacific stock, neck entanglements in marine debris by year and type reported to the NMFS Alaska Regional Office, marine mammal stranding database, for the ~~2007-2011~~2008-2012 period (Allen et al. 2014, Allen ~~and Helker~~ et al. in prep). 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	~~2007~~	2008	2009	2010	2011*	2012*	Mean Annual Mortality
Entanglement (unknown fishing net)		0	0	0	0	1	0.2
Entanglement (unknown marine debris / gear)		0	0	0	0	1	0.2
Neck entanglement (fishing line)	~~0~~	0	0	0	1	0	0.2
Neck entanglement (fishing net)		0	0	0	0	2	0.4
Neck Entanglement (packing band)	~~0~~	0	0	0	2	0	0.4
Neck entanglement (pot gear)	~~0~~	0	0	0	1	0	0.2
Neck entanglement (trawl gear)	~~0~~	0	0	0	2	0	0.4
Neck entanglement (unknown fishing gear)	~~0~~	1	0	0	0	0	0.2
Neck entanglement (unknown marine debris / gear)	~~0~~	0	0	0	8	3	~~1.6~~ 2.2
Sum of 2011, 2012 M/SI events					14	7	10.5
Minimum total annual mortality							~~3~~ 4.4

*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 Alaska Regional Office stranding database as of 2011. The average of the sum of M/SI events reported in 2011 and 2012 may be a more accurate number of annual M/SI for management purposes due to more thorough reporting for that year.

Subsistence/Native 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 historic 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. No adult males and three females were struck and killed during the harvest on St. Paul Island in 2007 (Lestenkof and Zavadil 2007). Of the 331 fur seals taken for subsistence on St. Paul in 2008, 328 were sub-adult males and 3 were females (Zavadil 2008). 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 in 2011 (Lestenkof et al. 2011). Between ~~2007~~2008 and ~~2011~~2012, there was an annual average of ~~463~~461 seals harvested per year in the subsistence harvest (Table 14).

Table 14. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands for ~~2007-2011~~2008-2012.

Year	St. Paul	St. George	Total harvested
~~2007~~	~~272[1]~~	~~210[2]~~	~~482~~
2008	331[31]	170[42]	501
2009	341[53]	114[64]	455
2010	357[75]	78[86]	435
2011	323[97]	120[108]	443
2012	383[9]	64[10]	447
Mean annual take (~~2006-2010~~2008-2012)			~~463~~461

~~[1]Lestenkof and Zavadil 2007; [2]Malavansky 2007,~~ [31]Zavadil 2008, [42]Lekanof 2008, [53]Zavadil 2009, [64]Lekanof 2009, [75]Zavadil et al. 2011, [86]Merculief 2010, [97]Lestenkof et al. 2011, [108]Merculief 2011, [9]Lestenkof et al. 2012, [10] Lekanof 2013.

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.

~~Mortality resulting from entanglement in marine debris has been implicated as a contributing factor in the decline observed in the northern fur seal population on the Pribilof Islands during the 1970s and early 1980s (Fowler~~

~~1987, Swartzman et al. 1990, Fowler 2002). Surveys conducted from 1995 to 1997 on St. Paul Island indicate a rate of entanglement among subadult males comparable to the 0.2% rate observed from 1988 to 1992 (Fowler and Ragen 1990, Fowler et al. 1994) and lower than the rate of entanglement (0.4%) observed during 1976-85 (Fowler et al. 1994). Between 1995 and 2000, responsibility for entanglement studies of northern fur seals shifted gradually from the NMFS National Marine Mammal Laboratory to the Tribal Government of St. Paul's Ecosystem Conservation Office (ECO). ECO has managed the entanglement studies under a co-management agreement with NOAA for northern fur seals since 2000. Entanglement rates of male northern fur seals on St. Paul from 1998 to 2002 were 0.2, 0.26, 0.25, 0.3, and 0.37 (Zavadil et al. 2003). The recent rates of entanglements are close to those recorded in the mid 1980s; however, recent changes in methods (counting juvenile males vs. all males) make direct comparisons between recent and historical data difficult (Zavadil et al. 2003). In 2002, the composition of entangling debris switched from predominantly packing bands to trawl net fragments (Zavadil et al. 2003).~~

The mean annual mortality and serious injury rate due to circumferential neck entanglement from packing bands (0.4) and unknown marine debris or gear (~~1.6~~2.4) is ~~2.0~~2.8 for the ~~2007-2011~~2008-2012 period (Table 13).

Mortalities may occasionally occur incidental to marine mammal research activities authorized under Marine Mammal Protection Act (MMPA) permits issued to a variety of government, academic, and other research organizations. Between ~~2007-2011~~2008-2012, there was a single mortality resulting from research on this stock of northern fur seals in 2009, an average of 0.2 mortalities per year (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910). The only fisheries research mortality of a Northern fur seal for the ~~2007-2011~~2008-2012 period occurred in 2009 during a groundfish bottom trawl research survey, resulting in an average of 0.2 mortalities per year. The total combined mortalities of northern fur seals from marine mammal (0.2) and fisheries (0.2) research activities is 0.4 per year for the ~~2007-2011~~2008-2012 period.

STATUS OF STOCK

Based on currently available data, the minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock (~~4.6~~1.7) is less than 10% of the calculated PBR (~~1,164~~1,180) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The estimated annual level of total human-caused mortality and serious injury (~~4.6~~1.7 [commercial fisheries] + ~~1.0~~1.6 [unknown fisheries] + ~~463~~461 [Alaska Native harvest] + 0.4 [research activities] + ~~2.0~~2.8 [marine debris] = ~~471~~468) ~~is not known to~~does not exceed the PBR (~~11,638~~11,802) 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, there is no reason to believe that limiting mortalities 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) had changed substantially since the late 1950s. The Eastern Pacific stock of northern fur seal 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, Sinclair et al. 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. George and St. Paul Islands (Figs. 6 and 7). 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 eight 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 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

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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 on request - National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA, 98115).

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

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

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. Pp. 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 sixth meeting of the Alaska Scientific Review Group, 21-23 October 1997, Seattle, Washington. 40 pp. (Available upon request - National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

Dickerson B.R., Ream R.R., Vignieri S.N., Bentzen P. 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 upon request - National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.)

Fowler, C. W. 1987. Marine debris and northern fur seals: A case study. Mar. Poll. Bull. 18:326-335.

Fowler, C. W. and T. J. Ragen. 1990. Entanglement studies, St. Paul Island, 1989; Juvenile male roundups. U.S. Dep. Commer., NWAFC Processed Rep. 90-06, 39 pp. (Available online: www.afsc.noaa.gov/Publications/ProcRpt/PR1990-06.pdf)

Fowler, C. W., J. D. Baker, R. Ream, B. W. Robson, and M. Kiyota. 1994. Entanglement studies on juvenile male northern fur seals, St. Paul Island, 1992. Pp. 100-136 *In* Sinclair, E. H. (editor), Fur seal investigations, 1992, U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-45.

Fowler, C.W. 2002. Ecological effects of marine debris: the example of northern fur seals. Pp. 40-58 *In* Proceedings of the International Marine Debris Conference: Derelict Fishing Gear and the Ocean Environment held in Honolulu Hawaii, August 6-11, 2000. (CD-ROM;pdf). U.S. Dep. Comm., National Oceanic and Atmospheric Administration, Hawaii Islands Humpback Whale National Marine Sanctuary, Honolulu, HI.

Gerrodette, T., D. Goodman, and J. Barlow. 1985. Confidence limits for population projections when vital rates vary randomly. Fish. Bull. 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. 104:445-455.

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 pp.

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 the NMFS, 68 pp. + appendices.

Lekanof, P. A. 2008. The subsistence harvest of northern fur seals on St. George Island in 2008. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, Alaska. 9 pp.

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, Alaska. 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, Alaska. 5 pp.

Lestenkof, P. M., P. I. Melovidov, D. V. Roberts, and P. A. Zavadil. 2011. The subsistence harvest of sub_adult 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, Alaska. 24 pp.

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, Alaska. 36 pp.

~~Lestenkof, A. D. and P. A. Zavadil. 2006. 2006 Subsistence Fur Seal Harvest on St. Paul Island. Memorandum for the Record, August 31, 2006. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska. 3 pp.~~

~~Lestenkof, A. D. and P. A. Zavadil. 2007. 2007 Subsistence Fur Seal Harvest on St. Paul Island. Memorandum for the Record, October 5, 2007. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska. 3 pp.~~

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 pp. (Available online: www.fakr.noaa.gov/protectedresources/observers/bycatch/1999-2000cookinlet.pdf)

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 pp.

~~Malavansky, A. 2007. The subsistence harvest of northern fur seals on the St. George Island in 2007. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, Alaska. 8 pp.~~

~~Malavansky, A. and M. Malavansky Jr. 2006. The subsistence harvest of northern fur seals on the St. George Island in 2006. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, Alaska. 8 pp.~~

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, Alaska. 8 pp.

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, Alaska. 7 pp.

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, Washington, and the Office of Protected Resources/National Marine Fisheries Service, Silver Spring, Maryland. 80 pp.

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, Alaska.

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.

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 pp.

Ream, R. R. 2002. Molecular ecology of northern otarrids: Genetic assessment of northern fur seal and Steller sea lion distributions. Ph.D. dissertation, Univ. Washington, Seattle, WA. 134 pp.

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 pp.

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*. Pp. 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.

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.

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.

Swartzman, G. L., C. A. Ribic, and C. P. Haung. 1990. Simulating the role of entanglement in northern fur seal, *Callorhinus ursinus*, population dynamics. Pp. 513-530 *In* R. S. Shomura and M. L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-154.

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 pp.

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Rept. NMFS/NOAA Contract 50ABNF000036. 65 pp. 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 Rept. NMFS/NOAA Contract 50ABNF000036. 53 pp. 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). Pp. 9-21 *In* J. P. Croxall and R. L. Gentry (eds.), Status, biology, and ecology of fur seals. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 51.

York, A. E., and C. W. Fowler. 1992. Population assessment, Pribilof Islands, Alaska. Pp. 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. 2008. 2008 Subsistence Fur Seal Harvest on St. Paul Island. Memorandum for the Record, December 7, 2008. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska. 2 pp.

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, Alaska. 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. Unpublished report available from the Aleut Community of St. Paul Island, Ecosystem Conservation Office. 12 pp.

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, Alaska. 2 pp.

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 pp. (Available online: http://doc.nprb.org/web/research/research%20pubs/outside_publications/733_entanglement.pdf)

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.

HARBOR SEAL (*Phoca vitulina richardii*)

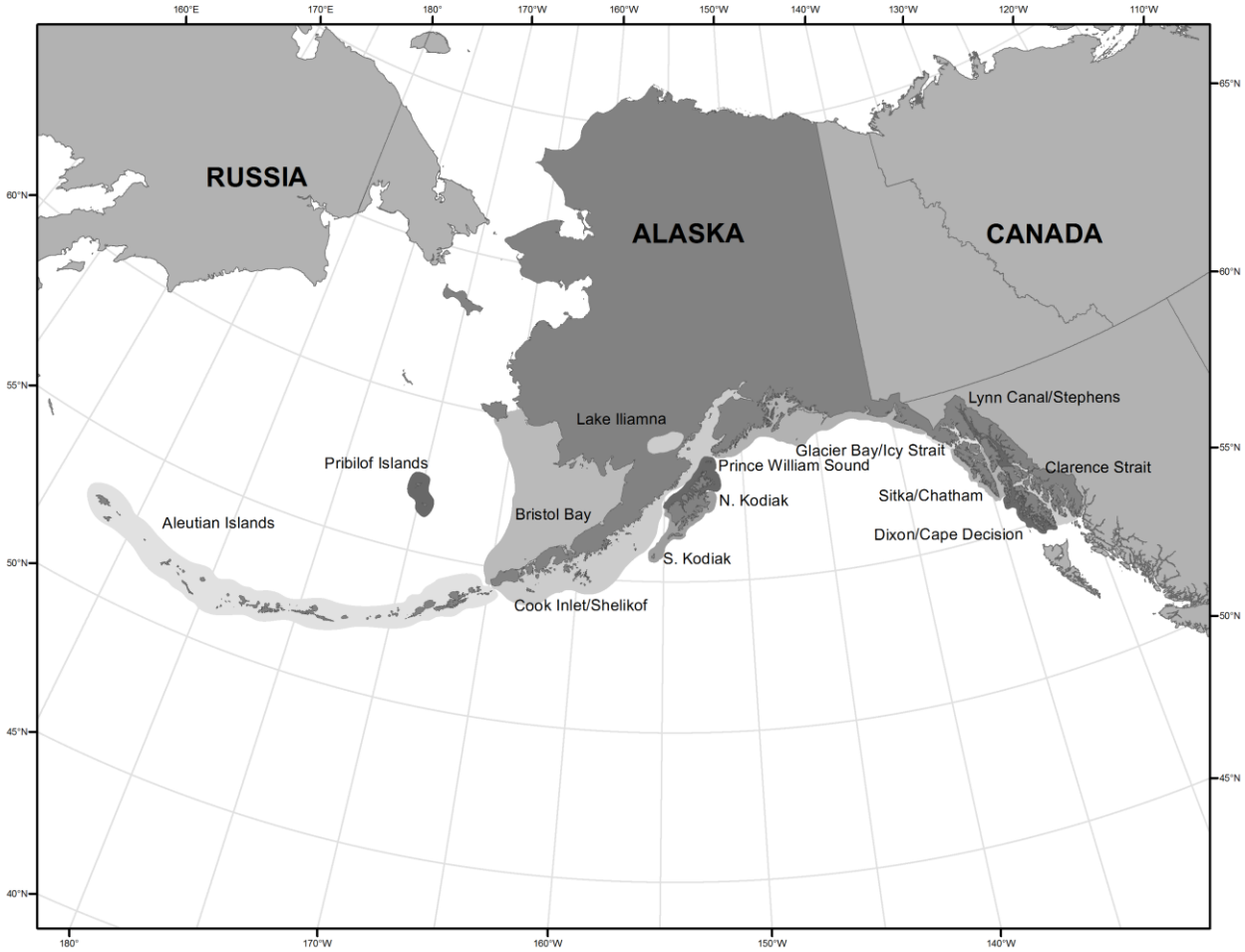

Figure 8. Approximate distribution of harbor seals in Alaska waters (shaded area).

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice, and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944, Fisher 1952, Bigg 1969, 1981, Hastings et al. 2004). The results of recent satellite tagging studies in Southeast Alaska, Prince William Sound, and Kodiak are also consistent with the conclusion that harbor seals are non-migratory (Swain et al. 1996, Lowry et al. 2001, Small et al. 2003). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Lowry et al. 2001, Small et al. 2003). Strong fidelity of individuals for haul-out sites during the breeding season has been documented in several populations (Härkönen and Harding 2001), including in Alaska (Pitcher and McAllister 1981, Small et al. 2005). Harbor seals have declined dramatically in some parts of their Alaska range over the past few decades while in other parts their numbers have increased or remained stable over similar time periods, suggesting areas with independent population dynamics (O'Corry-Crowe et al. 2003).

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

In 2010, the National Marine Fisheries Service and their co-management partners, the Alaska Native Harbor Seal Commission, decided on 12 separate stocks of harbor seals based largely on the genetic structure. Given the genetic samples were not obtained continuously throughout the range, a total evidence approach was used to consider additional factors such as population trends, observed harbor seal movements and traditional Alaska Native use areas in the final designation of stock boundaries. This represents a significant increase in the number of harbor seal stocks from the three stocks (Bering Sea, Gulf of Alaska, Southeast Alaska) previously recognized. The 12 stocks of harbor seals identified in Alaska are 1) the Aleutian Islands stock, 2) the Pribilof Islands stock, 3) the Bristol Bay stock, 4) the North Kodiak stock, 5) the South Kodiak stock, 6) the Prince William Sound stock, 7) the Cook Inlet/Shelikof stock, 8) the Glacier Bay/Icy Strait stock, 9) the Lynn Canal/Stephens stock, 10) the Sitka/Chatham stock, 11) the Dixon/Cape Decision stock, and 12) the Clarence Strait stock (Fig. 8). Individual stock distributions can be seen in Figures 9a-l.

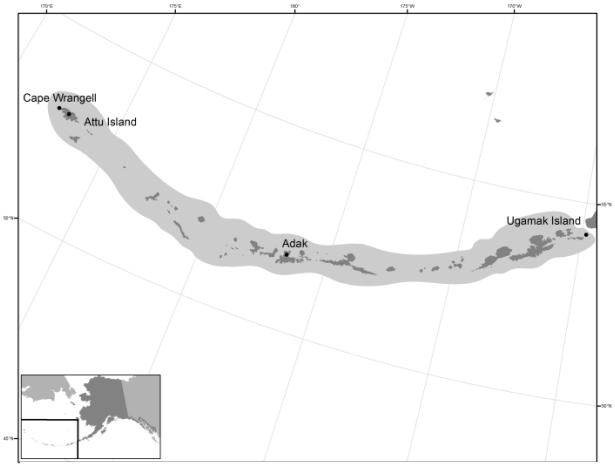

Figure 9a. Approximate distribution of Aleutian Islands harbor seal stock (shaded area).

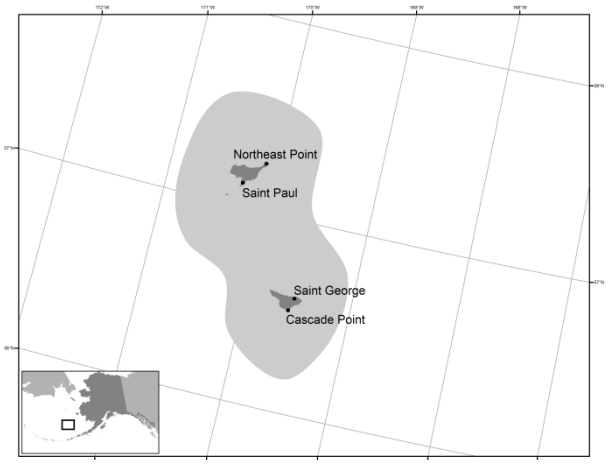

Figure 9b. Approximate distribution of Pribilof Islands harbor seal stock (shaded area).

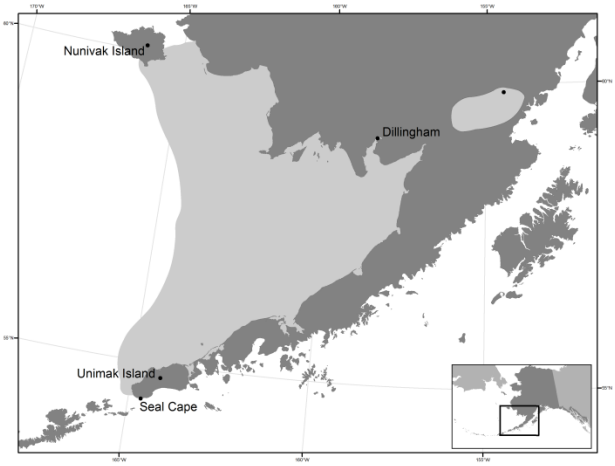

Figure 9c. Approximate distribution of Bristol Bay harbor seal stock (shaded area).

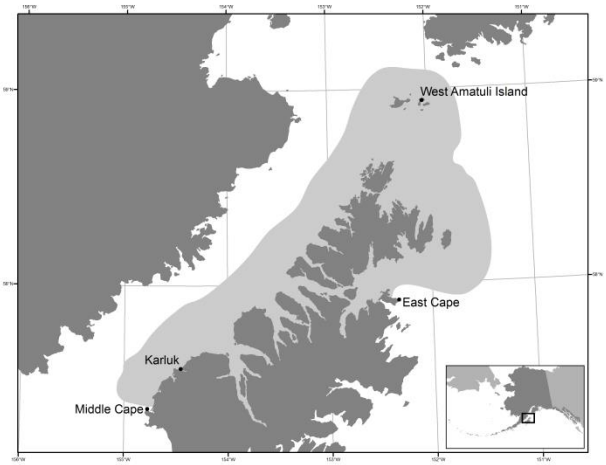

Figure 9d. Approximate distribution of North Kodiak harbor seal stock (shaded area).

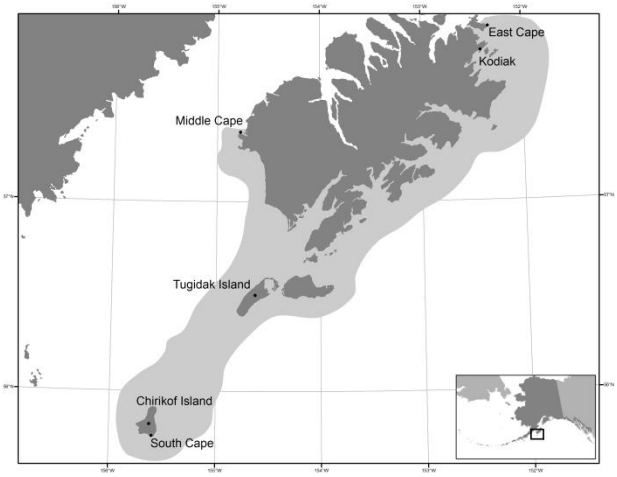

Figure 9e. Approximate distribution of South Kodiak harbor seal stock (shaded area).

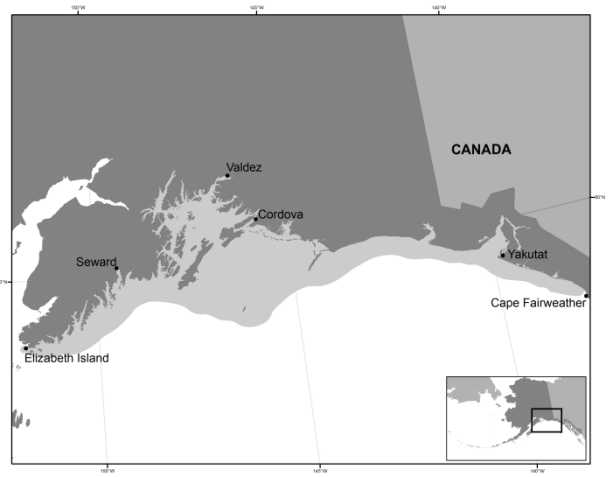

Figure 9f. Approximate distribution of Prince William Sound harbor seal stock (shaded area).

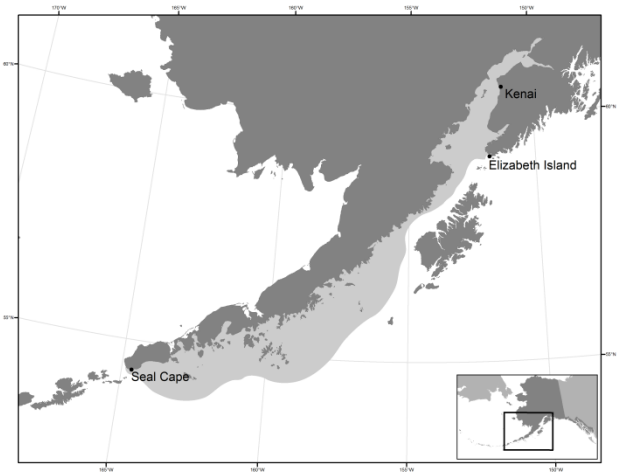

Figure 9g. Approximate distribution of Cook Inlet/Shelikof harbor seal stock (shaded area).

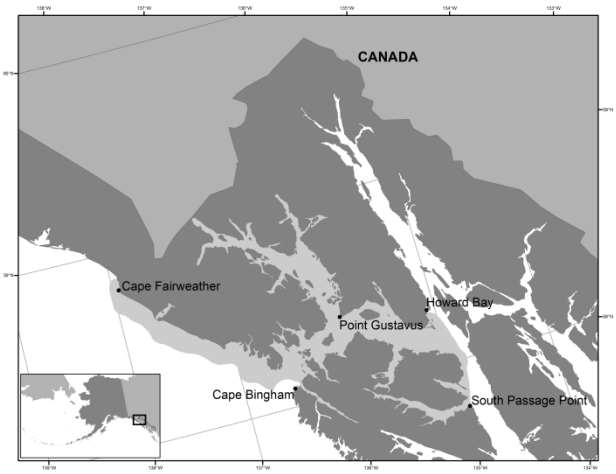

Figure 9h. Approximate distribution of Glacier Bay/Icy Strait harbor seal stock (shaded area).

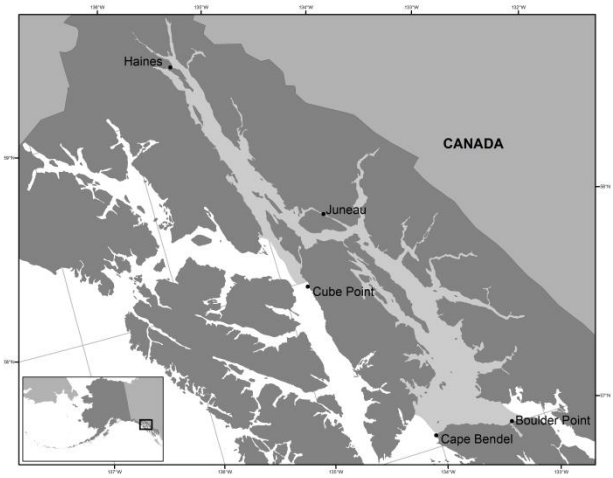

Figure 9i. Approximate distribution of Lynn Canal/Stephens harbor seal stock (shaded area).

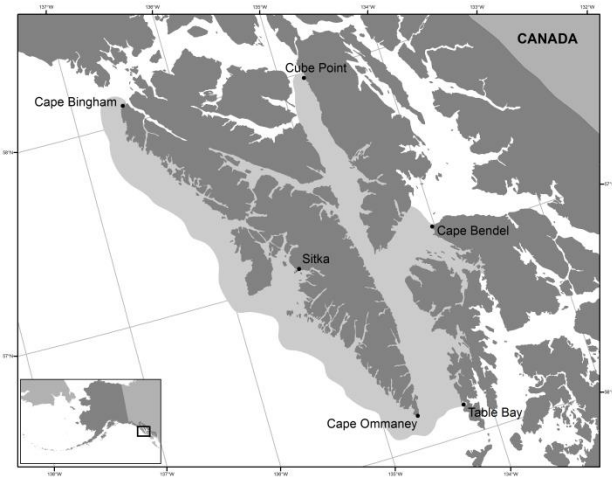

Figure 9j. Approximate distribution of Sitka/Chatham harbor seal stock (shaded area).

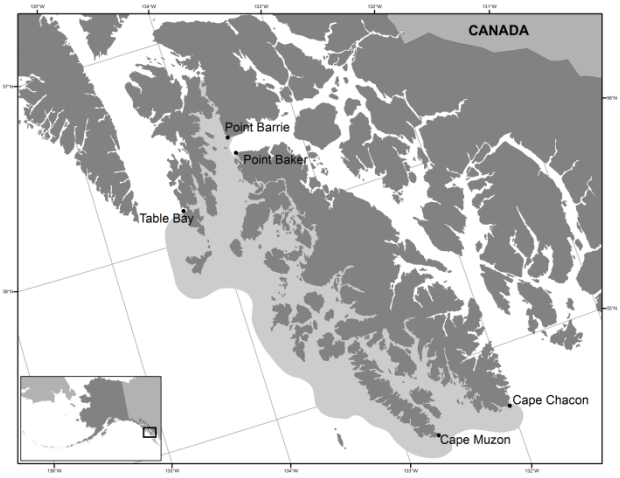

Figure 9k. Approximate distribution of Dixon/Cape Decision harbor seal stock (shaded

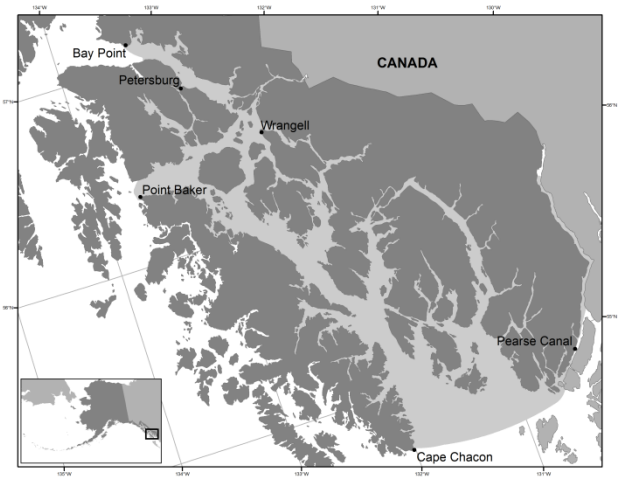

Figure 9l. Approximate distribution of Clarence Strait harbor seal stock (shaded area).

POPULATION SIZE

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

Abundance Estimates and Minimum Population Estimates

The current statewide abundance estimate for Alaskan harbor seals is 152,602 (SE: 7,703) (NMFS, unpublished data), based on aerial survey data collected during 1998-2007. See Table 15 for abundance estimates of the twelve stocks of harbor seals identified in Alaska. The minimum population estimate (N_{MIN}) for each of the twelve stocks of harbor seals identified in Alaska is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$.

Table 15. Abundance and minimum population size estimates of harbor seals in Alaska by stock.

Stock	Year of Last Survey	Abundance Estimate	SE	CV	Nmin
Aleutian Islands	2004	3,579	329	0.092	3,313
Pribilof Islands	2010	232		Unavail.	232
Bristol Bay	2005	18,577	1,080	0.058	17,690
N. Kodiak	2006	4,509	290	0.064	4,272
S. Kodiak	2006	11,117	573	0.052	10,645
Prince William Sound	2006	31,503	5,599	0.178	27,157
Cook Inlet/Shelikof	2006	22,900	1,221	0.053	21,896
Glacier Bay/Icy Strait	2007	5,042	377	0.075	4,735
Lynn Canal/Stephens	2007	8,870	473	0.053	8,481
Sitka/Chatham	2007	8,586	443	0.052	8,222
Dixon/Cape Decision	2003	14,388	860	0.060	13,682
Clarence Strait	2003	23,289	989	0.042	22,471

Current Population Trend

Aerial surveys of harbor seal haulout sites throughout Alaska have been conducted annually and provide information on trends in abundance. The following summarizes available information on the population trend for each of the 12 new stocks.

Aleutian Islands: A partial estimate of harbor seal abundance in the Aleutian Islands was conducted from a skiff survey of 106 islands from 1977-1982 (8,601 seals). Small et al. (2008) compared counts from the same islands during a 1999 aerial survey (2,859 seals). Counts decreased at a majority of the islands. Islands with greater than 100 seals decreased by 70%. The overall estimates showed a 67% decline during the approximate 20-year period (Small et al. 2008). The current population trend in the Aleutian Islands is unknown.

Surveying harbor seals in the Aleutian Islands is notoriously difficult. The Aleutian Islands are often blanketed with fog or high winds that limit aerial surveys to narrow windows of time. The logistics of surveying the entire length of the Aleutian Chain are also quite difficult with limited airports and limited access to fuel. Additionally, the haul-out patterns of harbor seals in the Aleutian Islands have not been studied, and there is no stock specific estimate of a survey correction factor. NMFS is committed to conducting surveys on an annual basis within the Aleutian Islands stock and improving our understanding of these behaviors; however, the logistical challenges likely mean longer time periods before adequate assessment of population trends and parameters can be completed.

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

Bristol Bay: At Nanvak Bay (the largest haul-out in northern Bristol Bay), harbor seals declined in abundance between 1975-1990 and increased from 1990-2000 (Jemison et al. 2006). Land-based harbor seal counts at Nanvak Bay from 1990-2000 increased at 9.2%/year during the pupping period and 2.1%/year during the molting period (Jemison et al. 2006). Data from the NMFS aerial surveys also show an increasing trend for this stock (NMFS unpublished data).

North Kodiak: Population trend information for the North Kodiak harbor seal stock is not available at this time.

South Kodiak: A significant portion of the harbor seal population within the South Kodiak stock is located at and around Tugidak Island off the southwest of Kodiak Island. Sharp declines in the number of seals present on Tugidak were observed between 1976 and 1998. The highest rate of decline was 21% per year between 1976 and 1979 (Pitcher 1990). While the number of seals on Tugidak has stabilized and show some evidence of increase since the decline, the population in 2000 remained reduced by 80% compared to the levels in the 1970s (Jemison et al. 2006). The current population trend for this stock is unknown.

Prince William Sound: The Prince William Sound stock includes harbor seals both within and adjacent to Prince William Sound. Within Prince William Sound proper, harbor seals declined in abundance by 63% between 1984 and 1997 (Frost et al. 1999). More recent analysis of population abundance (ADFG, unpublished) and trend within Prince William Sound proper indicates the population stabilized around 2002 and has likely been increasing since then. Trend information and analysis for the entire Prince William Sound stock is not available at this time.

Cook Inlet/Shelikof: A multi-year study of seasonal movements and abundance of harbor seals in Cook Inlet was conducted between 2004 and 2007. This study involved multiple aerial surveys throughout the year, and data from this study indicates a stable population of harbor seals during the August molting period (Montgomery et al. 2007). Aerial surveys along the Alaska Peninsula present greater logistical challenges and have therefore been conducted less frequently. The current population trend for the entire stock is unknown.

Glacier Bay/Icy Strait: The Glacier Bay/Icy Strait stock shows a negative population trend estimate for harbor seals from 1992-2008 in June and August for glacial (-7.7%/yr; -8.2%/yr) and terrestrial sites (-12.4%/yr, August only) (Womble et al. 2010). Trend estimates by Mathews and Pendleton (2006) were similar for both glacial and terrestrial sites. Long-term monitoring of harbor seals on glacial ice has occurred in Glacier Bay since the 1970's (Hoover 1983, Hoover-Miller 1994, Mathews and Pendleton 2006), and has shown this area to support one of the largest breeding aggregations in Alaska (Steveler 1979, Calambokidis et al. 1987). After a dramatic retreat of Muir Glacier, in the East Arm of Glacier Bay, between 1973 and 1986 (more than 7 km) and the subsequent grounding and cessation of calving in 1993, floating glacial ice was greatly reduced as a haul-out substrate for harbor seals and ultimately resulted in the abandonment of upper Muir Inlet by harbor seals (Calambokidis et al. 1987, Hall et al. 1995, Mathews 1995), Prior to 1993 seal counts were up to 1,347 in the East Arm of Glacier Bay; 2008 counts were fewer than 200 (Streveler 1979, Molnia 2007). The most recent data through 2008 show a decline of harbor seals in Glacier Bay (Womble et al. 2010) with adjusted mean counts from 2004-2008 less than those for 1992-2002 (Mathews and Pendleton 2006).

Lynn Canal/Stephens: Population trend information for the Lynn Canal/Stephens harbor seal stock is unknown.

Sitka/Chatham: The population trend for the Sitka/Chatham harbor seal stock is unknown.

Dixon/Cape Decision: Population trend information for the Dixon/Cape Decision harbor seal stock is either increasing or stable.

Clarence Strait: The population trend for the Clarence Strait harbor seal stock is either stable or increasing.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reliable rates of maximum net productivity have not been estimated for the twelve stocks of harbor seals identified in Alaska. Population growth rates were estimated at 6% and 8% between 1991 and 1992 in Oregon and Washington, respectively (Huber et al. 1994). Harbor seals have been protected in British Columbia since 1970, and the population has responded with an annual rate of increase of approximately 12.5% since 1973 (Olesiuk et al. 1990). However, until additional data become available from which more reliable estimates of population growth can be determined, it is recommended that the pinniped maximum theoretical net productivity rate (R_{MAX}) of 12% be employed for these stocks (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 pinniped stocks with unknown population status is 0.5, whereas a value of 1.0 is used for those stocks with an increasing or stable population trend (Wade and Angliss 1997). Table 16 summarizes the PBR levels for each stock of harbor seals in Alaska based on N_{MIN} estimates and population trend, if known.

Table 16. PBR levels for each stock of harbor seals in Alaska based on N_{MIN} estimates, R_{MAX}, and population trend. A recovery factor of 1.0 was used for stocks with an increasing or stable population, and 0.5 was used for those stocks with unknown population status.

Stock	**Nmin**	**R_{MAX}**	**Recovery Factor (F_R)**	**PBR Calculation ($PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$)**	**PBR**
Aleutian Islands	3,313	0.12	0.5	3,313 x 0.06 x 0.5	99
Pribilof Islands	232	0.12	0.5	232 × 0.06 × 0.5	7
Bristol Bay	17,690	0.12	1.0	17,690 × 0.06 × 1.0	1,061
N. Kodiak	4,272	0.12	1.0	4,272 × 0.06 × 1.0	256
S. Kodiak	10,645	0.12	1.0	10,645 × 0.06 × 1.0	639
Prince William Sound	27,157	0.12	0.5	27,157 × 0.06 × 0.5	815
Cook Inlet/Shelikof	21,896	0.12	1.0	21,896 × 0.06 × 1.0	1,314
Glacier Bay/Icy Strait	4,735	0.12	0.5	4,735× 0.06 × 0.5	142
Lynn Canal/Stephens	8,481	0.12	0.5	8,481 × 0.06 × 0.5	254
Sitka/Chatham	8,222	0.12	0.5	8,222 × 0.06 × 0.5	247
Dixon/Cape Decision	13,682	0.12	1.0	13,682 × 0.06 × 1.0	821
Clarence Strait	22,471	0.12	1.0	22,471 × 0.06 × 1.0	1,348

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Previous stock assessment for harbor seals indicated three observed commercial fisheries operated within the range of the Bering Sea stocks of harbor seals, three within the range of stocks in Southeast Alaska, and five within the range of harbor seal stocks in the Gulf of Alaska. As of 2003, changes in how fisheries are defined in the List of Fisheries have resulted in separating these fisheries in the Bering Sea into 14 fisheries, those in Southeast Alaska into 9 fisheries, and 22 fisheries in the Gulf of Alaska based on both gear type and target species (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska.

Observer programs in several fisheries have documented mortalities or serious injuries of harbor seals in the Bering Sea/Aleutian Islands flatfish trawl, the Bering Sea/ Aleutian Islands pollock trawl, and the Bering Sea/Aleutian Islands Pacific cod trawl, as well as in salmon set gillnet (Cook Inlet and Kodiak Island) and salmon drift gillnet (Prince William Sound, Alaska Peninsula/ Aleutian Islands, and Cook Inlet) fisheries. Between 2007-2009, there was one observed mortality of a harbor seal in the Bering Sea/ Aleutian Islands pollock trawl fishery, which is the only observed serious injury or mortality observed in any Alaska groundfish fishery for this 3-year period (NMFS unpubl. data; Table 17).

The estimated minimum annual mortality rate of harbor seals incidental to commercial groundfish fisheries for the period 2007-2010 is 1.03. However, a reliable estimate of the overall mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in salmon gillnet fisheries known to interact with several of these stocks. Additionally, allocating any reported fishery mortalities to any one particular

stock is problematic and the methodology for stock assignment is still under development. Therefore, for the purposes of stock assessment, a rate of 1.03 commercial fisheries mortalities is used for each stock.

Table 17. Summary of incidental mortality of harbor seals due to commercial fisheries from 2007 through 2010 and calculation of the mean annual mortality rate.

Fishery name	Years	Data type	Range of observer coverage (%)	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/ Aleutian Islands pollock trawl	2007 2008 2009 2010	obs data	85 85 86 86	0 1 0 0	0 1.2 0 0	0.30 (CV = 0.64)
Bering Sea/ Aleutian Islands flatfish trawl	2007 2008 2009 2010	obs data	72 100 100 100	1 0 0 0	1.3 0 0 0	0.31 (CV = 0.67)
Gulf of Alaska Pacific cod trawl	2007 2008 2009 2010	obs data	17 15 29 31	0 0 0 1	0 0 0 2.9	0.73 (CV = 0.82)
Minimum total annual mortality						1.34 (CV = 0.49)

The Prince William Sound salmon drift gillnet fishery is known to interact with harbor seals, although the most recent observer data available for this fishery is from 1990 and 1991. The estimated minimum annual mortality rate incidental to salmon set and drift gillnet commercial fisheries is 24.0 (Table 11). This estimated annual mortality rate in the Prince William Sound salmon drift gillnet fishery (24.0) is added to the overall annual commercial fishery mortality (1.3) in the overall commercial fisheries mortality estimate (25.3) for the Prince William Sound stock of harbor seals.

Table 18. Summary of incidental mortality of harbor seals due to commercial salmon drift and set gillnet fisheries from 1990 through 2002 and calculation of the mean annual mortality rate based on the most recent observer program data available.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Prince William Sound salmon drift gillnet	90-91	obs data	4-5%	2, 1	36, 12	24 (CV = 0.50)
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90	obs data	4%	0	0	0
Cook Inlet salmon drift gillnet	1999 2000	obs data	1.8% 3.7%	0 0	0 0	0
Cook Inlet salmon set gillnet	1999 2000	obs data	7.3% 8.3%	0 0	0 0	0
Kodiak Island salmon set gillnet	2002	obs data	6.0%	0	0	0
Observer program total						24.0 (CV = 0.50)
Minimum total annual mortality						24.0 (CV = 0.50)

Subsistence/Native Harvest Information

The Alaska Native subsistence harvest of harbor seals has been estimated by the Alaska Native Harbor Seal Commission (ANHSC) and the Alaska Department of Fish and Game (ADFG). Recent information from the ADFG indicates the average harvest levels for the 12 stocks of harbor seals identified in Alaska from 2004-2008, including struck and lost, as follows (see Table 19; average annual take column). As of 2009, data on community subsistence harvests are no longer being collected by ADFG. Therefore, the most recent 5-years of data (2004-2008) will be retained and used for estimating annual mortality estimates for all areas.

Table 19. Summary of the subsistence harvest data for all 12 harbor seal stocks in Alaska, 2004-2008. Data are from (Wolfe et al. 2004, Wolfe et al. 2006, Wolfe et al. 2008, Wolfe et al. 2009a, Wolfe et al. 2009b).

Stock	Minimum Annual Harvest	Maximum Annual Harvest	Average Annual Harvest
Aleutian Islands	50	146	90
Pribilof Islands	0	0	0
Bristol Bay	82	188	141
N. Kodiak	66	260	131
S. Kodiak	46	126	78
Prince William Sound	325	600	439
Cook Inlet/Shelikof	177	288	233
Glacier Bay/Icy Strait	22	108	52
Lynn Canal/Stephens	17	60	30
Sitka/Chatham	97	314	222
Dixon/Cape Decision	100	203	157
Clarence Strait	71	208	164

Other Mortality

The Alaska Region stranding records from 2006 to 2010 document stranded harbor seals with signs of human interaction. During this 5-year period, 6 strandings occurred due to unknown fishery interaction (1 in 2006, 1 in 2007, 2 in 2008, 1 in 2009, and 1 in 2010) and 3 from vessel collision (1 in 2008, 1 in 2009, and 1 in 2010). The average annual serious injury and mortality estimate based on stranding data is 1.8 over the 5 year period from 2006-2010. Stock assignment for these mortalities have not been made; therefore, the conservative approach of applying the 1.8 average annual mortality will be attributed to all stocks will be used. Mortalities may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2003-2007, there were no mortalities resulting from research on the Bering Sea stock of harbor seals (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

Harbor seals are not designated as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 10% of PBR can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. The status of all 12 stocks of harbor harbor seals identified in Alaska relative to their Optimum Sustainable Population size is unknown.

Aleutian Islands: Harbor seals are not designated as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 9.9 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 90 + 1.8= 93.1) is not known to exceed the PBR (99). Therefore, the Aleutian Islands stock of harbor seals is not classified as a strategic stock

Pribilof Islands:. Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 0.7 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 0 + 1.8 = 3.1) is not known to exceed the PBR (7). Therefore, the Pribilof Islands stock of harbor seals is not classified as a strategic stock.

Bristol Bay: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 106.1 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 141 + 1.8 = 144.1) is not known to exceed the PBR (1061). Therefore, the Bristol Bay stock of harbor seals is not classified as a strategic stock.

North Kodiak: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 25.6 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 131 + 1.8 = 134.1) is not known to exceed the PBR (256). Therefore, the North Kodiak stock of harbor seals is not classified as a strategic stock.

South Kodiak: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 63.9 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 78 + 1.8 = 81.1) is not known to exceed the PBR (639). Therefore, the South Kodiak stock of harbor seals is not classified as a strategic stock.

Prince William Sound: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 81.5 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (25.3 + 439 + 1.8 = 466.1) is not known to exceed the PBR (815). Therefore, the Prince William Sound stock of harbor seals is not classified as a strategic stock.

Cook Inlet/Shelikof: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 131.4 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 233 + 1.8 = 236.1) is not known to exceed the PBR (1314). Therefore, the Bristol Bay stock of harbor seals is not classified as a strategic stock.

Glacier Bay/Icy Strait: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 14.2 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 52 + 1.8 = 55.1) is not known to exceed the PBR (142). Therefore, the Glacier Bay/Icy Strait stock of harbor seals is not classified as a strategic stock.

Lynn Canal/Stephens: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 25.4 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 30 + 1.8 = 33.1) is not known to exceed the PBR (254). Therefore, the Lynn Canal/Stephens stock of harbor seals is not classified as a strategic stock.

Sitka/Chatham: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 24.7 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 222 + 1.8 = 225.1) is not known to exceed the PBR (247). Therefore, the Sitka/Chatham stock of harbor seals is not classified as a strategic stock.

Dixon/Cape Decision: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 82.1 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 157 + 1.8 = 160.1) is not known to exceed the PBR (821). Therefore, the Dixon/Cape Decision stock of harbor seals is not classified as a strategic stock.

Clarence Strait: Harbor seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. At present, U.S. commercial fishery-related annual mortality levels less than 134.8 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.3 + 164 + 1.8 = 167.1) is not known to exceed the PBR (1,348). Therefore, the Clarence Strait stock of harbor seals is not classified as a strategic stock.

CITATIONS

Bigg, M. A. 1969. The harbor seal in British Columbia. Bull. Fish. Res. Bd. Can. 172:1-33.

Bigg, M. A. 1981. Harbour seal: *Phoca vitulina* Linnaeus, 1758, and *Phoca largha* Pallas, 1811. Pages 1-27 *in* S. H. Ridgway and R. J. Harrison, editors. Handbook of Marine Mammals. Volume 2: Seals. Academic Press, London, UK.

Boveng, P. L., J. L. Bengtson, D. E. Withrow, J. C. Cesarone, M. A. Simpkins, K. J. Frost, and J. J. Burns. 2003. The abundance of harbor seals in the Gulf of Alaska. Mar. Mammal Sci. 19:111-127.

Calambokidis, J., B. L. Taylor, S. D. Carter, G. H. Steiger, P. K. Dawson, and L. D. Antrim. 1987. Distribution and haul-out behavior of harbor seals in Glacier Bay, Alaska. Can. J. Zool. 65:1391-1396.

Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. Bull. Fish. Res. Bd. Can. 93:1-58.

Frost, K. J., L. F. Lowry, and J. M. Ver Hoef. 1999. Monitoring the trend of harbor seals in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. Mar. Mammal Sci. 15:494-506.

Hall, D. K., C. S. Benson, and W. O. Field. 1995. Changes of glaciers in Glacier Bay, Alaska using ground and satellite measurements. Phys. Geog. 16:27-41.

Härkönen, T., and K. C. Harding. 2001. Spatial structure of harbour seal populations and the implications thereof. Can. J. Zool. 79:2115-2127.

Hastings, K. K., K. J. Frost, M. A. Simpkins, G. W. Pendleton, U. G. Swain, and R. J. Small. 2004. Regional differences in diving behavior of harbor seals in the Gulf of Alaska. Can. J. Zool. 82:1755-1773.

Hoover, A. A. 1983. Behavior and ecology of harbor seals, *Phoca vitulina richardsi*, inhabiting glacial ice in Aialik Bay, Alaska. M.S. Thesis. University of Alaska, Fairbanks, Fairbanks, AK. 133 p.

Hoover-Miller, A. 1994. The harbor seal (*Phoca vitulina*) biology and management in Alaska. Marine Mammal Commission. 1-67 p.

Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor seal, *Phoca vitulina richardsi*, stock assessment in Washington and Oregon, 1993. U.S. Department of Commerce, 1993 Annual Report to the MMPA Assessment Program, Office of Protected Resources.

Jemison, L. A., G. W. Pendleton, C. A. Wilson, and R. J. Sniall. 2006. Long-term trends in harbor seal numbers at Tugidak Island and Nanvak Bay, Alaska. Mar. Mammal Sci. 22:339-360.

Lowry, L. F., K. J. Frost, J. M. Ver Hoef, and R. A. DeLong. 2001. Movements of satellite-tagged subadult and adult harbor seals in Prince William Sound, Alaska. Mar. Mammal Sci. 17:835-861.

Mathews, E. A. 1995. Longterm trends in the abundance of harbor seals, *Phoca vitulina richardsi*) and the development of monitoring methods in Glacier Bay National Park, Southeast Alaska. D. R. Engstrom, editor. Proceedings of the Third Glacier Bay Science Symposium, Gustavus, AK. U.S. National Park Service, Glacier Bay National Park and Preserve.

Mathews, E. A., and G. W. Pendleton. 2006. Declines in harbor seal (*Phoca vitulina*) numbers in Glacier Bay National Park, Alaska, 1992-2002. Mar. Mammal Sci. 22:167-189.

Molnia, B. F. 2007. Late nineteenth to early twenty-first century behavior of Alaskan glaciers as indicators of changing regional climate. Global Planetary Change 56:23-56.

Montgomery, R. A., J. M. Ver Hoef, and P. L. Boveng. 2007. Spatial modeling of haul-out site use by harbor seals in Cook Inlet, Alaska. Mar. Ecol. Progr. Ser. 341:257-264.

O'Corry-Crowe, G. M., K. K. Martien, and B. L. Taylor. 2003. The analysis of population genetic structure in Alaskan harbor seals, *Phoca vitulina*, as a framework for the identification of management stocks. Southwest Fish. Sci. Cent. Admin. Rep. LJ-03-08. 1-54 p.

Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Recent trends in the abundance of harbor seals, *Phoca vitulina*, in British Columbia. Can. J. Fish. Aquat. Sci. 47:992-1003.

Pitcher, K. W. 1990. Major decline in number of harbor seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska. Mar. Mammal Sci. 6:121-134.

Pitcher, K. W., and D. C. McAllister. 1981. Movements and haulout behavior of radio-tagged harbor seals, *Phoca vitulina*. Can. Field-Nat. 95:292-297.

Scheffer, V. B., and J. W. Slipp. 1944. The harbor seal in Washington State. Am. Midland Nat. 32:373-416.

Simpkins, M. A., D. E. Withrow, J. C. Cesarone, and P. L. Boveng. 2003. Stability in the proportion of harbor seals hauled out under locally ideal conditions. Mar. Mammal Sci. 19:791-805.

Small, R. J., P. L. Boveng, V. G. Byrd, and D. E. Withrow. 2008. Harbor seal population decline in the Aleutian archipelago. Mar. Mammal Sci. 24:845-863.

Small, R. J., L. F. Lowry, J. M. Ver Hoef, K. J. Frost, R. A. DeLong, and M. J. Rehberg. 2005. Differential movements by harbor seal pups in contrasting Alaska environments. Mar. Mammal Sci. 21:671-694.

Small, R. J., G. W. Pendleton, and K. W. Pitcher. 2003. Trends in abundance of Alaska harbor seals, 1983-2001. Mar. Mammal Sci. 19:344-362.

Streveler, G. P. 1979. Distribution, population ecology and impact susceptibility of the harbor seal in Glacier Bay, Alaska U. S. National Park Service Final Report 49 p.

Swain, U., J. Lewis, G. Pendleton, and K. Pitcher. 1996. Movements, haul-out, and diving behaviour of harbor seals in southeast Alaska and Kodiak Island. Pages 59-144 *in* Annual Report: Harbor Seal Investigations in Alaska, NOAA Grant NA57FX0367. Division of Wildflife Conservation, Alaska Department of Fish and Game, Douglas, AK.

Wade, P. R., and R. P. 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.

Westlake, R. L., and G. M. O'Corry-Crowe. 2002. Macrogeographic structure and patterns of genetic diversity in harbor seals (*Phoca vitulina*) from Alaska to Japan. J. Mammal. 83:1111-1126.

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 Native Harbor Seal Commission and Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 339. 91 p.

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 Native Harbor Seal Commission and Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 345. 95 p.

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 Native Harbor Seal Commission and Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 347. 93 p.

Wolfe, R. J., J. A. Fall, and R. T. Stanek. 2004. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2003. Division of Subsistence, Alaska Department of Fish and Game, Technical Paper No. 291.

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. Division of Subsistence, Alaska Department of Fish and Game, Technical Paper No. 319.

Womble, J. N., G. W. Pendleton, E. A. Mathews, G. M. Blundell, N. M. Bool, and S. M. Gende. 2010. Harbor seal (*Phoca vitulina richardii*) decline continues in the rapidly changing landscape of Glacier Bay National Park, Alaska 1992–2008. Mar. Mammal Sci. 26:686-697.

SPOTTED SEAL (*Phoca largha*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Spotted seals are distributed along the continental shelf of the Bering, Chukchi, and Beaufort seas, and the Sea of Okhotsk south to the western Sea of Japan and northern Yellow Sea (Fig. 10). Eight main areas of spotted seal breeding have been reported (Shaughnessy and Fay 1977). On the basis of small samples and preliminary analyses of genetic composition, potential geographic barriers, and significance of breeding groups Boveng et al. (2009) grouped those breeding areas into three Distinct Population Segments (DPSs): The Bering DPS, which includes breeding areas in the Bering Sea ~~and summering areas in the Beaufort, Chukchi and East Siberian seas~~; the Okhotsk DPS; and the Southern DPS, which includes spotted seals breeding in the Yellow Sea and Peter the Great Bay in the Sea of Japan. For the purposes of this stock assessment the Bering DPS is considered the Alaska stock of the spotted seal.

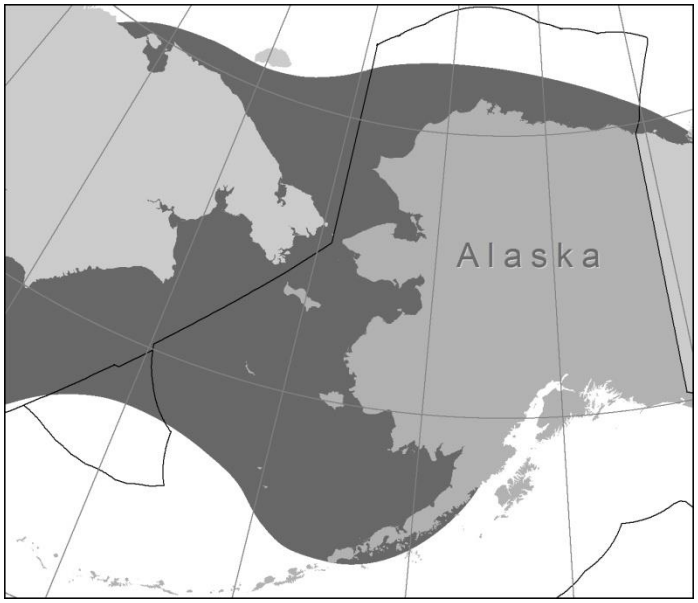

Figure 10. Approximate distribution of spotted seals (shaded area).

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

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous; 2) Population response data: unknown; 3) Phenotypic data: unknown; 4) Genotypic data: unknown. Based on this limited information, and the absence of any significant fishery interactions, there is currently no strong evidence to suggest splitting ~~the distribution of~~ Alaska spotted seals into more than one stock. Therefore, only ~~the~~ one Alaska stock is recognized in U.S. waters.

POPULATION SIZE

Recent surveys and analyses have substantially improved the documentation of the spotted seal population breeding in the U.S. waters of the Bering Sea. A large segment (280,000 km^2) of the breeding area was surveyed by

helicopter from an icebreaker in the spring of 2007; the abundance of spotted seals was estimated using a model that incorporated variation due to detectability, availability (proportion hauled out), and changes in extent and concentration of sea ice during the surveys. The modal estimate of abundance was 233,700 spotted seals with a 95% credible interval of 137,300 – 793,100 (Ver Hoef et al. 2014). A more extensive fixed-wing aerial survey (767,000 km^2) conducted during April – May of 2012 and 2013 encompassed the vast majority of the spotted seal breeding area. Analysis of a portion of the data, from 10 broadly-distributed survey flights during 20 – 27 April 2012, resulted in a mean estimate of 460,268 spotted seals, with a 95% CI of 391,000 – 559,993 (Conn et al. 2014). The method accounted for uncertainty in detection rate and species classification, as well as availability.

