

APRIL 2010

**Alaska Marine Mammal  
Stock Assessments, 2010**

B. M. Allen and R. P. Angliss, Editors  
National Marine Mammal Laboratory  
Alaska Fisheries Science Center  
7600 Sand Point Way, NE  
Seattle, WA 98115

with contributions from

P. R. Wade, M. Perez, L. W. Fritz, D. J. Rugh, M. E. Dahlheim, J. M. Waite, P. J. Clapham, R. R. Ream,  
K. E. W. Sheldon, B. S. Fadely, R. C. Hobbs, R. G. Towell, B. K. Rone, G. R. Lewis, S. A. Mizroch, A. Zerbini  
and the Publications Unit of the Alaska Fisheries Science Center.



## 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 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), and 2008 (Angliss and Allen, 2009). 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, 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 2008-2009. This review, and a review of other stocks, led to the revision of the following stock assessments for the 2009 document: Steller sea lion (western and eastern U.S. stocks), northern fur seal, harbor seal (southeast Alaska, Gulf of Alaska, Bering Sea stocks), spotted seal, bearded seal, ringed seal, ribbon seal, killer whale (AT1 transient), Pacific white-sided dolphin, harbor porpoise (southeast Alaska, Gulf of Alaska, and Bering Sea stocks), Dall's porpoise, sperm whale, central and western stocks of humpback whales, fin whale, 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: Brendan Kelly (chair through 2004), Lance Barrett-Lennard, John Gauvin, Lloyd Lowry, Beth Mathews (chair from 2007 to present), Craig Matkin, George Noongwook, Grey Pendleton, Jan Straley, Robert Suydam, 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.



## CONTENTS

SPECIES	STOCK	PAGE
<b><u>Pinnipeds</u></b>		
Steller Sea Lion	Western U. S.	1
Steller Sea Lion	Eastern U. S.	14
Northern Fur Seal	Eastern Pacific	23
Harbor Seal	Southeast Alaska	32
Harbor Seal	Gulf of Alaska	38
Harbor Seal	Bering Sea	45
Spotted Seal	Alaska	51
Bearded Seal	Alaska	57
Ringed Seal	Alaska	62
Ribbon Seal	Alaska	67
<b><u>Cetaceans</u></b>		
Beluga Whale	Beaufort Sea	72
Beluga Whale	Eastern Chukchi Sea	76
Beluga Whale	Eastern Bering Sea	81
Beluga Whale	Bristol Bay	85
Beluga Whale	Cook Inlet	90
<b>Narwhal</b>	<b>Unidentified</b>	<b>90</b>
Killer Whale	Eastern North Pacific Alaska Resident	96
Killer Whale	Eastern North Pacific Northern Resident	104
Killer Whale	Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea transient	109
Killer Whale	AT1 transient	115
Killer Whale	West Coast Transient	121
Pacific White-Sided Dolphin	North Pacific	127
Harbor Porpoise	Southeast Alaska	130
Harbor Porpoise	Gulf of Alaska	134
Harbor Porpoise	Bering Sea	139
Dall's Porpoise	Alaska	144
Sperm Whale	North Pacific	148
Baird's Beaked Whale	Alaska	153
Cuvier's Beaked Whale	Alaska	156
Stejneger's Beaked Whale	Alaska	158
Gray Whale	Eastern North Pacific	160
Humpback Whale	Western North Pacific	171
Humpback Whale	Central North Pacific	182
Fin Whale	Northeast Pacific	198
Minke Whale	Alaska	202
North Pacific Right Whale	North Pacific	205
Bowhead Whale	Western Arctic	211
<b><u>Appendices</u></b>		
Appendix 1. Summary of changes for the 2008 stock assessments		220
Appendix 2. Stock summary table		221
Appendix 3. Summary table for Alaska category 2 commercial fisheries		224
Appendix 4. Interaction table for Alaska category 2 commercial fisheries		226
Appendix 5. Interaction table for Alaska category 3 commercial fisheries		228
Appendix 6. Observer coverage in Alaska commercial fisheries, 1990-2005		230
Appendix 7. Self-reported fisheries information		232
Appendix 8. Humpback whale entanglement and other human impact records, 2001-2005		235
Appendix 9. Stock Assessment Reports published by the U.S. Fish and Wildlife Service		240

## 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, respectively. The species is not known to migrate, but individuals disperse widely outside of the breeding season (late May-early July), thus potentially intermixing with animals from other areas. 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) appears low (NMFS 1995).

Loughlin (1997) considered the following information when classifying stock structure based on the phylogeographic approach of Dizon et al. (1992): 1) Distributional data: geographic distribution continuous, yet a high degree of natal site fidelity and low (<10%) exchange rate of breeding animals between rookeries; 2) Population response data: substantial differences in population dynamics (York et al. 1996); 3) Phenotypic data: unknown; 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 east of Cape Suckling, Alaska (144°W), and a western U. S. stock, which includes animals at and west of Cape Suckling (Loughlin 1997, Fig. 1).

Steller sea lions that breed in Asia have been considered part of the western stock. While Steller sea lions seasonally inhabit coastal waters of Japan in the winter, breeding rookeries 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) concluded that there was evidence for an additional Asian stock and that Commander Island (Russia) was genetically within the western U.S. stock. However, Hoffman et al. (2006) did not support an Asian/western stock split based on their analysis of nuclear microsatellite markers, which indicated high rates of male gene flow. The Baker et al. (2005) and Hoffman et al. (2006) results are consistent with a social structure in which there is stronger breeding site fidelity for females compared to males (Hoffman et al. 2006). In addition, Hoffman et al. (2006) concluded that “the three Asian regions are closely related and form a branch separate from all other populations.”

### POPULATION SIZE

The most recent comprehensive estimate (pups and non-pups) of abundance of the western stock of Steller sea lions in Alaska is based on aerial surveys of non-pups in June-July 2008 (Fritz et al. 2008a) and aerial and ground-based pup counts in June and July of 2004 and 2005 through 2009 (Fritz et al. 2008b). Data from these surveys represent actual counts of pups and non-pups at all rookeries and major haulout sites. During the 2008 aerial survey, a total of 31,246 non-pups were counted at 275 rookeries and haulout sites; 6,522 in the Gulf of Alaska and 14,724 in the Bering Sea/Aleutian Islands (Fritz et al. 2008b). A composite pup count for 2004 and 2005-2009 includes counts from 2 sites in 2004, and 53 sites in 2008, and 172 sites in 2005-2009. There were

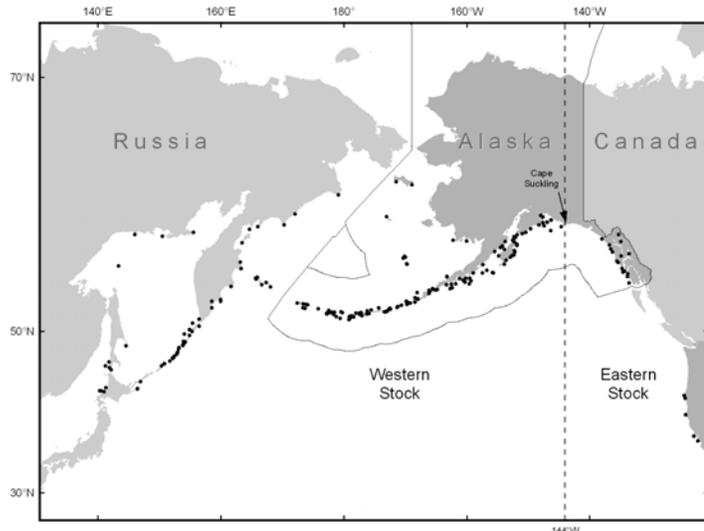


Figure 1. Approximate distribution of Steller sea lions in the North Pacific. Major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993) and active Asian haulouts and rookeries (Burkanov and Loughlin, 2005) are depicted (points). Black dashed line (144° W) indicates stock boundary (Loughlin 1997).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

4,518,546 pups counted in the Gulf of Alaska and 5,433,566 pups counted in the Bering Sea/Aleutian Islands for a total of 9,951,112 for the stock in Alaska. Combining the pup count data from 2004-2005-2009 (9,951,112) and non-pup count data from 2008 (31,246) results in a minimum abundance estimate of 42,366,197 Steller sea lions in the western U.S. stock in 2004-2008.

An estimate of the total population size of western Steller sea lion in Alaska may be obtained by multiplying the best estimate of total pup production (9,951,112) by 4.5 (Calkins and Pitcher 1982), which equals 44,780,503. This would not be a minimum abundance estimate since it is based on extrapolating total population size from pup counts based on survival and fecundity estimates in a life table. The 4.5 multiplier used for estimating the size of the eastern stock of Steller sea lions may not be appropriate for use in estimating the abundance of the western stock, as it is based on a life history table using age-specific fecundity and survival for the stable, mid-1970s population. The demographics of central Gulf of Alaska populations suggest that these rates have changed considerably since the mid-1970s (Holmes and York 2003; Holmes et al. 2007).

Holmes and York (2003) and Holmes et al. (2007) estimated changes in adult and juvenile survival and natality (females only for all vital rates) in the female segment of the population that were consistent with time series of pup and non-pup counts, and changes in the juvenile proportion of the population in the central Gulf of Alaska. They analysts found that the rapid decline of the central Gulf sea lion population in the 1980s was associated with a large drop in juvenile survival and smaller drops in adult survival and natality. As the rate of population decline lessened in the 1990s, rates of juvenile and adult survival increased, followed by a return to pre-decline levels in the 1998-2004 period. Rates of natality, however, continued to decline throughout the 1990s and into the 21<sup>st</sup> century 2000s. Thus, the authors concluded that factors that caused the population decline (those contributing to lower rates of juvenile survival) were likely quite different from those that may are now affecting recovery (those contributing to lower reproductive rates of adult females).

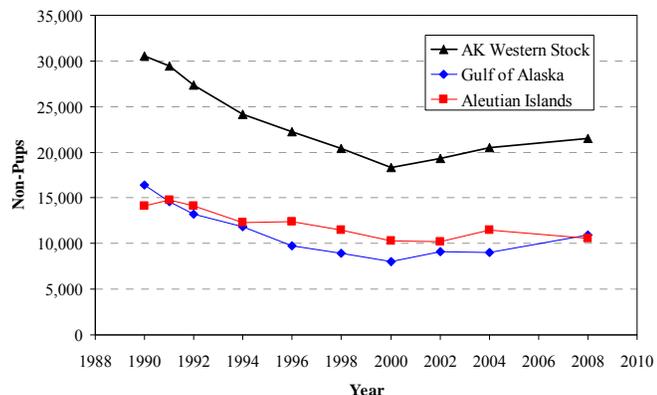
In 2007 and 2008, over 19,000 Steller sea lions were counted in Russia. Methods used to survey Steller sea lions in Russia differ from those used in Alaska, with less use of aerial photography and more use of skiff surveys and ground counts. Burkanov and Loughlin (2005) estimated that the size of the current (2005) population (pups and non-pups) of Steller sea lions breeding population (pups and non-pups) in Russia at about was 16,000 in 2005. This includes approximately 1,000 animals (674 non-pups and 236 pups counted in 2004) on the Commander Islands that are likely members of the same genetic stock as those breeding west of 144°W in Alaska (Baker et al. 2005). Data collected since then indicate that Steller sea lion numbers in the Kuril Islands and the Sea of Okhotsk increased while those in the western Bering Sea, eastern Kamchatka and Commander Islands have remained stable or declined.

### Minimum Population Estimate

The 2008 count of non-pups (31,246) plus the number of pups in 2004-2005-2009 (9,951,112) is 41,197,42,366, which 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 (an index 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 factors 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 indicated about 110,000 sea lions (no correction factors applied, Table 1). The decline appears to have spread eastward to the Kodiak Island area during the late 1970s and early 1980s, and then westward to the central and western Aleutian



**Figure 2.** Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the western U.S. stock in Alaska, 1990-2008. Correction factor applied to 2004 and 2008 counts for film format differences (Fritz and Stinchcomb 2005).

Islands during the early and mid-1980s (Merrick et al. 1987, Byrd 1989). The greatest declines since the 1970s occurred in the eastern Aleutian Islands and western Gulf of Alaska, but declines also occurred in the central Gulf of Alaska and central Aleutian Islands. Counts of Steller sea lions at trend sites for the western U. S. stock decreased 40% from 1991 to 2000 (Table 1), an average annual decline of 5.4% (Loughlin and York 2000).

Recently, counts of non-pup Steller sea lions at trend sites for the western U.S. stock increased 5.5% from 2000 to 2002, and at a similar rate between 2002 and 2004 (Table 1, Fig. 2). These were the first region-wide increases for the western stock since standardized surveys began in the 1970s. Aerial surveys for non-pup Steller sea lions were conducted in 2006 and 2007, but were incomplete due to a court-ordered cessation of research that caused a delay to the start of the survey in 2006, and loss of survey days due to bad weather and aircraft maintenance requirements in both years. Although some trend sites were unsurveyed in both 2006 and 2007, available data indicated that the size of the adult and juvenile portion of the western Steller sea lion population throughout much of its range (Cape St. Elias to Tanaga Island, 145°-178° W) in Alaska remained largely unchanged between 2004 (N=23,107) and 2007 (N=23,118) (Fritz et al. 2008a). Results of the aerial survey conducted in 2008 (Fritz et al. 2008b) confirmed that the recent (2004-2008) overall trend in the western population of adult and juvenile Steller sea lions in Alaska is stable or possibly declining slightly. There continues to be considerable regional variability in recent (2004-2008) trends (percentages listed below are % change between years):

- the population in the eastern Aleutian Islands is the only one that has consistently increased from 2004-2008 (+7%);
- the populations in the central and western Aleutian Islands **declined (-30% and -16%, respectively)**, which together comprised over 30% of the population in 2004 but less than 25% in 2008, declined at relatively high rates (-30% and -16%, respectively);
- the populations in the central and western Gulf of Alaska increased between 2004 and 2007, but declined slightly between 2007 and 2008; and
- **the population non-pup counts** in the eastern Gulf of Alaska increased by 35%, but likely because of **with some of this increase likely related to timing of the 2008 survey (earlier than usual) and seasonal movement of animals into this area from the central Gulf and Southeast Alaska (eastern stock)**.

Counts in the area from the central Gulf of Alaska through the western Aleutian Islands (85% of the 2008 population) declined slightly (-1%) between 2004 and 2008, indicating that the overall increase observed between 2004 and 2008 (3%) was entirely in the eastern Gulf of Alaska. The increase in the eastern Gulf of Alaska may be **partially** explained by movement of animals from the eastern stock, since counts at index sites in Southeast Alaska were approximately 1,200 lower in 2008 than in 2002, despite the overall 3% per year increase in the Steller sea lion population observed in Southeast Alaska through 2005 (NMFS 2008).

In 2009 (DeMaster 2009), NMML conducted a non-pup survey in late June ('late' compared with the 'early' 2008 survey to further investigate seasonal movement of sea lions in the northern Gulf of Alaska and how it could affect trend counts in both the eastern and western stocks. In the 'late' 2009 compared to the 'early' 2008 survey, NMFS counted:

- 2,636 more non-pups on all sites in SE Alaska;
- 812 fewer non-pups on all sites in the eastern Gulf of Alaska; and
- 404 more non-pups on 28 of the 33 trend sites surveyed consistently since 1991 in the central Gulf of Alaska.

These results are consistent with the hypothesis proposed in 2008 (Fritz et al. 2008) that seasonal movement into the eastern Gulf of Alaska may have affected non-pup trend analyses in this area as well as for the western DPS as a whole. DeMaster (2009) estimated the number of sea lions from SE Alaska (eastern stock) and from the central Gulf of Alaska (western stock) that were counted in the eastern Gulf of Alaska (western stock) in 2008 by comparing actual to predicted 2008 sub-area totals based on the 2000-2009 overall trends. These analyses indicated that approximately 570 animals from the eastern stock may have been counted within the range of the western stock in 2008. If 570 non-pups are subtracted from the 2008 total, the overall western stock increase between 2004 and 2008 is reduced from 3% to 1%. The 2009 non-pup survey results in the northern Gulf of Alaska supports the earlier conclusion that the increase observed between 2000 and 2004 in the size of the western stock of Steller sea lion did not continue, and that the population was generally stable between 2004 and 2008.

**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 from the late 1970s through 2008 (NMFS 1995, Sease et al. 2001, Fritz et al. 2008b, 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 <sup>1</sup>	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 <sup>1</sup>	18,325	19,340	20,500	21,489

<sup>1</sup>Identifies 637 non-pups counted at six trend sites in 1999 in the eastern Gulf of Alaska which were not surveyed in 1998.

## 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,  $PBR = 247,254$  animals ( $41,197 \times 0.06 \times 0.1$ ). ~~When Steller sea lions on the Commander Islands are included,  $PBR = 253$  animals ( $42,197 \times 0.06 \times 0.1$ ).~~

The PBR levels for some stocks of marine mammals in the U.S. have been called “undetermined” (e.g., PBR levels for Cook Inlet beluga whales, Hawaiian monk seals); this has not been proposed for the western stock of Steller sea lions. The PBR management approach was developed with the assumption that direct human-related mortalities would be the primary reason for observed declines in abundance for marine mammal stocks in U. S. waters. For at least this stock, this assumption seems unwarranted. Because direct human-related mortalities are at a low level and are unlikely to either be responsible for the decline or to contribute substantially towards extinction risk, calling the PBR level “undetermined” is unnecessarily conservative for this population of over 40,000 animals.

## 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 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 2002-2006, there were incidental serious injuries and mortalities of western Steller sea lions in the following fisheries: 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, Gulf of Alaska Pacific cod trawl, Gulf of Alaska pollock trawl, and Bering Sea/Aleutian Islands Pacific cod longline (Table 2). Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006) and Perez (unpubl. ms.). ~~More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

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 in review). There were no mortalities of Steller sea lions observed in the set or drift gillnet fisheries in either 1999 or 2000 (Manly in review). 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 and Gulf of Alaska groundfish trawl and Gulf of Alaska longline fisheries presented above (11.3) 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 25.8 (CV = 0.60) 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 2002 through 2006 (or most recent data available) and calculation of the mean annual mortality rate. Data from 2007 and 2008 are preliminary; estimates of percent observer coverage and CVs are not currently available for some preliminary data. Mean annual mortality in brackets represents a minimum estimate from stranding data. 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. 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	2002	obs	98.3	0	0	0.25 (CV = 0.44)
	2003	data	95.3	1	1.2	
	2004		95.6	0	0	
	2005		97.8	0	0	
	2006		96.7	0	0	
	2007		-	0	0	0
	2008		-	0	0	
	Bering Sea/Aleutian Is. flatfish trawl	2002	obs	58.4	1	1.6
2003		data	64.1	2	2.7	
2004			64.3	2	3.1	
2005			68.3	0	0	
2006			67.8	4	7.6	
2007			61.2	4	5.0	8.85
2008			79.8	10	12.7	(CV = 0.15)
Bering Sea/Aleutian Is. Pacific cod trawl		2002	obs	47.4	0	0
	2003	data	49.9	2	4.3	
	2004		50.4	0	0	
	2005		52.8	0	0	
	2006		50.4	0	0	
	2007		-	3	3	1.5
	2008		-	0	0	
	Bering Sea/Aleutian Is. pollock trawl	2002	obs	80.0	3	3.4
2003		data	82.2	0	0	
2004			81.2	1	1	
2005			77.3	4	5.2	
2006			73.0	7	9.5	
2007			95.0	2	2.1	5.6
2008			88.6	8	9.1	(CV = 0.12)

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	2002	obs	23.2	0	0	0
	2003	data	27.3	0	0	
	2004		27.0	0	0	
	2005		21.4	0	0	
	2006		22.8	0	0	
	2007		-	0	0	
	2008		-	0	0	
	Gulf of Alaska pollock trawl	2002	obs	26.0	0	
2003		data	31.2	1	2.4	
2004			27.4	0	0	
2005			24.2	1	4.2	
2006			26.5	0	0	
2007			-	0	0	
2008			-	0	0	
Bering Sea/Aleutian Is. Pacific cod longline		2002	obs	29.6	1	3.7
	2003	data	29.9	0	0	
	2004		23.8	0	0	
	2005		24.6	0	0	
	2006		23.9	1	6.2	
	2007		-	0	0	
	2008		-	0	0	
	Prince William Sound salmon drift gillnet	1990-1991	obs data	4-5%	0 2	0 29
1990		obs data	3%	0	0	
Alaska Peninsula/Aleutian Islands salmon drift gillnet	1990	obs data	4%	0	0	0
Cook Inlet salmon set gillnet <sup>1</sup>	1999-2000	obs data	2-5%	0 0	0, 0	0
Cook Inlet salmon drift gillnet <sup>1</sup>	1999-2000	obs data	2-5%	0 0	0, 0	0
Kodiak Island salmon set gillnet	2002	obs data	6.0%	0	0	0
Observer program total						25.8 (CV = 0.60)
				<b>Reported mortalities</b>		
Alaska sport salmon troll (non-commercial)	1993-2005	strand	N/A	0, 0, 0, 0, 0, 1, N/A, N/A, N/A, 1, N/A, N/A, N/A	N/A	[0.2]
Miscellaneous fishing gear	2001-2005	strand	N/A	N/A, N/A, 1, N/A, N/A	N/A	[0.2]
Minimum total annual mortality						26.2 (CV = 0.60)

<sup>1</sup>Data from the 1999 Cook Inlet observer program are preliminary.

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 2001 to 2005, there was only one confirmed fishery-related Steller sea lion stranding in the range of the western stock. This sighting involved an animal at Round Island with netting or rope around its neck; no more specific information is available on the type of fishing gear involved. In addition to this incident, a Steller sea lion was entangled in a large

flasher/spoon in 1998. It is likely that this injury occurred as a result of a sport fishery, not a commercial fishery (Table 2). There are sport fisheries for both salmon and shark in this area; there is no way to distinguish between them since both fisheries use a similar type of gear (J. Gauvin, Groundfish Forum, Inc., pers. comm.). Fishery-related strandings during 2001-2005 result in an estimated annual mortality of 0.4 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.

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 26.2 sea lions per year, based on observer data (25.8) and stranding data (0.4) where observer data were not available. **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 a minimum estimate.

### 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 conducts 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. 2004). The interviews are conducted once per year in the winter (January to March), and cover hunter activities for the previous calendar year. 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. 2004). Information on subsistence harvest levels is provided in Table 3a; data from ECO (e.g., Zavadil et al. 2004) 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. 2004).

The mean annual subsistence take from this stock over the 5-year period from 2003<sup>4</sup> through 2007<sup>8</sup> was 206<sup>197</sup> Steller sea lions/year (Table 3a).

**Table 3a.** Summary of the subsistence harvest data for the western U. S. stock of Steller sea lions, 2003<sup>4</sup>-2007<sup>8</sup>.

Year	All areas except St. Paul Island			St. Paul Island	
	Number harvested	Number struck and lost	Total	Number harvested + struck and lost	Total take
2003	149.7	36.9	186.6 <sup>4</sup>	18 <sup>6</sup>	205
2004	136.8	49.1	185.9 <sup>2</sup>	18 <sup>7</sup>	204
2005	153.2	27.6	180.8 <sup>3</sup>	22 <sup>8</sup>	203
2006	114.3	33.1	147.4 <sup>4</sup>	26 <sup>9</sup>	173
2007	165.7	45.2	210.9 <sup>5</sup>	34 <sup>10</sup>	245
2008	114.7	21.6	136.3 <sup>5</sup>	22	158
Mean annual take (2003 <sup>4</sup> -2007 <sup>8</sup> )	143 <sup>136.9</sup>	38 <sup>5.43</sup>	18 <sup>72.3</sup>	24	206 <sup>197</sup>

<sup>1</sup>Wolfe et al. 2004; <sup>2</sup>Wolfe et al. 2005; <sup>3</sup>Wolfe et al. 2006; <sup>4</sup>Wolfe et al. 2008; <sup>5</sup>J. Fall, pers. comm., ADFG, 13 Jan 2009; <sup>6</sup>Wolfe et al. 2009a;

<sup>7</sup>Wolfe et al. 2009b; <sup>8</sup>Zavadil et al. 2004; <sup>9</sup>Zavadil et al. 2005; <sup>10</sup>Lestenkof and Zavadil 2006; <sup>11</sup>Lestenkof et al. 2007; <sup>12</sup>Lestenkof et al. 2008.

### Other Mortality

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 2003-2007, there was a total of 3 mortalities resulting from research on the western stock of Steller sea lions, which results in an average of 0.6 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).

### STATUS OF STOCK

The current annual level of incidental U. S. commercial fishery-related mortality (26.2) exceeds 10% of the PBR (24) 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 ( $26.2 + 206197 + 0.6 = 2232.8$ ) is below the PBR level (247254) 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, given that the population has declined for unknown reasons that are not explained by the level of direct human-caused mortality, there is no **guarantee** **reason to believe** that limiting those mortalities to the level of the PBR will reverse the decline, if in fact the population is still declining.

The slight increase in the population estimate and PBR level should be interpreted and applied with caution. The **increase in number of nonpups in the** summer 2008 aerial survey of nonpups may be attributable to an increase in numbers of eastern Steller sea lions hauled out in the eastern Gulf of Alaska at the time the aerial survey was conducted. A concurrent decrease in numbers in the eastern Steller sea lion stock counts occurred and NMFS is currently investigating the possibility that the increase in counts in the eastern Gulf of Alaska was due to seasonal movements of eastern Steller sea lion stock animals rather than recruitment into the stock.

### Habitat Concerns

The ~~unprecedented~~ 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 suggest that the decline has slowed or stopped in some portions of the range of the western U. S. stock, but continues in others. Many factors have been suggested as causes of the steep decline observed in the 1980s, (e.g., competitive effects of fishing, environmental change, disease, killer whale predation, incidental take, illegal and legal shooting). 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 **high important** threats to recovery (NMFS 2008). Additional potential threats to Steller sea lion recovery ~~can be found~~ **are shown** in Table 3b.

**Table 3b.** Potential threats and impacts to Steller sea lion recovery and associated references. Threats and impact to recovery as described by the Draft 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

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 **at 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 will be reviewed in a programmatic, status quo ESA Biological Opinion on the effects of groundfish fisheries on listed species scheduled for release and review in ~~summer 2009~~ **early 2010**.

NMFS reconstituted the Steller Sea Lion Recovery Team in 2002 to write a revised recovery plan for the eastern and western U.S. stocks. The Team’s draft plan was reviewed by five independent reviewers in February 2006, prior to its delivery to NMFS, who then released the Plan for public review in May 2006. NMFS addressed the peer and public review comments and released the second draft Plan for another round of public and independent peer (one by the Council of Independent Experts and another commissioned by the Council) review in May 2007. NMFS released the final recovery plan in March 2008 (NMFS 2008). The de-listing criteria approved by NMFS for the western stock of Steller sea lion are:

1. The population for the U.S. region of this [stock] has increased (statistically significant) for 30 years (at an average annual growth rate of 3%), based on counts of non-pups (i.e., juveniles and adults). Based on an

estimated population size of about 42,500 animals in 2000, this would represent approximately 103,000 animals in 2030.

2. The trends in non-pups in at least 5 of the 7 sub-regions are stable or increasing, consistent with the trend observed under criterion #1. The population trend in any two adjacent sub-regions can not be declining significantly. The population trend in any subregion cannot have declined by more than 50%. The 7 sub-regions are:
  - a. Eastern Gulf of Alaska (US)
  - b. Central Gulf of Alaska (US)
  - c. Western Gulf of Alaska (US)
  - d. Eastern Aleutian Islands (including the eastern Bering Sea) (US)
  - e. Central Aleutian Islands (US)
  - f. Western Aleutian Islands (US)
  - g. Russia/Asia
3. The ESA listing factor criteria are met.

### 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.
- Atkinson, S., D. P. DeMaster, and D. G. Calkins. 2008. Anthropogenic causes of the western Steller sea lion *Eumetopias jubatus* population decline and their threat to recovery. *Mammal Review* 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.
- 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.
- 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 Technical 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., 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.

- 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., 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. Mamm. 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 pp.
- Fritz, L., M. Lynn, E. Kunisch, and K. Sweeney. 2008a. Aerial, ship, and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in the western stock in Alaska, June and July 2005-2007. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-183, 70 p.
- Fritz, L. W., K. Sweeney, C. Gudmundson, T. Gelatt, M. Lynn and W. Perryman. 2008b. 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>.
- 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 pp.
- 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., C. W. Matson, W. Amos, T. R. Loughlin, and J. W. Bickham. 2006. Deep genetic subdivision within a continuously distributed and highly vagile marine mammal, the Steller’s sea lion (*Eumetopias jubatus*). *Mol. Ecol.* 15:2821-2832.
- Holmes, E. E., L. W. Fritz, A. E. York, K. Sweeney. 2007. Age-structured modeling provides evidence for a 28-year decline in the birth rate of western Steller sea lions. *Ecological Applications* 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. *Cons. Biol.* 17:1794-1806.
- 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 pp.
- 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., and P. A. Zavadil. 2006. 2005 subsistence harvest of Steller sea lion on St. Paul Island. Memorandum for the Record, August 31, 2006, 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. 2007. 2006 subsistence harvest of Steller sea lion on St. Paul Island. Memorandum for the Record, April 11, 2007, 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. In review. 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 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.
- 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 pp.
- National Marine Fisheries Service. 2001. Endangered Species Act, Section 7 Consultation Biological Opinion and Incidental Take Statement on the authorization of the Bering Sea/Aleutian Islands and Gulf of Alaska Groundfish Fishery Management Plan Amendments 61 and 70. NMFS Alaska Region, Protected Resources Division, Juneau, AK.
- National Marine Fisheries Service. 2008. Recovery Plan for the Steller sea lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pp.
- 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.
- 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.
- Pitcher, K. W., D. G. Calkins, and G. W. Pendleton. 1998. Reproductive performance of female Steller sea lions: an energetics-based reproductive strategy? Canadian Journal of Zoology 76:2075-2083.
- 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 pp.
- 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. Mamm. 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. Mamm. 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 pp.
- 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.
- 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. 2004. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2003. Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 291. 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.
- 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., 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., A. D. Lestenkof, D. Jones, P. G. Tetof, and M. T. Williams. 2004. The subsistence harvest of Steller sea lions on St. Paul Island in 2003. Unpublished report. Available from Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office. St. Paul Island, Pribilof Islands, Alaska.
- Zavadil, P.A., D. Jones, A. D. Lestenkof, P. G. Tetoff, and B. W. Robson. 2005. The subsistence harvest of Steller sea lions on St. Paul Island in 2004. Unpublished report. Available from Aleut Community of St. Paul Island, 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, respectively. The species is not known to migrate, but individuals disperse widely outside of the breeding season (late May-early July), thus potentially intermixing with animals from other areas. 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) appears 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).

Loughlin (1997) 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; 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 east of Cape Suckling, Alaska (144° W), and a western U. S. stock, which includes animals 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 that includes Commander Island (Russia) within the western U.S. 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. While all genetic analyses confirm a strong separation between western and eastern stocks, recent work indicates that western stock haplotypes are present in southeast Alaska rookeries (Gelatt et al. 2007).