Other, previous surveys and estimates for spotted seals in the Bering Sea (e.g., Braham et al. 1984, Fedoseev et al. 1988, Fedoseev 2000, Rugh et al. 1995) are problematic to interpret and to compare with recent estimates because there is insufficient information available to assess detection rates, species mis-classification rates, area surveyed, extrapolation to unsurveyed areas, and other critical factors for estimating abundance and trends (Burkanov et al. 1988, Ver Hoef et al. 2014, Conn et al. 2013).~~A reliable estimate of the Alaska stock of spotted seal abundance is currently not available (Boveng et al. 2009). A joint U.S. Soviet effort in 1976 was the most thorough ice seal survey of the southeastern Bering Sea to date (Braham et al. 1984) and produced an unstratified density estimate of spotted seals of 0.37 per nmi^2. Abundance estimates for that region were reported as 10,876 (stratified) and 13,125 (unstratified); however, only seals on the ice were counted, and no adjustment was made for seals in the water. Results were reported primarily in units of seals sighted per unit of surveying time and therefore do not represent abundance estimates.~~

~~Based on extensive surveys of the Bering Sea ice in 1987, Fedoseev et al. (1988) reported a minimum estimate of 100,000 spotted seals in the Bering Sea, based on raw counts of 432 spotted seals in April and 179 in May. Four aerial surveys in the western Bering Sea during 1974-1987 produced abundance estimates ranging between 78,000 and 143,000 spotted seals (Fedoseev 2000), with a multi-year average of 140,000 seals. Burkanov et al. (1988) criticized the aerial survey methods used by Fedoseev and others during 1979 and 1987 in the western Bering Sea and argued that significant errors may have resulted from incorrect determinations of the area inhabited by seals.~~

~~The Alaska Fisheries Science Center's National Marine Mammal Laboratory (NMML) conducted aerial surveys of the Bering Sea pack ice in 1992 and calculated the density of spotted seals to be 0.28 seals/nmi^2 (Rugh et al. 1995). These surveys were shore based and limited to the areas around Bristol Bay, Nunivak Island, and between Nome and St. Lawrence Island and were not adjusted for seals in the water. More thorough aerial surveys by NMML in 2007 were conducted from U.S. Coast Guard icebreakers that provided greater access to the central and eastern Bering Sea pack ice (Ver Hoef et al. *in review*). Frequencies of sightings data and information on ice distribution and the timings of seal haul-out behavior were analyzed to develop a population estimate of 141,479 (95% CI 92,769-321,882) spotted seals in the areas surveyed within the eastern and central Bering Sea (Ver Hoef et al. *in review*).~~

Minimum Population Estimate

The 2012 survey was used as the basis for the minimum population estimate because it was the most current survey, the survey tracks encompassed more of the spotted seal breeding area than did the 2007 tracks, and it was conducted at a substantially higher altitude (1000 ft.) than the 2007 survey (400 ft.), reducing the potential for bias from disturbance. Conn et al. (2014) acknowledged potential upward bias resulting from the process of extrapolating to unsurveyed areas; consequently, the lower 95% confidence limit, rather than the lower 80% limit was used for the minimum population estimate, N_{MIN} = 391,000.~~A reliable minimum population estimate (N_{MIN}) for this stock can not presently be determined because current reliable estimates of abundance are not available.~~

Current Population Trend

Frost et al. (1993) report that counts of spotted seals were relatively stable at Kasegaluk Lagoon from the mid-1970s through 1991. ~~As~~Because this represents only a fraction of the stock's range and the ~~likelihood that these~~ data are outdated, reliable data on trends in population abundance for the Alaska stock of spotted 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 spotted 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). Therefore, PBR for this stock is 391,000×0.06×0.5 = 11,730 individuals.~~However, because a reliable estimate of N_{MIN} is currently not available, 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

~~Until 2003, there were six different federally regulated commercial fisheries in Alaska that could have interacted with spotted seals. These fisheries were monitored for incidental mortality by fishery observers. As of~~~~In 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these six fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska.~~ Prior to 2004, there were no reports of incidental serious injuries and mortalities of spotted seals in any of the observed fisheries. ~~The Bering Sea/Aleutian Islands flatfish trawl fishery is the only known observed commercial fishery to incur mortalities of spotted seals, with an average of 1.00 (CV = 0.01) seals per year for the period 2007-2009 (Table 15a).~~ Between 2008 and 2012, incidental serious injuries and mortalities of spotted seals were reported in 3 of the 22 federally regulated commercial fisheries in Alaska monitored for incidental mortality by fisheries observers, the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, and the Bering Sea/ Aleutian Islands Pacific cod longline fisheries (Table 20). The total estimated minimum annual mortality rate incidental to commercial fisheries is 1.5 (CV = 0.13) spotted seals per year, based on observer data.

~~The estimated minimum mortality rate incidental to commercial fisheries is 1.0~~~~1.5 animals~~~~individuals per year. However, s~~Serious injury and mortality of harbor seals incidental to commercial fisheries has occurred within the past five years, and because it is virtually impossible to distinguish between these two species, some of the reported harbor seal takes may actually have been spotted seals. Further, no observer programs have been done on nearshore Bristol Bay fisheries that are known to interact with this stock, making the total mortality due to fisheries unknown.

Table 20. Summary of incidental mortality of spotted seals (Alaska stock) due to commercial fisheries from ~~2007~~2008 through ~~2009~~2012 and calculation of the mean annual mortality rate (Breiwick 2013). Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	~~Range of~~ Observer coverage	Reported mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/ Aleutian Islands flatfish trawl	~~2007~~	obs data	~~72~~	~~0~~	~~0~~	1.00
	2008		100	2	2.0	(CV = 0.01)
	2009		100	1	1.0	
	2010		100	0	0	
	2011		100	0	0	
	2012		100	2	2.0	

Fishery name	Years	Data type	~~Range of~~ Observer coverage	Reported mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/ Aleutian Islands pollock trawl	2008 2009 2010 2011 2012	obs data	85 86 86 98 98	0 0 1 0 0	0 0 1.0 0 0	0.20 (CV = 0.11)
Bering Sea/ Aleutian Islands Pacific cod longline	2008 2009 2010 2011 2012	obs data	63 60 64 57 51	0 0 0 1 0	0 0 0 1.6 0	0.32 (CV = 0.61)
Minimum total annual mortality						~~1.00~~1.52 (CV = ~~0.01~~0.13)

Subsistence/Native Harvest Information

Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions~~, with historical estimated annual harvests ranging from 850 to 3,600 seals (averaging about 2,400 annually) taken during 1966-76 (Lowry 1984)~~.

Few studies give a statewide estimate of subsistence take. The Division of Subsistence, Alaska Department of Fish and Game and the Alaska Native Harbor Seal Commission has reported subsistence harvest levels of harbor seals and sea lions annually (e.g., Wolfe et al. 2009b). Harvest data were reported from 63 coastal communities, including 6 communities from northern Bristol Bay. Due to seasonal geographic overlap in spotted and harbor seal distribution in northern Bristol Bay in combination with the difficulty in distinguishing the two species from external morphology, reports of harvests of spotted seals were differentiated from harbor seals based on ecological features of the kill, primarily degree of association with seasonal ice (Wolfe et al. 2008). ~~As of 2009, data on community subsistence harvests are no longer being collected, so the estimates from 2004-2008 will be used to estimate the annual harvest for the most recent 5-year period. The estimates given in Table 15b represent the best estimate of the subsistence harvest of spotted seals in northern Bristol Bay, although species identifications were not confirmed; therefore, the harvest estimates for spotted seals may include some harbor seals, and some spotted seals may have been recorded as harbor seals (Wolfe et al. 2009b).~~ In 2008, six coastal villages in northern Bristol Bay reported a total of 271 spotted seals taken during for subsistence harvest (213 harvested, 58 struck and lost). As of 2009, data on community subsistence harvests are no longer being collected. Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 119 spotted seals were harvested during 2012 (Ice Seal Committee 2013). No complete data for the spotted seal harvest and struck and lost animals are available for the 2008-2012 period.

~~The mean annual subsistence harvest in north Bristol Bay from this stock over the 5-year period from 2004 through 2008 was 193 spotted seals per year (Table 15b). The combined harvest from Bristol Bay (mean annual harvest = 193) and Northwest Alaska (119 in 2012) is 312.~~

~~**Table 15b.** Summary of the subsistence harvest data for spotted seals from six coastal villages in northern Bristol Bay, 2002-2006~~~~2004-2008~~.

~~Year~~	~~Estimated total number taken~~	~~Number harvested~~	~~Number struck and lost~~
~~2004~~	~~170[1]~~	~~124~~	~~46~~
~~2005~~	~~201[2]~~	~~170~~	~~31~~
~~2006~~	~~170[3]~~	~~140~~	~~30~~
~~2007~~	~~153[4]~~	~~137~~	~~16~~
~~2008~~	~~271[5]~~	~~213~~	~~58~~
~~Mean annual take (2004-2008)~~	~~193~~	~~157~~	~~36~~

~~[1] Wolfe et al. 2005; [2] Wolfe et al. 2006; [3] Wolfe et al. 2008; [4] Wolfe et al. 2009a; [5] Wolfe et al. 2009b.~~

The Division of Subsistence, Alaska Department of Fish and Game, maintains a database that provides additional information on the subsistence harvest of ice seals in different regions of Alaska (ADFG 2000a, b). Information on subsistence harvest of spotted seals has been compiled for 135 villages from reports from the Division of Subsistence (Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarbrough 1999) and a report from the Eskimo Walrus Commission (Sherrod 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990-98 were used. As of August 2000; the subsistence harvest database indicated that the estimated number of spotted seals harvested for subsistence use per year ~~is~~was 5,265.

At this time, there are no efforts to quantify the total statewide level of harvest of spotted seals by all Alaska communities.

A report on ice seal subsistence harvest in three Alaskan communities indicated that the number and species of ice seals harvested in a particular village may vary considerably ~~between~~among years (Coffing et al. 1999). These interannual differences are likely due to differences in ice and wind conditions that change the hunters' access to different ice habitats frequented by different types of seals. Although some of the more recent entries in the ADFG database have associated measures of uncertainty (Coffing et al. 1999, Georgette et al. 1998), the overall total does not. The estimate of 5,265 spotted seals is the best estimate of harvest level currently available.

STATUS OF STOCK

Spotted seals in Alaska are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. ~~Reliable estimates of the minimum population, PBR, and human-caused mortality and serious injury are currently not available. Because the PBR for spotted seals is unknown, the level of annual U.S. commercial fishery related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown.~~ Based on currently available data, the minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock (1.52) is less than 10% of the calculated PBR (1,173) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The estimated annual level of total human-caused mortality and serious injury is 1.52 (commercial fisheries) + 5,265 (Alaska Native harvest) = 5,267 does not exceed the PBR (11,730) for this stock. The Alaska stock of spotted seals is not considered a strategic stock.

On 28 March 2008, NMFS initiated a status review of the spotted seal (73 FR 16617). On 28 May 2008, NMFS received a petition to list spotted seals under the ESA, primarily due to concern about threats to this species' habitat from loss of sea ice and climate change in the Arctic. NMFS found that the petition presented sufficient information to consider listing and proceeded with the status review (73 FR 51615, 4 September 2008). After the status review was complete (Boveng et al. 2009), NMFS determined that listing the Bering and Okhotsk DPSs of spotted seals was not warranted at this time. The Southern DPS, however, was proposed for listing as "threatened" under the ESA (74 FR 53683, 20 October 2009). After fully considering comments from peer reviewers and the public, NMFS issued a final rule listing the Southern DPS as "threatened" on 22 October 2010 (75 FR 65239).

Habitat Concerns

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

A second major concern, related by the common driver of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may impact spotted seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The

nature and timing of such impacts are extremely uncertain. Because of spotted seals' apparent dietary flexibility, this threat should be of less immediate concern than the direct effects of sea-ice degradation (Boveng et al. 2009).

Additional habitat concerns include the potential effects from 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

Alaska Department of Fish and Game. 2000a. Community Profile Database 3.04 for Access 97. Division of Subsistence, Anchorage.

Alaska Department of Fish and Game. 2000b. Seals+ Database for Access 97. Division of Subsistence, Anchorage.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

Boveng, P. L., J. L. Bengtson, T. W. Buckley, M. F. Cameron, S. P. Dahle, B. P. Kelly, B. A. Megrey, J. E. Overland, and N. J. Williamson. 2009. Status review of the spotted seal (*Phoca largha*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-200, 153 p.

Braham, H. W., J. J. Burns, G. A. Fedoseev, and B. D. Krogman. 1984. Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walruses in the Bering Sea, April 1976 Pages 25-47 in F. H. Fay and G. A. Fedoseev, editors. Soviet-American Cooperative Research on Marine Mammals. Volume 1 - Pinnipeds. U.S. Department of Commerce, NOAA Technical Report NMFS 12.

Burkanov, V. N., A. R. Semenov, S. A. Mashagin, and E. V. Kitayev. 1988. Data on abundance of ice forms of seals in the Karaginski Gulf of the Bering Sea in 1986-1987. Pages 71-80 *in* N. S. Chernysheva, editor. Scientific Research on Sea Mammals of the Northern Part of the Pacific Ocean in 1986-1987. All-Union Scientific Research Institute of Sea Fisheries and Oceanography (VNIRO), Moscow, Russia. (Translated from Russian by Canada Institute for Scientific and Technical Information, National Research Council, Ottawa, Canada, 9 p.).

Coffing, M., C. Scott, and C.J. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1997-1998. Technical Paper No. 255, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Coffing, M., C. Scott, and C.J. Utermohle. 1999. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1998-1999. Technical Paper No. 257, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Conn, P. B., B. T. McClintock, M. F. Cameron, D. S. Johnson, E. E. Moreland, and P. L. Boveng. 2013. Accommodating species identification errors in transect surveys. Ecology 94:2607-2618.

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 in Ecology and Evolution DOI 10.1111/2041-210X.12127

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

Fay, F. H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea. Pp. 383-389 *In* D. W. Hood and E. J. Kelley (eds.), Oceanography of the Bering Sea. Univ. Alaska, Fairbanks, Inst. Mar. Sci. Occas. Publ. 2.

Fedoseev, G. A. 2000. Population biology of ice-associated forms of seals and their role in the northern Pacific ecosystems. Center for Russian Environmental Policy, Russian Marine Mammal Council, Moscow, Russia. 271 p. (Translated from Russian by I. E. Sidorova, 271 p.).

Fedoseev, G. A., Y. V. Razlivalov, and G. G. Bobrova. 1988. Distribution and abundance of the ice forms of pinnipeds on the ice of the Bering Sea in April and May 1987. Pages 42-59 *in* N. S. Chernysheva, editor. Scientific Research on Sea Mammals of the Northern Part of the Pacific Ocean in 1986-1987. All-Union Scientific Research Institute of Sea Fisheries and Oceanography (VNIRO), Moscow, Russia. (Translated from Russian by Canada Institute for Scientific and Technical Information, National Research Council, Ottawa, Canada, 189 p.).

Frost, K. J., L. F. Lowry, and G. Carroll. 1993. Beluga whale and spotted seal use of a coastal lagoon system in the northeastern Chukchi Sea. Arctic 46:8-16.

Georgette, S., M. Coffing, C. Scott, and C. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in the Norton Sound-Bering Strait Region, Alaska, 1996-97. Technical Paper No. 242, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

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.

Lowry, L. F. 1984. The spotted seal (*Phoca largha*). Pp. 1-11 *In* Alaska Dep. Fish and Game marine mammal species accounts. Vol. 1. Juneau, Alaska.

Lowry, L. F., V. N. Burkanov, K. J. Frost, M. A. Simpkins, A. Springer, D. P. DeMaster, and R. Suydam. 2000. Habitat use and habitat selection by spotted seals (*Phoca largha*) in the Bering Sea. Can. J. Zool. 78:1959-1971.

Lowry, L. F., K. J. Frost, R. Davis, D. P. DeMaster, and R. S. Suydam. 1998. Movements and behavior of satellite-tagged spotted seals (*Phoca largha*) in the Bering and Chukchi Seas. Polar Biol. 19:221-230.

Porsild, A. E. 1945. Mammals of the Mackenzie Delta. Can. Field-Nat. 59:4-22.

Quakenbush, L. T. 1988. Spotted seal, *Phoca largha*. Pp. 107-124 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Rugh, D. J., K. E. W. Shelden, and D. E. Withrow. 1995. Spotted seal sightings in Alaska 1992-93: Final Report. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Shaughnessy, P. D., and F. H. Fay. 1977. A review of the taxonomy and nomenclature of North Pacific harbour seals. J. Zool. (Lond.) 182:385-419.

Sherrod, G.K. 1982. Eskimo Walrus Commission's 1981 Research Report: The Harvest and Use of Marine Mammals in Fifteen Eskimo Communities. Kawerak, Inc., Nome.

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.

Ver Hoef, J. M., M. F. Cameron, P. L. Boveng, J. M. London, and E. E. Moreland. 2014. A spatial hierarchical model for abundance of three ice-associated seal species in the eastern Bering Sea. Statistical Methodology 17:46-66. (Published online April 8, 2013).

~~Ver Hoef, J. M., Cameron, M. F., Boveng, P. L., London, J. M., and Moreland, E. M. *In Press*. A hierarchical model for abundance of three ice-associated seal species in the Eastern Bering Sea. Statistical Methodology.~~

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 pp.

Wolfe, R., and L.B. Hutchinson-Scarbrough. 1999. The subsistence harvest of harbor seal and sea lion by Alaska Natives in 1998. Technical Paper No. 250, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

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. 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 Native Harbor Seal Commission and Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 345. Anchorage, 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 Native Harbor Seal Commission and Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 347. Anchorage, AK.

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 Dep. 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 Dep. Fish and Game, Division of Subsistence Technical Paper No. 339. Juneau, AK.

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, Burns and Frost 1979, Burns 1981, 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).

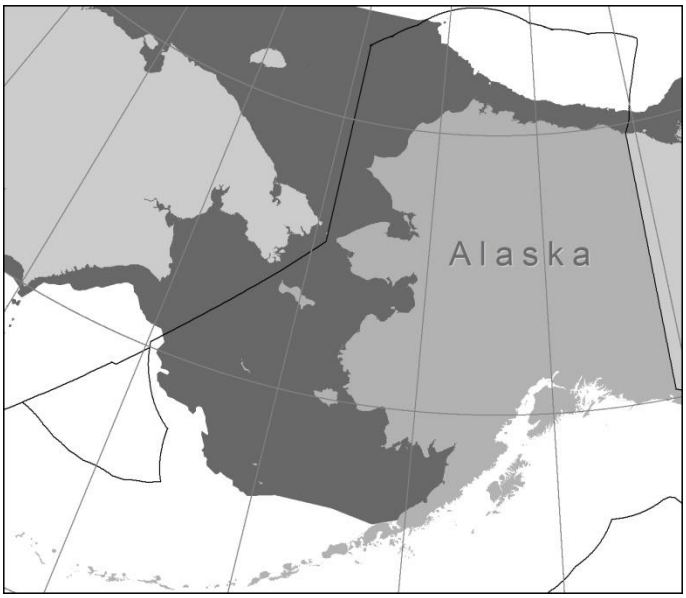

Figure 11. Approximate distribution of bearded seals (shaded area) in Alaska. The combined summer and winter distribution are depicted.

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, Cameron et al. (2010) defined longitude 112° W in the Canadian Arctic Archipelago as the North American delineation between the two subspecies and 145° E as the Eurasian 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 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.

Spring surveys conducted in 1999 and 2000 along the Alaskan coast indicate that bearded seals tend to prefer areas of between 70% and 90% sea ice coverage, and are typically more abundant 20-100 nmi from shore than within 20 nmi of shore, with the exception of high concentrations nearshore to the south of Kivalina (Bengtson et al. 2000; Bengtson et al. 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 along the ice edge in the Chukchi Sea (Burns 1967, Burns 1981), although aerial surveys and tagging data suggest they ~~hang out~~spend time in open water with the loss of ice edge in the Chukchi in summer months. Bearded seals sounds (produced by adult males) have been recorded year-round at multiple locations in the Beaufort Sea and calling behavior is closely related to the presence of sea ice (MacIntyre et al. 2013). 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, Heptner et al. 1976, Burns 1981, 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, Cameron and Boveng 2007, Frost et al. 2008, Cameron and Boveng 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 this stock is currently considered not available. A few regions have been surveyed by various techniques over the past four decades, although only crude estimates for these areas exist and many assumptions used to derive these estimates are conservative (e.g., seals in the water were often not included, some areas were not surveyed or were omitted from the analysis). However, based on studies by Ver Hoef et al. (2010), Fedoseev (2000) and Bengtson et al. (2005), for purposes of the ESA status review of the species, Cameron et al. (2010) estimated about 125,000 bearded seals in the Bering Sea and 27,000 bearded seals in the Chukchi Sea. Cameron et al. (2010) did not present population estimates for the East Siberian and Beaufort Seas, but did estimate that the Beringia DPS contained approximately 155,000 bearded seals. This number is considered a crude estimate based on multiple surveys using various techniques over the past four decades, which involved conservative assumptions. However, given that these numbers are outdated, this estimate cannot necessarily be considered strictly minimum or conservative overall (Cameron et al. 2010). Ver Hoef et al. (2014) calculated an abundance of 61,800 (95% CI 34,900-171,600) bearded seals in a core area (297,880 km^2) of the central and eastern Bering Sea using survey data collected from helicopters operating off of an ice breaker in 2007. U.S. and Russian researchers conducted comprehensive and synoptic aerial abundance and distribution surveys of ice-associated seals in the Bering and Okhotsk Seas in 2012 and 2013. Those data are currently being analyzed to provide abundance estimates for bearded seals (Moreland et al. 2013). Conn et al. (2014) reported a preliminary estimate of 299,174 (95% CI 245,476 - 360,544) bearded seals in the Bering Sea using data from a more extensive, fixed-wing survey (767,000 km^2) conducted in April and May of 2012 and 2013; however, these data are still being further analyzed. These data do not include bearded seals in the Chukchi and Beaufort Seas, and so may have provided a low-biased estimate of the abundance of this DPS. The differences in abundance estimates from 2007 (Ver Hoef et al. 2014) and 2012 (Conn et al. 2014) are likely attributable to differences in area sampled and refinement of abundance estimates over time. Further analysis of these data is pending.

Minimum Population Estimate

A reliable minimum population estimate (N_{MIN}) for this stock can not presently be determined because current reliable estimates of abundance are not available. Data from the 2012 and 2013 surveys are currently being analyzed to provide abundance and minimum population estimates for bearded seals (Moreland et al. 2013).

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 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). 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

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

~~Until 2003, there were three different federally regulated commercial fisheries in Alaska that could have interacted with bearded seals and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these 3 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 serious injury or mortality of marine mammal stocks in Alaska.~~Of the 22 federally regulated commercial fisheries in Alaska monitored for incidental mortality by fisheries observers, 12 fisheries could potentially interact with bearded seals. Between ~~2007~~2008 and ~~2011~~2012, there were incidental serious injuries and mortalities of bearded seals in two of these fisheries: the Bering Sea/Aleutian Islands pollock trawl and the Bering Sea/ Aleutian Islands flatfish trawl fisheries (Table 21). The estimated minimum mortality rate incidental to commercial fisheries is 1.8 (CV = 0.05) bearded seals per year, based exclusively on observer data.

Table 21. Summary of incidental mortality of bearded seals (Alaska stock) due to commercial fisheries from ~~2007~~2008 to ~~2011~~2012 and calculation of the mean annual mortality rate (Breiwick ~~in review~~2013). Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. pollock trawl	~~2007~~ 2008 2009 2010 2011 2012	obs data	~~85~~ 85 86 86 98 98	~~1~~ 4 1 0 (+1)* 0 1	~~1.0~~ 4.1 1.0 0 (1)** 0 1.0	~~1.4~~1.23 (CV = ~~0.06~~0.07)
Bering Sea/ Aleutian Islands flatfish trawl	~~2007~~ 2008 2009 2010 2011 2012		~~72~~ 100 100 100 100 100	~~0~~ 1 0 0 1 1	~~0~~ 1.0 0 0 1.0 1.0	~~0.4~~0.6 (CV = ~~0.03~~0.02)
Total estimated annual mortality						~~1.8~~1.83 (CV = 0.05)

*Total mortalities observed in unsampled hauls.
**Total mortalities observed in sampled and unsampled hauls. Since the total known mortality (1) exceeds the estimated mortality (0) for 2010, the sum of actual mortalities observed (1) will be used as a minimum estimate for that year.

Subsistence/Native Harvest Information

Bearded seals are an important ~~species~~resource for Alaska subsistence hunters, with estimated annual harvests of 1,784 (SD = 941) from 1966 to 1977 (Burns 1981). Between August 1985 and June 1986, 791 bearded seals were harvested in five villages in the Bering Strait region based on reports from the Alaska Eskimo Walrus Commission (Kelly 1988). Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 258 bearded seals were harvested during 2012 (Ice Seal Committee 2013).

The Division of Subsistence, Alaska Department of Fish and Game maintained a database that provides additional information on the subsistence harvest of ice seals in different regions of Alaska (ADFG 2000a, b). Information on subsistence harvest of bearded seals was compiled for 129 villages from reports from the Division of Subsistence (Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarbrough 1999) and a report from the Eskimo Walrus Commission (Sherrod 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990 to 1998 were used. As of August

2000, the subsistence harvest database indicated that the estimated number of bearded seals harvested for subsistence use per year was 6,788. Data on overall statewide community subsistence harvests are no longer being collected and no new annual statewide harvest estimates exist.

At this time, there are no efforts to quantify the total statewide level of harvest of bearded seals by all Alaska communities. A report on ice seal subsistence harvest in three Alaskan communities indicated that the number and species of ice seals harvested in a particular village may vary considerably between years (Coffing et al. 1999). These interannual differences are likely due to differences in ice and wind conditions that change the hunters' access to different ice habitats frequented by different types of seals. Regardless of the extent to which the harvest may vary interannually, it is clear that the harvest level of 6,788 bearded seals estimated by the ADFG Division of Subsistence is considerably higher than the previous minimum estimate of 791 per year from five villages in the Bering Strait and the recent report of 258 seals harvested during 2012 by five northwest Alaska Native communities. Although some of the more recent entries in the ADFG database have associated measures of uncertainty (Coffing et al. 1999, Georgette et al. 1998), the overall total does not. The estimate of 6,788 bearded seals from 2000 is the best estimate of the total statewide annual harvest level currently available.

Other Mortality

Mortalities 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 2007-2011, there was 1 mortality resulting from research on the Alaska stock of bearded seals (2007), which results in an average of 0.2 mortalities per year from this stock (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910, 11 January 2012).

STATUS OF STOCK

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). 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). Because of its threatened status under the ESA, this stock is designated as "depleted" under the MMPA. As a result, the stock is classified as a strategic stock. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The total estimated annual level of human-caused mortality and serious injury based on commercial fisheries observer data (1.8), recent MMPA permit records, and Alaska Native harvest (6,788) is 6,790. Population trends and status of this stock relative to OSP are currently unknown.

Habitat Concerns

The main concern about the conservation status of bearded seals stems from the likelihood that their sea-ice habitat has been modified by the warming climate and, more so, that the 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 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., 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 the future conservation status of each bearded seal species segment 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 the Gulf of Anadyr and in the area between St. Lawrence Island and Bering Strait. 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 in the atmosphere, may impact 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 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

Alaska Department of Fish and Game. 2000a. Community Profile Database 3.04 for Access 97. Division of Subsistence, Anchorage.

Alaska Department of Fish and Game. 2000b. Seals+ Database for Access 97. Division of Subsistence, Anchorage. 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. Pp. 149-160 *In* A. L. Lopez and D. P. DeMaster. Marine Mammal Protection Act and Endangered Species Act Implementation Program 1999. AFSC Processed Rep. 2000-11, Alaska Fish. Sci. Cent., 7600 Sand Point Way NE, Seattle, WA 98115.

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.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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. Pp. 149-160 *In* A. L. Lopez and D. P. DeMaster. Marine Mammal Protection Act and Endangered Species Act Implementation Program 1999. AFSC Processed Rep. 2000-11, Alaska Fish. Sci. Cent., 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. Burns, J., G. A. Fedoseev, and B. D. Krogman. 1981. Distribution and density of ice-associated pinnipeds in the Bering Sea. Available at: NOAA, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA. 27 p.

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

Burns, J. J. 1967. The Pacific bearded seal. Alaska Dep. Fish and Game, Pittman-Robertson Proj. Rep. W-6-R and W-14-R. 66 pp.

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

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

Cameron, M. 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.

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.

Coffing, M., C. Scott, and C.J. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1997-1998. Technical Paper No. 255, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Coffing, M., C. Scott, and C.J. Utermohle. 1999. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1998-1999. Technical Paper No. 257, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Fay, F. H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea. Pages 383-399 in D. W. Hood and E. J. Kelley, editors. 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.).

Fedoseev, G. A. 2000. Population biology of ice-associated forms of seals and their role in the northern Pacific ecosystems. Center for Russian Environmental Policy, Russian Marine Mammal Council, Moscow, Russia. 271 p. (Translated from Russian by I. E. Sidorova, 271 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. Pages 98-99 in Proceedings of the Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, CA. Society for Marine Mammalogy.

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.

Georgette, S., M. Coffing, C. Scott, and C. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in the Norton Sound-Bering Strait Region, Alaska, 1996-97. Technical Paper No. 242, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Heptner, L. V. G., K. K. Chapskii, V. A. Arsen'ev, and V. T. Sokolov. 1976. Bearded seal. *Erignathus barbatus* (Erxleben, 1777). Pages 166-217 *in* L. V. G. Heptner, N. P. Naumov, and J. Mead, editors. 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. 2013. Northwest Arctic ice seal harvest survey for 2012. Ice Seal Committee Newsletter, 1(1):3.

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

Kelly, B. P. 1988. Bearded seal, *Erignathus barbatus.* Pp. 77-94 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

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

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

MacIntyre, K. M., 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 Biology.

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, Alaska. 125 pp.

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

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.

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. (Transl. from Russian by Israel Prog. Sci. Transl., 1962, 741 pp.).

Rice, D. W. 1998. Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Lawrence, KS. 231 p.

Scheffer, V. B. 1958. Seals, sea lions and walruses: a review of the Pinnipedia. Stanford University Press, Palo Alto, CA. 179 p.

Sherrod, G. K. 1982. Eskimo Walrus Commission's 1981 Research Report: The Harvest and Use of Marine Mammals in Fifteen Eskimo Communities. Kawerak, Inc., Nome.

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, Canadian Technical Report of Fisheries and Aquatic Sciences No. 1042. 49 p.

Ver Hoef, J. M., M. F. Cameron, P. L. Boveng, J. M. London, and E. M. Moreland. 2014. A spatial hierarchical model for abundance of three ice-associated seal species in the Eastern Bering Sea. Statistical Methodology. 17:46-66. DOI: 10.1016/j.stamet.2013.03.001

Ver Hoef, J. M., J. M. London, and P. L. Boveng. 2010. Fast computing of some generalized linear mixed pseudo-models with temporal autocorrelation. Comp. Stat. 25:39-55.

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 pp.

Wolfe, R., and L.B. Hutchinson-Scarbrough. 1999. The subsistence harvest of harbor seal and sea lion by Alaska Natives in 1998. Technical Paper No. 250, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Ringed seals 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: *Phoca hispida hispida* in the Arctic Ocean and Bering Sea; *Phoca hispida ochotensis* in the Sea of Okhotsk and northern Sea of Japan; *Phoca hispida botnica* in the northern Baltic Sea; *Phoca hispida lagodensis* in Lake Ladoga, Russia; and *Phoca hispida 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) but suggest gene flow from the Arctic to the Baltic as well as widespread mixing within the Arctic (Palo et al. 2001, Davis et al. 2008, Kelly et al. 2009, Martinez-Bakker et al. 2013). Differences in body size, morphology, growth rates, or diet between 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, this has not been thoroughly examined and the taxonomic status of the Arctic subspecies remains unresolved (Berta and Churchill 2012). ~~The lake-inhabiting subspecies are genetically isolated and those in the Baltic Sea and the Sea of Okhotsk apparently exchange genes with the Arctic subspecies minimally or not at all (Palo et al. 2001, Palo 2003, Kelly et al. 2009). The genetic structuring of *Phoca hispida hispida*, however, remains unresolved, and it may prove to be composed of multiple distinct populations (Kelly et al. 2010a).~~ For the purposes of this stock assessment, the Alaska stock of ringed seals is considered the portion of *Phoca hispida hispida* that occurs within the U.S. Exclusive Economic Zone (EEZ) of the Beaufort, Chukchi, and Bering Seas (Fig. 12).

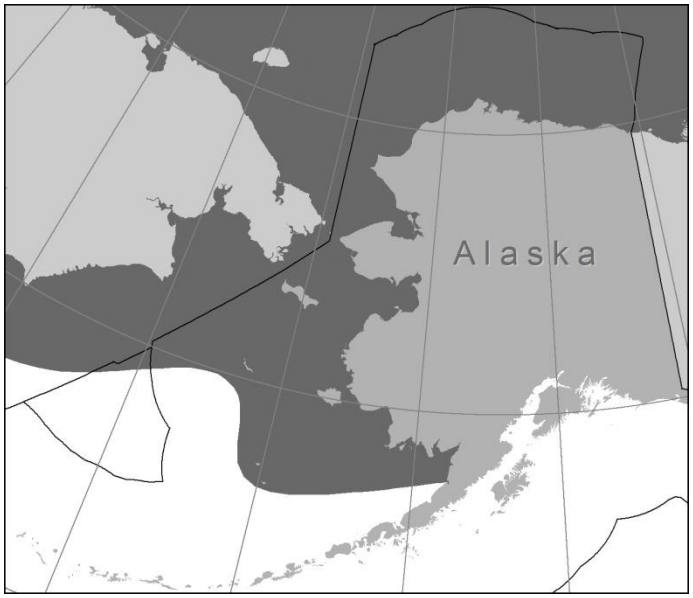

Figure 12. Approximate distribution of ringed seals (shaded area). The combined summer and winter distribution are depicted.

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 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, although land haulouts may be increasingly used because of increases in summer sea ice retreat. 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 Alaskan 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 migrate north in spring as the seasonal ice melts and retreats (Burns 1970) and ~~have historically spent~~spend summer in the pack ice of the northern Chukchi and Beaufort seas, as well as in nearshore ice remnants in the Beaufort Sea (Frost 1985~~); however, very little pack ice exists in the summer months in the northern Chukchi and Beaufort seas~~. During summer, ringed seals range hundreds to thousands of kilometers to forage along ice edges or in highly productive open-water areas

(Freitas et al. 2008, Kelly et al. 2010b). With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted and 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 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 incomplete coverage of 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 Alaskan 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 Alaskan 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 Alaskan 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 Alaskan 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. (~~2002~~2004) conducted surveys within 40 km of shore in the Alaskan 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 Alaskan Beaufort Sea during 1997-1999 but reported substantially lower ringed seal densities than Frost et al. (~~2002~~2004). The reason for this disparity was unclear (Frost et al. 2004). Bengtson et al. (2005) conducted surveys in the Alaskan 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 6 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 estimates from surveys by Bengtson et al. (2005) and Frost et al. (2004) in the late 1990s and 2000, for purposes of the ESA status review of the species, Kelly et al. (2010a) estimated the total population in the Alaskan Chukchi and Beaufort Seas as at least 300,000 ringed seals, which Kelly et al. (2010a) state is likely an underestimate since the Beaufort surveys were limited to within 40 km of shore.

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. 2013). This estimate does not account for availability bias, thus the actual number of ringed seals is likely much higher, perhaps by a factor of two or more. These data do not include bearded seals in the Chukchi and Beaufort Seas, and so may have provided a low-biased estimate of the abundance of this DPS. 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 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 is not considered a reliable abundance

estimate, is likely an underestimate, and is based on surveys of a portion of the range and are greater than 8 years old. A reliable estimate of N_{MIN} for the total population in the Alaskan Chukchi and Beaufort Sea regions is not available.

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 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.

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

~~Until 2003, there were three different federally regulated commercial fisheries in Alaska that could have interacted with ringed seals and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these three 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 serious injury or mortality of marine mammal stocks in Alaska.~~Between ~~2007~~2008 and ~~2011~~2012, there were incidental serious injuries and mortalities of ringed seals in reported in 4 of the 22 federally regulated commercial fisheries in Alaska monitored for incidental mortality by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl fishery, the Bering Sea/ Aleutian Islands pollock trawl, Bering Sea/ Aleutian Islands Pacific cod trawl, and the Bering Sea/ Aleutian Islands Pacific cod longline (Table 22). Based on data from ~~2007~~2008 to ~~2011~~2012, there have been an average of ~~3.52~~4.1 (CV = 0.06) mortalities of ringed seals incidental to commercial fishing operations.

Table 22. Summary of incidental mortality of ringed seals (Alaska stock) due to commercial fisheries from ~~2007~~2008 to ~~2011~~2012 and calculation of the mean annual mortality rate (Breiwick ~~in review~~2013). Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. flatfish trawl	~~2007~~	obs	~~72~~	~~0~~	~~0~~	~~2.0~~2.6
	2008	data	100	2	2.0	(CV = 0.02)
	2009		100	1	1.0	
	2010		100	0	0	
	2011		100	6 (+1)*	6.0 (7)**	
	2012		100	3	3.0	
Bering Sea/ Aleutian Is. pollock trawl	~~2007~~	obs	~~85~~	~~0~~	~~0~~	1.0
	2008	data	85	1	1.0	(CV = 0.04)
	2009		86	1	1.0	
	2010		86	0	0	
	2011		98	3	3.0	
	2012		98	0	0	
Bering Sea/ Aleutian Is. Pacific cod trawl	~~2007~~	obs	~~53~~	~~0~~	~~0~~	0.2
	2008	data	59	0	0	(CV = 0.01)
	2009		63	0	0	
	2010		66	0	0	
	2011		60	1	1.0	
	2012		68	0	0	
Bering Sea/ Aleutian Is. Pacific cod longline	~~2007~~	obs	~~63~~	~~0~~	~~0~~	0.32
	2008	data	63	0	0	(CV = 0.6)
	2009		60	0	0	
	2010		64	0	0	
	2011		57	1	1.6	
	2012		51	0	0	
Total estimated annual mortality						~~3.52~~4.12 (CV = 0.06)

*Total mortalities observed in unsampled hauls.

**Total mortalities observed in sampled and unsampled hauls. Since the total known mortality (7) exceeds the estimated mortality (6.0) for 2011, the sum of actual mortalities observed (7) will be used as a minimum estimate for that year.

Subsistence/Native Harvest Information

Ringed seals are an important ~~species~~resource for Alaska Native subsistence hunters. The estimated annual subsistence harvest in Alaska dropped from 7,000-15,000 ~~in the period from~~during 1962-1972 to an estimated 2,000-3,000 in 1979 (Frost 1985). Based on data from two villages on St. Lawrence Island, the annual take in Alaska during the mid-1980s likely exceeded 3,000 seals (Kelly 1988a).

The Alaska Department of Fish and Game (ADFG) Division of Subsistence~~, Alaska Department of Fish and Game (ADFG),~~ maintained a database that provided additional information on the subsistence harvest of ice seals in different regions of Alaska (ADFG 2000a, b). Information on subsistence harvest of ringed seals was compiled for 129 villages from reports from the Division of Subsistence (Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarbrough 1999) and a report from the Eskimo Walrus Commission (Sherrod 1982). Data were lacking for 22 villages~~;~~ so their harvests were estimated using the annual per capita rates of subsistence harvest from ~~a~~ nearby villages. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990 to 1998 were used. As of August 2000, the subsistence harvest database indicated that the estimated number of ringed seals harvested for subsistence use per year is 9,567. Data on community subsistence harvests are no longer routinely being collected, and no new statewide annual harvest estimates exist. Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 40 ringed seals were harvested during 2012 (Ice Seal Committee 2013).

At this time, there are no efforts to quantify the total statewide level of harvest of ringed seals by all Alaska communities. A report on ice seal subsistence harvest in three Alaskan communities indicated that the number and species of ice seals harvested in a particular village may vary considerably between years (Coffing et al. 1999). These interannual differences are likely due to differences in ice and wind conditions that change the hunters' access to different ice habitats frequented by different types of seals. Regardless of the extent to which the harvest may vary interannually, it is clear that the harvest level of 9,567 ringed seals estimated by the Division of Subsistence is considerably higher than the previous minimum estimate reported by Frost (1985). Although some of the more recent entries in the ADFG database have associated measures of uncertainty (Coffing et al. 1999, Georgette et al. 1998), the overall total does not. The estimate of 9,567 ringed seals is the best estimate currently available.

Other human-caused mortality and injury

Table 23. Summary of Alaska stock ringed seal mortalities and serious injures by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, Allen et al. in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Gunshot	0	0	0	1	0	0*
Minimum total annual mortality						0.0

*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.

Between ~~2007~~2008 and ~~2011~~2012, there were 4 records of dead and injured ringed seals reported to the Alaska Regional Office Marine Mammal Stranding Network. All 3 injuries were considered not serious (Allen and et al. 2014). One male ringed seal was found in 2008 with a packing band and circumferential wound around its neck; it was disentangled. Two injured ringed seals were reported in 2010, one with a bleeding flipper that was captured and released on site, another that was caught in a subsistence salmon set net. This animal was disentangled by ADFG and released. In 2011, one ringed seal was reported dead from a gunshot wound to the head, presumably a struck and lost animal from the subsistence hunt (Table 23). This animal presented with skin lesions consistent with those seen in animals considered part of the multi-species northern pinnipeds 2011 Unusual Mortality Event.

STATUS OF STOCK

On December 28, 2012, NMFS listed Arctic ringed seals (*Phoca hispida hispida*) and, thus, the Alaska stock of ringed seals, as threatened under the Endangered Species Act ~~(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 is designated as "depleted" under the MMPA. As a result, the stock is classified as a strategic stock. Since PBR is undetermined, it is not known whether current annual level of incidental U. S. commercial fishery-related mortality (~~3.52~~4.1) exceeds 10% of the PBR. However, mortality and serious injury occurring incidental to commercial fishing is likely small~~insignificant and approaching a zero mortality and serious injury rate~~. The total estimated level of human-caused mortality and serious injury based on commercial fisheries observer data (~~3.52~~4.1) and Alaska Native harvest (9,567) is 9,571. Population trends and status of this stock relative to OSP 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 affect 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 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 the 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.

Additional habitat concerns include the potential effects from 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

Alaska Department of Fish and Game. 2000a. Community Profile Database 3.04 for Access 97. Division of Subsistence, Anchorage.

Alaska Department of Fish and Game. 2000b. Seals+ Database for Access 97. Division of Subsistence, Anchorage.

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

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

Angliss, R. P., and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: report of the serious injury workshop 1-2 April 1997, Silver Spring, Maryland. 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.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). Page 147 *in* N. A. Smirnov, editor. 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.).

Coffing, M., C. Scott, and C.J. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1997-1998. Technical Paper No. 255, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Coffing, M., C. Scott, and C.J. Utermohle. 1999. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1998-1999. Technical Paper No. 257, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

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. 2013. Estimating multispecies abundance using automated detection systems: ice-associated seals in the Bering Sea. Methods in Ecology and Evolution, 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 Biology 35:241-255.

Davis, C. S., I. Stirling, C. Strobeck, and D. W. Coltman. 2008. Population structure of ice-breeding seals. Molecular Biology 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*). Pages 79-87 *in* J. J. Burns, K. J. Frost, and L. F. Lowry, editors. Marine Mammals Species Accounts. Alaska Department Fish and Game, Juneau, AK.

Frost, K. J., and L. F. Lowry. 1984. Trophic relationships of vertebrate consumers in the Alaskan Beaufort Sea. Pages 381-401 *in* P. W. Barnes, D. M. Schell, and E. Reimnitz, editors. 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 Rep. contract no. 84-ABC-00210 submitted to U.S. Dep. Interior, Minerals Management Service, Anchorage, AK. 101 pp.

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 Dep. Fish and Game, Juneau, AK, for U.S. Minerals Management Service, Anchorage, AK. 66 pp. + 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.

Georgette, S., M. Coffing, C. Scott, and C. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in the Norton Sound-Bering Strait Region, Alaska, 1996-97. Technical Paper No. 242, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

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. Marine Mammal Science 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*). Pages 167-180 *in* M. P. Heide-Jørgensen and C. Lydersen, editors. Ringed Seals in the North Atlantic. NAMMCO Scientific Publications, Volume 1, Tromsø, Norway.

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.

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. Geophysical Research Letters 39:L17505.

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

Ice Seal Committee. 2013. Northwest Arctic ice seal harvest survey for 2012. Ice Seal Committee Newsletter, 1(1):3.

Kelly, B. P. 1988a. Ringed seal, *Phoca hispida*. Pp. 57-75 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

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.

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.

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.

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 ed. Br. Muss. (Nat. Hits.), London. 240 pp.

Kumlien, L. 1879. Mammals. Pages 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, D.C.

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

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. (Translated from Russian by the Baltic Fund for Nature (BFN), State University of St. Petersburg, Russia).

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.

Lydersen, C. 1998. Status and biology of ringed seals (*Phoca hispida*) in Svalbard. Pages 46-62 *in* M. P. Heide-Jørgensen and C. Lydersen, editors. Ringed Seals in the North Atlantic. NAMMCO Scientific Publications, Volume 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., 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.

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.

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. Bo. 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.

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.

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

Palo, J. 2003. Genetic diversity and phylogeography of landlocked seals. Dissertation. Universiy of Helsinki, Helsinki, Finland. 29 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. Conservation Genetics 4:117-128.

Rice, D. W. 1998. Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Lawrence, KS. 231 p.

Sherrod, G.K. 1982. Eskimo Walrus Commission's 1981 Research Report: The Harvest and Use of Marine Mammals in Fifteen Eskimo Communities. Kawerak, Inc., Nome.

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.

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. Page 4 *in* V. M. Belkovich, A. N. Boltunov, and I. V. J. Smelova, editors. Marine Mammals of the Holarctic. 2000. Materials from the International Conference, Archangel, Russia. Pravda Severa. (Translated from Russian by Olga Romanenko, 4 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 pp.

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. Pages 184-189 *in* Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK.

Wolfe, R., and L.B. Hutchinson-Scarbrough. 1999. The subsistence harvest of harbor seal and sea lion by Alaska Natives in 1998. Technical Paper No. 250, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Revised 5/15/2013

RIBBON SEAL (*Histriophoca fasciata*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Ribbon seals inhabit the North Pacific Ocean and adjacent parts of the Arctic Ocean. In Alaska waters, ribbon seals range northward from Bristol Bay in the Bering Sea into the Chukchi and western Beaufort Seas (Fig. 13). From late March to early May, ribbon seals inhabit the Bering Sea ice front (Burns 1970, Burns 1981, Braham et al. 1984). They are most abundant in the northern part of the ice front in the central and western parts of the Bering Sea (Burns 1970, Burns et al. 1981). As the ice recedes in May to mid-July the seals move farther to the north in the Bering Sea, where they haul out on the receding ice edge and remnant ice (Burns 1970, Burns 1981, Burns et al. 1981). There is little known about the range of ribbon seals during the rest of the year. Recent sightings and a review of the literature suggest that many ribbon seals migrate into the Chukchi Sea for the summer (Kelly 1988). Ribbon seal vocalizations were detected on the northern Chukchi Plateau only in late fall of 2008 and not thereafter (Moore et al. 2012). Satellite tag data from 2005 and 2007 suggest ribbon seals disperse widely. Ten seals tagged in 2005 near the eastern coast of Kamchatka spent the summer and fall throughout the Bering Sea and Aleutian Islands; eight of the 26 seals tagged in 2007 in the central Bering Sea moved to the Bering Strait, Chukchi Sea, or Arctic Basin as the seasonal ice retreated (Boveng et al. 2008).

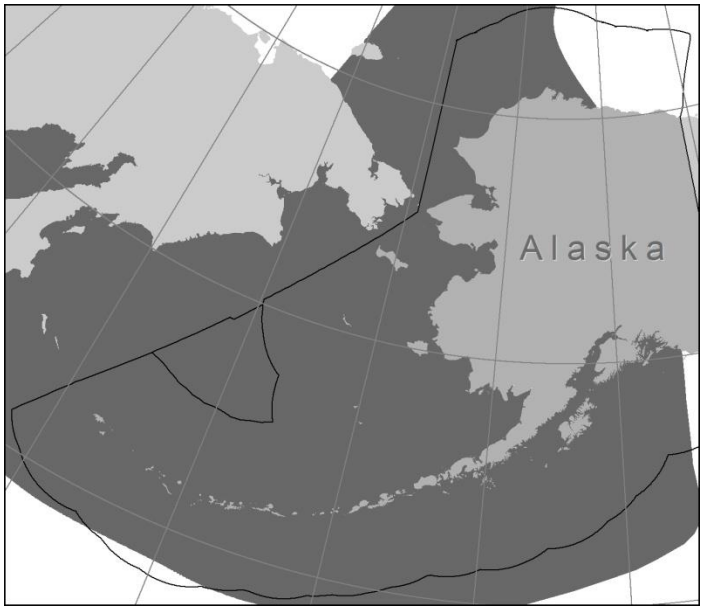

Figure 13 Approximate distribution of ribbon seals (shaded area) in Alaska waters. The combined summer and winter distribution is depicted.

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous, 2) Population response data: unknown; 3) Phenotypic data: unknown; 4) Genotypic data: unknown. Based on this limited information, and the absence of any significant fishery interactions, there is currently no strong evidence to suggest splitting the distribution of ribbon seals into more than one stock (Boveng et al. 2008). Therefore, only the Alaska stock of ribbon seal is recognized in U.S. waters.

POPULATION SIZE

A reliable abundance estimate for the Alaska stock of ribbon seals is currently not available. Burns (1981) estimated the worldwide population of ribbon seals at 240,000 in the mid-1970s, with an estimate for the Bering Sea at 90,000-100,000.

Aerial surveys were conducted in portions of the eastern and central Bering Sea in spring of 2003 (Simpkins et al. 2003), 2007 (Cameron and Boveng 2007, Moreland et al. 2008), and 2008 (Cameron et al. 2008). Frequencies of sightings data from the 2007 surveys and information on ice distribution and the timings of seal haul-out behavior were analyzed to develop a population estimate of 61,100 (95% CI 35,200-189,300) ribbon seals in the areas surveyed in that year (Ver Hoef et al. *in press*). In spring of 2012, NOAA researchers, in collaboration with Russian colleagues, conducted aerial abundance and distribution surveys of the entire Bering Sea (Moreland et al. 2012). Information from these surveys and similar surveys planned for both the Bering and Okhotsk Seas in 2013, should provide the current range-wide estimates of ribbon seal abundance.

Minimum Population Estimate

A reliable minimum population estimate (N_{MIN}) for this stock can not presently be determined because current reliable estimates of abundance are not available.

Current Population Trend

At present, reliable data on trends in population abundance for the Alaska stock of ribbon seals are unavailable. Although the current population trend is unknown, a recent provisional estimate of 49,000 ribbon seals in portions of the eastern and central Bering Sea is consistent enough with historical estimates to suggest that no major or catastrophic change has occurred in recent decades (Boveng et al. 2008). This stock is thought to occupy its entire historically-observed range (Boveng et al. 2008).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the 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). 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

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

Until 2003, there were three different federally regulated commercial fisheries in Alaska that could have interacted with ribbon seals and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these three fisheries into 13 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. Between ~~2007~~2008 and ~~2011~~2012, there were incidental serious injuries and mortalities of ribbon seals in the Bering Sea/ Aleutian Islands Atka mackerel trawl and the Bering Sea/ Aleutian Islands pollock trawl fisheries (Table 24). The estimated minimum mortality rate incidental to commercial fisheries is 1.02 (CV = ~~0.08~~0.06) ribbon seal per year, based exclusively on these observer data.

Table 24. Summary of incidental mortality of ribbon seals (Alaska stock) due to fisheries from ~~2007~~2008 to ~~2011~~2012 and calculation of the mean annual mortality rate (Breiwick 2013). Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/ Aleutian Islands flatfish trawl	2008	obs data	100	0	0	0.2 (CV = 0.01)
	2009		100	0	0	
	2010		100	0	0	
	2011		100	0	0	
	2012		100	1	1.0	

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/ Aleutian Islands Atka mackerel trawl	~~2007~~ 2008 2009 2010 2011 2012	obs data	~~94~~ 100 99 100 100 100	~~1~~ 0 1 0 0 0	~~1.0~~ 0 1.0 0 0 0	~~0.4~~0.2 (CV = ~~0.11~~0.01)
Bering Sea/ Aleutian Islands pollock trawl	~~2007~~ 2008 2009 2010 2011 2012	obs data	~~85~~ 85 86 86 98 98	~~0~~ 2 1 0 0 0	~~0~~ 2.1 1.0 0 0 0	0.62 (CV = 0.10)
Total estimated annual mortality						1.02 (CV = ~~0.08~~0.06)

Subsistence/Native Harvest Information

Ribbon seals are harvested occasionally by Alaska Native subsistence hunters, primarily from villages in the vicinity of Bering Strait and to a lesser extent at villages along the Chukchi Sea coast (Kelly 1988). The annual subsistence harvest was estimated to be less than 100 seals annually from 1968 to 1980 (Burns 1981). In the mid-1980s, the Alaska Eskimo Walrus Commission estimated the subsistence take to still be less than 100 seals annually (Kelly 1988).

The Division of Subsistence, Alaska Department of Fish and Game maintained a database that provided additional information on the subsistence harvest of ice seals in different regions of Alaska (ADFG 2000a, b). Information on subsistence harvest of ribbon seals was compiled for 129 villages from reports from the Division of Subsistence (Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarbrough 1999) and a report from the Eskimo Walrus Commission (Sherrod 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990 to 1998 were used. As of August 2000; the subsistence harvest database indicated that the estimated number of ribbon seals harvested for subsistence use per year was 193. Data on community subsistence harvests are no longer routinely being collected, and no new statewide annual harvest estimates exist. Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 1 ringed seal was harvested during 2012 (Ice Seal Committee, 2013).

At this time, there are no efforts to quantify the total statewide level of harvest of ribbon seals by all Alaska communities. A report on ice seal subsistence harvest in three Alaskan communities indicated that the number and species of ice seals harvested in a particular village may vary considerably between years (Coffing et al. 1999). These interannual differences are likely due to differences in ice and wind conditions that change the hunters' access to different ice habitats frequented by different types of seals. Regardless of the extent to which the harvest may vary interannually, it is clear that the harvest level of 193 ribbon seals estimated by the Division of Subsistence is higher than the previous minimum estimate. Although some of the more recent entries in the ADFG database have associated measures of uncertainty (Coffing et al. 1999, Georgette et al. 1998), the overall total does not.

STATUS OF STOCK

Ribbon seals are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act (ESA). Reliable estimates of the minimum population, PBR, and human-caused mortality and serious injury are currently not available. Because the PBR for ribbon seals is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The Alaska stock of ribbon seals is not considered a strategic stock.

On 20 December 2007, NMFS received a petition to list ribbon seals under the ESA, primarily due to concern about threats to the species' habitat from climate warming and loss of sea ice. NMFS found that the petition presented sufficient information to consider listing and initiated a conservation status review of ribbon seals (73 FR 16617, 28 March 2008). After the status review of the ribbon seal was complete (Boveng et al. 2008), NMFS

published a finding on December 30, 2008, that listing ribbon seals was not warranted at that time (73 FR 79822, 30 December 2008). New information became available after this finding, including data on ribbon seal movements and diving, and a modified threat-specific approach to analyzing the foreseeable future, which was used in the more recent spotted, ringed, and bearded seal ESA status reviews. In consideration of this new information, NMFS is conducted a new status review of the ribbon seal (78 FR 41371; July 10, 2013) and determined that listing the ribbon seal as threatened or endangered under the ESA is not warranted at this time.

Habitat Concerns

Evidence indicates that the Arctic climate is changing significantly and that one result of the change is a reduction in the extent of sea ice in at least some regions of the Arctic (ACIA 2004, Johannessen et al. 2004). Ribbon seals, along with other seals that are dependent on sea ice for at least part of their life history, will be vulnerable to reductions in sea ice. The main concern about the conservation status of ribbon seals stems from the likelihood that their sea-ice habitat has been modified by the warming climate and, more so, that the scientific consensus projections are for continued and perhaps accelerated warming in the foreseeable future (Boveng et al. 2008). A second major concern, related by the common driver of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may impact ribbon seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The nature and timing of such impacts are extremely uncertain. Laidre et al. (2008) concluded that on a worldwide basis ribbon seals were likely to be moderately sensitive to climate change based on an analysis of various life history features that could be affected by climate. Additional habitat concerns include the potential effects from oil and gas exploration activities, particularly in the outer continental shelf leasing areas, such as disturbance from vessel traffic, seismic exploration noise, and the potential for oil spills.

CITATIONS

ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, U.K.

Alaska Department of Fish and Game. 2000a. Community Profile Database 3.04 for Access 97. Division of Subsistence, Anchorage.

Alaska Department of Fish and Game. 2000b. Seals+ Database for Access 97. Division of Subsistence, Anchorage. Braham, H. W., J. J. Burns, G. A. Fedoseev, and B. D. Krogman. 1984. Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walruses in the Bering Sea, April 1976. Pp. 25-47 *In* F. H. Fay and G.A. Fedoseev (eds.), Soviet-American cooperative research on marine mammals. vol. 1. Pinnipeds. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 12.

Boveng, P. L., J. L. Bengtson, T. W. Buckley, M. F. Cameron, S. P. Dahle, B. A. Megrey, J. E. Overland, and N. J. Williamson. 2008. Status review of the ribbon seal (*Histriophoca fasciata*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-191, 115 p.

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

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

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

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

Burns, J. J., L. H. Shapiro, and F. H. Fay. 1981. Ice as marine mammal habitat in the Bering Sea. Pp. 781-797 *In* D. W. Hood and J. A. Calder (eds.), The eastern Bering Sea shelf: oceanography and resources. vol. 2. U.S. Dep. Commer., NOAA, Off. Mar. Pollut. Assess., Juneau, Alaska.

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

Cameron, M. F., Moreland, E.M., and P. L. Boveng. 2008. Abundance and distribution surveys for ice seals conducted from the USCG icebreaker *Polar Sea*, 6-27 April 2008. Alaska Fisheries Science Center *Quarterly Report*, April-May-June 2008.

Coffing, M., C. Scott, and C.J. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1997-1998. Technical Paper No. 255, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

Coffing, M., C. Scott, and C.J. Utermohle. 1999. The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskokwim Delta, Alaska, 1998-1999. Technical Paper No. 257, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

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.

Georgette, S., M. Coffing, C. Scott, and C. Utermohle. 1998. The subsistence harvest of seals and sea lions by Alaska Natives in the Norton Sound-Bering Strait Region, Alaska, 1996-97. Technical Paper No. 242, Draft Final report for year five, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dep. Fish and Game, Juneau, Alaska, 79 pp. + appendices.

Ice Seal Committee. 2013. Northwest Arctic ice seal harvest survey for 2012. Ice Seal Committee Newsletter, 1(1):3.

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

Kelly, B. P. 1988. Ribbon seal, *Phoca fasciata*. Pp. 96-106 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

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.

Moore, S. E., Stafford, K. M., Melling, H., et al. 2012. Comparing marine mammal acoustic habitats in Atlantic and Pacific sectors of the High Arctic: year-long records from Fram Strait and the Chukchi Plateau. Polar Biol 35:475–480. doi: 10.1007/s00300-011-1086-y.

Moreland, E. E., M. F. Cameron, and P. L. Boveng. 2008. Densities of seals in the pack ice of the Bering Sea (Poster presentation). Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, Seattle, WA.

Moreland, E. E., M. F. Cameron, and P. L. Boveng. 2012. Bering Okhotsk Seal Surveys (BOSS): Joint U.S.-Russian Aerial Surveys. Alaska Fisheries Science Center *Quarterly Report*, April-May-June 2012.

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.

Sherrod, G.K. 1982. Eskimo Walrus Commission's 1981 Research Report: The Harvest and Use of Marine Mammals in Fifteen Eskimo Communities. Kawerak, Inc., Nome.

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.

Ver Hoef, J. M., Cameron, M. F., Boveng, P. L., London, J. M., and Moreland, E. M. *In press.* A hierarchical model for abundance of three ice-associated seal species in the Eastern Bering Sea. Statistical Methodology.

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 pp.

Wolfe, R., and L.B. Hutchinson-Scarbrough. 1999. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 1998. Technical paper No. 250. Draft Final report for year five, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dep. Fish and Game, Juneau, Alaska, 72 pp. + appendices.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta, Norton Sound), eastern Chukchi Sea, ~~Kasegaluk Lagoon,~~ and the Mackenzie Delta (Hazard 1988). Satellite transmitters on a few whales from the Beaufort Sea, Chuckchi Sea and Eastern Bering Sea stocks have lasted through the winter demonstrating~~It is assumed~~~~confirmed~~ that ~~most~~ beluga whales from these summering areas overwinter in the Bering Sea and the stocks may use separate wintering locations (Suydam 2009, Richard et al. 2010, ABWC unpublished data). Belugas~~, excluding those~~ found in Bristol Bay and the northern Gulf of Alaska/ Cook Inlet remain in those areas throughout the year (Shelden 1994, Quakenbush 2003, NMFS and ADF&G unpublished data). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985).

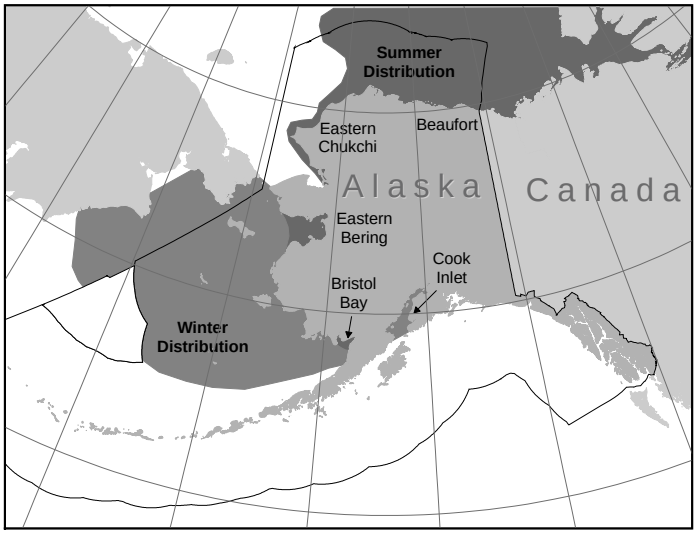

Figure 14. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

The general distribution pattern for beluga whales shows major seasonal changes. During the winter, they occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982; Suydam 2009) and give birth to and care for their calves (Sergeant and Brodie 1969). Annual migrations ~~may cover~~can be more than thousands of kilometers (~~Reeves 1990~~Richard et al. 2001, 2010).

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990)~~, and distribution poorly known~~~~understood outside of summer~~; 2) Population response data: ~~possible extirpation of local populations;~~ distinct population trends between regions occupied in summer~~ and possible extirpation of local populations~~; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, 5 ~~stocks of~~ beluga whale stocks are recognized within U. S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) eastern Bering Sea, 4) eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 14).

POPULATION SIZE

The sources of information to estimate abundance for belugas in the waters of northern Alaska and western Canada have included both opportunistic and systematic observations. Duval (1993) reported an estimate of 21,000 belugas for the Beaufort Sea stock, similar to that reported by Seaman et al. (1985). The most recent aerial survey was conducted in July ~~of~~ 1992, and resulted in an estimate of 19,629 (CV = 0.229) beluga whales in the eastern Beaufort Sea (Harwood et al. 1996). To account for availability bias a correction factor (CF), which was not data-based, has been recommended for the Beaufort Sea beluga whale stock (Duval 1993), resulting in a population estimate of 39,258 (19,629 × 2) animals. A coefficient of variation (CV) for the CF is not available; however, this CF was considered negatively biased by the Alaska SRG considering that aerial survey CFs for this species have

been estimated to be between 2.5 and 3.27 (Frost and Lowry 1995). Additionally, the 1992 surveys did not encompass the entire summer range of Beaufort Sea belugas (Richard et al. 2001), thus are negatively biased.

Minimum Population Estimate

For the Beaufort Sea beluga whale stock~~ of beluga whales~~, the minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Thus, $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 39,258 whales and an associated CV(N) of 0.229, N_{MIN} for this stock is 32,453 whales. Because the survey data are more than 8 years old, it would not be considered a reliable minimum population estimate for calculating a PBR and N_{MIN} would be considered unknown. However, trend data from Harwood and Kingsley (2013) indicate the stock is at least stable or increasing; therefore, the Alaska SRG recommended at the 2014 meeting that NMFS retain the N_{MIN} estimate of 32,453 whales.

Current Population Trend

The current population trend of the Beaufort Sea stock of beluga whales is ~~unknown~~stable or increasing. Recent and historical aerial surveys off the Mackenzie River Delta indicate that the stock is at least stable or increasing (Harwood and Kingsley 2013). There are no data to suggest the stock is declining.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for the Beaufort Sea beluga whale stock~~ of beluga whales~~. Hence, until additional data become available, it is recommended that the ~~cetacean~~default maximum theoretical net productivity rate (R_{MAX}) for cetaceans 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. As the stock trend is ~~undocumented~~at least stable, the recovery factor (F_R) for this stock is ~~0.5~~1 (Wade and Angliss 1997). Thus, using the abundance estimate calculated from 1992 surveys, the PBR for the Beaufort Sea stock of beluga whale stock would be calculated to be ~~324~~649 animals (32,453 × 0.02 × ~~0.5~~1.0). ~~However, the~~ 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. However, the recent trend data suggest that the stock is at least as large as it was during the last estimate of Nmin; thus the 1992 estimate of Nmin=32,452 whales is sufficient to use for a PBR calculation. Therefore, the PBR for this stock is 649~~considered undetermined~~ (NMFS 2005).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

The total fishery mortality and serious injury for this stock is estimated to be zero as there are no reports of mortality incidental to commercial fisheries~~ in recent years~~.

Subsistence/Native Harvest Information

The subsistence take of beluga whales from this stock within U. S. waters is reported by the Alaska Beluga Whale Committee (ABWC). The most recent Alaska Native subsistence harvest estimates for the Beaufort Sea beluga stock are provided in Table 25 (Frost and Suydam ~~in press~~2010; Alaska Beluga Whale Committee, ~~18~~

~~February 2010~~unpubl. data 2012). Given these data, the annual subsistence take by Alaska Native hunters averaged ~~26~~65.6 belugas during the 5-year period from ~~2005~~2008 to ~~2009~~2012.

Table 25. Summary of ~~the number of~~ beluga whales landed by the Alaska Native subsistence ~~harvest~~hunters from the Beaufort Sea ~~stock of~~ beluga whale stock, ~~2005-2009~~2008-2012. Total taken includes landed and struck and lost in years 2010-2012; struck and lost data for 2008 and 2009 have not been quantified and are minimum counts.

Year	Harvested whales	Struck and lost whales	Reported total number taken
~~2005~~			~~20~~
~~2006~~			~~5~~
~~2007~~			~~40~~
2008	48	N/A	48
2009	16	N/A	16
2010	71	1+	72
2011	42	6	48
2012	92	42+	144
Mean annual number of animals landed (~~2005-2009~~2008-2012):			~~25.8~~65.6+

The subsistence take of beluga whales within the Canadian waters of the Beaufort Sea is reported by the Fisheries Joint Management Committee (FJMC). The data are collected by on-site harvest monitor~~sing~~ conducted by the FJMC at Inuvialuit communities in the Mackenzie ~~River d~~Delta, Northwest Territories. The ~~most recent~~ Canadian Inuvialuit subsistence harvest estimates for the Beaufort Sea beluga stock are provided in Table 26 (data for 2005 to 2009 from FJMC Beluga Monitor Program, Fisheries Joint Management Committee, Inuvik, NT, Canada). Given these data, the annual subsistence take in Canada averaged 100 belugas during the 5-year period from 2005 to 2009. Thus, the mean estimated subsistence take in Canadian (2005-2009) and U. S. (2008-2012) waters from the Beaufort Sea beluga stock ~~during 2005-2009~~ is ~~126~~166 (~~26 +~~ 100 + 65.6) whales. ~~Data on beluga that were struck and lost have not been quantified and are not included in these estimates.~~

Table 26. Summary of the Canadian subsistence harvest from the Beaufort Sea stock of beluga whales, 2005-2009. N/A indicates the data are not available.

Year	Reported total number taken
2005	108
2006	126
2007	82
2008	81
2009	102
Mean annual landed (2005-2009)	100

STATUS OF STOCK

Beaufort Sea beluga whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. ~~Based on a lack of~~ There are no reported fisheries mortalities, thus the estimated annual U.S. commercial fishery-related mortality is zero (0). The total mean annual human-cause mortality estimate is ~~126~~166 based on ~~subsitence~~the known subsistence harvest in the United States (~~26~~65.6) and Canada (100). Because the PBR is ~~undetermined~~less than 10% of PBR (65), the level of annual U.S. commercial fishery-related mortality ~~that can be~~is considered insignificant and approaching zero mortality and serious injury rate~~is unknown~~. ~~Beaufort Sea beluga whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act.~~ Although the abundance estimates are ~~greater~~more than 8 years old, ~~the level of~~ since there are no records of incidental mortality in commercial fisheries, the level of incidental mortality and serious injury is considered to be insignificant. The Beaufort Sea beluga stock ~~of beluga whales~~ is classified as a non-strategic stock. At this time it is not possible to assess the status of this stock relative to its Optimum Sustainable Population size.

HABITAT CONCERNS

Evidence indicates that the Arctic climate is changing rapidly and significantly, and ~~that~~ one result of this~~e~~ change is a reduction in the extent of sea ice in at least some regions~~ of the Arctic~~ (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant effect on prey availability. Currently, there are insufficient data to make reliable predictions of the effects ~~of~~from Arctic climate change on beluga whales, but Laidre et al. (2008) and Heide-Jørgensen (2010) concluded that on a worldwide basis belugas were likely to be less sensitive to climate change than other ~~a~~Arctic cetaceans because of their wide distribution and flexible behavior. Increased human activity in the Arctic, including increasing oil and gas exploration and development, and increased nearshore development, have the potential to impact beluga whale habitat ~~for beluga whales~~ (Moore et al. 2000, Lowry et al. 2006).~~, but~~ However, predicting the type and magnitude of the impacts is difficult at this time.

CITATIONS

ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, U.K.

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.

Duval, W. S. 1993. Proceedings of a workshop on Beaufort Sea beluga: February 3-6, 1992. Vancouver, B.C. Env. Studies Res. Found. Rep. No 123. Calgary. 33 pp. + appendices.

Finley, K. J. 1982. The estuarine habitat of the beluga or white whale, *Delphinapterus leucas*. Cetus 4:4-5.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska. Pp. 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.

Frost, K. J., and L. F. Lowry. 1995. Radio tag based correction factors for use in beluga whale population estimates. Working paper for Alaska Beluga Whale Committee Scientific Workshop, Anchorage, AK, 5-7 April 1995. 12 pp. (available upon request- Alaska Dep. Fish and Game, 1300 College Rd., Fairbanks, AK 99701).

Frost, K. J., and R. S. Suydam. In Press. Subsistence harvest of beluga or white whales (*Delphinapterus leucas*) in northern and western Alaska 1987-2006. J. Cetacean Res. Manage.

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

Harwood, L. A., S. Innes, P. Norton, and M. C. S. Kingsley. 1996. Distribution and abundance of beluga whales in the Mackenzie Estuary, southeast Beaufort Sea and west Amundsen Gulf during late July 1992. Can. J. Fish. Aquat. Sci. 53:2262-2273.

Harwood, L. A. and M. C. S. Kingsley. 2013. Trends in the offshore distribution and relative abundance of Beaufort Sea belugas, 1982-85 vs 2007-09. Arctic. 66(3):247-256.

Hazard, K. 1988. Beluga whale, *Delphinapterus leucas*. Pp. 195-235 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Heide-Jørgensen, M., Laidre, K., Borchers, D., Marques, T., Stern, H. and Simon, M. 2010. The effect of sea-ice loss on beluga whales (*Delphinapterus leucas*) in West Greenland. Polar Res., 29: 198–208. doi: 10.1111/j.1751-8369.2009.00142.x

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

Laidre, K. L., I. Stirling, L. 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.

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

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

Moore, S.E., K.W. Shelden, 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. 2005. Guidelines for preparing Stock Assessment Reports pursuant to Section 117 of the Marine Mammal Protection Act, SAR guidelines revisions, June 2005, 24 pp.

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

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.

Reeves, R. R. 1990. An overview of the distribution, exploitation and conservation status of belugas, worldwide. Pp. 47-58 *In* J. Prescott and M. Gauquelin (eds.), For the future of the beluga: Proceedings of the International Forum for the Future of the Beluga. Univ. Quebec Press, Canada.

Richard P. R., Martin A. R., Orr J. R. 2001a. Summer and Autumn Movements of Belugas of the Eastern Beau-fort Sea Stock. Arctic 54: 223-236.

Seaman, G. A., K. J. Frost, and L. F. Lowry. 1985. Investigations of belukha whales in coastal waters of western and northern Alaska. Part I. Distribution, abundance and movements. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 56:153-220. (available from NOAA-OMA-OAD, Alaska Office, 701 C. Street, P.O. Box 56, Anchorage, AK 99513).

Sergeant, D. E., and P. F. Brodie. 1969. Body size in white whales, *Delphinapterus leucas*. J. Fish. Res. Bd. Can. 26:2561-2580.

Shelden, K. E. W. 1994. Beluga whales (*Delphinapterus leucas*) in Cook Inlet - A review. Appendix *In* Withrow, D. E., K. E. W. Shelden, and D. J. Rugh. Beluga whale (*Delphinapterus leucas*) distribution and abundance in Cook Inlet, summer 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Suydam, R. S. 2009. Age, growth, reproduction, and movements of beluga whales (*Delphinapterus leucas*) from the eastern Chukchi Sea. Ph.D. Dissertation, University of Washington, School of Aquatic and Fishery Sciences.

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 pp.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta, Norton Sound), eastern Chukchi Sea, ~~Kasegaluk Lagoon,~~ and the Mackenzie Delta (Hazard 1988). Satellite transmitters on a few whales from the Beaufort Sea, Chuckchi Sea and Eastern Bering Sea stocks have lasted through the winter demonstrating~~It is assumed~~~~confirmed~~ that ~~most~~ beluga whales from these summering areas overwinter in the Bering Sea and the stocks may use separate wintering locations (Suydam 2009, Richard et al. 2010, ABWC unpublished data). Belugas~~, excluding those~~ found in Bristol Bay and the northern Gulf of Alaska/ Cook Inlet remain in those areas throughout the year (Shelden 1994, Quakenbush 2003, NMFS and ADF&G unpublished data). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985).

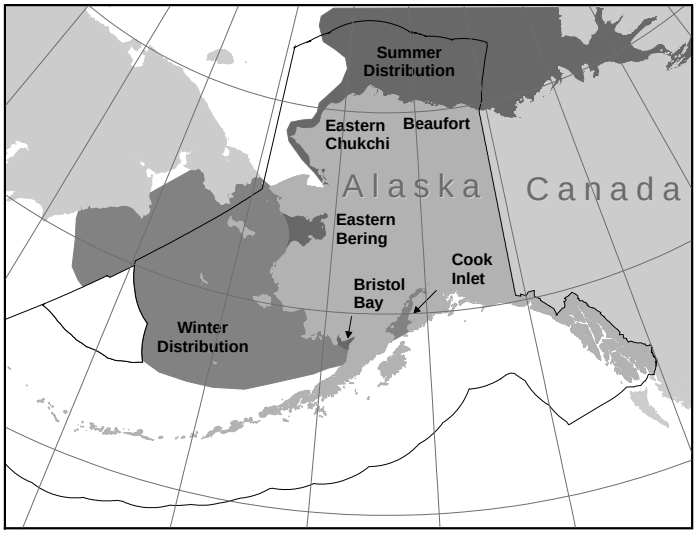

Figure 15. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

The general distribution pattern for beluga whales shows major seasonal changes. During the winter, the~~y~~ Beaufort Sea, eastern Chukchi Sea, and Bering Sea stocks occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982; Suydam 2009) and give birth to and care for their calves (Sergeant and Brodie 1969). Annual migrations ~~may cover~~can be more than thousands of kilometers (~~Reeves 1990~~Pierre Richard et al. 2001, 2010).

Eastern Chukchi Sea belugas move into coastal areas~~ along shore~~, including Kasegaluk Lagoon, in late June and animals are sighted in the area until about mid-July (Frost and Lowry 1990, Frost et al. 1993). Satellite~~-linked~~ tags attached ~~in summer~~ to eastern Chukchi belugas ~~occur~~captured in Kaseguluk Lagoon during the summer showed ~~that~~these whales traveled 1,100 km north of the Alaska coastline, ~~and~~ into the Canadian Beaufort Sea within 3 months ~~of tagging~~ (Suydam et al. 2001).~~,~~ This movement indicated~~ing~~ ~~an~~some overlap in distribution with the Beaufort Sea beluga whale stock~~ of beluga whales~~ during late summer. Satellite telemetry data from 23 whales tagged during 1998~~-2002~~2007 suggest variation in movement patterns for different age and/or sex classes during July – September (Suydam et al. 2005). Adult males used deeper waters and remained there for the duration of the summer; all belugas that moved into the Arctic Ocean (north of 75◦N) were males, and males traveled through 90% pack ice cover to reach deeper waters ~~of~~in the Beaufort Sea and Arctic Ocean (79-80◦N) by late July/early August. Adult and immature female belugas remained at or near the shelf break ~~of~~in the Chukchi Sea. After October, only three tags continued to transmit, and those whales migrated south through the eastern Bering Strait into the northern Bering Sea, remaining north of Saint Lawrence Island over the winter. Data from a whale tagged in the eastern Chukchi Sea in 2007 overwintered in the waters north of Saint Lawrence Island during 2007/2008, moved to near King Island in April and May before moving norther through the Bering Strait in late May and early June ~~ and was still transmitting in this location as of April 2008~~ (Suydam 2009)~~, through June or July 2009 (pers. comm. Suydam)~~.

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990)~~, and distribution poorly known~~~~understood outside of summer~~; 2) Population response data:

~~possible extirpation of local populations;~~ distinct population trends between regions occupied in summer~~ and possible extirpation of local populations~~; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, 5 ~~stocks of~~ beluga whale stocks are recognized within U. S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) eastern Bering Sea, 4) eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 15).

POPULATION SIZE

Frost et al. (1993) estimated the minimum size of the eastern Chukchi beluga stock ~~of belugas~~ at 1,200 whales, based on counts of animals from aerial surveys conducted during 1989-91. Survey effort was concentrated ~~on~~along the sea side of the 170 km long Kasegaluk Lagoon, an area known to be regularly used by belugas during the open-water season. Other areas that these belugas ~~from this stock~~ are known to frequent (e.g., ~~offshore~~~~Kotzebue Sound~~) were not surveyed. Therefore, these surveys ~~effort resulted in~~provided only a minimum raw count. If this count is corrected~~,~~ using radio telemetry data, for the proportion of animals that were diving and thus not visible at the surface (2.62, Frost and Lowry 1995), and for the proportion of newborns and yearlings not observed due to small size and dark coloration (1.18; Brodie 1971), the total corrected abundance estimate for the eastern Chukchi stock is 3,710 (1,200 × 2.62 × 1.18) whales.

During 25 June to 6 July 1998, aerial surveys were conducted in the eastern Chukchi Sea (DeMaster et al. 1998). The maximum single day count (1,172 whales) was derived from a photographic count of a large aggregation near Icy Cape (1,018), plus animals (154) counted along an ice edge transect. This count is an underestimate because it was clear to the observers that many more whales were present along and in the ice than they were able to count and only a small portion of the ice edge habitat was surveyed. Furthermore, only one of five belugas equipped with satellite tags a few days earlier remained within the survey area on the day the peak count occurred (DeMaster et al. 1998).

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

It is not possible to estimate the abundance for this stock from the 1998 survey. Not only were a large number of whales unavailable for counting, but the large Icy Cape aggregation was in shallow, clear water (DeMaster et al. 1998). Currently, a correction factor (to account for missed whales) does not exist for belugas encountered in such conditions. As a result, the abundance estimate from the 1989-91 surveys (3,710 whales) is still considered to be the most reliable for the eastern Chukchi Sea beluga whale stock.

Aerial surveys were conducted in the summer of 2012 in the northeastern Chukchi and Alaskan Beaufort seas in late June through August (Clarke et al. 2013). Those data are currently being analyzed by the Alaska Beluga Whale Committee and an updated estimate should be available by 2015.

Minimum Population Estimate

The survey technique used for estimating ~~the abundance of~~ beluga whale~~s~~ abundance is a direct count ~~which~~that incorporates correction factors. Although coefficients of variation (CVs) of the correction factors are not available, the Alaska Scientific Review Group concluded that the population estimate of 3,710 belugas can serve as ~~an~~the estimated ~~of~~ minimum population size because the survey did not include all areas where beluga are known to occur (Small and DeMaster 1995). That is, if the beluga distribution ~~of beluga whales~~ in the eastern Chukchi Sea is similar to ~~the~~beluga distribution ~~of beluga whales~~ in the Beaufort Sea, which is likely based on satellite tag results (Suydam et al. 2001, Lowry and Frost 2002), then a substantial fraction of the population was likely to have been in offshore waters during the survey period (DeMaster 1997). However, because the survey data are more than 8 years old, it is not considered a reliable minimum population estimate for calculating a PBR, and N_{MIN} is considered unknown.

Current Population Trend

~~The maximum 1998 count (1,172 animals) is similar to counts of beluga whale counts conducted in the same area during the summers of 1989-91 (1,200 animals) and counts of 1,104 and 1,601 in the summer of 1979 (Frost et al. 1993, DeMaster et al. 1998). Based on these data, there is no evidence that the eastern Chukchi Sea beluga stock of beluga whales is declining.~~ The current population trend for the eastern Chukchi Sea beluga stock is unknown.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this ~~stock of~~ beluga whale stock. Hence, until additional data become available, it is recommended that the ~~cetacean~~default maximum theoretical net productivity rate (R_{MAX}) for cetaceans 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. This stock is considered relatively stable and not declining in the presence of known take, thus the recovery factor (F_R) for this stock is 1.0 (DeMaster 1995, Wade and Angliss 1997). ~~Using the abundance estimate calculated from 1991 surveys, the PBR for the eastern Chukchi Sea beluga stock of beluga whales would be calculated to be 74 animals (3,710 × 0.02 × 1.0).~~ 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

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

Three different commercial fisheries that could have interacted with beluga whales from this stock were monitored for incidental take by fishery observers during 1990-97: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. Observers did not report any mortality or serious injury ~~of~~to beluga whales incidental to these groundfish fisheries. In the nearshore waters of ~~the~~ southeastern Chukchi Sea, substantial efforts occur~~s~~ in gillnet (mostly set nets)~~,~~ and personal-use fisheries. Although a potential source of mortality, there have been no reported ~~takes of~~ beluga whale takes as a result of these fisheries.

Based on a lack of reported mortalities, the ~~estimated~~ inferred minimum mortality rate incidental to commercial fisheries is zero belugas per year from this stock.

Subsistence/Native Harvest Information

The subsistence take of beluga whales from the eastern Chukchi Sea stock is provided by the Alaska Beluga Whale Committee (ABWC). The most recent subsistence harvest estimates for the stock are provided in Table 27 (Frost and Suydam in press~~, Alaska Beluga Whale Committee, 18 February 2010~~). Given these data, the annual subsistence take by Alaska Native hunters averaged ~~94.2~~57.4 belugas landed during the 5-year period ~~2005-2009~~2008-2012 based on reports from ABWC representatives and on-site harvest monitoring. ~~Data on beluga that were struck and lost have not been quantified and are not included in these estimates.~~

Table 27. Summary of the number of beluga whales landed by the Alaska Native subsistence harvest of eastern Chukchi Sea beluga whales, ~~2005-2009~~2008-2012. It should be noted that the 2010 and 2011 statistics include takes at Kivalina (2 in 2010 and 2 in 2011) and Kotzebue/Noatak (0 in 2010 and 30 in 2011) which may be from a population that is genetically distinct from the main population comprising the eastern Chukchi Sea beluga whales stock. Totals include landed and struck and lost.

~~2005~~	~~43~~
~~2006~~	~~31~~
~~2007~~	~~270~~
2008	74
2009	53

2010	36
2011	66
2012	58
Mean annual number of animals landed (~~2005-2009~~2008-2012):	~~94.2~~57.4

STATUS OF STOCK

~~The estimated minimum annual mortality rate incidental to U. S. commercial fisheries (0) is not known to exceed 10% of the PBR (7) and, therefore, is Although the abundance estimates are more than 8 years old and PBR is undetermined, since there are no records of incidental mortality in commercial fisheries, the level of incidental mortality and serious injury is considered to be insignificant and approaching zero mortality and serious injury rate.~~ The level of incidental mortality in commercial fisheries is unknown, although it is considered to be insignificant based on no reports. ~~Based on currently available data, the estimated annual rate of human-caused mortality and serious injury (94.257.4) would not exceed the PBR (74) if a PBR were to be calculated based on the most recent abundance estimate of 3,710. Because this estimate is based on surveys from 1989-1991 and is greater than 8 years old, the PBR for this stock is considered undetermined.~~ Eastern Chukchi Sea beluga whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Therefore, the eastern Chukchi Sea stock of beluga whales is not classified as a strategic stock. The population trend is unknown~~size is considered stable~~; however, at this time it is not possible to assess the status of this stock relative to its Optimum Sustainable Population size.

HABITAT CONCERNS

Evidence indicates that the Arctic climate is changing rapidly and significantly, and ~~that~~ one result of this~~e~~ change is a reduction in the extent of sea ice in at least some regions ~~of the Arctic~~ (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant effect on prey availability. Currently, there are insufficient data to make reliable predictions of the effects ~~of~~from Arctic climate change on beluga whales, but Laidre et al. (2008) and Heide-Jørgensen (2010) concluded that on a worldwide basis belugas were likely to be less sensitive to climate change than other ~~a~~Arctic cetaceans because of their wide distribution and flexible behavior. Increased human activity in the Arctic, including increasing oil and gas exploration and development, and increased nearshore development, have the potential to impact beluga whale habitat ~~for beluga whales~~ (Moore et al. 2000, Lowry et al. 2006).~~, but~~However, predicting the type and magnitude of the impacts is difficult at this time.

CITATIONS

ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, U.K.

Brodie, P. F. 1971. A reconsideration of aspects of growth, reproduction, and behavior of the white whale with reference to the Cumberland Sound, Baffin Island, population. J. Fish. Res. Bd. Can. 28:1309-1318.

DeMaster, D.P. 1995. Minutes from the 4-5 and 11 January 1995 meeting of the Alaska Scientific Review Group, Anchorage, Alaska. 27 pp. + appendices. (available upon request - D. P. DeMaster, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

DeMaster, D. P. 1997. Minutes from fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. (available upon request - D. P. DeMaster, Alaska Fisheries Science , 7600 Sand Point Way, NE, Seattle, WA 98115).

DeMaster, D. P., W. Perryman, and L. F. Lowry. 1998. Beluga whale surveys in the eastern Chukchi Sea, July, 1998. Alaska Beluga Whale Committee Rep. 98-2. 16 pp.

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

Finley, K. J. 1982. The estuarine habitat of the beluga or white whale, *Delphinapterus leucas*. Cetus 4:4-5.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska. Pp. 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.

Frost, K. J., L. F. Lowry, and G. Carroll. 1993. Beluga whale and spotted seal use of a coastal lagoon system in the northeastern Chukchi Sea. Arctic 46:8-16.

Frost, K. J., and L. F. Lowry. 1995. Radio tag based correction factors for use in beluga whale population estimates. Working paper for Alaska Beluga Whale Committee Scientific Workshop, Anchorage, AK, 5-7 April 1995. 12 pp. (available upon request- Alaska Dept. Fish and Game, 1300 College Rd., Fairbanks, AK 99701).

Frost, K. J., and R. S. Suydam. In Press. Subsistence harvest of beluga or white whales (*Delphinapterus leucas*) in northern and western Alaska 1987-2006. J. Cetacean Res. Manage.

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

Hazard, K. 1988. Beluga whale, *Delphinapterus leucas*. Pp. 195-235 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Heide-Jørgensen, M., Laidre, K., Borchers, D., Marques, T., Stern, H. and Simon, M. 2010. The effect of sea-ice loss on beluga whales (*Delphinapterus leucas*) in West Greenland. Polar Res., 29: 198–208. doi: 10.1111/j.1751-8369.2009.00142.x

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

Laidre, K. L., I. Stirling, L. 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.

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

Lowry, L., and K. Frost. 2001. Beluga whale surveys in the Chukchi Sea, July 2001. Alaska Beluga Whale Committee Rep. 01-1 submitted to NMFS, Juneau, AK. 9 pp.

Lowry, L., and K. Frost. 2002. Beluga whale surveys in the eastern Chukchi Sea, July 2002. Alaska Beluga Whale Committee Rep. 02-2 submitted to NMFS, Juneau, AK. 10 pp.

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

Moore, S.E., K.W. Shelden, 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. 2005. Guidelines for Preparing Stock Assessment Reports Pursuant to Section 117 of the Marine Mammal Protection Act, SAR Guidelines Revisions, June 2005, 24 pp.

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

Reeves, R. R. 1990. An overview of the distribution, exploitation and conservation status of belugas, worldwide. Pp. 47-58 *In* J. Prescott and M. Gauquelin (eds.), For the future of the beluga: Proceedings of the International Forum for the Future of the Beluga. Univ. Quebec Press, Canada.

Richard P. R., Martin A. R., Orr J. R. 2001a. Summer and Autumn Movements of Belugas of the Eastern Beau-fort Sea Stock. Arctic 54: 223-236.

Sergeant, D. E., and P. F. Brodie. 1969. Body size in white whales, *Delphinapterus leucas*. J. Fish. Res. Bd. Can. 26:2561-2580.

Shelden, K. E. W., 1994. Beluga whales (*Delphinapterus leucas*) in Cook Inlet - A review. Appendix *In* Withrow, D. E., K. E. W. Shelden, and D. J. Rugh. Beluga whale (*Delphinapterus leucas*) distribution and abundance in Cook Inlet, summer 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Small, R. J., and D. P. DeMaster. 1995. Alaska marine mammal stock assessments 1995. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-57, 93 pp.

Suydam, R. S., L. F. Lowry, and K. J. Frost. 2005. Distribution and movements of beluga whales from the eastern Chukchi Sea stock during summer and early autumn. OCS Study MMS 2005-035 Final Report. 48 pp.

Suydam, R. S., L. F. Lowry, K. J. Frost, G. M. O'Corry-Crowe, and D. Pikok, Jr. 2001. Satellite tracking of eastern Chukchi Sea beluga whales in to the Arctic Ocean. Arctic. 54(3):237-243.

Suydam, R. S. 2009. Age, growth, reproduction, and movements of beluga whales (*Delphinapterus leucas*) from the eastern Chukchi Sea. Ph.D. Dissertation, University of Washington, School of Aquatic and Fishery Sciences.

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 pp.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta, Norton Sound), eastern Chukchi Sea, ~~Kasegaluk Lagoon,~~ and the Mackenzie Delta (Hazard 1988). Satellite transmitters attached to whales from the Beaufort Sea, Chukchi Sea and Eastern Bering Sea stocks have provided detailed information on distribution and movements. The few transmitters that lasted through the winter showed~~It is assumed~~~~confirmed~~ that ~~most~~ beluga whales from these summering areas overwinter in the Bering Sea and the stocks may use separate wintering locations (Suydam 2009, Richard et al. 2010, ABWC unpublished data). Belugas~~, excluding those~~ found in Bristol Bay and the northern Gulf of Alaska/ Cook Inlet remain in those areas throughout the year, showing only small seasonal shifts in distribution (Shelden 1994, Quakenbush 2003, NMFS and ADF&G unpublished data). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human ~~interaction~~activities (Lowry 1985).

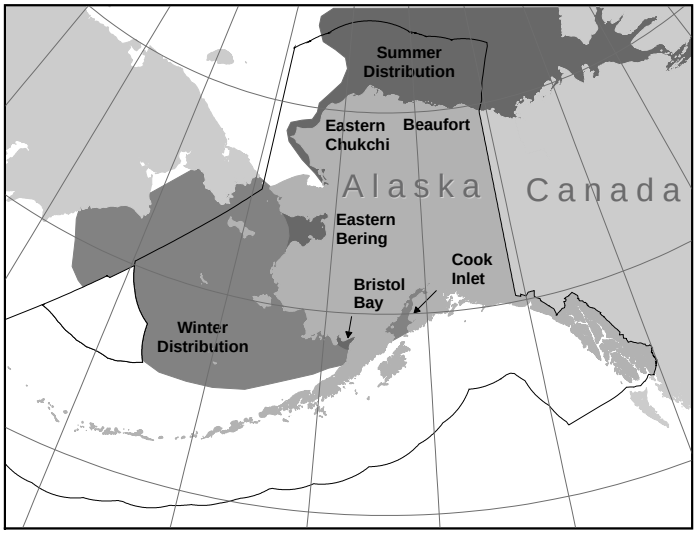

Figure 16. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

The general distribution pattern for beluga whales shows major seasonal changes. During the winter, they occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982; Suydam 2009) and give birth to and care for their calves (Sergeant and Brodie 1969). Annual migrations may cover thousands of kilometers (~~Reeves 1990~~Pierre Richard et al. 2001, 2010).

~~Recent efforts by the Alaska Beluga Whale Committee to train hunters to attach satellite transmitters~~ Two belugas from the eastern Bering Sea stock were tagged with satellite transmitters in 2012. The belugas were tagged near Nome, and moved south from there in ice covered shelf waters during the winter, as far as the vicinity of Hagemeister Island and the Walrus Islands in Bristol Bay, before returning north to Norton Sound in the spring (Alaska Beluga Whale Committee, unpublished data).

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990)~~, and distribution poorly known~~~~understood outside of summer~~; 2) Population response data: ~~possible extirpation of local populations;~~ distinct population trends between regions occupied in summer~~ and possible extirpation of local populations~~; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, five ~~stocks of~~ beluga whale stocks are recognized within U. S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) eastern Bering Sea, 4) eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 16).

POPULATION SIZE

The Alaska Beluga Whale Committee has been working to develop a population estimate for eastern Bering Sea stock beginning with the first systematic aerial surveys of beluga whales in the Norton Sound/Yukon Delta region flown during May, June, and September 1992, and June 1993-1995 (Lowry et al. 1999). Beluga density estimates were calculated for June 1992 surveys using strip transect methods, and for June 1993-1995 using line transect methods.

Correction factors were applied to account for animals that were missed during the surveys (those below the surface and not visible, and dark colored neonates). Lowry et al. (1999) concluded that the best estimate of abundance for the eastern Bering Sea beluga stock was 17,675 (95% confidence interval 9,056-34,515 not accounting for variance in correction factors) based on counts made in early June 1995. Additional aerial surveys of the Norton Sound/Yukon Delta region were conducted in June 1999 and 2000 (L. Lowry, pers. comm., 29 January 2011). Unlike previous survey years, in 1999 sea ice persisted in western Norton Sound resulting in a much different distribution of belugas, and the data were not used for population estimation. In 2000 systematic transect lines were flown covering the entire study region, and the data were analyzed using a covariate line transect model. Preliminary results indicate ~~9,188~~9,593 belugas (CV=~~0.42~~ 0.32) seen at the surface in the study area (~~A. Zerbini~~ R. Hobbs, AFSC-NMML, pers. comm. ~~22 December 2010~~ 05 March 2014). If ~~the correction factors used previously for this survey region (Lowry et al. 1999) are used (2.62~~ this estimate were doubled to correct for the proportion of animals that were diving and thus not visible at the surface, ~~and 1.18 to correct for the proportion of newborns and yearlings not observed due to their small size and dark coloration),~~ the total ~~corrected~~ abundance ~~estimate~~ for the eastern Bering Sea stock ~~is 28,406 (9,188 X 2.62 X 1.18) beluga~~ would be 19,186 whales. However, while these results confirm that the eastern Bering Sea beluga stock is quite large they are preliminary and are not ready to use for calculation of N_{MIN} or PBR at this time.

Minimum Population Estimate

For the eastern Bering Sea stock of beluga whales, the minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Therefore, $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of ~~28,406~~19,186 and an associated CV(N) of ~~0.42~~ 0.32, N_{MIN} for this stock is ~~20,231~~14,751 beluga whales. However, because the survey data are ~~greater~~more than 8 years old, it is not considered a reliable minimum population estimate for calculating a PBR, and N_{MIN} is considered unknown. More recent data are considered preliminary and are not ready to be used for calculation of $N_{MIN,}$ but will be available soon (R. Hobbs, AFSC-NMML, pers. comm. 05 March 2014).

Current Population Trend

Surveys to estimate population abundance in Norton Sound were not conducted prior to 1992. Annual estimates of population size from surveys flown in 1992-95 and 1999-2000 have varied widely, due partly to differences in survey coverage and conditions between years. Data currently available do not allow an evaluation of population trend for the Eastern Bering Sea stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for the eastern Bering Sea stock of beluga whales. Lowry et al. (2008) estimated the rate of increase of the Bristol Bay beluga stock as was 4.8% per year (95% CI = 2.1%-7.5%) over a 12-year period. However, until additional data become available specific to the eastern Bering Sea stock, 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 1.0, the value for cetacean stocks that are thought to be stable in the presence of a subsistence harvest (Wade and Angliss 1997). ~~The Alaska SRG recommended using a F_R of 1.0 for this stock to estimate abundance for this stock and to annually monitor levels of subsistence harvest (DeMaster 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 the eastern Bering Sea stock of beluga whales is considered undetermined (NMFS 2005).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for

distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*." Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fisheries Information

In previous assessments, there were three different federally observed commercial fisheries in Alaska that could have had incidental serious injuries or mortalities of eastern Bering Sea beluga whales. In 2004, the definitions of these commercial fisheries were changed to reflect target species; this new definition has resulted in the identification of several observed fisheries in the Bering Sea that use trawl, longline, or pot gear. There have been no observed serious injuries or mortalities in any of these commercial fisheries.

In the nearshore waters of the eastern Bering Sea, substantial effort occurs in commercial and subsistence fisheries, mostly for salmon and herring. The salmon fishery uses gillnet gear similar to that used in Bristol Bay where it is known that belugas have been incidentally taken (Frost et al. 1984). However there are no useful data on beluga incidental takes from this stock because there have never been observer programs on the commercial fisheries and there is no reporting requirement for takes in personal use fisheries. ~~The only reported beluga mortality in this region occurred in a personal use king salmon gillnet in 1996.~~ In 2010, one beluga was reported entangled in a subsistence salmon gillnet in the eastern Bering Sea (Table 28). NMFS assumes that all beluga whales killed are used for subsistence, regardless of the method of harvest, are reported to the ABWC, and included in the following section on Subsistence/Native Harvest Information.

A reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable.

Table 28. Summary of Eastern Bering stock beluga whale mortalities and serious injuries by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Entangled in subsistence salmon gillnet	0	0	1	0	0	0.2
Minimum total annual mortality						0.20

Because there has never been an observer program for nearshore commercial fisheries in the eastern Bering Sea region, a reliable estimate of the number of ~~mortality rate~~deaths incidental to commercial fisheries is currently unavailable.

Subsistence/Native Harvest Information

The subsistence take of beluga whales from the eastern Bering Sea stock is provided by the ABWC. The most recent subsistence harvest estimates for the stock are provided in Table 29 (Frost and Suydam in press; Alaska Beluga Whale Committee, pers. comm., ~~18 February 2010~~13 June 2013). Belugas harvested in Kuskokwim villages are included in the total harvest for the eastern Bering Sea beluga stock. The annual subsistence take by Alaska Natives averaged ~~193~~181 belugas landed from the eastern Bering Sea stock during the 5-year period ~~2005-2009~~2008-2012.

Table 29. Summary of the number of belugas landed by the Alaska Native subsistence harvest from the eastern Bering Sea stock of beluga whales, ~~2005-2009~~2008-2012.

Year	Reported total number landed
~~2005~~	~~259~~
~~2006~~	~~172~~

~~2007~~	~~232~~
2008	119
2009	181
2010	194
2011	224
2012	186
Mean annual number of animals landed (~~2005-2009~~2008-2012):	~~192.6~~180.8

STATUS OF STOCK

The estimated minimum annual mortality ~~rate~~ incidental to U.S. commercial fisheries is 0. Because the PBR is undetermined, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The total estimated annual human-caused mortality rate is ~~193~~181 based on subsistence harvest (180.8) and entanglement in a subsistence salmon gillnet (0.2). Eastern Bering Sea beluga whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. ~~Although the abundance estimates are greatermore than 8 years old and PBR is undetermined, t~~The level of incidental mortality in commercial fisheries is unknown, although it is considered to be insignificant. Therefore the Eastern Bering Sea stock of beluga whales is classified as a non-strategic stock.

HABITAT CONCERNS

Evidence indicates that the Arctic climate is changing significantly and that one result of the change is a reduction in the extent of sea ice in ~~at least some~~ most regions of the Arctic (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant effect on prey availability. Currently, there are insufficient data to make reliable predictions of the effects of Arctic climate change on beluga whales, but Laidre et al. (2008) and Heide-Jørgensen (2010) concluded that on a worldwide basis belugas were likely to be less sensitive to climate change than other arctic cetaceans because of their wide distribution and flexible behavior. Increased human activity in the Arctic, including increasing oil and gas exploration and development, and increased nearshore development, have the potential to impact habitat for beluga whales (Moore et al. 2000, Lowry et al. 2006), but predicting the type and magnitude of the impacts is difficult at this time.

CITATIONS

ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, U.K.

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

DeMaster, D. P. 1997. Minutes from fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. (Available upon request - Alaska Fisheries Science Center, 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.

Finley, K. J. 1982. The estuarine habitat of the beluga or white whale, *Delphinapterus leucas*. Cetus 4:4-5.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska. Pp. 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.

Frost, K. J., and R. S. Suydam. In Press. Subsistence harvest of beluga or white whales (*Delphinapterus leucas*) in northern and western Alaska 1987-2006. J. Cet. Res. Manage.

Frost, K. J., L. F. Lowry, and R. R. Nelson. 1984. Belukha whale studies in Bristol Bay, Alaska. Pp. 187-200 *In* Proceedings of the workshop on biological interactions among marine mammals and commercial fisheries in the Southeastern Bering Sea. Oct. 18-21, 1983, Anchorage AK. Alaska Sea Grant Rep. 84-1.

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

Hazard, K. 1988. Beluga whale, *Delphinapterus leucas.* Pp. 195-235 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Heide-Jørgensen, M., Laidre, K., Borchers, D., Marques, T., Stern, H. and Simon, M. 2010. The effect of sea-ice loss on beluga whales (*Delphinapterus leucas*) in West Greenland. Polar Res., 29: 198–208. doi: 10.1111/j.1751-8369.2009.00142.x

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

Laidre, K. L., I. Stirling, L. 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.

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Lowry, L. F., D. P. DeMaster, and K. J. Frost. 1999. Alaska Beluga Whale Committee Surveys of Beluga Whales in the Eastern Bering Sea, 1992-1995. Rep. International Whaling Commission. SC/51/SM 34.

Lowry, L. F., K. J. Frost, A. Zerbini, D. DeMaster, R. R. Reeves. 2008. Trend in aerial counts of beluga or white whales (*Delphinapterus leucas*) in Bristol Bay, Alaska. J. Cet. Res. Manage. 10(3):201-207.

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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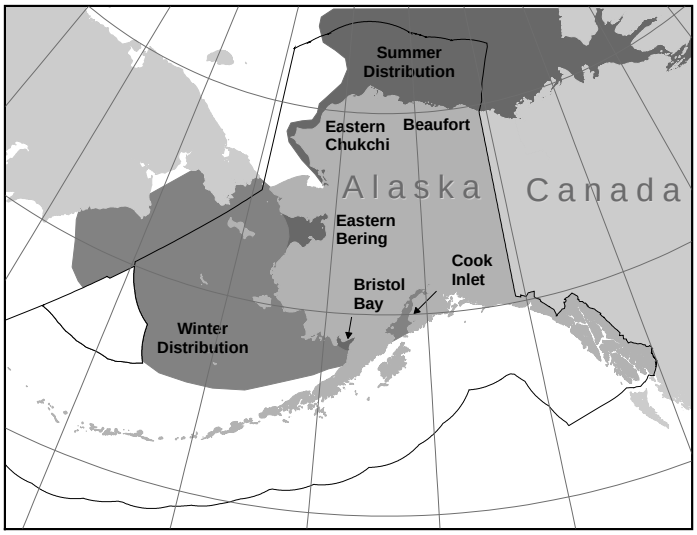

Figure 17. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

The general distribution pattern for beluga whales shows major seasonal changes. During the winter, they occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982; Suydam 2009) and give birth to and care for their calves (Sergeant and Brodie 1969). Annual migrations may cover thousands of kilometers (~~Reeves 1990~~Pierre Richard et al. 2001, 2010).

Summer movement patterns of Bristol Bay belugas were determined from satellite-linked tags deployed on 10 animals in the Kvichak River during 2002 and 2003, and 5 in the Nushagak River in 2006, 10 in 2008, 5 in 2010, 10 in 2012, and 12 in 2013 (NMFS, BBMMC, ADFG, unpublished data). Those whales used the shallow upper portions of Kvichak and Nushagak bays between May and August (Quakenbush, 2003) and remained in the nearshore waters of Bristol Bay through the months of September and October (Quakenbush and Citta, 2006). Data from two belugas whose tags lasted into December and January showed that they were in Nushagak and Kvichak bays, suggesting that some belugas do not leave the nearshore waters of Bristol Bay during the winter (Lori Quakenbush, Alaska Department of Fish and Game, Fairbanks, AK, pers comm. 31 March 2008). Tags attached to whales in 2012 and 2013 have confirmed these observations (NMFS unpublished data).

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous in summer (Frost and Lowry 1990)~~, and distribution poorly known~~~~understood outside of summer~~; 2) Population response data: ~~possible extirpation of local populations;~~ distinct population trends between regions occupied in summer~~ and possible extirpation of local populations~~; 3) Phenotypic data: unknown; and 4) Genotypic data: mitochondrial DNA analyses indicate distinct differences among the five summering areas (O'Corry-Crowe et al. 1997). Based on this information, ~~5~~five ~~stocks of~~ beluga whale stocks are recognized within U. S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) eastern Bering Sea, 4) eastern Chukchi Sea, and 5) Beaufort Sea (Fig. 17).

POPULATION SIZE

The sources of information to estimate abundance for belugas in the waters of western and northern Alaska have included both opportunistic and systematic observations. Frost and Lowry (1990) compiled data collected from aerial surveys conducted between 1978 and 1987 that were specifically designed to estimate the number of beluga whales. Surveys did not cover the entire habitat of belugas, but were directed to specific areas at the times of year when belugas are known to concentrate during summer. Frost and Lowry (1990) reported an estimate of 1,000-1,500 whales for Bristol Bay, similar to that reported by Seaman et al. (1985). In 1994, the number ~~of beluga whales in Bristol Bay~~ was estimated at 1,555 belugas (Lowry and Frost 1998). That estimate was based on a maximum count of 503 animals, which was corrected using radio-telemetry data for the proportion of animals that were diving and thus not visible at the surface (2.62, Frost and Lowry 1995), and for the proportion of newborns and yearlings not observed due to their small size and dark coloration (1.18; Brodie 1971). The Alaska Department of Fish and Game and the Alaska Beluga Whale Committee conducted beluga surveys in Bristol Bay in 1999, 2000, 2004 and 2005, with maximum counts of 690, 531, 794, and 1,067 whales (Lowry et al. 2008). Using the correction factors described above and the maximum counts for 2004 and 2005 gives population estimates of 2,455 and 3,299 whales, with an average annual estimate of 2,877 (L. Lowry, University of Alaska Fairbanks, pers. comm., March 2011).

Minimum Population Estimate

The survey technique used for estimating the abundance of beluga whales in this stock is a direct count which incorporates correction factors. Given this survey method, estimates of the variance of abundance are unavailable. The abundance estimate is thought to be conservative because no correction has been made for whales that were at the surface but were missed by the observers, and the dive correction factor is probably negatively biased (Lowry and Frost 1998). Consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1997), a default CV(N) of 0.2 was used in the calculation of the minimum population estimate (N_{MIN}). N_{MIN} for this beluga whale stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the average estimate for 2004 and 2005 of (N) of 2,877 and the default CV (0.2), N_{MIN} for the Bristol Bay stock of beluga whales is 2,467.

Current Population Trend

~~Population estimates from the 1950s (Brooks 1955, Lensink 1961) suggested there were about 1,000-1,500 belugas in Bristol Bay. Aerial surveys flown in 1983 produced an abundance estimate of 1,250 which indicated that there had been little change in population size.~~ A survey program involving replicate aerial counts using standardized methods was conducted during 1993-2005. Data from 28 complete counts of Kvichak and Nushagak bays made in good or excellent survey conditions were analyzed, and results showed that the population had increased by 65% over the 12-year period (Lowry et al. 2008).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. As this stock is known to be increasing (Lowry et al. 2008), the recovery factor (F_R) is 1.0 (Wade and Angliss 1997, DeMaster 1997; see discussion under PBR for the eastern Bering Sea stock). Thus, for the Bristol Bay stock of beluga whales, PBR = ~~49~~59 animals (2,467 × 0.024 × 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

Three different commercial fisheries that could have interacted with beluga whales in Bristol Bay were monitored for incidental take by fishery observers during 1990-97: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. Observers did not report any mortality or serious injury of beluga whales incidental to these groundfish fisheries.

Observers have never monitored the Bristol Bay commercial salmon set gillnet and drift gillnet fisheries which combined had 2,845 active permits in 2010. These fisheries are known to have caused mortality of beluga whales from this stock in the past (Frost et al. 1984). However, they have never been monitored by an observer program so there is no reliable information on the number of animals that have been or are being taken.

There is substantial effort in a subsistence gillnet fishery for salmon in Bristol Bay. Belugas are occasionally entangled and killed in this fishery, but there is no established protocol for non-commercial takes to be reported to NMFS. During ~~2005-2009~~2008-2012, ~~four mortalities~~one mortality of a beluga in a subsistence salmon net~~s were~~was reported to the stranding network (Table 30). ~~One entanglement was reported as in a subsistence net, one was in a commercial salmon set net, and two others were in unspecified salmon nets.~~ Based on ~~these~~this stranding report~~s~~, the minimum annual mortality estimate due to fishery interactions over the 5-year period from ~~2005-2009~~2008-2012 was ~~0.8~~0.2 per year. However, this figure is clearly an underestimate because ~~personal-use~~subsistence fishers are not required to report marine mammal takes, and the commercial fishery has not been observed. Also, it should be noted that in this region of western Alaska, belugas taken incidental to the personal-use or commercial salmon fisheries may be used by Alaska Native for subsistence and may be included in the subsistence harvest data reported below.

A reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable.

Table 30. Summary of Bristol Bay stock beluga whale mortalities and serious injuries by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Entangled in Bristol Bay subsistence king salmon set gillnet	0	1	0	0	0	0.2
Minimum total annual mortality						0.20

Subsistence/Native Harvest Information

Data on the subsistence take of beluga whales from the Bristol Bay stock is provided by the ABWC. The most recent subsistence harvest estimates for the stock are provided in Table 31 (Frost and Suydam in press, Alaska Beluga Whale Committee, 18 February 2010) These data show that the annual subsistence take by Alaska Natives averaged ~~20~~24 belugas from the Bristol Bay stock during the 5-year period ~~2005-2009~~2008-2012.

Table 31. Summary of the Alaska Native subsistence harvest from the Bristol Bay stock of beluga whales, ~~2005-2009~~2008-2012. N/A indicates the data are not available.

Year	Reported total number landed
~~2005~~	~~21~~

~~2006~~	~~20~~
~~2007~~	~~20~~
2008	19
2009	20
2010	27
2011	22
2012	32
Mean annual number of animals landed (~~2005-2009~~2008-2012):	~~20.0~~24.0

STATUS OF STOCK

It is unknown whether the U. S. commercial fishery-related mortality level is insignificant and approaching zero mortality and serious injury rate (i.e., 10% of PBR; less than ~~4.9~~5.9 per year) because a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable. Bristol Bay beluga whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the estimated annual rate of human-caused mortality and serious injury (~~20~~24 + ~~0.8~~0.2 = ~~21~~24.2) is not known to exceed the PBR (~~49~~59). Because the population size has been increasing at a rate near Rmax, the sum of human impacts on the population are not a problem at this point (Lowry et al. 2008). Therefore, the Bristol Bay stock of beluga whales is not classified as a strategic stock. However, as noted previously, the estimate of fisheries-related mortality is unreliable and likely to be underestimated.

HABITAT CONCERNS

Evidence indicates that the Arctic climate is changing significantly and that one result of the change is a reduction in the extent of sea ice in ~~at least some~~ most regions of the Arctic (ACIA 2004, Johannessen et al. 2004). These changes are likely to affect marine mammal species in the Arctic. Ice-associated animals, such as the beluga whale, may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant effect on prey availability. Currently, there are insufficient data to make reliable predictions of the effects of Arctic climate change on beluga whales, but Laidre et al. (2008) and Heide-Jørgensen (2010) concluded that on a worldwide basis belugas were likely to be less sensitive to climate change than other arctic cetaceans because of their wide distribution and flexible behavior. Increased human activity in the Arctic, including increasing oil and gas exploration and development, and increased nearshore development, have the potential to impact habitat for beluga whales (Moore et al. 2000, Lowry et al. 2006), but predicting the type and magnitude of the impacts is difficult at this time. Because the population size has been increasing (Lowry et al. 2008), habitat impacts most likely have been minimal during recent years.

CITATIONS

ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, U.K.

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Brodie, P. F. 1971. A reconsideration of aspects of growth, reproduction, and behavior of the white whale with reference to the Cumberland Sound, Baffin Island, population. J. Fish. Res. Bd. Can. 28:1309-1318.

Brooks, J. W. 1955. Beluga. Pp. 98-106 *In* Annual Rep. for 1955. Alaska Fisheries Board and Alaska Dep. Fisheries, Juneau, Alaska.

DeMaster, D. P. 1997. Minutes from fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. (available upon request - D. P. DeMaster, Alaska Fisheries Science Center, 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.

Finley, K. J. 1982. The estuarine habitat of the beluga or white whale, *Delphinapterus leucas*. Cetus 4:4-5.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska. Pp. 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.

Frost, K. J., and L. F. Lowry. 1995. Radio tag based correction factors for use in beluga whale population estimates. Working paper for Alaska Beluga Whale Committee Scientific Workshop, Anchorage, AK, 5-7 April 1995. 12 pp.

Frost, K. J., L. F. Lowry, and R. R. Nelson. 1984. Belukha whale studies in Bristol Bay, Alaska. Pp. 187-200 *In* Proceedings of the workshop on biological interactions among marine mammals and commercial fisheries in the Southeastern Bering Sea. Oct. 18-21, 1983, Anchorage AK. Alaska Sea Grant Rep. 84-1.

Frost, K. J., and R. S. Suydam. In Press. Subsistence harvest of beluga or white whales (*Delphinapterus leucas*) in northern and western Alaska 1987-2006. J. Cet. Res. Manage.

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

Hazard, K. 1988. Beluga whale, *Delphinapterus leucas*. Pp. 195-235 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Heide-Jørgensen, M., Laidre, K., Borchers, D., Marques, T., Stern, H. and Simon, M. 2010. The effect of sea-ice loss on beluga whales (*Delphinapterus leucas*) in West Greenland. Polar Res., 29: 198–208. doi: 10.1111/j.1751-8369.2009.00142.x

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

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

Lensink, C. J. 1961. Status report: beluga whale. Alaska Dep. Fish and Game, Juneau, AK. Unpubl. Rep. 38 pp.