### 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 could be estimated by multiplying pup counts by a factor based on the birth rate, sex and age structure, and growth rate of the Steller sea lion population. Using the

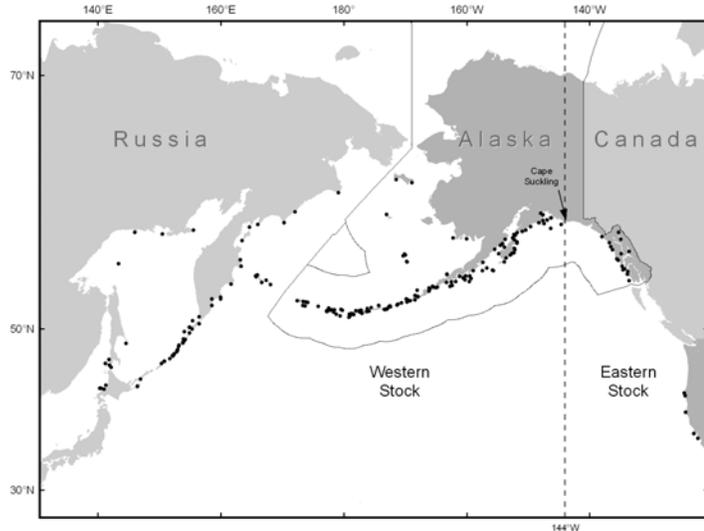


Figure 3. Approximate distribution of Steller sea lions in the North Pacific. Major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993) and active Asian haulouts and rookeries (Burkanov and Loughlin, 2005) are depicted (points). Black dashed line (144° W) indicates stock boundary (Loughlin 1997).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

most recent 20026-20059 pup counts available by region from aerial surveys across the range of the eastern stock (total N=10,73713,889), the total population of the eastern stock of Steller sea lions is estimated to be within the range of 45,09558,334 to 55,83272,223. This range is based on multiplying the total number of pups counted in southeast Alaska (5,510 in 2005; NMFS 20087,462 in 2009; DeMaster 2009), British Columbia (3,2814,118 in 20026; Olesiuk and Trites 20038), Oregon (1,128418 in 20029; NMFS, 2008unpublished data), and California (8918 in 20049; NMFS 2008unpublished data) by either 4.2 or 5.2 (Pitcher et al. 2007). Using these pup multipliers, the population estimate is estimated to be within the range of 45,09558,334 (10,73713,889 × 4.2) and 55,83272,223 (10,73713,889 × 5.2). These are not minimum population estimates, since they are extrapolated from pup counts from photographs taken in 20026-20059, and demographic parameters estimated for an increasing (at 3.1% per year) eastern Steller sea lion population in equilibrium. The extrapolation factor varied depending on the vital rate parameter that resulted in the increased growth rate: as low as 4.2 if it were due to increased fecundity, and as high as 5.2 if it were due to decreased juvenile mortality. Pitcher et al. (2007) estimated the eastern stock of Steller sea lion to number between 46,000 and 58,000 in 2002 using this same method, but estimated a slightly higher population range because they estimated true fecundity by accounting for pup mortality between birth and when counts were made at approximately one month of age.

### Minimum Population Estimate

The minimum population estimate was calculated by adding the most recent non-pup and pup counts from each trend site listed in all sites surveyed (Table 3c).

**Table 3c.** Non-pup and pup counts from rookery and haulout trend sites of eastern U.S. Steller sea lions. The most recent counts for each site were used to calculate the minimum population estimate.

Trend site	Year	Non-pups	Pups	Total count per site
Southeast Alaska	20059	15,28316,985	5,5107,462	20,79324,447
British Columbia	20026	12,12115,700	3,2814,118	15,40219,818
Washington (Pitcher et al., 2007)	2001	516	--	516
Oregon Non-Pups	2002	4,169	1,128--	5,2974,169
Oregon Pups	2009		1,418	1,418
California	20049	1,5788	8918	2,3962,479
Minimum population estimate				44,40452,847

This results in an  $N_{MIN}$  for the eastern U. S. stock of Steller sea lions of 44,40452,847 based on counts as old as 2001 for sea lions hauled out in WA to as recent as 2009 for sites in SE Alaska and California, and all rookeries in Oregon. This count is considered a minimum estimate of population size because it has not been corrected for animals which that were at sea. Pitcher et al. (2007) counted 45,378 sea lions during the 2002 survey, which represented a minimum population size because not every site was surveyed and animals missing from rookeries and haulout sites were not counted. More recent counts from Southeast Alaska and California sites were used in place of the Pitcher et al. (2007) counts to calculate  $N_{MIN}$ .

### Current Population Trend

Trend counts (an index to examine population trends) for Steller sea lions in Oregon were relatively stable in the 1980s, with uncorrected counts in the range of 2,000-3,000 sea lions (NMFS 1992). Counts in Oregon have shown a gradual increase since 1976, as the adult and juvenile state-wide count for that year was 1,486 compared to 4,169 in 2002 (NMFS 2008).

Steller sea lion numbers in California, especially in southern and central California, have declined from historic numbers. Counts in California between 1927 and 1947 ranged between 4,000 and 6,000 non-pups with no apparent trend, but have subsequently declined by over 50%, remaining and were between 1,500 and 2,000 non-pups between during 1980-2004. At Año Nuevo Island off central California, a steady decline in ground counts started around 1970, resulting in and there was an 85% reduction in the breeding population by 1987 (LeBoeuf et al. 1991). Overall, counts of non-pups at trend sites in California and Oregon have been relatively stable or increasing slowly since the 1980s (Table 4, Fig. 4).

**Table 4.** Counts of adult and juvenile Steller sea lions observed at rookery and haulout trend sites by year and geographical area for the eastern U. S. stock from 1982 through 2002<sup>9</sup> (NMFS 1995; Strick et al. 1997; Sease et al. 1999; Sease and Loughlin 1999; Sease et al. 2001; Olesiuk 2003; 2008; Brown et al. 2002; NMFS 2008; ODF&W unpubl. data, 7118 NE Vandenberg Ave., Corvallis, OR 97330; Point Reyes Bird Observatory, unpubl. data, 4990 Shoreline Hwy., Stinson Beach, CA 94970; NMFS unpublished data (M. Lowry, SWFSC); DeMaster 2009). Central California data include only Año Nuevo and Farallon Islands. Trend site counts in northern California/Oregon include St. George, Rogue, and Orford Reefs. British Columbia data include counts from all sites.

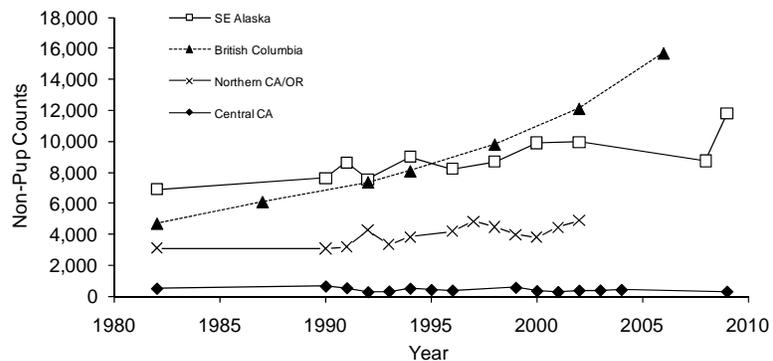
Area	1982	1990	1991	1992	1994	1996	1998	2000	2002	2006	2009
Central CA	511 <sup>1</sup>	655	537	276	508	382	564 <sup>3</sup>	349	380		308
Northern CA/OR	3,094	3,088	3,180	4,274	3,831	4,192	4,464	3,793	4,885		
British Columbia	4,713	6,109 <sup>2</sup>	--	7,376	8,091	--	9,818	--	12,121	15,700	
Southeast Alaska	6,898	7,629	8,621	7,555	9,001	8,231	8,693	9,892	9,951		11,965
Total	15,216	17,481	--	19,48	21,43	--	23,53	--	27,337		

<sup>1</sup> This count includes a 1983 count from Año Nuevo.

<sup>2</sup> This count was conducted in 1987.

<sup>3</sup> This count was conducted in 1999.

In Southeast Alaska, counts of non-pups at trend sites increased by 56% from 1979 to 2002 from 6,376 to 9,951 (Merrick et al. 1992; Sease et al. 2001; NMFS 2008). NMFS conducted an aerial survey of Southeast Alaska in early June 2008 and counted only 8,748 non-pups on trend sites (Fritz et al. 2008). It is thought that the lower than expected count in Southeast Alaska may have been due to movement of animals early in the survey period (early June to early July) north to the Prince William Sound region, since counts of non-pups there were over 1,300 more than in 2007 (since counts of non-pups there were over 1,300 greater in 2008 than 2007) or south to British Columbia. This hypothesis was supported by counts from a late June 2009 non-pup survey in SE Alaska, in which 11,965 nonpups were observed on trend sites, over 3,200 more than were counted in early June 2008. During Between 1979 and 2005<sup>9</sup>, counts of pups on the three largest rookeries in Southeast Alaska increased a total of 148% (Forrester Island complex, Hazy Island and White Sisters) more than tripled (from 2,219 to 6,859). In British Columbia, counts of non-pups throughout the Province increased at a rate of 3.29% annually from 1971 through 2002<sup>6</sup> (Olesiuk and Trites 2003). Counts of non-pups at trend sites throughout the range of the eastern Steller sea lion stock are shown in Figure 4. Since the Between the 1970s and 2002, the average annual population growth rate of Eastern Steller sea lions was 3.1% (Pitcher et al. 2007).



**Figure 4.** Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the eastern U.S. stock, 1982-2004<sup>9</sup>. Data from British Columbia include all sites.

#### 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 of Steller sea lions, but concluded this rate did not represent a maximum rate of increase. Thus in the absence of published data to the contrary, NMFS will continue to use the default value for pinnipeds. 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 default recovery factor ( $F_R$ ) for stocks listed as “threatened” under the Endangered Species Act (ESA) is 0.5 (Wade and Angliss 1997). However, as total population estimates for the eastern U. S. stock have remained stable or increased over the last 20 years, 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). This approach is consistent with recommendations of the Alaska Scientific Review Group. Thus, for the eastern U. S. stock of Steller sea lions,  $PBR = 1,9982,378$  animals ( $44,40452,847 \times 0.06 \times 0.75$ ).

## 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 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.

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 5. There have been no observed serious injuries or mortalities incidental to the CA/OR thresher shark and swordfish drift gillnet fishery 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 2001-03; these observed takes in combination with a mortality that occurred in an unmonitored haul resulted in a mean estimated annual mortality level of 0.8 (Table 5). No data are available after 1998 for the northern Washington marine set gillnet fishery. There have been no observer reported mortalities in the Gulf of Alaska sablefish longline since 2000 (Perez unpubl. ms.). These mortalities result in a mean annual mortality rate of 0.8 (CV = 0.02) Steller sea lions. 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 5.** Summary of incidental mortality of Steller sea lions (eastern U. S. stock) due to commercial fisheries from 2001 to 2005 (or most recent data available) and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from stranding data. 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. 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 trawl (Pacific whiting component)	2000	Obs data	80.3	0	1 <sup>1</sup>	0.8 (CV = 0.02)
	2001		96.2	1	1	
	2002		66.8	1	1	
	2003		85.5	1	1	
	2004		91.5	0	0	
Observer program total						0.8 (CV = 0.02)
				<b>Reported mortalities</b>		

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Alaska salmon troll	1992-2005	Strand data	N/A	0, 0, 0, 1, 0, 0, N/A, N/A, 1, 1, N/A, N/A, 2, N/A	N/A	{0.6}
British Columbia aquaculture predator control program	2001-2005	Permit reports	N/A	27 15 N/A <sup>2</sup> N/A <sup>2</sup> N/A <sup>2</sup>	N/A	0
Minimum total annual mortality						1.4 (CV = 0.58)

<sup>1</sup> A mortality was seen by an observer, but during an unmonitored haul; because the haul was not monitored, an estimated annual mortality cannot be extrapolated.

<sup>2</sup> Aquaculture facilities are no longer permitted to shoot Steller sea lions.

Strandings of Steller sea lions provide additional information on the level of 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. In Alaska, during the 5-year period from 2004-2005<sup>8</sup>, there were three situations where a flasher was seen in a mortality of Steller sea lion's mouth due to ingestion of J-hooks attached to a "flasher" (an attractor used in salmon trolling) in which the hook was lodged in the esophagus and penetrating adjacent tissue (NMFS Alaska Region, unpublished data). A total of 121 observations of Steller sea lions with flashers hanging from their mouth were reported in Southeast Alaska and northern British Columbia between 2003 and 2007 (Raum-Suryan et al. 2009; Lauri Jemison, Steller Sea Lion Program, Alaska Department of Fish and Game, 1255 West 8<sup>th</sup> Street, P.O. Box 115526, Juneau, AK 99811) indicating an average rate of hook ingestion of 24.2 per year. It is not clear whether entanglements with hooks and flashers involved the recreational or commercial component of the salmon troll fishery. Based on Angliss and DeMaster (1998), it is appropriate to call these entanglements "serious injuries". Based on Mortality records from the Alaska stranding records, this information database indicates a rate of incidental mortality of at least 0.6/year from the troll fishery. There were no fishery-related strandings of Steller sea lions in Washington, Oregon, or California between 2004<sup>4</sup> and 2005<sup>8</sup>.

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 1.425.6 sea lions per year, based on fisheries observer data (0.8), opportunistic observations (24.2), and stranding data (0.6).

### Subsistence/Native Harvest Information

The subsistence harvest of Steller sea lions during 2003<sup>4</sup>-2007<sup>8</sup> is summarized in Wolfe et al. (2008<sup>9b</sup>). 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. The average number of animals harvested and struck but lost is 14.2 animals/year (Table 6).

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. 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 the cooperative management process.

**Table 6.** Summary of the subsistence harvest data for the eastern stock of Steller sea lions, 2003<sup>4</sup>-2007<sup>8</sup>.

Year	Estimated total number taken	Number harvested	Number struck and lost
2003	7 <sup>1</sup>	2	5
2004	12 <sup>21</sup>	5	7
2005	19 <sup>32</sup>	0	19

Year	Estimated total number taken	Number harvested	Number struck and lost
2006	12.6 <sup>4,3</sup>	2.5	10.1
2007	6.1 <sup>3,4</sup>	0	6.1
2008	9.7 <sup>5</sup>	1.7	8.0
Mean annual take (2003-2007)	11.39	1.98	9.410.0

<sup>1</sup> Wolfe et al. 2004; <sup>2</sup> Wolfe et al. 2005; <sup>3</sup> Wolfe et al. 2006; <sup>4</sup> Wolfe et al. 2008; <sup>5</sup> J. Fall pers. comm., ADFG, 13 Jan 2009; Wolfe et al. 2009a; Wolfe 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. 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 hunting 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 investigated in Southeast Alaska between 1995 and 1999: the cases involved the illegal shooting of one Steller sea lion near Sitka, and three Steller sea lions in Petersburg. Both cases were successfully prosecuted (NMFS, Alaska Enforcement Division). There are no records of illegal shooting of Steller sea lions from the eastern stock listed in the NMFS enforcement records for 1999-2003 (NMFS, unpublished data).

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 45.875 Steller sea lions from this stock over the period from 1999 to 2003 (Olesiuk 2004). As of Starting in 2004, aquaculture facilities were no longer permitted to shoot Steller sea lions (P. Olesiuk, Pacific Biological Station, Canada, pers. comm.).

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 2004 to 2005, strandings of animals from this stock with gunshot wounds from this stock occurred in Oregon and Washington (one in 2004 and three in 2005) resulting in an estimated annual mortality of 0.8 Steller sea lions from this stock. This estimate is considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel). In addition, human-related stranding data are not available for British Columbia. Reports of stranded animals in Alaska with gunshot wounds have not been included in the above estimates because it is not possible to tell whether the animal was illegally shot or if the animal was struck and lost by subsistence hunters (in which case the mortality would have been legal and accounted for in the subsistence harvest estimate).

Stranding data may also provide information on additional sources of potential human-related mortality. Between 2001 and 2005 there were three reported non-fishery related serious injuries or mortalities to Steller sea lions in Washington and Oregon: one with a head injury (2001), one with a piece of cargo net around its neck (2003), and one mortality due to blunt trauma (2004). If the number of interactions (3) is averaged over 5 years, the “other” interaction rate would be a minimum of 0.6 animals per year.

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 and 2007, there were a total of 9 incidental mortalities resulting from research on the eastern stock of Steller sea lions, which results in an annual average of 1.8 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).

### STATUS OF STOCK

Based on currently available data, the minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock ( $0.8 + 0.6 = 1.425.6$ ) is less than that 10% of the calculated PBR (200) 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 ( $1.425.6 + 1.2 + 0.8 + 0.6 + 1.8 = 15.640.8$ ) does not exceed the PBR (1998) for this stock. The eastern U.S. stock of Steller sea lion is currently listed as “threatened” under the ESA, and therefore designated as “depleted” under the MMPA. As a result, this stock is classified as a strategic stock. The eastern stock of Steller sea lion has been proposed as considered a potential candidate for removal from listing under the ESA by the Steller sea lion recovery team and NMFS (NMFS 2008), based on its annual rate of increase of approximately 3% since the mid-1970s. Although the stock size has increased, the status

of this stock relative to its Optimum Sustainable Population size is unknown. The overall annual rate of increase of 3.1% throughout most of the range (Oregon to southeastern Alaska) of the eastern U. S. stock has been consistent and long-term, and may indicate that this stock is reaching OSP size (Pitcher et al. 2007).

### Habitat Concerns

Unlike the observed decline in the western U. S. stock of Steller sea lion, there has not been an overall concomitant decline in the eastern U. S. stock. 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 possible 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).

### CITATIONS

- 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. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-13, 48 pp.
- 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 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.
- 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 AK 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>
- Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. *Conserv. Biol.* 6:24-36.
- Fritz, L. W., 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>.
- 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. 4<sup>th</sup> Glacier Bay Science Symposium. Juneau, AK. October 2004.

- 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.
- 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.
- Merrick, R.L., D.G. Calkins, and D.C. McAllister. 1992. Aerial and ship-based surveys of Steller sea lions in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands during June and July 1991. U.S. Dep. Commer, NOAA Tech. Memo. NMFS-AFSC-1. 37 pp.
- National Marine Fisheries Service. 1992. Recovery Plan for the Steller Sea Lion (*Eumetopias jubatus*). Prepared by the Steller Sea Lion Recovery Team for the National Marine Fisheries Service, Silver Spring, MD. 92 pp.
- 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 pp.
- National Marine Fisheries Service. 2008. Recovery Plan for the Steller sea lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pp.
- Olesiuk, P. F. 2003. Recent trends in the abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia. NMMRC Working Paper No. 2003-11; and DFO. 2003. Steller Sea Lion (*Eumetopias jubatus*). DFO Can. Sci. Advis. Sec. Stock Status Rep. 2003/037.
- 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.
- 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. *Marine Pollution Bulletin* 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 pp.
- 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 pp.
- 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 pp.
- 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. Mamm.* 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. 2004. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2003. Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 291. 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.

## 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).

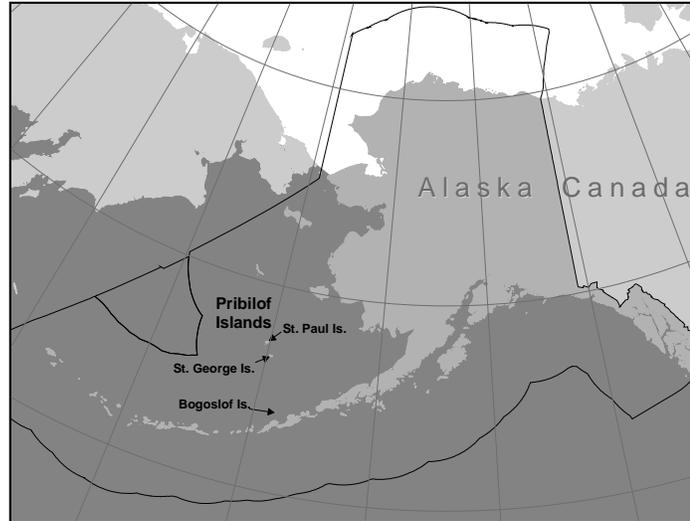
During the reproductive season, adult males usually are on shore during the four month period from May-August, though some may be present until November (well after giving up their territories). Adult females are ashore for as long as during a six months period (June-November). Following their respective 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, 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 feeding 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 (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 counted 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 estimate multiplied by 4.5. 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 estimates are conducted biennially on these islands. Counts are made less frequently on Sea Lion Rock (adjacent to St. Paul Island) and Bogoslof Island (Table 7). The most recent estimate for the number of fur seals in the Eastern Pacific stock, based on pup counts from 2002 on Sea Lion Rock, from 2006 on St. Paul and St. George Islands, and from 2007 on Bogoslof Island, is 687,902 (653,171 (4.5 × 152,867) 145,149).



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

**Table 7.** Estimates and/or counts of northern fur seal pups born on the Pribilof Islands and Bogoslof Island. Standard errors for pup estimates/ counts at rookery locations and the CV for total pup production estimates are provided in parentheses. 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.

Year	Rookery location				Total
	St. Paul	Sea Lion Rock	St. George	Bogoslof	
1992 <sup>1</sup>	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)	“	17,070 <sup>2</sup> (144)	“	147,900 (0.011)
2007	“	“	“	17,574 (843)	152,867 (0.011)
<b>2008</b>	<b>102,674</b> <b>(1,084)</b>	<b>6,741</b> <b>(80)</b>	<b>18,160</b> <b>(288)</b>	<b>“</b>	<b>145,149</b> <b>(0.009)</b>

<sup>1</sup>Incorporates the 1990 estimate for Sea Lion Rock and the 1993 count for Bogoslof Island.

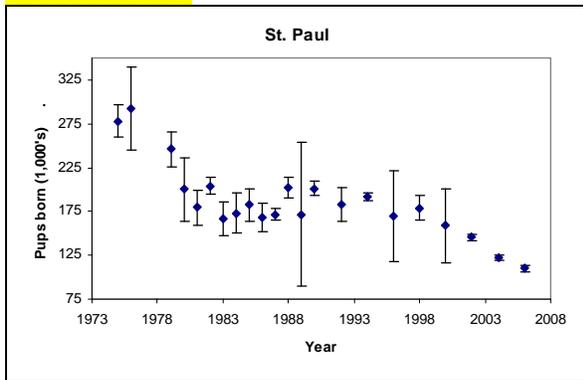
### Minimum Population Estimate

A CV(N) that incorporates the variance due to the correction factor is not currently 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):  $N_{MIN} = N / \exp(0.842 \times [\ln(1 + [CV(N)]^2)]^{1/2})$ . Using the population estimate (N) of 687,902<sup>653,171</sup> and the default CV (0.2),  $N_{MIN}$  for the Eastern Pacific stock of northern fur seals is 676,416<sup>642,265</sup>.

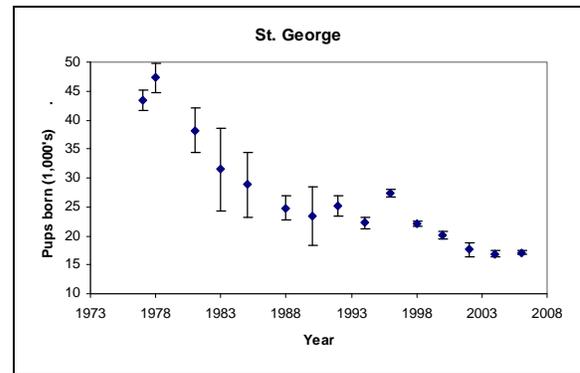
### Current Population Trend

Estimates of the size of the Alaska population of northern fur seals increased to approximately 1.25 million in 1974 after the killing of females in the pelagic fur seal harvest was terminated in 1968<sup>termination of commercial sealing on St. George in 1972 and pelagic sealing for science in 1974; commercial sealing on St. Paul continued until 1984</sup>. 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. Although there was a slight increase in the number of pups born on St. George Island in 1996, the number of pups born declined between 1996 and 1998, and the 1998 counts were similar to those obtained in 1990, 1992, and 1994 (Fig. 7). During 1998-2006, pup production declined 6.1% per year (SE = 0.45%; P < 0.01) on St. Paul Island and 3.4% per year (SE = 0.60%; P = 0.01) on St. George Island. The estimated pup production in 2006 was below the 1918 level on St. Paul Island and below the 1916 level on St. George Island (Towell et al. 2006; NMFS unpubl. data). The population of northern fur seals at Bogoslof Island has grown at an exponential rate exponential rate since the 1990s. (R. Ream, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, 5 February 2009). The increase in counts from 2005 to 2007 at Bogoslof Island result in a slight increase in overall pup counts from 2006 to 2007;

however, this slight increase in total counts ~~was~~ similar to the slight increase in total counts from 2004 to 2005 when new counts from Bogoslof were added to counts from the previous years in other areas to obtain the overall estimate. ~~This slight increase in overall counts from 2006 to 2007 is not considered sufficient to determine an overall decline has ceased.~~ Incorporation of the 2008 counts 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 pups at St. Paul Island.



**Figure 6.** Estimated number of northern fur seal pups born on St. Paul Island, 1970-2006 (modified from Towell et al. 2006).



**Figure 7.** Estimated number of northern fur seal pups born on St. George Island, 1970-2006 (modified from Towell et al. 2006).

#### CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The northern fur seal population increased steadily during 1912-1924 after the commercial harvest ~~on land~~ no longer included pregnant females. 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,  $PBR = 44,543$  ~~13,809~~ animals (~~676,416~~ ~~642,265~~  $\times 0.043 \times 0.5$ ).

#### ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

##### 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 ~~six~~ ~~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. Estimates of marine mammal

serious injury/mortality in each of these observed fisheries are provided in Perez (2006) and Perez (unpubl. ms.). The total estimated annual fishery-related incidental mortality in these fisheries is 1.59 (Table 8). ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

Observer programs for five Alaska 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 8.** Summary of incidental mortality of northern fur seals from the eastern Pacific stock due to commercial fisheries from 2002 through 2006 and calculation of the mean annual mortality rate. ~~Data from 2007 and 2008 are preliminary; estimates of percent observer coverage and CVs are not currently available for some preliminary data. 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	2002	obs	58.4	0	0	0.30 (CV = 0.23)
	2003	data	64.1	0	0	
	2004		64.3	0	0	
	2005		68.3	1	1.5	
	2006		64.7	0	0	
	2007		-	0	0	1.2
	2008		89.0	2	2.4	(CV = 0.35)
	Bering Sea/Aleutian Islands pollock trawl	2002	obs	80.0	0	0
2003		data	82.2	0	0	
2004			92.8	0	0	
2005			77.3	1	1	
2006			73.0	0	0	
2007			85.9	3	4.3	2.7
2008			95.8	1	1.0	(CV = 0.14)
Bering Sea/Aleutian Islands Pacific cod longline		2002	obs		0	0
	2003	data		0	0	
	2004			0	0	
	2005			0	0	
	2006			1	6.2	
	2007			0	0	
	2008			0	0	
Minimum total annual mortality						1.59 (CV = 0.61)

The estimated minimum annual mortality rate incidental to commercial fisheries is 1.9 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 estimate. 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).

Stranding reports of northern fur seals entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality data. In September 2001 a northern fur seal stranding was reported near Unalaska as entangled in 8-inch poly trawl web. The animal was cut free and was apparently healthy upon release. The NMFS stranding database also includes reports of five fur seals on St. George that were entangled in fishing gear in 2003; there were no strandings reported in 2004 or 2005. Including these stranding data in an annual average mortality estimate will be delayed until comparisons between these data and those from entanglement studies (e.g., Zavadil et al. 2003) can be cross-referenced.

### Subsistence/Native Harvest Information

Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, with a take range designed to meet local needs as determined from annual household surveys. Typically, only juvenile males are taken in the subsistence harvest, which likely results in a much smaller impact on population growth than a harvest that includes females. However, occasional harvest of females and adult males does occur: in 2004, there were two adult males that were struck but lost, and one that was killed (Malavansky et al. 2005). In 2006, one adult male and four females were struck and killed (Lestenkof and Zavadil 2006). No adult males and three females fur seals 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). Between 2003<sup>4</sup> and 2007<sup>8</sup>, there was an annual average of 593<sup>5</sup> 562 seals harvested per year in the subsistence hunt (Table 9).

**Table 9.** Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands for 2003<sup>4</sup>-2007<sup>8</sup>.

Year	St. Paul	St. George	Total harvested
2003	522 <sup>1</sup>	132 <sup>2</sup>	654
2004	493 <sup>3,1</sup>	123 <sup>4,1</sup>	616
2005	466 <sup>4,2</sup>	139 <sup>4,2</sup>	605
2006	396 <sup>5,3</sup>	212 <sup>6,4</sup>	608
2007	272 <sup>7,5</sup>	210 <sup>8,6</sup>	482
2008	331 <sup>7</sup>	170 <sup>8</sup>	501
Mean annual take (2002 <sup>4</sup> -2006 <sup>8</sup> )			593 <sup>5</sup> 562

<sup>1</sup>Zavadil and Lestenkof 2003; <sup>2</sup>D. Cormany, NMFS, pers. comm.; <sup>3</sup>Malavansky et al. 2005; <sup>4</sup>Lestenkof et al. 2006; <sup>5</sup>Lestenkof and Zavadil 2006; <sup>6</sup>Malavansky and Malavansky 2006; <sup>7</sup>Lestenkof and Zavadil 2007; <sup>8</sup>Malavansky 2007; <sup>9</sup>Zavadil 2008; <sup>10</sup>Lekanof 2008.

### Other Mortality

Intentional killing of northern fur seals by commercial fishers, sport fishers, and others may occur, but the magnitude of this<sup>11</sup> mortality is unknown. Such shooting has been illegal since the species was listed 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), which is<sup>12</sup> 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 NMML 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).

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 2003-2007, there was a total of 7 mortalities resulting from research on **this stock of** northern fur seals, an average of 1.4 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).

## STATUS OF STOCK

Based on currently available data, the minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock (1.6) is less than 10% of the calculated PBR (~~4,454~~ **1,381**) 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 ( $1.6 + 593,562 + 1.4 = 596,565$ ) is not known to exceed the PBR (~~44,543~~ **13,809**) 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 direct human-caused mortality, there is no **guarantee 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 ~~Marine Mammal Protection Act (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; 1.8 million~~) 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 listed 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. ~~As of the 1990s, s~~ **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 seals collected from Pribilof Island rookeries during 1987-2000 found that pollock (46-75% by frequency of occurrence, FO) and gonatid squids dominated 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).

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 relative rates of pollock harvest (catch divided by estimated biomass) by fisheries were approximately five times greater where they overlap with summer foraging areas used by females from St. George compared with those from St. Paul (Robson and Fritz in prep); this overlap may result in resource competition between fisheries and foraging fur seals. At the same time, 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 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

- Alaska Regional Office. 2005. Setting the annual subsistence harvest of the northern fur seals on the Pribilof Islands, Final Environmental Impact Statement. U.S. Dep. Commer., NMFS, Alaska Regional Office, P.O. Box 21668, Juneau, AK 99802, 208 pp.
- 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.
- 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).
- 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).
- 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., NAWFC Processed Rep. 90-06, 39 pp. (Available upon request - Alaska Fish. Sci. Cent., NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115).
- 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., U.S.* 83:207-217.
- Gudmundson, C. J., T. K. Zeppelin, and R. R. Ream. 2006. Application of two methods for determining diet of northern fur seals (*Callorhinus ursinus*). *Fish. Bull.* 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 the 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.

- 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.
- Lestenkof, A. D., P. A. Zavadil, A. Malavansky and M. Malavansky Jr. 2006. The Subsistence Harvest of Northern Fur Seals on the Pribilof Islands in 2005. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska. 24 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. Draft report to NMFS Alaska Region. 98 pp.
- 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.
- Malavansky, A., M. Malavansky Jr., P. A. Zavadil, A. D. Lestenkof, and P. G. Tetoff. 2005. The subsistence harvest of northern fur seals on the Pribilof Islands in 2004. St. George and St. Paul Islands, Pribilof Islands, Alaska. 12 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, Juneau, Alaska.
- 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.
- 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.
- 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.
- Robson, B. R., and L. W. Fritz. In prep. The impact of habitat conservation measures for Steller sea lions on the distribution of fisheries in northern fur seal foraging habitat. Alaska Fish. Sci. Cent., 7600 Sand Point Way NE, Seattle, WA 98115.
- 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. Haug. 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.
- Towell, R. G., R. R. Ream, and A. E. York. 2006. Decline in northern fur seal (*Callorhinus ursinus*) pup production on the Pribilof Islands. Mar. Mamm. Sci. 22(2):486-491.
- 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., and A. D. Lestenkof. 2003. The subsistence harvest of northern fur seals on St. Paul Island in 2003. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office. St. Paul Island, Pribilof Islands, Alaska. 6 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., 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.
- 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. of Zool. 270:565-576.

### HARBOR SEAL (*Phoca vitulina richardsi*): Southeast Alaska Stock

**NOTE – January 2009<sup>10</sup>:** NMFS has new genetic information on harbor seals in Alaska which indicates that the current division of Alaskan harbor seals into the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks needs to be reassessed. NMFS, in cooperation with our partners in the Alaskan Native community, is evaluating the new genetic information and hopes to make a joint recommendation regarding stock structure in 2009<sup>10</sup>. In the interim, new information on harbor seal mortality levels is provided within this report. A complete revision of the harbor seal stock assessments will be postponed until new stocks are defined.

#### STOCK DEFINITION AND GEOGRAPHIC RANGE

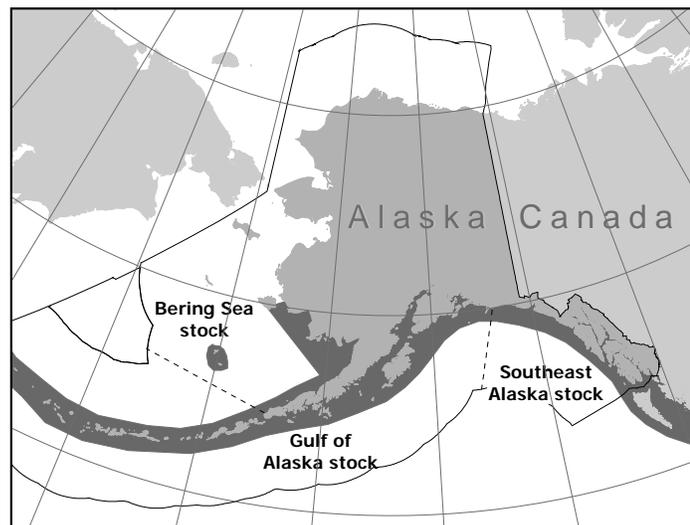
Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out 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). 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. 2001). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Lowry et al. 2001, Small et al. 2001). Strong fidelity of individuals for haulout sites during the breeding season has been documented in several populations (Härkönen and Harding 2001), including in Alaska (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

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 additional research is required as unsampled areas within the Alaskan harbor seal range remain (O’Corry-Crowe et al. 2003).

Currently there are three stocks of harbor seals identified in Alaska: 1) the Southeast Alaska stock - occurring from the Alaska/British Columbia border to Cape Suckling, Alaska (144°W), 2) the Gulf of Alaska stock - occurring from Cape Suckling to Unimak Pass, including animals throughout the Aleutian Islands, and 3) the Bering Sea stock - including all waters north of Unimak Pass (Fig. 8). Information concerning the three harbor seal stocks recognized along the West Coast of the continental United States can be found in the Stock Assessment Reports for the Pacific Region.

#### POPULATION SIZE

The National Marine Mammal Laboratory (Alaska Fisheries Science Center) routinely conducts aerial surveys of harbor seals across the entire range of harbor seals in Alaska. Each of five survey regions was surveyed,



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

with one region surveyed per year. 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, weather, 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 for each survey region. 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 harbor seals in Alaska. Discussions of estimates from a previous survey (1993) can be found in earlier stock assessment reports.

The statewide abundance estimate for Alaskan harbor seals as of 2000 is 180,017 (CV = 0.03 NMFS, unpublished data). This estimate is based on 1996-2000 surveys that had incomplete coverage of terrestrial sites in Prince William Sound and of glacial sites in the Gulf of Alaska and the Southeast Alaska regions. Those omissions have been addressed in a more recent survey (2001-2005). Prince William Sound was surveyed completely in 2001, and new methods have been developed and used for surveying glacial sites in 2001-2002. Analyses are currently underway, and a manuscript describing the regional and statewide population estimates is in preparation; the analytical methods are described in Boveng et al. (2003) and Simpkins et al. (2003). The current abundance estimate for the SE Alaska stock (112,391; CV=0.04) was calculated from northern southeast Alaska surveys (32,454;  $27,090 \times 1.198$ ; CV = 0.06) in 1997 and southern southeast Alaska surveys (79,937;  $66,725 \times 1.198$ ; CV = 0.05) in 1998 (NMFS, unpublished data).

#### **Minimum Population Estimate**

The minimum population estimate ( $N_{\text{MIN}}$ ) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997):  $N_{\text{MIN}} = N/\exp(0.842 \times [\ln(1 + [CV(N)]^2)]^{1/2})$ . Using the population estimate (N) of 112,391 and its associated CV(N) of 0.04,  $N_{\text{MIN}}$  for this stock of harbor seals is 108,670.

#### **Current Population Trend**

Population trend data have been collected in the vicinity of Sitka and Ketchikan since 1983. Based on counts near Ketchikan, abundance has increased 7.4% annually (95% CI: 6.1-8.7) from 1983 to 1998, but at a lower rate of 5.6% during the latter portion between 1994 and 1998 (Small et al. 2003). Counts near Sitka failed to show a significant trend either between 1984 and 2001 or 1995 and 2001 (Small et al. 2003). It should be emphasized that these data are from selected 'trend' sites and not complete census surveys. Further, both of these trend routes are for terrestrial haulouts, which may not be representative of animals that use glacial haulouts. Alaska Natives who hunt for seals in Yakutat Bay believe the local harbor seal population has declined over the past 10-15 years, as determined by less successful hunting trips over time (Yakutat Tlingit Tribe, pers. comm., cited in Jansen et al. 2006).

Additional information concerning trend counts in Southeast Alaska come from Glacier Bay. The number of harbor seals in Johns Hopkins Inlet (a tidewater glacial fjord in Glacier Bay) increased steeply (30.7% annually) between 1975 and 1978, and then at a slower rate (2.6% annually) for the period from 1983 to 1996 (Mathews and Pendleton 1997). Immigration and reduced mortality may have contributed to the steep growth between 1975 and 1978. During 1992-96, the number of seals in Johns Hopkins Inlet (glacial ice haul out) increased 7.1% annually (95% CI: 1.7%-12.4%), whereas the number of seals using terrestrial haul outs decreased 8.6% annually (95% CI: 5.6%-11.7%) over the same period. A sharp overall decline of 63-75% in harbor seal abundance was observed in Glacier Bay from 1992 to 2002 (Mathews and Pendleton 2006). Although the full cause of the decline is unknown, there is some evidence for predation and competition (Taggart et al. 2005). The decline in harbor seals in Glacier Bay has continued at rates comparable to those since 1992 (Womble et al. in review). Results from trend analyses among trend routes within Southeast Alaska are variable, and therefore provide an uncertain basis for inferring trends in the Southeast Alaska stock as a whole.

#### **CURRENT AND MAXIMUM NET PRODUCTIVITY RATES**

Reliable rates of maximum net productivity have not been estimated for the Southeast Alaska harbor seal stock. A population growth rate of 7.4% was observed in Ketchikan between 1983 and 1998 (Small et al. 2003). 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, 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 status (Wade and Angliss 1997). Thus, for this stock of harbor seals,  $PBR = 3,260$  animals ( $108,670 \times 0.06 \times 0.5$ ).

### ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

#### Fisheries Information

The previous stock assessment for harbor seals indicated that there were three observed commercial fisheries that operated within the range of the Southeast Alaska stock of harbor seals. As of 2003, changes in how fisheries are defined in the List of Fisheries have resulted in separating these fisheries into nine fisheries 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. During the 5-year period from 2002 to 2006 there were no observed incidental takes in any of these fisheries (Perez 2006, Perez unpubl. ms.). ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

The estimated minimum annual mortality rate incidental to commercial fisheries is 0. A reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in the gillnet fisheries known to interact with this stock.

#### 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). The previous stock assessment reported that the estimated average harvest of the Southeast Alaska stock of harbor seals for 1994-1996 was 1,749 animals per year (including struck and lost). Recent information from the ANHSC and ADFG indicates the average harvest level from 2003 to 2007, including struck and lost, was 782 harbor seals per year (Table 10). The subsistence harvest level in southeastern Alaska has declined over the same period of time that harbor seal numbers in the area have declined, but it is not known if this is due to reduced effort, or fewer seals available to hunt (Mathews and Pendleton 2006).

**Table 10.** Summary of the subsistence harvest data for the Southeast Alaska stock of harbor seals, 2003-2007. Data are from Wolfe et al. 2004; Wolfe et al. 2006; Wolfe et al. 2008; J. Fall, ADFG, pers. comm., 04 February 2009.

Year	Estimated total number taken	Number harvested	Number struck and lost
2003	1,069	945	124
2004	845	743	102
2005	634	545	89
2006	708	593	115
2007	654	586	68
Mean annual harvest (2002-2006)	782	682	100

#### Other Mortality

Illegal intentional killing of harbor seals occurs, but the magnitude of this mortality is unknown (Note: the 1994 Amendments to the MMPA made intentional lethal take of any marine mammal illegal except where imminently necessary to protect human life). The Alaska Region stranding records from 1998 to 2002 documents five reports of stranded harbor seals that had been shot, for an average of 1 per year over 5 years. It is not known

whether these animals were killed illegally or if they were struck but lost in the subsistence harvest. Because the reason for the shooting is not known, these animals are added to the total number of human-related mortalities.

The Alaska Region stranding records document one Southeast Alaska harbor seal was killed by a vessel collision between 1998 and 2002. One Southeast Alaska harbor seal was entangled in a non-commercial hatchery seine net and released without injury.

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 was 1 mortality resulting from research on the Southeast Alaska stock of harbor seals, 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).

## STATUS OF STOCK

Harbor seals are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. At present, annual U.S. commercial fishery-related mortality levels less than 326 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 is insignificant. Based on the best scientific information available, the estimated annual level of total human-caused mortality ( $782 + 0.2 + 1 + 0.2 = 783$ ) is not known to exceed the PBR (3,260) for this stock. Therefore, the Southeast Alaska stock of harbor seals is not classified as a strategic stock. The status of this stock relative to its Optimum Sustainable Population size is unknown.

## CITATIONS

- Bigg, M. A. 1969. The harbour seal in British Columbia. Fish. Res. Bd. Can. Bull. 172. 33 pp.
- Bigg, M. A. 1981. Harbour seal, *Phoca vitulina*, Linnaeus, 1758 and *Phoca largha*, Pallas, 1811. Pp. 1-27 In S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals, vol.2: Seals. Academic Press, New York.
- 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(1):111-127.
- Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. Fish. Res. Bd. Can. Bull. 93. 58 pp.
- Härkönen, T., and K. C. Harding. 2001. Spatial structure of harbour seal populations and the implications thereof. Canadian Journal of Zoology 79:2115-2127.
- Jansen, J. K., J. L. Bengtson, P. L. Boveng, S. P. Dahle, and J. VerHoef. 2006. Disturbance of harbor seals by cruise ships in Disenchantment Bay, Alaska: An investigation at three spatial and temporal scales. AFSC Processed Report 2006-02. 75pp.
- Lowry, L. F., K. J. Frost, J. M. VerHoef, 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., and G. W. Pendleton. 1997. Estimation of trends in abundance of harbor seals at terrestrial and glacial ice haulouts in Glacier Bay National Park, Southeast Alaska, 1975-1996. Pp. 57-75 In Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. Fish and Game, Division of Wildlife Conservation. Anchorage, AK.
- 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.
- O’Corry-Crowe, G. M., Martien, K. K., 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. Administrative Report LJ-03-08, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 8604 La Jolla Shores Dr., La Jolla, CA 92037.
- Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Recent trends in the abundance of harbour seals, *Phoca vitulina*, in British Columbia. Can. J. Fish. Aquat. Sci. 47:992-1003.
- 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.

- Pitcher, K. W., and D. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19(1983):231-310.
- Pitcher, K. W., and D. C. McAllister. 1981. Movements and haul out 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. Amer. Midl. 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(4):791-805.
- Small, R. J., G. W. Pendleton, and K. W. Pitcher. 2003. Trends in abundance of Alaska harbor seals, 1983-2001. Mar. Mammal Sci. 19(2):344-362
- Small, R. J., L. F. Lowry, K. J. Frost, J. M. VerHoef, R. A. DeLong, and M. J. Rehberg. 2001. Movements of satellite-tagged harbor seal pups in Prince William Sound and the Gulf of Alaska. Mar. Mammal Sci. 17:835-861.
- Swain, U., J. Lewis, G. Pendleton, and K. Pitcher. 1996. Movements, haulout, and diving behavior of harbor seals in southeast Alaska and Kodiak Island. Pp. 59-144, *In* Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. Fish and Game, Division of Wildlife Conservation. Douglas, AK.
- Taggart, S. J., A. G. Andrews, J. Mondragon, and E. A. Mathews. 2005. Co-occurrence of Pacific sleeper sharks *Somniosus pacificus* and harbor seals *Phoca vitulina* in Glacier Bay. Alaska Fishery Research Bulletin 11:113-117.
- 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.
- Westlake, R. L., and G. O’Corry-Crowe. 2002. Macrogeographic structure and patterns of genetic diversity in harbor seals (*Phoca vitulina*) from Alaska to Japan. J. Mamm. 83(4):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 Dep. Fish and Game, Division of Subsistence Technical Paper No. 339. Juneau, AK.
- 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. Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 291. 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. 319. Juneau, AK.
- Womble, J. N., G. W. Pendleton, E. A. Mathews, G. M. Blundell, N. M. Bool, and S. M. Gende. In review. Status and Trend of Harbor Seals (*Phoca vitulina*) in Glacier Bay National Park, Alaska 1992-2008.

## HARBOR SEAL (*Phoca vitulina richardsi*): Gulf of Alaska Stock

**NOTE – January 2009<sup>10</sup>:** NMFS has new genetic information on harbor seals in Alaska which indicates that the current division of Alaskan harbor seals into the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks needs to be reassessed. NMFS, in cooperation with our partners in the Alaskan Native community, is evaluating the new genetic information and hopes to make a joint recommendation regarding stock structure in 2009<sup>10</sup>. In the interim, new information on harbor seal mortality levels is provided within this report. A complete revision of the harbor seal stock assessments will be postponed until new stocks are defined.

### STOCK DEFINITION AND GEOGRAPHIC RANGE

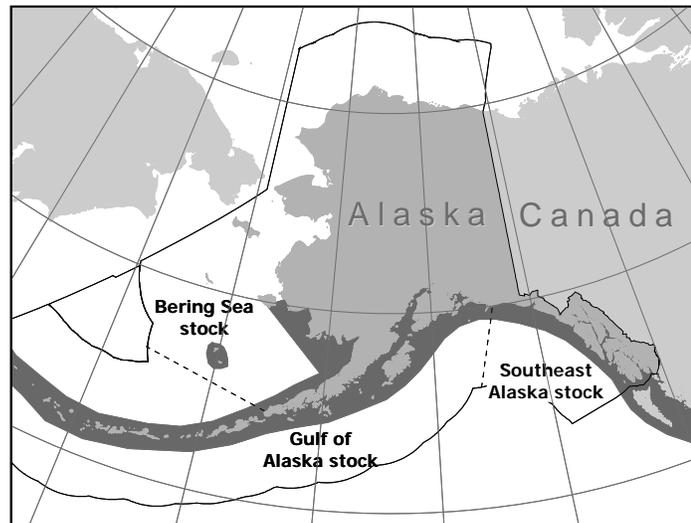
Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out 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). 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. 2001). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Lowry et al. 2001, Small et al. 2001). Strong fidelity of individuals for haulout sites during the breeding season has been documented in several populations (Härkönen and Harding 2001), including in Alaska (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

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 additional research is required as unsampled areas within the Alaskan harbor seal range remain (O’Corry-Crowe et al. 2003).

Currently there are three stocks of harbor seals identified in Alaska: 1) the Southeast Alaska stock - occurring from the Alaska/British Columbia border to Cape Suckling, Alaska (144°W), 2) the Gulf of Alaska stock - occurring from Cape Suckling to Unimak Pass, including animals throughout the Aleutian Islands, and 3) the Bering Sea stock - including all waters north of Unimak Pass (Fig. 8). Information concerning the three harbor seal stocks recognized along the West Coast of the continental United States can be found in the Stock Assessment Reports for the Pacific Region.

### POPULATION SIZE

The National Marine Mammal Laboratory (Alaska Fisheries Science Center) routinely conducts aerial surveys of harbor seals across their entire range in Alaska. Each of five survey regions is surveyed, with one region surveyed per year. 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



**Figure 9.** Approximate distribution of harbor seals in Alaska waters (shaded area).

surveys. Many factors influence the propensity of seals to haul out, including tides, weather, 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 for each survey region. 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 harbor seals in Alaska. Discussions of estimates from previous surveys (1994 and 1996) can be found in earlier stock assessment reports.

The statewide abundance estimate for Alaskan harbor seals based on 1996-2000 surveys was 180,017 (CV=0.03; NMFS, unpublished data). Those surveys had incomplete coverage of terrestrial sites in Prince William Sound and of glacial sites in the Gulf of Alaska and the Southeast Alaska regions. Those problems have been addressed in the most recent surveys (2001-2005). Prince William Sound was surveyed completely in 2001. Data analyses are currently underway, and a manuscript describing the regional and statewide population estimates is in preparation. The current abundance estimate for the GOA stock (45,975; CV = 0.04) is calculated from GOA surveys in 1996 (35,982;  $30,035 \times 1.198$ ; CV = 0.05) and Aleutian Islands surveys in 1999 (9,993;  $8,341 \times 1.198$ ; CV = 0.06; NMFS, unpublished data).

### **Minimum Population Estimate**

The minimum population estimate ( $N_{\text{MIN}}$ ) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997):  $N_{\text{MIN}} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{1/2})$ . Using the population estimate (N) of 45,975 and its associated CV(N) of 0.04, results in an  $N_{\text{MIN}}$  of 44,453 harbor seals for the Gulf of Alaska stock.

### **Current Population Trend**

There are data on population trends available from three areas within the Gulf of Alaska stock of harbor seals: Prince William Sound, Kodiak, and the Aleutian Islands. In Prince William Sound, harbor seal numbers declined by 57% from 1984 to 1992 (Pitcher 1989, Frost and Lowry 1993). Frost et al. (1999) reported a 63% decline in Prince William Sound from 1984-97; more recent information on trends in this area is not available. The decline began before the 1989 *Exxon Valdez* oil spill, was greatest in the year of the spill, and may have lessened thereafter. Between 1989 and 1995, aerial survey counts of 25 haulout sites in Prince William Sound (trend route A) showed significant declines in the number of seals during the molt (19%) and during pupping (31%) (Frost et al. 1996). Adjusted molt period counts for 1996 were 15% lower than the 1995 counts, indicating that harbor seal numbers in Prince William Sound have not yet recovered from the spill or whatever was causing the decline and that the long-term decline has not ended (Frost et al. 1997).

A steady decrease in numbers of harbor seals has been reported throughout the Kodiak Archipelago from the mid-1970s to the 1990s. Trend counts from Kodiak documented a significant increase of 6.6%/year (95% CI: 5.3-8.0; Small et al. 2003) over the period 1993-2001, which was the first documented increase in harbor seals in the Gulf of Alaska. On southwestern Tugidak Island, formally one of the largest concentrations of harbor seals in the world, counts declined 85% from 1976 (6,919) to 1988 (1,014) (Pitcher 1990). More recently, the Tugidak Island mean count has increased from 769 in 1992 to 2,090 in 2001 (Small 1996, Withrow et al. 2002), although this still only represents a fraction of its historical size. Despite some positive signs of growth in certain areas, the overall Gulf of Alaska stock size likely remains small compared to its size in the 1970s and 1980s.

Small et al. (2008) compared harbor seal counts from 106 islands in the Aleutian Islands surveyed in 1977-1982 with counts from the same islands surveyed in 1999. An overall decline of 67% was observed during this 20-year period; the largest decline of 86% was in the western Aleutians, followed by 66% in the central Aleutians, and 45% in the eastern Aleutians (Small et al. 2008). These findings indicate that harbor seal abundance throughout the Aleutian Islands was significantly lower in the late 1990s than in the 1970s and 1980s.

### **CURRENT AND MAXIMUM NET PRODUCTIVITY RATES**

Reliable rates of maximum net productivity have not been estimated for the Gulf of Alaska or Bering Sea harbor seal stock. 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 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 status (Wade and Angliss 1997). Thus, for the Gulf of Alaska stock of harbor seals,  $PBR = 1,334$  animals ( $44,453 \times 0.06 \times 0.5$ ).

### ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

#### Fisheries Information

The previous stock assessment for harbor seals indicated that there were five observed commercial fisheries that operated within the range of the Gulf of Alaska stock of harbor seals. As of 2003, changes in how fisheries are defined in the List of Fisheries have resulted in separating these fisheries into 22 fisheries 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. During the 5-year period from 2002 to 2006 there were no observed incidental takes of harbor seals by any of these fisheries (Perez 2006, Perez unpubl. ms.). ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

In the Prince William Sound salmon drift gillnet fishery, observers recorded two incidental mortalities of harbor seals in 1990 (Wynne et al. 1991), and one in 1991 (Wynne et al. 1992). The extrapolated kill estimates were 36 (95% CI: 2-74) in 1990 and 12 (95% CI: 1-44) in 1991, resulting in a mean kill rate of 24 (CV = 0.5) animals per year for this fishery. In 1990, observers were onboard 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 were onboard 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. The estimated mortality rate of harbor seals based on the 1990 and 1991 observed mortalities for this fishery is 0.0002 kills per set. Fisher self-reports of harbor seal mortalities due to this fishery detail 19, 4, 7, 24, and 0 mortalities in 1990, 1991, 1992, 1993, and 1996, respectively. The extrapolated (estimated) mortality from the 1990-91 observer program (24 seals per year) accounts for these mortalities, so they do not appear in Table 11. In 1990, observers were onboard 59 (38.3%) of the 154 vessels participating in the Alaska Peninsula/Aleutian Island 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).

Between 1998 and 2002 there were no fishery related standings of Gulf of Alaska harbor seals documented in the Alaska Region stranding records.

The estimated minimum annual mortality rate incidental to commercial fisheries is 24.0, based on observer data (24.0), and stranding data (0) where observer data were not available. However, a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer programs in several salmon gillnet fisheries known to interact with this stock.

**Table 11.** Summary of incidental mortality of harbor seals (Gulf of Alaska stock) due to fisheries from 1990 through 2004 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from stranding data. Data from 2000 to 2004 (or 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.

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

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
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

Table 12 provides a summary of the subsistence harvest information for the Gulf of Alaska stock. 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). The previous stock assessment reported that the mean annual subsistence take from this stock of harbor seals, including struck and lost, over the 3-year period from 1994 to 1996 was 791 animals. Recent information from the ADFG indicates the average harvest level from 2003 to 2007, including struck and lost, was 807 harbor seals per year.

**Table 12.** Summary of the subsistence harvest data for the Gulf of Alaska stock of harbor seals, 2003-2007. Data are from Wolfe et al. 2004; Wolfe et al. 2006; Wolfe et al. 2008; J. Fall, ADFG, pers. comm., 04 February 2009.

Year	Estimated total number taken	Number harvested	Number struck and lost
2003	688	613	75
2004	857	747	110
2005	958	861	97
2006	848	766	82
2007	686	620	66
Mean annual harvest (2003-2007)	807	721	86

### Other Mortality

Illegal intentional killing of harbor seals occurs, but the magnitude of this mortality is unknown (Note: the 1994 Amendments to the MMPA made intentional lethal take of any marine mammal illegal except where imminently necessary to protect human life). The Alaska Region stranding records from 1998 to 2002 document three reports of stranded harbor seals found shot in the Gulf of Alaska, for an average of 0.6 over 5 years. It is not known whether these animals were killed illegally or if they were struck but lost in the subsistence harvest. Because the reason for the shooting is not known, these animals are added to the total number of human-related mortalities.

The Alaska Region stranding records document one Gulf of Alaska harbor seal was killed by a ship collision, and one was killed by massive blunt trauma between 1998 and 2002.

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 was one mortality resulting from research on the Gulf of Alaska stock of harbor seals, 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).

### STATUS OF STOCK

Harbor seals are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. At present, annual U.S. commercial fishery-related mortality levels less than 133 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 currently available data, the minimum estimated annual level of total human-caused mortality is  $832 (24.0 + 0.4 + 807 + 0.6 + 0.2)$  harbor seals which does not exceed the PBR (1,334) for this stock. Until additional information on mortality incidental to commercial fisheries becomes available, the Gulf of Alaska stock of harbor seals is not classified as strategic. The status of this stock relative to its Optimum Sustainable Population size is unknown.

#### CITATIONS

- Bigg, M. A. 1969. The harbour seal in British Columbia. Fish. Res. Bd. Can. Bull. 172. 33 pp.
- Bigg, M. A. 1981. Harbour seal, *Phoca vitulina*, Linnaeus, 1758 and *Phoca largha*, Pallas, 1811. Pp. 1-27 In S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals, vol.2: Seals. Academic Press, New York.
- 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(1):111-127.
- Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. Fish. Res. Bd. Can. Bull. 93. 58 pp.
- Frost, K. F., and L. F. Lowry. 1993. Assessment of injury to harbor seals in Prince William Sound, Alaska, and adjacent areas following the *Exxon Valdez* oil spill. State-Federal Natural Resource Damage Assessment, Marine Mammals Study No.5. 95 pp.
- Frost, K. F., L. F. Lowry, R. J. Small, and S. J. Iverson. 1996. Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Project # 95064), Alaska Dep. Fish and Game, Division of Wildlife Conservation. Fairbanks, AK. 131 pp.
- Frost, K. F., L. F. Lowry, J. M. VerHoef, and S. J. Iverson. 1997. Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound, Alaska. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Project # 96064), Alaska Dep. Fish and Game, Division of Wildlife Conservation. Fairbanks, AK. 56 pp.
- Frost, J. J., L. F. Lowry, and J. M. VerHoef. 1999. Monitoring the trend of harbor seals in Prince William Sound, Alaska. Mar. Mammal Sci. 17:813-834.
- Härkönen, T., and K. C. Harding. 2001. Spatial structure of harbour seal populations and the implications thereof. Canadian Journal of Zoology 79:2115-2127.
- Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor Seal Stock Assessment in Washington and Oregon 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.
- Lowry, L. F., K. J. Frost, J. M. VerHoef, 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.
- O’Corry-Crowe, G. M., Martien, K. K., 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. Administrative Report LJ-03-08, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 8604 La Jolla Shores Dr., La Jolla, CA 92037.
- Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Recent trends in the abundance of harbour seals, *Phoca vitulina*, in British Columbia. Can. J. Fish. and Aquat. Sci. 47:992-1003.
- 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.
- Pitcher, K. W. 1989. Harbor seal trend count surveys in southern Alaska, 1988. Final report Contract MM4465852-1 to U.S. Marine Mammal Commission, Washington, D.C. 15 pp.
- 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. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19(1983):231-310.
- Pitcher, K. W., and D. C. McAllister. 1981. Movements and haul out 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. Amer. Midl. 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(4):791-805.
- Small, R. J. 1996. Population assessment of harbor seals in Alaska: report of a workshop held in Fairbanks, Alaska, November 14-16, 1995. 36 pp.
- Small, R. J., P. L. Boveng, G. V. Byrd and D. E. Withrow. 2008. Harbor seal population decline in the Aleutian Archipelago. *Mar. Mammal Sci.* 24(4):845-863.
- Small, R. J., G. W. Pendleton, and K. W. Pitcher. 2003. Trends in abundance of Alaska harbor seals, 1983-2001. *Mar. Mammal Sci.* 19(2):344-362.
- Small, R. J., L. F. Lowry, K. J. Frost, J. M. VerHoef, R. A. DeLong, and M. J. Rehberg. 2001. Movements of satellite-tagged harbor seal pups in Prince William Sound and the Gulf of Alaska. *Mar. Mammal Sci.* 17:835-861.
- Swain, U., J. Lewis, G. Pendleton, and K. Pitcher. 1996. Movements, haulout, and diving behavior of harbor seals in southeast Alaska and Kodiak Island. Pp. 59-144, *In* Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. Fish and Game, Division of Wildlife Conservation. Douglas, AK.
- 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.
- Westlake, R. L., and G. O’Corry-Crowe. 2002. Macrogeographic structure and patterns of genetic diversity in harbor seals (*Phoca vitulina*) from Alaska to Japan. *J. Mamm.* 83(4):1111-1126.
- Withrow, D. E., J. C. Cesarone, L. Hiruki-Raring, and J. L. Bengtson. 2002. Abundance and distribution of harbor seals (*Phoca vitulina*) in the Gulf of Alaska (including the south side of the Alaska Peninsula, Kodiak Island, Cook Inlet and Prince William Sound) during 2001. Pp. 19-63, *In* A. L. Lopez and S. E. Moore (eds.), Marine Mammal Protection Act and Endangered Species Act implementation program 2001. U.S. Dep. Commer., Seattle, WA. (AFSC Processed Report 2002-06) 80 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, Division of Subsistence Technical Paper No. 339. Juneau, AK.
- 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. Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 291. 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. 319. Juneau, 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.

## HARBOR SEAL (*Phoca vitulina richardsi*): Bering Sea Stock

**NOTE – January 2009<sup>10</sup>:** NMFS has new genetic information on harbor seals in Alaska which indicates that the current division of Alaskan harbor seals into the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks needs to be reassessed. NMFS, in cooperation with our partners in the Alaskan Native community, is evaluating the new genetic information and hopes to make a joint recommendation regarding stock structure in 2009<sup>10</sup>. In the interim, new information on harbor seal mortality levels is provided within this report. A complete revision of the harbor seal stock assessments will be postponed until new stocks are defined.

### STOCK DEFINITION AND GEOGRAPHIC RANGE

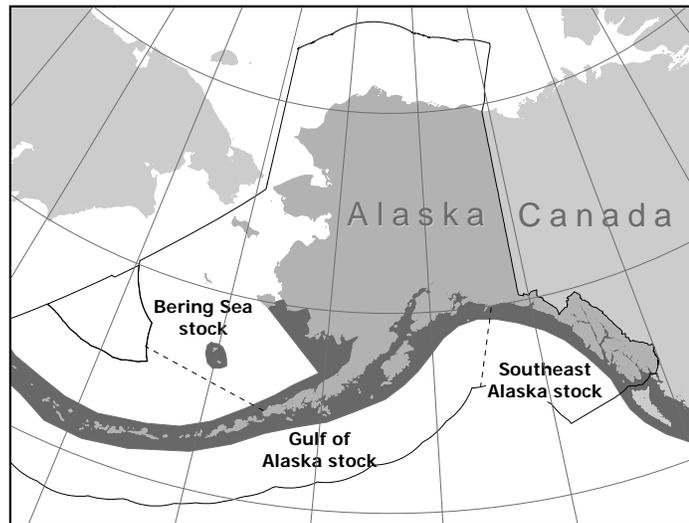
Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out 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). 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. 2001). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Lowry et al. 2001, Small et al. 2001). Strong fidelity of individuals for haulout sites during the breeding season has been documented in several populations (Härkönen and Harding 2001), including in Alaska (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

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 additional research is required as unsampled areas within the Alaskan harbor seal range remain (O’Corry-Crowe et al. 2003).

Currently there are three stocks of harbor seals identified in Alaska: 1) the Southeast Alaska stock - occurring from the Alaska/British Columbia border to Cape Suckling, Alaska (144°W), 2) the Gulf of Alaska stock - occurring from Cape Suckling to Unimak Pass, including animals throughout the Aleutian Islands, and 3) the Bering Sea stock - including all waters north of Unimak Pass (Fig. 8). Information concerning the three harbor seal stocks recognized along the West Coast of the continental United States can be found in the Stock Assessment Reports for the Pacific Region.