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

Lowry, L. F., and K. J. Frost. 1998. Alaska Beluga Whale Committee surveys of beluga whales in Bristol Bay, Alaska, 1993-1994. Alaska Beluga Whale Committee Rep. 98-3. 13 pp.

Lowry, L. F., K. J. Frost, A. Zerbini, D. DeMaster, and R. R. Reeves. 2008. Trend in aerial counts of beluga whales (*Delphinapterus leucas*) in Bristol Bay, Alaska, 1993-2005.

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

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

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

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.

Quakenbush, L. and Citta, J. 2006. Fall movements of beluga whales captured in the Nushagak River, in September 2006. Alaska Beluga Whale Committee Rep. 9 pp.

Reeves, R. R. 1990. An overview of the distribution, exploitation and conservation status of belugas, worldwide. Pp. 47-58 *In* J. Prescott and M. Gauquelin (eds.), For the future of the beluga: Proceedings of the International Forum for the Future of the Beluga. Univ. Quebec Press, Canada.

Seaman, G. A., K. J. Frost, and L. F. Lowry. 1985. Investigations of belukha whales in coastal waters of western and northern Alaska. Part I. Distribution, abundance and movements. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 56:153-220. Available from NOAA-OMA-OAD, Alaska Office, 701 C. Street, P.O. Box 56, Anchorage, AK 99513.

Sergeant, D. E., and P. F. Brodie. 1969. Body size in white whales, *Delphinapterus leucas*. J. Fish. Res. Bd. Can. 26:2561-2580.

Shelden, K. E. W. 1994. Beluga whales (*Delphinapterus leucas*) in Cook Inlet - A review. Appendix *In* Withrow, D. E., K. E. W. Shelden, and D. J. Rugh. Beluga whale (*Delphinapterus leucas*) distribution and

abundance in Cook Inlet, summer 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

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 pp.

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). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with summer concentrations in upper Cook Inlet, Bristol Bay, the eastern Bering Sea (i.e., Yukon Delta, Norton Sound), eastern Chukchi Sea, ~~Kasegaluk Lagoon,~~ and the Mackenzie Delta (Hazard 1988). Satellite transmitters on a few whales from the Beaufort Sea, Chuckchi Sea and Eastern Bering Sea stocks have lasted through the winter demonstrating~~It is assumed~~~~confirmed~~ that ~~most~~ beluga whales from these summering areas overwinter in the Bering Sea and the stocks may use separate wintering locations (Suydam 2009, Richard et al. 2010, ABWC unpublished data). Belugas~~, excluding those~~ found in Bristol Bay and the northern Gulf of Alaska/ Cook Inlet remain in those areas throughout the year (Shelden 1994, Quakenbush 2003, NMFS and ADF&G unpublished data). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985).

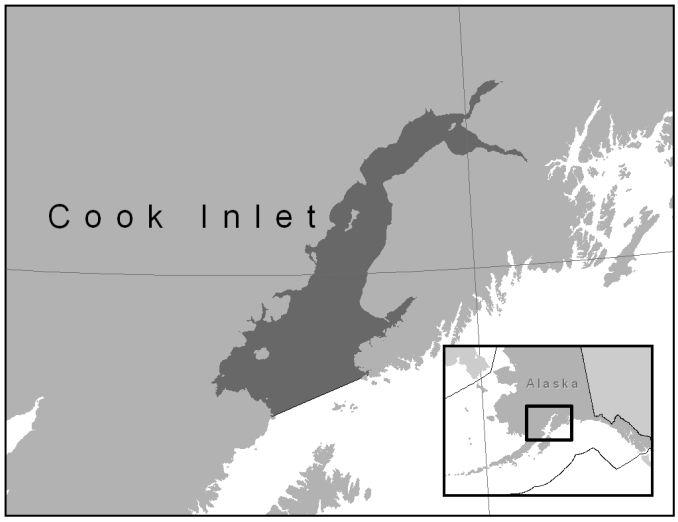

Figure 18. Approximate distribution of beluga whales in Cook Inlet.

The following information was considered in classifying beluga whale stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution discontinuous (Frost and Lowry 1990); 2) Population response data: possible extirpation of local populations, distinct population trends between 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, 5 beluga whales stocks are recognized within U. S. waters: 1) Cook Inlet, 2) Bristol Bay, 3) eastern Bering Sea, 4) eastern Chukchi Sea, and 5) Beaufort Sea.

During the open water months in upper Cook Inlet (north of the forelands), beluga whales are typically concentrated near river mouths (Rugh et al. 2010; Fig. 19). The winter distribution of this stock is not well known; however, there is evidence that some whales ~~may~~ inhabit upper Cook Inlet year-round (Hansen and Hubbard 1999, Rugh et al. 2004, Hobbs et al. 2005). Satellite tags were attached to 17 belugas in late summer during 2000-2002 in order to determine their distribution through the fall and winter months (Hobbs et al. 2005). Ten tags transmitted through the fall, and of those, three tags deployed on adult males transmitted through April and late May (2003). None of the tagged beluga moved south of Chinitna Bay on the west side of Cook Inlet. A review of all marine mammal surveys conducted in the Gulf of Alaska from 1936 to 2000 discovered only 31 beluga sightings among 23,000 marine mammal sightings, indicating that very few belugas occur in the Gulf of Alaska outside ~~of~~ Cook Inlet (Laidre et al. 2000). A small number of beluga whales (fewer than 20 animals; Laidre et al. 2000, O'Corry-Crowe et al. 2006) are regularly observed in Yakutat Bay. Although not included in the Cook Inlet 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 Cook Inlet stock (75 FR 12498, 16 March 2010), defined as depleted ~~at~~in 50 CFR 216.15. Notice-and-comment rulemaking procedures would be required to change this regulatory definition. Until such procedures are completed, these animals remain designated as depleted and part of the Cook Inlet stock.

POPULATION SIZE

Aerial surveys for beluga whales in Cook Inlet have been conducted by the National Marine Fisheries Service each year from~~since 1994~~1993 to 2012. In 2013 the survey was not conducted due to cost considerations; a survey is planned for 2014 and is planned as a biennial survey in subsequent years. The survey protocol includes paired, independent observers~~ to estimate the number of whale groups missed~~. When groups were seen, a series of aerial passes were made to allow each observer to make independent counts simultaneously with video camera recordings of the whales (Rugh et al. 2000, 2005, Shelden et al. 2013). This duel independent effort would provide two estimated counts and allow for the number of whale groups missed to be estimated.

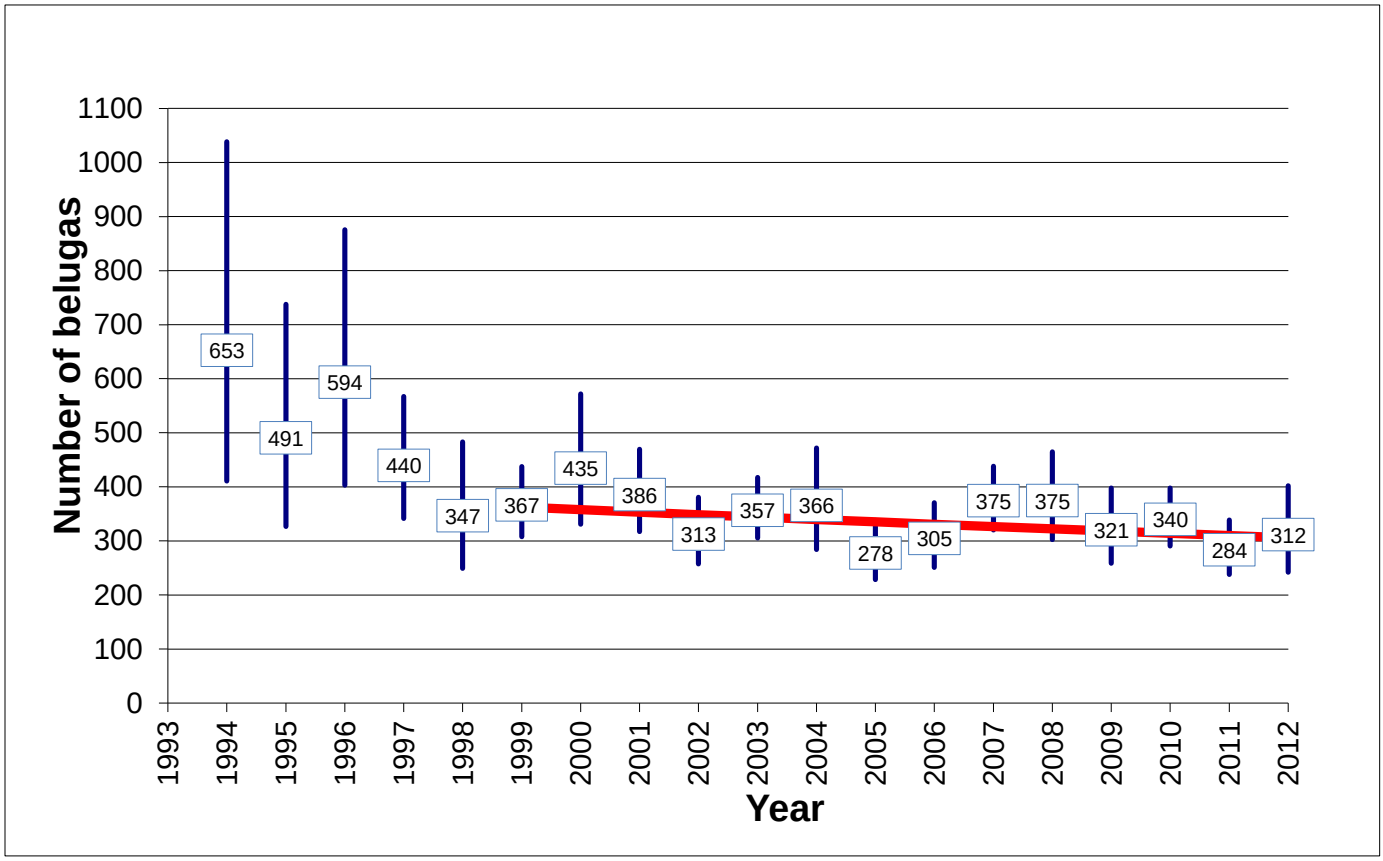

Figure 19. Annual abundance estimates of beluga whales in Cook Inlet, Alaska 1994-2012 (Hobbs et al. 2012). Vertical bars depict plus and minus one standard error. Over the last 10 years (2002-2012), the rate of decline (red trend line) has been -0.6% per year.

The ~~abundance of~~ beluga whale~~s~~ abundance in Cook Inlet is estimated annually based on counts by aerial observers and video analysis of whale groups. Each count estimate 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. 2000a). When video counts are not available, observers' counts are corrected for availability and sightability using a regression of counts and an interaction term of counts with an encounter rate against the video count estimates (Hobbs et al. 2000a). ~~The estimate of the variance of the abundance equation in Hobbs et al. (2000b) was revised to use the squared standard error of the average for the abundance estimates in place of the variance of the abundance estimate and the measurement error (Hobbs at al. 2012); this reduced CVs by almost half, as represented in Figure 20a. The most recent annual abundance estimate of beluga whales in Cook Inlet from the 2012 aerial survey is 312 (CV = 0.13) (Hobbs et al. 2012).~~ Hobbs et al. (2006b) revised the estimate of the abundance equation variance by using the squared standard error of the average for the abundance estimates in place

of the abundance estimate variance and the measurement error (Hobbs at al. 2012). This reduced the CVs by almost half, as represented in Figure 19. The most recent annual abundance estimate was conducted in June 2012, and resulted in an estimate of 312 whales (CV = 0.13) (Hobbs et al. 2012). This estimate is more than the estimate of 284 for 2011; however, it falls within the statistical variation around the recent trend line (in red) and probably represents variability of the estimation process rather than an increase in the population from 2011 to 2012. Annual abundance estimates based on aerial surveys of Cook Inlet beluga during the most recent 3-year period were 340 (2010), 284 (2011), and 312 (2012), resulting in an average abundance estimate for this stock of 312 (CV = 0.10) belugas.

Minimum Population Estimate

The minimum population ~~size~~estimate (N_{MIN}) ~~for this stock~~ is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Thus, $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 3-year average population estimate (N) of 312 animals and ~~its~~an associated CV(N) of 0.10, N_{MIN} for the Cook Inlet stock of beluga whales is 280 belugas.

Current Population Trend

The corrected annual abundance estimates for the period 1994-2012 are shown in Figure 20a. ~~A statistically significant declining trend in abundance was detected between 1994 and 1998 (Hobbs et al. 2000b), although the power of the analysis was low due to the short time series. A Bayesian inference on the population abundance estimates gave a modal trend estimate of -1.2% per year for 1994-2005, with a 71% probability that the population was declining (Lowry et al. 2006), whereas t~~The trend for 2002 to 2012 is an annual decline of 0.6% (SE = 0.011)~~ per year~~. The 2008 status review of the population indicated there was an 80% chance that the population would decline further (Hobbs and Shelden 2008).

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% percent annual increase that has been documented for the Bristol Bay beluga stock (Lowry et al. 2008).

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. In reports from 1998 through 2005, NMFS calculated a value for PBR. However, given the low abundance relative to historic 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, 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 OSP. Thus, the PBR for this stock is undetermined ~~for the Cook Inlet stock of beluga whale~~.

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

In 1999 and 2000, observers were placed on Cook Inlet salmon set and drift gillnet vessels because of the potential for those fisheries to entangle beluga whales. No mortalities or serious injuries were observed in either

year (Manly 2006). No observer data have been collected in these fisheries since 2000. However, two entanglements have since been reported: 1) on July 14, 2005 a set net fisherman near Nikiski reported a beluga was entangled and then released from his net and the whale's condition was unknown; and 2) on May 7, 2012 a fisherman reported that a juvenile beluga was entangled in his salmon fishing net during a special use subsistence fishery near Kenai; the whale was dead, and necropsy findings reported this animal was in poor health prior to entanglement.

~~A photogrammetric~~~~photo-identification~~ ~~study by (Kaplan et al. (2009) did not find any instances where Cook Inlet belugas appeared to have been entangled in, or to have otherwise interacted with, fishing gear. However, in 2010, a beluga 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, and~~

~~August 2012, still entangled in the rope line (pers comm. Tamara McGuire, LGL Alaska Research Associates, Inc. 2000 W International Airport Road, Anchorage, AK 99502; 15 February 2013).~~

The estimated minimum mortality rate incidental to commercial fisheries is unknown, although probably low because only one known beluga mortality was reported in over 10 years.

Subsistence/Native Harvest Information

Subsistence harvest of beluga whales in Cook Inlet has been important to one local village (Tyonek) and the subsistence hunter community in Anchorage. Between 1993 and 1999, the annual subsistence take ranged from 30 to more than 100 animals (Mahoney and Shelden 2000). The average annual subsistence harvest, including struck and lost, for 1995 and 1996 was 87 whales (CIMMC 1997).

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 by Alaska Natives conducted under cooperative agreements between NMFS and affected Alaska Native organizations. There were no signed co-management agreements in 1999, 2004, and 2007, so no harvest was authorized. Harvest from 2001 through 2004 was conducted under harvest regulations (69 FR 17973, 6 April 2004) following an interim harvest management plan developed through an administrative hearing; three belugas were harvested in Cook Inlet under this interim harvest plan. In August 2004, an administrative hearing was held to determine a long-term harvest plan, which allowed for 8 whales to be harvested during 2005 - 2009. From ~~2010~~2008 until recovery, 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 over the previous 10-year period; no harvest is allowed if the previous 5-year average abundance is

Year	Number Dead from Natural or Unknown Causes	Number of Belugas per Live Stranding Event* (# associated known mortalities)
1994	108	186 (0)
1995	3	0
1996	12	63(0), 60(4), ~~25~~20-30(1), 1(0), ~~15~~10-20(0)
1997	3	0
1998	~~10~~14	30(0), 5(0)
1999	12	58-70(5), 12-13(0)
2000	13 (~~2~~3 predations)	8(0), ~~17~~15-20(0), 2(0)
2001	10	0
2002	~~13~~10	0
2003	20 (1 predation)	2(0), 46(5), 26(0), 32(0), 9(0)
2004	13	N/A
2005	6	7(1)
2006	8	12(0)
2007	15	0
2008	11 (1 predation?)	28(0), 30(0)
2009	4	17-20 (0)
2010	5 (1 predation)	11(0), 2(0)
2011	3	2(0)
2012	3	12(0), 23(0), 3(0)
Total	179	735-738 (16)

Table 32. Cook Inlet beluga strandings investigated by NMFS (Vos and Shelden 2005; Hobbs and Shelden 2008, NMFS unpublished data). * Harvested beluga are not included in the number dead.

less than 350 belugas. Because the 5-year average abundance during 2003-2007 was 336 (i.e., below 350 whales), no harvest was allowed during the subsequent 5-year period, 2008–2012. (73 FR 60976; 15 October 2008). Since the average abundance of Cook Inlet beluga whales remains below 350 whales (2008-2012), no harvest is allowed for the 5-year period 2013-2017.

OTHER MORTALITY

Mortalities related to stranding events have been reported in Cook Inlet (Table 32). Improved record-keeping was initiated in 1994, and reports have since included the number of dead and live stranded belugas~~, including live strandings~~. The majority of whales involved in a live stranding event probably survive, recognizing that some mortalities are missed by observers ~~and~~if whales ~~may~~ die later ~~of~~from stranding-related injuries. The ~~following are the~~ number of whale mortalities suspected to have resulted from live strandings: 5 belugas in 1996, 5 whales in 1999, 5 belugas in 2003 (Vos and Shelden 2005); and 1 beluga in 2005 (Hobbs and Shelden 2008). In 2012 there were 38 whales involved in 3 live stranding events, with no mortalities reported (Table 32). Most live strandings have occurred in Knik Arm and Turnagain Arm, shallow and dangerous waterways and Turnagain Arm has the largest tidal rand in the U.S., with a mean of 9.2 m (30 ft.).~~not frequented by motorized vessels; thus, vessel disturbance of belugas is likely at low levels and probably not the cause of many live strandings.~~

Another source of beluga whale mortality in Cook Inlet is killer whale predation. Killer whale sightings were not well documented and appear to be rare in the upper inlet prior to the mid-1980s.~~, but~~ From 1985-2002 there are ~~now include~~ 18 reported sightings of killer whales in upper Cook Inlet~~from 1985-2002~~ (Shelden et al. 2003). The most recent possible predation event ~~that~~ was reported in ~~the~~ upper Cook Inlet in June 2010, where an adult beluga carcass, discovered near Point Possession, showed evidence of possible predation, but poor body condition of the beluga carcass prevented a positive determination.

A ~~photogrammetric~~photo-identification study ~~by~~ (Kaplan et al. ~~(~~2009) did not find any instances where Cook Inlet belugas appeared to have been entangled in, or to have otherwise interacted with, fishing gear. However, in 2010, a beluga 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, and August 2012, still entangled in the rope line (pers comm. Tamara McGuire, LGL Alaska Research Associates, Inc. 2000 W International Airport Road, Anchorage, AK 99502; 15 February 2013).

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 belugas as endangered under the ESA. Therefore, the Cook Inlet beluga whale stock is considered a strategic stock. There are no fisheries observers in Cook Inlet and there have been no voluntary reports of beluga mortalities in U.S. commercial fisheries. ~~Thus, annual mortality levels are considered insignificant and approaching zero~~Annual mortality and serious injury rate for commercial fisheries is likely low, although the incompleteness of ~~fisheries~~ data for commercial fisheries operating within the range of Cook Inlet beluga is a concern for this small population. NMFS convened a Recovery Team to aide 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 2014, in advance of finalizing the Recovery Plan for Cook Inlet Beluga Whale:.
(http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/recovery/ci.htm
~~consisting of a Scientific Panel and Stakeholder Panel, which submitted a draft Recovery Plan for Cook Inlet beluga whales in March 2013. (http://www.fakr.noaa.gov/protectedresources/whales/beluga/recovery/ci.htm). NMFS will consider revisions to the draft Recovery Plan, seek public comment, and then finalize the Recovery Plan in 2014~~.

Habitat Concerns

Based on visual observations and satellite tagging, the distribution of Cook Inlet belugas during May-September~~the ice-free summer period~~ is currently restricted to the upper inlet (north of the forelands), especially the Susitna Delta, Knik Arm, Turnagain Arm, and Chickaloon Bay (Rugh et al. 2000, 2005, 2010; Goetz et al. 2007). ~~During the~~ When Cook Inlet is ice-covered~~winter period~~, belugas ~~are distributed~~expand their distribution into the ~~deeper~~ water~~areas~~ of the upper inlet and mid-inlet (Hobbs et al. 2005). With the ~~very restricted~~limited range of this stock, Cook Inlet beluga are vulnerable to human-induced or natural perturbations within their preferred habitat. Although the best available information indicated that human activities, including those associated with oil and gas development, were not a contributing factor in the stock becoming in danger of extinction (65 FR 38778; 22 June 2000), potential effects from human activities impeding on beluga recovery remain a concern (73 FR 62919, 22

October 2008). Additional effects that have the potential to impact this stock and its habitat include: changes in prey availability due to natural environmental variability, ocean acidification, and commercial fisheries; climatic changes affecting habitat; competition with fisheries; increased predation by killer whales; contaminants; noise; vessel traffic; 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). As part of the NMFS Recovery Plan for Cook Inlet Beluga Whales, acoustic threats are being evaluated and a list of actions will be proposed to better understand the impact of anthropogenic noise on Cook Inlet Belugas, fill the gaps in knowledge and improve mitigation. A ~~photogrammetric~~photo-identification study ~~by Kaplan et al. (2009)~~(McGuire 2012) ~~recorded a few instances where~~identified belugas that had probably been struck by boat propellers or ships. Projects planned that may alter the physical habitat include a highway bridge across Knik Arm, highway improvements, coal mine construction and operation~~ of a coal mine~~ near Chuitna River; oil and gas exploration and development, as well as ~~planned 3-D~~ seismic surveys; and expansion and improvements to the Port of Anchorage. 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).

CITATIONS

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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. Pp. 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.

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 Rep. OCS Study. MMS 99-0024. U.S. Dep. Int., Minerals Manage. Serv. Alaska OCS Region, Anchorage, AK. v. p.

Hazard, K. 1988. Beluga whale, *Delphinapterus leucas*. Pp. 195-235 *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

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., and K. E. W. Shelden. 2008. Supplemental status review and extinction assessment of Cook Inlet belugas (*Delphinapterus leucas*). AFSC Processed Rep. 2008-08, 76 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.

Hobbs, R. C., C. L. Sims, and K. E. W Shelden. 2012. Estimated abundance of belugas in Cook Inlet, Alaska, from aerial surveys conducted in June 2012. NMFS, NMML Unpublished Report. 7 pp. Available at: http://alaskafisheries.noaa.gov/protectedresources/whales/beluga/abundance/2012estimates.pdf

Hobbs, R.C., J. M. Waite, and D.J. Rugh. 2000a. 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., J. M. Waite, and D.J. Rugh. 2000b. Abundance of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, 1994-2000. Mar. Fish. Rev. 62(3):37-45.

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.

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.

Lowry, L., O'Corry-Crowe, G., and Goodman, D. 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.

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.

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 the NMFS Alaska Region. 98 pp. (Available online: http://www.fakr.noaa.gov/protectedresources/observers/bycatch/1999-2000cookinlet.pdf)

Moore, S. E., K. W. Shelden, 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.

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.

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. Pp. 464 *In* C. J. Pfeiffer (ed.), Molecular and cell biology of marine mammals. Kreiger Publishing Company. Malabar, Florida.

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. 22pp.

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.

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

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. NOAA Tech Memo. NMFS-AFSC-149. 71 pp.

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 Technical Memorandum NMFS-AFSC-**, ** p.

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.

Vos, D., and K.E.W. Shelden. 2005. Unusual mortality in the depleted Cook Inlet beluga (*Delphinapterus leucas*) population. Northwest. Nat. 86:59–65.

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 pp.

NARWHAL (*Monodon monoceros*): Unidentified Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Narwhals typically inhabit waters of the Arctic Ocean. They are common in the waters of Nunavut, Canada, west Greenland, and in the European Arctic; however, they rarely occur in the East Siberian, Bering, Chukchi, and Beaufort Seas (COSEWIC 2004). The three recognized populations of narwhals are based on summer distribution: Baffin Bay, Hudson Bay, and east Greenland (DFO 1998a, 1998b; COSEWIC 2004). The Baffin Bay population of narwhals summers in the waters of West Greenland and the Canadian High Arctic and overwinters in Baffin Bay and Davis Strait (Koski and Davis 1994; Dietz et al. 2001; Heide-Jørgensen et al. 2003). Narwhals from the northwest Hudson Bay population are thought to overwinter in eastern Hudson Strait (Richard 1991). The east Greenland population is believed to winter in the pack ice between eastern Greenland and Svalbard (Dietz et al. 1994). The amount of interchange between these populations is unknown; populations are defined for management purposes, and these designated populations may actually consist of several populations (COSEWIC 2004). Population definition based on molecular genetics 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 20. Potential distribution of narwhals in Arctic waters based on extralimital sightings and strandings (George and Suydam, unpubl. ms., Reeves and Tracey 1980, COSEWIC 2004).

Local observations and traditional ecological knowledge are the primary source for observation data of 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 Pt. 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). George and Suydam (unpubl. ms.) summarized observations from Alaska Native hunters during eight sighting events of narwhals in the Chukchi and Beaufort Seas between 1989 and 2008. Of these records, seven were sightings of live animals totaling 11-12 individuals; one record was a report of a beach cast narwhal tusk at Cape Sabine. Four of the seven sightings of live animals consisted of mixed groups of beluga 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 specimens of narwhals collected in Alaska have been documented. Huey (1952) reported on a specimen collected near Cape Halkett, Harrison Bay, at the mouth of the Colville River. 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 a narwhal tusk was found on the beach at Wainwright. 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. There are insufficient data to apply the phylogeographic approach to stock structure (Dizon et al. 1992) for narwhal.

POPULATION SIZE

Reliable estimates of abundance for narwhal 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 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 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 the level of serious injury and mortality 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 is not classified as strategic.

CITATIONS

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

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

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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 pp.

COSEWIC 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 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

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, Canadian Science Advisory Secretariat Research Document 2003/080: 23 p.

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

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

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 animals and fishes. New York: A. S. Barnes. xviii + 297 pp.

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

George, J. C. and Suydam, R. unpubl. ms. Recent observations of narwhal in the Chukchi and Beaufort Seas by local hunters. 13 January 2009. 3 pp. (Available from D. Allen, National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

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.

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

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.

Ljungblad, D. K., S. E. Moore, and D. R. Van Schoik. 1983. Aerial surveys of endangered whales in the Beaufort, Eastern Chukchi and Northern Bering Seas, 1982 NOSC Technical Document 605. 110 pp plus appx.

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. 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 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, Huntington, H.P., and 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. Washington, 695 pp.

Reeves, R. R. and 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 marine mammals of the northwestern coast of North America, described and illustrated: together with an account of the American whale fishery. New York: G. P. Putnam's Sons. 319 pp.

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.

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 pp.

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade, 2006). Killer whales are found throughout the North Pacific. Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where whales have been labeled as 'resident,' 'transient,' and 'offshore' type killer whales (Bigg et al. 1990, Ford et al. 2000; Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, 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).

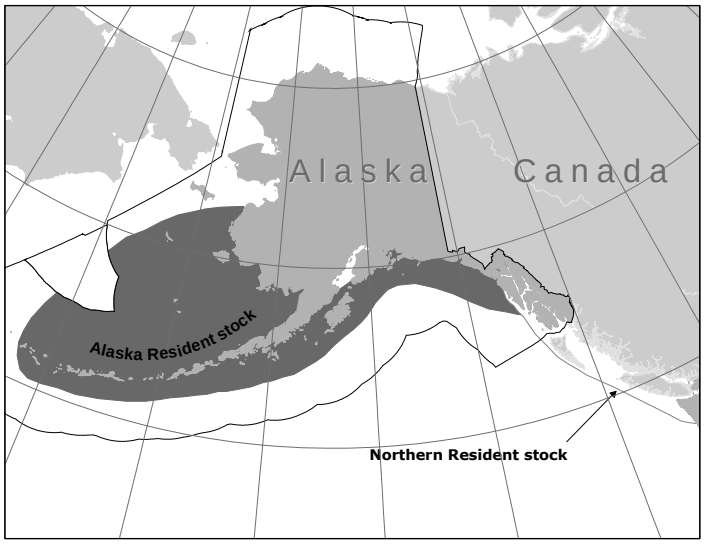

Figure 21. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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

Genetic differences have also been found between populations within the 'transient' and 'resident' ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Within the resident ecotype, association data were 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., NMML-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 (NMML 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 (NMML) 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 NMML 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 NMML data sets have not yet been matched so it is unknown how many of these 600 animals are included in the NMML 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 NMML photographs.

NMML 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 33).

Table 33. 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-NMML, 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 NMML unpublished data[2]**	**2001/2003 NMML unpublished data[2]**	**2001-2012 NMML/NGOS unpublished catalog[2]**
Unassigned to pods (NMML)	68+	464	1,475 (H. Fernbach, 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 33). 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 (NMML 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 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

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 three that incurred serious injuries or mortalities of killer whales (any stock) between 2007 and 2011: the BSAI flatfish trawl, the BSAI rockfish trawl and the BSAI Greenland turbot longline.

Over the past few years, observers have collected tissue samples of many of the killer whales that were killed incidental to commercial fisheries. Genetics analyses of samples from seven killer whales collected between 1999-2004 have confirmed Alaska resident killers whales are occasionally killed incidentally in the BSAI flatfish trawl (n = 3) and the BSAI Pacific cod fisheries (n = 1). Also during this period, 3 transient killer whales from the GOA/AI/BS stock were killed incidental to the BSAI pollock trawl fishery (M. Dahlheim, pers. comm., National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105; 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, given the overlap in range of the transient and resident stocks, unless genetic samples can be collected from animals injured or killed by gear or the propeller, these events are assigned to both the transient and resident stock occurring in that area. Thus, the mean annual estimated level of serious injury and mortality of Alaska resident killer whales is 0.9/year (CV = 0.17) (Table 34).

Typically, if serious injury and mortality occurs incidental to commercial fishing, it is due to interactions with the fishing gear. However, reports indicate that observed killer whale mortalities incidental to the BSAI flatfish trawl fishery often occur due to contact with the ship's propeller.

Table 34. Summary of incidental mortality of Alaska resident stock of killer whales due to commercial fisheries from 2007 to 2011 and calculation of the mean annual mortality rate (Breiwick 2013). Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
BSAI flatfish trawl	2007	obs data	72	0	0	0.4(CV = 0.02)
	2008		100	1	1.0	
	2009		100	1*	1.0	
	2010		100	0	0	
	2011		100	0	0	

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
BSAI rockfish trawl	2007 2008 2009 2010 2011	obs data	88 98 99 100 100	0 0 0 1 0	0 0 0 1.0 0	0.2 CV = N/A
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)
Estimated total annual mortality						0.9 (CV = 0.17)

[*]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).

The estimated minimum mortality rate incidental to U. S. commercial fisheries recently monitored is 0.9 animals per year, based exclusively on observer data.

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 (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 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, 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 predate on longline catch in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003; Sigler et al. 2002; Perez 2006) and in the Gulf of Alaska (Sigler et al. 2002, Perez 2006). In addition, there are 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 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 (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 unpublished data); consumption of the processing waste in the vicinity of the propeller may be the cause of the propeller-caused mortalities of killer whales in the trawl fisheries.

STATUS OF STOCK

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

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

Based on currently available data, the estimated annual U. S. commercial fishery-related mortality level (0.9) is less than 10% of the PBR (2.3) and therefore is considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (0.9 animals per year) is not known to exceed the PBR (23.4). Therefore, the eastern North Pacific Alaska Resident stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population 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. 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. 66:2582-2585.

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. Administrative Report LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 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, University of British Columbia, Vancouver, BC, Canada, 97 pp.

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. Pp. 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 pp.

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. 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 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. Wildlife Biology 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 whales of Southeast Alaska: a catalogue of photoidentified individuals. Day Moon Press, Seattle, WA. 82 pp. + 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. 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 pp. + appendices. (Available upon request - National Marine Mammal Laboratory, 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 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 whales: the natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. UBC Press, Vancouver BC and University of Washington Press, Seattle. 102 pp.

Ford, J.K.B., G.M. Ellis, K.C. Balcomb. 2000. Killer Whales. University of British Columbia Press, Vancouver, Toronto, Canada; University of Washington Press, Seattle. 104p.

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 of Oregon and Washington, 1989-1990. Pp. 1-100 *In* Brueggeman (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. 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. Heredity 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. 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, 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. Fisheries Bulletin, U.S. 105:74-87.

Matkin, C.O., G. Ellis, D. Herman, E. Saulitis, R. Andrews, A. Gaylord, and H. Yurk. 2010. Monitoring, Tagging, Acoustics, Feeding Habits and Restoration of Killer 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, A. Gaylord. In prep. Monitoring, Tagging,Feeding Habits and Restoration of Killer 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: 269–281.

Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Bd. 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, T. Harkins. 2010. Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. Genome Research, 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., Barrett-Lennard L. G., Ellis G. M., Ford J. K. B., Deecke V. B. 2012. Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? Biological Journal of the Linnean Society, 106:1-17.

Sigler, M.F., C. R. Lunsford, J. T. Fujioka, and S. A. Lowe. 2002. Alaska Sablefish Assessment for 2003. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Bering Sea/Aleutian Islands Regions. North Pac. Fish. Mgmt. Council, Anchorage, AK, Section 5:229-294.

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 pp.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

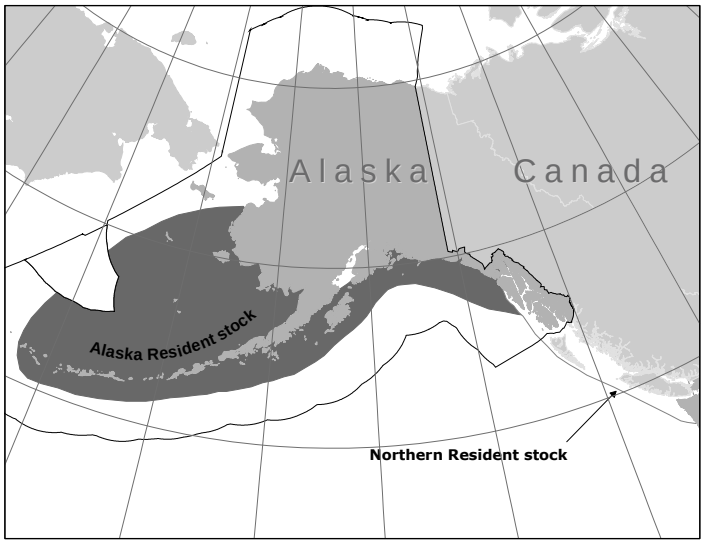

Figure 22. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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

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

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

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

POPULATION SIZE

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

Table 35. Numbers of animals in each pod of killer whales belonging to the Eastern North Pacific Northern Resident stock of killer whales.

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

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

Minimum Population Estimate

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

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

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

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Subsistence/Native Harvest Information

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

Other Mortality

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

Other Issues

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

STATUS OF STOCK

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

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

HABITAT CONCERNS

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

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

CITATIONS

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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. 66:2582-2585.

Baird, R. W., Abrams, P. A., 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.

Baird, R W. 1999. Status of Killer Whales in Canada. Report submitted to the Committee on the Status of Endangered Wildlife in Canada. 42 pp.

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. Administrative Report LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 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, University of British Columbia, Vancouver, BC, Canada, 97 pp.

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. Pp. 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 catalogue of photo-identified individuals. NOAA Technical Memorandum-NMFS-SWFSC-247. 174 pages.

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. 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 pp. (Available online: http://www.afsc.noaa.gov/Publications/ProcRpt/PR%2088-14.pdf).

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 pp. + appendices.

Dahlheim, M. E. A. Shulman-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. Sci. 24(3): 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.

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

Department of Fisheries and Oceans Canada (DFO). 2008. Recovery strategy for the Northern and Southern resident killer whales (*Orcinus orca*) in Canada. Species at Risk Act Recovery Strategy Series, Fisheries and Oceans Canada, Ottawa, ix + 81 pp.

Ellis, G. M., J. R. Towers, and J. K. B. Ford. 2011. Northern Resident Killer Whales of British Columbia: Photo-identification Catalogue and Population Status to 2010. Canadian Technical Report of Fisheries and Aquatic Sciences 2942. 71 pages.

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 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 whales: the natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. UBC Press, Vancouver BC and University of Washington Press, Seattle. 102 pp.

Ford, J.K.B., G.M. Ellis, and K.C. Balcomb. 2000. Killer Whales. University of British Columbia Press, Vancouver, Toronto, Canada; University of Washington Press, Seattle. 104 pp.

Ford, J.K.B., G.M. Ellis, and P.F. Olesiuk. 2005. Linking prey and population dynamics: did food limitation cause recent declines of 'resident' killer whales (*Orcinus orca*) in British Columbia? Canadian Science Advisory Secretariat Research Document 2005/042.

Ford, J. K. B., Ellis, G. M., Olesiuk, P. F., and Balcomb, K. C. 2010. Linking killer whale survival and prey abundance: food limitation in the oceans' apex predator? Biology Letters, 6: 139-142. doi: 10.1098/rsbl.2009.0468

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 of Oregon and Washington, 1989-1990. Pp. 1-100 *In* Brueggeman (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. OCS Study MMS 91-0093.

Guenther, T. J., R. W. Baird, R. L. Bates, P. M. Willis, R. L. Hahn, and S. G. Wischniowski. 1995. Strandings and fishing gear entanglements of cetaceans of the west coast of Canada in 1994. Unpubl. doc. submitted to Int. Whal. Comm. (SC/47/O6). 7pp.

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. Heredity 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 pp.

Matkin, C.O., G. Ellis, D. Herman, E. Saulitis, R. Andrews, A. Gaylord, and H. Yurk. 2010. Monitoring, Tagging, Acoustics, Feeding Habits and Restoration of Killer Whales in Prince William Sound/Kenai Fjords 2003-2009. EVOS Trustee Council Restoration Project 090742 Final Report North Gulf Oceanic Society, Homer, Alaska.

Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Bd. 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, T. Harkins. 2010. Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. Genome Research, 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.

Olesiuk, P. F., G. M. Ellis, and J. K. B. Ford. 2005. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia Research Document 2005/045. Fisheries and Oceans Canada, Nanaimo, B.C. Canada.

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

Sigler, M.F., C. R. Lunsford, J. T. Fujioka, and S. A. Lowe. 2002. Alaska Sablefish Assessment for 2003. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Bering Sea/Aleutian Islands Regions. North Pac. Fish. Mgmt. Council, Anchorage, AK, Section 5:229-294.

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 pp.

Williams, R. and P. O'Hara. 2010. Modelling ship strike risk to fin, humpback, and killer whales in British Columbia, Canada. J. Cetacean Res. Manage. 11(1):1-8.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade, 2006). Killer whales are found throughout the North Pacific. Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State, where whales have been labeled as 'resident,' 'transient,' and 'offshore' type killer whales (Bigg et al. 1990, Ford et al. 2000; Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of photographs of recognizable individuals, 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).

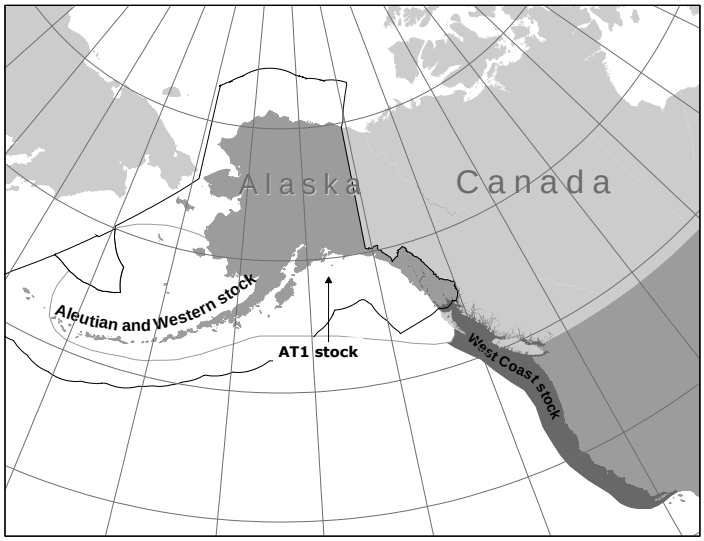

Figure 23. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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

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 Penninsula 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). 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 (NMML) 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). NMML identified 43 whales and 11 matches were found between the NGOS and NMML 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/NMML catalogue (NGOS/NMML 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.

NMML 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 (NMML/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 $\geq$ 0.80 (Wade and Angliss 1997). Thus, for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale stock, PBR = 5.87 animals (587 × 0.02 × 0.5). Although only a few individuals have been observed in Canadian waters, 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

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 three which incurred serious injury and mortality of killer whales (any stock) between 2007 and 2011: the BSAI flatfish trawl, BSAI rockfish trawl, and the BSAI Greenland turbot longline.

Over the past few years, observers have collected tissue samples of many of the killer whales which were killed incidental to commercial fisheries. Genetics analyses of samples from seven killer whales collected between 1999-2004 have confirmed Alaska resident killers whales are occasionally killed incidentally in the BSAI flatfish trawl (n = 3) and the BSAI Pacific cod fisheries (n = 1); during this period, 3 transient killer whales from the GOA/AI/BS stock were killed incidental to the BSAI pollock trawl fishery (M. Dahlheim, pers. comm., National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105; 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, given the overlap in range of the transient and resident stocks, unless genetic samples can be collected from animals injured or killed by gear or the propeller, these events are assigned to both the transient and resident stock occurring in that area. Thus, the mean annual estimated level of serious injury and mortality of Alaska resident killer whales for 2007-2011 is 0.6/year (CV = 0.02) (Table 36).

Table 36. Summary of incidental mortality of killer whales (Gulf of Alaska, Aleutian Islands, Bering Sea transient stock) due to commercial fisheries and calculation of the mean annual mortality rate (Breiwick 2013). Mean annual takes are based on 2007-2011 data. Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
BSAI flatfish trawl	2007 2008 2009 2010 2011	obs data	72 100 100 100 100	0 1 1* 0 0	0 1.0 1.0* 0 0	0.4(CV = 0.02)
BSAI rockfish trawl	2007 2008 2009 2010 2011	obs data	88 98 99 100 100	0 0 0 1 0	0 0 0 1.0 0	0.2 CV = N/A
Estimated total annual mortality						0.6 (CV = 0.02)

*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).

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 source of mortality. One mortality due to a ship strike occurred in 1998, when a killer whale was struck by a propeller of a vessel in the Bering Sea groundfish trawl fishery.

Other Issues

Killer whales are known to predate on longline catch 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 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 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 Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock of killer whales is not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the estimated annual U. S. commercial fishery-related mortality level (0.6) is equal to 10% of the PBR (0.6) and, therefore, is considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (0.6 animals per year) is less than the PBR (5.9). Therefore, the Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population (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. 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. Administrative Report LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25 pp.

Barrett-Lennard, L. G. 2000. Population structure and mating patterns of killer whales as revealed by DNA analysis. Doctoral thesis. Univ. 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. Pp. 386-406 *In* 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 catalogue of photo-identified individuals. NOAA Technical Memorandum-NMFS-SWFSC-247. 174 pages.

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 pp. (Available online: http://www.afsc.noaa.gov/Publications/ProcRpt/PR%2088-14.pdf).

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 pp. + 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. 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., Ellifrit, D., Dahlheim, M., Waite, J., Matkin, C., Barrett-Lennard, L., Ellis, G., Pitman, R., LeDuc, R, and 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 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 pp.

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.

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.

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 Can. Sci. Advis. Sec. Res. Doc. 2012/nnn. vi + xx p.

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. Pp. 1-100 *In* Brueggeman, J. J. (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. 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. Heredity 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. 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. 110:143–155.

Matkin, C. O., G. M. Ellis, E. L. Saulitis, R. D. Andrews. In prep. Monitoring, Tagging, Feeding Habits, and Restoration of Killer Whales in Prince William Sound/Kenai Fjords 2010-2012 Final 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. 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, T. Harkins. 2010. Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. Genome Research, 20:908-916.

NGOS-NMML 2012. A Working Catalogue of Western 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.

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 pp.

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.

Riesch R., L. G. Barrett-Lennard, G. M. Ellis, J. K. B. Ford, V. B. Deecke. 2012. Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? Biological Journal of the Linnean Society, 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.

Sigler, M. F., C. R. Lunsford, J. T. Fujioka, and S. A. Lowe. 2003. Alaska sablefish assessment for 2004. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Bering Sea/Aleutian Islands Regions. North Pac. Fish. Mgmt. Council, Anchorage, AK, Section 3:223-292.

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 pp.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade, 2006). Killer whales are found throughout the North Pacific. 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).

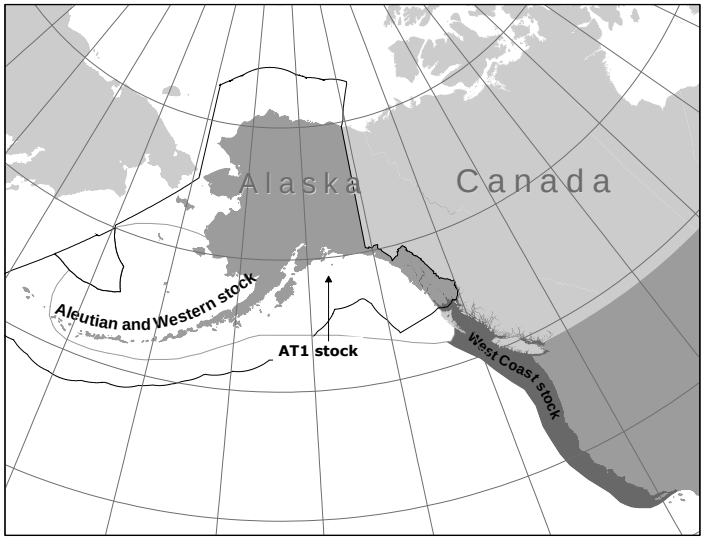

Figure 24. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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

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~~communities~~ 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 ~~were~~ 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 ~~are primarily seen~~ 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 ~~transients~~ 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~~community~~ have been found to have two mtDNA haplotypes, neither of which is found in the west coast or AT1 populations~~communities~~. Members of the AT1 population~~community~~ share a single mtDNA haplotype. Transient killer whales from the 'west coast' population~~community~~ have been found to share a single mtDNA haplotype that is not found in the other populations~~communities~~. Additionally, all three populations~~communities~~ 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~~communities~~ are considered discrete from the 'west coast' transients.

Biopsy samples from the eastern Aleutians and 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 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. 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 Gulf of Alaska AT1 transient population (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 (Saulitis ~~1993~~et al. 1995, 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 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.

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). As discussed above, the AT1 group was found to be acoustically and genetically different from other transient killer whales in the North Pacific (Saulitis et al. 2005, Barrett-Lennard 2000). The AT1 transients appear to have a more limited geographic range than do other transients. Though seen mostly in Prince William Sound, they have also been seen in Resurrection and Aialik Bays of the Kenai Fjords year-round (Saulitis et al. 2000). Tagging of a single individual in the summer of 2010 showed movements between Prince William Sound and Kenai Fjords (Matkin et al. 2012). However, they have never been observed east of~~

~~Prince William Sound or west of Kenai Fjords, Alaska, resulting in an apparent range of about 200 miles (Matkin et al. 1999, 2012)~~ have never been seen in association with sympatric resident killer whale pods or with Gulf of Alaska transients (Matkin et al. 1999, Matkin et al. 2012), are genetically and acoustically distinct from other transient killer whales in the North Pacific (Saulitis et al. 2005, Barrett-Lennard 2000), and appear to have a more limited range than other transients. Their approximately two hundered mile 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 population were completely 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, Matkin el al. 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 2 have been missing since 1992 (last seen in 1990 and 1991). Three of the missing AT1s (AT5, AT7, and AT8) were seen near the *Exxon Valdez* (with AT6) shortly after the spill (Matkin et al. 1993, 1994, Matkin et al. 2008). Two whales were found dead, stranded in 1989-1990, both genetically assigned to the AT1 population and one visually recognized as AT19 (Heise et al. 2003, Matkin et al. 1994, Matkin et al. 2008). Additional mortalities of four older males include whale AT1 found stranded in 2000, AT13 and AT17 missing in 2002 (one of which was thought to be an AT1 carcass 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 re-sighted (Matkin et al., 2008). All 15 are presumed dead based on criteria that whales are dead if missing from the population for four or more years (Matkin et al. 2008). Therefore, the population size as of the summer of ~~2012~~2013 is seven whales (C. Matkin, North Gulf Oceanic Society, pers. comm., 21 March 2014). 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, 4 of those whales have not been seen for four or more consecutive years, so the minimum population estimate is 7 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 may be the total population size.

Current Population Trend

The population counts have declined from a level of 22 whales in 1989 to 7 whales in ~~2009~~2013, a decline of 68%. Most of the mortalities apparently occurred in 1989-90.

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 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 Marine Mammal Protection Act and there has been no recruitment into the stock since 1984. Thus, for the AT1 killer whale stock, PBR = 0 animals ($7 \times 0.02 \times 0.1$).

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

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 injuries or mortalities 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.

Subsistence/Native Harvest Information

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

Other Mortality

Collisions with boats may be an occasional source of mortality of killer whales. One mortality due to a ship strike occurred in 1998 when a killer whale struck the propeller of a vessel in the Bering Sea groundfish trawl fishery; however, this mortality did not involve a whale from the AT1 stock. There have been no known mortalities of AT1 killer whales due to ship strikes. Most of the mortality occurred from 1989-1991 following the *Exxon Valdez* oil spill.

STATUS OF STOCK

The AT1 Transient stock of killer whales ~~was~~is below its Optimum Sustainable Population size and designated as "depleted" under the MMPA; ~~and is~~ therefore, it is classified as a strategic stock. The AT1 Transient stock of killer whales is not listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the estimated annual U. S. commercial fishery-related mortality level (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 as of 2009, only 7 individuals remain alive. The AT1 group has been reduced to 32% (7/22) of its 1984 level.

CITATIONS

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25 pp.

Barrett-Lennard, L. G. 2000. Population structure and mating patterns of killer whales as revealed by DNA analysis. Doctoral thesis. Univ. 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. Pp. 386-406 *In* 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 catalog of photo-identified individuals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-247, 174 pp.

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

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 pp. + 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.

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

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 pp.

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.

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.

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 Can. Sci. Advis. Sec. Res. Doc. 2012/nnn. vi + xx p.

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. Pp. 1-100 *In* Brueggeman, J. J. (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. OCS Study MMS 91-0093.

Heise, K., G. Ellis, and C. Matkin. 1991. A catalogue of Prince William Sound killer whales. North Gulf Oceanic Society, Homer, AK, 51 pp.

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. Aquatic 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. Heredity 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. *In Exxon Valdez* Oil Spill Trustee Council, *Exxon Valdez* oil spill symposium abstract book, February 2-5, 1993, Anchorage, Alaska, p. 303-307.

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. 110:143–155.

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

Matkin, C. O., and E. L. Saulitis. 1994. Killer whale (*Orcinus orca*) biology and management in Alaska. Report to the Marine Mammal Commission, Contract T75135023, 46 pp. (Available from Marine Mammal Commission, 1825 Connecticut Ave. NW, Washington, DC 20009).

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 pp.

Matkin, C. O., G. M. Ellis, L. G. Barrett-Lennard, H. Yurk, E. L. Saulitis, D. Scheel, P. Olesiuk, and 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, Alaska. 118 pp.

Matkin, C. O., E. L. Saulitis, G. M. Ellis, P. Olesiuk, 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.

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

Morin, P. A., I. A. Frederick, A. D. Foote, J. Vilstrup, E. E. Allen, P. Wade, J. Durban, K. Parsons, R. Pitman, L. Lewyn, 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.

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, 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, V. B. Deecke. 2012. Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? Biological Journal of the Linnean Society, 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. Matkin, L. Barrett-Lennard, K. Heise, and G. Ellis. 2000. Foraging strategies of sympatric killer whale (*Orcinus orca*) populations in Prince William Sound, Alaska. Mar. Mammal Sci. 16(1): 94-109.

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, 0., 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. 2004. Status Review of the AT1 Group of killer whales from the Prince William Sound and Kenai Fjords area. Unpublished document. (Available from AFSC-NMML, 7600 Sand Point Way NE, Seattle, WA 98115).

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

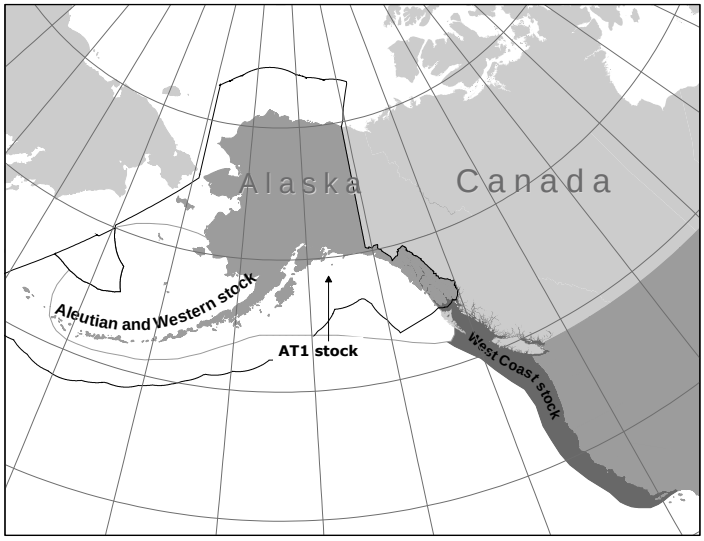

Figure 25. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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

Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. EEZ: 1) the Alaska Resident stock - occurring from southeastern Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of southeastern Alaska, 3) the Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from southeastern Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1 transient stock -

occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast transient stock - occurring from California through southeastern Alaska, 7) the Offshore stock - occurring from California through Alaska, and 8) the Hawaiian stock. 'Transient' whales in Canadian waters are considered part of the West Coast Transient stock. The Stock Assessment Reports for the Alaska Region contain information concerning all the killer whale stocks except the Hawaiian and Offshore stocks.

Until recently, transient killer whales in Alaska had only been studied intensively in Southeast Alaska and in the Gulf of Alaska (from Prince William Sound, through the Kenai Fjords, and around Kodiak Island). In the Gulf of Alaska, Matkin et al. (1999) described two populations of transients which were never found in association with one another, the so-called 'Gulf of Alaska' transients and 'AT1' transients. Gulf of Alaska' transients are documented throughout the Gulf of Alaska, including occasional sightings in Prince William Sound. AT1 transients are primarily seen in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with 'Gulf of Alaska' transients. Recently members of the Gulf of Alaska transient population have been seen in association with the transient killer whales that range from California to southeastern Alaska, the west coast transients, which are identified by a unique mtDNA haplotype. Recent data have identified 14 out of 217 whales considered "outer coast" transients in British Columbia as photographed in Alaskan waters and considered Gulf of Alaska transients (Ford et al. 2013). Transients within the 'Gulf of Alaska' population have been found to have two mtDNA haplotypes, neither of which is found in the west coast or AT1 populations. Members of the AT1 population share a single mtDNA haplotype. Transient killer whales from the 'west coast' stock have been found to share a single mtDNA haplotype that is not found in the other communities. Additionally, all three populations have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found, as well, as Saulitis (1993) and Saulitis et al. 2005 described acoustic differences between 'Gulf of Alaska' transients and AT1 transients. For these reasons, the 'Gulf of Alaska' transients are considered part of a population that is discrete from the AT1 population, and both of these communities are considered discrete from the 'west coast' transients.

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

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

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

POPULATION SIZE

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

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{Max} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status with a mortality rate CV 0.80 (Wade and Angliss 1997). Thus, for the West Coast Transient killer whale stock, PBR = 2.4 animals (243 × 0.02 × 0.5). The proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, Pacific Biological Station, Canada, pers. comm.)

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

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

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

Subsistence/Native Harvest Information

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

Other Mortality

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

Collisions with boats are another source of mortality. Killer whales interacting with trawl vessels are occasionally struck by the propeller; there were 4 incidents of mortality and serious injury in the Bering Sea/

Aleutian Islands flatfish trawl and Bering Sea/ Aleutian Islands rockfish trawl fisheries between 2007-2011. Stock identification for these occurrences is unknown; however, this area is outside of the known range for this stock. There have been no reported mortalities of killer whales from this stock due to vessel collisions.

STATUS OF STOCK

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

CITATIONS

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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. Administrative Report LJ-97-11, Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25 pp.

Barlow, J., and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Paper SC/51/SM2 presented to the International Whaling Commission, May 1998 (unpublished). 20 pp.

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

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. Pp. 386-406 *In* 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 catalog of photo-identified individuals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-247, 174 pp.

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.

Cameron, G. A., and K. A. Forney. 1999. Preliminary estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Paper SC/51/O4 presented to the International Whaling Commission, May 1999 (unpublished). 14 pp.

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 pp.

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 pp.

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 pp.

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

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

Department of Fisheries and Oceans (DFO) Canada. 2009. Recovery Potential Assessment for West Coast Transient Killer Whales. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/039.

Department of Fisheries and Oceans (DFO) Canada. 2007. Recovery Strategy for the Transient Killer Whale (*Orcinus orca*) in Canada. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Vancouver. 47 pp.

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 pp.

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.

Ford, J.K.B., G.M. Ellis, K.C. Balcomb. 2000. Killer Whales. University of British Columbia Press, Vancouver, Toronto, Canada; University of Washington Press, Seattle. 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 Can. Sci. Advis. Sec. Res. Doc. 2012/nnn. vi + xx p.

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. Pp. 1-100 *In* Brueggeman, J. J. (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. OCS Study MMS 91-0093.

Guenther, T. J., R. W. Baird, R. L. Bates, P. M. Willis, R. L. Hahn, and S. G. Wischniowski. 1995. Strandings and fishing gear entanglements of cetaceans on the west coast of Canada in 1994. Paper SC/47/O6 presented to the International Whaling Commission, May 1995 (unpublished). 7 pp.

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. Heredity 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.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: preliminary estimates for 1996. Paper SC/49/SM02 presented to the Int. Whal. Comm., September 1997 (unpublished). 13 pp.

Julian, F., and M. Beeson. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull., U.S. 96(2):271-284.

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 pp.

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

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. 110:143–155.

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

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, 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, V. B. Deecke. 2012. Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? Biological Journal of the Linnean Society, 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. M.S. Thesis, University of Alaska Fairbanks, Fairbanks, AK, 193 pp.

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.

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 pp.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

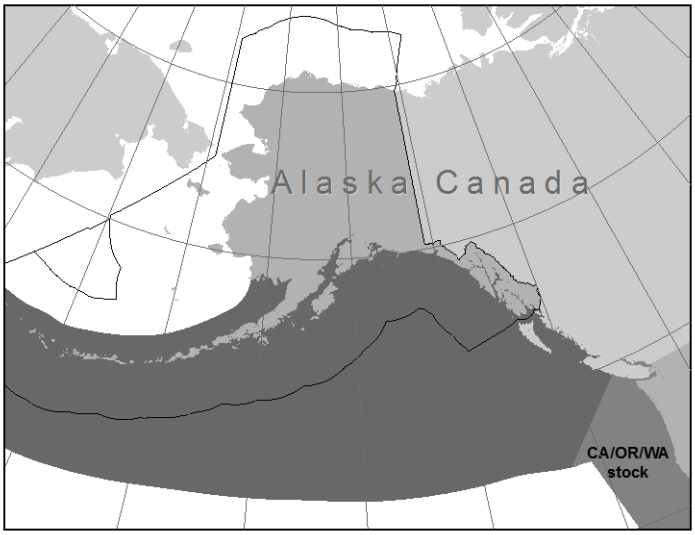

Figure 26. Approximate distribution of Pacific white-sided dolphins in the eastern North Pacific (shaded area).

The following information was considered in classifying Pacific white-sided dolphin stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution is continuous; 2) Population response data: unknown; 3) Phenotypic data: two morphological forms are recognized (Walker et al. 1986, Chivers et al. 1993); and 4) Genotypic data: preliminary genetic analyses on 116 Pacific white-sided dolphin collected in four areas (Baja California, the U.S. west coast, British Columbia/southeast Alaska, and offshore) do not support phylogeographic partitioning, though they are sufficiently differentiated to be treated as separate management units (Lux et al. 1997). This limited information is not sufficient to define stock structure throughout the North Pacific beyond the generalization that a northern form occurs north of about 33°N from southern California along the coast to Alaska, a southern form ranges from about 36°N southward along the coasts of California and Baja California while the core of the population ranges across the North Pacific to Japan at latitudes south of 45°N. Data are lacking to determine whether this latter group might include animals from one or both of the coastal forms. Although the genetic data are unclear, management issues support the designation of two stocks.; because the California and Oregon thresher shark/swordfish drift gillnet fishery (operating between 33°N and approximately 47°N) and, to a lesser extent, the groundfish and salmon fisheries in Alaska are known to interact with Pacific white-sided dolphins, two management stocks are recognized: 1) the California/Oregon/Washington stock, and 2) the North Pacific stock (Fig. 26). The California/Oregon/ Washington stock is reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

The most complete population abundance estimate for Pacific white-sided dolphins was calculated from line transect analyses applied to the 1987-90 central North Pacific marine mammal sightings survey data (Buckland et al. 1993). The Buckland et al. (1993) abundance estimate, 931,000 (CV = 0.90) animals, more closely reflects a range-wide estimate rather than one that can be applied to either of the two management stocks off the west coast of North America. Furthermore, Buckland et al. (1993) suggested that Pacific white-sided dolphins show strong vessel attraction but that a correction factor was not available to apply to the estimate. While the Buckland et al. (1993) abundance estimate is not considered appropriate to apply to the management stock in Alaskan waters, the portion of the estimate derived from sightings north of 45°N in the Gulf of Alaska can be used as the population estimate for this area (26,880). For comparison, Hobbs and Lerczak (1993) estimated 15,200 Pacific white-sided dolphins in the Gulf of Alaska based on a single sighting of 20 animals. Small cetacean aerial surveys in the Gulf of Alaska during

1997 sighted one group of 164 Pacific white-sided dolphins off Dixon entrance, while similar surveys in Bristol Bay in 1999 made 18 sightings of a school or parts thereof off Port Moller (R. Hobbs, NMFS-NMML, pers. comm.).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock would be 26,880, based on the sum of abundance estimates for 4 separate 5° × 5° blocks north of 45°N (1,970+6,427+6,101+12,382 = 26,880) reported in Buckland et al. (1993). This is considered a minimum estimate because the abundance of animals in a fifth 5° × 5° block (53,885) which straddled the boundary of the two coastal management stocks were not included in the estimate for the North Pacific stock and because much of the potential habitat for this stock was not surveyed between 1987 - 1990. However, because the abundance estimate used in this calculation is more than 8 years old, the minimum population estimate for this stock is unknown.

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks of unknown status (Wade and Angliss 1997). The estimate of abundance for Pacific white-sided dolphins is now more than 8 years old; Wade and Angliss (1997) recommend that abundance estimates older than 8 years no longer be used to calculate a PBR level. In addition, there is no corroborating evidence from recent surveys in Alaska that provide abundance estimates for a portion of the stock's range or any indication of the current status of this stock. Thus, the PBR for this stock is undetermined (NMFS 2005).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Between 1978 and 1991, thousands of Pacific white-sided dolphins were killed annually incidental to high seas fisheries. However, these fisheries have not operated in the central North Pacific since 1991.

Until 2003, there were six different federally-regulated commercial fisheries in Alaska that could have interacted with Pacific white-sided dolphins. These fisheries were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these six fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. There were no serious injuries or mortalities incidental to observed commercial fisheries reported between 2002 and 2006 (Perez 2006, Perez unpubl. ms).

The Prince William Sound salmon drift gillnet fishery was also monitored by observers in 1990 and 1991. In 1990, observers boarded 300 (57.3%) of the 524 vessels participating in that fishery, monitoring a total of 3,166 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). In 1991, observers boarded 531 (86.9%) of the 611 registered vessels and monitored a total of 5,875 sets, or roughly 5% of the estimated sets made by the fleet (Wynne et al. 1992). No incidental takes of Pacific white-sided dolphins were recorded in the Cook Inlet salmon driftnet and setnet fisheries (1999-2000), the Kodiak Island salmon set gillnet fishery (2002 and 2005), and Yakutat salmon setnet fishery (2007 and 2008) by the Alaska Marine Mammal Observer Program, and Pacific white-sided dolphins were not among the species spotted in the area of operations (Manly et al. 2003; Manly 2006, 2007).

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

Subsistence/Native Harvest Information

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

Other mortality

From 2006-2010, there were no human-caused mortalities or serious injuies reported to the Alaska Region Stranding Program (NMFS Alaska Regional Office, unpublished data).

STATUS OF STOCK

Pacific white-sided dolphins are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. The level of human-caused mortality and serious injury (0) is not known to exceed the PBR, which is undetermined as the most recent abundance estimate is more than 8 years old. Because the PBR for Pacific white-sided dolphin is undetermined, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The North Pacific stock of Pacific white-sided dolphins is not classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

CITATIONS

Buckland, S.T., K. L. Cattanach, and R. C. Hobbs. 1993. Abundance estimates of Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987/90. Pp. 387-407 *In* W. Shaw, R. L. Burgner, and J. Ito (eds.), Biology, Distribution and Stock Assessment of Species Caught in the High Seas Driftnet Fisheries in the North Pacific Ocean. Intl. North Pac. Fish. Comm. Symposium; 4-6 November 1991, Tokyo, Japan.

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

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

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

Hobbs, R.C., and J.A. Lerczak. 1993. Abundance of Pacific white-sided dolphin and Dall's porpoise in Alaska estimated from sightings in the North Pacific Ocean and the Bering Sea during 1987-1991. NMML, AFSC, NOAA, 7600 Sand Point Way, NE, Bldg. 4, Seattle, WA 98115. 13p.

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

Manly, B. F. J., A. S. Van Atten, K. J. Kuletz, and C. Nations. 2003. Incidental catch of marine mammals and birds in the Kodiak Island set gillnet fishery in 2002. Final report to NMFS Alaska Region. 91 pp.

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 pp. (Available online: www.fakr.noaa.gov/protectedresources/observers/bycatch/1999-2000cookinlet.pdf)

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 pp.

NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks, 24 pp. Available at: *http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf*

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.

Perez, M. A. Unpubl. ms. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2006. 67 pp. Available NMML-AFSC, 7600 Sand Point Way, NE, Seattle, WA 98115.

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

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

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Rept. NMFS/NOAA Contract 50ABNF000036. 65 pp. 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 Rept. NMFS/NOAA Contract 50ABNF000036. 53 pp. NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

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

NOTE – March 2008: In areas outside of Alaska, studies of harbor porpoise distribution have shown that stock structure is more finely-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, smaller stocks are likely. 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, along the Alaska coast, and down the west coast of North America to Point Conception, California (Gaskin 1984). Harbor porpoise primarily frequent coastal waters and in the Gulf of Alaska and Southeast Alaska (Dahlheim et al. 2000, 2009), they occur most frequently 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, and Sitkalidak Strait (Dahlheim et al. 2000, Hobbs and Waite 2010). 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 8 more from Alaska, found significant genetic differences for three of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (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 insufficient samples. Accordingly, harbor porpoise stock structure in Alaska is unknown at this time.

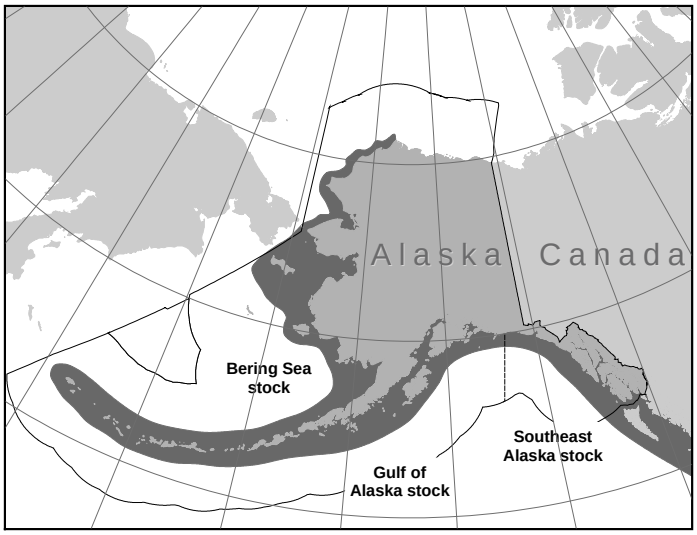

Figure 27. Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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 the Zarembo/Wrangell Islands may represent different subpopulations (M. Dahlheim, pers comm. AFSC-NMML, 7600 Sand Point Way, NE, Seattle, WA 98115; Dahlheim et al. in prep.). The Alaska Scientific Review Group concurred that while the available data were insufficient to justify recognizing three biological stocks of harbor porpoise in Alaska, instead of only one, 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, recognizing that the boundaries were set based on geography: 1) the Southeast Alaska stock - occurring from the northern border of British Columbia 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. 28).

POPULATION SIZE

In June and July of 1997, an aerial survey covering the waters of the eastern Gulf of Alaska from Dixon Entrance to Cape Suckling and offshore to the 1,000 fathom depth contour resulted in an observed abundance estimate of 3,766 (CV = 0.162) animals (Hobbs and Waite 2010). The inside waters of Southeast Alaska, Yakutat Bay, and Icy Bay were included in addition to the offshore waters. The total area surveyed across inside waters, was 106,087 km^2. Only a fraction of the small bays and inlets (< 5.5 km wide) of Southeast Alaska were surveyed and included in this abundance estimate, although the areas omitted represent only a small fraction of the total survey area. 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 observed abundance estimate includes a correction factor (1.56) for perception bias to correct for animals not counted because they were not observed. 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 from this survey is 11,146 (3,766 × 2.96; CV = 0.242) harbor porpoise for both the coastal and inside waters of Southeast Alaska (Hobbs and Waite, 2010).

In 1991, researchers from the AFSC National Marine Mammal Laboratory (NMML) initiated harbor porpoise studies aboard the NOAA Ship *John N. Cobb* with survey coverage throughout 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. Three surveys were carried out each year spanning 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 standard line-transect methodology was not used, 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 again in 2010, 2011, and 2012. Previous studies reported no evidence of seasonality for harbor porpoise occupying the inland waters of Southeast Alaska. Thus we opted to analyze data collected during the summer season only given the broader spatial coverage and greater number of surveys completed for this season (i.e., representing a total of 8 line-transect vessel surveys). Methods were comparable to those employed during the early 1990s; however, these surveys only cover inland waters and not the entire range of this stock, and therefore are not used to calculate overall abundance. Within each year, greater densities of harbor porpoise were observed in Glacier Bay/Icy Strait region and near Zarembo and Wrangell Islands and adjacent waters of Sumner Strait. ~~Total abundance in the entire study area was highest in 1991 (N = 1293, CV=0.15) and lowest in 2006 (N=485, CV=0.17) with 2010 values at N= 809, CV=0.19 (Dahlheim et al., in prep.). Abundance estimates for 2011 and 2012 are currently being analyzed. The overall abundance estimation assumes g(0) = 1 (the probability of detection directly on the track line), and therefore may be substantially biased low.~~ Abundance for harbor porpoise occupying the inland waters of Southeast Alaska fluctuated by year with total abundance highest in 1991 (N=1,485, CV=0.16), lowest in 2006 (N=527, CV=0.20), and 2012 values at N=1,081, CV=0.15). The overall abundance estimation assumes g(0) = 1 (the probability of detection directly on the track line), and therefore may be substantially biased low.

Minimum Population Estimate

For the Southeast Alaska stock of harbor porpoise, the minimum population estimate (N_{MIN}) for the aerial surveys is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimates (N) of 11,146 from 1997 and its associated CV

(0.242), N_{MIN} for this stock is 9,116 (Hobbs and Waite 2010). However, because the survey data are now 15 years old, it is not considered a reliable minimum population estimate for calculating a PBR. The abundance for harbor porpoise occupying the inland waters of Southeast Alaska of 1,081 (CV=0.15) only represents a small area within the entire stock bounderies. Therefore, this number would not be an accurate estimate for N_{MIN} of the entire stock of Southeast Alaska harbor porpoises.

Current Population Trend

~~The abundance of harbor porpoise in Southeast Alaska was estimated for 1993 and 1997. Abundance estimates were determined from coastal aerial surveys from Prince William Sound to Dixon entrance, and from coastal and inshore aerial surveys in 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 estimate of 11,146 is double the 1993 estimate (Hobbs and Waite 2010); however, the 1997 surveys included inside waters of Southeast Alaska while the 1993 survey covered only coastal waters. These estimates are not directly comparable because the area surveyed in 1997 was larger than that in 1993, including inside waters, and because the 1997 abundance estimation involved direct calculation of perception bias, while the 1993 estimate used a correction factor based on some untested assumptions about observer behavior and visibility of harbor porpoise.~~

The abundance of harbor porpoise for 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 1997 survey was greater than in 1993 and included a correction of perception bias.

~~Preliminary analysis of harbor porpoise trend in Southeast Alaska, as reported in the 2012 SAR, indicated the population declined between 1991 and 2010. However, a new estimate shows that abundance in 2011 was comparable to those from the early 1990s, suggesting the decline was not as steep as previously thought. Data analysis from a new survey (2012) are underway, and a refined estimate of trends in abundance for Southeast Alaska harbor porpoise will be available next year.~~

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). However, when data from 2011 and 2012 were added to this analysis, the rate of population decline decreased substantially and was not longer significant (Dahlheim et al. in prep.). It is still unclear why the population fluctuation observed for harbor porpoise in Southeast Alaska occurred. It is possible that the negative trends seen between 1991 and 2010 occurred as a result of a combination of factors including increased mortality due to bycatch or predation or shifts in distribution due to changes in prey abundance. Interestingly, when examined on a more regional scale, abundance was relatively constant in Glacier Bay throughout the survey period. In contrast, large declines were documented for the Wrangell and Zarembo Island areas; an area where net fisheries occur.

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

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

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 List of Fisheries resulted in separating the 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 (Pacific cod longline, Pacific halibut longline, rockfish longline, and sablefish longline) were monitored for incidental mortality by fishery observers from 2007 to 2011, although observer coverage has been very low in the offshore waters of Southeast Alaska. No mortalities from this stock of harbor porpoise incidental to commercial groundfish fisheries have been observed. There is no consistent observer coverage for fisheries operating within the inside waters of Southeast Alaska. A reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the near-absence of observer placements in Southeast Alaska fisheries. Therefore, it is unknown whether the kill rate is insignificant.

In 2007 and 2008, the Alaska Marine Mammal Observer Program (AMMOP) placed observers in four regions where the Yakutat salmon set gillnet fishery operates. These regions included the Alsek River area, the Situk area, the Yakutat Bay area, and the Kaliakh River and Tsiu River areas. Overall observer coverage was 5.3% in 2007 and 7.6% in 2008. Based on observed mortalities during these two years, the estimated mean annual mortality of harbor porpoise in the Yakutat salmon set gillnet fishery was 21.8 (Table 37).

Table 37. Summary of incidental mortality of harbor porpoise from the Southeast Alaska stock due to commercial fisheries from 2007 and 2008 and calculation of the mean annual mortality rate (Manly 2009). Details of how percent observer coverage is measured are included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Yakutat salmon set gillnet	2007-2008	obs data	5.3% 7.6%	1 3	16.1 27.5	21.8 (CV = 0.54)
Minimum total annual mortality						21.8 (CV = 0.54)

In 2011, an observer pilot study began within the inland waters of Southeast Alaska. This effort was based out of Wrangell and Petersburg Alaska. In 2012 and 2013, the AMMOP placed observers on independent vessels to assess harbor porpoise mortality associated with gillnet fisheries. Areas around and adjacent to Wrangell and Zarembo Islands were targeted during the 2012/2013 program, however overall coverage was low. In 2012, there were no incidental takes of harbor porpoises reported through this observer program. ~~This program will continue during the summer/fall of 2013.~~ In 2013, two harbor porpoise were captured alive and released apparently uninjured.

There were 3 mortalities of harbor porpoises due to entanglement in fishing gear near Yakutat reported to the NMFS stranding network between ~~2007-2011~~2008-2012 (Table 38). Two mortalities occurred in 2009, one in a set gillnet and one in a subsistence king salmon gillnet. A single porpoise entangled in an unspecified gillnet fishery was reported to the stranding network in 2010; this animal died after a disentanglement attempt by the fisher. The estimated minimum mean annual mortality of harbor porpoises in Southeast Alaska based on incidental catch reported to the stranding network is 0.6 for the 5-year period from ~~2007-2011~~2008-2012.

Table 38. Summary of Southeast Alaska stock harbor porpoise mortalities and serious injuries by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al.

2014, in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Caught in Yakutat salmon set gillnet	0	1	1	0	0	0.4
Caught in Yakutat subsistence king salmon set gillnet	0	1	0	0	0	0.2
Stabbed	1	0	0	0	0	0.2

Minimum total annual mortality						0.80

Subsistence/Native Harvest Information

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

Other Mortality

Stranding data may also provide information on additional sources of potential human-related mortality. In 2008, there was one report to NOAA's Office of Law Enforcement of a harbor porpoise that had been found floating dead with multiple stab wounds and chaffing on fins suggesting possible net entanglement (Table 38). This event is likely a result of fishery interaction; however, since the cause of death was not confirmed to be due to incidental catch in commercial fisheries, this human-caused mortality is being summarized within the "other mortality" section. The average minmum annual human-caused mortality and serious injury of Southeast Alaska harbor porpoises based on unconfirmed incidental catch and other human-caused activity reported to the stranding network is 0.2 for the 5-year period from 2007-2011.

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 unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The estimated annual level of human-caused mortality and serious injury based on observer data (21.8) and stranding data (0.8) is 22.6. Because the abundance estimates are 12 years old and the frequency of incidental mortality in commercial fisheries 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 OSP are currently unknown.

HABITAT CONCERNS

Most harbor porpoise are found in waters less than 100m in depth and often concentrate in near-shore areas and inland waters, including bays, tidal areas and river mouths (Dahlheim et al. 2009). As a result, harbor porpoise are more vulnerable to nearshore physical habitat modifications resulting from urban and industrial development, including waste management, nonpoint source runoff; and physical habitat modifications including construction of docks and other over water structures, filling of shallow areas and dredging.

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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. 101-110. *In* J. E. Reynolds III and D. K. Odell (editors). 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, NOAA, 7600 Sand Point Way, NE, Seattle, WA 98115. 55 pp.

Chivers, S.J., Dizon, A.E., Gearin, P J. 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.

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., 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. E., A. Zerbini, J. Waite, and A. Kennedy. In prep. ~~Abundance of harbor porpoise (*Phocoena phocoena*) throughout the inland waters of Southeast Alaska.~~ Southeast Alaska harbor porpoise (*Phocoena phocoena*): An assessment of abundance with insights into population fluctuations. Submitted to Fishery Bulletin.

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

DeMaster, D. P. 1997. Minutes from fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. (Available upon request - Alaska Fish. Sci. Cent., 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.

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.

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 pp. Available online at: http://alaskafisheries.noaa.gov/protectedresources/observers/bycatch/yakutat07-08.pdf

NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks, 24 pp. Available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf

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.

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

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.

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. (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 pp.

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.

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

NOTE – March 2008: In areas outside of Alaska, studies of harbor porpoise distribution have shown that stock structure is more finely-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, smaller stocks are likely. 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, along the Alaska coast, and down the west coast of North America to Point Conception, California (Gaskin 1984). Harbor porpoise primarily frequent coastal waters and in the Gulf of Alaska and Southeast Alaska (Dahlheim et al. 2000, 2009), they occur most frequently 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, and Sitkalidak Strait (Dahlheim et al. 2000, Hobbs and Waite 2010). 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 8 more from Alaska, found significant genetic differences for three of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (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 insufficient samples. Accordingly, harbor porpoise stock structure in Alaska is unknown at this time.

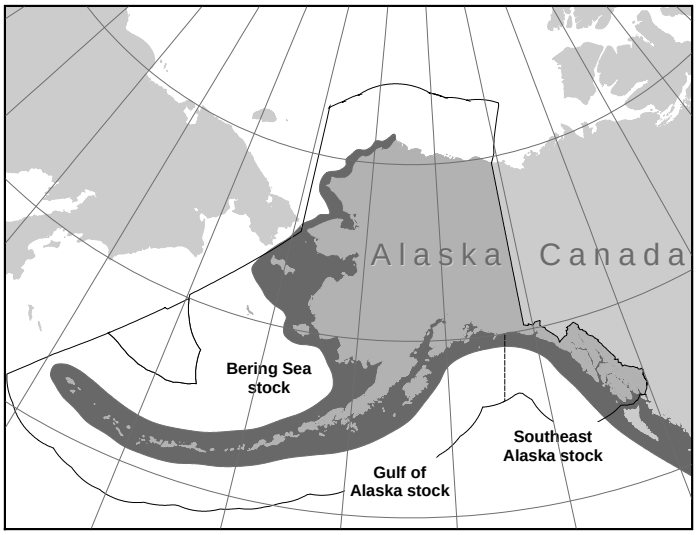

Figure 28. Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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 while the available data were insufficient to justify recognizing three biological stocks of harbor

porpoise in Alaska, 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 are recommended, recognizing that the boundaries were set based on geography: 1) the Southeast Alaska stock - occurring from the northern border of British Columbia 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. 28).

POPULATION SIZE

In June and July of 1998 an aerial survey covered the waters of the western Gulf of Alaska from Cape Suckling to Sutwik 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 1991-93 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 PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. 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 14 years old, it is not considered a reliable minimum population estimate for calculating a PBR.

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

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

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: Gulf of Alaska groundfish trawl, longline, and pot fisheries. As of 2003, changes in fishery definitions in the List of Fisheries resulted in separating these 3 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 of harbor porpoise was observed in these fisheries. Observers also monitored the State of Alaska-managed Prince William Sound salmon drift gillnet fishery in 1990 and 1991, recording one mortality in 1990 and three mortalities in 1991. These mortalities extrapolated to 8 (95% CI: 1-23) and 32 (95% CI: 3-103) kills for the entire fishery, resulting in a mean kill rate of 20 (CV = 0.60) animals per year for 1990 and 1991. In 1990, observers boarded 300 (57.3%) of the 524 vessels that fished in the Prince William Sound salmon drift gillnet fishery, monitoring a total of 3,166 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). In 1991, observers boarded 531 (86.9%) of the 611 registered vessels and monitored a total of 5,875 sets, or roughly 5% of the estimated sets made by the fleet (Wynne et al. 1992). The Prince William Sound salmon drift gillnet fishery has not been observed since 1991; therefore, 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 primarily because of the potential for these fisheries to cause incidental mortalities of beluga whales. One harbor porpoise mortality was observed in 2000 (Manly 2006). This single mortality extrapolates to an estimated mortality level of 31.2 for that year, and an average of 15.6 per year when averaged over the 2 years of observer data.

In 2002 and 2005, observers were placed on state-managed Kodiak Island set gillnet vessels. Two harbor porpoise mortalities were observed in both 2002 and 2005 in this fishery. These mortalities extrapolate to an estimated mortality level of 35.8 animals per year (Manly 2007).

Table 39. Summary of incidental mortality of harbor porpoise (Gulf of Alaska stock) due to fisheries from 1990 through 2005, and calculation of the mean annual mortality rate.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean 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[1]% 3.6[1]%	0 1	0 31.2	15.6
Cook Inlet salmon set gillnet	1999 2000	obs data	0.16-1.1[1]% 2.7[1]%	0 0	0 0	0
Kodiak Island set gillnet	2002 2005	obs data	6.0% 4.9%	2 2	32.2 39.4	35.8 (CV = 0.68)
Minimum total annual mortality						71.4

[1] Manley, 2006.

Between ~~2007-2011~~2008-2012, the NMFS stranding network received one report of a Gulf of Alaska harbor porpoise entanglement in Cook Inlet, a self-report by a fisher of a mortality that occurred in a commercial silver salmon fishing net off Kalgin Island in 2008 (Table 40). An estimate of annual mortality and serious injury occurring in the commercial Cook Inlet gillnet fisheries has been derived from observer data; therefore, this single event is considered to be accounted for in the extrapolated estimate of mortality for these fisheries.

Table 40. Summary of Gulf of Alaska stock harbor porpoise mortalities and serious injuries by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Caught in Cook Inlet salmon gillnet	1	0	0	0	0	0.2
Minimum total annual mortality						0.20

Strandings of marine mammals with fishing gear attached or with injuries caused by interactions with fishing gear are another source of mortality data. In the period from 1990 to 1994, 12 harbor porpoise scarred with gillnet marks were discovered stranded in Prince William Sound (Copper River Delta; NMFS Alaska Regional Office, Marine Mammal Stranding Database). Based on scar patterns, temporal-spatial analysis, and necropsy findings, these strandings were likely the result of the Prince William Sound salmon drift gillnet fishery. The extrapolated (estimated) observer mortality for this fishery accounts for these mortalities, so they do not appear in Table 30a. There were no confirmed reports of strandings of fishery-related mortalities of harbor porpoise in this area during 1999-2003.

A reliable estimate of the total number of mortalities incidental to commercial fisheries is unavailable because of the absence of observer placements in several salmon gillnet fisheries. However, the estimated minimum annual mortality rate incidental to U. S. commercial fisheries is 71.4 (Table 39).

Subsistence/Native Harvest Information

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

Other Mortality

Harbor porpoises occasionally become entangled in subsistence gillnets, although the frequency of occurrence is not well known. In 1995, two harbor porpoise were taken incidentally in subsistence gillnets, one near Homer Spit and the other near Port Graham.

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 unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The estimated level of human-caused mortality and serious injury is 71.4. Because the most recent abundance estimate is 14 years old and information on incidental harbor porpoise mortality in commercial fisheries is not well understood, the Gulf of Alaska stock of harbor porpoise is classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

HABITAT CONCERNS

Most harbor porpoise are found in waters less than 100 m in depth and they often concentrate in near-shore areas, bays, tidal areas, and river mouths. 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 and dredging.

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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. Eds: John E. Reynolds III and Daniel K. Odell. Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987. Miami, Florida. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-98:101-110.

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, NOAA, 7600 Sand Point Way, NE, Seattle, WA 98115. 55 pp.

Chivers, S.J., Dizon, A.E., Gearin, P J. 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.

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., 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.

DeMaster, D. P. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group. Anchorage, Alaska. 20 pp. + appendices. (Available upon request - Alaska Fish. Sci. Cent., 7600 Sand Point Way, NE, Seattle, WA 98115).

DeMaster, D. P. 1997. Minutes from fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. (Available upon request – Alaska Fish. Sci. Cent., 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.

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

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 pp. (Available at: http://alaskafisheries.noaa.gov/protectedresources/observers/bycatch/1999-2000cookinlet.pdf)

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 pp. (Available at: http://www.fakr.noaa.gov/protectedresources/observers/bycatch/kodiakreport02_05.pdf)

NMFS. 2005. Guidelines for Preparing Stock Assessment Reports Pursuant to Section 117 of the Marine Mammal Protection Act, SAR Guidelines Revisions, June 2005, 24 pp.

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.

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

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.

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. (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 pp.

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. Series 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 Rept. NMFS/NOAA Contract 50ABNF000036. 65 pp. (available upon request - 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 Rept. NMFS/NOAA Contract 50ABNF000036. 53 pp. (available upon request - Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802).

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

NOTE – March 2008: In areas outside of Alaska, studies of harbor porpoise distribution have shown that stock structure is more finely-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, smaller stocks are likely. 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, along the Alaska coast, and down the west coast of North America to Point Conception, California (Gaskin 1984). Harbor porpoise primarily frequent coastal waters and in the Gulf of Alaska and Southeast Alaska (Dahlheim et al. 2000, 2009), they occur most frequently 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, and Sitkalidak Strait (Dahlheim et al. 2000, Hobbs and Waite 2010). 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 8 more from Alaska, found significant genetic differences for three of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (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 insufficient samples. Accordingly, harbor porpoise stock structure in Alaska is unknown at this time.

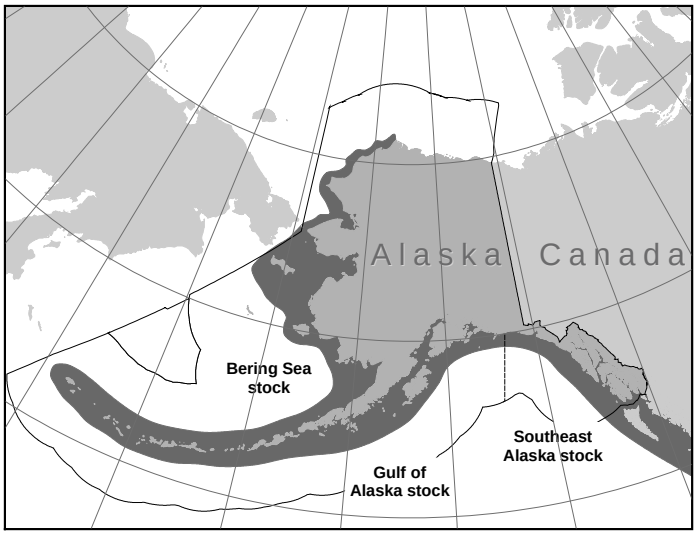

Figure 29. Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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 while the available data were insufficient to justify recognizing three biological stocks of harbor

porpoise in Alaska, 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 are recommended, recognizing that the boundaries were set based on geography: 1) the Southeast Alaska stock - occurring from the northern border of British Columbia 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. 28).

Harbor porpoises 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 - November from 2006-2010 (Aerts et al. 2011, Funk et al. 2010, Funk et al. 2011, Reiser et al. 2011). Harbor porpoises were the third most frequently sighted cetacean species in the Chukchi Sea, after gray and bowhead whales, with most sightings occurring during the Sept.- Oct. monitoring period (Funk et al. 2011, Reiser et al. 2011). Over the 2006-2010 industry-sponsored monitoring period, six sightings of 11 harbor porpoises were reported in the Beaufort Sea, suggesting harbor porpoises are occurring more regularly in small numbers 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 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). The observed abundance estimate includes a correction factor (1.337; CV = 0.062) for perception bias to correct for animals not counted because they were not observed. 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 is 48,215 (16,289 × 2.96 = 48,215; CV = 0.223). The estimate for 1999 can be considered conservative, as the surveyed areas did not include known harbor porpoise range near either the Pribilof Islands or in the waters north of Cape Newenham (approximately 59°N). However, because the survey data are now ~~12~~15 years old, it is not considered a reliable minimum population estimate for calculating a PBR.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the 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).

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 is a result of survey design. Thus, at present, there is no reliable information on trends in abundance for the Bering Sea stock of harbor porpoise.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not currently 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 potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5,

the value for cetacean stocks with unknown population status (Wade and Angliss 1997). However, the 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

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

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 1990-98: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. As of 2003, changes in fishery definitions in the 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 serious injury or mortality of marine mammal stocks in Alaska. ~~One harbor porpoise mortality was observed in 2007 in the Bering Sea/Aleutian Islands flatfish trawl, which is the only harbor porpoise mortality observed during the 2007-2011 period. Therefore, the mean annual (total) mortality rate resulting from observed mortalities was 0.36 (Breiwick in review).~~ There were no harbor porpoises mortalities of the Bering Sea stock reported in commercial fisheries during 2008-2012.

~~**Table 30b.** Summary of incidental mortality of harbor porpoise (Bering Sea stock) due to observed commercial fisheries from 2007 to 2011 (Breiwick in review). Details of how percent observer coverage is measured is included in Appendix 6.~~

~~**Fishery name**~~	~~**Years**~~	~~**Data type**~~	~~**Percent observer coverage**~~	~~**Observed mortality**~~	~~**Estimated mortality**~~	~~**Mean annual takes (CV in parentheses)**~~
~~BSAI flatfish trawl~~	~~2007~~	~~obs data~~	~~72~~	~~1~~	~~1.8~~	~~0.36~~
	~~2008~~		~~100~~	~~0~~	~~0~~	~~(CV = 0.67)~~
	~~2009~~		~~100~~	~~0~~	~~0~~	
	~~2010~~		~~100~~	~~0~~	~~0~~	
	~~2011~~		~~100~~	~~0~~	~~0~~	
~~Estimated total annual takes~~						~~0.36~~ ~~(CV = 0.67)~~

The estimated minimum annual mortality rate incidental to commercial fisheries is 0~~.36~~ animals. However, a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in several salmon gillnet fisheries. Therefore, it is unknown whether the kill rate is insignificant.

A single report of a harbor porpoise entanglement in a subsistence gillnet occurred in 2012 (mean annual mortality = 0.2) (Table 41).

Table 41. Summary of Bering Sea stock harbor porpoise mortalities and serious injuries by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, in prep). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Entangled in subsistence gillnet	0	0	0	0	1	0.2

Minimum total annual mortality						0.20

Subsistence/Native Harvest Information

There have been historic reports of harbor porpoise mortalities from bycatch in subsistence gillnets in the area from Nome to Unalakleet (Barlow et al. 1994) and near Point Barrow (Suydam and George 1992). Bee and Hall (1956) reported on two entanglements in subsistence nets in Elson Lagoon, near Barrow, in 1952. More recently, subsistence fishermen in Barrow state that it is not uncommon for one or two porpoises to be caught each summer (Suydam and George 1992). In 1991, pack ice may have contributed to the relatively high number (4) of porpoises caught in subsistence nets (Suydam and George 1992). One confirmed report of an entangled animal near Emmonak occurred between 1999 and 2003. In 2007, 2 harbor porpoises were found dead in a subsistence net in Nome, AK (NMFS, Alaska Regional Office, Marine Mammal Stranding Database), resulting in an average annual mortality of 0.4 for the 2007-2011 period.

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 unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The minimum estimate of mean annual mortality (0~~.36~~ from commercial fisheries and ~~0.4~~0.2 from subsistence fisheries) is ~~0.76~~0.2; the estimated annual level of human-caused mortality and serious injury relative to PBR is unknown. Because the abundance estimates are 13 years old and information on incidental mortality 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 OSP are currently unknown.

HABITAT CONCERNS

Most harbor porpoise are found in waters less than 100 m in depth and often concentrate in near-shore areas, bays, tidal areas and river mouths. As a result, harbor porpoise are more vulnerable to nearshore physical habitat modifications resulting from urban and industrial development, including waste management, nonpoint source runoff; and physical habitat modifications including construction of docks and other over water structures, filling of shallow areas and dredging. 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 porpoises in the Chukchi Sea (Funk et al. 2010). Shipping and noise from oil and gas activities may also be a habitat concern for harbor porpoises, 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).

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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.

Barlow, J., R. W. Baird, J. E. Heyning, K. Wynne, A. M. Manville, II, L. F. Lowry, D. Hanan, J. Sease, and V. N. Burkanov. 1994. A review of cetacean and pinniped mortality in coastal fisheries along the west coast of the USA and Canada and the east coast of the Russian Federation. Rep. Int. Whal. Comm., Special Issue 15:405-425.

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

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. Eds: John E. Reynolds III and Daniel K. Odell. Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987. Miami, Florida. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-98:101-110.

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, NOAA, 7600 Sand Point Way, NE, Seattle, WA 98115. 55 pp.

Chivers, S.J., Dizon, A.E., Gearin, P J. 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.

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.

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., 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.

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

DeMaster, D. P. 1997. Minutes from fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. + appendices. (Available upon request - National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

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. plus 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. plus 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.

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.

NMFS. 2005. Guidelines for Preparing Stock Assessment Reports Pursuant to Section 117 of the Marine Mammal Protection Act, SAR Guidelines Revisions, June 2005, 24 pp.

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.

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 Rep. P1171E–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC for Shell Offshore Inc, Houston, TX, Nat. Mar. Fish. Serv., Silver Spring, MD, and U.S. Fish and Wild. Serv., Anchorage, AK. 240 pp, plus appendices.

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

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.

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. (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 pp.

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. Series 177:255-268.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dall's porpoise are widely distributed across the entire North Pacific Ocean (Fig. 30). They are found over the continental shelf adjacent to the slope and over deep (2,500+ m) oceanic waters (Hall 1979). They have been sighted throughout the North Pacific as far north as 65°N (Buckland et al. 1993), and as far south as 28°N in the eastern North Pacific (Leatherwood and Fielding 1974). The only apparent distribution gaps in Alaska waters are upper Cook Inlet and the shallow eastern flats of the Bering Sea. Throughout most of the eastern North Pacific they are present during all months of the year, although there may be seasonal onshore-offshore movements along the west coast of the continental United States (Loeb 1972, Leatherwood and Fielding 1974), and winter movements of populations out of Prince William Sound (Hall 1979) and areas in the Gulf of Alaska and Bering Sea (NMFS, unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115).

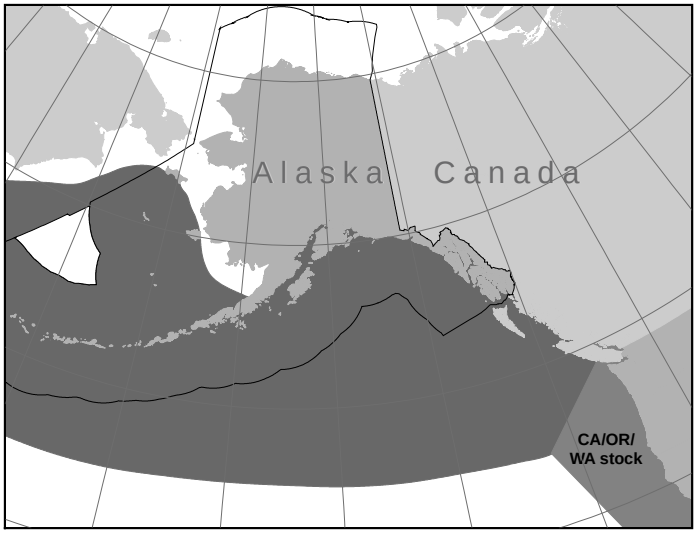

Figure 30. Approximate distribution of Dall's porpoise in Alaska waters (shaded area).

Surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 (see Fig. 40 for locations of surveys) resulted in new information about the distribution and relative abundance of Dall's porpoise in these areas (Moore et al. 2002). Dall's porpoise were abundant in both areas, were consistently found in deeper water (286 m, SE = 23 m) than harbor porpoise (67 m; SE = 3 m; t-test, P<0.0001) and were particularly clustered around the shelf break in the central-eastern Bering Sea (Moore et al. 2002).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous, 2) Population response data: differential timing of reproduction between the Bering Sea and western North Pacific; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. The stock structure of eastern North Pacific Dall's porpoise is not adequately understood at this time, but based on patterns of stock differentiation in the western North Pacific, where they have been more intensively studied, it is expected that separate stocks will emerge when data become available (Perrin and Brownell 1994). Based primarily on the population response data (Jones et al. 1986) and preliminary genetics analyses (Winans and Jones 1988), a delineation between Bering Sea and western North Pacific stocks has been recognized. However, similar data are not available for the eastern North Pacific, thus one stock of Dall's porpoise is recognized in Alaskan waters. Dall's porpoise along the west coast of the continental U. S. from California to Washington comprise a separate stock and are reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

Data collected from vessel surveys, performed by both U. S. fishery observers and U. S. researchers from 1987 to 1991, were analyzed to provide population estimates of Dall's porpoise throughout the North Pacific and the Bering Sea (Hobbs and Lerczak 1993). The quality of data used in analyses was determined by the procedures recommended by Boucher and Boaz (1989). Survey effort was not well distributed throughout the U. S. Exclusive Economic Zone (EEZ) in Alaska, and as a result, Bristol Bay and the northern Bering Sea received little survey effort. Only 3 sightings were reported between 1987 to 1991 in this area by Hobbs and Lerczak (1993), resulting in an estimate of 9,000 (CV = 0.91). In the U. S. EEZ north and south of the Aleutian Islands, Hobbs and Lerczak (1993) reported an estimated abundance of 302,000 (CV = 0.11), whereas for the Gulf of Alaska EEZ, they reported

106,000 (CV = 0.20). Combining these three estimates (9,000 + 302,000 + 106,000) results in a total abundance estimate of 417,000 (CV = 0.097) for the Alaska stock of Dall's porpoise. Turnock and Quinn (1991) estimate that abundance estimates of Dall's porpoise are inflated by as much as 5 times because of vessel attraction behavior. Therefore, a corrected population estimate from 1987-1991 is 83,400 (417,000 × 0.2) for this stock. Surveys for this stock are greater than 21 years old, consequently there is no reliable abundance data for the Alaska stock of Dall's porpoise. No reliable abundance estimates for British Columbia are currently available.

Sighting surveys for cetaceans were conducted during a NMFS pollock acoustic survey in 1999, 2000, 2002 and 2004 on the eastern Bering Sea shelf. The area was stratified into northern and southern regions determined by the survey legs of the pollock survey, and oceanographic domains within each (Friday et al. in press). Pooling the northern domains, abundance for Dall's porpoise was estimated to be 12,486 (CV = 0.38) in 1999 and 14,597 (CV=0.27) in 2002 (the northern regions were not surveyed in 2000 and 2004). Pooling the southern domains, the abundance for Dall's porpoise was estimated to be 13,012 (CV = 0.45) in 2000, 26,922 (CV = 0.92) in 2002, and 6,478 (CV = 0.36) in 2004 (the southern region were not surveyed in 1999). These estimates have not been corrected for animals missed on the trackline or animals submerged when the ship passed. They are also uncorrected for potential biases from responsive movements (ship attraction) and are, therefore, not used as minimum population estimates.

Minimum Population Estimate

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

Current Population Trend

At present, there is no reliable information on trends in abundance for the Alaska stock of Dall's porpoise.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. This stock was considered to be within optimum sustainable population (Buckland et al. 1993), thus the recovery factor (F_R) for this stock was 1.0 (Wade and Angliss 1997). However, the PBR level is currently unknown. The estimate of abundance for Dall's porpoise is now more than 8 years old; Wade and Angliss (1997) recommend that abundance estimates older than 8 years no longer be used to calculate a PBR level. Thus, because the abundance estimate for this stock is quite old, the N_{MIN} is unknown and therefore the PBR level is undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Until 2003, there were six different federally-regulated commercial fisheries in Alaska that could have interacted with Dall's porpoise and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these six fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. For the fisheries with observed takes, the range of observer coverage over the 4-year period (2007-2010), as well as the annual observed and estimated mortalities are presented in Table 42.

The Alaska Peninsula and Aleutian Island salmon driftnet fishery was monitored in 1990. Observers were onboard 59 (38.3%) of the 154 vessels participating in the fishery, monitoring a total of 373 sets, or less than 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). One Dall's porpoise mortality was observed which extrapolated to an annual (total) incidental mortality rate of 28 Dall's porpoise. Combining the estimates from the Bering Sea and Gulf of Alaska fisheries (0.69) with the estimate from the Alaska Peninsula and Aleutian Island salmon drift gillnet fishery (28) results in an estimated annual incidental kill rate in observed fisheries of 28.7 porpoise per year from this stock.

The Prince William Sound salmon drift gillnet fishery was also monitored by observers during 1990 and 1991, with no incidental mortality of Dall's porpoise reported. In 1990, observers boarded 300 (57.3%) of the 524 vessels that fished in the Prince William Sound salmon drift gillnet fishery, monitoring a total of 3,166 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). In 1991, observers boarded 531 (86.9%) of the 611 registered vessels and monitored a total of 5,875 sets, or roughly 5% of the estimated sets made by the fleet (Wynne et al. 1992).

Table 42. Summary of incidental mortality of Dall's porpoise (Alaska stock) due to commercial fisheries from 2007 to 2010 and calculation of the mean annual mortality rate.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/ Aleutian Is. (BSAI) pollock trawl	2007 2008 2009 2010	obs data	85 85 86 86	0 0 1 0	0 0 1.2 0	0.31 (CV = 0.67)
Bering Sea/ Aleutian Is. (BSAI) Pacific cod longline	2007 2008 2009 2010	obs data	63 63 61 64	0 0 1 0	0 0 1.5 0	0.38 (CV = 0.77)
Gulf of Alaska (GOA) pollock trawl	2007 2008 2009 2010	obs data	27 34 43 29	0 0 0 0	0 0 0 0	0
AK Peninsula/ Aleutian Island salmon drift gillnet	1990	obs data	4%	1	28	28 (CI: 1-81)
Minimum total annual mortality						28.69 (CV = 0.52)

No incidental takes of Dall's porpoises were recorded in the Cook Inlet salmon driftnet and setnet fisheries (1999-2000), the Kodiak Island salmon set gillnet fishery (2002 and 2005), and Yakutat salmon setnet fishery (2007 and 2008) by the Alaska Marine Mammal Observer Program, although Dall's porpoises were among the species spotted in the area of operations (Manly et al. 2003; Manly 2006, 2007). Note that no observers have been assigned to several of the gillnet fisheries that are known to interact with this stock, making the estimated mortality unreliable. However, due to the large stock size it is unlikely that unreported mortalities from those fisheries are a significant source of mortality.

From 2006-2010, two entanglements of Dall's porpoises have been reported to the Alaska Region Stranding Program (NMFS Alaska Regional Office, unpublished data). These animals both entangled together in a sockeye salmon gillnet in 2008, with one self-release and one mortality. The mean minimum annual mortality rate of Dall's porpoises based on stranding reports is 0.2.

Subsistence/Native Harvest Information

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

STATUS OF STOCK

Dall's porpoise are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. The level of human-caused mortality and serious injury (29) is

not known to exceed the PBR, which is undetermined as the most recent abundance estimate is more than 8 years old. Because the PBR is undetermined, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. The Alaska stock of Dall's porpoise is not classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

CITATIONS

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

Buckland, S. T., K. L. Cattanach, and R. C. Hobbs. 1993. Abundance estimates of Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987/90. Pp. 387-407 *In* W. Shaw, R. L. Burgner, and J. Ito (eds.), Biology, Distribution and Stock Assessment of Species Caught in the High Seas Driftnet Fisheries in the North Pacific Ocean. Intl. North Pac. Fish. Comm. Symposium; 4-6 November 1991, Tokyo, Japan.

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

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

Friday, N. A., J. M. Waite, A. N. Zerbini, and S. E. Moore. In press. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf: 1999 to 2004. Deep-Sea Res. Part II: Top. Studies Oceanogr.

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

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

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

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

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

Manly, B. F. J., A. S. Van Atten, K. J. Kuletz, and C. Nations. 2003. Incidental catch of marine mammals and birds in the Kodiak Island set gillnet fishery in 2002. Final report to NMFS Alaska Region. 91 pp.

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 pp. (Available online: www.fakr.noaa.gov/protectedresources/observers/bycatch/1999-2000cookinlet.pdf).

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 pp.

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. Progr. Oceanogr. 55(1-2):249-262.

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

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

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

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

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Rept. NMFS/NOAA Contract 50ABNF000036. 65 pp. 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 Rept. NMFS/NOAA Contract 50ABNF000036. 53 pp. NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

The sperm whale is one of the most widely distributed of any marine mammal species, perhaps only exceeded 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 (numerically) the primary target of illegal Soviet whaling in the second half of the 20th century (Ivashchenko et al. 2013).

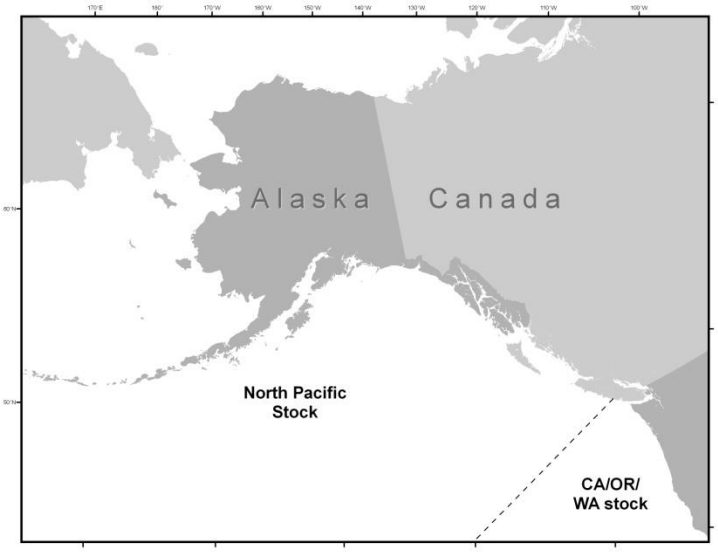

Figure 31. Approximate distribution of sperm whales in the North Pacific includes deep waters south of 62°N to the equator.

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. 31), 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) showed that there were extensive catches of female sperm whales above 50°N and Mizroch and Rice (2012) show female movements into the Gulf of Alaska and western Aleutians and catch concentrations in the western Aleutians. Males are found in the summer ~~to feed~~ in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Kasuya and Miyashita 1988, Mizroch and Rice 2012). Sightings surveys conducted by the NMFS National Marine Mammal Laboratory 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 (NMML unpublished 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 migrate to higher latitudes in summer and migrate to lower latitudes in winter (Whitehead and Arnbom 1987).

Mizroch and Rice (2012) examined 261 Discovery mark recoveries from the days of commercial whaling (recovery data from Omura and Ohsumi 1964, Ivashin and Rovnin 1967, Ohsumi and Masaki 1975, Wada 1980, Kasuya and Miyashita 1988) and found extensive movements from U.S. and Canadian coastal waters into the Gulf of Alaska and Bering Sea. Rice (AFSC-NMML, retired, pers. comm.) marked 176 sperm whales during U.S. cruises from 1962-1970, mostly between 32° and 36° N off the California coast. Seven of those marked whales in locations ranging from offshore California, Oregon, 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 (Jan Straley, Univ. of Alaska, Southeast, pers. comm., May 2012). 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 other to a location near the Mexico-Guatemala border (Jan Straley, Univ. of Alaska, Southeast, pers. comm., May 2012). 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 (BSAI). Mizroch and Rice (2012) also analyzed whaling data and found that males and females concentrated seasonally along oceanic frontal zones, e.g., in the subtropical frontal zone (ca. 28-34°N lat) and the subarctic frontal zones (ca. 40-43°N lat). 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.

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: genetics studies indicate the possibility of a "somewhat" discrete US 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 information from Mizroch and Rice (in press) 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 Pacific Region.

POPULATION SIZE

Current and historic estimates for the abundance of sperm whales in the North Pacific are considered unreliable. Therefore, caution should be exercised in interpreting published estimates of abundance. 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 Pacific Region).

Although Kato and Miyashita (1998) believe their estimate to be ~~upwardly~~positively biased, their ~~preliminary~~ analysis indicates 102,112 (CV = 0.155) sperm whales in the western North Pacific. The number of sperm whales of the North Pacific occurring within Alaska waters is unknown. As the data used in estimating the abundance of sperm whales in the entire North Pacific are over 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 whale. 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

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*." Injury determinations

for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fisheries Information

Between ~~2007~~2008 and ~~2011~~2012, there ~~was one~~ were no observed serious injuries of a sperm whale in the Federal commercial groundfish fisheries. ~~Gulf of Alaska sablefish longline fishery (Table 32). This animal was designated as seriously injured because it became caught in the gear, and was released alive with trailing gear. Thus, t~~The mean annual estimated level of serious injury and mortality of the the North Pacific stock of sperm whale stock for ~~2007-2011~~2008-2012 is 0~~.28 (Table 32)~~.

~~**Table 32.** Summary of incidental mortality and serious injury of sperm whales due to commercial fisheries and calculation of the mean annual mortality rate (Breiwick in review). Mean annual takes are based on 2007-2011 data. Details of how percent observer coverage is measured is included in Appendix 6.~~

~~**Fishery name**~~	~~**Years**~~	~~**Data type**~~	~~**Percent observer coverage**~~	~~**Observed mortality**~~	~~**Estimated mortality**~~	~~**Mean annual takes (CV in parentheses)**~~
~~GOA sablefish longline~~	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~	~~obs data~~	~~17~~ ~~16~~ ~~16~~ ~~15~~ ~~14~~	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~1.4~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0.28~~ ~~(CV = 0.57)~~
~~Estimated total annual takes~~						~~0.28~~ ~~(CV = 0.57)~~

Subsistence/Native 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 (Mizroch and Rice 2006). 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 (International Whaling Commission, BIWS catch data, February 2008 version, unpublished). This value underestimates the actual kill in the North Pacific as a result of under-reporting by U.S.S.R. pelagic whaling operations. Berzin (2008) described extreme underreporting and misreporting of Soviet sperm whale catches from the mid-1960s into the early 1970s including enormous (and underreported) whaling pressure on female sperm whales in the latter years of whaling. More recently, Ivashchenko et al. (2013) estimate that more than 159,000 sperm whales were killed by the USSR in the North Pacific between 1948 and 1979. In addition, new information suggests that Japanese land-based whaling operations also under-reported sperm whale catches during the post-World War II era (Kasuya 1999). 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 (International Whaling Commission, BIWS catch data, October 2010 version, unpublished).

From 2006-2010, there were 11 sperm whale mortalities reported to Alaska Region Stranding Program (NMFS Alaska Regional Office, unpublished data). Human interaction for these cases 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 1995-97 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 areas (Hanselman et al. 2008; Perez 2006). Sigler et al. (2008) analyzed catch data from 1998-2004 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 between sets were compared with sperm whales present and 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 size are currently not available, although the estimated annual rate of human-caused mortality and serious injury seems minimal for this stock. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown.

HABITAT CONCERNS

There are no known habitat issues that are of particular concern for this stock.

CITATIONS

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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 pp. + tables. (Available upon request - Alaska Fisheries Science Center, 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.

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. Rept. 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. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. North Pac. Fish. Mgmt. Counc., Anchorage, AK, Section 3:303-420.

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 upon request – S. Mizroch, Alaska Fisheries Science Center, 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 pp.

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

Ivashin M. V., and A. A. Rovnin. 1967. Some results of the Soviet whale marking in the waters of the North Pacific. Norsk Hvalfangst-tidende 56:123-135.

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. report submitted to Int. Whal. Comm. (SC/50/CAWS/52). 6 pp.

Mellinger, D. K., Stafford, K. M., and Fox, C. G. 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, et al. 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. 2012. Ocean nomads: distribution and movements of sperm whales in the North Pacific shown by whaling data and Discovery marks. Mar. Mamm. Sci. 29(2):E136-E165. DOI: 10.1111/j.1748-7692.2012.00601.x

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.

Ohsumi S., and Y. Masaki. 1975. Japanese whale marking in the North Pacific, 1963-1972. Bull. Far Seas Fish. Res. Lab. 12:171-219.

Omura, H. 1955. Whales in the northern part of the North Pacific. Nor. Hvalfangst-tidende 44(6):323-345.

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 53:90-112.

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 pp.