### POPULATION SIZE

The National Marine Mammal Laboratory (Alaska Fisheries Science Center) routinely conducts aerial surveys of harbor seals across their entire range in Alaska. Each of five survey regions was surveyed, with one region surveyed per year. To derive an accurate estimate of population size from these surveys, a method was



**Figure 10.** Approximate distribution of harbor seals in Alaska waters (shaded area).

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, weather, 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 for each survey region. 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 harbor seals in Alaska. Discussions of estimates from a previous survey (1995) can be found in earlier stock assessment reports.

The current statewide abundance estimate for Alaskan harbor seals is 180,017 (CV = 0.03; NMFS, unpublished data), based on data collected during 1996-2000. This estimate, however, is believed to be low because it is based on incomplete coverage of terrestrial sites in Prince William Sound and of glacial sites in the Gulf of Alaska and the Southeast Alaska regions. Those problems have been addressed in the current survey (2001-2005). Prince William Sound was surveyed completely in 2001, and new methods have been developed and used for surveying glacial sites in 2001-2002. Analyses are currently underway, and a manuscript describing the regional and statewide population estimates is in preparation; the analytical methods are described in Boveng et al. (2003) and Simpkins et al. (2003) and have been presented at the 14th Biennial Conference on the Biology of Marine Mammals. The current abundance estimate for the Bering Sea stock (21,651;  $18,073 \times 1.198$ ; CV = 0.1) is calculated from surveys in 2000 (NMFS, unpublished data).

### **Minimum Population Estimate**

The minimum population estimate ( $N_{\text{MIN}}$ ) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997):  $N_{\text{MIN}} = N/\exp(0.842 \times [\ln(1 + [\text{CV}(N)]^2)]^{1/2})$ . Using the population estimate (N) of 21,651 from the aerial surveys and the associated CV(N) of 0.1, results in an estimate of 19,907 harbor seals. Adding the maximum count of 202 seals from the Otter Island survey results in an  $N_{\text{MIN}}$  of 20,109 for the Bering Sea harbor seal stock.

### **Current Population Trend**

The number of harbor seals in the Bering Sea stock is thought to have declined between the 1980s and 1990s (Alaska SRG, see DeMaster 1996); however, published data to support this conclusion are unavailable. Specifically, in 1974 there were 1,175 seals reported on Otter Island. The maximum count in 1995 (202 seals) represents an 83% decline (Withrow and Loughlin 1996). However, as noted by the Alaska SRG (DeMaster 1996), the reason(s) for this decline is(are) confounded by the recolonization of Otter Island by northern fur seals since 1974, which has caused a loss of available habitat for harbor seals. Further, counts of harbor seals on the north side of the Alaska Peninsula in 1995 were less than 42% of the 1975 counts, representing a decline of 3.5% per year. The number of harbor seals in northern Bristol Bay are also lower, but have remained stable since 1990 (Withrow and Loughlin 1996). Trend counts have been conducted in Bristol Bay only between 1998 and 2001. During this period, counts indicated a non-significant trend of -1.3% (95% CI: -5.9 - 3.3; Small et al. 2003). Calculation of trends in abundance in this area is somewhat problematic due to the presence of a sympatric species, spotted seals, which may overlap the range of harbor seals but cannot be identified as a different species by aerial surveys.

### **CURRENT AND MAXIMUM NET PRODUCTIVITY RATES**

Reliable rates of maximum net productivity have not been estimated for the Gulf of Alaska or Bering Sea stock of harbor seal. 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 ( $R_{\text{MAX}}$ ) 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:  $\text{PBR} = N_{\text{MIN}} \times 0.5R_{\text{MAX}} \times F_R$ . The recovery factor ( $F_R$ ) for this stock is 0.5,

the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Thus, for the Bering Sea harbor seal stock, PBR = 603 animals ( $20,109 \times 0.06 \times 0.5$ ).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

The previous stock assessment for harbor seals indicated that there were three observed commercial fisheries that operated within the range of the Bering Sea stock of harbor seals. As of 2003, changes in how fisheries are defined in the List of Fisheries have resulted in separating these fisheries into 14 fisheries 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 in the Bering Sea/Aleutian Islands flatfish trawl and the Bering Sea/Aleutian Islands Pacific cod trawl (Table 13). Over the last 5 years, there were no observed serious injuries or mortalities of harbor seals in any Bering Sea/Aleutian Islands groundfish longline fisheries, or any Bering Sea/Aleutian Islands finfish pot fisheries (Perez 2006, Perez unpubl. ms).

The estimated minimum annual mortality rate incidental to commercial fisheries for the period 2002-2006 is 2.9. However, a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in salmon gillnet fisheries known to interact with this stock. ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table 13.** Summary of incidental mortality of harbor seals (Bering Sea stock) due to commercial fisheries from 2002 through 2006 and calculation of the mean annual mortality rate. Data from 2007 and 2008 are preliminary; estimates of percent observer coverage and CVs are not currently available for some preliminary data.

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 Pacific cod trawl	2002	obs	38.3	0	0	1.33 (CV = 0.44)
	2003	data	42.3	1	2.0	
	2004		45.3	1	2.0	
	2005		52.8	0	0	
	2006		46.8	1	2.7	
	2007		-	-	-	
	2008		-	-	-	
Bering Sea/Aleutian Islands flatfish trawl	2002	obs	58.4	0	0	1.31 (CV = 0.34)
	2003	data	64.1	0	0	
	2004		64.3	0	1.0	
	2005		68.3	2	3.0	
	2006		67.8	1	2.6	
	2007		-	1	1	
	2008		-	0	0	
Bering Sea/Aleutian Islands pollock trawl	2002	obs	80.0	0	0	0.29 (CV = 0.56)
	2003	data	82.2	0	0	
	2004		81.2	0	0	
	2005		77.3	1	1.5	
	2006		73.0	0	0	
	2007		-	-	0	
	2008		87.1	1	1.1	
Minimum total annual mortality						2.93 (CV = 0.26)

### 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). The previous stock assessment reported that the estimated average harvest of the Bering Sea stock of harbor seals for 1994-1996 was 161 animals per year (including struck and lost). Recent information from the ADFG indicates the average harvest level from 2002-2006, including struck and lost, was 106.5 animals per year. Due to seasonal geographic overlap in species distribution in north Bristol Bay in combination with the difficulty in distinguishing the two species from external morphology, reports of harvest levels of harbor seals were differentiated from spotted seals based on ecological features of the kill, primarily degree of association with seasonal ice (Wolfe et al. 2008). The estimates given in Table 14 represent the best estimate of the subsistence harvest of harbor seals, although species identifications were not confirmed; therefore, the harvest estimates for harbor seals may include some spotted seals, and some spotted seals may actually have been recorded as harbor seals (Wolfe et al. 2008).

Table 14 provides a summary of the subsistence harvest information for the Bering Sea stock. Takes from the Bering Sea stock have decreased about 63.5%, declining from 243 seals in 1992 to 88 seals in 2006 (Wolfe et al. 2008).

**Table 14.** Summary of the subsistence harvest data for the Bering Sea stock of harbor seals, 2003-2007. Data are from Wolfe et al. 2004; Wolfe et al. 2006; Wolfe et al. 2008; J. Fall, ADFG, pers. comm., 04 February 2009.

Year	Estimated total number taken	Number harvested	Number struck and lost
2003	82	65	17
2004	119	76	43
2005	104	64	40
2006	88	64	24
2007	88	61	27
Mean annual harvest (2002-2007)	96	66	30

### Other Mortality

Illegal intentional killing of harbor seals occurs, but the magnitude of this mortality is unknown (Note: the 1994 Amendments to the MMPA made intentional lethal take of any marine mammal illegal except where imminently necessary to protect human life). The Alaska Region stranding records from 1998 to 2002 document 2-3 reports of stranded harbor seals found shot in Bristol Bay, for a maximum average of 0.6 harbor seals/year over 5 years. It is not known whether these animals were killed illegally or if they were struck but lost in the subsistence harvest. Because the reason for the shooting is not known, these animals are added to the total number of human-related mortalities.

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 listed 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 60 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 ( $2.93 + 96 + 0.6 = 99.5$ ) is not known to exceed the PBR (603). Therefore, the Bering Sea stock of harbor seals is not classified as a strategic stock. The status of this stock relative to its Optimum Sustainable Population size is unknown.

### CITATIONS

Bigg, M. A. 1969. The harbour seal in British Columbia. Fish. Res. Bd. Can. Bull. 172. 33 pp.

- Bigg, M. A. 1981. Harbour seal, *Phoca vitulina*, Linnaeus, 1758 and *Phoca largha*, Pallas, 1811. Pp. 1-27 In S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals, vol. 2: Seals. Academic Press, New York.
- 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(1):111-127.
- 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).
- Fisher, H. D. 1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. *Fish. Res. Bd. Can. Bull.* 93. 58 pp.
- Härkönen, T., and K. C. Harding. 2001. Spatial structure of harbour seal populations and the implications thereof. *Canadian Journal of Zoology* 79:2115-2127.
- Huber, H., S. Jeffries, R. Brown, and R. DeLong. 1994. Harbor Seal Stock Assessment in Washington and Oregon 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.
- Lowry, L. F., K. J. Frost, J. M. VerHoef, 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.
- O’Corry-Crowe, G. M., Martien, K. K., 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. Administrative Report LJ-03-08, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 8604 La Jolla Shores Dr., La Jolla, CA 92037.
- Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Recent trends in the abundance of harbour seals, *Phoca vitulina*, in British Columbia. *Can. J. Fish. Aquat. Sci.* 47:992-1003.
- 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.
- Pitcher, K. W., and D. G. Calkins. 1979. Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19(1983):231-310.
- Pitcher, K. W., and D. C. McAllister. 1981. Movements and haul out 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. *Amer. Midl. 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(4):791-805.
- 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.
- Small, R. J., G. W. Pendleton, and K. W. Pitcher. 2003. Trends in abundance of Alaska harbor seals, 1983-2001. *Mar. Mammal Sci.* 19(2):344-362.
- Small, R. J., L. F. Lowry, K. J. Frost, J. M. VerHoef, R. A. DeLong, and M. J. Rehberg. 2001. Movements of satellite-tagged harbor seal pups in Prince William Sound and the Gulf of Alaska. *Mar. Mammal Sci.* 17:835-861.
- Swain, U., J. Lewis, G. Pendleton, and K. Pitcher. 1996. Movements, haulout, and diving behavior of harbor seals in southeast Alaska and Kodiak Island. Pp. 59-144, In Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. Fish and Game, Division of Wildlife Conservation. Douglas, AK.
- 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.
- Westlake, R. L., and G. O’Corry-Crowe. 2002. Macrogeographic structure and patterns of genetic diversity in harbor seals (*Phoca vitulina*) from Alaska to Japan. *J. Mamm.* 83(4):1111-1126.
- Withrow, D. E., and T. R. Loughlin. 1996. Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) along the north side of the Alaska Peninsula and Bristol Bay during 1995. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

- 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 R. T. Stanek. 2004. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2003. Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 291. 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. 319. Juneau, AK.

## 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 Okhotsk Sea south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977, Fig. 11). This SAR deals only with spotted seals that occur in the Bering, Chukchi, and Beaufort seas. 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, with movement to coastal habitats after 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 haulouts 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. Of eight known breeding areas, three occur in the Bering Sea, with the remaining five in the Okhotsk Sea and Sea of Japan. There is little morphological difference between seals from these areas. Spotted seals are closely related to and often mistaken for Pacific harbor seals (*Phoca vitulina richardsi*). 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).



**Figure 11.** Approximate distribution of spotted seals (shaded area).

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

### POPULATION SIZE

A reliable estimate of spotted seal population abundance is currently not available (Rugh et al. 1995). However, early estimates of the world population were in the range of 335,000-450,000 animals (Burns 1973). The population of the Bering Sea, including Russian waters, was estimated to be 200,000-250,000 based on the distribution of family groups on ice during the mating season (Burns 1973). Fedoseev (1971) estimated 168,000 seals in the Okhotsk Sea. Aerial surveys were flown in 1992 and 1993 to examine the distribution and abundance of spotted seals in Alaska. In 1992, survey methods were tested and distributional studies were conducted over the Bering Sea pack ice in spring and along the western Alaska coast during summer (Rugh et al. 1993). In 1993, the survey effort concentrated on known haul out sites in summer (Rugh et al. 1994). The sum of maximum counts of hauled out animals were 4,145 and 2,951 in 1992 and 1993, respectively. Using mean counts from days with the highest estimates for all sites visited in either 1992 or 1993, there were 3,570 seals seen, of which 3,356 (CV = 0.06) were hauled out (Rugh et al. 1995).

Studies to determine a correction factor for the number of spotted seals at sea missed during surveys have been initiated, but only preliminary results are currently available. The Alaska Department of Fish and Game placed satellite transmitters on four spotted seals in Kasegaluk Lagoon and estimated the ratio of time hauled out versus time at sea. Preliminary results indicated that the proportion hauled out averaged about 6.8% (CV = 0.85) (Lowry et al. 1994). Using this correction factor with the maximum count of 4,145 from 1992 results in an estimate of 59,214.

#### **Minimum Population Estimate**

A reliable minimum population estimate ( $N_{\text{MIN}}$ ) 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 this represents only a fraction of the stock's range, 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 ( $R_{\text{MAX}}$ ) 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:  $PBR = N_{\text{MIN}} \times 0.5R_{\text{MAX}} \times F_R$ . 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  $N_{\text{MIN}}$  is currently not available, the PBR for this stock is unknown.

#### **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 spotted seals. 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. Prior to 2004, there were no incidental serious injuries and mortalities of spotted seals in any of the observed fisheries. However, in 2004, the Bering Sea/Aleutian Islands flatfish trawl fishery incurred three mortalities of spotted seals, resulting in a total estimated take of 4.4 spotted seals for that year and an average of 1.18 seals per year for the period 2002-2006 (Table 15a; Perez 2006, Perez unpubl. ms a, Perez unpubl. ms b). ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

The estimated minimum mortality rate incidental to commercial fisheries is 1.18 animals per year. However, 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 observers have been assigned to the Bristol Bay drift gillnet fisheries that are known to interact with this stock, making the estimated mortality unreliable.

**Table 15a.** Summary of incidental mortality of spotted seals (Alaska stock) due to commercial fisheries from 2002 through 2006 and calculation of the mean annual mortality rate. 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 flatfish trawl	2002	obs data	58.4	0	0	1.18 (CV = 0.28)
	2003		64.1	0	0	
	2004		64.3	3	4.4	
	2005		68.3	1	1.5	
	2006		67.8	0	0	
Minimum total annual mortality						1.18 (CV = 0.28)

### Subsistence/Native Harvest Information

Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions, with estimated annual harvests ranging from 850 to 3,600 seals (averaging about 2,400 annually) taken during 1966-76 (Lowry 1984). From September 1985 to June 1986 the combined harvest from five Alaska villages was 986 (Quakenbush 1988). In a study designed to assess the subsistence harvest of harbor seals and Steller sea lions in Alaska, Wolfe and Mishler (1993, 1994, 1995, 1996) estimated subsistence takes of spotted seals in the northern part of Bristol Bay. The spotted seal take (including struck and lost) was estimated to be 437 in 1992, 265 in 1993, 270 in 1994, and 197 in 1995. Variance estimates for these values are not available. The mean annual subsistence take of spotted seals in this region during the 3-year period from 1993 to 1995 was 244 animals.

The Division of Subsistence, Alaska Department of Fish and Game and the Alaska Native Harbor Seal Commission reports subsistence harvest levels of harbor seals and sea lions annually (e.g., Wolfe et al. 2008). Harvest data are reported from 63 coastal communities, including 6 communities from north Bristol Bay. Due to seasonal geographic overlap in species distribution in north Bristol Bay in combination with the difficulty in distinguishing the two species from external morphology, reports of harvest levels 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). The estimates given in Table 15b represent the best estimate of the subsistence harvest of spotted seals, although species identifications were not confirmed; therefore, the harvest estimates for spotted seals may include some harbor seals, and some spotted seals may actually have been recorded as harbor seals (Wolfe et al. 2008).

The mean annual subsistence harvest in north Bristol Bay from this stock over the 5-year period from 2002 through 2006 was 166 spotted seals per year (Table 15b).

**Table 15b.** Summary of the subsistence harvest data for spotted seals from 6 coastal villages in north Bristol Bay, 2002-2006.

Year	Estimated total number taken	Number harvested	Number struck and lost
2002	229 <sup>1</sup>	184	45
2003	62 <sup>2</sup>	52	10
2004	170 <sup>3</sup>	124	46
2005	201 <sup>4</sup>	170	31
2006	170 <sup>5</sup>	140	30
Mean annual take (2002-2006)	166	134	32

<sup>1</sup>Wolfe et al. 2003; <sup>2</sup>Wolfe et al. 2004; <sup>3</sup>Wolfe et al. 2005; <sup>4</sup>Wolfe et al. 2006; <sup>5</sup>Wolfe et al. 2008.

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-Scarborough 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 5,265.

At this time, there are no efforts to quantify the current level of harvest of spotted seals by all Alaska communities. However, the U.S. Fish and Wildlife Service collects information on the level of spotted seal harvest in five villages during their Walrus Harvest Monitoring Program. Results from this program indicated that an average of 37 spotted seals were harvested annually in Little Diomedes, Gambell, Savoonga, Shishmaref, and Wales from 2000-2004 (U.S. Fish and Wildlife Service, Marine Mammals Management, Walrus Harvest Monitoring Project). Because this represents only 5 of the over 100 villages that may harvest spotted seals, this level of harvest underestimates the actual harvest level for these years. Since 2005, harvest data are only available from St. Lawrence Island (Gambell and Savoonga) due to lack of walrus harvest monitoring in areas previously monitored. One spotted seal was reported as being harvested in 2005 from St. Lawrence Island.

**Table 15c.** Summary of the 2000-2004 subsistence harvest data for spotted seals from Little Diomedes, Gambell, Savoonga, Shishmaref, and Wales. Data were collected by the U.S. Fish and Wildlife Service during the Walrus Harvest Monitoring Project. These counts only reflect the number of seals harvested during the spring walrus harvest and do not indicate total annual harvest.

Year	Estimated number harvested
2000	18
2001	1
2002	26
2003	98
2004	44
Mean annual harvest (2000-2004)	37

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. 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 are not listed 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. No information is available on the status of spotted seals. Due to a minimal level of interactions between U.S. commercial fisheries and spotted seals, the Alaska stock of spotted seals is not considered a strategic stock.

NMFS received a petition on 28 May 2008 to list spotted seals under the ESA due to loss of sea ice habitat caused by climate change in the Arctic. NMFS published a Federal Register notice (73 FR 51615, 4 September 2008) indicating that there were sufficient data to warrant a review of the status of the species.

### 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). Spotted 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 (Boveng et al. 2008). There are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska spotted seal stock.

## CITATIONS

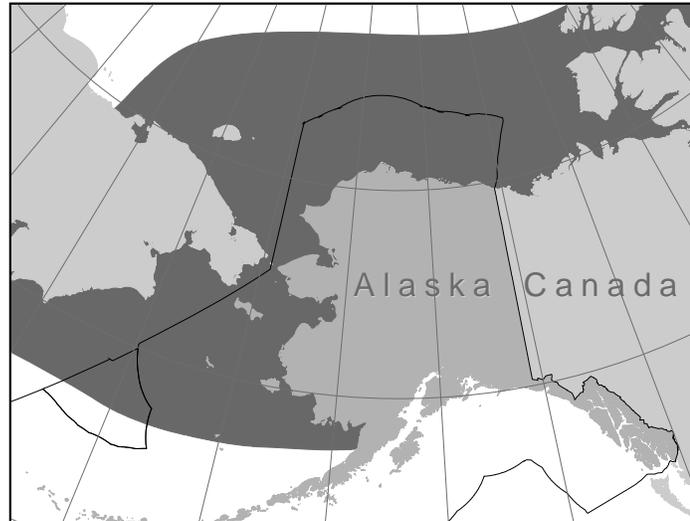
- ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, U.K.
- Alaska Department of Fish and Game. 2000a. Community Profile Database 3.04 for Access 97. Division of Subsistence, Anchorage.
- Alaska Department of Fish and Game. 2000b. Seals+ Database for Access 97. Division of Subsistence, Anchorage.
- Burns, J. J. 1973. Marine mammal report. Alaska Dep. Fish and Game, Pittman-Robertson Proj. Rep. W-17-3, W-17-4, and W-17-5.
- 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 (*Histiophoca fasciata*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-191, 115 p.
- Burns, J. J. 1973. Marine mammal report. Alaska Dep. Fish and Game, Pittman-Robertson Proj. Rep. W-17-3, W-17-4, and W-17-5.
- 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.
- 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. 1971. The distribution and numbers of seals on whelping and moulting patches in the Sea of Okhotsk. Pp. 135-158 *In* K. K. Chapskii and E. S. Mil'chenko (eds.), *Research on marine mammals*. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 39:1-344 (Transl. From Russian by Can. Fish. Mar. Serv., 1974, Transl. Ser. 3185).
- 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.
- Johannessen, O. M., L. Bengtsson, 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.
- 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., K. J. Frost, R. Davis, R. S. Suydam, and D. P. DeMaster. 1994. Movements and behavior of satellite-tagged spotted seals (*Phoca largha*) in the Bering and Chukchi Seas. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-38. 71 pp.
- 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.
- 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
- 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. a Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 7 pp. Available NMML-AFSC.
- Perez, M. A. Unpubl. ms. b Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2006. 67 pp. Available NMML-AFSC.
- 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, D. E. Withrow, H. W. Braham, and R. P. Angliss. 1993. Spotted seal (*Phoca largha*) distribution and abundance in Alaska, 1992. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.
- Rugh, D. J., K. E. W. Shelden, and D. E. Withrow. 1994. Spotted seals in Alaska, 1993 annual report. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.
- 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.
- 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., and C. Mishler. 1993. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1992. Final report for year one, subsistence study and monitor system (no. 50ABNF20055). Prepared for the NMFS by Alaska Dep. Fish and Game, Juneau, Alaska, 94 pp. + appendices.
- Wolfe, R. J., and C. Mishler. 1994. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1993. Final report for year two, subsistence study and monitor system (no. 50ABNF20055). Prepared for the NMFS by Alaska Dep. Fish and Game, Juneau, Alaska, 60 pp. + appendices.
- Wolfe, R. J., and C. Mishler. 1995. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1994. Draft final report for year three, subsistence study and monitor system (no. 50ABNF20055). Prepared for NMFS by Alaska Dep. Fish and Game, Juneau, Alaska, 69 pp. + appendices.
- Wolfe, R. J., and C. Mishler. 1996. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1995. Draft final report for year four, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dep. Fish and Game, Juneau, Alaska, 69 pp. + appendices.
- Wolfe, R., and L.B. Hutchinson-Scarborough. 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 R. T. Stanek. 2003. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2002. Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 277. Juneau, AK.
- 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. Alaska Dep. Fish and Game, Division of Subsistence Technical Paper No. 291. 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, 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*): Alaska Stock

### STOCK DEFINITION AND GEOGRAPHIC RANGE

Bearded seals are circumpolar in their distribution, extending from the Arctic Ocean (85°N) south to Hokkaido (45°N) in the western Pacific. They generally inhabit areas of shallow water (less than 200 m) that are at least seasonally ice covered. During winter they are most common in broken pack ice (Burns 1967) and in some areas also inhabit shorefast ice (Smith and Hammill 1981). In Alaska waters, bearded seals are distributed over the continental shelf of the Bering, Chukchi, and Beaufort Seas (Ognev 1935, Johnson et al. 1966, Burns 1981, Fig. 12). Bearded seals are evidently most concentrated from January to April over the northern part of the Bering Sea shelf (Burns 1981, Braham et al. 1984). 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). The overall summer distribution is quite broad, with seals rarely hauled out on land, and some seals may not follow the ice northward but remain in open-water areas of the Bering and Chukchi Seas (Burns 1981, Nelson 1981, Smith and Hammill 1981). An unknown proportion of the population moves southward from the Chukchi Sea in late fall and winter, and Burns (1967) noted a movement of bearded seals away from shore during that season as well.



**Figure 12.** Approximate distribution of bearded seals (shaded area). The combined summer and winter distribution are 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 bearded seals into more than one stock. A study by Davis et al. (2008) found no significant differences between microsatellite allele frequencies in bearded seals sampled in Anadyr Bay and at St. Lawrence Island, but strong differences between seals from those Bering Sea locations and samples collected in the eastern Beaufort Sea. This study also found limited gene flow between bearded seals sampled in Labrador, Greenland, and Svalbard. Bearded seals range throughout the Arctic into Russian and Canadian waters, however, only the Alaska stock is recognized in U.S. waters.

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 bearded seals into more than one stock. A study by Davis et al. (2008) found no significant differences between microsatellite allele frequencies in bearded seals sampled in Anadyr Bay and at St. Lawrence Island, but strong differences between seals from those Bering Sea locations and samples collected in the eastern Beaufort Sea. This study also found limited gene flow between bearded seals sampled in Labrador, Greenland, and Svalbard. Bearded seals range throughout the Arctic into Russian and Canadian waters, however, only the Alaska stock is recognized in U.S. waters.

### POPULATION SIZE

Early estimates of the Bering-Chukchi Sea population range from 250,000 to 300,000 (Popov 1976, Burns 1981). Surveys flown from Shishmaref to Barrow during May-June 1999 and 2000 resulted in an average density of 0.07 seals/km<sup>2</sup> and 0.14 seals/km<sup>2</sup>, respectively, with consistently high densities along the coast to the south of Kivalina (Bengtson et al. 2005). These densities cannot be used to develop an abundance estimate because no correction factor is available. There is no reliable population abundance estimate for the Alaska stock of bearded seals.

### Minimum Population Estimate

A reliable minimum population estimate ( $N_{\text{MIN}}$ ) 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 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 ( $R_{\text{MAX}}$ ) 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:  $PBR = N_{\text{MIN}} \times 0.5R_{\text{MAX}} \times F_R$ . 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  $N_{\text{MIN}}$  is currently not available, the PBR for this stock is unknown.

### ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

#### 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. Between 2002 and 2006, there were incidental serious injuries and mortalities of bearded seals in the Bering Sea/Aleutian Islands pollock trawl (Table 16a). Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006) and Perez (unpubl. ms. a, b). The estimated minimum mortality rate incidental to commercial fisheries is 1.0 bearded seals per year, based exclusively on observer data. ~~More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table 16a.** Summary of incidental mortality of bearded seals (Alaska stock) due to commercial fisheries from 2002 to 2006 and calculation of the mean annual mortality rate. 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	2002	obs data	80.0	0	0	1.00 (CV = 0.66)
	2003		82.2	0	0	
	2004		81.2	0	0	
	2005		77.3	0	0	
	2006		73.0	2	5	
Total estimated annual mortality						1.00 (CV = 0.66)

#### Subsistence/Native Harvest Information

Bearded seals are an important species 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).

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 bearded seals has been compiled for 129 villages from reports from the Division of Subsistence (Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarborough 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 is 6,788.

At this time, there are no efforts to quantify the current level of harvest of bearded seals by all Alaska communities. However, the U.S. Fish and Wildlife Service collects information on the level of bearded seal harvest in five villages during their Walrus Harvest Monitoring Program. Results from this program indicated that an average of 239 bearded seals were harvested annually in Little Diomed, Gambell, Savoonga, Shishmaref, and Wales from 2000 to 2004 (U.S. Fish and Wildlife Service, Marine Mammals Management, Walrus Harvest Monitoring Project). Because this represents only 5 of the over 100 villages that may harvest bearded seals, this level of harvest is known to underestimate the actual harvest level for these years. Since 2005, harvest data are only available from St. Lawrence Island (Gambell and Savoonga) due to lack of walrus harvest monitoring in areas previously monitored. There were 21 bearded seals harvested during the walrus harvest monitoring period on St. Lawrence Island in 2005, 41 in 2006, and 82 in 2007.

**Table 16b.** Summary of the 2000-2004 subsistence harvest data for bearded seals from Little Diomed, Gambell, Savoonga, Shishmaref, and Wales. Data were collected by the U.S. Fish and Wildlife Service during the Walrus Harvest Monitoring Project. Bearded seal harvest numbers reflect only those that were taken during the spring walrus harvest monitoring and are not an annual total for these locations.

Year	Estimated total number harvested
2000	267
2001	178
2002	166
2003	302
2004	280
Mean annual harvest (2000-2004)	239

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. 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 is the best estimate of 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 2003-2007, there was 1 mortality resulting from research on the Alaska stock of bearded seals, 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).

#### STATUS OF STOCK

Bearded seals are not listed 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 bearded 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. No information is available on the status of bearded seals. Due to a very low level of interactions between U.S. commercial fisheries and bearded seals, the Alaska stock of bearded seals is not considered a strategic stock.

NMFS received a petition to list bearded seals under the ESA on 28 May 2008 due to loss of sea ice habitat caused by climate change in the Arctic. NMFS published a Federal Register notice (73 FR 51615, 4 September 2008) indicating that there were sufficient data to warrant a status review of the species.

### 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). Bearded 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. There are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska bearded seal stock.

### CITATIONS

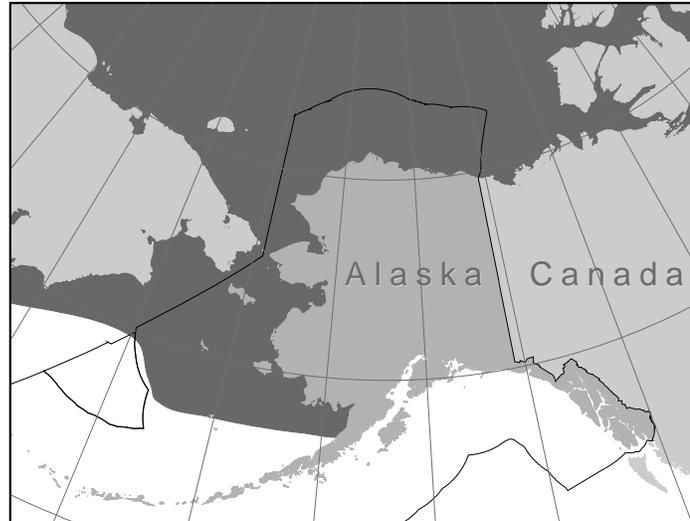
- ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, U.K.
- Alaska Department of Fish and Game. 2000a. Community Profile Database 3.04 for Access 97. Division of Subsistence, Anchorage.
- Alaska Department of Fish and Game. 2000b. Seals+ Database for Access 97. Division of Subsistence, Anchorage. 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., 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. J. Burns, G. A. Fedoseev, and B. D. Krogman. 1984. Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walrus 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.
- 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.
- 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.
- Davis, C. S., I. Stirling, C. Strobeck, and C. W. Coltman. 2008. Population structure of ice-breeding seals. Molecular Ecology 17:3078-3094.
- 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, Alaska Dep. Fish and Game, Division of Subsistence, Juneau.

- Johannessen, O. M., L. Bengtsson, 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.
- 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.
- Nelson, R. K. 1981. *Harvest of the sea: coastal subsistence in modern Wainwright*. North Slope Borough, Barrow, Alaska. 125 pp.
- 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.).
- 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. a Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 7 pp. Available NMML-AFSC.
- Perez, M. A. Unpubl. ms. b Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2006. 67 pp. Available NMML-AFSC.
- Popov, L. A. 1976. Status of main ice forms of seals inhabiting waters of the U.S.S.R. and adjacent to the country marine areas. FAO ACMRR/MM/SC/51. 17 pp.
- 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., and M. O. Hammill. 1981. Ecology of the ringed seal, *Phoca hispida*, in its fast-ice breeding habitat. *Can. J. Zool*. 59:966-981.
- 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-Scarborough. 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*): Alaska Stock

### STOCK DEFINITION AND GEOGRAPHIC RANGE

Ringed seals have a circumpolar distribution from approximately 35°N to the North Pole, occurring in all seas of the Arctic Ocean (King 1983). In the North Pacific, they are found in the southern Bering Sea and range as far south as the Seas of Okhotsk and Japan. Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying seasonal and permanent ice. They tend to prefer large floes (i.e., > 48 m in diameter) and are often found in the interior ice pack where the sea ice coverage is greater than 90% (Simpkins et al. 2003). They remain in contact with ice most of the year and pup on the ice in late winter-early spring. Ringed seals are found throughout the Beaufort, Chukchi, and Bering Seas, as far south as Bristol Bay in years of extensive ice coverage (Fig. 13). During late April through June, ringed seals are distributed throughout their range from the southern ice edge northward (Burns and Harbo 1972, Burns et al. 1981, Braham et al. 1984).



**Figure 13.** Approximate distribution of ringed seals (shaded area). The combined summer and winter distribution are depicted.

et al. 1981, Braham et al. 1984). Preliminary results from recent surveys conducted in the Chukchi Sea in May-June 1999 and 2000 indicate that ringed seal density is higher in nearshore fast and pack ice, and lower in offshore pack ice (Bengtson et al. 2005). Results of surveys conducted by Frost and Lowry (1999) indicate that, in the Alaskan Beaufort Sea, the density of ringed seals in May-June is higher to the east than to the west of Flaxman Island. The overall winter distribution is probably similar, and it is believed there is a net movement of seals northward with the ice edge in late spring and summer (Burns 1970). Thus, ringed seals occupying the Bering and southern Chukchi Seas in winter apparently are migratory, but details of their movements are unknown.

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. Davis et al. (2008) found little evidence for genetic differentiation among ringed seals sampled from various regions throughout the Arctic. Based on this limited information, and the absence of any significant fishery interactions, there is currently no strong evidence to suggest splitting ringed seals into more than one stock. Therefore, only the Alaska ringed seal stock is recognized in U.S. waters.

### POPULATION SIZE

A reliable abundance estimate for the entire Alaska stock of ringed seals is currently not available. One partial estimate of ringed seal numbers was based on aerial surveys conducted in May-June 1985-1987 in the Chukchi and Beaufort Seas from southern Kotzebue Sound north and east to the U.S.-Canada border (Frost et al. 1988). Effort was directed towards shorefast ice within 20 nmi of shore, though some areas of adjacent pack ice were also surveyed. The estimate of the number of hauled out seals in 1987 was  $44,360 \pm 9,130$  (95% CI). During May-June 1999 and 2000 surveys were flown along lines perpendicular to the eastern Chukchi Sea coast from Shishmaref to Barrow (Bengtson et al. 2005). Bengtson et al. (2005) indicate that the estimated abundance of ringed seals for the study area (corrected for seals not hauled out) in 1999 and 2000 was 252,488 (SE = 47,204) and 208,857 (SE = 25,502), respectively. Similar surveys were flown in 1996-99 in the Alaska Beaufort Sea from Barrow to Kaktovik. Observed seal densities in that region ranged from 0.81 to 1.17/km<sup>2</sup> (Frost et al. 2002, 2004). Moulton et al. (2002) surveyed some of the same area in the central Beaufort Sea during 1997-1999, and reported lower seal densities than Frost et al. (2002). Frost et al. (2002) did not produce a population estimate from their

1990s Beaufort Sea surveys. However, the area they surveyed covered approximately 18,000 km<sup>2</sup> (L. Lowry, University of Alaska Fairbanks, pers. comm.), and the average seal density for all years and ice types was 0.98/km<sup>2</sup> (Frost et al. 2002), which indicates that there were approximately 18,000 seals hauled out in the surveyed portion of the Beaufort Sea. Combining this with the average abundance estimate of 230,673 from Bengtson et al. (2005) for the eastern Chukchi Sea results in a total of approximately 249,000 seals. This is a minimum population estimate because it does not include much of the geographic range of the stock and the estimate for the Alaska Beaufort Sea has not been corrected for the number of ringed seals not hauled out at the time of the surveys. Nonetheless, it provides an update to the estimate from 1987.

### **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 ringed seals are unavailable.

Frost et al. (2002) reported that trend analysis based on an ANOVA comparison of observed seal densities in the central Beaufort Sea suggested a marginally significant but substantial decline of 31% from 1980-87 to 1996-99. A Poisson regression model indicated highly significant density declines of 72% on fast ice and 43% on pack ice over the 15-year period. However, the apparent decline between the 1980s and the 1990s may have been due to a difference in the timing of surveys rather than an actual decline in abundance.

### **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). However, because a reliable estimate of minimum abundance ( $N_{MIN}$ ) is currently not available, the PBR for this stock is unknown.

### **ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY**

#### **Fisheries Information**

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 2002 and 2006, there were incidental serious injuries and mortalities of ringed seals in the Bering Sea/Aleutian Islands flatfish trawl fishery (Table 17a). Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006) and Perez (unpubl. ms). Based on data from 2002 to 2006, there have been an average of 0.46 mortalities of ringed seals incidental to commercial fishing operations. ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table 17a.** Summary of incidental mortality of ringed seals (Alaska stock) due to commercial fisheries from 2002 to 2006 and calculation of the mean annual mortality rate. 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	2002	obs	58.4	0	0	0.46 <sup>1</sup> (CV = N/A <sup>1</sup> )
	2003	data	64.1	0	0	
	2004		64.3	0	0	
	2005		68.3	1	1.3	
	2006		67.8	0	1.0 <sup>1</sup>	
Total estimated annual mortality						0.46

<sup>1</sup> Mortality seen by observer, but not during a monitored haul.

### Subsistence/Native Harvest Information

Ringed seals are an important species for Alaska Native subsistence hunters. The estimated annual subsistence harvest in Alaska dropped from 7,000 to 15,000 in the period from 1962 to 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 1988).

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 ringed seals has been compiled for 129 villages from reports from the Division of Subsistence (Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarborough 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 ringed seals harvested for subsistence use per year is 9,567.

At this time, there are no efforts to quantify the level of harvest of ringed seals by all Alaska communities. However, the U.S. Fish and Wildlife Service collects information on the level of ringed seal harvest in five villages during their Walrus Harvest Monitoring Program. Results from this program indicated that an average of 47 ringed seals were harvested annually in Little Diomedes, Gambell, Savoonga, Shishmaref, and Wales from 1998 to 2003 (U.S. Fish and Wildlife Service, Marine Mammals Management, Walrus Harvest Monitoring Project). Because this represents only 5 of the over 100 villages that may harvest ringed seals, this level of harvest is known to underestimate the actual harvest level for these years. Since 2005, harvest data are only available from St. Lawrence Island (Gambell and Savoonga) due to lack of walrus harvest monitoring in areas previously monitored. There were no ringed seals harvested on St. Lawrence Island in 2005, 1 in 2006, and 1 in 2007.

**Table 17b.** Summary of the 2000-2004 subsistence harvest data for ringed seals from Little Diomedes, Gambell, Savoonga, Shishmaref, and Wales. Data were collected by the U.S. Fish and Wildlife Service during the Walrus Harvest Monitoring Project. These counts only reflect the number of seals harvested during the spring walrus harvest and do not indicate total annual harvest.

Year	Estimated total number harvested
2000	75
2001	29
2002	51
2003	32
2004	34
Mean annual harvest (2000-2004)	44.2

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. 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.

## **STATUS OF STOCK**

Ringed seals are not listed 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 ringed 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. No information is available on the status of ringed seals. Due to a very low level of interactions between U.S. commercial fisheries and ringed seals, the Alaska stock of ringed seals is not considered a strategic stock.

NMFS received a petition to list ringed seals under the ESA on 28 May 2008 due to loss of sea ice habitat caused by climate change in the Arctic. NMFS published a Federal Register notice, 73 FR 51615, 04 September 2008, indicating that there were sufficient data to warrant a review of the species.

## **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). Ringed 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. There are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska ringed seal stock.

Oil and gas exploration and development overlaps with both the summer and winter ranges of ringed seals in the Alaska Beaufort Sea. NMFS has worked with the oil and gas industry to recommend changes to operations to ensure that mortalities of ringed seals are eliminated or minimized, and to ensure that monitoring occurs to verify that population-level changes in distribution are minor. There has been concern that oil and gas exploration, especially seismic exploration, could result in changes in ringed seal distribution. However, aerial surveys conducted for 3 years both before and after industry activities indicate that local seal densities in the spring were not significantly different after the advent of industry activity (Moulton et al. 2002). It is not known to what extent this study can be used to determine likely responses of ringed seals to activity in other parts of the species' range.

## **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.
- Bengtson, J. L., L. M. Hiruki-Raring, M. A. Simpkins, and P. L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999-2000. *Polar Biol.* 28: 833-845.
- Braham, H. W., J. J. Burns, G. A. Fedoseev, and B. D. Krogman. 1984. Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walrus 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.
- 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.
- 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.

- 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.
- Davis, C. S., I. Stirling, C. Strobeck, D. W. Coltman. 2008. Population structure of ice-breeding seals. *Mol. Ecol.* 17:3078-3094.
- 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. 1985. Unpubl. rep. The ringed seal. Alaska Dep. Fish and Game, Fairbanks. 14 pp.
- 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., and L. F. Lowry. 1999. Monitoring distribution and abundance of ringed seals in northern Alaska. Interim Rep. Cooperative Agreement Number 14-35-0001-30810 submitted to the U.S. Dep. Interior, Minerals Management Service, Anchorage, AK. 37p + appendix
- 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.
- Johannessen, O. M., L. Bengtsson, 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. 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.
- King, J. E. 1983. Seals of the world. 2nd ed. Br. Muss. (Nat. Hits.), London. 240 pp.
- 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.
- 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.
- 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.
- 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-Scarborough. 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.

**RIBBON SEAL (*Histiophoca 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 are found in the open sea, on the pack ice, and only rarely on shorefast ice (Kelly 1988). They range northward from Bristol Bay in the Bering Sea into the Chukchi and western Beaufort Seas (Fig. 14). 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



**Figure 14** Approximate distribution of ribbon seals (shaded area). The combined summer and winter distribution is depicted.

Sea for the summer (Kelly 1988). 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).

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 Bering Sea in spring of 2003 (Simpkins et al. 2003), 2007 (Cameron and Boveng 2007, Moreland et al. 2008), and 2008 (Peter Boveng, NMML, unpubl. data). The data from these surveys are currently being analyzed to construct estimates of abundance for the eastern Bering Sea from frequencies of sightings, ice distribution, and the timings of seal haul-out behavior. In the interim, NMML researchers have developed a provisional estimate of 49,000 ribbon seals in the eastern and central Bering Sea during the surveys.

**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 estimate of 49,000 ribbon seals in the

eastern and central Bering Sea is consistent with historical estimates, suggesting 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**

**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 2002 and 2006, there were incidental serious injuries and mortalities of ribbon seals in the Bering Sea/Aleutian Islands flatfish trawl fishery (Table 18a). Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006) and Perez (unpubl. ms). The estimated minimum mortality rate incidental to commercial fisheries is 0.3 ribbon seal per year, based exclusively on observer data. ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table 18a.** Summary of incidental mortality of ribbon seals (Alaska stock) due to fisheries from 2002 to 2006 and calculation of the mean annual mortality rate. Details of how percent observer coverage is measured is included in Appendix 6.

<b>Fishery name</b>	<b>Years</b>	<b>Data type</b>	<b>Observer coverage</b>	<b>Observed mortality (in given yrs.)</b>	<b>Estimated mortality (in given yrs.)</b>	<b>Mean annual mortality</b>
Bering Sea/Aleutian Is. flatfish trawl	2002	obs	58.4	0	0	0.27 (0.50)
	2003	data	64.1	0	0	
	2004		64.3	0	0	
	2005		68.3	1	1.3	
	2006		67.8	0	0	
Total estimated annual mortality						0.3 (CV=0.50)

<sup>1</sup> Mortality seen by observer, but not during a monitored haul.

**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 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 ribbon seals has been compiled for 129 villages from reports from the

Division of Subsistence (Coffing et al. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarborough 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 is 193.

At this time, there are no efforts to quantify the level of harvest of ribbon seals by all Alaska communities. However, the U.S. Fish and Wildlife Service collects information on the level of ribbon seal harvest in 5 villages as part of their Walrus Harvest Monitoring Program. Results from this program indicated that an average of 13 ribbon seals were harvested annually in Little Diomedede, Gambell, Savoonga, Shishmaref, and Wales from 1999 to 2003 (U.S. Fish and Wildlife Service, Marine Mammals Management, Walrus Harvest Monitoring Project). Because this represents only five of the over 100 villages that may harvest ribbon seals, this level of harvest is known to underestimate the actual harvest level for these years. Since 2005, harvest data are only available from St. Lawrence Island (Gambell and Savoonga) due to lack of walrus harvest monitoring in areas previously monitored. There were no ribbon seals harvested on St. Lawrence Island from 2005 - 2007.

**Table 18b.** Summary of the 2000-2004 subsistence harvest data for ribbon seals from Little Diomedede, Gambell, Savoonga, Shishmaref, and Wales. Data were collected by the U.S. Fish and Wildlife Service during the Walrus Harvest Monitoring Project. These counts only reflect the number of seals harvested during the spring walrus harvest and do not indicate total annual harvest.

Year	Estimated total number harvested
2000	2
2001	2
2002	9
2003	36
2004	3
Mean annual harvest (2000-2004)	10.4

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 somewhat 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 listed 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 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. No information is available on the status of ribbon seals. Due to a very low level of interactions between U.S. commercial fisheries and ribbon seals, the Alaska stock of ribbon seals is not considered a strategic stock.

NMFS received a petition to list ribbon seals under the ESA on 20 December 2007 due to loss of sea ice habitat caused by climate change in the Arctic. NMFS published a Federal Register notice, 73 FR 16617, 28 March 2008, indicating that there were sufficient data to warrant a review of the species. NMFS conducted a thorough review of the species and published a status review of the ribbon seal in December 2008 (Boveng et al. 2008). The findings of this review were reported in 73 FR 79822, 30 December 2008, in which it was determined that listing of the ribbon seal 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. Although a gradual decline in the ribbon seal population is likely with a decrease in frequency of years with suitable sea ice habitat, ribbon seals are not likely to become an endangered species within the foreseeable future (Boveng et al. 2008).

## 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 (*Histiophoca 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.
- 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.
- 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.
- 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.
- 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.

- 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.
- 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 Biology* 26:577-586.
- 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-Scarborough. 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.

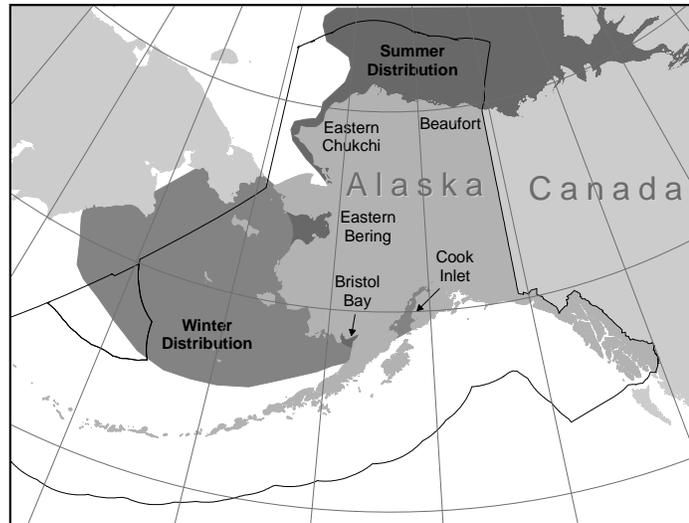
## BELUGA WHALE (*Delphinapterus leucas*): Beaufort Sea Stock

### 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 concentrations in Cook Inlet, Bristol Bay, the Yukon Delta, Norton Sound, Kasegaluk Lagoon, and the Mackenzie Delta (Hazard 1988). It is assumed that most beluga whales from these summering areas overwinter in the Bering Sea, excluding those found in the northern Gulf of Alaska (Shelden 1994). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985).

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) and give birth to and care for their calves (Sergeant and Brodie 1969). Annual migrations may cover thousands of kilometers (Reeves 1990).

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), distribution poorly known outside of summer; 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 summering areas (O'Corry-Crowe et al. 1997). Based on this information, 5 stocks of beluga whales 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).



**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.

### 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 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 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).

### Minimum Population Estimate

For the Beaufort Sea stock of beluga whales, the minimum population estimate ( $N_{\text{MIN}}$ ) is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Thus,  $N_{\text{MIN}} = N/\exp(0.842 \times [\ln(1 + [CV(N)]^2)]^{1/2})$ . Using the population estimate (N) of 39,258 and an associated CV(N) of 0.229,  $N_{\text{MIN}}$  for this stock is 32,453.

### Current Population Trend

The current population trend of the Beaufort Sea stock of beluga whales is unknown.

### CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for the Beaufort Sea stock of beluga whales. Hence, until additional 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:  $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$ . As the stock trend is undocumented, the recovery factor ( $F_R$ ) for this stock is 0.5 (Wade and Angliss 1997). Thus, using the abundance estimate calculated from 1992 surveys, the PBR for the Beaufort Sea stock of beluga whales would be calculated to be 324 animals ( $32,453 \times 0.02 \times 0.5$ ). However, the 2005 revisions to the SAR guidelines (NMFS 2005) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. Therefore, the PBR for this stock is considered undetermined.

### ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

#### 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 19 (K. Frost, University of Alaska, Fairbanks, pers. comm. 2007). Given these data, the annual subsistence take by Alaska Natives averaged 25 belugas during the 5-year period from 2002 to 2006.

**Table 19.** Summary of the number of beluga whales landed by the Alaska Native subsistence harvest from the Beaufort Sea stock of beluga whales, 2002-2006.

Year	Reported total number taken
2002	27
2003	43
2004	32
2005	20
2006	5
Mean annual number of animals landed (2002-2006):	25.4

The subsistence take of beluga whales within Canadian waters of the Beaufort Sea is reported by the Fisheries Joint Management Committee (FJMC). The data are collected by on-site harvest monitoring conducted by the FJMC at Inuvialuit communities in the Mackenzie River delta, Northwest Territories. The most recent Canadian Inuvialuit subsistence harvest estimates for the Beaufort Sea beluga stock are provided in Table 20 (data for 2002-2006 from FJMC Beluga Monitor Program, Fisheries Joint Management Committee, Inuvik, NT, Canada). Given these data, the annual subsistence take in Canada averaged 114 belugas during the 5-year period from 2002-2006. Thus, the mean estimated subsistence take in Canadian and U. S. waters from the Beaufort Sea beluga stock during 2002-2006 is 139 (25 + 114) whales. Data on beluga that were struck and lost have not been quantified and are not included in these estimates.

**Table 20.** Summary of the Canadian subsistence harvest from the Beaufort Sea stock of beluga whales, 2002-2006. N/A indicates the data are not available.

Year	Reported total number taken
2002	88
2003	126
2004	122
2005	108
2006	126
Mean annual landed (2002-2006)	114

### STATUS OF STOCK

Beaufort Sea beluga whales are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. Based on a lack of reported mortalities, the estimated annual U.S. commercial fishery-related mortality (0) is not known to exceed 10% of the PBR (32) and, therefore, is considered to be insignificant and approaching zero mortality and serious injury rate. Based on currently available data, the estimated annual level of human-caused mortality and serious injury (139) is not known to exceed the PBR (324). Therefore, the Beaufort Sea stock of beluga whales is not classified as a 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 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). 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. 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

- 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. 1998. Harvest report: statewide summary for the eastern Bering Sea beluga population, 1995-97. Alaska Beluga Whale Committee Rep. 98-1. 15 pp.
- Frost, K. J. 2003. Harvest report: statewide summary for the western Alaska Beluga stocks, 1998-2002. Alaska Beluga Whale Committee Rep. 03-2. 16 pp.
- 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. Suydam. 1995. Harvests of beluga whales, *Delphinapterus leucas*, in Alaska, 1987-1994. Working paper for Alaska Beluga Whale Committee Scientific Workshop, Anchorage, AK, 5-7 April 1995. 14 pp.
- 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., P. Norton, B. Day and P. Hall. 2002. The harvest of beluga whales in Canada's Western Arctic: hunter-based monitoring of the size and composition of the catch. *Arctic* 55(1):10-20.
- 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.
- 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.
- 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.
- 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*): 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 concentrations in Cook Inlet, Bristol Bay, the Yukon Delta, Norton Sound, Kasegaluk Lagoon, and the Mackenzie Delta (Hazard 1988). It is assumed that most beluga whales from these summering areas overwinter in the Bering Sea, excluding those found in the northern Gulf of Alaska (Shelden 1994). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985).

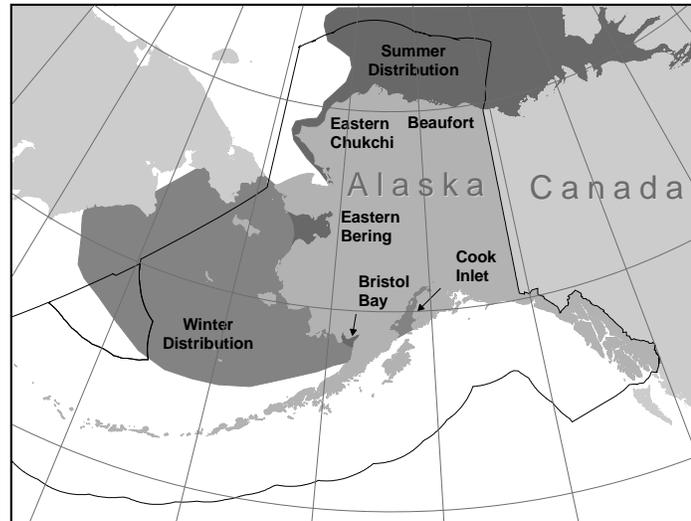
The general distribution pattern for beluga whales shows major seasonal changes. During the winter, they occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982) and give birth to and care for their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

Eastern Chukchi Sea belugas move into coastal areas along 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 in Kasegaluk Lagoon showed that whales traveled 1,100 km north of the Alaska coastline and to the Canadian Beaufort Sea within 3 months of tagging (Suydam et al. 2001), indicating an overlap in distribution with the Beaufort Sea stock of beluga whales. Satellite telemetry data from 23 whales tagged during 1998-2002 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 the Beaufort Sea and Arctic Ocean (79-80°N) by late July/early August. Adult and immature females remained at or near the shelf break of the Chukchi Sea. After October, only three tags continued to transmit, and those whales migrated south through the Bering Strait into the northern Bering Sea north of Saint Lawrence Island. Data from a whale tagged in the eastern Chukchi Sea in 2007 overwintered in the waters north of Saint Lawrence Island during 2007/2008 and was still transmitting in this location as of April 2008 (Robert Suydam, Department of Wildlife Management, North Slope Borough, Barrow, AK, pers comm. 02 April 2008).

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), distribution unknown outside of summer; 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 summering areas (O’Corry-Crowe et al. 1997). Based on this information, 5 stocks of beluga whales 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

Frost et al. (1993) estimated the minimum size of the eastern Chukchi stock of belugas at 1,200, based on counts of animals from aerial surveys conducted during 1989-91. Survey effort was concentrated on the 170 km



**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.

long Kasegaluk Lagoon, an area known to be regularly used by belugas during the open-water season. Other areas that belugas from this stock are known to frequent (e.g., Kotzebue Sound) were not surveyed. Therefore, the survey effort resulted in a minimum count. If this count is corrected, using radio telemetry data, for the proportion of animals that were diving and thus not visible at the surface (2.62, Frost and Lowry 1995), and for the proportion of newborns and yearlings not observed due to small size and dark coloration (1.18; Brodie 1971), the total corrected abundance estimate for the eastern Chukchi stock is 3,710 ( $1,200 \times 2.62 \times 1.18$ ).

During 25 June to 6 July 1998, aerial surveys were conducted in the eastern Chukchi Sea (DeMaster et al. 1998). The maximum single day count (1,172 whales) was derived from a photographic count of a large aggregation near Icy Cape (1,018), 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.

### **Minimum Population Estimate**

The survey technique used for estimating the abundance of beluga whales is a direct count which incorporates correction factors. Although CVs of the correction factors are not available, the Alaska Scientific Review Group concluded that the population estimate of 3,710 can serve as an estimate of minimum population size because the survey did not include areas where beluga are known to occur (Small and DeMaster 1995). That is, if the distribution of beluga whales in the eastern Chukchi Sea is similar to the 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).

### **Current Population Trend**

The maximum 1998 count (1,172 animals) is similar to counts of beluga whales 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 stock of beluga whales is declining.

### **CURRENT AND MAXIMUM NET PRODUCTIVITY RATES**

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of beluga whales. Hence, until additional 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:  $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$ . 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 stock of beluga whales would be calculated to be 74 animals ( $3,710 \times 0.02 \times 1.0$ ). However, the 2005 revisions to the SAR guidelines (NMFS 2005) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. Therefore, the PBR for this stock is considered undetermined.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### 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 beluga whales incidental to these groundfish fisheries. In the nearshore waters of the southeastern Chukchi Sea, substantial effort occurs in gillnet (mostly set nets), and personal-use fisheries. Although a potential source of mortality, there have been no reported takes of beluga whales as a result of these fisheries.

Based on a lack of reported mortalities, the estimated 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 21 (K. Frost, University of Alaska, Fairbanks, pers. comm. 2007). Given these data, the annual subsistence take by Alaska Natives averaged 59 belugas landed during the 5-year period 2002-2006 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 21.** Summary of the number of beluga whales landed by the Alaska Native subsistence harvest of eastern Chukchi Sea beluga whales, 2002-2006.

2002	93
2003	74
2004	54
2005	43
2006	31
Mean annual number of animals landed (2002-2006):	59

### 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 considered to be insignificant and approaching zero mortality and serious injury rate. Based on currently available data, the estimated annual rate of human-caused mortality and serious injury (59) is not known to exceed the PBR (74). Eastern Chukchi Sea beluga whales are not listed 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 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 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). 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. 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.

- 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, 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 - D. P. DeMaster, National Marine Mammal Laboratory, 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 Dep. Fish and Game, 1300 College Rd., Fairbanks, AK 99701).
- 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.
- 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. Sheldon, 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.
- 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.
- 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. Sheldon, 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.
- 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

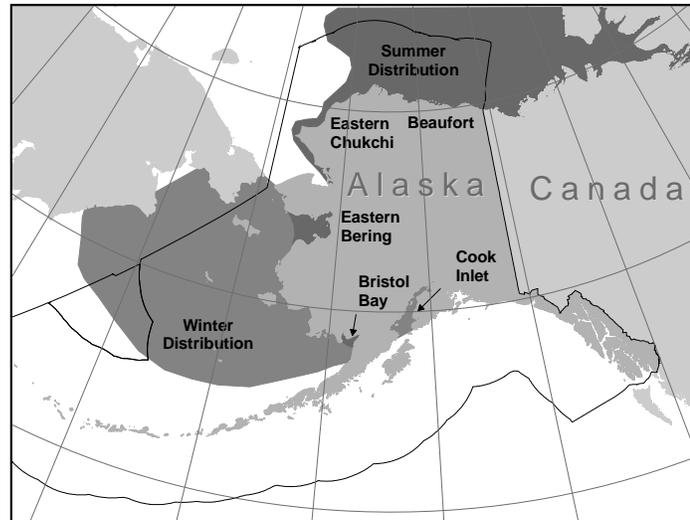
Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with concentrations in Cook Inlet, Bristol Bay, the Yukon Delta, Norton Sound, Kasegaluk Lagoon, and the Mackenzie Delta (Hazard 1988). It is assumed that most beluga whales from these summering areas overwinter in the Bering Sea, excluding those found in the northern Gulf of Alaska (Shelden 1994). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interactions (Lowry 1985).

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) and give birth to and care for their calves (Sergeant and Brodie 1969). Annual migrations may cover thousands of kilometers (Reeves 1990).

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), distribution unknown outside of summer; 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 summering areas (O'Corry-Crowe et al. 1997). Based on this information, 5 stocks of beluga whales 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

DeMaster et al. (1994) estimated the minimum abundance (e.g., uncorrected for probability of sighting) of belugas from aerial surveys over Norton Sound in 1992, 1993, and 1994 at 2,095, 620, and 695, respectively (see also Lowry et al. 1995). The variation between years was due, in part, to variability in the timing of the migration and movement of animals into the Sound. As a result the 1993 and 1994 estimates were considered to be negatively biased. Due to the disparity of estimates, the Norton Sound aerial surveys were repeated in June of 1995 leading to the highest abundance estimate of any year, but not significantly different than in 1992. An aerial survey conducted 22 June 1995 resulted in an uncorrected estimate of 2,583 beluga whales (Lowry and DeMaster 1996). It should be noted that a slightly higher estimate (2,666) occurred during the 1995 survey over 3-day period from June 6-8. The single day estimate of (2,583), instead of the 3-day estimate was used to minimize the potential for double counting of whales. Correction factors (CF) recommended from studies of belugas range from 2.5 to 3.27 (Frost and Lowry 1995). For Norton Sound, the correction factor of 2.62 (CV [CF] not available) is recommended for the proportion of animals that were diving and thus not visible at the surface (based on methods of Frost and Lowry 1995), given the particular altitude and speed of the survey aircraft. If this correction factor is applied to the June 22 estimate of 2,583 (CV = 0.26) along with the additional correction factor for the proportion of newborns and yearlings not observed due to their small size and dark coloration (1.18; Brodie 1971), the total corrected abundance estimate for the eastern Bering Sea stock is 7,986 ( $2,583 \times 2.62 \times 1.18$ ) beluga whales.



**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.

Aerial surveys of Norton Sound were also conducted in 2000. Preliminary analyses indicate that the uncorrected estimate was 5,868 animals; when corrected for animals not visible at the surface and for newborn and yearling animals not observed due to their small size and dark coloration, the estimated population size for Norton Sound is 18,142 (CV = 0.24; R. Hobbs, AFSC-NMML, pers. comm.).

### **Minimum Population Estimate**

For the eastern Bering Sea stock of beluga whales, the minimum population estimate ( $N_{\text{MIN}}$ ) is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Therefore,  $N_{\text{MIN}} = N/\exp(0.842 \times [\ln(1 + [CV(N)]^2)]^{1/2})$ . Using the population estimate (N) of 18,142 and an associated CV(N) of 0.24,  $N_{\text{MIN}}$  for this stock is 14,898 beluga whales. A CV(N) that incorporates variance due to all of the correction factors is currently not available. However, the Alaska Scientific Review Group considers the CV derived from the abundance estimate (CV = 0.24) as adequate in calculating a minimum population estimate (DeMaster 1996, 1997; see discussion of  $N_{\text{MIN}}$  for the eastern Chukchi stock of beluga whales).

### **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. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate ( $R_{\text{MAX}}$ ) 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:  $PBR = N_{\text{MIN}} \times 0.5R_{\text{MAX}} \times F_R$ . 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). For the eastern Bering Sea stock of beluga whales,  $PBR = 298$  animals ( $14,898 \times 0.02 \times 1.0$ ).

### **ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY**

#### **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.

Based on a lack of reported mortalities, the estimated minimum mortality rate incidental to commercial fisheries is zero belugas per year from this stock. The estimated mortality is considered a minimum due to a lack of observer programs in fisheries likely to take beluga.

In the nearshore waters of the eastern Bering Sea, substantial effort occurs in gillnet (mostly set nets), herring, and personal-use fisheries. The only reported beluga mortality in this region occurred in a personal-use king salmon gillnet near Cape Nome in 1996. NMFS assumes that all beluga whales used for subsistence, regardless of the method of harvest, are reported to the ABWC and are reflected in the following section on Subsistence/Native Harvest Information; however, some underreporting is known to occur (Unpublished SRG meeting minutes November 2004, available from Robyn Angliss, NMML, 7600 Sand Point Way NE, Seattle, WA 98115).

### 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 22 (K. Frost, University of Alaska, Fairbanks, pers. comm. 2007). Given these data, the annual subsistence take by Alaska Natives averaged 197 belugas landed from the eastern Bering Sea stock during the 5-year period 2002-2006 estimates are based on reports from ABWC representatives. The 1993-97 data are considered negatively biased due to a lack of reporting in several villages prior to 1996. In addition, there is not a reliable estimate for the number of struck and lost prior to 1996.