Rice, D. W. 1989. Sperm whale, *Physeter macrocephalus*. Pp. 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. Lunsford, C. R., Straley, J. M., and Liddle, J. B. 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.

Wada S. 1980. On the genetic uniformity of the North Pacific sperm whale. Reports of the Int. Whal. Comm. Special Issue 2:205-211.

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 pp.

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Baird's beaked, or giant bottlenose, whale inhabits the North Pacific Ocean and adjacent seas (Bering Sea, Okhotsk Sea, Sea of Japan, and the Sea of Cortez in the southern Gulf of California, Mexico), with the best-known populations occurring in the coastal waters around Japan (Balcomb 1989) and the Commander Islands (Fedutin et al. 2012). Within the North Pacific Ocean, Baird's beaked whales have been sighted in virtually all areas north of 30°N in deep waters over the continental shelf, particularly in regions with submarine escarpments and seamounts (Ohsumi 1983, Kasuya and Ohsumi 1984, Kasuya 2002). The range of the species extends north from Cape Navarin (62° N) and the central Sea of Okhotsk (57° N) to St. Matthew Island, the Pribilof Islands in the Bering Sea, and the northern Gulf of Alaska (Rice 1986, Rice 1998, Kasuya 2002, Fig. 32). An apparent break in distribution occurs in the eastern Gulf of Alaska, but from the mid-Gulf to the Aleutian Islands and in the southern Bering Sea there are numerous sighting records (Kasuya and Ohsumi 1984, Forney and Brownell 1996, Moore et al. 2002). In the Sea of Okhotsk and the Bering Sea, Baird's beaked whales arrive in April-May, are numerous during the summer, and decrease in October (Tomilin 1957, Kasuya 2002). Observations during 2007-2011 in the western Bering Sea were made in all months except winter (December to March) around the Commander Islands, with encounters peaking in April-June and to a lesser extent in August-November (Fedutin et al. 2012). During winter months, they are rarely found in offshore waters and their winter distribution is unknown (Kasuya 2002). However, acoustic detections of Baird's beaked whales from November through January (and no detections in July-October) in the northern Gulf of Alaska suggest that this region may be wintering habitat for some Baird's beaked whales (Baumann-Pickering et al. 2012b). There were no detections of this species from early June to late August 2010 off Kiska Island (Baumann-Pickering et al. 2012a). They are the most commonly seen beaked whales within their range, perhaps because they are relatively large and gregarious, traveling in schools of a few to several dozen, making them more noticeable to observers than other beaked whale species. Baird's beaked whales are migratory, arriving in continental slope waters during summer and fall months when surface water temperatures are the highest (Dohl et al. 1983, Kasuya 1986). Photo-identification analysis of animals sighted between 2007-2011 revealed resightings of some individuals around the Commander Islands and confirmed associations of individuals over several years in this species (Fedutin et al. 2012).

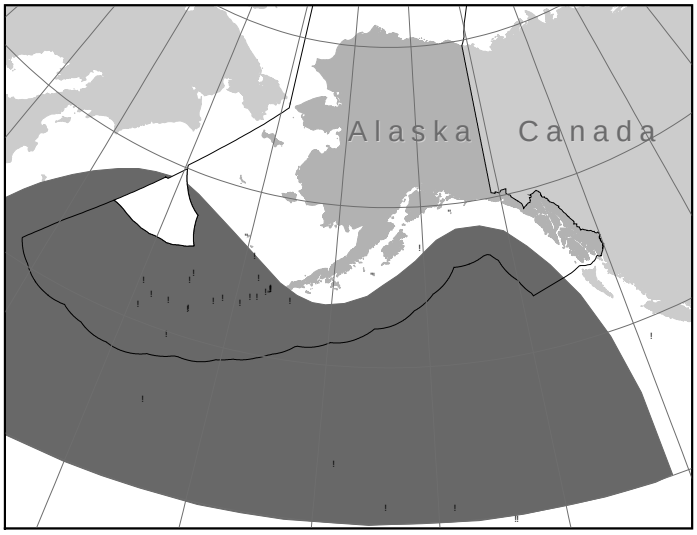

Figure 32. Approximate distribution of Baird's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted. (Forney and Brownell 1996, Moore et al. 2002, NMFS unpublished data). Note: Distribution updated based on Kasuya 2002.

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

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

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

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Subsistence/Native Harvest Information

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

Other Mortality

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

STATUS OF STOCK

Baird's beaked whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Reliable estimates of the minimum population, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are currently not available.

Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown. However, the estimated annual rate of human-caused mortality and serious injury seems minimal for this stock. Thus, the Alaska stock of Baird's beaked whale is not classified as strategic.

Habitat concerns

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

CITATIONS

Aguilar deSoto, N., M. Johnson, P. T. Madsen, P. L. Tyack, A. Bocconcelli and F. Borsani. 2006. Does intense ship noise disrupt foraging in deep diving Cuvier's beaked whales (*Ziphius cavirostris*)? Mar. Mamm. Sci., 22 (3), 690-699.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

Balcomb, K. C. 1989. Baird's beaked whale, *Berardius bairdii* Stejneger, 1883: Arnoux's beaked whale *Berardius arnouxii* Douvernoy, 1851. Pp. 261-288 *In* S. H. Ridgway and R. Harrison (eds.), Handbook of marine mammals: River dolphins and the larger toothed whales. Academic Press, New York.

Baumann-Pickering S., A. E. Simonis, S. M. Wiggins, et al. 2012a. Aleutian Islands beaked whale echolocation signals. Mar. Mamm. Sci. 29:221–227. doi: 10.1111/j.1748-7692.2011.00550.x

Baumann-Pickering, S., A. Širović, J. Hildebrand, A. Debich, R. Gottlieb, S. Johnson, S. Kerosky, L. Roche, A. S. Berga, L. Wakefield, and S. Wiggins. 2012b. Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area 2011-2012. Marine Physical Laboratory, Scripps Institute of Oceanography. MPL Technical Memorandum # 538.

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.

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.

Dohl, T., R. Guess, M. Duman, and R. Helm. 1983. Cetaceans of central and northern California, 1980-1983: status, abundance, and distribution. Rep. Outer Continental Shelf Study, MMS 84-0045, U.S. Dep. Interior.

Fedutin, I. D., O. A. Filatove, E. G. Mamaev, E. I. Chekalski, A. M. Burdin, and E. Hoyt. 2012. The results of long-term monitoring and first evidence of stable social associations in Baird's beaked whales (*Berardius bairdii*) in the waters of the Commander Islands, Russian Far East, (SC/64/SM5). 11 pp.

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. (SC/48/O11). 15 pp.

Kasuya, T. 2011. Conservation Biology of Small Cetacean around Japan. University of Tokyo Press. In Japanese.

Kasuya, T. 1986. Distribution and behavior of Baird's beaked whales off the Pacific coast of Japan. Sci. Rep. Whales Res. Inst. 37:61-83.

Kasuya, T. 2002. Giant beaked whales. Pp. 519-522 *In* William F. Perrin, Bernd Würsig and J. G. M. Thewissen editors, Encyclopedia of marine mammals. Academic Press, San Diego, CA.

Kasuya, T., and Ohsumi, S. 1984. Further analysis of the Baird's beaked whale stock in the western North Pacific. Rep. Int. Whal. Comm. 34:587-595.

McCarthy E., D. Moretti, L. Thomas, N. DiMarzio, R. Morrissey, et al. 2011. Changes in spatial and temporal distribution and vocal behavior of Blainville's beaked whales (*Mesoplodon densirostris*) during multiship exercises with mid-frequency sonar. Marine Mammal Science 27: E206–E226.

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. Progr. Oceanogr. 55(1-2):249-262.

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.

Ohsumi, S. 1983. Population assessment of Baird's beaked whales in the waters adjacent to Japan. Rep. Int. Whal. Comm. 33:633-641.

Rice, D. W. 1986. Beaked whales. Pp. 102-109 *In* D. Haley (ed.), Marine mammals of the eastern North Pacific and Arctic waters. Pacific Search Press, Seattle.

Rice, D. W. 1998. Marine mammals of the world: Systematics and distribution. The Society for Marine Mammalogy, Special pub. 4, Allen Press, Lawrence, KS, 231 pp.

Tomilin, A. G. 1957. Mammals of the USSR and Adjacent Countries. vol. 9. Cetacea. Izdatel'stvo Akademi Nauk SSSR, Moscow. 756pp. (English translation by Israel Program Sci. Transl. 1967. 717pp. Available from U.S. Dep. Commer., Natl. Tech. Info. Serv., Springfield, VA, as TT 65-50086.)

Tyack P. L., Zimmer W. M. X., Moretti D., Southall B. L., Claridge D. E., Durban J. W., Clark C. W., D'Amico A., DiMarzio N., Jarvis S., McCarthy E., Morrissey R., Ward J., Boyd I. L. 2011. Beaked Whales Respond to Simulated and Actual Navy Sonar. PLoS ONE 6(3):e17009. doi:10.1371/journal.pone.0017009

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 pp.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of Cuvier's beaked, or goosebeak, whale (Fig. 33) is known primarily from strandings, which indicate that it is the most widespread of the beaked whales and is distributed in all oceans and most seas except in the high polar waters (Moore 1963). In the Pacific, they range north to the northern Gulf of Alaska, the Aleutian Islands, and the Commander Islands (Rice 1986, 1998). In the northeastern Pacific from Alaska to Baja California, no obvious pattern of seasonality to strandings has been identified (Mitchell 1968). Strandings of Cuvier's beaked whales are the most numerous of all beaked whales, indicating that they are probably not as rare as originally thought (Heyning 1989). Observations reveal that the blow is low, diffuse, and directed forward (Backus and Schevill 1961, Norris and Prescott 1961), making sightings more difficult, and there is some evidence that they avoid vessels by diving (Heyning 1989). Relatively few (4 total) acoustic detections of Cuvier's beaked whales were recorded off Kiska Island (1 in summer) and in the offshore Gulf of Alaska (3 total detections, 1 in October and 2 in January; Baumann-Pickering et al. 2012a, 2012b).

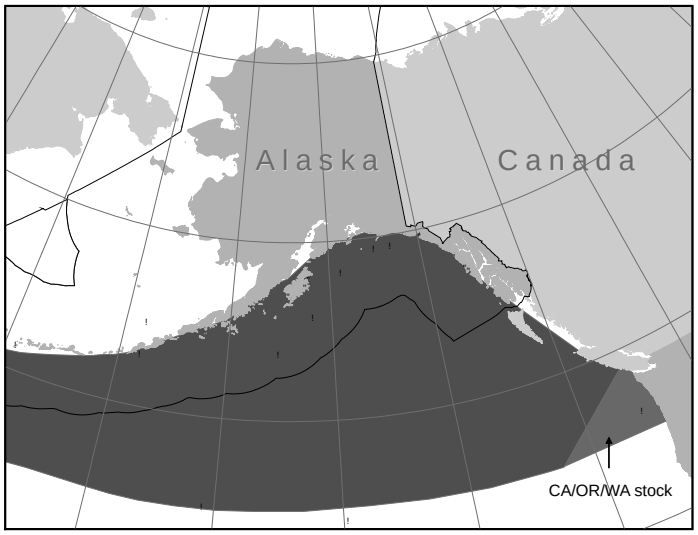

Figure 33. Approximate distribution of Cuvier's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted (Forney and Brownell 1996, NMFS unpublished data).

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

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

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

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Subsistence/Native Harvest Information

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

Other Mortality

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

STATUS OF STOCK

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

of human-caused mortality and serious injury seems minimal for this stock. Thus, the Alaska stock of Cuvier's beaked whale is not classified as strategic.

Habitat concerns

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

CITATIONS

Aguilar deSoto, N., Johnson, M., Madsen, P. T., Tyack, P. L., Bocconcelli, A. & Borsani, F. 2006. Does intense ship noise disrupt foraging in deep diving Cuvier's beaked whales (*Ziphius cavirostris*)? Mar. Mamm. Sci. 22 (3), 690-699.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

Backus, R. H., and W. E. Schevill. 1961. The stranding of a Cuvier's beaked whale (*Ziphius cavirostris*) in Rhode Island, USA. Norsk Hval. 50:177-181.

Baumann-Pickering S., A. E. Simonis, S. M. Wiggins, et al. 2012a. Aleutian Islands beaked whale echolocation signals. Mar. Mamm. Sci. 29:221–227. doi: 10.1111/j.1748-7692.2011.00550.x

Baumann-Pickering, S., A. Širović, J. Hildebrand, A. Debich, R. Gottlieb, S. Johnson, S. Kerosky, L. Roche, A. S. Berga, L. Wakefield, and S. Wiggins. 2012b. Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area 2011-2012. Marine Physical Laboratory, Scripps Institute of Oceanography. MPL Technical Memorandum # 538.

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.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fern´andez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. MacLeod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead and L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. J. Cetacean Res. Manage. 7:177–187.

D'Amico, A., Gisiner, R. C., Ketten, D. R., Hammock, J. A., Johnson, C., Tyack, P. L., and Mead, J. 2009. Beaked whale strandings and naval exercises. Aquat. Mamm. 34: 452–472.

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

Forney, K. A., and R. L. Brownell. 1996. Preliminary report of the 1994 Aleutian Island marine mammal survey. Unpubl. doc. submitted to Int. Whal. Comm. (SC/48/O11). 15 pp.

Frantzis, A. 1998. Does acoustic testing strand whales? Nature 392:29.

Gentry, R. L. 2002. Mass stranding of beaked whales in the Galapagos Islands, April 2000. http://www.nmfs.noaa.gov/prot_res/PR2/Health_and_Stranding_Response_Program/Mass_Galapagos_Islands.htm.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M. P. Simmonds, R. Swift, D. Thompson. 2003/2004. A review of the effects of seismic surveys on marine mammals. Mar. Tech. Soc. J. 37(4): 16-34.

Heyning, J. E. 1989. Cuvier's beaked whale - *Ziphius cavirostris* G. Cuvier, 1823. Pp. 289-308 *In* S. H. Ridgway and R. Harrison (eds.), Handbook of marine mammals: River dolphins and the larger toothed whales. Academic Press, New York.

Hooker, S. K., A. Fahlman, M. J. Moore, N. Aguilar de Soto, Y. Bernaldo de Quirós, A. O. Brubakk, D. P. Costa, A. M. Costidis, S. Dennison, K. J. Falke, A. Fernandez, M. Ferrigno, J. R. Fitz-Clarke, M. M. Garner, D. S. Houser, P. D. Jepson, D. R. Ketten, P. H. Kvadsheim, P. T. Madsen, N. W. Pollock, D. S. Rotstein, T. K. Rowles, S. E. Simmons, W. Van Bonn, P. K. Weathersby, M. J. Weise, T. M. Williams and P. L. Tyack. 2011. Deadly diving? Physiological and behavioral management of decompression stress in diving mammals. Proc. R. Soc. B. doi: 10.1098/rspb.2011.2088.

Jepson, P. D., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada, H. M. Ross, P. Herraez, A. M. Pocknell, F. Rodriguez, F. E. Howie, A. Espinosa, R. J. Reid, J. R. Jaber, V. Martin, A. A. Cunningham, and A. Fernández. 2003. Gas-bubble lesions in stranded animals: Was sonar responsible for a spate of whale deaths after an Atlantic military exercise? Nature 425(6958):575-76.

Malakoff, D. 2002. Suit ties whale deaths to research cruise. Science 298:722-723.

Martel, V. M. 2002. Summary of the report on the atypical mass stranding of beaked whales in the Canary Islands in September 2002 during naval exercises. Society for the Study of the Cetaceans in the Canary Archipelago (SECAC). Unpublished report. 11p.

McCarthy E., D. Moretti, L. Thomas, N. DiMarzio, R. Morrissey, et al. 2011. Changes in spatial and temporal distribution and vocal behavior of Blainville's beaked whales (*Mesoplodon densirostris*) during multiship exercises with mid-frequency sonar. Mar. Mamm. Sci. 27: E206–E226.

Mitchell, E. 1968. Northeast Pacific stranding distribution and seasonality of Cuvier's beaked whale, *Ziphius cavirostris.* Can. J. Zool. 46:265-279.

Moore, J. C. 1963. The goose-beaked whale, where in the world? Bull. Chicago Nat. Hist. Mus. 34:2-3, 8.

Moore J. E., J. P. Barlow. 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE 8(1): e52770. doi:10.1371/journal.pone.0052770

Norris, K. S., and J. H. Prescott. 1961. Observations on Pacific cetaceans of California and Mexican waters. Univ. Calif. Pub. Zool. 63:291-370.

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.

Rice, D. W. 1986. Beaked whales. Pp. 102-109 *In* D. Haley (ed.), Marine mammals of the eastern North Pacific and Arctic waters. Pacific Search Press, Seattle.

Rice, D. W. 1998. Marine mammals of the world: Systematics and distribution. The Society for Marine Mammalogy, Special pub. 4, Allen Press, Lawrence, KS, 231 pp.

Simmonds, M. P., and L. F. Lopez-Jurado. 1991. Whales and the military. Nature 351:448.

Tyack P. L., Zimmer W. M. X., Moretti D., Southall B. L., Claridge D. E., Durban J. W., Clark C. W., D'Amico A., DiMarzio N., Jarvis S., McCarthy E., Morrissey R., Ward J., Boyd I. L. 2011. Beaked Whales Respond to Simulated and Actual Navy Sonar. PLoS ONE 6(3):e17009. doi:10.1371/journal.pone.0017009

United States Department of Commerce and United States Navy. 2001. Joint interim report on the Bahamas marine mammal stranding event of 15-16 March 2000 (December 2001). NOAA unpublished report. 59pp. [Available at *http://www.nmfs.noaa.gov/pro_tres/overview/Interim_Bahamas_Report.pdf*].

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Stejneger's, or Bering Sea, beaked whale is rarely seen at sea, and its distribution generally has been inferred from stranded specimens (Loughlin and Perez 1985, Mead 1989, Walker and Hanson 1999). It is endemic to the cold-temperate waters of the North Pacific Ocean, Sea of Japan, and deep waters of the southwest Bering Sea (Fig. 34). The range of Stejneger's beaked whale extends along the coast of North America from Cardiff, California, north through the Gulf of Alaska to the Aleutian Islands, into the Bering Sea to the Pribilof Islands and Commander Islands, and, off Asia, south to Akita Beach on Noto Peninsula, Honshu, in the Sea of Japan (Loughlin and Perez 1985). Near the central Aleutian Islands, groups of 3-15 Stejneger's beaked whales have been sighted on a number of occasions (Rice 1986). The species is not known to enter the Arctic Ocean and is the only species of *Mesoplodon* known to occur in Alaska waters. The distribution of *M. stejnegeri* in the North Pacific corresponds closely, in occupying the same cold-temperate niche and position, to that of *M. bidens* in the North Atlantic. It lies principally between 50°and 60°N and extends only to about 45°N in the eastern Pacific, but to about 40°N in the western Pacific (Moore 1963, 1966). Acoustic signals believed to be produced by Stejneger's beaked whales (based on frequency characteristics, interpulse interval and geographic location, Baumann-Pickering et al. 2012a) were recorded 2-5 times a week in July off Kiska Island and almost weekly from July 2011 to February 2012 in the northern Gulf of Alaska (Baumann-Pickering et al. 2012b).

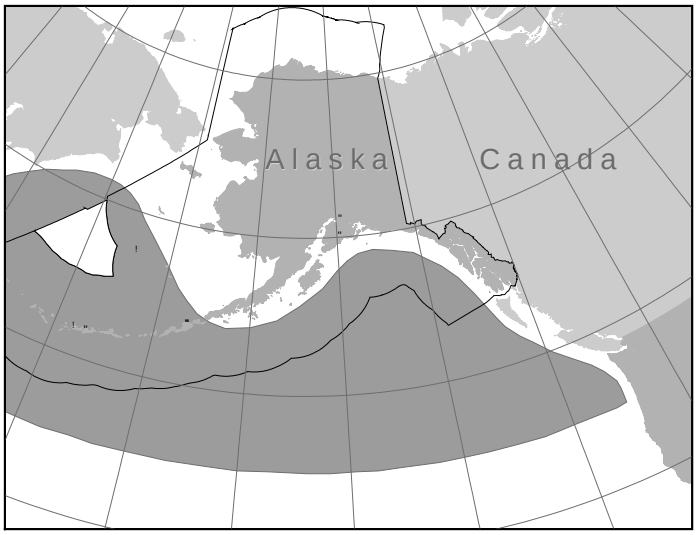

Figure 34. Approximate distribution of Stejneger's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last 10 years are also depicted (Walker and Hanson 1999, NMFS unpublished data).

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

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

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

Current Population Trend

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

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

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

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

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

Fisheries Information

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

Subsistence/Native Harvest Information

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

STATUS OF STOCK

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

Habitat concerns

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

CITATIONS

Aguilar deSoto, N., Johnson, M., Madsen, P. T., Tyack, P. L., Bocconcelli, A. & Borsani, F. 2006. Does intense ship noise disrupt foraging in deep diving Cuvier's beaked whales (*Ziphius cavirostris*)? Mar. Mamm. Sci. 22 (3), 690-699.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

Baumann-Pickering S., A. E. Simonis, S. M. Wiggins, et al. 2012a. Aleutian Islands beaked whale echolocation signals. Mar. Mamm. Sci. 29:221–227. doi: 10.1111/j.1748-7692.2011.00550.x

Baumann-Pickering, S., A. Širović, J. Hildebrand, A. Debich, R. Gottlieb, S. Johnson, S. Kerosky, L. Roche, A. S. Berga, L. Wakefield, and S. Wiggins. 2012b. Passive Acoustic Monitoring for Marine Mammals in the Gulf of Alaska Temporary Maritime Activities Area 2011-2012. Marine Physical Laboratory, Scripps Institute of Oceanography. MPL Technical Memorandum # 538.

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.

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.

Loughlin, T. R., and M. A. Perez. 1985. *Mesoplodon stejnegeri*. Mammalian Species, No. 250.

McCarthy E., D. Moretti, L. Thomas, N. DiMarzio, R. Morrissey, et al. 2011. Changes in spatial and temporal distribution and vocal behavior of Blainville's beaked whales (*Mesoplodon densirostris*) during multiship exercises with mid-frequency sonar. Mar. Mamm. Sci. 27: E206–E226.

Mead, J. G. 1989. Beaked whales of the genus - *Mesoplodon*. Pp. 349-430 *In* S. H. Ridgway and R. Harrison (eds.), Handbook of marine mammals: River dolphins and the larger toothed whales. Academic Press, New York.

Moore, J. C. 1963. Recognizing certain species of beaked whales of the Pacific Ocean. Amer. Midl. Nat. 70:396-428.

Moore, J. C. 1966. Diagnoses and distributions of beaked whales of the genus *Mesoplodon* known from North American waters. Pp. 32-61 *In* K. S. Norris (ed.), Whales, dolphins and porpoises. Univ. California Press, Berkeley.

Moore J. E., J. P. Barlow. 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE 8(1): e52770. doi:10.1371/journal.pone.0052770

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.

Rice, D. W. 1986. Beaked whales. Pp. 102-109 *In* D. Haley (ed.), Marine mammals of the eastern North Pacific and Arctic waters. Pacific Search Press, Seattle.

Tyack P. L., W. M. X. Zimmer, D. Moretti., B. L. Southall, D. E. Claridge, J. W. Durban, C. W. Clark, A. D'Amico, N. DiMarzio, S. Jarvis, E. McCarthy, R. Morrissey, J. Ward, I. L. Boyd. 2011. Beaked Whales Respond to Simulated and Actual Navy Sonar. PLoS ONE 6(3):e17009. doi:10.1371/journal.pone.0017009

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

Walker, W. A., and M. B. Hanson. 1999. Biological observations on Stejneger's beaked whale, *Mesoplodon stejnegeri*, from strandings on Adak Island, Alaska. Mar. Mammal Sci. 15(4): 1314-1329.

Revised ~~3/09/2013~~02/06/2014

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

NOTE – February 2014: The status and population structure of humpback whales in the North Pacific and elsewhere is currently under review by NMFS as part of a global Status Review of the species. Changes to existing management units are being considered as part of this process, notably following analysis of genetic data from the SPLASH project (Baker et al. 2013); however, until the Status Review is published it is inappropriate to change the existing stock designations described here, including for the western North Pacific and central North Pacific populations.

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 2004-06 (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.

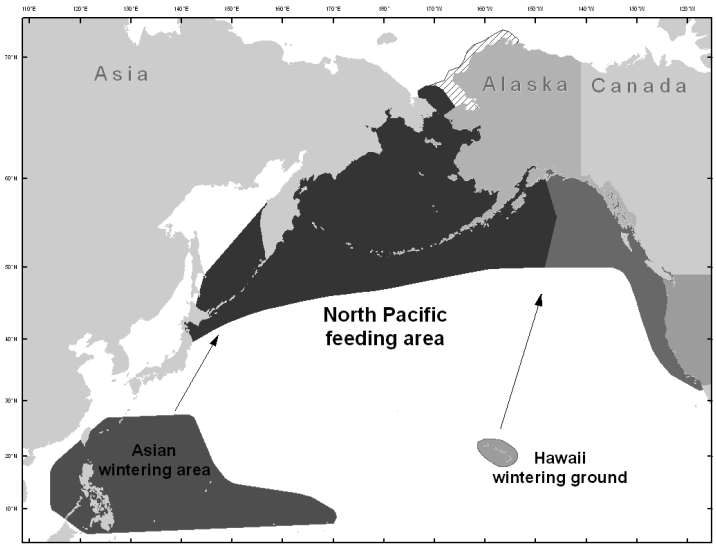

Figure 35. Approximate distribution of humpback whales in the western North Pacific (shaded area). Feeding and wintering grounds are presented above (see text). Area within the hash lines is a probable distribution area based on sightings in the Beaufort Sea (Hashagen et al. 2009). See Figure 36 for humpback whale distribution in the eastern North Pacific.

The historic 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 historic range, 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 range includes waters around the southern part of the Baja California peninsula, the central portions of the Pacific coast of mainland Mexico, and the Revillagigedos 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 (Calambokidis et al. 1997, Baker et al. 1998, Darling 1991, Darling and Cerchio 1993). 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 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.

~~New i~~Information from the SPLASH project mostly 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 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 on the same side: whales from Asia in the west migrate to Russia and whales from mainland Mexico and Central America in the east migrate to California-Oregon. ~~Whales from Hawaii and Mexico's offshore islands in the Revillagigedo Archipelago migrate to more central- and northern latitude feeding areas, with considerable overlap (Calambokidis et al. 2008). Humpback whales from the Revillagigedos have been previously documented migrating to feeding areas off California, British Columbia, southeastern Alaska, Prince William Sound, and the Kodiak Island area (Gabriele et al. 1996, Calambokidis et al. 1997), and more recently Witteveen et al. (2004) reported matches between whales photographed at the Shumagin Islands in the western Gulf of Alaska between 1999 and 2002 and whales photographed in the Revillagigedos.~~

The SPLASH data now show the Revillagigedos whales are seen in all sampled feeding areas except California-Oregon and the south side of the Aleutians, and 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. A revision of population structure in the North Pacific, possibly similar to the structure based on summer feeding areas for the Atlantic population, will be considered when the full genetic results from the SPLASH project are available.

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 Tawian, and east of Ogasawara in the Marshall and Marianas 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 the SPLASH project is that whales from the Aleutian Islands have an unusually low re-sighting rate in winter areas compared to whales from other feeding areas. To a lesser extent this is also true of whales from the Gulf of Anadyr in Russia and the Bering Sea. 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. No areas with high densities of humpback whales are known between the Hawaiian main islands and Ogasawara, but this could be due to a lack of search effort.

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 (Nishiwaki 1966, Omura and Ohsumi 1964, 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 re-confirms 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 Aleutians Islands, and in the Gulf of Anadyr just southwest of the Bering Strait. Analysis of whaling data show historical catches of humpback whales well into the Bering Sea and catches in the Bering Strait and Chukchi Sea from August-October in the 1930s (Mizroch and Rice 2007), but no survey effort occurred during SPLASH north of the Bering Strait. Other locations in the far western Pacific where humpback whales have been seen in summer include the northern Kuril Islands (V. Burkanov, AFSC-NMML, 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 900-1,100, and the estimates for Kamchatka in Russia ranged from about 100-700, suggesting a large portion of the Asian population occurs near 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, give 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.

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. ~~Additionally, a~~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 (un-quantified) and the likely existence of an unknown and un-sampled wintering area (-7.2%).

During the SPLASH study surveys were conducted in three winter field seasons (2004-06). 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 were a total of 20 individuals seen in more than one area, leaving a total of 566 unique individuals seen in the Asian wintering areas. For abundance in winter or summer areas, a 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.

On the summer feeding grounds, the initial SPLASH abundance estimates for Kamchatka in Russia ranged from about 100-700, 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 3,000-5,000 (Calambokidis et al. 2008).

~~From line-transect surveys Moore et al. (2000) estimated abundance of humpback whales in the central Bering Sea as 1,175 humpback whales (95% CI: 197-7,009) in 1999, though Moore et al. (2002) suggested these sightings were too clumped in the central-eastern Bering Sea to be used to provide a reliable estimate for the area. Moore et al. (2002) estimated abundance as 102 (95% CI: 40-262) for humpback whales in the eastern Bering Sea in 2000. Zerbini et al. (2006) estimated abundance of humpback whales from line-transect surveys as 2,644 (95% CI 1,899-3,680) for coastal/shelf waters from the central Gulf of Alaska through the eastern Aleutian Islands. Although there is a small amount over overlap between these surveys in the eastern Aleutian Islands, this suggests a combined total of about 4,000 whales, considerably less than the SPLASH abundance estimates, which range from 9,000 to 19,000 combined for the Aleutian Islands, Bering Sea, and Gulf of Alaska. However, the SPLASH surveys were more extensive in scope, including areas not covered in those 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 Island, 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.~~

Minimum Population Estimate

As discussed above, point estimates of abundance for Asia ranged from 938 to 1,107 (for 2004 to 2006), but no associated CV has yet been calculated. The 1991-93 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 PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. Using the population estimate (N) of ~~938~~1,107 from the best fit model and an assumed conservative CV(N) of 0.30 would result in an N_{MIN} for this humpback whale stock of ~~732~~865. ~~Additionally, 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.~~

Current Population Trend

The SPLASH abundance estimate for Asia represents a 6.7% annual rate of increase over the 1991-93 abundance estimate (Calambokidis et al. 2008). However, the 1991-93 estimate was for Ogaswara and Okinawa only, whereas the SPLASH estimate includes the Philippines, so the annual rate of increase is biased high to an unknown degree. ~~No confidence limits are available as yet for the rate of increase.~~

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% for 1993-00 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% C.I. of 3-16%). For shelf waters of the northern Gulf of Alaska Zerbini et al. (2007) estimated an annual rate of increase for humpback whales from 1987-2003 of 6.6% (95% C.I. of 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 from 1991-93. Comparisons of SPLASH abundance estimates for Hawaii to estimates from 1991-93 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.

Although there is no estimate of the maximum net productivity rate for the Western 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 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 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 listed as endangered under the Endangered Species Act (Wade and Angliss 1997). Using the lowest SPLASH abundance estimate calculated for 2004 - 2006 of 938 with an assumed CV of 0.300 for the Western North Pacific stock of humpback whale, PBR is calculated to be ~~2.6~~3.0 animals (~~732~~865 × 0.035 × 0.1). ~~Alternatively, using the number of unique individuals seen during the SPLASH study results in a PBR of 2.0 (566 x 0.035 x 0.1).~~

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

~~Until 2004, there were six different federally regulated commercial fisheries in Alaska that occurred within the range of the Western North Pacific humpback whale stock that were monitored for incidental mortality by fishery observers. As of 2004, changes in fishery definitions in the List of Fisheries have resulted in separating these 6 fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska.~~ Between ~~2007~~2008 and ~~2011~~2012, there was one mortality of a Western North Pacific humpback whale in the Bering Sea/Aleutian Islands pollock trawl fishery and one in the Bering Sea/ Aleutian Islands flatfish trawl (Table 43). Average minimum annual mortality from observed fisheries was 0.40 humpbacks from this stock (Table 43).

Table 43. Summary of incidental mortality and serious injury of humpback whales (Western North Pacific stock) due to observed commercial fisheries from ~~2007~~2008 to ~~2011~~2012 and calculation of the mean annual mortality rate (Breiwick ~~in review~~2013). All events occurred within the area of known overlap with the western and central North Pacific humpback whale stocks. Since the stock identification is unknown, the mortalities and serious injuries are reflected in both stock assessments. Details of how percent observer coverage is measured is included in Appendix 6. N/A indicates that data are not available.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
BSAI flatfish trawl	~~2007~~	obs	~~72~~	~~0~~	~~0~~	0.20
	2008	data	100	0	0	(CV = N/A)
	2009		100	0	0	
	2010		100	0 (+1)*	0 (1)**	
	2011		100	0	0	
	2012		100	0	0	

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
BSAI pollock trawl	~~2007~~ 2008 2009 2010 2011 2012	obs data	~~85~~ 85 86 86 98 98	~~0~~ 0 0 1 0 0	~~0~~ 0 0 1.0 0 0	0.20 (CV = 0.08)
Minimum total annual mortality						0.40 (CV = 0.08)

*Total mortalities observed in unsampled hauls.
**Total mortalities observed in sampled and unsampled hauls. Since the total known mortality (1) exceeds the estimated mortality (0) for 2010, the sum of actual mortalities observed (1) will be used as a minimum estimate for that year.

The estimated annual mortality rate incidental to U. S. commercial fisheries is 0.40 whales per year from this stock based on observed fisheries. However, this estimate is considered a minimum because there are no data concerning fishery-related mortalities in Japanese, Russian, or international waters. In addition, there is a small probability that fishery interactions discussed in the assessment for the Central North Pacific stock may have involved animals from this stock because of the overlap with the Central North Pacific stock.

Strandings of humpback whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality data. However, very few stranding reports are received from areas west of Kodiak. The mean annual human-caused mortality and serious injury rate for ~~2007-2011~~2008-2012 based on fishery and gear entanglements reported in the NMFS Alaska Regional Office stranding database is ~~0.45~~0.3 (Table 44). These events have not been attributed to a specific fishery listed on the List of Fisheries (76 FR 73912; 29 November 2011). The estimated annual mortality rate due to interactions with all fisheries is ~~0.85~~0.7 (0.4 + ~~0.45~~0.3).

Table 44. Summary of western North Pacific humpback whale mortalities and serious injuries by year and type reported to the NMFS Alaska Regional Office, marine mammal stranding database, for the ~~2007-2011~~2008-2012 period (Allen ~~and Helker in prep~~et al. 2014, Allen et al. in prep.). Injury events lacking detailed information on the injury are assigned prorated values following injury determination guidelines described in NOAA (2012). All events occurred within the area of known overlap with the western and central North Pacific humpback whale stocks. Since the stock identification is unknown, the mortalities and serious injuries (M/SI) are reflected in both stock assessments.

Cause of Injury	~~2007~~	2008	2009	2010	2011	2012	Mean Annual ~~Mortality~~ (M/SI)
Entangled in unknown gillnet gear	~~0.75~~	0	0	0	0	0	~~0.15~~ 0
Entangled in recreational shrimp pot gear	~~0~~	0	0	0	0	0	0
Entangled in unspecified crab gear	~~0~~	0	0	0	0	0	0
Entangled in unspecified longline gear	~~0~~	0	0	0	0	0	0
Entangled in unspecified pot gear	~~0~~	0	0	0	0.75	0	0.15
Entangled in unspecified set net gear	~~0~~	0	0	0	0.75	0	0.15
Ship strike (charter)	~~0.52~~	0.52	0	0	0	0.2	~~0.21~~ 0.14
Ship strike (recreational)	~~0.2~~	0.56	0	0	0	0	~~0.15~~ 0.11
Ship strike (research)	~~0~~	0	0	0	0	0	0
~~Ship strike (unknown)~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
Ship strike (whale watch)		0	0	0	0	1	0.2
Unknown marine debris / gear entanglement	~~0.75~~	0	0.75	0	2.5	0.75	0.8

Minimum total annual mortality	~~1.61~~ 1.56

Brownell et al. (2000) compiled records of bycatch in Japanese and Korean commercial fisheries between 1993 and 2000. During the period 1995-99, 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/year (using bycatch data only) to 2.4/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).

Subsistence/Native Harvest Information

There are no reported takes of humpback whales from this stock by subsistence hunters in Alaska or Russia for the ~~2007-2011~~2008-2012 period.

Other mortality

Other sources of human-caused mortality and serious injury include reported collisions with vessels and entanglement in marine debris. The mean minimum annual human-caused mortality and serious injury rate for ~~2007-2011~~2008-2012 based on vessel collisions (~~0.36~~0.45) and entanglement in unknown marine debris/ gear (0.8) reported in the NMFS Alaska Regional Office stranding database is ~~1.16~~1.25 (Table 44).

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 Ogaswara 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 USSR continued until 1972 (Ivashchenko et al. 2007). From 1961 to 1971, 6,793 humpback whales were killed illegally by the USSR. 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, the report of which is being finalized. NMFS will include the relevant results of this review in the SARs when they are available. The estimated human-related annual mortality rate (~~0.85~~0.7 + ~~1.16~~1.25 = ~~2.0~~1.95) is ~~equal to~~less than the calculated conservative PBR level for this stock (~~2.0~~3.0). The estimated human-related mortality rate based solely on mortalities that occurred incidental to U. S. commercial fisheries is 0.40; therefore, the estimated fishery mortality and serious injury rate exceeds 10% of the PBR (~~0.2~~0.3) and cannot be considered insignificant and approaching zero. 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 (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. 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 size 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, increased fishing, and 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

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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. Gozález-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, Urbán R. Jorge, P. R. Wade, D. Weller, B. H. Witteveen, M. Yamaguchi. 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. Marine Ecology Progress Series, Vol. 494: 291–306; DOI: 10.3354/meps10508.

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

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

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. Unpublished report to the International Whaling Commission. 5 pp.

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. Dept of Commerce Western Administrative Center, Seattle, Washington. (available at http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-Report-May08.pdf)

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 pp.

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. A. Y. 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., 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, P.O. Box 271, La Jolla, CA 92038. 67 pp.

Calambokidis, J., G. H. Steiger, J. M. Straley, T. Quinn, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. R. Urban, 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, P.O. Box 271, La Jolla, CA 92038. 72 pp.

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. Cet. Res. Manage. 5:13-22.

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

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 pp.

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, J., K. C. Balcomb, P. Bloedel, K. Flynn, A. Mochizuki, K. Mori, F. Sato, 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. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet whaling data (1949-1979), Center for Russian Environmental Policy, Marine Mammal Council, Moscow, 96-103.

Fleming, A., and J. Jackson. 2011. Global review of humpback whales (Megaptera novaeangliae). U.S. Dep. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFSC-474, 206 p.

Gabriele, C. M., J. M. Straley, L. M. Herman, and R. J. Coleman. 1996. Fastest documented migration of a North Pacific humpback whale. Mar. Mammal Sci. 12:457-464.

Hashagen, K. A., Green, G. A., and Adams, B. 2009. Observations of humpback whales, *Megaptera novaeangliae*, in the Beaufort Sea, Alaska. Northwestern Nat. 90:160-162.

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 pp. [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.

Melnikov, V.V. 2000. Humpback whales *Megaptera novaeangliae* off Chukchi Peninsula. Russ. J. Oceanog. 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. Paper SC/58/NPM5 presented at the 58th annual meeting of the Scientific Committee of the International Whaling Commission, St. Kitts.

Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, O. von Ziegesar. 2004. Estimating the adult survival rate of central North Pacific humpback whales. J. Mammal. 85(5):963-972.

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.

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 pp.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. C. Hobbs. 2000. 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. Progr. Oceanogr. 55(1-2):249-262.

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*cientific Reports of the Whales Research Institute, 14**:**149-290.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. Pp. 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 Injuries of Marine Mammals. http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf.

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. Pp. 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. Society Marine Mammalogy, Spec. Publ. No. 4.

Springer, A., G.B. van Vliet, J.F. Piatt, and E. M. Danner. 2006. Pages 245-261 In: Whales, Whaling and Ocean Ecosystems, J.A. Estes, R.L. Brownell, Jr., D.P DeMaster, D.F. Doak, and T.M. Williams (eds), University of California Press. 418 pp.

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 Sci. Transl. No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 pp. (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 pp.

Witteveen, B. H., J. M. Straley, O. 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. 2007. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. Part I:1772-1790.

Revised ~~3/09/2013~~02/06/2014

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

NOTE – February 2014: The status and population structure of humpback whales in the North Pacific and elsewhere is currently under review by NMFS as part of a global Status Review of the species. Changes to existing management units are being considered as part of this process, notably following analysis of genetic data from the SPLASH project (Baker et al. 2013); however, until the Status Review is published it is inappropriate to change the existing stock designations described here, including for the western North Pacific and central North Pacific populations.

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.

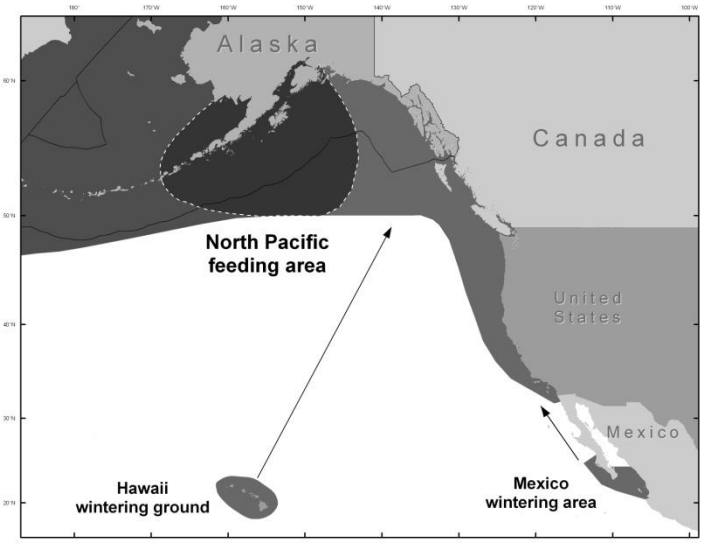

Figure 36. Approximate distribution of humpback whales in the eastern North Pacific (shaded area). Feeding and wintering areas are presented above (see text). Area within the dotted line is known to be an area of overlap with Western North Pacific stock. See Figure 35 for distribution of humpback whales in the western North Pacific.

A large-scale study of humpback whales throughout the North Pacific was conducted in 2004-06 (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, ~~in review~~2013), and are also summarized in Fleming and Jackson (2011); however, these results are still being considered for stock structure analysis.

The historic 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 historic 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 range includes waters around the southern part of the Baja California peninsula, the central portions of the Pacific coast of mainland Mexico, and the Revillagigedos 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 (Calambokidis et al. 1997, Baker et al. 1998, Darling 1991; Darling and Cerchio 1993). 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 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.

~~New i~~Information from the SPLASH project mostly 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 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 on the same side: whales from Asia in the west migrate to Russia and whales from mainland Mexico and Central America in the east migrate to California-Oregon. ~~Whales from Hawaii and Mexico's offshore islands in the Revillagigedo Archipelago migrate to more central- and northern latitude feeding areas, with considerable overlap (Calambokidis et al. 2008). Humpback whales from the Revillagigedos have been previously documented migrating to feeding areas off California, British Columbia, southeastern Alaska, Prince William Sound, and the Kodiak Island area (Gabriele et al. 1996, Calambokidis et al. 1997), and more recently Witteveen et al. (2004) reported matches between whales photographed at the Shumagin Islands in the western Gulf of Alaska between 1999 and 2002 and whales photographed in the Revillagigedos.~~

The SPLASH data now show the Revillagigedos whales are seen in all sampled feeding areas except Northern California-Oregon and the south side of the Aleutians, and 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. A revision of population structure in the North Pacific will be considered when the full genetic results from the SPLASH project are available.

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 have an unusually low re-sighting rate in winter areas compared to whales from other feeding areas. To a lesser extent this is also true of whales from the Gulf of Anadyr in Russia and the Bering Sea. 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 Marianas Islands (southwest of the Ogaswara Islands), the Marshall Islands (approximately half-way between the Marianas and Hawiian 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). No areas with high densities of humpback whales are known between the Hawaiian main islands and Ogasawara, but this could be due to a lack of search effort. Which stock 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 north 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.

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 1991-93, 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 (un-quantified) and the likely existence of an unknown and un-sampled wintering area (-7.2%).

The central North Pacific stock of humpback whales winters in Hawaiian waters (Baker et al. 1986). Baker and Herman (1987) used capture-recapture methods in Hawaii to estimate the population at 1,407 (95% CI: 1,113-1,701), which they considered an estimate for the entire stock for 1980-83. Mobley et al. (2001) conducted aerial surveys throughout the main Hawaiian Islands during 1993, 1995, 1998, and 2000. Abundance during these line-transect surveys was estimated as 2,754 (95% CI: 2,044-3,468), 3,776 (95% CI: 2,925-4627), 4,358 (95% CI: 3,261-5,454), and 4,491 (95% CI: 3,146-5,836). Before the SPLASH study, the best estimate of abundance for Hawaii from photo-identification data was 4,005 (CV = 0.10) for the years 1991-93 (Calambokidis et al. 1997). Initial mark-recapture abundance estimates have been calculated from the SPLASH data. Point estimates of abundance for Hawaii ranged from 7,469 to 10,103; the estimate from the best model (as chosen by AICc) was 10,103. Confidence limits or CVs have not yet been calculated for the SPLASH abundance estimates.

~~In summer feeding areas of the central North Pacific stock, photo-identification studies have been conducted in a number of locations in Alaska, but abundance estimates have been relatively modest. These include a catalogue of 315 individual humpback whales in Prince William Sound from 1977 to 2001 (von Ziegesar 1992, Waite et al. 1999, von Ziegesar et al. 2004), and mark-recapture estimates of 651 (95% CI: 356-1,523) for the Kodiak region (Waite et al. 1999) and 410 (95% CI: 241-683) for the Shumagin Islands from 1999-2002 (Witteveen et al. 2004).~~

~~From line-transect surveys Moore et al. (2000) estimated abundance of humpback whales in the central Bering Sea as 1,175 humpback whales (95% CI: 197-7,009) in 1999, though Moore et al. (2002) suggested these sightings were too clumped in the central-eastern Bering Sea to be used to provide a reliable estimate for the area. Moore et al. (2002) estimated abundance as 102 (95% CI: 40-262) for humpback whales in the eastern Bering Sea in 2000. Zerbini et al. (2007) estimated abundance of humpback whales from line-transect surveys in 2001-03 as 2,644 (95% CI 1,899-3680) for coastal/shelf waters from the central Gulf of Alaska through the eastern Aleutian Islands. Although there is a small amount of overlap between this survey and the Bering Sea surveys (in the eastern Aleutian Islands), considering both surveys this suggests a combined total of about 4,000 whales.~~ In the SPLASH study the number of unique identifications in different regions 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 abundance estimates ranged from 6,000 to 19,000 combined for the Aleutian Islands, Bering Sea, and Gulf of Alaska, a considerable increase from previous estimates that were available. However, the SPLASH surveys were more extensive in scope, including areas not covered in those 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 Island, 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, the SPLASH estimates ranged from 2,889 to 13,594. For the Gulf of Alaska, 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 from 1979 to 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 to 1986 data set. Using data from 1986 to 1992 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 from 1994 to 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.). 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, 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) 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 1991-93 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 PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. ~~As a worst case, using the lowest population estimate (N) of 7,469 and an assumed conservative CV(N) of 0.30~~ Using the population estimate (N) of ~~7,469~~10,103 from the best fit model and an assumed conservative CV(N) of 0.30 results in an N_{MIN} for the central North Pacific humpback whale stock of ~~5,833~~7,890.

Although the Southeast Alaska/northern British Columbia feeding aggregation is not formally considered a stock, the calculation of a PBR 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 0.30, 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 0.30 results in an N_{MIN} of 2,256. For the Gulf of Alaska, using the lowest SPLASH estimate of 2,845 with an assumed worst-case CV of 0.30 results in an N_{MIN} of 2,222. Estimates for these feeding areas may include whales from the western North Pacific stock.

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 model fit to data from Hawaii for the years 1980-1996 resulted in an estimated rate of increase of 10% per year (95% C.I.

of 3-16%). For shelf waters of the northern Gulf of Alaska, Zerbini et al. (2007) estimated an annual rate of increase for humpback whales from 1987-2003 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 from 1991-93. Comparisons of SPLASH abundance estimates for Hawaii to estimates from 1991-93 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 for the northern Gulf of Alaska a value 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 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 default recovery factor (F_R) for this stock is 0.1, the recommended value for cetacean stocks listed as endangered under the Endangered Species Act (Wade and Angliss 1997). 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 whale, using the ~~smallest~~ SPLASH study abundance estimate from the best fit model for 2004-06 for Hawaii of ~~7,469~~10,103 with an assumed CV of 0.300 and its associated N_{MIN} of ~~5,833~~7,890, PBR is calculated to be ~~61.2~~82.8 animals (~~5,833~~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. For Southeast Alaska and northern British Columbia, the smallest abundance estimates from the SPLASH study were used with an assumed worst-case CV of 0.3 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 only for the Southeast Alaska/ northern British Columbia feeding aggregation since this aggregation has an Nmin greater than 1,500 and less than 5,000 and 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 Nmin is greater than 1,500 and less than 5,000 and based on an unknown population trend. For the Southeast Alaska/northern British Columbia feeding aggregation PBR is calculated to be 23.6 (2,251 x 0.035 x 0.3). For the Aleutian Islands and Bering Sea, PBR is calculated to be 7.9 (2,256 x 0.035 x 0.1). For the Gulf of Alaska, PBR is calculated to be 7.8 (2,222 x 0.035 x 0.1).

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

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 by fishery observers. As of 2004, changes in fishery definitions in the List of Fisheries have resulted in separating these four 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 ~~2007~~2008 and ~~2011~~2012, there were two incidental serious injuries and mortalities of central North Pacific humpback whales in the Bering Sea/Aleutian Islands flatfish trawl and one in the Bering Sea/ Aleutian Islands pollock trawl; one humpback whale injured in the Hawaii shallow set longline fishery is prorated at 0.75 under the injury determination guidelines for large whales since the severity of the injury in unknown (Table 45).

Table 45. Summary of observer reported incidental mortalities and serious injuries of humpback whales (Central North Pacific stock) due to commercial fisheries from ~~2007~~2008 to ~~2011~~2012 and calculation of the mean annual mortality rate (Breiwick 2013). Details of how percent observer coverage is measured is included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality/ serious injury (in given yrs.)	Estimated mortality/ serious injury (in given yrs.)	Mean annual mortality/ serious injury
BSAI flatfish trawl	~~2007~~	obs data	~~72~~	~~0~~	~~0~~	0.20
	2008		100	0	0	(CV = N/A)
	2009		100	0	0	
	2010		100	0 (+1)*	0 (1)**	
	2011		100	0	0	
	2012		100	0	0	
BSAI pollock trawl	~~2007~~	obs data	~~85~~	~~0~~	~~0~~	0.20
	2008		85	0	0	(CV = 0.08)
	2009		86	0	0	
	2010		86	1	1.0	
	2011		98	0	0	
	2012		98	0	0	
HI shallow set longline	~~2007~~	obs data	~~100~~	~~0~~	~~0~~	0.15
	2008		100	0	0	
	2009		100	0	0	
	2010		100	0	0	
	2011		100	1[2]	0.75[2]	
	2012		100	0	0	
Minimum total annual mortality				North: 0.40 SE: 0.0 HI: 0.15 Total: 0.55		

*Total mortalities observed in unsampled hauls.

**Total mortalities observed in sampled and unsampled hauls. Since the total known mortality (1) exceeds the estimated mortality (0) for 2010, the sum of actual mortalities observed (1) will be used as a minimum estimate for that year.

[1]Mortality assigned to both the western North Pacific and central North Pacific. Stock identification is unknown, and both stocks overlap within the area of operation of these fisheries.

[2]A humpback was entangled and cut free with gear trailing. Due to the unknown configuration of the entanglement, this injury is being prorated with a value of 0.75 (Bradford and Forney 2014).

Reports of entangled humpback whales found swimming, floating, or stranded with fishing gear attached occur in both Alaskan and Hawaiian waters. All reports of Alaska mortalities or injuries of humpback whales from the central North Pacific stock from ~~2007~~2008 to ~~2011~~2012 are summarized in Allen ~~and Helker~~et al. (~~in prep~~2014)

and Allen et al. (in prep.) along with details regarding injury determination and assessement. A summary of the information is provided in Tables 46 and 47. The estimated annual human-caused mortality and serious injury rate for ~~2007-2011~~2008-2012 based on fishery and gear entanglements reported in the NMFS Alaska Regional Office stranding database is ~~2.15~~2.55 (Table 46). These events have not been attributed to a specific fishery listed on the List of Fisheries (76 FR 73912; 29 November 2011). The estimated annual mortality and serious injury for 2007-2011 due to entanglements reported in waters off Hawaii is 4.1 (Table 47). 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.

Table 46. Summary of opportunistic reports of central North Pacific humpback whale mortalities and serious injuries caused by entanglement (marine debris, commercial and recreational fisheries) as well as vessel collisions reported to the NMFS Alaska Regional Office, marine mammal stranding database, for the ~~2007-2011~~2008-2012 period (Allen ~~and Helker~~et al. 2014, Allen et al. in prep). 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 Allen ~~and Helker~~et al. (~~in prep~~2014).

Cause of Injury	~~2007~~	2008	2009	2010	2011	2012	Mean Annual Mortality
Entangled in SE AK salmon drift gillnet		0	0	0	0	1	0.20
Entangled in unknown gillnet gear	~~1.5~~	0	0.75	3	0.75	1.75	~~1.2~~ 1.25
Entangled in recreational shrimp pot gear	~~0~~	0	1.75	0	0	0	0.35
Entangled in unspecified crab gear	~~0~~	0	0	0	0.75	0	0.15
Entangled in unspecified longline gear	~~0~~	0	0	0	0.75	0.75	~~0.15~~ 0.30
Entangled in unspecified pot gear	~~0~~	0	0	1.5	0	0	0.30
~~Entangled in unspecified set net gear~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
Ship strike (charter)	~~0.2~~	0.2	0.76	0	0	0.2	~~0.232~~ 0.23
Ship strike (pilot vessel)		0	0	0	0	0.2	0.04
Ship strike (recreational)	~~0.36~~	0.2	0	0	0	0	~~0.112~~ 0.04
Ship strike (research)	~~0~~	0.2	0	0	0	0	0.04
Ship strike (unknown)	~~0.4~~	0.4	0.36	4	2	1.2	~~1.432~~ 1.59
Ship strike (whale watch)		0	0	0	0	1	0.20
Unknown marine debris / gear entanglement	~~1.5~~	3	1.5	2.25	3	0.75	~~2.25~~ 2.10

Minimum total annual mortality	~~6.216~~ 6.79

Table 47. Data on opportunistically reported entanglements and vessel collisions occurring in Hawaii waters are reported in Bradford and Lyman (2013).

Cause of Injury	2007	2008	2009	2010	2011	Mean Annual Mortality
Entanglement	5.0	1.75	6.5	5.0	5.5	4.75
Vessel Collision	2.0	5.04	1.4	2.0	1.72	2.43

Minimum total annual mortality	7.18

The overall U. S. commercial fishery-related minimum mortality and serious injury rate for the entire stock is ~~0.55~~0.75 humpback whales per year, based on observer data from Alaska (0.40), opportunistic stranding and human interaction reports from Alaska in which the fishery is confirmed (0.20), and observer data from Hawaii (0.15). Additional fisheries-related (may include commercial, recreational, or subsistence fisheries reports) mortality and serious injury rates based on stranding records from Alaska (~~2.15~~2.55) and stranding records from Hawaii (4.75) result in an overall minimum estimate of mortality and serious injury rate due to fisheries of ~~7.45~~8.05 (~~0.55~~0.75 + ~~2.15~~2.55 + 4.75).

As mentioned previously, these estimates of serious injury/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 rate unreliable. Further, due to limited Canadian observer program data, mortality 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 related to commercial fisheries in northern British Columbia are not available, again indicating that the estimated mortality incidental to commercial fisheries is underestimated for this stock.

Subsistence/Native 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

Ship strikes and other interactions with vessels unrelated to fisheries have also occurred to humpback whales (Table 46, 47). The mean annual human-caused mortality and serious injury rate for ~~2007-2011~~2008-2012 due to vessel collisions reported in Alaska (~~1.8~~2.14) and Hawaii (2.43) is ~~4.23~~4.57 (Table 46, 47). Most vessel collisions with humpbacks are reported from Southeast Alaska; however, there are also reports from the south-central and Kodiak areas of Alaska (Allen et al. 2014, Allen ~~and Helker~~et al. in prep). Many of the vessel collisions occurring off Hawaii are reported from waters near Maui (Bradford and Lyman 2013). 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 account for an estimated mortality and serious injury rate of ~~2.25~~2.10 humpbacks annually.