**Table 22.** Summary of the number of belugas landed by the Alaska Native subsistence harvest from the eastern Bering Sea stock of beluga whales, 2002-2006.

Year	Reported total number landed
2002	234
2003	101
2004	132
2005	249
2006	166
Mean annual number of animals landed (2002-2006):	197

### 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 (30) and, therefore, is considered to be insignificant and approaching zero mortality and serious injury rate. Based on currently available data, the estimated annual rate, over the 5-year period from 2002-2006, of human-caused mortality and serious injury (197, including the estimated mortality in non-commercial fisheries) is not known to exceed the PBR (298) for this stock. Eastern Bering Sea beluga whales are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. Therefore, the eastern Bering Sea beluga whale stock is not classified as strategic. No decreasing trend has been detected for this stock in the presence of a known harvest, although 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 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). 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. 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

- 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.
- Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1, 96 pp.
- DeMaster, D. P., K. Frost, L. Lowry, and T. Pierce. 1994. Abundance estimate for beluga whales (*Delphinapterus leucas*) in Norton Sound: June 1992, 1993, and 1994. Alaska Beluga Whale Committee Report No. 94-1, November 1994, 13 pp.
- DeMaster, D. P. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group. Anchorage, Alaska. 20 pp. (available upon request - 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 - 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. 1998. Harvest report: statewide summary for the eastern Bering Sea beluga population, 1995-97. Alaska Beluga Whale Committee Rep. 98-1. 15 pp.
- Frost, K. J. 2003. Harvest report: statewide summary for the western Alaska Beluga stocks, 1998-2002. Alaska Beluga Whale Committee Rep. 03-2. 16 pp.
- 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., and R. Suydam. 1995. Harvests of beluga whales, *Delphinapterus leucas*, in Alaska, 1987-1994. Working paper for Alaska Beluga Whale Committee Scientific Workshop, Anchorage, AK, 5-7 April 1995. 14 pp.
- 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.
- 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. F., K. J. Frost, D. P. DeMaster, and R. R. Nelson. 1995. Distribution and abundance of beluga whales in the Norton Sound/Yukon Delta region, 1992-1994. Working paper for Alaska Beluga Whale Committee Scientific Workshop, Anchorage, AK, 5-7 April 1995. 13 pp.
- Lowry, L. F., and D. P. DeMaster. 1996. Alaska Beluga Whale Committee beluga whale surveys in Norton Sound, June 1995. Alaska Beluga Whale Committee Report No.96-1. 5 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. *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.
- 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.
- 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* D. E. Withrow, 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.
- Tynan, C. T., and D. P. DeMaster. 1997. Observations and predictions of Arctic climate change: potential effects on marine mammals. *Arctic* 50(4):308-322.
- 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*): Bristol Bay Stock

### STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with concentrations in Cook Inlet, Bristol Bay, the Yukon Delta, Norton Sound, Kasegaluk Lagoon, and the Mackenzie Delta (Hazard 1988). It is assumed that most beluga whales from these summering areas overwinter in the Bering Sea, excluding those found in the northern Gulf of Alaska (Shelden 1994). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985).

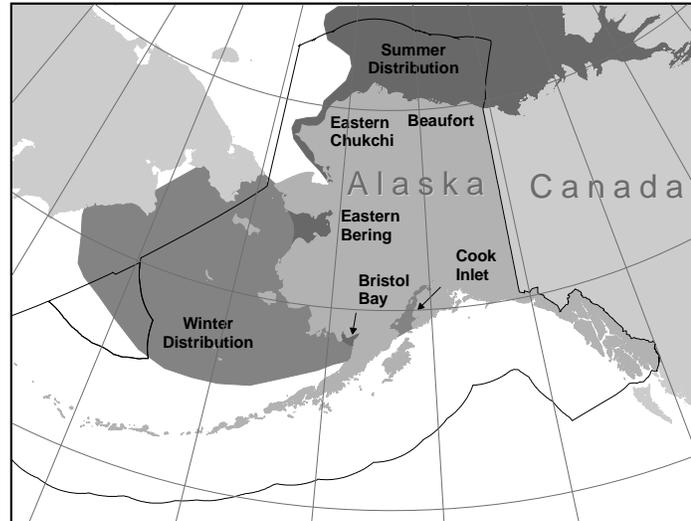
The general distribution pattern for beluga whales shows major seasonal changes. During the winter, they occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982) and give birth to and care for their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

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. 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).

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), distribution poorly known outside of summer; 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 summering areas (O'Corry-Crowe et al. 1997). Based on this information, 5 stocks of beluga whales 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. 18).

### 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 designed to specifically 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 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 (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



**Figure 18.** 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.

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 (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 (L. Lowry, University of Alaska Fairbanks, pers. comm.).

### **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):  $N_{MIN} = N / \exp(0.842 \times [\ln(1 + [CV(N)]^2)]^{1/2})$ . 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 4.7% per year (95% CI = 2.1%-7.2%; Lowry et al. in prep). 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 as such a high rate (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 considered stable (Frost and Lowry 1990) and because of the regular surveys to estimate abundance and the annual harvest monitoring program supported by the Alaska Beluga Whale Committee (ABWC), the recovery factor ( $F_R$ ) for this stock 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,  $PBR = 49$  animals ( $2,467 \times 0.02 \times 1.0$ ).

### **ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY**

#### **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 salmon set gillnet and drift gillnet fisheries which combined had over 2,900 active permits in 1996.

A reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in the Bristol Bay gillnet fisheries that have been known to interact with this stock in the past (Frost et al. 1984).

### 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 23 (K. Frost, University of Alaska Fairbanks, pers. comm. 2007) Given these data, the annual subsistence take by Alaska Natives averaged 17 belugas from the Bristol Bay stock during the 5-year period 2002-2006.

**Table 23.** Summary of the Alaska Native subsistence harvest from the Bristol Bay stock of beluga whales, 2002-2006. N/A indicates the data are not available.

Year	Reported total number landed
2002	9
2003	21
2004	16
2005	19
2006	20
Mean annual number of animals landed (2002-2006):	17

There is substantial effort in a subsistence gillnet fishery for salmon in Bristol Bay. There were 6 mortalities of beluga in subsistence salmon gillnet fisheries in 2000 and one mortality of a beluga whale in a subsistence gillnet in 2002 reported to the Alaska Beluga Whale Committee. If this level of mortality is averaged over 5 years, an average of 1.4 belugas per year would be caught in subsistence gillnet fisheries in this area. In addition, records indicate that one and two beluga whales were killed incidental to commercial salmon set nets in 2000 and 2002, respectively, and these animals were used for subsistence purposes. Thus, the total subsistence harvest resulting from net entanglements is 2 belugas per year. Note that these mortalities did not occur incidental to a commercial fishery, or did occur incidental to a commercial fishery and were used for subsistence purposes. As a result, this estimate is considered a minimum because personal-use fishers are not aware of a reporting requirement and there is no established protocol for non-commercial takes to be reported to NMFS. It should also be noted that in this region of western Alaska any whales taken incidentally to the personal-use fishery are used by Alaska Native subsistence users. It is not clear whether the mortalities reported in 2000 and 2002 are accounted for in the 2000 and 2002 Alaska Native subsistence harvest report; the subsistence harvest report will be used to document the reported take of beluga whales in Bristol Bay.

### 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 per year) because a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable. Bristol Bay beluga whales are not listed 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 (17) is not known to exceed the PBR (49). 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 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. 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.
- 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.
- 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.
- 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.
- 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. Sheldon, 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**

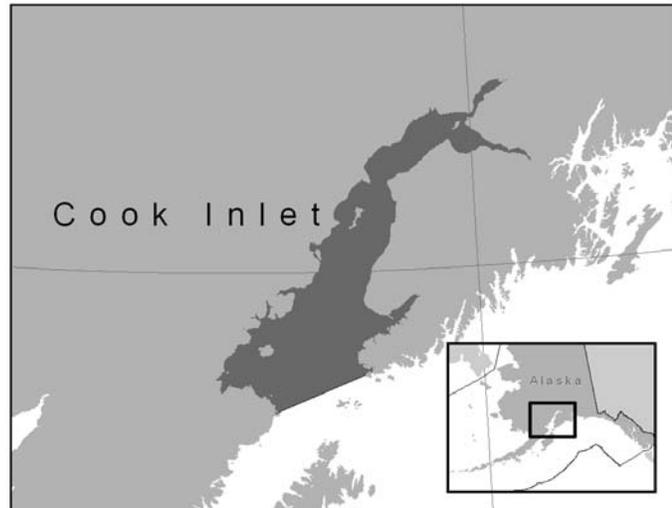
Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980) and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with concentrations in Cook Inlet, Bristol Bay, the Yukon Delta, Norton Sound, Kasegaluk Lagoon, and the Mackenzie Delta (Hazard 1988). 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 summering areas (O’Corry-Crowe et al. 2002). Based on this information, 5 stocks of beluga whales 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 spring and summer months, beluga whales in Cook Inlet are typically concentrated near river mouths in the northern Inlet (Rugh et al. 2000). Although the exact winter distribution of this stock is unknown, there is evidence that some, if not all, of this population may inhabit Cook Inlet year-round (Fig. 19; Hansen and Hubbard 1999, Rugh et al. 2000). Satellite tags have been attached to 17 belugas in late summer in order to determine their distribution through the fall and winter (Hobbs et al. 2005). Ten tags lasted through the fall, and of those, three lasted through the winter. The three tags that transmitted through the winter stopped working in April and late May. No tagged beluga moved south of Chinitna Bay on the west side of Cook Inlet. A review of all cetacean surveys conducted in the Gulf of Alaska from 1936 to 2000 discovered only 31 sightings of belugas among 23,000 sightings of other cetaceans, 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) also occur in Yakutat Bay; while not included in the Cook Inlet DPS as listed under the ESA, the Yakutat beluga group is considered part of the Cook Inlet stock. (73 FR 62919, 22 October 2008).

**POPULATION SIZE**

Aerial surveys for beluga whales in Cook Inlet have been conducted by the National Marine Fisheries Service each year since 1993. Starting in 1994, the survey protocol included paired, independent observers so that the number of whale groups missed can be estimated. When groups were seen, a series of aerial passes were made to allow each observer to make independent counts at the same time that a video camera was photograph recording the whale group (Rugh et al. 2000).

The annual abundances of beluga whales in Cook Inlet are estimated from counts by aerial observers and aerial video group counts. Each group size 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. 2000b). When video counts are not available, observer’s counts are corrected for availability and sightability using a regression of counts and an interaction term of counts with encounter rate against the video group size estimates (Hobbs et al. 2000b). The most recent abundance estimate of beluga whales in Cook Inlet, resulting from the 2008



**Figure 19.** Approximate distribution of beluga whales in Cook Inlet. The dark shading displays the summer distribution.

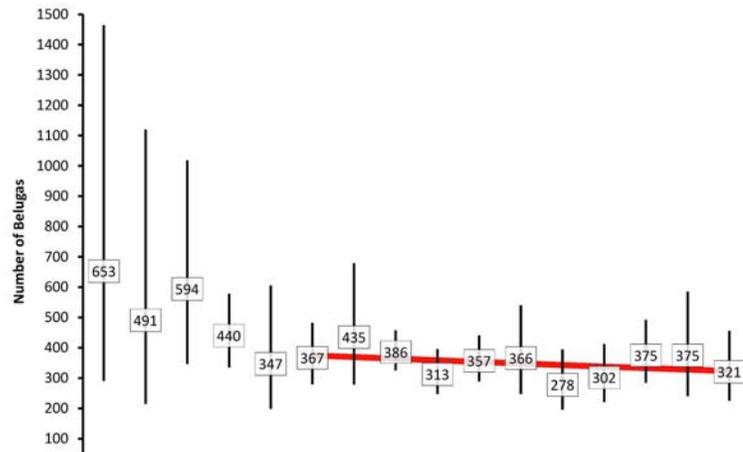
aerial survey is 375 (CV = 0.23) animals, the same number of whales estimated from the 2007 aerial survey (375 CV = 0.14) (Hobbs and Shelden 2008, NMFS unpubl. data 2009). While this estimate is larger than the estimates of 278 for 2005 and 302 for 2006, it is equivalent to the average of 370 fits well with the declining trend for the years 1999-2004. Abundance estimates based on aerial surveys of Cook Inlet beluga over the last 3-year period were 375 (2007), 375 (2007), and 321 (2009). Based on an average population estimates of the Cook Inlet beluga over the last 3 years, the abundance estimate for this stock is 355 (CV = 0.10).

### Minimum Population Estimate

The minimum population size ( $N_{MIN}$ ) 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 3-year average population estimate (N) of 375 and its associated CV(N) of 0.23,  $N_{MIN}$  for the Cook Inlet stock of beluga whales is 314.

### Current Population Trend

The corrected abundance estimates for the period 1994-2008 are shown in Figure 20. A statistically significant declining trend in abundance was detected between 1994 and 1998 (Hobbs et al. 2000a), although the power of the analysis was low due to the short time series. A Bayesian inference on the population size estimates for 1994-2005 gave a modal estimate of the current trend during that period of -1.2% per year, with a 71% probability that the population was declining (Lowry et al. 2006). A trend line fit to the estimates for 1999 to 2008 estimates an average rate of decline of 1.45% (SE = 0.014) per year. A recent review of the status of the population indicated that there is an 80% chance that the population will decline further (Hobbs and Shelden 2008).



**Figure 20.** Abundance of beluga whales in Cook Inlet, Alaska 1994-2008 (Rugh et al. 2005, Hobbs and Shelden 2008). Error bars depict 95% confidence intervals. In the years since a hunting quota was in place (1999-2009), the rate of decline (red trend line) has been -1.49% per year.

### CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently not available for the Cook Inlet stock of beluga whales. Hence, until additional 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). 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:  $PBR = N_{MIN} \times 0.5R_{MAX} \times Fr$ . The  $Fr$  and PBR for the Cook Inlet stock of beluga whale were both undetermined in Small and DeMaster (1995). 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 stock of beluga whale does not appear to be increasing. Because this stock does not meet the assumptions inherent to the use of the PBR, NMFS cannot determine a maximum number that may be removed while allowing the population to achieve OSP. Thus, the PBR is undetermined for the Cook Inlet stock of beluga whale.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

In 1999 and 2000, observers were placed on Cook Inlet salmon set and drift gillnet vessels because of the potential for these fisheries to entangle beluga whales. No mortalities or serious injuries were observed in either year (Manly 2006).

A photogrammetric 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.

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

### Subsistence/Native Harvest Information

Subsistence harvest of beluga whales in Cook Inlet has been important to local villages. Between 1993 and 1999, the annual subsistence take ranged from 30 to over 100 animals (Mahoney and Shelden 2000). The average annual subsistence harvest for 1995 and 1996 was 87 whales.

Following a significant decline in Cook Inlet beluga whale abundance estimates between 1994 and 1998, the Federal Government took actions to 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 by the Alaska Native organizations and NMFS. Three belugas were harvested in Cook Inlet under the interim harvest plan (2001-2004). In August 2004 an administrative law judge hearing occurred was held to determine a long-term harvest plan. The recommended decision allowed a total of 8 whales to be harvested between 2005 and 2009, followed by the use of a table of allowable harvest levels from 2010 until recovery. This table would set harvest levels dependent on the previous 5-year periods for an average abundance and previous 10-year period to determine the growth rate (increasing, stable, or decreasing). No harvest would be allowed if the 5-year average abundance dropped below 350 beluga. Because the 5-year average abundance was below 350 whales for the 2003-2007 time period, the allowable harvest during the next subsequent 5-year period, 2008–2012, was set at zero. (73 FR 60976; 15 October 2008).

**Table 24.** Summary of the Alaska Native subsistence harvest from the Cook Inlet stock of beluga whales, 2004-2008.

Year	Reported total number taken	Reported number harvested	Estimated number struck and lost
2004	0	0	0
2005	2	2	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	0
Mean annual take (2004-2008)	0.4		

### OTHER MORTALITY

Mortalities related to stranding events have been reported in Cook Inlet (Table 25). Since improved recordkeeping was initiated in 1994, there are more reports of stranded belugas in Cook Inlet, including live strandings. These live strandings resulted in suspected mortalities of 5 animals in 1996, 5 animals in 1999, and 5 animals in 2003 (Vos and Shelden 2005) and 1 animal in 2005 (Hobbs and Shelden 2008). Many of the live strandings occurred in Turnagain Arm. Because Turnagain Arm is a shallow, dangerous waterway, it is not frequented by motorized vessels, and thus it is unlikely that the strandings resulted from human interactions on the water. A live stranding of 17-20 animals occurred in Knik Arm in 2009; however, there were no mortalities reported from that event. Another source of

mortality in Cook Inlet is killer whale predation. Killer whale sightings were rare in the upper Inlet prior to the mid-1980s, but have increased and include 18 reported sightings from 1985 to 2002 (Shelden et al. 2003). The three most recent predation events that occurred in the upper Inlet were in 1) September 1999 in which the outcome was unknown, 2) in September 2000 that involved two lactating female belugas that subsequently died (Shelden et al. 2003), 3) August 2003 where a male beluga died (Vos and Shelden 2005), and 4) in September 2008 where an adult beluga (sex not yet determined) died (Hobbs and Shelden 2008).

#### STATUS OF STOCK

Efforts to develop co-management agreements with Alaska Native organizations for several marine mammal stocks harvested by Native subsistence hunters across Alaska, including belugas in Cook Inlet, have been underway for several years. An umbrella agreement on co-management among the Indigenous People’s Council for Marine Mammals, U.S. Fish and Wildlife Service, and NMFS was signed in August 1997, and an updated co-management agreement was signed in October 2006. During 1998, efforts were initiated to formalize a specific agreement between local Alaska Native organizations and NMFS regarding the management of Cook Inlet belugas, but without success.

Federal legislation was implemented in May 1999, placing a moratorium on beluga hunting in Cook Inlet except under cooperative agreements between NMFS and affected Alaska Native organizations. Co-management agreements between NMFS and the Cook Inlet Marine Mammal Council have since been signed for 2000-2003 and 2005-2006.

#### Habitat Concerns

Observation and tagging data both indicate that the northernmost parts of upper Cook Inlet, including the Susitna Delta, Knik Arm, and Chickaloon Bay, are the focus of the stock’s distribution in both summer (Rugh et al. 2000; Goetz et al. 2007) and winter (Hobbs et al. 2005). Because of the very restricted range of this stock, Cook Inlet beluga can be assumed to be vulnerable to human-induced or natural perturbations within their habitat. Although the best available information has indicated that human activities, including oil and gas development, had not caused the stock to be in danger of extinction as of 2000 (65 FR 38778; 22 June 2000), potential effects of human activities on recovery remain a concern (73 FR 62919, 22 October 2008). Additional concerns which have the potential to impact this stock or its habitat include changes in prey availability due to climate changes; competition with fisheries for available prey; contaminants and sounds associated with oil and gas exploration; vessel traffic; waste management and urban runoff; and physical habitat modifications that may occur as upper Cook Inlet becomes increasingly urbanized (Moore et al. 2000, Lowry et al. 2006). A photogrammetric study by Kaplan et al. (2009) recorded a few instances where belugas had probably been struck by boat propellers or ships. Projects planned that may alter the physical habitat include a highway bridge across Knik Arm, ferry operations in lower

Year	Total Dead of Natural or Unknown Cause	Number of Belugas per Live Stranding Event* (associated known mortalities)
1994	10	186 (0)
1995	3	0
1996	12	63(0), 60(4), 25(1), 1(0), 15(0)
1997	3	0
1998	10	30(0), 5(0)
1999	12	58(5), 13(0)
2000	13 (2 killer whale)	8(0), 17(0), 2(0)
2001	10	0
2002	13	0
2003	20 (1 killer whale)	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 killer whale)	28(0), 30(0)
2009	4	17-20 (0)
Total	16973	67390-67898 (16)

**Table 25.** Cook Inlet beluga strandings investigated by NMFS (Vos and Shelden 2005; Hobbs and Shelden 2008). \* Harvested beluga are not included in the number dead. \*\* Many belugas that strand do not die. Although some mortalities may have been missed by observers, and animals may die later of stranding-related injuries, the majority of animals involved in a stranding event often survive.

Knik Arm, construction and operation of a coal mine near Chitna, and improvements to the Port of Anchorage. NMFS released a proposed rule to designate two areas comprising 7,809 square miles of marine habitat as critical habitat for the Cook Inlet beluga (74 FR 63080, 2 December 2009).

## CITATIONS

- 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. *Marine 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 Management 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., D. J. Rugh, and D. P. DeMaster. 2000a. Abundance of belugas, *Delphinapterus leucas*, in Cook Inlet, Alaska, 1994-2000. *Mar. Fish. Rev.* 62(3):37-45.
- 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., J. M. Waite, and D.J. Rugh. 2000b. Beluga, *Delphinapterus leucas*, group sizes in Cook Inlet, Alaska, based on observer counts and aerial video. *Mar. Fish. Rev.* 62(3):46-59.
- 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. Zerbin, 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. Draft report to the NMFS Alaska Region. 83 pp.
- 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. 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 neartic. 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., K. E. W. Shelden, C. L. Sims, B. A. Mahoney, B. K. Smith, L. K. Litzky, and R. C. Hobbs. 2005. Aerial surveys of belugas in Cook Inlet, Alaska, June 2001, 2002, 2003, and 2004. U. S. Dep. Commer., NOAA Tech Memo. NMFS-AFSC-149, 71 pp.
- 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.
- Small, R.J., and D. P. DeMaster (eds.) 1995. Alaska marine mammal stock assessments, 1995. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-57, 93 pp.
- Vos, D., and K.E.W. Shelden. 2005. Unusual mortality in the depleted Cook Inlet beluga (*Delphinapterus leucas*) population. *Northwestern Naturalist* 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; population definition is based on 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 (Palsbøll et al. 1997; de March et al. 2001, 2003).



**Figure 32.** 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 records 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 Kivalik 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.

Which of the Canadian populations narwhal in Alaska belong is unknown. 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 ( $N_{\text{MIN}}$ ) 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 ( $R_{\text{MAX}}$ ) 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:  $PBR = N_{\text{MIN}} \times 0.5R_{\text{MAX}} \times F_R$ . 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**

##### **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 listed 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 Alaska stock of narwhals is not classified as strategic.

#### **CITATIONS**

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

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](http://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. Grøn. Biosci.* 39: 69-86.
- 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. *Journal of Mammalogy*, 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.
- 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. *Jour. Mamm.* 33:496.
- Koski, W.R. and R.A. Davis. 1994. Distribution and numbers of narwhals (*Monodon monoceros*) in Baffin Bay and Davis Strait. *Medd. Grøn. 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. Natl. 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.
- 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*. *Mammalian 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.
- 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

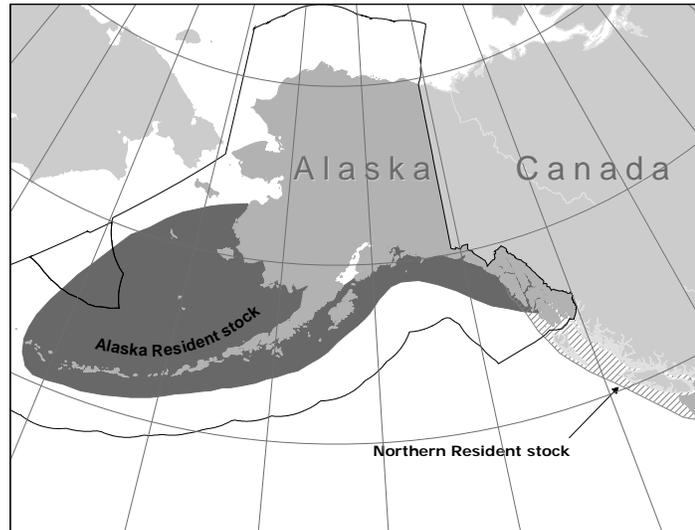
### STOCK DEFINITION AND GEOGRAPHIC RANGE

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, and 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 pods have been labeled as 'resident,' 'transient,' and 'offshore' (Bigg et al. 1990, Ford et al. 2000) based on aspects of morphology, ecology, genetics, acoustics and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). 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 southeastern 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 southeastern Alaska and central California have also been documented (Goley and Straley 1994).

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). Separate stock assessment reports have always acknowledged the distinction between resident, offshore, and transient killer whale populations.

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 Alaskan residents. Alaskan 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.

Based on data regarding association patterns, movements, acoustics, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. EEZ: 1) the Alaska Resident stock - occurring from



**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).

southeastern Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from British Columbia 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 British Columbia 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 (see Fig. 21), 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.

Movement data on Alaska Resident stock members have been documented based on photographic matches. Southeastern Alaska killer whale pods have been seen in Prince William Sound (Matkin et al. 1997) and in the Gulf of Alaska. Prince William Sound pods have been seen near Kodiak Island but never observed in southeastern Alaska (Matkin et al. 2003, Dahlheim et al. 1997). New information on movements of western Alaska killer whales is being analyzed. However, recent studies have documented movements between the Bering Sea and Gulf of Alaska (NMML unpublished data).

## 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, 117,109 'resident' whales have been identified as of 2004<sup>9</sup> (NMML and North Gulf Oceanic Society (NGOS), 3430 Main Street, Suite B1, Homer, Alaska; unpublished data). In Prince William Sound and Kenai Fjords, another 504,675 resident whales have been identified as of 2004<sup>9</sup> (Matkin et al. 2003; C. Matkin, North Gulf Oceanic Society, pers. comm.). ~~In the last stock assessment, a minimum count of 68 western Alaska whales were added to the count because photo-identification data indicated that they associate with Prince William Sound whales. Given that this information is now over 10 years old, we opted to deduct these 68 whales from the current counts because there is no way to know whether these animals are alive.~~

Beginning in 2001, dedicated killer whale studies were initiated by NMML in Alaska waters west of Kodiak Island, including the Aleutian Islands and Bering Sea. Between 2001 and 2003<sup>9</sup> ~~(not all data from 2003 have been analyzed)~~, using field assessments based on morphology, association data, and genetic analyses, additional resident whales have now been 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 2004<sup>5</sup> and 2003<sup>9</sup> as 4641,300 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 9053 km of tracklines were surveyed between the Kenai Peninsula (~150°W) and Amchitka Pass (~179°W). 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 1,123,084 (Southeast Alaska + Prince William Sound + Western Alaska; 117,109 + 501,675 + 505,300) killer whales belonging to the Alaska Resident stock (Table 26).

**Table 26.** 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)	2005-2009 estimate (and source)
<b>Southeast Alaska</b>			
AF	49 (Dahlheim et al. 1997, Matkin et al. 1999)	61 (C. Matkin, NGOS, pers. comm.)	69 (C. Matkin, NGOS, pers. comm.)
AG	27 (Dahlheim et al. 1997, Matkin et al. 1999)	33 (C. Matkin, NGOS, pers. comm.)	40 (C. Matkin, NGOS, pers. comm.)
AZ	23+ (Dahlheim, AFSC-NMML, pers. comm.)	23+ (Dahlheim et al. 1997)	Not seen since prior to 1997
<b>Total, Southeast Alaska</b>	<b>99+</b>	<b>117+</b>	<b>109 (excluding AZ)</b>
<b>Prince William Sound</b>			
	<b>Matkin et al. 1999</b>	<b>Matkin et al. 2003 and C. Matkin, NGOS, pers. comm.</b>	<b>Matkin et al. 2003 and C. Matkin, NGOS, pers. comm.</b>
AA1	---	8	8
AA30	---	---	28
AB17	25	19	19
AB25	---	10	9
AD05	---	16	17
AD16	7	4	8
AE	16	19	17
AH01		9	9
AH20		12	12
AI	7	7	7
AJ	38	42	50
AK	12	13	16
AL	---	---	23
AN10	20	27	28
AN20	assume 9	33	30
AS	assume 20	21	22
AS30		14	13
AW		24	33+
AX01	21	20	29
AX27		24	25
AX32		15	19
AX40		14	14
AX48		20	23
AY	assume 11	18	17
Unassigned to pods	138 (C. Matkin, NGOS, pers. comm.)	112	199
<b>Total, Prince William Sound/ Kenai Fjord/ Kodiak</b>	<b>341</b>	<b>501</b>	<b>675</b>
<b>Western Alaska</b>	<b>Dahlheim 1997 and NMML unpublished data</b>	<b>2001/2003 NMML unpublished data</b>	<b>2000-2009 NMML/NGOS unpublished catalog</b>

Pod ID	1999/2000 estimate (and source)	2001/2004 estimate (and source)	2005-2009 estimate (and source)
Unassigned to pods (NMML)	68+	464	1,300 (D. Ellifrit pers. comm. Feb. 2010)
Unassigned to pods (NGOS; Kodiak waters only)		41 (C. Matkin, NGOS, pers. comm.)	
<b>Total, Western Alaska</b>	<b>68+</b>	<b>505</b>	<b>1,300</b>
<b>Total, all areas</b>	<b>507</b>	<b>1,123</b>	<b>2,084<sup>1</sup></b>

<sup>1</sup>Although there is evidence (Matkin et al. 2003) 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 2000-2009 period.

### 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 is 1,123 animals. 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 preliminary data from 2004 indicates that the rate of discovering new individual whales has decreased (NMML unpublished data).

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

Recent 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 has increased 3.32% (95% CI = 1.94 to 4.36%) per year from 1984<sup>90</sup> to 2002<sup>5</sup> (Matkin et al. 2008). Although the current minimum population count of 1,123 is higher than the last population count of 507, 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,  $PBR = 11,2320.8$  animals ( $1,1232,084 \times 0.02 \times 0.5$ ).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### 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~~two which incurred serious injuries or mortalities of killer whales (any stock) between 2002 and 2004: the BSAI flatfish trawl, the BSAI pollock trawl, and the BSAI Pacific cod longline. The mean annual (total) mortality rate for all fisheries from 2002-2004 was 1.96 (CV = 0.428). Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006). A single mortality occurred in the BSAI Greenland turbot longline in 2007.

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 the killer whales have indicated that the mortalities incidental to the BSAI flatfish trawl and the BSAI Pacific cod fisheries are of the “resident” type, and mortalities incidental to the BSAI pollock trawl fishery are of the “transient” type (M. Dahlheim, pers. comm.). Thus, the mean annual estimated level of serious injury and mortality of Alaska resident killer whales is 1.481.19/year (Table 27).

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 occur due to contact with the ship’s propeller.

**Table 27.** Summary of incidental mortality of killer whales (Alaska resident stock) due to commercial fisheries from 2002 to 2004 and calculation of the mean annual mortality rate. Data from 2007 and 2008 are preliminary; estimates of percent observer coverage and CVs are not currently available for some preliminary 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	2000	obs data	64.5	0	0	0.640.35 (CV = 0.4466)
	2001		57.6	1	1.5	
	2002		58.4	0	0	
	2003		64.1	0	0	
	2004		64.3	1 <sup>1</sup>	1.8	
	2005		70.3	0	0	
	2006		67.8	0	0	
	2007		-	0	0	
	2008		-	0	0	
BSAI Pacific cod longline	2000	obs data	35.2	0	0	0.84 (CV = 0.87)
	2001		29.5	0	0	
	2002		29.6	0	0	
	2003		29.9	1	4.2	
	2004		23.8	0	0	
	2005		24.6	0	0	
	2006		23.9	0	0	
	2007		-	0	0	
	2008		-	0	0	
BSAI Greenland turbot longline	2007	obs data	68.9	1 <sup>2</sup>	1.5	0.75 (CV = 0.56)
	2008		-	0	0	
Estimated total annual mortality						1.481.19 (CV = 0.5364)

<sup>1</sup> A second killer whale mortality may have occurred in 2004; genetics results determining whether the samples are from one, or two individuals, are pending.

<sup>2</sup> Genetics are not available to confirm whether this observed mortality was of a resident or transient killer whale. Thus, this mortality will be reflected in the SARs for both stocks.

The estimated minimum mortality rate incidental to U. S. commercial fisheries recently monitored is ~~4.5~~1.2 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 what group or groups of individuals are 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.

Recently, several fisheries observers reported that large groups of killer whales in the Bering Sea have followed 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 resident killer whales in the BSAI flatfish trawl fishery.

### **STATUS OF STOCK**

The eastern North Pacific Alaska Resident stock of killer whales is not listed 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 (~~4.5~~1.2) exceeds 10% of the PBR (1.1) and therefore cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (~~4.5~~1.19 animals per year) is not known to exceed the PBR (11.2). 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**

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.
- 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.
- 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 upon request - Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115).
- 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 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.
- 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., 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., 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. O., D. R. Matkin, G. Ellis, E. Saulitis, and D. McSweeney. 1997. Movements of resident killer whales (*Orcinus orca*) in southeastern Alaska and Prince William Sound, Alaska. *Mar. Mamm. Sci.* 13 (3): 469-475.
- 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 CO, Saulitis EL, Ellis GM, Olesiuk P, Rice SD. 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.
- 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.
- 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. 2004. Status Review of the AT1 Group of killer whales from the Prince William Sound and Kenai Fjords area. Unpublished document.
- 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**

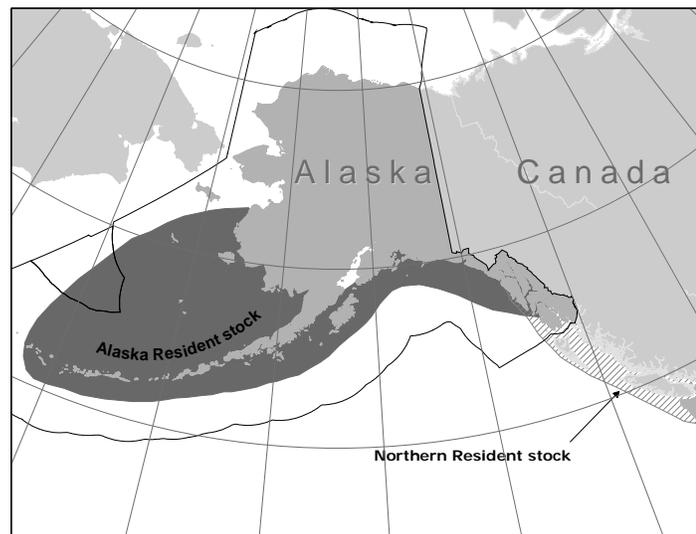
### **STOCK DEFINITION AND GEOGRAPHIC RANGE**

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 pods have been labeled as ‘resident,’ ‘transient,’ and ‘offshore’ (Bigg et al. 1990, Ford et al. 2000) 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). 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).

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). **Separate stock assessment reports have always acknowledged the distinction between residents, offshore, and transient killer whale populations.**

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 throughout 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. ~~Separate stock assessment reports have always acknowledged the distinction between residents, offshore, and transient killer whale 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 British



**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).

Columbia 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 British Columbia 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 (see Fig. 22), 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 known range of the Northern Resident stock includes Canadian waters from approximately Mid-Vancouver Island and throughout most of southeastern Alaskan waters. The Eastern North Pacific Northern Resident stock is a transboundary stock, and includes killer whales that frequent British Columbia, Canada and southeastern Alaska (Ford et al. 2000, Dahlheim unpublished data). They have been seen infrequently in Washington state waters.

### POPULATION SIZE

The Eastern North Pacific Northern Resident stock is a transboundary stock, and includes killer whales that frequent British Columbia, Canada and southeastern Alaska. Photo-identification studies since 1970 (Ford et al. 2000) have catalogued every individual in this population resulting in the following minimum count for ‘resident’ killer whales belonging to the Eastern North Pacific Northern Resident stock (Note: note that individual whales that have been matched between geographical regions and missing animals likely to be dead have been subtracted). A count of The photo catalog included 216 ‘resident’ whales was made as of 1998 (Ford et al. 2000; Table 28). Births and deaths since 1998 are not accounted for here.

**Table 28.** 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
A1	15	16
A4	11	11
A5	12	13
B1	9	7
C1	13	14
D1	7	12
H1	8	9
I1	10	8
I2	7	2
I18	19	16
G1	28	29
G12	11	13
I11	18	22
I31	10	12
R1	23	29
W1	3	3
<b>Total</b>	<b>204</b>	<b>216</b>

### Minimum Population Estimate

The survey technique utilized used for obtaining the estimating abundance estimate 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 period, each individual is well documented, and except for births, no new individuals are expected to be discovered. Therefore, the estimated population size of 216 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 216 animals, which includes animals found in Canadian waters (see PBR Guidelines (Wade and Angliss 1997) regarding

the status of migratory transboundary stocks, Wade and Angliss 1997). 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. This approach is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1996).

### **Current Population Trend**

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). These rates were for combined northern and southern resident communities. Recent analyses indicate that some pods in the Northern Resident population had increased at approximately 3% per year and were apparently approaching carrying capacity since their rates of increase appeared to be slowing (P. Olesiuk as reported in Dahlheim et al. 2000) in the early 1990s, and the population declined from approximately 1997 to 2001; the population increased back to approximately the 1997 level by 2004 (Ford et al. 2005).

### **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 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). Recent analyses indicate that some pods in the Northern Resident population had increased at approximately 3% per year (P. Olesiuk as reported in Dahlheim et al. 2000). Therefore, the maximum net productivity rate ( $R_{MAX}$ ) is estimated to be 3%. Until more recent 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 Northern Resident killer whale stock,  $PBR = 216 \times 0.02015 \times 0.5$ .

### **ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY**

#### **Fisheries Information**

Due to limited coverage by Canadian observer programs, there are few data on the mortality of marine mammals incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with killer whales). 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. No killer whale interactions have been reported in the British Columbia halibut longline fishery. Since 1990, there have been no reported fishery-related strandings 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). Data regarding the level of killer whale mortality related to commercial fisheries in Canadian waters, though thought to be small, are not readily available or reliable which could result in an underestimate of the annual mortality for this stock.

#### **Subsistence/Native Harvest Information**

There are no reports of a subsistence harvest of killer whales. 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 2008). 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). However, it is unknown whether these interactions also occur in Canada.

## STATUS OF STOCK

The Northern Resident killer whale stock is not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. In April 1999, the Committee on the Status of Endangered Wildlife in Canada voted to designate all northern resident killer whales in British Columbia as “threatened” and listed in Schedule 1 of the Species at Risk Act (SARA) for Canada, and the “threatened” designation appears to have been based on the fact that the small size and low growth rate make the northern resident populations at risk from immunotoxic effects of persistent toxic chemicals and a reduction in prey availability (Baird 1999). Baird (1999) also indicates that the commercial and recreational whale watching industry may be having an impact. 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.) It is likely that the human-caused mortality level for this stock is underestimated. The human-caused mortality has likely been underestimated due primarily to a lack of information on Canadian fisheries; however, a review of the status of killer whales in Canada indicated that the available evidence suggests that mortality incidental to commercial fisheries is rare and does not have the potential to cause substantial population reductions in the future (Baird, 1999).

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 (0.220.16) 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 (1) is not known to exceed the PBR (2.21.6). 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

- 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.
- 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.
- 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 upon request - Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115).
- 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., D. Bain, D. P. DeMaster, and C. Simms. 2000. Report of the Southern Resident Killer Whale Workshop, 1-2 April 2000, Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle, WA 98115. AFSC Processed Rep. 2000-06, 17 pp.
- 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.
- 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., 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. 104 pp.
- Ford, J.K.B., G.M. Ellis, 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.
- 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. Ro. Soc. London* 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.
- Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. *J. Fish. Res. Bd. Can.* 32:914-916.
- Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. *Rep. Int. Whal. Comm.* (Special Issue 12):209-242.
- 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.

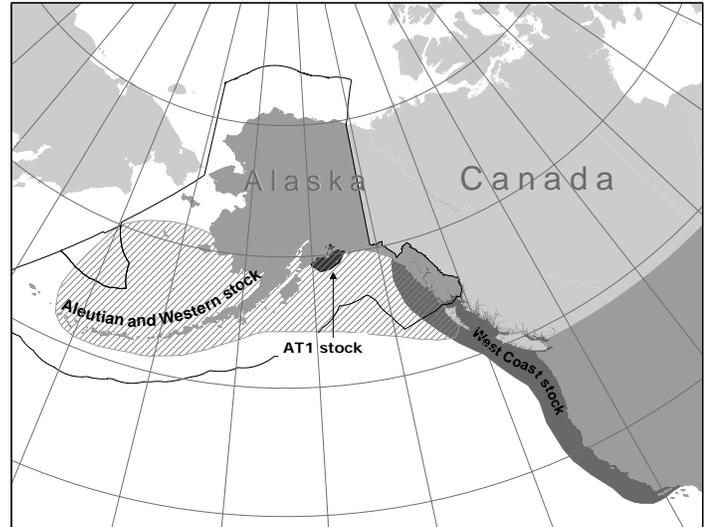
**KILLER WHALE (*Orcinus orca*):  
Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock**

**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, and 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 pods have been labeled as ‘resident,’ ‘transient,’ and ‘offshore’ (Bigg et al. 1990, Ford et al. 2000) 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). 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).

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).

Until recently, transient killer whales of Alaska had only been studied intensively in southeastern 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 communities of transients which were never found in association with one another, the so-called ‘Gulf of Alaska’ transients and ‘AT1’ transients. Neither of these communities associates with transient killer whales that range from California to southeastern Alaska, which has been termed the ‘west coast’ community. ‘Gulf of Alaska’ transients are seen 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. Transients that associate with the ‘Gulf of Alaska’ community have been found to have two mtDNA haplotypes, neither of which is found in the west coast or AT1 communities. Members of the AT1 community share a single mtDNA haplotype. Transient killer whales from the ‘west coast’ community have been found to share a single mtDNA haplotype that is not found in the other communities. Additionally, all three communities have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found, as well, as Saulitis (1993) described acoustic differences between ‘Gulf of Alaska’ transients and AT1 transients. For these reasons, the



**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).

'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.

Recent research in western Alaska, particularly along the south side of the Alaska Peninsula and in the eastern Aleutian Islands, have identified transient killer whales that share acoustic calls and mtDNA haplotypes with the Gulf of Alaska transients (NMML unpublished, North Gulf Oceanic Society unpublished), suggesting transient whales there may be part of the same population as Gulf of Alaska transients. However, samples from the central Aleutian Islands and Bering Sea have identified mtDNA haplotypes not found in Gulf of Alaska transients, suggesting the possibility there is some population structure in western Alaska. At this time, there are insufficient data to further resolve transient population structure in western Alaska. Therefore, 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 also seen in the northern Bering Sea and Beaufort Sea, but little is known about these whales and they are assumed to be part of this stock if they are transient-type 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) confirms that 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, movements, acoustics, 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 British Columbia 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 British Columbia 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 (see Fig. 23), 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), 6082 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 1011 matches were found between the NGOs and NMML catalogues. Therefore, a total of 93114 transients (6082 + 43 - 1011) 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 (D Ellifrit, pers. comm.) now contains 438 whales (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 (438) with the Gulf of Alaska count (114), a total count of 552 individual whales have been identified in catalogs of this stock. using data from 2001-03, NGOs identified a total of 123 transient killer whales. Over the same time period, NMML identified 124 transient killer whales. Twenty six matches were found between these two catalogues, leaving a total of 221 transient whales (123+124-26) identified in the Aleutian Islands and Bering Sea (not counting 3 whales previously identified in the eastern area). Combining the counts of catalogued 'transient' whales gives a minimum number of 314 (93 + 221) transient killer whales belonging to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient 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. in press). A total of 154 individuals were identified from 6489 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, unpublished data). 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.

~~The line transect surveys provide an “instantaneous” (across ~40 days) estimate of the number of transient 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 and Pribilof Islands~~ that were outside the line-transect survey area. ~~The photo catalogue also encompasses a much long time period (through 2008).~~ 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 20<sup>th</sup> percentile of the line transect survey estimate is 167. ~~The 20<sup>th</sup> percentile of the mark-recapture estimates of 345 is ~303.~~ A total count of 552 individual whales have been identified in the Gulf of Alaska, Aleutian Islands, and Bering Sea transient killer whale stock. 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 can not 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 to 2003~~ 1999 to 2009, 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, 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<sup>th</sup> 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 ~~314~~ 552 animals based on the count of individuals using photo-identification.

### Current Population Trend

At present, reliable data on trends in population abundance for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient 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,  $PBR = 3,455.5$  animals ( $344,552 \times 0.02 \times 0.5$ ). 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

### 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 2000<sup>2</sup> and 2004<sup>6</sup>: the BSAI flatfish trawl, the BSAI pollock trawl, and the BSAI Pacific cod longline. The mean annual (total) mortality rate for all fisheries for 2000<sup>2</sup>-2004<sup>6</sup> was 1.9<sup>6</sup> ( $CV = 0.428$ ). Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006). **A single serious injury/mortality event occurred in the BSAI Greenland turbot longline in 2007.**

Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006). 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 the killer whales have indicated that the mortalities incidental to the BSAI flatfish trawl and the BSAI Pacific cod fisheries are of the “resident” type, and mortalities incidental to the BSAI pollock trawl fishery are of the “transient” type (M. Dahlheim, NMML-AFSC, pers. comm.). Thus, the mean annual estimated level of serious injury and mortality of the Gulf of Alaska, Aleutian Islands, Bering Sea transient killer whale stock for 2002-2006 is 0.4/year (Table 29).

**Table 29.** Summary of incidental mortality of killer whales (Eastern North Pacific Transient stock) due to commercial fisheries and calculation of the mean annual mortality rate. Mean annual takes are based on 2000<sup>2</sup>-2004<sup>6</sup> data. **Data from 2007 and 2008 are preliminary; estimates of percent observer coverage and CVs are not currently available for some preliminary 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)
BSAI pollock trawl	2000	obs data	76.2	0	0	0.41 (CV = 0.22)
	2001		79.0	0	0	
	2002		80.0	1	1	
	2003		82.2	0	1 <sup>1</sup>	
	2004		81.2	0	0	
	2005		77.3	0	0	
	2006		73.0	0	0	
	2007		95.0	0	0	
	2008		88.6	0	0	
BSAI Greenland turbot longline	2007	obs data	68.9	1 <sup>2</sup>	1.5	0.75 (CV = 0.56)
	2008		-	0	0	
Estimated total annual takes						0.41 (CV = 0.22)

<sup>1</sup> Killer whale mortality seen by the observer, but not in a monitored haul.

<sup>2</sup> Genetics are not available to confirm whether this observed mortality was of a resident or transient killer whale. Thus, this mortality will be reflected in the SARs for both stocks.

### **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 only 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 (0.4) exceeds 10% of the PBR (0.3) and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (0.4 animals per year) is less than the PBR (3.1). 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.

### **REFERENCES**

- 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.
- 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.
- 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 at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
- 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.

- Durban, J., Ellifrit, D., Dahlheim, M.I, Waite, J.I, Matkin, C., Barrett-Lennard, L., Ellis, G., Pitman, R., LeDuc, R, and Wade, P.R. Accepted. Photographic mark-recapture analysis of clustered mammal-eating killer whales around the Aleutian Islands and Gulf of Alaska. *Marine Biology*.
- 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.
- 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. London* 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., 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. *Fishery Bulletin* 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.
- 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.
- 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.

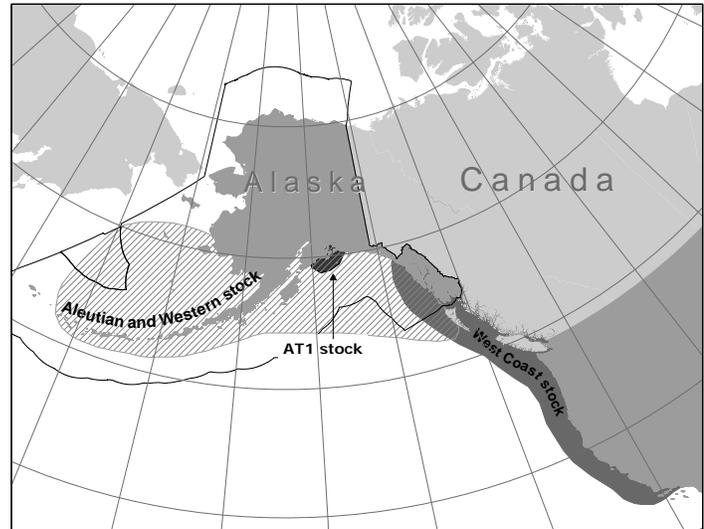
**KILLER WHALE (*Orcinus orca*):  
AT1 Transient Stock**

**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, and 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; Dahlheim et al. 2009) and in the intracoastal waterways of British Columbia and Washington State, where pods have been labeled as ‘resident,’ ‘transient,’ and ‘offshore’ (Bigg et al. 1990, Ford et al. 2000) 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).

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).

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 genetically distinct communities of transients which were never found in association with one another, the so-called ‘Gulf of Alaska’ transients and ‘AT1’ transients. Neither of these communities regularly associates with transient killer whales that range from California to southeastern Southeast Alaska, which has been termed the ‘west coast’ community. ‘Gulf of Alaska’ transients are seen throughout the Gulf of Alaska, including occasional sightings in Prince William Sound, and are seen rarely in Southeast Alaska and British Columbia. AT1 transients have only been observed in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with ‘Gulf of Alaska’ transients. Transients within the ‘Gulf of Alaska’ community have been found to have two mtDNA haplotypes, neither of which is found in the west coast or AT1 communities. Members of the AT1 community share a single mtDNA haplotype. Transient killer whales from the ‘west coast’ community have been found to share a single mtDNA haplotype that is not found in the other communities. Additionally, all three 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



**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).

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.

Recent research in western Alaska, particularly along the south side of the Alaska Peninsula and in the eastern Aleutian Islands, have identified transient killer whales with mtDNA haplotypes identical with the Gulf of Alaska transients (Zerbini et al. 2007, Matkin et al. 2007), however their connection with Gulf of Alaska transients is equivocal considering there has been little documented interchange between these areas and nuclear DNA analysis has not been completed. AT1 haplotypes are also found in western Alaska, but nuclear DNA assignment tests indicate these whales are part of an Aleutian Islands population rather than part of the AT1 population (Wade 2004). Samples from the central Aleutian Islands and Bering Sea have also identified mtDNA haplotypes not found in Gulf of Alaska transients, suggesting the ~~strong~~ possibility there is **at least one additional** population ~~structure~~ in western Alaska (P. Wade pers comm.). At this point, analyses have not been completed to resolve transient population structure in western Alaska. Therefore, 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 seen in the northern Bering Sea and Beaufort Sea, 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) confirms 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, movements, acoustics, genetic differences and potential fishery interactions, eight killer whale stocks are 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 British Columbia 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 British Columbia 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 (see Fig. 24), 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.

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. 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 between resightings not uncommon.

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 ~~were~~ **was** found to be acoustically and genetically different from other transient killer whales in the North Pacific (Saulitis et al. 2005, Barrett-Lennard 2000). AT1 **transient** killer whales ~~transients~~ are considered a population that is discrete from 'Gulf of Alaska' transients, which are part of the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock.

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 ~~Prince William Sound and~~ Resurrection and Aialik Bays of the Kenai Fjords year-round (Saulitis et al. 2000). 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).

## 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 et 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 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 4 years has ever been re-sighted (Matkin et al., 2008). Therefore, the population size as of the summer of 2009 is seven whales. 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).

~~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 4 years has ever been re-sighted (Matkin et al., 2008). Therefore, the population size as of the summer of 20089 is seven whales.~~

### **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 20089, 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**

#### **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.

#### **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 designated as “depleted” under the MMPA. **and is therefore, the AT1 Transient stock of killer whales is classified as a strategic stock.** 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 2008<sup>9</sup>, only 7 individuals remain alive. **Therefore, the AT1 group has been reduced to at least 50% (11/22) of its 1984 level, and has likely been reduced to 32% (7/22) of its 1984 level.** The AT1 Transient stock of killer whales is not listed as “threatened” or “endangered” under the Endangered Species Act.

## REFERENCES

- 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 et al. 1997. Photo-id catalog depicting whales from California and Mexico.**
- 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.
- 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. *Marine Mammal Science* 24: 719-729.**
- Dahlheim, M. E., P. A. White, and J. M. Waite. 2009. Cetaceans of Southeast Alaska: distribution and seasonal occurrence. *Journal of Biogeography* 36: 410-426.**
- 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.
- 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 Mammals 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. Ro. Soc. London 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., L. Barrett-Lennard, H. Yurk, D. Ellifrit, and A. Trites. 2007. Ecotypic variation and predatory behavior of killer whales (*Orcinus orca*) in the Eastern Aleutian Islands, Alaska. Fish. Bull. 105:74-87
- 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., 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., Ellis, G. M., Barrett-Lennard, L. G., Yurk, H., Saulitis, E. L., Scheel, D., Olesiuk, P., 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.
- 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.
- 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. Mamm. 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. Jour. Zool.* 83:1015-1029.
- Wade, P. R. 2004. Status Review of the AT1 Group of killer whales from the Prince William Sound and Kenai Fjords area. Unpublished document.
- 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. W. Durban, R. G. 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.* 150:1033-1045.

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

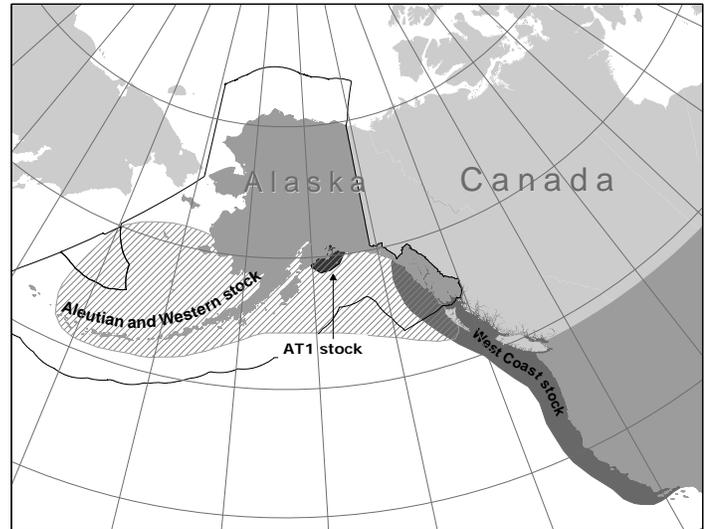
**STOCK DEFINITION AND GEOGRAPHIC RANGE**

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, and 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, Dahlheim et al., 2008, 2009), 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, Dahlheim et al., 2008, 2009) and in the intracoastal waterways of British Columbia and Washington State, where pods have been labeled as ‘resident,’ ‘transient,’ and ‘offshore’ (Bigg et al. 1990, Ford et al. 2000) 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 and transient 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). Although uncommon, movements of transient killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994; Black et al., 1997).

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).

Based on data regarding association patterns, movements, acoustics, genetic differences and potential fishery interactions, eight killer whale stocks are 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 British Columbia 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 British Columbia 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 (see Fig. 25), 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 southeastern Southeast Alaska and in the Gulf of Alaska (from Prince William Sound, through the Kenai Fjords, and around Kodiak Island).



**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).

In the Gulf of Alaska, Matkin et al. (1999) described two communities of transients which were never found in association with one another, the so-called ‘Gulf of Alaska’ transients and ‘AT1’ transients. Neither of these communities associates with transient killer whales that range from California to southeastern Alaska, which has been termed the ‘west coast’ stock. ‘Gulf of Alaska’ transients are seen 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. Transients that associate with the ‘Gulf of Alaska’ community have been found to have two mtDNA haplotypes, neither of which is found in the west coast or AT1 communities. Members of the AT1 community share a single mtDNA haplotype. Transient killer whales from the ‘west coast’ community have been found to share a single mtDNA haplotype that is not found in the other communities. Additionally, all three communities have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found, as well, as Saulitis (1993) 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.

Recent research in western Alaska, particularly along the south side of the Alaska Peninsula and in the eastern Aleutian Islands, have identified transient killer whales that share acoustic calls and mtDNA haplotypes with the Gulf of Alaska transients (NMML unpublished, NGOS unpublished), suggesting transient whales there may be part of the same population as Gulf of Alaska transients. On the other hand, samples from the central Aleutian Islands and Bering Sea have identified mtDNA haplotypes not found in Gulf of Alaska transients, suggesting the possibility there is some population structure in western Alaska. At this point, there are insufficient data to resolve transient population structure in western Alaska any further. Therefore, 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 seen in the northern Bering Sea and Beaufort Sea, 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) confirms 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, movements, acoustics, genetic differences and potential fishery interactions, eight killer whale stocks are 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 British Columbia 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 British Columbia 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 (see Fig. 25), 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 West Coast Transient Stock includes animals that occur in California, Oregon, Washington, British Columbia and southeastern Alaska.—~~On many occasions, transient whales from the inland waters of southeastern **Southeast** Alaska have been seen in association with British Columbia/Washington State transients. On other occasions, some of those same British Columbia whales have been sighted with whales more frequently seen off California thus linking these whales by association, and the West Coast Transient Stock is therefore considered to include transient killer whales from California to 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” (Fisheries and Oceans Canada 2007). They noted that 100 or so transient killer whales identified off the central coast of California (Black et al. 1997) were in the past considered to be an extension of this population because of acoustical similarities and occasional mixing with WCT individuals in BC waters (Ford and Ellis 1999), but that a recent reassessment indicated that the available evidence was insufficient to warrant inclusion of those whales in the WCT population (DFO 2010). They noted this was also the case for Gulf of Alaska transients, which are seen occasionally within the range of WCTs (in southeastern Alaska) but have only been observed to travel in association with WCTs on one occasion (Fisheries and Oceans Canada 2007). 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 (Note: individual whales have been matched between geographical regions and missing animals likely to be dead have been subtracted). In British Columbia and ~~southeastern~~ Southeast Alaska, 219 'transient' whales have been cataloged (Ford and Ellis 1999; Dahlheim et al., 1997). Off the coast of California, 105 'transient' whales have been identified (Black et al. 1997): 10 whales were matched to photos of 'transients' in other catalogs and the remaining 95 were linked by association. An additional 14 whales in southeastern Alaska (M. Dahlheim unpubl. data) and 16 whales off the coast of California (N. Black, Monterey Bay Cetacean Project, pers. comm.) have been provisionally classified as 'transient' whales by association. Combining the counts of cataloged 'transient' whales gives a minimum number of ~~344~~354 (219 + 95 + 10 + 14 + 16) killer whales belonging to the West Coast Transient stock. A recent mark-recapture estimate for the West Coast Transient population, excluding whales from California, 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 southeastern Alaska, British Columbia, and northern Washington.

### 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. On the other hand, given that researchers continue to identify new whales, the estimate of abundance based on the number of uniquely identified individuals cataloged is likely conservative. However, the rate of discovering new adult whales within ~~southeastern~~ Southeast Alaska is relatively low (Marilyn Dahlheim, AFSC-NMML, pers. comm. 20 November 2009). In addition, the abundance estimate does not include 14 whales from southeastern Alaska and 16 whales off the coast of California that have been provisionally classified as 'transients'.

Other estimates of the overall population size (i.e.,  $N_{BEST}$ ) and associated CV(N) are not currently available. Thus, the minimum population estimate ( $N_{MIN}$ ) for the ~~Eastern North Pacific~~ West Coast Transient stock of killer whales is ~~344~~354 animals, 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

~~At present, reliable data on trends in population abundance for the West Coast Transient stock of killer whales are unavailable.~~ Recent analyses indicate that the West Coast Transient population 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 WCT 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).

### 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). However, a population

increases at the maximum growth rate ( $R_{MAX}$ ) only when the population is at extremely low levels; thus, the estimate of 2.92% is not a reliable estimate of  $R_{MAX}$ . Hence, until additional 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 ~~Eastern North Pacific~~ **West Coast** Transient killer whale stock,  $PBR = 344354 \times 0.02 \times 0.5$ . 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**

#### **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.

Due to a lack of Canadian observer programs, there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries, which are analogous to U.S. fisheries that are known to interact with killer whales. 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. Since 1990, there have been no reported fishery-related strandings of killer whales in Canadian waters. However, in 1994, one killer whale was reported to have contacted a salmon gillnet, but it did not entangle (Guenther et al. 1995). Data regarding the level of killer whale mortality related to commercial fisheries in Canadian waters, though thought to be small, are not readily available or reliable which results in an underestimate of the annual mortality for this stock.

#### **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. 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. There have been no reported mortalities of killer whales from this stock due to ship strikes.

## 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. Recall that the human-caused mortality has ~~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 ~~southeastern~~ 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 (0.34) 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 (~~3-4~~ 3.5). Therefore, the West Coast Transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population (OSP) level are currently unknown.

## REFERENCES

- 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.

- Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.
- 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. *Marine Mammal Science* 24: 719-729.
- Dahlheim, M. E., P. A. White, and J. M. Waite. 2009. Cetaceans of Southeast Alaska: distribution and seasonal occurrence. *Journal of Biogeography* 36: 410-426.
- 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 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 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., 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. 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 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. Ro. Soc. London* 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.
- 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.
- 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.
- Stevens, T. A., D. Duffield, E. Asper, K. Hewlett, A. Bolz, L. Gage, and G. Bossart. 1989. Preliminary findings of restriction fragment differences in mitochondrial DNA among killer whales (*Orcinus orca*). *Can. J. Zool.* 67:2592-2595.
- 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)

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. However, 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.



**Figure 26.** Approximate distribution of Pacific white-sided dolphins in the eastern North Pacific (shaded area).

**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 ( $N_{\text{MIN}}$ ) for this stock would be 26,880, based on the sum of abundance estimates for 4 separate  $5^\circ \times 5^\circ$  blocks north of  $45^\circ\text{N}$  ( $1,970+6,427+6,101+12,382 = 26,880$ ) reported in Buckland et al. (1993). This is considered a minimum estimate because the abundance of animals in a fifth  $5^\circ \times 5^\circ$  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 Central 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 ( $R_{\text{MAX}}$ ) was based. Thus, it is recommended that the cetacean maximum net productivity rate ( $R_{\text{MAX}}$ ) 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:  $\text{PBR} = N_{\text{MIN}} \times 0.5R_{\text{MAX}} \times F_R$ . The recovery factor ( $F_R$ ) for this stock is 0.5, the value for cetacean stocks of unknown status (Wade and Angliss 1997). Using the abundance estimate of 26,880, the North Pacific stock of Pacific white-sided dolphin PBR has been reported in previous stock assessments as 269 animals ( $26,880 \times 0.02 \times 0.5$ ). 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.

### **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). ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

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).

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.

### STATUS OF STOCK

Pacific white-sided dolphins are not listed 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.
- 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.
- 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.

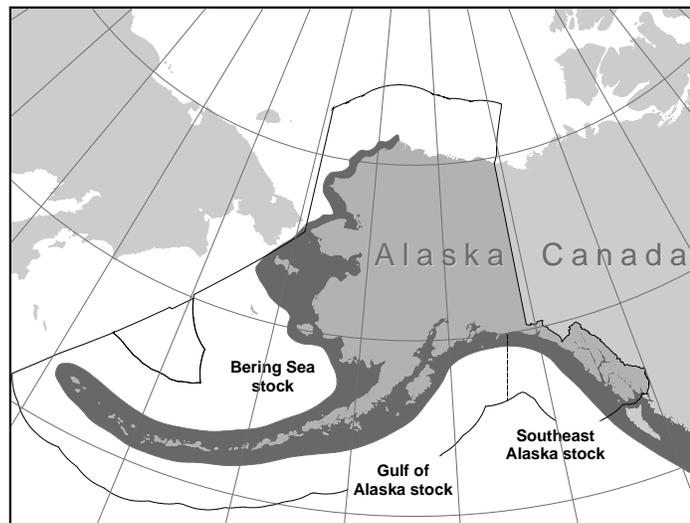
## HARBOR PORPOISE (*Phocoena phocoena*): Southeast Alaska Stock

**NOTE – March 2008:** In areas outside of Alaska, studies have shown that stock structure is more fine-scale than is reflected in the Alaska Stock Assessment Reports. At this time, no data are available to reflect stock structure for harbor porpoise 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). The harbor porpoise primarily frequents coastal waters and in the Gulf of Alaska and Southeast Alaska (Dahlheim et al., 2009), they occur most frequently in waters less than 100 m in depth (Hobbs and Waite unpubl. ms). 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 unpubl. ms). 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 exist 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 data 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). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic, and that movement is sufficiently restricted to evolve 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 one sample each from St. Paul, Adak, Kodiak, and Kenai. Unfortunately, no conclusions can be drawn about the genetic structure of harbor porpoise within Alaska because of insufficient samples. Accordingly, harbor porpoise stock structure in Alaska remains unknown at this time.