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 USSR. 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 density 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 density 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, the report of which is being finalized. NMFS will include the relevant results of this review in the SARs when they are available. Although the estimated annual mortality and serious injury rate for the entire stock (~~13.93~~14.52; ~~0.55~~0.75 of which were commercial

fishery-related; Table ~~38~~36; 37a,b) is considered a minimum, it is unlikely that the level of human-caused mortality and serious injury exceeds the PBR level (~~61.2~~82.8) for the entire stock. The minimum estimated U. S. commercial fishery-related mortality and serious injury (~~0.55~~0.75) for this stock is less than 10% of the calculated PBR for the entire stock (~~6.1~~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 Endangered Species Act, and therefore designated as "depleted" under the MMPA. As a result, the central North Pacific stock of humpback whale is classified as a strategic stock. However, the status of the entire stock relative to its Optimum Sustainable Population size 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 waters in an attempt to minimize the impact of whale watching. Additional concerns have been raised about the impact of jet skis and similar fast waterborne tourist-related traffic, notably in nearshore areas inhabited by mothers and calves. In 2001, NMFS issued regulations to prohibit most approaches to humpback whales in Alaska within 100 yards (91.4 m; 66 FR 29502; 31 May 2001). The growth of the whale watching industry, however, is a concern as preferred habitats may be abandoned if disturbance levels are too high.

~~Elevated levels of sound from the U.S. Navy's Low Frequency Active (LFA) sonar program and other anthropogenic sources (i.e., shipping and whale watching) in Hawaii waters is of potential concern for this stock. Results from experiments in 1996 off Hawaii indicated only subtle responses of humpback whales to ATOC-like transmissions (Frankel and Clark 1998). Frankel and Clark (2002) indicated that there were also slight shifts in humpback whale distribution in response to ATOC. Efforts are underway to evaluate the relative contribution of sound (e.g., experiments with LFA sound sources) to Hawaii's marine environment, although reports summarizing the results of recent research are not available.~~

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.

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.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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., 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., D. Steel, J. Calambokidis, J. Barlow, A. M. Burdin, P. J. Clapham, E. A. Falcone, J. K. B. Ford, C. M. Gabriele, U. Gozález-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, Urbán R. Jorge, P. R. Wade, D. Weller, B. H. Witteveen, M. Yamaguchi. 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. Marine Ecology Progress Series, Vol. 494: 291–306; DOI: 10.3354/meps10508.

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

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

Bradford, A. L., K. A. Forney. 2014. Injury Determinations for Cetaceans Observed Interacting with Hawaii and American Samoa Longline Fisheries during 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-39, 20 p. + Appendix.

Bradford, A. L. and E. Lyman. 2013. Injury determinations for humpback whales and other cetaceans reported to the Pacific Islands Region Marine Mammal Response Network during 2007-2011. Pacific Islands Fisheries Science Center Working Paper WP-13-005, submitted to the 2013 Pacific Scientific Review Group Meeting.

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. E.A. Falcone, T.J. Quinn, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urbán R., D. Weller, B.H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final report for Contract AB133F-03-RP-00078. 58 p.
(Available at http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-Report-May08.pdf)

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 pp.

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 92038. 67 pp.

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. Mamm. Sci. 17(4): 769-794.

Calambokidis, J., G. H. Steiger, J. M. Straley, T. Quinn, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. R. Urban, 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, P.O. Box 271, La Jolla, CA 92038. 72 pp.

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

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

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 pp.

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. *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet whaling data (1949-1979), Center for Russian Environmental Policy, Marine Mammal Council, Moscow, 96-103.

Fleming, A., and J. Jackson. 2011. Global review of humpback whales (*Megaptera novaeangliae*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFSC-474, 206 p.

Frankel, A. S., and C. W. Clark. 1998. Results of low-frequency playback of M-sequence noise to humpback whales, *Megaptera novaeangliae*, in Hawai'i. Can. J. Zool. 76:521-535.

Frankel, A. S., and C. W. Clark. 2002. ATOC and other factors affecting the distribution and abundance of humpback whales (*Megaptera novaeangliae*) off the North Shore of Hawaii. Mar. Mamm. Sci. 18(3):644-662.

Gabriele, C. M., J. M. Straley, L. M. Herman, and R. J. Coleman. 1996. Fastest documented migration of a North Pacific humpback whale. Mar. Mamm. Sci. 12:457-464.

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 pp. [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 .

Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, 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 pp.

Moore, S. E., J. M. Waite, L. L. Mazzuca, and R. L. Hobbs. 2000. Mysticete whale abundance observations of prey associations 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. Progr. Oceanogr. 55(1-2):249-262.

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. Scientific Reports of the Whales Research Institute, 14**:**149-290.

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.

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. Pp. 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., G.B. van Vliet, J.F. Piatt, and E. M. Danner. 2006. Pages 245-261 In: "Whales, Whaling and Ocean Ecosystems", J.A. Estes, R.L. Brownell, Jr., D.P DeMaster, D.F. Doak, and T.M. Williams (eds), University of California Press. 418 pp.

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, Alaska, 99775. 121 pp.

Straley, J. M., C. M. Gabriele, and C. S. Baker. 1995. Seasonal characteristics of humpback whales (*Megaptera novaeangliae*) in southeastern Alaska. Pp. 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. NOAA-TM-NMFS-SWFSC-354, 6 pp.

Tomlin, A. G. 1967. Mammals of the USSR and adjacent countries. vol. 9, Cetacea. Israel Program Sci. Transl. No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 pp. (Translation of Russian text published in 1957).

von Ziegesar, O. 1992. A catalogue of Prince William Sound humpback whales identified by fluke photographs between the years 1977 and 1991. North Gulf Oceanic Society, P. O. Box 15244, Homer, AK. 29 pp.

von Ziegesar, O., B. Goodwin, and R. Devito. 2004. A catalog of humpback whales in Prince William Sound Alaska, 1977-2001. Eye of the Whale Research, Fritz Creek, Alaska.

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 pp.

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. 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. 2007. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. Part I:1772-1790.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the U.S. waters in the Pacific, fin whales are found seasonally off the coast of North America and in the Bering Sea during the summer (Fig. 37). 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). Moore et al. (1998, 2006) Watkins et al. (2000), and Stafford et al. (2007) both documented high levels of fin whale call rates 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. 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). In addition, fin whale calls were detected in the southeast Bering Sea using an instrument moored there from April 2006 through April 2007, which showed peaks fin whale in call detections from September through November 2006 and also in February and March 2007 (Stafford et al. 2010). While seasonal differences in recorded call rates are in some cases consistent with the results of aerial surveys which have documented seasonal whale distribution, it is not known whether these differences in call rates reflect true seasonal differences in whale distribution, differences in calling rates, or differences in oceanographic properties (Moore et al. 1998). Some fin whale calls have also been recorded in Hawaiian waters 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 by Dale Rice in 1979 (Mizroch et al. 2009), a sighting during an aerial survey in 1994 (Mobley et al. 1996), and 5 sightings during a survey in 2002 (Barlow 2006).

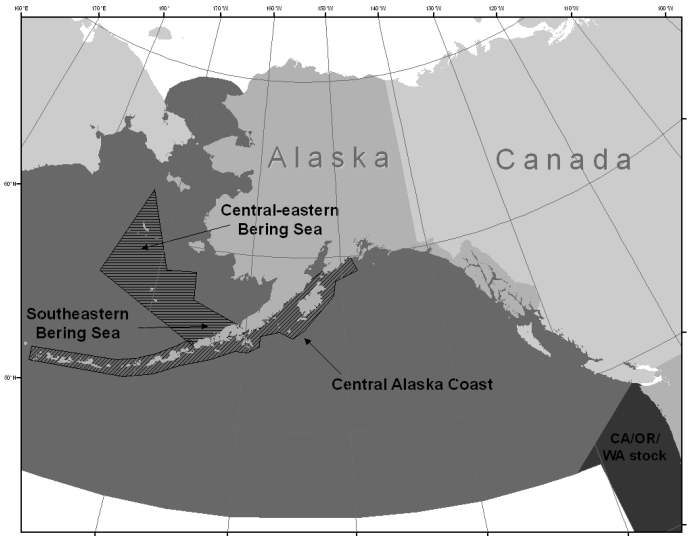

Figure 37. Approximate distribution of fin whales in the eastern North Pacific (shaded area). Striped areas indicate where vessel surveys occurred in 1999-2000 (Moore et al. 2002) and 2001-2003 (Zerbini et al. 2006).

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, Friday et al. ~~in review~~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, Friday et al. ~~in press~~2013). Fin whales were consistently distributed both in the 'green belt', an area of high productivity along the edge of the 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, Friday et al. ~~in press~~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).

Fin whales were seen regularly by whaling vessels in the Chukchi Sea in the 1920-1940's and were taken by whalers at least until the early 1950s. After this time, despite some continued effort to hunt other species, many fewer fin whales were seen through at least until the late 1970s but not thereafter (Nemoto 1959, Sleptsov 1961). Fin whales are again being seen increasingly during sighting surveys in the Chukchi Sea in summer (Funk et al. 2010, Aerts et al. 2011; Clarke et al. 2013) and have been recorded each year from 2007-2010 in August and September on

bottom-mounted hydrophones in the Chukchi (Delarue et al. 2013) suggesting they may be re-occupying habitat used prior to large-scale commercial whaling.

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 6 populations of fin whales: 2 that are migratory (eastern and western North Pacific) and 2 to 4 more that are resident year-round in peripheral seas such as the Gulf of California, East China Sea, Sanriku-Hokkaido and possibly in 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. ~~New information from~~ Mizroch et al. (2009) suggest~~s~~ 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~~current data~~. The California/Oregon/Washington and Hawaii fin whale stocks are reported separately in the Stock Assessment Reports for the 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 can be made. ~~Passive acoustics were used off the island of Oahu, Hawaii, to document a minimum density estimate of 0.081 fin whales/1,000km^2 from peak call rates during the winter (McDonald and Fox 1999). This density estimate is well below the population density of 1.1 animals/1,000 km^2 documented off the coast of California (Barlow 1995, Forney et al. 1995) but does indicate the presence of at least a few fin whales in waters off of Hawaii.~~

Visual 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, Moore et al. 2002, Friday et al. 2012, Friday et al. ~~in review~~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), respectively (Friday et al. ~~in review~~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. 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 part of the stock's range.

Dedicated line transect cruises were conducted in coastal waters 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 in coastal waters (as far as 85 km offshore) 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) whales occurred in the area.

Minimum Population Estimate

Although the full range of the northeast Pacific stock of fin whales in Alaskan waters has not been surveyed, a rough estimate of the size of the population west of the Kenai Peninsula has been calculated in previous SARs by summing the estimates from Moore et al. (2002) and Zerbini et al. (2006) (n = 5,700). However, new information indicates that whales surveyed in the Aleutians (Zerbini et al. 2006) could migrate into the Bering Sea and be counted during the Bering Sea surveys (Mizroch et al. 2009). There are also indications that fin whale distribution in the Bering Sea is related to oceanographic conditions (Friday et al. ~~in press~~2013, Stabeno et al. 2012), 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 of the Kenai Peninsula would be ~~1,214~~1,368, the ~~average of the~~greater of the minimum estimates ~~in~~from the 2008 and 2010 surveys (Friday et al. ~~in press~~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 Nmin for the entire stock is unknown.

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 the fin whales in the area. Also, the study represented only a small fraction of the range of the northeast Pacific stock.

Friday et al. (~~in press~~2013) estimated a 14% (95% CI = 1.0 - 26.5%) annual rate of change in abundance of fin whales between 2002 and 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. (~~in press~~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.

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). However, because an estimate of minimum abundance is not available, the PBR level for the Alaska fin whale stock is undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012).

NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*." Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fisheries Information

Between ~~2007~~2008 and ~~2011~~2012, there ~~were no~~was one observed incidental mortality~~ies~~ of a fin whale~~s~~ in ~~any Alaska commercial fishery (Breiwick in review)~~ due to entanglement in the ground tackle of a commercial mechanical jig fishing vessel (Allen et al. in prep; Table 48).

Table 48. Summary of Northeast Pacific stock fin whale mortalities and serious injuries by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, Allen et al. in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Ship strike	0	1	1	0	0	0.4
Entangled in ground tackle of commercial mechanical jig fishing vessel	0	0	0	0	1	0.2
Minimum total annual mortality						0.60

Subsistence/Native Harvest Information

Subsistence hunters in Alaska and Russia have not been reported to take fin whales from this stock.

Other Mortality

Between 1911 and 1985, 49,936 fin whales were reported killed 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). Two ship strike mortalities of fin whales occurred in Alaska waters between ~~2007-2011~~2008-2012 (one in 2009 and one in 2010) and have been reported in the Alaska Region stranding database (Allen ~~and Helker in prep~~et al. 2014), resulting in a mean annual mortality rate of 0.4 fin whales.

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 size is currently not available. The total estimated annual rate of mortality and serious injury for this stock is ~~0.4~~0.6 based on takes incidental to U. S. commercial fisheries (0.2) and ship strikes (0.4). Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown.

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.

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.

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

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. Mamm. 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, http://dx.doi.org/10.5670/oceanog.2013.81.

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. *In* Soviet whaling data (1949-1979). Eds: Yablokov, A. V. and Zemsky, V. A. Center for Russian Environmental Policy, Marine Mammal Council, Moscow, 96-103.

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. (SC/48/O 11). 15 pp.

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.

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. ~~In review~~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. plus Appendices.

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, Jr., J. R., M. Smultea, T. Norris, and D. Weller. 1996. Fin whale sighting north of Kaua'i, Hawai'i. Pac. Sci. 50(2):230-233.

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. Mamm. Sci. 14(3):617-627.

Moore, S. E., K. M. Stafford, D. K. Mellinger, C. G. Hildebrand. 2006. Listening for large whales in the offshore waters of Alaska. BioScience 56(1):49-55.

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. Progr. Oceanogr. 55(1-2):249-262.

Nemoto, T. 1959. Food of baleen whales with reference to whale movements. Scientific Reports of the Whales Research Institute of Tokyo 14:149-290.

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.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. Pp. 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. Available from: National Technical Information Service, Springfield, Virginia. PB82-109398.

Sleptsov, M.M. 1961. Fluctutations in the numbers of whales of the Chukchi Sea in various years. Translation by US Naval Oceanographic Office 1970. [O kolebanii chislennosti kitov v Chukotskom More v raznyye gody. Trudy Instituta Morfologiya Zhivotnykh Akademiya Nauk SSSR 34:54–64].

Springer, A. M., C. P. McRoy, M. V. Flint. 1996. The Bering Sea green belt: shelf-edge processes and ecosystem production. Fish Oceanogr. 5:205–223.

Stabeno, P., Moore, S., Napp, J., Sigler, M., Zerbini, A., 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, 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. Let., Vol. 37, L02606, doi:10.1029/2009GL040724, 2010.

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 pp.

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., P. J. Clapham and P. R. Wade. 2010. Assessing plausible rates of population growth in humpback whales from life-history data. Marine Biology 157:1225-1236.

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. Part I:1772-1790.

MINKE WHALE (*Balaenoptera acutorostrata*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the North Pacific, minke whales occur from the Bering and Chukchi Seas south to near the Equator (Leatherwood et al. 1982). The following information was considered in classifying stock structure according to the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous, 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. Based on this limited information, in 1991 the International Whaling Commission (IWC) recognized three stocks of minke whales in the North Pacific: one in the Sea of Japan/East China Sea, one in the rest of the western Pacific west of 180°N, and one in the "remainder" of the Pacific (Donovan 1991). The "remainder" stock designation reflects the lack of exploitation in the eastern Pacific and does not indicate that only one population exists in this area (Donovan 1991). In the "remainder" area, minke whales are relatively common in the Bering and Chukchi Seas and in the inshore waters of the Gulf of Alaska (Mizroch 1992), but are not considered abundant in any other part of the eastern Pacific (Leatherwood et al. 1982, Brueggeman et al. 1990). Minke whales are known to penetrate loose ice during the summer, and some individuals venture north of the Bering Strait (Leatherwood et al. 1982).

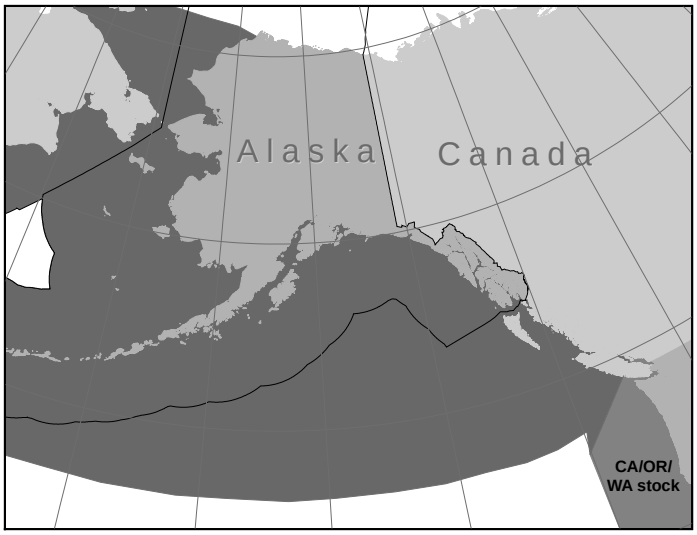

Figure 38. Approximate distribution of minke whales in the eastern North Pacific (shaded area).

Ship surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 resulted in new information about the distribution and relative abundance of minke whales in these areas (Moore et al. 2000; Moore et al. 2002; see Fig. 38 for location of survey areas). Minke whale abundance estimates were similar in the central-eastern Bering Sea and the southeastern Bering Sea (Moore et al. 2002). Minke whales occurred throughout the area surveyed, but most sightings of minke whales in the central-eastern Bering Sea occurred along the upper slope in waters 100-200 m deep (Moore et al. 2000); sightings in the southeastern Bering Sea occurred along the north side of the Alaska Peninsula and were associated with the 100 m contour near the Pribilof Islands (Moore et al. 2002).

In the northern part of their range minke whales are believed to be migratory, whereas they appear to establish home ranges in the inland waters of Washington and along central California (Dorsey et al. 1990). Because the "resident" minke whales from California to Washington appear behaviorally distinct from migratory whales farther north, minke whales in Alaska are considered a separate stock from minke whales in California, Oregon, and Washington (Dorsey et al. 1990). Accordingly, two stocks of minke whales are recognized in U. S. waters: 1) Alaska, and 2) California/Washington/Oregon (Fig. 38). The California/ Oregon/Washington minke whale stock is reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

No estimates have been made for the number of minke whales in the entire North Pacific. However, some information is now available on the numbers of minke whales in some areas of Alaska. A visual survey for cetaceans was conducted in the central-eastern Bering Sea in July-August 1999, and in the southeastern Bering Sea in 2000, in cooperation with research on commercial fisheries (Moore et al. 2000; Moore et al. 2002; see Fig. 40 for locations of survey areas). The survey included 1,761 km and 2,194 km of effort in 1999 and 2000, respectively. Results of the surveys in 1999 and 2000 provide provisional abundance estimates of 810 (CV = 0.36) and 1,003 (CV = 0.26) minke whales in the central-eastern and southeastern Bering Sea, respectively (Moore et al. 2002). These estimates are considered provisional because they have not been corrected for animals missed on the trackline, animals submerged when the ship passed, or responsive movement. Additionally, line-transect surveys were

conducted in shelf and nearshore waters (within 30-45nm of land) in 2001-2003 from the Kenai Fjords in the Gulf of Alaska to the central Aleutian Islands. Minke whale abundance was estimated to be 1,233 (CV=0.34) for this area (Zerbini et al. 2006). This estimate has also not been corrected for animals missed on the trackline. The majority of the sightings were in the Aleutian Islands rather than in the Gulf of Alaska, and in water shallower than 200 m. These estimates cannot be used as an estimate of the entire Alaska stock of minke whales because only a portion of the stock's range was surveyed.

Minimum Population

At this time, it is not possible to produce a reliable estimate of minimum abundance for this stock, as current estimates of abundance are not available.

Current Population Trend

There are no data on trends in minke whale abundance in Alaska waters.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of minke whale populations in the North Pacific (Best 1993). Hence, until additional data become available, it is recommended that the cetacean maximum net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{Max} \times F_R$. Given the status of this stock is unknown, the appropriate recovery factor is 0.5 (Wade and Angliss 1997). However, because an estimate of minimum abundance is not available, the PBR for the Alaska minke whale stock is unknown at this time.

ANNUAL HUMAN-CAUSED MORTALITY

Fishery Information

Six different commercial fisheries operating in Alaska waters within the range of the Alaska minke whale stock were monitored for incidental take by NMFS observers during 2002-2006: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. In 1989, one minke whale mortality (extrapolated to 2 mortalities) was observed in the Bering Sea/Gulf of Alaska joint-venture groundfish trawl fishery, the predecessor to the current Alaska groundfish trawl fishery. The Bering Sea/Aleutian Islands groundfish trawl fishery incurred one mortality of a minke whale in 2000, which extrapolated to an estimated two minke whale mortalities for that year. The total estimated mortality and serious injury incurred by this stock as a result of interactions with U. S. commercial fisheries for 2006-2010 is 0.

Subsistence/Native Harvest Information

No minke whales were ever taken by the modern shore-based whale fishery in the eastern North Pacific which lasted from 1905 to 1971 (Rice 1974). Subsistence takes of minke whales by Alaska Natives are rare, but have been known to occur. Only seven minke whales are reported the have been taken for subsistence by Alaska Natives between 1930 and 1987 (C. Allison, International Whaling Commission, United Kingdom, pers. comm.). The most recent reported catches (2 whales) in Alaska occurred in 1989 (Anonymous 1991), but reporting is likely incomplete. Based on this information, the annual subsistence take averaged zero minke whales during the 5-year period from 2006 to 2010.

Other Mortality

From 2006-2010, six dead minke whales have been reported to the Alaska Region Stranding Program (NMFS Alaska Regional Office, unpublished data). Two of these mortalities occurred in 2007, one of which was determined to be the result of a vessel strike. Four of these incidents occurred in 2010. The total mean annual mortality due to human-related causes based on stranding data is 0.2 for this 5-year period.

STATUS OF STOCK

Minke whales are not designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. The greatest uncertainty regarding the status of the Alaska minke whale stock has to do with the uncertainty pertaining to the stock structure of this species in the eastern North Pacific. Because minke whales are considered common in the waters off Alaska and because the number of human-related removals is currently thought to be minimal (0.2), this stock is presumed to not be a strategic stock. Reliable estimates of the minimum population size, population trends, PBR, and status of the stock relative to OSP are currently not available. Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown.

CITATIONS

Anon. 1991. International Whaling Commission Report. Rep. Int. Whal. Comm. 41:1-2.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Brueggeman, J. J., G. A. Green, K. C. Balcomb, C. E. Bowlby, R. A. Grotefendt, K. T. Briggs, M. L. Bonnell, R. G. Ford, D. H. Varoujean, D. Heinemann, and D. G. Chapman. 1990. Oregon-Washington marine mammal and seabird survey: Information synthesis and hypothesis formulation. U.S. Dep. Interior, Outer Continental Shelf Study, Minerals Management Service 89-0030.

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. Rept. Int. Whal. Comm. (Special Issue 13):39-68.

Dorsey, E. M., S. J. Stern, A. R. Hoelzel, and J. Jacobsen. 1990. Minke whale (*Balaenoptera acutorostrata*) from the west coast of North America: individual recognition and small scale site fidelity. Rept. Int. Whal. Comm. (Special Issue 12):357-368.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. U.S. Dep. Commer., NOAA Tech. Rept. NMFS Circular 444. 245 pp.

Mizroch, S. A. 1992. Distribution of minke whales in the North Pacific based on sightings and catch data. Unpubl. doc. submitted to the Int. Whal. Comm. (SC/43/Mi36). 37 pp.

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. Progr. Oceanogr. 55(1-2): 249-262.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. Pp. 170-195 *In* W. E. Schevill (ed.), The whale problem: A status report. Harvard Press, Cambridge, MA.

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 pp.

Zerbini, A.N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends, and distribution of baleen whales off Western Alaska and the central Aleutian Islands. Deep-Sea Res. I 53:1772–1790.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

A ~~comprehensive~~ review of all 20th century sighting, 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 (Figure 42; 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 (Scarff 1986, 1991; Fig. 39), 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. ~~During 1965-99, f~~Following large illegal catches (1962-1968) by the U.S.S.R. (Ivashchenko and Clapham 2012, Ivashchenko et al. 2013), ~~there were~~ only 82 sightings of right whales in the entire eastern North Pacific were reported from 1962-1999, with the majority of these occurring in the Bering Sea and adjacent areas of the Aleutian Islands (Brownell et al. 2001). Additional ~~S~~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 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, pers. comm., Department of Fisheries and Oceans, BC, Canada, 28 October 2013). However, most right whale sightings in the past twenty years have occurred in the southeast Bering Sea and in the Gulf of Alaska, particularly near Kodiak, AK (Waite et al. 2003, Shelden et al. 2005, Wade et al. 2011).

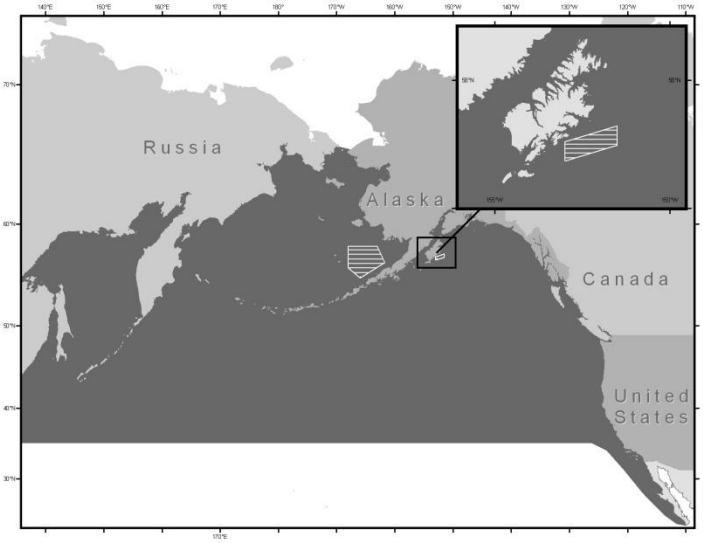

Figure 39. Approximate historical distribution of North Pacific right whales in the eastern North Pacific (shaded area). Striped areas indicate northern right whale critical habitat (71 FR 38277, 6 July 2006).

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 was identified 119 days later and 4,111km 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 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).

Information on the ~~current~~ 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 ~~which~~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. 39) 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 (Clapham et al. 2004, LeDuc et al. 2001, Moore et al. 2000, Moore et al. 2002). 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 ~~2012~~2013 have not yet been fully analyzed, but indicate the presence of right whales in the southeastern Bering Sea almost year-round, with a peak in August and a sharp decline in detections in early January (available Catherine Berchok, NOAA/AFSC/NMML, 7600 Sand Point Way, Seattle, WA; unpublished data). 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 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. ~~Right whale calls were rarely detected in the northwestern Gulf of Alaska in the late summer (Mellinger et al. 2004).~~ 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. in review). Right whales have not been observed outside the localized area in the southeastern Bering Sea during surveys conducted for fishery management purposes ~~which~~that covered a broader area of Bristol Bay and the Bering Sea (Moore et al. 2000, 2002; see Fig. ~~40~~37 in the fin whale SAR for locations of tracklines for these surveys).

~~The use of satellite telemetry has been implemented to provide information about habitat use and population size. In 2004, a right whale was successfully tagged with a satellite-monitored transmitter for 40 days, during which time the animal moved over a large part of the southeastern Bering Sea including the outer shelf area (Wade et al. 2006). In September 2004, information from the tag was used together with acoustic detections to find the largest aggregation of right whales observed in the eastern North Pacific since Soviet whaling. A minimum of 17 individuals were identified by photo-id and by genotyping from skin biopsies. During a NMFS survey in 2008, a second right whale, last sighted in 2002, was satellite tagged. The animal remained inside the Bering Sea critical habitat providing further indication of this area's importance as foraging habitat for eastern North Pacific right whales. Similarly, three other whales that were tagged in July and August 2009 remained within the critical habitat for periods of days to weeks (Phil Clapham, AFSC-NMML, pers. comm., 9 October 2009Zerbini et al. in review).~~

There are fewer recent sightings of right whales in the Gulf of Alaska than in the Bering Sea (Brownell et al. 2001), although 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 1959-97. ~~Seven sightings of right whales were reported, but only one sighting of four right whales at the mouth of Yakutat Bay in 1979 could be positively confirmed (Waite et al. 2003). Sightings of a single right whale off eastern Kodiak Island occurred in July 1998 during an aerial survey (Waite et al. 2003), and a~~Additional lone animals were observed off Kodiak Island in the Barnabas Canyon area from NOAA surveys in August 2004, 2005, and 2006 (available Alex Zerbini, AFSC-NMML, 7600 Sand Point Way, Seattle, WA; unpublished 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 researchers in Uganik Bay (Amy Kennedy, AFSC-NMML, pers. comm., 7 October 2012). Acoustic monitoring from May 2000 to July 2001 at seven sites in the Gulf of Alaska detected right whale calls at only two: one off eastern Kodiak ~~(detection distance 20-50 km)~~ and the other in deep water south of the Alaska Peninsula (detection distance 10s of kilometers) (Mellinger et al. 2004).

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 indicates at least occasional continuing use of this area.

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

Illegal catches of an estimated ~~661~~681 right whales in the eastern and western North Pacific between 1962 and 1968 severely impacted the 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 Ohkotsk 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-IDs 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 4,111km 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 April Maui sighting 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 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).

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 ~~which may have included a juvenile animal~~ (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 southeast 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 7 females was significant as only 1 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. 2011). The abundance estimates are for the last year of each study, corresponding to 2008 for the photo-identification estimate, and 2004 for the genetic identification estimates. Wade et al. (2011) also estimate the population consists of eight females (95% CL 7-18) and 20 males (95% CL 17-37). Wade et al. (2011) summarized the photo-identification and genetic-identification catalogues as follows~~. T~~: twenty-one individuals were identified from genotyping from the Aleutian Islands and Bering Sea from 1997-2004, comprising 15 males and 6 females. In aggregate, there were 8 photo matches of individual whales

across years involving 5 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 4 biopsies taken in 2008 and 2009 of 2 males and 2 females; three of these animals had been sampled in previous years. These samples were only recently processed and did not make it into Wade et al. (2011) abundance estimate (Amy Kennedy, 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 eighteen unique individuals identified from photographs of callosity patterns and scars from 1998-2008, with 10 resights across years involving 5 individuals.

Another 7 individuals were observed in the summer of 2009, and one individual was seen in the summer of 2010 (Amy Kennedy, AFSC-NMML, pers. comm. 3 November 2010). Four individuals were seen in the summer of 2011 (Brenda Rone, AFSC-NMML, pers. comm. 7 October 2012). There were two sightings of right whales (one in June and one in October) in British Columbia waters in 2013, one of which was also seen off northern Washington state (J. Ford, pers. comm.); these 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. One of the individuals was a large animal with a major injury on its rostrum, perhaps the result of an earlier entanglement in fishing gear (J. Ford, pers. comm., Department of Fisheries and Oceans, BC, Canada, 28 October 2013).

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 1963-64 (Ivashchenko and Clapham 2012), from the 1960's 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. 2011). 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.

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 2 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 5 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 4 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. 2011). 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). However, it is interesting to note the contrasting data

from the southeastern Bering Sea where similar instruments on the middle shelf (<100m depth) detected right whale calls on > 6 d per month in July-October (Munger et al. 2008), despite a population estimated to be only 31 whales (Wade et al. 2011). 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 pelagic waters 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. 2011) have not detected right whales other than the single detection near Kodiak Island by Waite et al. (2003). 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, 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).

~~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. 2011). The abundance estimates are for the last year of each study, corresponding to 2008 for the photo-identification estimate, and 2004 for the genetic identification estimates. There were two sightings of right whales (one in June and one in October) in British Columbia waters in 2013, one of which was also seen off northern Washington state (J. Ford, pers. comm.); these 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. One of the individuals was a large animal with a major injury on its rostrum, perhaps the result of an earlier entanglement in fishing gear (J. Ford, pers. comm., Department of Fisheries and Oceans, BC, Canada, 28 October 2013).~~

Minimum Population Estimate

The minimum estimate of abundance of North Pacific right whales is 25.7 based on the 20th percentile of the photo-identification estimate of 31 (CV=0.226; Wade et al. 2011). The photo-identification catalogue used in the mark-recapture abundance estimate has a minimum of ~~18~~20 ~~reliably~~ unique individuals seen from 1998 to ~~2011~~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 may 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 based on the mark-recapture estimate of 31 (CV = 0.226; Wade et al. 2011). The calculated PBR level for this stock is therefore 0.05 which would be equivalent to one take every 20 years. Regardless of the PBR level, because this species is listed under the Endangered Species Act and no negligible impact determination has been made, no human-caused takes of this population are authorized; PBR for this stock is 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

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 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 catalog shows potential fishing gear entanglement (Amy Kennedy, NMFS-AFSC-NMML, 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, pers. comm., Department of Fisheries and Oceans, BC, Canada, 28 October 2013). Vessel collisions are considered the primary source of human-caused mortality of right whales in the North Atlantic (Cole et al. 2005). Any mortality 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 for the North Atlantic right whale stock (Waring et al. 2004). ~~An analysis of right whale photographs to estimate entanglement rate from scarring data has found no evidence of entanglement in photographed individuals, with the one exception of the right whale photographed on 25 October 2013 off British Columbia and northern Washington state (J. Ford, pers. comm., Department of Fisheries and Oceans, BC, Canada, 28 October 2013).is currently under way.~~

There are no records of fisheries mortalities of eastern North Pacific right whales. Thus, the estimated annual mortality rate incidental to U. S. commercial fisheries approaches zero whales per year from this stock. Therefore, the annual human-caused mortality level is considered to be insignificant and approaching a zero mortality and serious injury rate.

Subsistence/Native Harvest Information

Subsistence hunters in Alaska and Russia are not reported to take animals from this stock.

Other Mortality

~~Right whales are large, slow-swimming whales which tend to congregate in coastal areas. Their thick layer of blubber causes them to float when killed. These attributes made them an easy and profitable species for early (pre-modern) whalers. By the time the modern whale fishery (harpoon cannons and steam powered catcher boats) began in the late 1800s, right whales were rarely encountered (Braham and Rice 1984). Best (1987) estimated that between 1835 and 1909 15,374 right whales were taken from the North Pacific by American registered whaling vessels, with most of those animals taken prior to 1875. Scarff (2001) updated that analysis with adjustments for struck and lost whales and whaling conducted by citizens of countries other than the U.S.; he estimated that 26,500-37,000 right whales were killed during the period 1839-1909, with the great majority taken in the single decade of 1840-49. Brownell et al. (2001) estimated that from 1900 to 1999, a total of 742 right whales were killed by whaling; of those, 331 were killed in the western North Pacific and 411 in the eastern North Pacific. New iInformation on illegal Soviet catches indicates that 681 right whales were killed illegally by the USSR during the period 1962 to 1968; this includes 529 whales killed in the eastern North Pacific (primarily in the Gulf of Alaska and Bering Sea), 132 in the Okhotsk Sea and 20 in other areas (Ivashchenko and Clapham 2012). This brings the total number of catches from 1900 on to 1031 whales.~~

Ship strikes are significant sources of mortality 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 North Pacific stock of right whales at this time. There is concern regarding the effects of increased shipping through the Arctic waters and Bering Sea with retreating sea ice, which may increase the potential risk to right whales from shipping.

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 size). The estimated annual rate of human-caused mortality and serious injury ~~seems~~ 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) noted the devastating impact of extensive illegal Soviet catches in the eastern North Pacific in the 1960s, and 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 arguably the most endangered stock of large whales in the world.

HABITAT CONCERNS

NMFS conducted an analysis of right whale distribution in historic 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. 42). In 2008, NMFS redesignated the same two areas as eastern North Pacific right whale critical habitat under the newly recognized species name, *E. japonica*.

There are no known current threats to the habitat of this population, although this partly reflects a lack of information about the current distribution and habitat requirements of right whales in the eastern North Pacific, as well as about the location and nature of any potential threats to the animal or its environment. The Department of the Interior has designated areas within the southeastern Bering Sea, including areas designated as right whale critical habitat, as one of their outer continental shelf oil and gas lease areas. 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. The Mineral Management Service (currently Bureau of Ocean Energy Management) supported a series of surveys from 2007-2009 to better understand right whale distribution in this area so that potential impacts and mitigation measures can be better assessed.

CITATIONS

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. 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.

Baumgartner, M.F., Lysiak, N., Carter Esch, H., Zerbini, A.N., Berchok, C.L., Clapham, P.J., 2013. Associations between North Pacific right whales and their zooplanktonic prey in the southeastern Bering Sea. Marine Ecology Progress Series 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.

Best, P. B. 1987. Estimates of the landed catch of right whale (and other whalebone) whales in the American fishery. Fish. Bull., U.S. 85(3):403-418.

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). 2:269-86.

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. Pp. 1-27 *In* Habitat Requirements and Extinction Risks of Eastern North Pacific Right Whales. Eds: Clapham, P.J., Shelden, K. E. W. and Wade, P. R. AFSC Processed Report 2006-06, Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle.

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.

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. Pp. 96-103 *In* Soviet whaling data (1949-1979). Eds: Yablokov, A. V. and Zemsky, V. A. 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.

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., Brownell, R. L. Jr. and Clapham, P. J. 2013. Soviet whaling in the North Pacific: revised catch totals. *Journal of Cetacean Research and Management* 13: 59-71.

Ivashchenko, Y.V. & Clapham, P.J. 2012. Soviet catches of bowhead (*Balaena mysticetus*) and right whales (*Eubalaena japonica)* in the North Pacific and Okhotsk Sea. *Endangered Species Research* 18: 201-217.

Josephson, E., T.D. Smith, and R.R. Reeves. 2008a. Historical distribution of right whales in the North Pacific. Fish Fish. 24:4, 795-814.

Josephson, E.A., T.D. Smith and R.R. Reeves. 2008b. Depletion within a decade: the American 19th-century North Pacific right whale fishery. In: *Oceans Past: Management Insights from the History of Marine Animal Populations* (eds D.J. Starkey, P. Holm and M. Barnard). Earthscan, London, p. 133-147.

Kennedy, A.S., Salden, D.R., Clapham, P.J. 2011. First high- to low-latitude match of an eastern North Pacific right whale (*Eubalaena japonica*). Mar. Mammal Sci. 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 pp.

LeDuc, R. G., W. L. Perryman, J. W. Gilpatrick, Jr., J. Hyde, C. Stinchcomb, J. V. Carretta, 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., Taylor, B.L., Kartien, K., Robertson, K.M., Pitman, R.L., Salinas, J.C., Burdin, A.M., Kennedy, A.S., Wade, P.R., Clapham, P.J. & Brownell, R.L. 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. Progr. 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.

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.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. Pp. 170-195 *In* W. E. Schevill (ed.), The whale problem: A status report. Harvard Press, Cambridge, MA.

Rone, B. K., Berchok, C. L., Crance, J. L. & Clapham, P. J. 2012. Employing aerial acoustics to increase encounters with the critically endangered North Pacific right whale. *Marine Mammal Science* 28: E528-538.

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. Molec. 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. Commn. 41:467-487.

Scarff, J. E. 2001. Preliminary estimates of whaling-induced mortality in the 19th century North Pacific right whale (*Eubalaena japonicus*) [sic] fishery, adjusting for struck-but-lost whales and non-American whaling. J. Cetacean Res. Manage. (Special Issue) 2:261-268.

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. Mamm. Rev. 35: 129-155.

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 #719, 24 pp.

Stafford, K.M., Moore, S.E., Stabeno, P.J., Holliday, D.V., Napp, J.M., Mellinger, D.K., 2010. Biophysical ocean observation in the southeastern Bering Sea. Geophysical Research Letters 37. 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. *In* 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. (Eds: Freeland, H. J., Peterson, W. T., Tyler, A.) (PICES Scientific Report No. 10) North Pacific Marine Science Organization (PICES), Sydney, BC, Canada, 115-117.

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 pp.

Wade, P. R., M. P. Heide-Jorgensen, 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. Carlos Salinas, A. Zerbini, R. L. Brownell, Jr., and P. Clapham. 2011. The world's smallest whale population. Biol. Letters 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, C. Wilson. 2011. 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., P. M. Richard, J. M. Quinta, 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.

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). Single small stocks occur in the Sea of Okhotsk and the offshore waters of Spitsbergen, comprised of only a few tens to a few hundreds of individuals (Shelden and Rugh 1995, Wiig et al. 2009, Zeh et al. 1993). Bowheads 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; Heide-Jørgensen et al. 2010; Wiig et al. 2010; Bachmann 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. 40 and 41), 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, Rugh et al. 2009, Taylor et al. 2007) and the IWC SC 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. 40) where they spend much of the summer (June through ~~September~~early to mid-October) before returning again to the Bering Sea (Fig. 41) in the fall (~~October~~September through

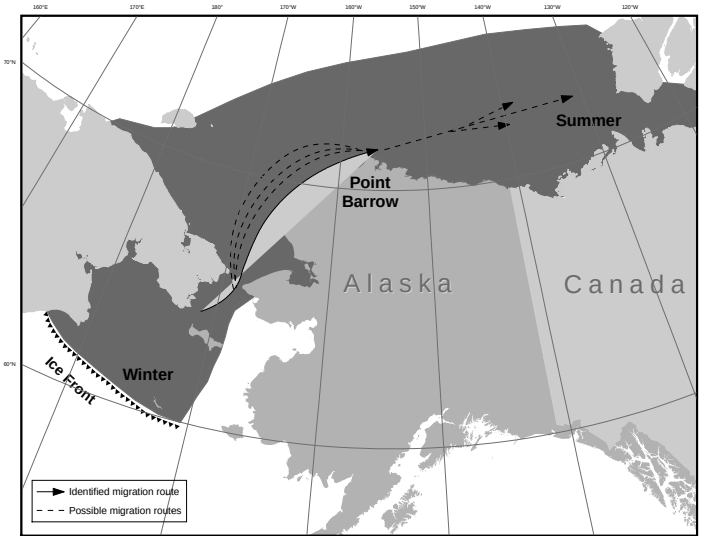

Figure 40. Dark areas depict the approximate distribution of the western Arctic stock of bowhead whales. The spring migration represented here by lines and arrows follows a route from the Bering Sea wintering area to the Beaufort Sea summering area, mostly along a coastal tangent that constricts somewhat as it goes east past Point Barrow.

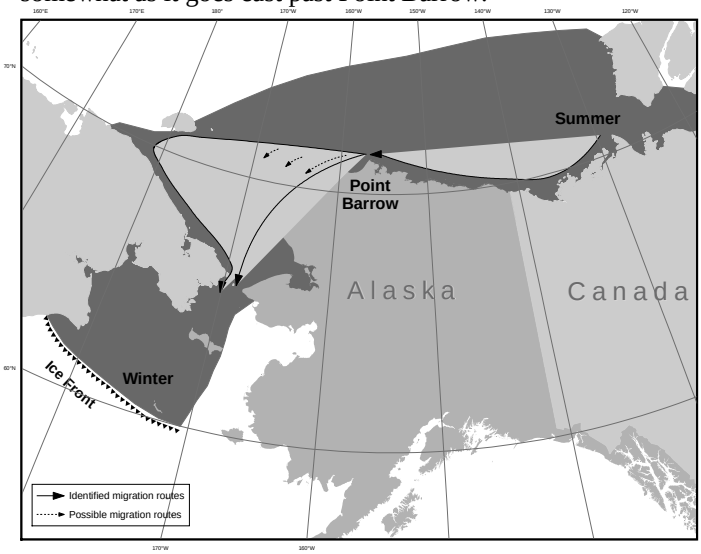

Figure 41. Dark areas depict the approximate distribution of the western Arctic stock of bowhead whales. The fall migration is represented here by lines and arrows showing generalized routes used to travel from the Beaufort Sea (summering area) to the Bering Sea (wintering area).

December) to overwinter (Braham et al. 1980, Moore and Reeves 1993, Quakenbush et al. 2010a). Some bowheads 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).

During winter and spring, bowhead whales are closely associated with sea ice (Moore and Reeves 1993, Quakenbush et al. 2010a). The bowhead 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 the summer, most of the population is in relatively ice-free waters in the southeastern Beaufort Sea, 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 and 2013 have had relatively high sighting rates of bowhead whales, including cows with calves and feeding animals (Clarke et al., 2013; NMML, unpublished data, Available at: http://www.afsc.noaa.gov/nmml/cetacean/bwasp/flights_2013.php). During the autumn migration through the Beaufort Sea, bowheads 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 ~~now uncommon~~becoming less common because of the retreat of Arctic sea ice. In winter in the Bering Sea, bowheads often use areas with ~100% sea ice cover, even when polynas are available (Quakenbush et al. 2010a).

Evidence suggests that bowhead whales feed on concentrations of zooplankton throughout their range. Likely or confirmed feeding areas include Amundsen Gulf and eastern Canadian Beaufort; central and western U.S. Beaufort Sea; Wrangel Island; and the coast of Chukotka, between Wrangel Island and the Bering Strait~~; and the western Bering Sea~~ (Quakenbush et al. 2010a; Quakenbush et al. 2010b; Lowry et al. 2004; Clarke and Ferguson 2010a; Ashjian et al. 2010; Okkonen et al. 2011; Clarke et al. 2012; NMML, unpublished data, Available at: http://www.afsc.noaa.gov/nmml/cetacean/bwasp/flights_2013.php). Bowheads 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 how many bowheads there were 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 (~~2004~~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) bowheads in 1848 at the start of commercial whaling.

Table 49. Summary of population 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	1000-3000	1986	8,917 (0215)
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 (0.244)

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 (through acoustical methods since the mid-1980s, described in Clark et al. 1994), whales missed when no watch was in effect (through interpolations from sampled periods), and whales missed during a watch (estimated as a function of visibility, number of observers, and distance offshore; Zeh et al. 1993). A summary of the resulting abundance estimates is provided in Table 49 and Figure 42. However, 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. ~~A count was successful in 2011, and the data are currently being analyzed (pers. comm., J. C. George, North Slope Borough, Barrow, AK).~~ The ~~most recent~~ 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 15,704-18,928).

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; SE 1,915) and 1986 (7,734; SE 1,450; Raftery and Zeh 1998). Aerial photographs provided another sampling of the bowhead population in 2003 and 2004. Sight-resight results provided estimates of 8,250 whales (95% CI: 3,150 to 15,450) in 2001 (Schweder et al. 2009) and 12,631 whales (95% CI: 7,900 to 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 in 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).

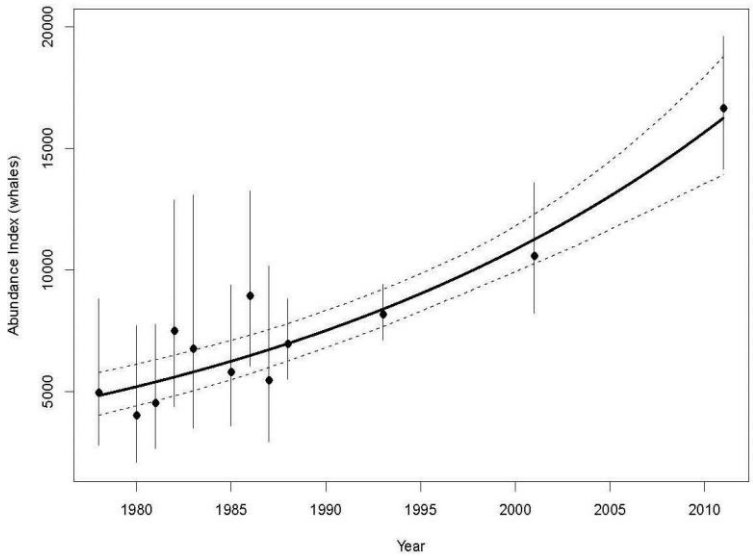

Figure 42. Population abundance estimates for the western Arctic stock of bowhead whales, ~~1977-2004~~1978-2011 (~~George et al. 2004, Koski et al. 2010~~Givens et al. 2013), as computed from ice-based counts, acoustic locations, and aerial transect data collected during bowhead whale spring migrations past Barrow, AK. ~~The 2004 estimate is based on sight-resight results. Vertical bars show +/- 1 standard error.~~

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the ~~2004~~2011 population estimate (N) of ~~12,631~~16,892 and its associated CV(N) of ~~0.2442~~0.244, N_{MIN} for the Western Arctic stock of bowhead whales is ~~10,314~~13,796.

Current Population Trend

Based on concurrent passive acoustic and ice-based visual surveys, ~~George~~Givens et al. (~~2004~~2013) reported that the Western Arctic stock of bowhead whales increased at a rate of ~~3.4~~3.7% (95% CI = 2.8-4.7%~~1.7-5.0%~~) from 1978 to ~~2001~~2011, during which time abundance ~~doubled~~tripled from approximately 5,000 to approximately ~~10,000~~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-~~3.4~~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 potential biological removal (PBR) level is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 guidelines Wade and Angliss 1997). Thus, PBR = ~~103~~138 animals (~~10,314~~13,796 × 0.02 × 0.5). The calculation of a PBR level for the Western Arctic bowhead stock is required by the MMPA even though the subsistence harvest quota is established under the authority of the IWC based on extensively tested strike limit algorithms. The quota is based on subsistence need or the ability of the bowhead 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 bowheads. Because some whales are struck and lost, a strike limit of 67 (plus up to 15 previously unused strikes) could be taken each year. This quota includes an allowance of 5 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 adjusted for 6 years.

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

Several cases of rope or net entanglement have been reported from whales taken in the subsistence hunt (Philo et al. 1993). Further, a thorough reexamination of bowhead harvest records is on-going and there are preliminary indications that entanglements or scarring attributed to ropes may include over 20 cases (Craig George, Department of Wildlife Management, North Slope Borough, pers. comm.).

There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska. However, some bowhead whales have historically had interactions with crab pot gear. ~~There are several documented cases of bowheads having ropes or rope scars on them.~~ In 2003 a bowhead whale was found dead in Bristol Bay entangled in line around the peduncle and both flippers; the origin of the line is unknown. In 2004 a bowhead whale near Point Barrow was observed swimming slowly with fishing net and line around the head. One dead whale was found floating in Kotzebue Sound in early July 2010 entangled in crab pot gear similar to that used by commercial crabbers in the Bering Sea (Suydam et al. 2011, Table 50). During the 2011 spring aerial photographic survey of bowhead whales near Point Barrow, one entangled bowhead was photographed (Mocklin et al. 2012). The minimum average annual entanglement rate in U.S. commercial fisheries for the 5-year period from ~~2007-2011~~2008-2012 is 0.4; however, the overall rate is currently unknown.

Table 50. Summary of Arctic stock bowhead whale mortalities and serious injuries by year and type reported to the Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, in prep.). Only cases of serious injury were recorded in this table; animals with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011	2012	Mean Annual Mortality
Entangled in unspecified pot gear	0	0	1	0	0	0.4
Minimum total annual mortality						0.40

Subsistence/Native 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 take approximately 0.1-0.5% of the population per annum, primarily from eleven Alaska communities (Philo et al. 1993; Suydam et al. 2011). Under this quota, the number of kills has ranged between 14 and 72 per year, the number depending in part on changes in management strategy, i.e., the quota, which is influenced by the subsistence need and the abundance and trend estimates (Stoker and Krupnik 1993). Suydam and George (2012) summarized Alaskan subsistence harvests of bowheads 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) while Shaktoolik landed only one. Alaska Natives landed ~~41 in 2007 (Suydam et al. 2008),~~ 38 in 2008 (Suydam et al. 2009), 31 in 2009 (Suydam et al. 2010), 45 in 2010 (Suydam et al. 2011), ~~and~~ 38 in 2011 (Suydam et al. 2012), and 55 in 2012 (Suydam et al. 2013). 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 quota in 1978. In 1978, the efficiency was about 50%~~, in 2010 it was 63% (Suydam et al. 2011), and in 2011 it was 76% (Suydam et al. 2012), and in 2012 it was 80% (Suydam et al. 2013).~~ and Suydam et al. (~~2012~~2013) reported that the current mean efficiency, from ~~2002~~2003 to ~~2011~~2012, is ~~75~~77%. ~~The somewhat low harvest efficiency in 2010 was considered an anomaly, and could be attributed to difficult environmental conditions in the spring of 2010, including ice conditions, struck whales escaping under the shorefast ice, and equipment failures.~~

Canadian and Russian Natives are also known to take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996. ~~Twelve whales were harvested by Russian subsistence hunters between 1999-2005 (IWC 2001, 2002, 2003, 2004, 2005, 2006, 2007).~~ No catches for Western Arctic bowheads were reported by either Canadian or Russian hunters for 2006-2007 (IWC 2008, 2009) or by Russia in 2009, 2011, and 2012 (IWC 2011, Ilyashenko 2013), but two bowheads were taken in Russia in 2008 (IWC 2010), and in 2010 (IWC 2012). The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from ~~2007~~2008 to ~~2011~~2012 was ~~39~~42 bowhead whales.

Other Mortality

Pelagic commercial whaling for bowheads 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 abundance was harvested, and effort remained high into the 20th century (Braham 1984). It is 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. 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 bowheads taken in the subsistence harvest, 4.1% to 7.9% had scars indicating that they had survived attacks by killer whales (George et al., 1994).

With increasing ship traffic and oil and gas activities in the Chukchi and Beaufort, bowheads may become increasingly at-risk from ship strikes.

STATUS OF STOCK

Based on currently available data, the estimated annual mortality rate incidental to U. S. commercial fisheries (0.4) is not known to exceed 10% of the PBR (~~10.3~~13.8), and therefore can be considered to be insignificant. The annual level of human-caused mortality and serious injury (~~39~~42) is not known to exceed the PBR (~~103~~138) nor the IWC annual maximum strike limit (67). The Western Arctic bowhead whale stock has been increasing in recent years; the estimate of ~~12,631~~16,892 from ~~2004~~2011 is between ~~22~~31% and ~~124~~170% of the pre-exploitation abundance (estimates ranging roughly from 10,000 to 55,000), and this stock may now be approaching its carrying capacity (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. An ESA recovery plan has not been prepared for bowhead whales because: 1) only the Western Arctic stock occurs in U.S. waters and, therefore, a U.S. recovery plan for other stocks

would not be appropriate; 2) all stocks are managed under the international authority of the IWC (of which the United States is a member); 3) cooperative agreements already exist between NOAA and the AEWC for purposes of protecting the bowhead whale and the Eskimo culture, promoting scientific investigations, and effectuating the other purpose of the MMPA, the Whaling Convention Act, and the ESA as these acts relate to aboriginal subsistence whaling; and, 4) a recovery plan is not needed to direct research and management necessary to promote the recovery of this stock. NMFS will use criteria developed for the recovery of large whales in general (Angliss et al. 2002) and bowhead whales in particular (Shelden et al. 2001) in the next five-year ESA status review to determine if a change in listing status is needed (Gerber et al. 2007).

Habitat Issues

There has been an increase in vessel traffic, both with an increase of oil and gas activities as well as commercial shipping, in Arctic waters. This increase in vessel presence could result in an increased number of vessel collisions with bowhead whales.

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. Noise produced by increased seismic surveys and vessel traffic resulting from exploration, development and production operations and shipping are also of concern. 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 the presence of an active drill rig (Schick and Urban 2000) or seismic operations (Miller et al. 1999) may cause bowhead whales to deflect away from the activity. Studies in the 1980s indicated that bowheads appeared to recover from these behavioral changes within 30-60 minutes following the end of seismic activity (Richardson et al. 1986, Ljungblad et al. 1988). Although 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 will avoid an area within 20 km of an active seismic source and suggest that the offshore displacement may have begun roughly 35 km (19 n. mi. or 22 statute miles [st. mi.]) 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 feeding bowheads 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 swim 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 greater tolerance of feeding bowhead whales to higher sound levels than migrating whales (Miller et al. 2005, Harris et al. 2007). Data from an aerial monitoring program in the Alaskan Beaufort Sea during 2006-2008 also indicated that bowheads 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 mean that bowheads are unaffected by the noise. Feeding bowheads may be so highly motivated to stay in a productive feeding area that they remain in an area with noise levels that could cause adverse physiological effects. They could be experiencing increased stress by staying in a location with very loud noise (MMS 2008).

Another concern is climate change in the Arctic, which is affecting high northern latitudes more than elsewhere. Climate 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). Within the Arctic, some of the largest changes are expected to occur in the Bering, Beaufort, and Chukchi seas (Chapman and Walsh 2007, Walsh 2008). Ice-associated animals, such as the bowhead whale, may be sensitive to changes in Arctic weather, sea-surface temperatures, or 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 of the effects of Arctic climate change on bowhead whales. A study reported in George et al. (2006) showed that landed bowheads had better body condition during years of light ice cover. This, together with high calf production in recent years, suggests that the stock is tolerating the recent ice-retreat, at least at present.

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.

Allen, B. M., V. T. Helker, and L. A. Jemison. In prep. Human-caused injury and mortality of NMFS-managed Alaska marine mammal stocks, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, X p.

Angliss, R. P. and D. P. DeMaster. 1998. Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations. NOAA Tech Memo. NMFS-OPR-13, 48 p.

Angliss, R. P., G. K. Silber, and R. Merrick. 2002. Report of a workshop on developing recovery criteria for large whale species. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-21. 32 pp.

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.

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*). Unpub. doc. Submitted to Int. Whal. Comm. (SC/62/BRG26). 6 pp.

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. J., and J. J. Burns. 1993. Commercial whaling in the North Pacific sector. Pp. 563-577 *In* J. J. Burns, J.J Montague, and C.J. Cowles (eds.). The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

Bockstoce, J. R., D. B. Botkin, A. Philp, B. W. Collins, and J. C. George. 2007. The geographic distribution of bowhead whales (*Balaena mysticetus*) in the Bering, Chukchi, and Beaufort Seas: Evidence from whaleship records, 1849-1914. Mar. Fish. Rev. 67(3): 1-43.

Brandon, J., and P. R. Wade. 2004. Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales. Unpubl. report submitted to Int. Whal. Comm. (SC/56/BRG20). 32 pp.

Brandon, J., and P.R. Wade, 2006. Assessment of the Bering-Chukchi-Beaufort Seas stock of bowhead whales using Bayesian model averaging. Journal of Cetacean Research and Management 8(3):225-239. Available at: http://fish.washington.edu/research/MPAM/Pubs/BrandonWade2006.pdf

Burns, J. J., J. J Montague, and C. J. Cowles (eds.). 1993. The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2. 787 pp.

Chapman, W.L., and Walsh, J.E., 2007, Simulations of Arctic temperature and pressure by global coupled models: Journal of Climate, v. 20, p. 609-632. February 2006 manuscript available at: http://igloo.atmos.uiuc.edu/IPCC/revised.IPCC.temp.slp.paper.final.lowerres.pdf

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. (SC/46/AS19). 24 pp.

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, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

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. (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. (SC/62/BRG13).

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. paper submitted to the Scientific Committee of the Int. Whal. Comm. June 2006 (SC/58/BRG7). 19 pp.

daSilva, C. Q., J. Zeh, D. Madigan, J. Laake, D. Rugh, L. Baraff, W. Koski, 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 Univ., Bellingham, WA. 51 pp.

Dueck, L. P., M. P. Hiede-Jorgensen, 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. paper submitted to the Scientific Committee of the Int. Whal. Comm. June 2006 (SC/58/BRG5). 17 pp.

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: Funk D.W., 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. plus Appendices.

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. report submitted to Int. Whal. Comm. (SC/63/BRG3). 14 pp.

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. report submitted to Int. Whal. Comm. (SC/59/BRG3). 15 pp.

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., 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.

Gerber, L.R., A.C. Keller, and D.P. DeMaster, 2007. Ten thousand and increasing: Is the western Arctic population of bowhead whale endangered? Biol. Conserv. 137(2007) 577-583.

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. report submitted to Int. Whal. Comm. (SC/65a/BRG1). 30 pp. (available at: https://events.iwc.int/index.php/scientific/SC65a/paper/view/199/239).

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 Rep. TA4319-1. Rep. from LGL Ltd., King City, Ont., for GX Technol., Houston, TX. 48 p.

Heide-Jørgensen, M. P., K. L. Laidre, M. V. Jensen, L. Dueck, L. D. Postma. 2006. Dissolving stock discreteness with satellite tracking: bowhead whales in Baffin Bay. Mar. Mamm. Sci. 22:34-45.

Heide-Jørgensen, M. P., K. Laidre, D. Borchers, F. Samarra, and H. Stern. 2007. Increasing abundance of bowhead whales in West Greenland. Biol. Lett. 3:577-580.

Heide-Jørgensen, M. P., K. L. Laidre, Ø. Wiig, and L. Dueck. 2010. Large scale sexual segregation of bowhead whales. Unpub. doc. Submitted to Int. Whal. Comm. (SC/62/BRG23). 13 pp.

Ilyashenko, V.U. 2013. Aboriginal harvest of gray and bowhead whales in the Russian federation in 2008 – 2012. Unpub. doc. submitted to Int. Whal. Comm. (SC-65a-BRG24). 2 pp.

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 at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

IWC. 2008. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 10(Suppl.):150-166.

IWC. 2009. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 11(Suppl.):169-192.

IWC. 2010. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 11(Suppl.2):154-179.

IWC. 2011. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 12(Suppl.):168-184.

IWC. 2012. Annex F: Report of the sub-committee on bowhead, right and gray whales. J. Cetacean Res. Manage. 13(Suppl.):154-174.

Jorde, P.E., T. Schweder, J. W. Bickham, G. H. Givens, R. Suydam. D. Hunter, and N. C. Stenseth. 2007. Detecting genetic structure in migrating bowhead whales off the coast of Barrow, Alaska. Mol. Ecol. 16:1993-2004.

Koski, W., J. Zeh, J. Mocklin, A. R. Davis, D. J. Rugh, J. C. George, and R. Suydam. 2010. Abundance of Bering-Chukchi-Beaufort bowhead whales (*Balaena mysticetus*) in 2004 estimated from photo-identification data. J. Cetacean Res. Manage. 11(2):89–99.

Krogman, B., D. Rugh, R. Sonntag, J. Zeh, and D. Ko. 1989. Ice-based census of bowhead whales migrating past Point Barrow, Alaska, 1978-1983. Mar. Mammal Sci. 5:116-138.

Laidre, K. L., I. Stirling, L. Lowry, Ø. Wiig, M. P. Heide-Jørgensen, and S. Ferguson. 2008. Quantifying the sensitivity of arctic marine mammals to climate-induced habitat change. Ecol. Appl. 18(2):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., Sheffield, G., and George, J. C. 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. Elliot, W. R. Koski, V. D. Moulton, and W. J. Richardson. 1999. Whales. *In* W. J. Richardson (ed.). Marine Mammal and Acoustical Monitoring of Western Geophysical's Open-Water Seismic Program in the Alaskan Beaufort Sea, 1998.

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. pp. 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, Ohio.

MMS. 2008. Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas Lease Sales 209, 212, 217, and 221, Draft Environmental Impact Statement: U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, MMS 2008-055, November. Available at: http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/2008-055-vol2.pdf

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. paper submitted to the Scientific Committee of the Int. Whal. Comm. June 2012 (SC/64/BRG3). 9 pp.

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. Pp. 313-386 *In* J. J. Burns, J. J. Montague, and C. J. Cowles (eds.), The bowhead whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

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.

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. Pp. 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-Jorgensen, 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. paper submitted to the Scientific Committee of the Int. Whal. Comm. June 2006 (SC/58/BRG4). 15 pp.

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. Pp. 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. Pp. 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., 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., T. L. McDonald, C. R. Greene, and S. B. Blackwell. 2004. Acoustic localization of bowhead whales near Northstar, 2001-2003: Evidence of deflection at high-noise times? Chapter 8 *In* W. J. Richardson and M. T. Williams (eds.). 2004. Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar oil development, Alaskan Beaufort Sea, 1999-2003. Rep. from LGL Ltd (King City, Ont.), Greenridge Science Inc (Santa Barbara, CA), and WEST Inc. (Cheyenne, WY) for BP Explor. (Alaska) Inc., Anchorage, AK.

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. Journal of the Acoustical Society of America 106(4, Pt. 2):2281.

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. America 79(4):1117-1128.

Ross, W. G. 1993. Commercial whaling the North Atlantic sector. Pp. 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., D. P. DeMaster, D. J. Rugh, and A. M. Olson. 2001. Developing classification criteria under the U.S. Endangered Species Act: Bowhead whales as a case study. Conserv. Biol. 15(5):1300-1307.

Shelden, K. E. W., and D. J. Rugh. 1995. The bowhead whale (*Balaena mysticetus*): status review. Mar. Fish. Rev. 57(3-4):1-20.

Stoker, S. W., and I. I. Krupnik. 1993. Subsistence whaling. Pp. 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., J. C. George, C. Rosa, B. Person, C. Hanns, G. Sheffield, and J. Bacon. 2008. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2007. Unpubl. report submitted to Int. Whal. Commn. (SC/60/BRG10). 7 pp.

Suydam, R., J. C. George, C. Rosa, B. Person, C. Hanns, G. Sheffield, and J. Bacon. 2009. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2008. Unpubl. report submitted to Int. Whal. Commn. (SC/61/BRG6). 6 pp.

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. Commn. (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. Commn. (SC/63/BRG2). 7 pp.

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. SC/64/BRG2. 8p.

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. SC/64/AWMP8. 13p.

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. report submitted to Int. Whal. Comm (SC/59/BRG35). 12 pp.

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, Holland-Bartels, L., and Pierce, B., eds., Alaska: U.S. Geological Survey Circular 1370, 278 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 pp.

Walsh, J.E., 2008, Climate of the Arctic marine environment: Ecological Applications, v. 18, no. 2, Supplement S3-S22. Available at: http://ic.ucsc.edu/~acr/BeringResources/Articles%20of%20interest/Central%20Artic/Walsh%202008.pdf

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. report submitted to Int. Whal. Comm. (SC/61/BRG2) 5pp.

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. Unpub. Doc. Submitted to Int. Whal. Comm. (SC/62/BRG25). 7 pp.

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. Unpub. Doc. Submitted to Int. Whal. Comm. (SC/63/BRG18) 4 pp.

Woodby, D. A., and D. B. Botkin. 1993. Stock sizes prior to commercial whaling. Pp. 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. report submitted to Int. Whal. Comm. (SC/56/BRG1). 10 pp.

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. Pp. 409-89 *In* J.J. Burns, J.J. Montague, and C.J. Cowles (eds.). The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2.

APPENDICES

Appendix 1. Summary of changes to the ~~2013~~2014 stock assessments. An 'X' indicates sections where the information presented has been updated since the ~~2012~~2013 stock assessments were released (last revised ~~06/11/2013~~07/29/2014).

Stock	Stock definition	Population size	PBR	Fishery mortality	Subsistence mortality	Status
Steller sea lion (western US)	X	X	X	X	~~X~~	X
Steller sea lion (eastern US)	X	X	X	X	X	X
Northern fur seal	X	X	X	X	X	X
Harbor seal (Aleutian Islands)						
Harbor seal (Pribilof Islands)						
Harbor seal (Bristol Bay)						
Harbor seal (N. Kodiak)						
Harbor seal (S. Kodiak)						
Harbor seal (Prince William Sound)						
Harbor seal (Cook Inlet/ Shelikof)						
Harbor seal (Glacier Bay/ Icy Strait)						
Harbor seal (Lynn Canal/ Stephens)						
Harbor seal (Sitka/ Chatham)						
Harbor seal (Dixon/ Cape Decision)						
Harbor seal (Clarence Strait)						
Spotted seal	X	X	X	X	X	X
Bearded seal	~~X~~	X		X	~~X~~	~~X~~
Ringed seal	X	X		X	~~X~~	X
Ribbon seal		~~X~~		~~X~~	~~X~~	
Beluga whale (Beaufort)	X	X	X		X	X
Beluga whale (E. Chukchi)	X	X	X		X	X
Beluga whale (E. Bering Sea)	X	X	X	X	X	X
Beluga whale (Bristol Bay)	X		X	X	X	X
Beluga whale (Cook Inlet)	X	X		X	X	X
Narwhal						
Killer whale (Alaska Resident)	~~X~~	~~X~~	~~X~~	~~X~~		~~X~~
Killer whale (Northern Resident)	~~X~~	~~X~~	~~X~~	~~X~~		
Killer whale (Gulf of Alaska, Bering Sea, Aleutian Islands Transient)	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	
Killer whale (AT1 Transient)	X	X		X		
Killer whale (West Coast Transient)	~~X~~	~~X~~	~~X~~	~~X~~		
Pacific white-sided dolphin						
Harbor porpoise (SE Alaska)		X		X		
Harbor porpoise (GOA)				X		
Harbor porpoise (Bering Sea)				X		X
Dall's porpoise						
Sperm whale				X		
Baird's beaked whale						
Cuvier's beaked whale						
Stejneger's beaked whale						
Humpback whale (western)	X	X	X	X		X
Humpback whale (central)	X	X	X	X		X
Fin whale		X	~~X~~	X		X

Stock	Stock definition	Population size	PBR	Fishery mortality	Subsistence mortality	Status
Minke whale						
North Pacific right whale	X	X	~~X~~	X		
Bowhead whale	X	X	X	X	X	X

~~**Appendix 2.** Stock summary table (last revised 06/12/2013~~~~7/31/2014~~~~). Stock assessment reports for those stocks in boldface were updated in the 2013~~~~2014~~ ~~draft 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)**~~	~~**Survey intervalYears since last survey/ year of last survey**~~	~~**Rmax**~~	~~**F(r)**~~	~~**PBR**~~	~~**Fishery mort.**~~	~~**Subsist. mort.**~~	~~**Total mort.**~~	~~**Status**~~
~~**Baird's beaked whale**~~	~~**Alaska**~~	~~**N/A**~~		~~**N/A**~~		~~**0.04**~~	~~**0.50**~~	~~**N/A**~~	~~**0**~~	~~**0**~~	~~**0**~~	~~**NS**~~
~~**Bearded seal**~~	~~**Alaska**~~	~~**N/A**~~		~~**N/A**~~		~~**0.12**~~	~~**0.50**~~	~~**N/A**~~	~~**1.8**~~	~~**6,788**~~	~~**6,790**~~	~~**S**~~
~~Beluga whale~~	~~Beaufort Sea~~	~~39,258~~	~~0.23~~	~~32,453~~	~~1921/1992~~	~~0.04~~	~~0.50~~	~~UNDET~~ ~~649~~	~~0~~	~~126~~ ~~166~~	~~126~~ ~~166~~	~~NS~~
~~Beluga whale~~	~~E. Chukchi Sea~~	~~3,710~~	~~N/A~~	~~3,710~~ ~~UNK~~	~~12/1998~~ ~~22/1991~~	~~0.04~~	~~1.00~~	~~UNDET~~	~~0~~	~~94.2~~ ~~57.4~~	~~94.2~~ ~~57.4~~	~~NS~~
~~Beluga whale~~	~~E. Bering Sea~~	~~28,406~~	~~0.24~~	~~20,231~~ ~~UNK~~	~~1013/2000~~	~~0.04~~	~~1.00~~	~~UNDET~~	~~0~~	~~192.6~~ ~~181~~	~~192.6~~ ~~181~~	~~NS~~
~~Beluga whale~~	~~Bristol Bay~~	~~2,877~~	~~0.2~~	~~2,467~~	~~68/2005~~	~~0.04~~ ~~0.048~~	~~1.00~~	~~49~~ ~~59~~	~~0.8~~[5] ~~0~~	~~20.0~~ ~~24~~	~~20.0~~ ~~24~~	~~NS~~
~~**Beluga whale**~~	~~**Cook Inlet**~~	~~**312**~~	~~**0.10**~~ ~~**0.13**~~	~~**280**~~	~~**1/2012**~~	~~**0.04**~~	~~**0.1**~~	~~**UNDET**~~	~~**0**~~	~~**0**~~	~~**0**~~	~~**S**~~
~~**Bowhead whale**~~	~~**W. Arctic**~~	~~**12,631**~~ ~~**16,892**~~	~~**0.24**~~	~~**10,314**~~ ~~**13,796**~~	~~**8/2004**~~ ~~**2/2011**~~	~~**0.04**~~	~~**0.50**~~	~~**103**~~ ~~**138**~~	~~**0.4**~~	~~**39**~~ ~~**42**~~	~~**39.4**~~ ~~**42.4**~~	~~**S**~~
~~**Cuvier's beaked whale**~~	~~**Alaska**~~	~~**N/A**~~		~~**N/A**~~		~~**0.04**~~	~~**0.50**~~	~~**N/A**~~	~~**0**~~	~~**0**~~	~~**0**~~	~~**NS**~~
~~Dall's porpoise~~	~~Alaska~~	~~83,400~~	~~0.097~~	~~N/A~~	~~18/1993~~	~~0.04~~	~~1.00~~	~~UNDET~~	~~28.9~~	~~0~~	~~28.9~~	~~NS~~
~~**Fin whale**~~	~~**NE Pacific**~~	~~**N/A**~~	~~**N/A**~~	~~**N/A**~~	~~**23/2010**~~	~~**0.04**~~	~~**0.10**~~	~~**UNDET**~~	~~**0**~~ ~~**0.2**~~	~~**0**~~	~~**0.4**~~ ~~**0.2**~~	~~**S**~~
~~**Harbor porpoise**~~	~~**SE Alaska**~~	~~**11,146**~~	~~**0.242**~~	~~**9,116**~~	~~**1516/1997**~~	~~**0.04**~~	~~**0.50**~~	~~**UNDET**~~	~~**22.6**~~[1]	~~**0**~~	~~**22.6**~~[1]	~~**S**~~
~~**Harbor porpoise**~~	~~**Gulf of Alaska**~~	~~**31,046**~~	~~**0.214**~~	~~**25,987**~~	~~**1415/1998**~~	~~**0.04**~~	~~**0.50**~~	~~**UNDET**~~	~~**71.4**~~	~~**0**~~	~~**71.4**~~	~~**S**~~
~~**Harbor porpoise**~~	~~**Bering Sea**~~	~~**48,215**~~	~~**0.223**~~	~~**40,039**~~	~~**1214/1999**~~	~~**0.04**~~	~~**0.50**~~	~~**UNDET**~~	~~**0.36**~~ ~~**0.2**~~	~~**0**~~	~~**0.76**~~ ~~**0.2**~~	~~**S**~~
~~Harbor seal~~	~~Aleutian Islands~~	~~3,579~~		~~3,313~~	~~7/2004~~	~~0.12~~	~~0.50~~	~~99~~	~~1.0~~	~~90~~	~~93.1~~	~~NS~~
~~Harbor seal~~	~~Pribilof Islands~~	~~232~~		~~232~~	~~1/2010~~	~~0.12~~	~~0.50~~	~~7~~	~~1.0~~	~~0~~	~~3.1~~	~~NS~~
~~Harbor seal~~	~~Bristol Bay~~	~~18,577~~		~~17,690~~	~~6/2005~~	~~0.12~~	~~1.0~~	~~1,061~~	~~1.0~~	~~141~~	~~144.1~~	~~NS~~

Species	Stock	N (est)	CV	N(min)	Survey intervalYears since last survey/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
Harbor seal	North Kodiak	4,509		4,272	5/2006	0.12	1.0	256	1.0	131	134.1	NS
Harbor seal	South Kodiak	11,117		10,645	5/2006	0.12	1.0	639	1.0	78	81.1	NS
Harbor seal	Prince William Sound	31,503		27,157	5/2006	0.12	0.5	815	25.0	439	466.1	NS
Harbor seal	Cook Inlet/ Shelikof	22,900		21,896	5/2006	0.12	1.0	1,314	1.0	233	236.1	NS
Harbor seal	Glacier Bay/ Icy Strait	5,042		4,735	4/2007	0.12	0.5	142	1.0	52	55.1	NS
Harbor seal	Lynn Canal/ Stephens	8,870		8,481	4/2007	0.12	0.5	254	1.0	30	33.1	NS
Harbor seal	Sitka/ Chatham	8,586		8,222	4/2007	0.12	0.5	247	1.0	222	225.1	NS
Harbor seal	Dixon/ Cape Decision	14,388		13,682	5/2003	0.12	1.0	821	1.0	157	160.1	NS
Harbor seal	Clarence Strait	23,289		22,471	5/2003	0.12	1.0	1,348	1.0	164	167.1	NS
Humpback whale	**W. N. Pacific**	**938** **1,107**	**0.30**	**732** **865**	**67/2006**	**0.07**	**0.10**	**2.6/2.0** **3.0**	**0.4** **0.7**	**0**	**2.0** **1.95**	**S**
Humpback whale	**CNP - entire stock**	**7,469** **10,103**	**0.30**	**5,833** **7,890**	**67/2004-2006**	**0.07**	**0.3**	**61.2** **82.8**	**7.45** **8.05**[4]	**0**	**13.9** **14.52**[4]	**S**
Killer whale	**Alaska Resident**	**2,347**[3]	**N/A**	**2,347**	**1/2012**	**0.04**	**0.50**	**23.4**	**0.9**	**0**	**0.9**	**NS**
Killer whale	**Northern Resident (British Columbia)**	**261**[3]	**N/A**	**261**	**2/2011**	**0.03**	**0.5**	**1.96**	**0**	**0**	**0**	**NS**
Killer whale	**AT1 transient**	**7**[3]	**N/A**	**7**	**1/2012** **2013**	**0.04**	**0.10**	**0**	**0**	**0**	**0**	**S**
Killer whale	**GOA, AI, BS Transient**	**587**[3]	**N/A**	**587**	**1/2012**	**0.04**	**0.5**	**5.9**	**0.6**	**0**	**0.6**	**NS**
Killer whale	**West Coast Transient**	**243**[3]	**N/A**	**243**	**3/2009**	**0.04**	**0.5**	**2.4**	**0**	**0**	**0**	**NS**
Minke whale	Alaska	N/A		N/A		0.04	0.50	N/A	0	0	0.2	NS
Narwhal	**Unidentified stock**	**N/A**		**N/A**		**0.04**	**0.50**	**N/A**	**0**	**0**	**0**	**NS**
Northern fur seal	**E. North Pacific**	**639,545** **648,534**	**N/A**	**541,317** **548,919**	**1/2011** **2/2012**	**0.086**	**0.50**	**11,638** **11,802**	**4.6** **1.7**	**463** **461**	**471** **468**	**S**

Species	Stock	N (est)	CV	N(min)	Survey intervalYears since last survey/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
Pacific white-sided dolphin	Cent. N. Pacific	26,880	N/A	N/A	12+/1990	0.04	0.50	UNDET	0	0	0	NS
Ribbon seal	**Alaska**	**61,100 (provisional)**		**N/A**	**1/2012**	**0.12**	**0.50**	**N/A**	**1.02**	**193**	**194**	**NS**
Right whale	**E. N. Pacific**	**31**	**0.23**	**25.7**	**3/2010**	**0.04**	**0.10**	**0**	**0**	**0**	**0**	**S**
Ringed seal	**Alaska**	**N/A**		**N/A**		**0.12**	**0.50**	**N/A**	**3.52 4.1**	**9,567**	**9,571**	**S**
Sperm whale	**N. Pacific**	**N/A**		**N/A**		**0.04**	**0.10**	**N/A**	**0.28 0**	**0**	**0.28 0**	**S**
Spotted seal	Alaska	N/A 460,268		N/A 391,000	2/2012	0.12	0.50	N/A 11,730	1.0 1.5	5,265	5,266 5,267	NS
Stejneger's beaked whale	**Alaska**	**N/A**		**N/A**		**0.04**	**0.50**	**N/A**	**0**	**0**	**0**	**NS**
Steller sea lion	**E. U. S.**	**63,160-78,198 60,131-74,448**		**34,485 36,551**	**2/2011 1/2013**	**0.12**	**0.75 OR 1.0**	**1,552 1,645 OR 2,193**	**49 51.6[4]**	**11.9 11.3**	**65.1 92.3**	**S NS**
Steller sea lion	**W. U. S.**	**45,659 55,422**		**45,659 48,676**	**1/2012 2013**	**0.12**	**0.10**	**274 292**	**29.6 31.5**	**199**	**230 238**	**S**

C.F. = correction factor; CV C.F. = CV of correction factor; Comb. CV = combined CV; Status: S = Strategic, NS = Not Strategic.

[1] No or minimal reported take by fishery observers; however, observer coverage was minimal or nonexistent.

[2] Recent changes in the abundance estimates do not indicate a major population increase. Instead, these increases are due to new analytical methods that take environmental covariates into account and thus provide an improved estimate of harbor seal abundance.

[3] N(est) based on counts of individual animals identified from photo-identification catalogs. Surveys for abundance estimates of these stocks are conducted infrequently.

[4] Includes entanglements from recreational or subsistence fisheries.

[5] Mortality and serious injury estimates calculated for humpbacks in the northern area of the Central North Pacific humpback whale stock range (Gulf of Alaska, Aleutian Islands, and Bering Sea).

Appendix 2. Stock summary table (last revised ~~06/12/2013~~7/31/2014). Stock assessment reports for those stocks in boldface were updated in the ~~2013~~2014 draft 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)	~~Survey interval~~Years since last survey/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
Steller sea lion	**W. U. S.**	**~~45,659~~ 55,422**		**~~45,659~~ 48,676**	**1/~~2012~~2013**	**0.12**	**0.10**	**~~274~~ 292**	**~~29.6~~ 31.5**	**199**	**~~230~~ 238**	**S**
Steller sea lion	**E. U. S.**	**~~63,160-78,198~~ 60,131-74,448**		**~~34,485~~ 36,551**	**~~2/2011~~ 1/2013**	**0.12**	**0.75 OR 1.0**	**~~1,552~~ 1,645 OR 2,193**	**~~49~~ 51.6[4]**	**~~11.9~~ 11.3**	**~~65.1~~ 92.3**	**~~S~~ NS**
Northern fur seal	**E. North Pacific**	**~~639,545~~ 648,534**	**N/A**	**~~541,317~~ 548,919**	**~~1/2011~~ 2/2012**	**0.086**	**0.50**	**~~11,638~~ 11,802**	**~~4.6~~ 1.7**	**~~463~~ 461**	**~~471~~ 468**	**S**
Harbor seal	Aleutian Islands	3,579		3,313	7/2004	0.12	0.50	99	1.0	90	93.1	NS
Harbor seal	Pribilof Islands	232		232	1/2010	0.12	0.50	7	1.0	0	3.1	NS
Harbor seal	Bristol Bay	18,577		17,690	6/2005	0.12	1.0	1,061	1.0	141	144.1	NS
Harbor seal	North Kodiak	4,509		4,272	5/2006	0.12	1.0	256	1.0	131	134.1	NS
Harbor seal	South Kodiak	11,117		10,645	5/2006	0.12	1.0	639	1.0	78	81.1	NS
Harbor seal	Prince William Sound	31,503		27,157	5/2006	0.12	0.5	815	25.0	439	466.1	NS
Harbor seal	Cook Inlet/ Shelikof	22,900		21,896	5/2006	0.12	1.0	1,314	1.0	233	236.1	NS
Harbor seal	Glacier Bay/ Icy Strait	5,042		4,735	4/2007	0.12	0.5	142	1.0	52	55.1	NS
Harbor seal	Lynn Canal/ Stephens	8,870		8,481	4/2007	0.12	0.5	254	1.0	30	33.1	NS
Harbor seal	Sitka/ Chatham	8,586		8,222	4/2007	0.12	0.5	247	1.0	222	225.1	NS

Species	Stock	N (est)	CV	N(min)	~~Survey interval~~Years since last survey/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
Harbor seal	Dixon/ Cape Decision	14,388		13,682	5/2003	0.12	1.0	821	1.0	157	160.1	NS
Harbor seal	Clarence Strait	23,289		22,471	5/2003	0.12	1.0	1,348	1.0	164	167.1	NS
Spotted seal	**Alaska**	**~~N/A~~ 460,268**		**~~N/A~~ 391,000**	**2/2012**	**0.12**	**0.50**	**~~N/A~~ 11,730**	**~~1.0~~ 1.5**	**5,265**	**~~5,266~~ 5,267**	**NS**
Bearded seal	**Alaska**	**N/A**		**N/A**		**0.12**	**0.50**	**N/A**	**1.8**	**6,788**	**6,790**	**S**
Ringed seal	**Alaska**	**N/A**		**N/A**		**0.12**	**0.50**	**N/A**	**~~3.52~~ 4.1**	**9,567**	**9,571**	**S**
Ribbon seal	Alaska	61,100 (provisional)		N/A	1/2012	0.12	0.50	N/A	1.02	193	194	NS
Beluga whale	**Beaufort Sea**	**39,258**	**0.23**	**32,453**	**~~19~~21/1992**	**0.04**	**0.50**	**~~UNDET~~ 649**	**0**	**~~126~~ 166**	**~~126~~ 166**	**NS**
Beluga whale	**E. Chukchi Sea**	**3,710**	**N/A**	**~~3,710~~ UNK**	**~~12/1998~~ 22/1991**	**0.04**	**1.00**	**UNDET**	**0**	**~~94.2~~ 57.4**	**~~94.2~~ 57.4**	**NS**
Beluga whale	**E. Bering Sea**	**28,406**	**0.24**	**~~20,231~~ UNK**	**~~10~~13/2000**	**0.04**	**1.00**	**UNDET**	**0**	**~~192.6~~ 181**	**~~192.6~~ 181**	**NS**
Beluga whale	**Bristol Bay**	**2,877**	**0.2**	**2,467**	**~~6~~8/2005**	**~~0.04~~ 0.048**	**1.00**	**~~49~~ 59**	**~~0.8~~[5] 0**	**~~20.0~~ 24**	**~~20.0~~ 24**	**NS**
Beluga whale	**Cook Inlet**	**312**	**~~0.10~~ 0.13**	**280**	**1/2012**	**0.04**	**0.1**	**UNDET**	**0**	**0**	**0**	**S**
Narwhal	Unidentified stock	N/A		N/A		0.04	0.50	N/A	0	0	0	NS
Killer whale	Alaska Resident	2,347[3]	N/A	2,347	1/2012	0.04	0.50	23.4	0.9	0	0.9	NS
Killer whale	Northern Resident (British Columbia)	261[3]	N/A	261	2/2011	0.03	0.5	1.96	0	0	0	NS
Killer whale	GOA, AI, BS Transient	587[3]	N/A	587	1/2012	0.04	0.5	5.9	0.6	0	0.6	NS
Killer whale	**AT1 transient**	**7[3]**	**N/A**	**7**	**1/~~2012~~2013**	**0.04**	**0.10**	**0**	**0**	**0**	**0**	**S**
Killer whale	West Coast Transient	243[3]	N/A	243	3/2009	0.04	0.5	2.4	0	0	0	NS

Species	Stock	N (est)	CV	N(min)	~~Survey interval~~Years since last survey/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
Pacific white-sided dolphin	Cent. N. Pacific	26,880	N/A	N/A	12+/1990	0.04	0.50	UNDET	0	0	0	NS
Harbor porpoise	**SE Alaska**	**11,146**	**0.242**	**9,116**	**~~15~~16/1997**	**0.04**	**0.50**	**UNDET**	**22.6[1]**	**0**	**22.6[1]**	**S**
Harbor porpoise	**Gulf of Alaska**	**31,046**	**0.214**	**25,987**	**~~14~~15/1998**	**0.04**	**0.50**	**UNDET**	**71.4**	**0**	**71.4**	**S**
Harbor porpoise	**Bering Sea**	**48,215**	**0.223**	**40,039**	**~~12~~14/1999**	**0.04**	**0.50**	**UNDET**	**~~0.36~~ 0.2**	**0**	**~~0.76~~ 0.2**	**S**
Dall's porpoise	Alaska	83,400	0.097	N/A	18/1993	0.04	1.00	UNDET	28.9	0	28.9	NS
Sperm whale	**N. Pacific**	**N/A**		**N/A**		**0.04**	**0.10**	**N/A**	**~~0.28~~ 0**	**0**	**~~0.28~~ 0**	**S**
Baird's beaked whale	Alaska	N/A		N/A		0.04	0.50	N/A	0	0	0	NS
Cuvier's beaked whale	Alaska	N/A		N/A		0.04	0.50	N/A	0	0	0	NS
Stejneger's beaked whale	Alaska	N/A		N/A		0.04	0.50	N/A	0	0	0	NS
Humpback whale	**W. N. Pacific**	**~~938~~ 1,107**	**0.30**	**~~732~~ 865**	**~~6~~7/2006**	**0.07**	**0.10**	**~~2.6/2.0~~ 3.0**	**~~0.4~~ 0.7**	**0**	**~~2.0~~ 1.95**	**S**
Humpback whale	**CNP - entire stock**	**~~7,469~~ 10,103**	**0.30**	**~~5,833~~ 7,890**	**~~6~~7/~~2004~~-2006**	**0.07**	**0.3**	**~~61.2~~ 82.8**	**~~7.45~~ 8.05[4]**	**0**	**~~13.9~~ 14.52[4]**	**S**
Fin whale	**NE Pacific**	**N/A**	**N/A**	**N/A**	**~~2~~3/2010**	**0.04**	**0.10**	**UNDET**	**~~0~~ 0.2**	**0**	**~~0.4~~ 0.2**	**S**
Minke whale	Alaska	N/A		N/A		0.04	0.50	N/A	0	0	0.2	NS
Right whale	**E. N. Pacific**	**31**	**0.23**	**25.7**	**3/2010**	**0.04**	**0.10**	**0**	**0**	**0**	**0**	**S**
Bowhead whale	**W. Arctic**	**~~12,631~~ 16,892**	**0.24**	**~~10,314~~ 13,796**	**~~8/2004~~ 2/2011**	**0.04**	**0.50**	**~~103~~ 138**	**0.4**	**~~39~~ 42**	**~~39.4~~ 42.4**	**S**

C.F. = correction factor; CV C.F. = CV of correction factor; Comb. CV = combined CV; Status: S = Strategic, NS = Not Strategic.

[1] No or minimal reported take by fishery observers; however, observer coverage was minimal or nonexistent.

[2] Recent changes in the abundance estimates do not indicate a major population increase. Instead, these increases are due to new analytical methods that take environmental covariates into account and thus provide an improved estimate of harbor seal abundance.
[3] N(est) based on counts of individual animals identified from photo-identification catalogs. Surveys for abundance estimates of these stocks are conducted infrequently.
[4] Includes entanglements from recreational or subsistence fisheries.
[5] Mortality and serious injury estimates calculated for humpbacks in the northern area of the Central North Pacific humpback whale stock range (Gulf of Alaska, Aleutian Islands, and Bering Sea).

Appendix 3. Summary table for Alaska **Category 2** commercial fisheries (last updated 08/08/2011). Source: 75 FR 68468; 08 November 2011 and the Alaska Commercial Fisheries Entry Commission (2011). Notice of continuing effect of list of fisheries.

Fishery (area and gear type)	**Target species**	**Permits issued or fished (2007)**	**Soak time**	**Landings per day**	**Sets per day**	**Season duration**	**Fishery trends (1990-1997)**
Southeast AK drift gillnet	salmon	474	20 min - 3 hrs; day / night	1	6 - 20	June 18 to Early Oct	# vessels stable but may vary with price of salmon; catch - high
Southeast AK purse seine	salmon	379	20 min-45 min; mostly daylight fishing, except at peak	1	6 - 20	end of June to early Sept	# vessel stable but may vary some with price of salmon; catch - high
Yakutat set gillnet	salmon	167	continuous soak during opener; day / night	1	net picked every 2 - 4hrs/day or continuous during peak	June 4 to mid-Oct	# sites fished stable; catch - variable
Prince William Sound drift gillnet	salmon	537	15 min - 3 hrs; day / night	1 or 2	10 - 14	mid-May to end of Sept	# vessels stable; catch - stable
Cook Inlet drift gillnet	salmon	569	15 min - 3 hrs or continuous; day only	1	6 - 18	June 25 to end of Aug	# vessels stable; catch - variable
Cook Inlet set gillnet	salmon	736	continuous soak during opener, but net dry with low tide; upper CI - day / night lower CI -day only except during fishery extensions	1	upper CI - picked on slack tide lower CI - picked every 2 - 6 hrs/day	June 2 to mid-Sept	# sites fished stable; catch - up for sockeye and kings, down for pinks
Kodiak set gillnet	salmon	188	continuous during opener; day only	1 or 2	picked 2 or more times	June 9 to end of Sept	# sites fished stable; catch - variable
AK Peninsula/Aleutians drift gillnet	salmon	162	2 -5 hrs; day / night	1	3 - 8	mid-June to mid-Sept	# vessels stable; catch up
AK Peninsula/Aleutians set gillnet	salmon	114	continuous during opener; day / night	1	every 2 hrs	June 18 to Mid-Aug	# sites fished stable; catch - up since 90; down in 96
Bristol Bay drift gillnet	salmon	1863	continuous soaking of part of net while other parts picked; day / night	2	continuous	June 17 to end of Aug or mid-Sept	# vessels stable; catch - variable
Bristol Bay set gillnet	salmon	982	continuous during opener, but net dry during low tide; day / night	1	2 or continuous	June 17 to end of Aug or mid-Sept	# sites fished stable; catch - variable
~~AK pair trawl~~	~~salmon~~	~~0~~					~~new fishery~~
~~Metlakatla/Annette Island drift gillnet~~	~~salmon~~	~~10~~					
AK Bering Sea, Aleutian islands flatfish trawl	flatfish	34					
AK Bering Sea, Aleutian Islands pollock trawl (subsistence)	pollock	95					
~~AK Bering Sea, Aleutian Islands Pacific cod longline~~	~~Pacific cod~~	~~154~~					

CITATIONS

Alaska Commercial Fisheries Entry Commission (CFEC). 2011. Fishery Participation & Earnings. Accessed on 4/26/2011. http://www.cfec.state.ak.us/.

Appendix 4. Interaction table for Alaska **Category 2** commercial fisheries (last revised 08/08/2011). Source: 75 FR 68468; 08 November 2011, Perez (2006), Manly (2009), Manly (2006), Manly et al. (2003), and the Alaska Commercial Fisheries Entry Commission (2011). Notice of continuing effect of list of fisheries.

Fishery (area and gear type)	**# of permits issued or fished (2010)**	**Observer program**	**Species recorded as taken incidentally in this fishery (records dating back to 1988)**	**Data type**
Southeast AK drift gillnet	474	never observed	Steller sea lion, harbor seal, harbor porpoise, Dall's porpoise, Pacific white-sided dolphin, humpback whale (self)	logbook and self reports
Southeast AK purse seine	379	never observed	humpback whale	self reports and stranding
Yakutat set gillnet	167	2007 2008	harbor seal, harbor porpoise (obs), humpback whale, gray whale (stranding)	logbook, observer, and stranding
Prince William Sound drift gillnet	537	1990 1991	Steller sea lion (obs), northern fur seal, harbor seal (obs), harbor porpoise (obs), Dall's porpoise, Pacific white-sided dolphin, sea otter	observer and logbook
Cook Inlet drift gillnet	569	1999 2000	Steller sea lion, harbor seal, harbor porpoise, Dall's porpoise, Cook Inlet beluga Note: observer program in 1999 and 2000 recorded one incidental mortality/serious injury of a harbor porpoise	observer and logbook
Cook Inlet set gillnet	736	1999 2000	harbor seal, harbor porpoise, Dall's porpoise, Cook Inlet beluga, humpback whale, Steller sea lion Note: observer program in 1999 and 2000 recorded one incidental mortality/serious injury of a harbor porpoise	observer and logbook
Kodiak set gillnet	188	2002 2005	harbor seal, harbor porpoise, sea otter, Steller sea lion	observer and logbook
Alaska Peninsula/Aleutians drift gillnet	162	1990	northern fur seal, harbor seal, harbor porpoise, Dall's porpoise (obs)	observer and logbook
Alaska Peninsula/Aleutians set gillnet	114	never observed	Steller sea lion, harbor porpoise	logbook
Bristol Bay drift gillnet	1863	never observed	Steller sea lion, northern fur seal, harbor seal, spotted seal, Pacific white-sided dolphin, beluga whale, gray whale	logbook
Bristol Bay set gillnet	982	never observed	northern fur seal, harbor seal, spotted seal, beluga whale, gray whale	logbook
~~Metlakatla/Annette Island drift gillnet~~	~~10~~	~~never observed~~	~~none documented~~	~~none~~
~~AK pair trawl~~	~~0~~	~~never observed~~	~~none documented~~	~~none~~
AK Bering Sea, Aleutian islands flatfish trawl	34	2009	Bearded seal, harbor porpoise (Bering Sea), harbor seal (Bering Sea), killer whale (Alaska Resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient), northern fur seal, spotted seal, ringed seal, ribbon seal, gray whale, Steller sea lion (Western U.S.), walrus	observer
AK Bering Sea, Aleutian Islands pollock trawl	95	2009	Dall's porpoise, harbor seal, humpback whale (Central North Pacific), humpback whale (Western North Pacific), fin whale, killer whale (GOA, Aleutian Islands, and Bering Sea Transient), minke whale, ribbon seal, spotted seal, ringed seal, bearded seal, northern fur seal, Steller sea lion (western U.S.)	observer
AK Bering Sea, Aleutian Islands Pacific cod longline	54	2009	Killer whale (Alaska Resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient), ribbon seal, northern fur seal, Steller sea lion (western U.S.)	observer
AK Bering Sea, Aleutian Islands sablefish pot	10	2009	humpback whale (Central North Pacific), humpback whale (Western North Pacific)	observer

Note: Only species with positive records of being taken incidentally in a fishery since 1988 (the first year of the Marine Mammal Protection Act interim exemption program) have been included in this table. A species' absence from this table does not necessarily mean it is not taken in a particular fishery. Rather,

in most fisheries, only logbook or stranding data are available which resulted in many reports of unidentified or misidentified marine mammals. Observer program indicates most recent year of observer data included in these reports.

CITATIONS

Alaska Commercial Fisheries Entry Commission (CFEC). 2011. Fishery Participation and Earnings. Accessed on 4/26/2011. http://www.cfec.state.ak.us/.

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 pp.

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 pp. Available online at: http://alaskafisheries.noaa.gov/protectedresources/observers/bycatch/yakutat07-08.pdf

Manly, B. F. J., A. S. Van Atten, K. J. Kuletz, and C. Nations. 2003. Incidental catch of marine mammals and birds in the Kodiak Island set gillnet fishery in 2002. Final report to NMFS Alaska Region. 91 pp.

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.

Appendix 5. Interaction table for Alaska **Category 3** commercial fisheries (last revised 08/08/2011). Note: Only species with positive records of being taken incidentally in a fishery since 1990 (the first year of the MMPA interim exemption logbook program) have been included in this table. A species' absence from this table does not necessarily mean it is not taken in a particular fishery. Rather, in most fisheries, only logbook or stranding data are available which resulted in many reports of unidentified or misidentified marine mammals. Source: 75 FR 68468; 08 November 2011, Perez (2006), and the Alaska Commercial Fisheries Entry Commission (2011). Notice of continuing effect of list of fisheries.

Fishery name	# of permits issued or fished 2010	Observer program	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
Prince William Sound salmon set gillnet	29	1990	Steller sea lion, harbor seal	logbook
Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	1702	never observed	harbor porpoise	none
AK roe herring and food/bait herring gillnet	990	never observed	none documented	none
AK miscellaneous finfish set gillnet	0	never observed	Steller sea lion	logbook
AK salmon purse seine (except for Southeast AK)	935	never observed	harbor seal, gray whale (eastern North Pacific)	logbook
AK salmon beach seine	31	never observed	none documented	none
AK roe herring and food/bait herring purse seine	367	never observed	none documented	none
AK roe herring and food/bait herring beach seine	6	never observed	none documented	none
Metlakatla purse seine (tribal)	10	never observed	none documented	none
AK octopus/squid purse seine	0	never observed	none documented	none
AK miscellaneous finfish purse seine	2	never observed	none documented	none
AK miscellaneous finfish beach seine	1	never observed	none documented	none
AK salmon troll (includes hand and power troll)	2008	never observed	Steller sea lion	logbook
AK north Pacific halibut/bottom fish troll	120	never observed	none documented	none
AK state waters groundfish longline /set line (incl. sablefish/ rockfish/misc. finfish)	1323	never observed	none documented	none
AK Gulf of Alaska halibut longline	1,302	2009	none documented	observer
AK Gulf of Alaska rockfish longline	0	2009	none documented	observer
AK Gulf of Alaska Pacific cod longline	0	2009	Steller sea lion (Western U.S.)	observer
AK Gulf of Alaska sablefish longline	291	2009	Steller sea lion, sperm whale	observer
AK Bering Sea, Aleutian Islands Greenland turbot longline	29	2009	Killer whale (Eastern North Pacific resident), Killer whale (Eastern North Pacific transient), Killer whale (Alaska resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient),	observer
AK Bering Sea, Aleutian islands rockfish longline	0	2009	none documented	observer
AK Bering Sea, Aleutian Islands sablefish longline	28	2009	none documented	observer
AK halibut longline/set line (state and federal waters)	2280	never observed	Steller sea lion	self reports
AK octopus/squid longline	2	never observed	none documented	none
AK shrimp otter and beam trawl (statewide and Cook Inlet)	33	never observed	none documented	none
AK Gulf of Alaska flatfish trawl	41	2009	northern elephant seal	observer
AK Gulf of Alaska Pacific cod trawl	62	2009	Steller sea lion	observer
AK Gulf of Alaska pollock trawl	62	2009	Steller sea lion (Western U.S.), fin whale, northern elephant seal, Dall's porpoise	observer
AK Gulf of Alaska rockfish trawl	34	2009	none documented	observer
AK Bering Sea, Aleutian Islands Atka mackerel trawl	9	2009	Ribbon seal, Steller sea lion (Western U.S.)	observer
AK Bering Sea, Aleutian Islands Pacific cod trawl	93	2009	Harbor seal, Steller sea lion (Western U.S.)	observer
AK Bering Sea, Aleutian Islands rockfish trawl	10	2009	none documented	observer

Fishery name	# of permits issued or fished 2010	Observer program	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
State waters of Kachemak Bay Cook Inlet, Prince William Sound, Southeast AK groundfish trawl	2	never observed	none documented	none
AK miscellaneous finfish otter or beam trawl	282	never observed	none documented	none
AK food/bait herring trawl (Kodiak area only)	4	never observed	none documented	none
AK Bering Sea, Aleutian Islands Pacific cod pot	68	2009	possible harbor seal	observer
AK Bering Sea, Aleutian Islands crab pot	296	2009	none documented	observer
AK Gulf of Alaska crab pot	389	2009	none documented	observer
AK Gulf of Alaska Pacific cod pot	154	2009	harbor seal	observer
AK Southeast Alaska crab pot	415	never observed	none documented	observer
AK Southeast Alaska shrimp pot	274	never observed	none documented	observer
AK octopus/squid pot	26	never observed	none documented	none
AK snail pot	1	never observed	none documented	none
AK statewide misc finfish pot	243	never observed	none documented	none
AK shrimp pot	210	never observed	none documented	none
AK North Pacific halibut handline and mechanical jig	180	never observed	none documented	none
AK other finfish handline and mechanical jig	456	never observed	none documented	none
AK octopus/squid handline	0	never observed	none documented	none
AK statewide Herring spawn on kelp (pound net)	411	never observed	none documented	none
Southeast AK herring food/bait pound net	4	never observed	none documented	none
Coastwise scallop dredge	12	never observed	none documented	none
AK Dungeness crab (hand pick/dive)	2	never observed	none documented	none
AK herring spawn-on-kelp (hand pick/dive)	266	never observed	none documented	none
AK urchin and other fish/shellfish (hand pick/dive)	521	never observed	none documented	none
AK commercial passenger fishing vessel	2,702 (may contain freshwater vessels, will be updated later)	never observed	none documented	none
~~AK octopus/squid "other"~~	~~0~~	~~never observed~~	~~none documented~~	~~none~~
AK abalone	0	never observed	none documented	none
AK clam	156	never observed	none documented	none

Note: Observer program indicates most recent year of observer data included in these reports.

CITATIONS

Alaska Commercial Fisheries Entry Commission (CFEC). 2011. Fishery Participation & Earnings. Accessed on 4/26/2011. http://www.cfec.state.ak.us/.

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.

Appendix 6. Observer coverage in Alaska commercial fisheries 1990-2009 (last revised 08/08/11). Sources: Manly in review, Manly et al. 2003, Perez 2006, Perez unpubl. ms., Wynne et al. 1991, and Wynne et al. 1992.

Fishery name	Method for calculating observer coverage	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gulf of Alaska (GOA) groundfish trawl		55%	38%	41%	37%	33%	44%	37%	33%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GOA flatfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	39.2%	35.8%	36.8%	40.5%	35.9%	40.6%	76.9%	29.2%	24.2%	31%	28%	22%
GOA Pacific cod trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.6%	16.4%	13.5%	20.3%	23.2%	27.0%	82.5%	21.4%	22.8%	25%	24%	38%
GOA pollock trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	37.5%	31.7%	27.5%	17.6%	26.0%	31.4%	96.1%	24.2%	26.5%	27%	34%	43%
GOA rockfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	51.4%	49.8%	50.2%	51.0%	37.2%	48.4%	74.1%	51.4%	49.1%	88%	87%	91%
GOA longline		21%	15%	13%	13%	8%	18%	16%	15%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GOA Pacific cod longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.8%	5.7%	6.1%	4.9%	11.4%	12.6%	21.4%	3.7%	10.2%	45%	32%	43%
GOA Pacific halibut longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	51.3%	47.1%	51.1%	43.0%	41.4%	9.6%	36.4%	6.5%	2.8%	N/A	N/A	N/A
GOA rockfish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0%	1.4%	0.2%	1.3%	4.9%	2.5%	0%	0%	3.1%	N/A	N/A	83%
GOA sablefish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.9%	14.0%	15.2%	12.4%	13.7%	9.4%	37.7%	10.4%	11.2%	37%	35%	38%
GOA finfish pots		13%	9%	9%	7%	7%	7%	5%	4%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BSAI finfish pots	% of observed biomass	43%	36%	34%	41%	27%	20%	17%	18%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BSAI Pacific cod pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14.6%	16.2%	8.5%	14.7%	12.1%	12.4%	33.1%	14.4%	12.4%	30%	23%	29%
BS sablefish pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	42.1%	44.1%	62.6%	38.7%	40.6%	21.4%	72.5%	44.3%	35.3%	N/A	N/A	N/A
AI sablefish pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100%	50.3%	68.2%	60.6%	69.4%	47.5%	51.2%	64.4%	18.7%	N/A	N/A	N/A
GOA Pacific cod pot	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.7 %	5.7%	7.0%	5.8%	7.0%	4.0%	40.6%	3.8%	2.9%	14%	18%	13%
Bering Sea/Aleutian Islands (BSAI) groundfish trawl		74%	53%	63%	66%	64%	67%	66%	64%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BSAI Atka mackerel trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	65.0%	77.2%	86.3%	82.4%	98.3%	95.4%	96.6%	97.8%	96.7%	94%	100%	99%
BSAI flatfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	59.4%	66.3%	64.5%	57.6%	58.4%	63.9%	68.2%	68.3%	67.8%	72%	100%	100%
BSAI Pacific cod trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	55.3%	50.6%	51.7%	57.8%	47.4%	49.9%	75.1%	52.8%	46.8%	52%	56%	64%
BSAI pollock trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	66.9%	75.2%	76.2%	79.0%	80.0%	82.2%	92.8%	77.3%	73.0%	85%	85%	86%

Fishery name	Method for calculating observer coverage	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BSAI rockfish trawl	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	85.4%	85.6%	85.1%	65.3%	79.9%	82.6%	94.1%	71.0%	80.6%	88%	98%	99%
BSAI longline		80%	54%	35%	30%	27%	28%	29%	33%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BSAI Greenland turbot longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	31.6%	30.8%	52.8%	33.5%	37.3%	40.9%	39.3%	33.7%	36.2%	64%	74%	74%
BSAI Pacific cod longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	34.4%	31.8%	35.2%	29.5%	29.6%	29.8%	25.7%	24.6%	26.3%	63%	63%	61%
BSAI Pacific halibut longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.9%	48.4%	55.3%	67.2%	57.4%	20.3%	44.5%	27.9%	26.4%	N/A	N/A	N/A
BSAI rockfish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	41.5%	21.4%	53.0%	26.9%	36.0%	74.9%	37.9%	36.3%	46.8%	88%	N/A	100%
BSAI sablefish longline	% of observed biomass	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.5%	28.4%	24.4%	18.9%	30.3%	10.4%	50.9%	19.3%	11.2%	48%	49%	56%
Prince William Sound salmon drift gillnet	% of estimated sets observed	4%	5%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Prince William Sound salmon set gillnet	% of estimated sets observed	3%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Alaska Peninsula/Aleutian Islands salmon drift gillnet (South Unimak area only)	% of estimated sets observed	4%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Cook Inlet salmon drift gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	1.8%	3.7%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Cook Inlet salmon set gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	7.3%	8.3%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Kodiak Island salmon set gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	6.0%	not obs.	not obs.	4.9%	not obs.	not obs.	not obs.	not obs.
Yakutat salmon set gillnet	% of fishing days observed	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	6.8	9.0	not obs.

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

CITATIONS

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 pp.

Manly, B. F. J., A. S. Van Atten, K. J. Kuletz, and C. Nations. 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 pp.

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 pp. Available online at: http://alaskafisheries.noaa.gov/protectedresources/observers/bycatch/yakutat07-08.pdf

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.

Perez, M. A. Unpubl. ms. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 67 pp. Available NMML-AFSC.

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual Rept. NMFS/NOAA Contract 50ABNF000036. 65 pp. 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 Rept. NMFS/NOAA Contract 50ABNF000036. 53 pp. NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

Appendix 7. Self-reported fisheries information.

The Marine Mammal Exemption Program (MMEP) was initiated in mid-1989 as a result of the 1988 amendments to the Marine Mammal Protection Act (MMPA). The MMEP required fishers involved in Category I and II fisheries to register with NMFS and to complete annual logbooks detailing each day's fishing activity, including: date fished, hours fished, area fished, marine mammal species involved, injured and killed due to gear interactions, and marine mammal species harassed, injured and killed due to deterrence from gear or catch. If the marine mammal was deterred, the method of deterrence was required, as well as indication of its effectiveness. Fishers were also required to report whether there were any losses of catch or gear due to marine mammals. These logbooks were submitted to NMFS on an annual basis, as a prerequisite to renewing their registration. Fishers participating in Category III fisheries were not required to submit complete logbooks, but only to report mortalities of marine mammals incidental to fishing operations. Logbook data are available for part of 1989 and for the period covering 1990-1993. Logbook data received during the period covering part of 1994 and all of 1995 was not entered into the MMEP logbook database in order for NMFS personnel to focus their efforts on implementing the 1994 amendments to the MMPA. Thus, aside from a few scattered reports from the Alaska Region, self-reported fisheries information is not available for 1994 and 1995.

In 1994, the MMPA was amended again to implement a long-term regime for managing mammal interactions with commercial fisheries (the Marine Mammal Authorization Program, or MMAP). Logbooks are no longer required. Instead, vessel owners/operators in any commercial fishery (Category I, II, or III) are required to submit one-page pre-printed reports for all interactions resulting in an injury or mortality to a marine mammal. The report must include the owner/operator's name and address, vessel name and ID, where and when the interaction occurred, the fishery, species involved, and type of injury (if animal was released alive). These postage-paid report forms are mailed to all Category I and II fishery participants that have registered with NMFS, and must be completed and returned to NMFS within 48 hours of returning to port for trips in which a marine mammal injury or mortality occurred. This reporting requirement was implemented in April 1996. During 1996, only 5 mortality/injury reports were received by fishers participating in all of Alaska's commercial fisheries. This level of reporting was a drastic drop in the number of reports compared to the numbers of interactions reported in the annual logbooks. As a result, the Alaska Scientific Review Group (SRG) considers the MMAP reports unreliable and has recommended that NMFS not utilize the reports to estimate marine mammal mortality (see June 1998 Alaska SRG meeting minutes; DeMaster 1998). As of the stock assessment reports for 2006, these records are no longer used to estimate annual fishery-related mortalities.

Fishery	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**Minimum estimated mortality**
Steller sea lion (Western U.S. stock)																
Alaska Peninsula/Aleutian Islands salmon set gillnet	0	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Bristol Bay salmon drift gillnet	0	4	2	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.5
Prince William Sound set gillnet	0	0	2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Alaska miscellaneous finfish set gillnet	0	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Alaska halibut longline (state and federal waters)	0	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2
Kodiak salmon set gillnet	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	2
Steller sea lion (Eastern U. S. stock)																
Southeast Alaska salmon drift gillnet	0	1	2	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.25
Northern fur seal (Eastern Pacific stock)																
Prince William Sound salmon drift gillnet	1	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Alaska Peninsula/Aleutian Islands salmon drift gillnet	2	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Bristol Bay salmon drift gillnet	5	0	49	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.5
Alaska misc. finfish pair trawl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	1

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Minimum estimated mortality
Harbor seal (Southeast Alaska stock)																
Southeast Alaska salmon drift gillnet	8	1	4	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	3.2
Yakutat salmon set gillnet	0	18	31	61	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	27.5
Harbor seal (Gulf of Alaska stock)																
Cook Inlet salmon set gillnet	6	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.75
Prince William Sound set gillnet	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Kodiak salmon set gillnet	3	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Alaska salmon purse seine (except for Southeast)	0	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Alaska Peninsula/Aleutian Islands salmon drift gillnet	9	2	12	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7
Harbor seal (Bering Sea stock)																
Bristol Bay salmon drift gillnet	38	23	2	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.25
Bristol Bay salmon set gillnet	0	0	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
AK misc. finfish pair trawl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	1
Spotted seal (Alaska stock)																
Bristol Bay salmon drift gillnet	5	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.5
Beluga whale (Bristol Bay stock)																
Bristol Bay salmon drift gillnet	0	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Bristol Bay salmon set gillnet	1	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Pacific white-sided dolphin (North Pacific stock)																
Prince William Sound salmon drift gillnet	1	4	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.25
Southeast Alaska salmon drift gillnet	0	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.25
Bristol Bay salmon drift gillnet	3	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Harbor porpoise (Southeast Alaska stock)																
Southeast Alaska salmon drift gillnet	2	2	7	2	N/A	N/A	2	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	2.7
Harbor porpoise (Gulf of Alaska stock)																
Cook Inlet salmon drift and set gillnet fisheries	3	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	0.8
AK Peninsula/Aleutian Island salmon drift gillnet	2	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75
Kodiak salmon set gillnet	8	4	2	1	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	3.2
Harbor porpoise (Bering Sea stock)																
AK Peninsula/Aleutian Island salmon set gillnet	0	0	2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Bristol Bay salmon drift gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Bristol Bay salmon set gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
AK Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Dall's porpoise (Alaska stock)																
Prince William Sound salmon drift gillnet	0	2	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Southeast Alaska salmon drift gillnet	6	6	4	6	N/A	N/A	N/A	1	N/A	1	N/A	1	N/A	?	N/A	3.6
Cook Inlet set and drift gillnet fisheries	1	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Eastern North Pacific gray whale																
Bristol Bay salmon drift and set gillnet fisheries	2	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
WA/OR/CA crab pot	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	0.5
Humpback whale (Central North Pacific stock)																
Southeast Alaska salmon drift gillnet	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Minimum estimated mortality
Southeast Alaska salmon purse seine	0	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2

CITATIONS

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

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