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint, it would be prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). The Alaska Scientific Review Group concurred that while the available data were insufficient to justify recognizing three biological stocks of harbor



**Figure 27.** Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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 ~~separate~~ harbor porpoise stocks in Alaska are recommended, recognizing that the boundaries were set arbitrarily: 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). ~~Information concerning the four harbor porpoise stocks occurring along the west coast of the continental United States (Central California, Northern California, Oregon/Washington Coast, and Inland Washington) is in the Stock Assessment Reports for the Pacific Region.~~

## 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, ~~which includes~~ (Hobbs and Waite unpubl. ms). 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 106,087km<sup>2</sup>. 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. 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.

## Minimum Population Estimate

For the Southeast Alaska stock of harbor porpoise, the minimum population estimates ( $N_{MIN}$ ) for the aerial ~~and vessel~~ surveys ~~are is~~ calculated ~~separately~~, using Equation 1 from the PBR Guidelines (Wade and Angliss 1997):  $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{1/2})$ . Using the population estimates (N) of 11,146 and its associated CV (0.242),  $N_{MIN}$  for this stock is 9,116 (Hobbs and Waite, unpubl. ms). However, because the survey data are now 12 years old, it is not considered a reliable minimum population estimate for calculating a PBR.

## 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 vessel~~ **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 unpubl. ms); 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. Dahlheim et al. (2009) found only a slight annual increase (0.2%) in harbor porpoise populations based on survey data from 1991-1993, 2006, and 2007, which is not considered a significant increase.

## 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). Thus, using the abundance estimate calculated from 1997 surveys, the PBR for the Southeast Alaska stock of harbor porpoise would be

calculated to be 91 animals ( $9,116 \times 0.02 \times 0.5$ ). However, the 2005 revisions to the SAR guidelines (NMFS 2005) 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. Recent survey data are currently being analyzed, and a new abundance estimate and PBR for this stock will be available in 2009 the early part of 2010 and incorporated into the 2010 SARs.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### 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 2002 to 2006, although observer coverage has been very low (average percent annual observer coverage for the 2002-2006 period ranged between 3.4-12.6 for these 4 fisheries) 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 observer coverage for inside waters of SE Southeast Alaska.

A reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in Southeast Alaska fisheries. Therefore, it is unknown whether the kill rate is insignificant. More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.

### 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. Between 2004 and 2008 there was one report to NMFS Enforcement of a harbor porpoise that had been found floating dead with approximately 91 stab wounds and chaffing on fins suggesting possible net entanglement.

## STATUS OF STOCK

Harbor porpoise are not listed 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 9.1 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate.~~ 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 1 is not known to exceed the PBR (91). 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

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. Cabbage, S. D. Osmeck, 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., A. York, R. Towell, J. Waite, and J. Breiwick. 2000. Harbor porpoise (*Phocoena phocoena*) abundance in Alaska: Bristol Bay to Southeast Alaska, 1991-1993. *Mar. Mammal Sci.* 16:28-45.
- Dahlheim, M., P. A. White, and J. Waite. 2009. Cetaceans of Southeast Alaska: distribution and seasonal occurrence. *J. Biogeogr.* 36(3): 410-426.
- 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. Unpubl. ms. Harbor porpoise abundance in three Alaska stocks, 1997-1999. Available upon request from J. Waite, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
- Laake, J. L., J. Calambokidis, S. D. Osmeck, 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.
- 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*. *Marine Biology* 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.

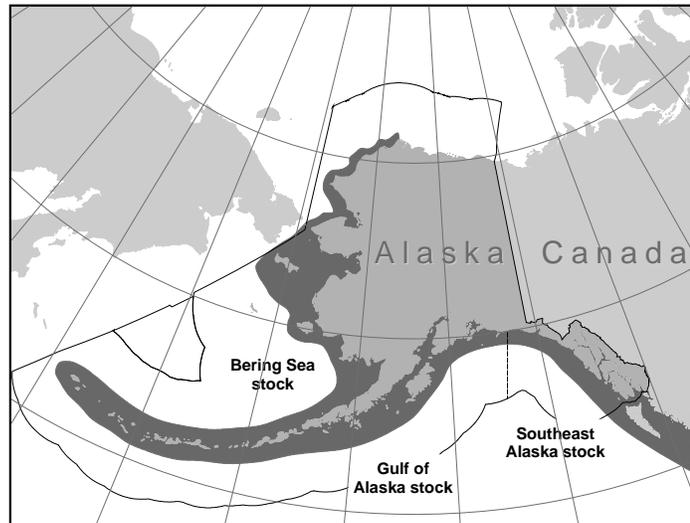
## HARBOR PORPOISE (*Phocoena phocoena*): Gulf of Alaska Stock

**NOTE – March 2008:** In areas outside of Alaska, studies have shown that stock structure is more fine-scale than is reflected in the Alaska Stock Assessment Reports. At this time, no data are available to reflect stock structure for harbor porpoise 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). The harbor porpoise primarily frequents coastal waters and in the Gulf of Alaska and Southeast Alaska (Dahlheim et al., 2009), they occur most frequently in waters less than 100 m in depth (Hobbs and Waite unpubl. ms). 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 unpubl. ms). 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 exist 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 data 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). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic, and that movement is sufficiently restricted to evolve 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 one 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 remains unknown at this time.

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint, it would be prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). The Alaska Scientific Review Group concurred that while the available data were insufficient to justify recognizing three biological stocks of harbor



**Figure 28.** Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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 ~~separate~~ harbor porpoise stocks in Alaska are recommended, recognizing that the boundaries were set arbitrarily: 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). ~~Information concerning the four harbor porpoise stocks occurring along the west coast of the continental United States (Central California, Northern California, Oregon/Washington Coast, and Inland Washington) is in the Stock Assessment Reports for the Pacific Region.~~

## POPULATION SIZE

In June and July of 1998 an aerial survey covering the waters of the western Gulf of Alaska from Cape Suckling to Sutwik Island, offshore to the 1,000 fathom depth contour resulted in an uncorrected abundance estimate for the Gulf of Alaska harbor porpoise stock of 10,489 (CV = 0.115) animals (Hobbs and Waite unpubl. ms). This ~~observed~~ abundance estimate 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 this survey is 31,046 ( $10,489 \times 2.96 = 31,046$ ; CV = 0.214).

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<sup>2</sup>) was greater than the area covered in the ~~composited~~ combined portions of the 1991, 1992, and 1993 surveys (106,600 km<sup>2</sup>). The 1998 survey included the waters of Prince William Sound, the bays, channels, and inlets of the Kenai Peninsula, the Alaska Peninsula, and 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 (unpubl. ms) 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 since it included more of the inshore habitat commonly used by harbor porpoise.~~

## 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):  $N_{MIN} = N / \exp(0.842 * [\ln(1 + [CV(N)]^2)]^{1/2})$ . 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. However, because the survey data are now 11 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.

## 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). Thus, using the abundance

estimate calculated from 1998 surveys, the PBR for the Gulf of Alaska stock of harbor porpoise would be calculated to be 260 animals ( $25,987 \times 0.02 \times 0.5$ ). However, the 2005 revisions to the SAR guidelines (NMFS 2005) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. Therefore, the PBR for this stock is considered undetermined.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

Prior to 2003, three different commercial fisheries operating within the range of the Gulf of Alaska stock of harbor porpoise were monitored by NMFS observers for incidental take by NMFS observers: 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. More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs. Observers also monitored the 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 Cook Inlet salmon set and drift gillnet vessels primarily because of the potential for these fisheries to incur 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 two years of observer data.

In 2002 and 2005, observers were placed on 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 30.** 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	1.8% 3.7%	0 1	0 31.2	15.6
Cook Inlet salmon set gillnet	1999 2000	obs data	7.3% 8.3%	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

In 2008, there was one self-report by a fisher of a mortality that occurred in a commercial silver salmon fishing net off Kalgin Island.

Strandings of marine mammals with fishing gear attached or with injuries caused by interactions with fishing gear are another final 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). These stranding reports were likely the result of operations in 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 30. There were no confirmed reports of strandings of harbor porpoise in this area ~~from~~ during 1999-2003.

A reliable estimate of the ~~mortality rate~~ **total number of mortalities** incidental to commercial fisheries is ~~considered~~ 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 (Table 30) **+ 1 = 72**.

### **Subsistence/Native Harvest Information**

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

### **Other Mortality**

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 listed 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 26 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. 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 734; (712 mortalities in commercial fisheries plus 2 in subsistence gillnets)-does not exceed the PBR (260). However, b~~ **Because the most recent abundance estimates are** 11 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 100m in depth and **they** 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 **of nearshore habitats** resulting from urban and industrial development, ~~(including waste management, and nonpoint source runoff); and physical habitat modifications including~~ **activities such as** construction of docks and other over water structures, filling of shallow areas and dredging.

### **CITATIONS**

- Barlow, J., C. W. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. Fish. Bull., U.S. 86:433-444.
- Calambokidis, J., and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. 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. Osmeck, 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., 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. Unpubl. ms. Harbor porpoise abundance in three Alaska stocks, 1997-1999. Available upon request from J. Waite, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
- Laake, J. L., J. Calambokidis, S. D. Osmeck, 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. Draft report to NMFS Alaska Region. 83 pp.
- 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.
- 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.
- 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*. *Marine Biology* 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).

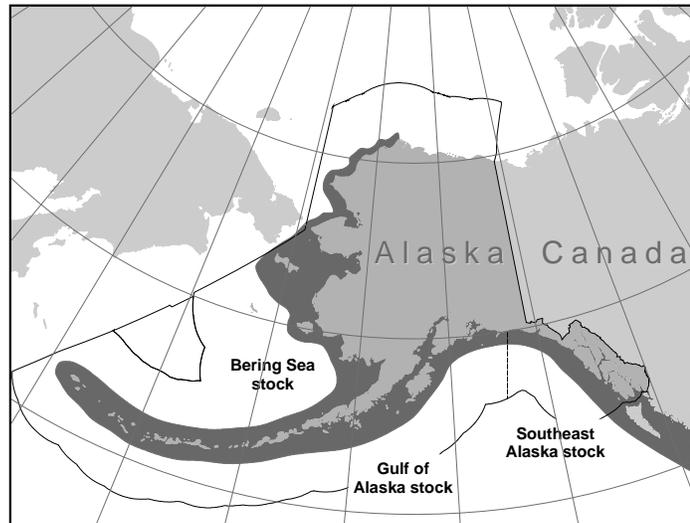
## HARBOR PORPOISE (*Phocoena phocoena*): Bering Sea Stock

**NOTE – March 2008:** In areas outside of Alaska, studies have shown that stock structure is more fine-scale than is reflected in the Alaska Stock Assessment Reports. At this time, no data are available to reflect stock structure for harbor porpoise 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). The harbor porpoise primarily frequents coastal waters and in the Gulf of Alaska and Southeast Alaska (Dahlheim et al., 2009), they occur most frequently in waters less than 100 m in depth (Hobbs and Waite unpubl. ms). 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 unpubl. ms). 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 exist 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 data 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). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic, and that movement is sufficiently restricted to evolve 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 one 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 remains unknown at this time.

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint, it would be prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). The Alaska Scientific Review Group concurred that while the available data were insufficient to justify recognizing three biological stocks of harbor



**Figure 29.** Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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 ~~separate~~ harbor porpoise stocks in Alaska are recommended, recognizing that the boundaries were set arbitrarily: 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). ~~Information concerning the four harbor porpoise stocks occurring along the west coast of the continental United States (Central California, Northern California, Oregon/Washington Coast, and Inland Washington) is in the Stock Assessment Reports for the Pacific Region.~~

## **POPULATION SIZE**

In June and July of 1999, an aerial survey covering the waters of Bristol Bay resulted in an observed abundance estimate for the Bering Sea harbor porpoise stock of 16,289 (CV = 0.132; Hobbs and Waite unpubl. ms). 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 ( $16,289 \times 2.96 = 48,215$ ; 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 10 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):  $N_{MIN} = N / \exp(0.842 * [\ln(1 + [CV(N)]^2)]^{1/2})$ . 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.

### **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 in review). 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 (unpubl. ms) 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). Thus, using the abundance estimate calculated from 1999 surveys, the PBR for the Bering Sea stock of harbor porpoise would be calculated to be 400 animals ( $40,039 \times 0.02 \times 0.5$ ). However, the 2005 revisions to the SAR guidelines (NMFS 2005) state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in confidence in the reliability of an aged abundance estimate. Therefore, the PBR for this stock is considered undetermined.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

Prior to 2003, three different 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 2001 in the Bering Sea/Aleutian Islands flatfish trawl. No harbor porpoise mortalities have been observed during the 2002-2006 period. Therefore, the mean annual (total) mortality rate resulting from observed mortalities was 0. ~~More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table XX.** Summary of incidental mortality of harbor porpoise (Bering Sea stock) due to commercial fisheries. Data from 2007 and 2008 are preliminary; estimates of percent observer coverage and CVs are not currently available for some preliminary 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)
BSAI flatfish trawl	2007	obs data	20.2	1	4.9	2.45
	2008		-	0	0	(CV = 0.89)
Estimated total annual takes						

The estimated minimum annual mortality rate incidental to commercial fisheries is 0 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.

### Subsistence/Native Harvest Information

Subsistence hunters in Alaska are known to occasionally take from this stock of harbor porpoise. Bee and Hall (1956) reported on two entanglements in subsistence nets in Elson Lagoon in 1952. Subsistence fishermen in Barrow state that it is not uncommon for one or two porpoises to be caught each summer (Suydam & George 1992). In 1991, pack ice may have contributed to the relatively high number (4) of porpoises caught in subsistence nets (Suydam & George 1992).

### Other Mortality

There have been historic reports of harbor porpoise mortalities in subsistence gillnets in the area from Nome to Unalakleet (Barlow et al. 1994) and near Point Barrow (Suydam and George 1992). ~~The only reports received between 1999 and 2003 were an unconfirmed report of a subsistence entanglement of two animals near Elin, and a third~~ **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.**

## STATUS OF STOCK

Harbor porpoise are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. The lack of surveys in a significant portion of this stock’s range results in a conservative PBR for this stock. ~~At present, U.S. commercial fishery-related annual mortality levels less than 40 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate.~~ **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 **relative to PBR is unknown.** ~~is not known to exceed the PBR (400).~~

However, because the abundance estimates are 10 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 100m 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.

## CITATIONS

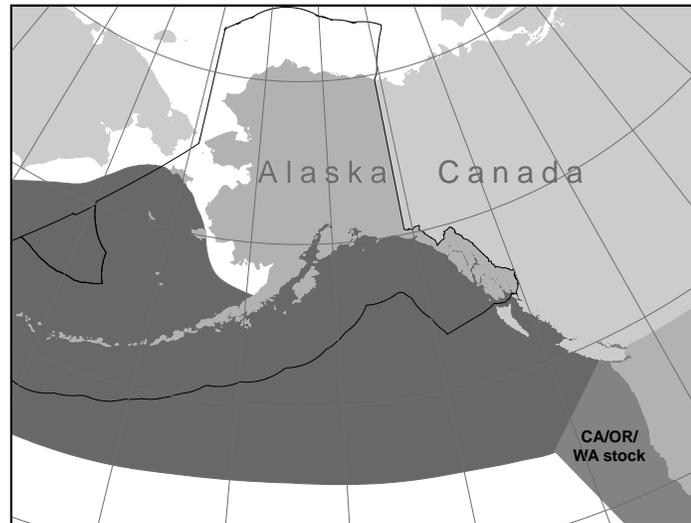
- Barlow, J., C. W. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. Fish. Bull., U.S. 86:433-444.
- Barlow, J., R. W. Baird, J. E. Heyning, K. Wynne, A. M. Manville, II, L. F. Lowry, 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.
- 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. Cabbage, 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., 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).
- 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. Unpubl. ms. Harbor porpoise abundance in three Alaska stocks, 1997-1999. Available upon request from J. Waite, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
- 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. Wildlife 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.
- 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*. Marine Biology 133: 583-591.

- Suydam, R. S., and J. C. George. 1992. Recent sightings of harbour porpoises, *Phocoena phocoena*, near Point Barrow, Alaska. *Can. Field-Naturalist* 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).

Recent 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 Alaska waters. Dall's porpoise along the west coast of the continental U. S. from California to Washington comprise a separate stock and are reported 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 north Bering Sea received little survey effort. Only 3 sightings were reported 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 is 83,400 (417,000 × 0.2) for this stock. No reliable abundance estimates for British Columbia are currently available.

Results of the surveys in 1999 and 2000 in the central-eastern Bering Sea and southeastern Bering Sea provided provisional estimates of 14,312 (CV = 0.26) and 9,807 (CV = 0.20) Dall's porpoise, respectively (Moore et al. 2002). 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):  $N_{MIN} = N / \exp(0.842 * [\ln(1 + [CV(N)]^2)]^{1/2})$ . Using the population estimate (N) of 83,400 and its associated CV of 0.097,  $N_{MIN}$  for the Alaska stock of Dall's porpoise would be 76,874. 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 PBR reported in the previous stock assessment was 1,537 animals (76,874 × 0.02 × 1.0). 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 5-year period (2002-2006), as well as the annual observed and estimated mortalities are presented in Table 31 (Perez 2006, Perez unpubl. ms). ~~More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

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 presented above ( $1.09 + 0.48 = 1.6$ ) 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 29.6 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 31.** Summary of incidental mortality of Dall's porpoise (Alaska stock) due to commercial fisheries from 2002 to 2006 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	2002	obs	80.0	1	1.4	1.09 (CV = 0.27)
	2003	data	82.2	0	0	
	2004		81.2	1	1.0	
	2005		77.3	1	1.4	
	2006		73.0	1	1.6	
Gulf of Alaska (GOA) pollock trawl	2002	obs	26.0	0	0	0.48 (CV = 0.70)
	2003	data	31.2	0	0	
	2004		27.4	0	0	
	2005		24.2	1	2.4	
	2006		26.5	0	0	
AK Peninsula/ Aleutian Island salmon drift gillnet	1990	obs data	4%	1	28	28 (CI: 1-81)
Minimum total annual mortality						29.6

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.

#### 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 listed 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 (30) 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. Mamm. Sci.* 15(2):273-313.
- 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.
- 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.
- 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.
- 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.

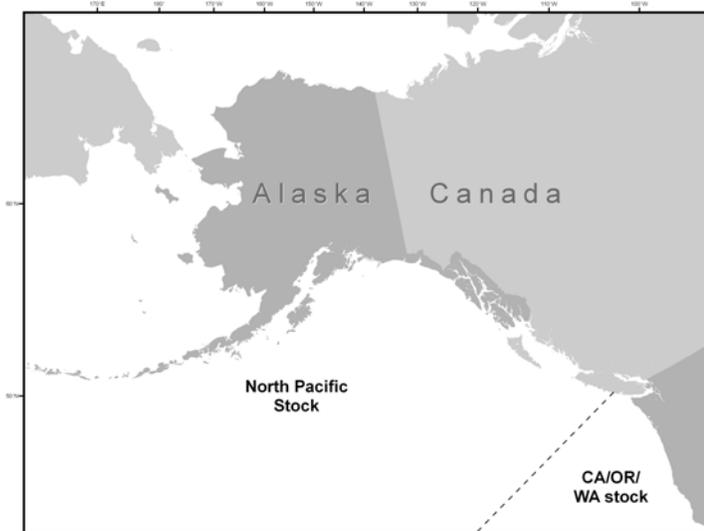
## SPERM WHALE (*Physeter macrocephalus*): North Pacific Stock

### 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). They 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 usually 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. While males are thought to move north in the summer to feed in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Kasuya and Miyashita 1988). Sightings surveys conducted by NMML in the summer months between 2001 and 2006 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 Arnborn 1987).

Discovery Mark data from the days of commercial whaling (2605 recoveries in the North Pacific with location data) show extensive movements from U.S. and Canadian coastal waters into the Gulf of Alaska and Bering Sea (Omura and Ohsumi 1964; Ivashin and Rovnin 1967; Ohsumi and Masaki 1975; Wada 1980; Kasuya and Miyashita 1988. 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 whale marked by Canadian researchers moved from near Vancouver Island, British Columbia to the Aleutian Islands near Adak. A whale marked by Japanese researchers moved from the Bering Sea just north of the Aleutians to waters off Vancouver Island, British Columbia. Based on these data, there appear to be 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) (S. Mizroch, AFSC-NMML, pers. comm. 22 December 2009).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous though data indicate three "somewhat" discrete population centers (i.e., Hawaii, west coast of the continental United States, and Alaska); 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. 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). Based on this limited information, and lacking additional data concerning population structure, sperm whales of the eastern North Pacific have been divided into three separate stocks as dictated by the U. S. waters in which they are found: 1) Alaska (North Pacific stock), 2) California/Oregon/Washington, and 3) Hawaii. The California/Oregon/Washington and Hawaii sperm whale stocks are reported separately in the Stock Assessment Reports for the Pacific Region.



**Figure 31.** Approximate distribution of sperm whales in the North Pacific includes deep waters south of 62°N to the equator.

## 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 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

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

### Fisheries Information

Between 2002 and 2006, there were three observed serious injuries of sperm whales in the Gulf of Alaska sablefish longline fishery (Table 32). Each animal was designated as seriously injured because it became caught in the gear, and was released alive with trailing gear. Estimates of marine mammal serious injury/mortality in observed fisheries are provided in Perez (unpubl. ms.). ~~More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table 32.** Summary of incidental mortality and serious injury of sperm whales due to commercial fisheries and calculation of the mean annual mortality rate. Mean annual takes are based on 2002-2006 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	2002	obs data		0	0	2.01	
	2003			0	0		
	2004			0	0		
	2005			0	0	3.25	
	2006			11.2	3		10
	2007			15.5	1		6.5
	2008			-	0		0
						(CV = 0.93)	

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Estimated total annual takes						2.01 (CV = 0.49)

### 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. Brownell et al. (2000) estimated that the U.S.S.R. under-reported catches during 1949-71 by as much as 60%. 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 42 sperm whales between 2000 and 2006 (International Whaling Commission, BIWS catch data, February 2008 version, unpublished).

### 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

- 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).
- Brownell, R. L., A. V. Yablokov, and V. A. Zemsky. 2000. USSR pelagic catches of North Pacific sperm whales, 1949-1979: conservation implications. Pp. 123-130 *In* A. V. Yablokov and V. A. Zemsky (eds.), Soviet whaling data (1949-1979). Center for Russian Environmental Policy, Marine Mammal Council, Moscow, Russia.
- 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. Council., 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 - P. S. Hill, 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.
- 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.
- 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.
- 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.
- 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.
- 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 Arnborn, 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). 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, NMFS unpublished data, 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, NMFS unpublished data). 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). During this time they are rarely found in offshore waters and their winter distribution is unknown (Kasuya 2002). 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).

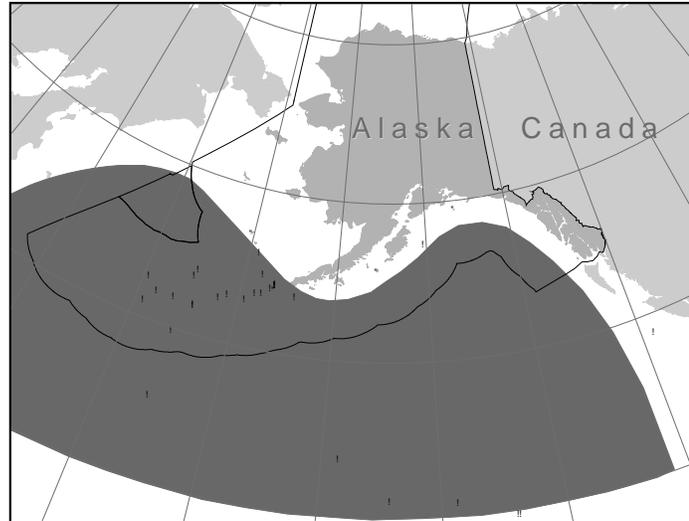
There are insufficient data to apply the phylogeographic approach to stock structure (Dizon et al. 1992) for Baird's beaked whale. Therefore, Baird's beaked whale stocks are defined as the two non-contiguous areas within Pacific U. S. waters where they are found: 1) Alaska and 2) California/Oregon/Washington. 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.



**Figure 32.** Approximate distribution of Baird's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last ten years are also depicted. (Forney and Brownell 1996, Moore et al. 2002, NMFS unpublished data). Note: Distribution updated based on Kasuya 2002.

### **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 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**

#### **Fisheries Information**

~~Six different commercial fisheries operating within the range of the Alaska stock of Baird's beaked whale were monitored for incidental take by fishery observers from 1990 to 2002: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No Baird's beaked whale mortalities were observed. The estimated annual mortality rate incidental to commercial fisheries is zero.~~

Until 2003, there were six different federally-regulated commercial fisheries in Alaska that could have interacted with the Alaska stock of Baird's beaked whales. 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 of Baird's beaked whales incidental to observed commercial fisheries reported between 2002 and 2006 (Perez 2006, Perez unpubl. ms a, b).

#### **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). ~~Recently, the Japanese have reported taking 54 whales annually off their coasts during the 7 year period between 1992 and 1998 and 62 whales were taken in 1999. There were no reported takes from 2000-02 (IWC 1996, 1997a, 1997b, 1998, 1999, 2000, 2001, 2002).~~ Total annual catches of Baird's beaked whales in Japan were 62 in 2003 (IWC 2004), 62 in 2004 (IWC 2005), 66 in 2005 (IWC 2006), 66 in 2006 (IWC 2007), and 67 in 2007 (IWC 2008). 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 listed 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 may prove to be an important habitat issue in some areas of this population's range, notably in areas of oil and gas activities or where shipping or naval activities are high.

## CITATIONS

- Balcomb, K. C. 1989. Baird's beaked whale, *Berardius bairdii* Stejneger, 1883: Arnoux's beaked whale *Iberardius arnouxii* Douverson, 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.
- Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1, 96 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.
- 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.
- 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.
- ~~International Whaling Commission. 1996. Report of the sub-committee on small cetaceans. Rep. Int. Whal. Comm. 46:160-179.~~
- ~~International Whaling Commission. 1997a. Report of the sub-committee on small cetaceans. Rep. Int. Whal. Comm. 47:169-191.~~
- ~~International Whaling Commission. 1997b. Japan progress report on cetacean research, May 1996 to April 1997. Unpubl. doc. submitted to Int. Whal. Comm. (SC/49/ProgRep.Japan). 14 pp.~~
- ~~International Whaling Commission. 1998. Japan progress report on cetacean research, May 1997 to March 1998. Unpubl. doc. submitted to Int. Whal. Comm. (SC/50/ProgRep.Japan). 18 pp.~~
- ~~International Whaling Commission. 1999. Japan progress report on cetacean research, April 1998 to March 1999. Unpubl. doc. submitted to Int. Whal. Comm. (SC/51/ProgRep.Japan). 19 pp.~~
- ~~International Whaling Commission. 2000. Japan progress report on cetacean research, April 1999 to April 2000. Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/ProgRep.Japan). 23 pp.~~
- ~~International Whaling Commission. 2001. Japan progress report on cetacean research, May 2000 to May 2001. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/ProgRep.Japan). 12 pp.~~
- ~~International Whaling Commission. 2002. Japan progress report on cetacean research, June 2001 to April 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/54/ProgRep.Japan). 14 pp.~~
- International Whaling Commission. 2004. Japan. progress report on cetacean research, April 2003 to April 2004. Unpubl. doc. submitted to Int. Whal. Comm. (SC/56/ProgRep.Japan). 15 pp.
- International Whaling Commission. 2005. Japanese progress report on small cetacean research, May 2004 to April 2005. Unpubl. doc. submitted to Int. Whal. Comm. (SC/57/ProgRep.Japan). 16 pp.
- International Whaling Commission. 2006. Japan. progress report on small cetacean research, May 2005 to April 2006. Unpubl. doc. submitted to Int. Whal. Comm. (SC/58/ProgRep.Japan). 12 pp.
- International Whaling Commission. 2007. Japan. progress report on small cetacean research, May 2006 to March 2007, with statistical data for the calendar year 2006. Unpubl. doc. submitted to Int. Whal. Comm. (SC/59/ProgRep.Japan). 9 pp.
- International Whaling Commission. 2008. Japan. progress report on small cetacean research, April 2007 to March 2008, with statistical data for the calendar year 2007. Unpubl. doc. submitted to Int. Whal. Comm. (SC/60/ProgRep.Japan). 9 pp.
- 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.
- 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.
- Ohsumi, S. 1983. Population assessment of Baird's beaked whales in the waters adjacent to Japan. *Rep. Int. Whal. Comm.* 33:633-641.

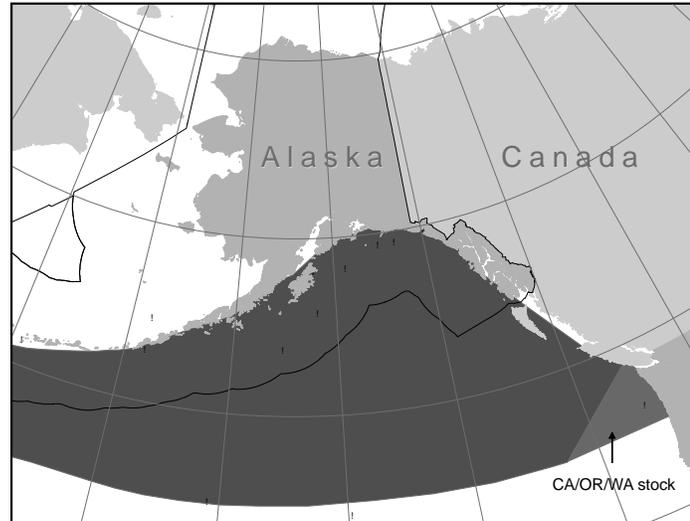
- Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167.
- Perez, M. A. Unpubl. ms. a. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 67 pp. Available NMML-AFSC.
- Perez, M. A. Unpubl. ms. b. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2006. 67 pp. Available NMML-AFSC.
- 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.)
- 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).

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.



**Figure 33.** Approximate distribution of Cuvier's beaked whales in the eastern North Pacific (shaded area). Sightings (circles) and strandings (squares) within the last ten years are also depicted (Forney and Brownell 1996, NMFS unpublished data).

### 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

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 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

### Fisheries Information

Six different commercial fisheries operating within the range of the Alaska stock of Cuvier's beaked whale were monitored for incidental take by fishery observers from 1990 to 2002: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No Cuvier's beaked whale mortalities were observed. 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.

## STATUS OF STOCK

Cuvier's beaked whales are not listed 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 may prove to be an important habitat issue in some areas of this population's range, notably in areas of oil and gas activities or where shipping or naval activities are high.

## CITATIONS

- 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.
- Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1, 96 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.
- 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.
- 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.
- 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.
- Norris, K. S., and J. H. Prescott. 1961. Observations on Pacific cetaceans of California and Mexican waters. *Univ. Calif. Pub. Zool.* 63:291-370.
- 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.

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).

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

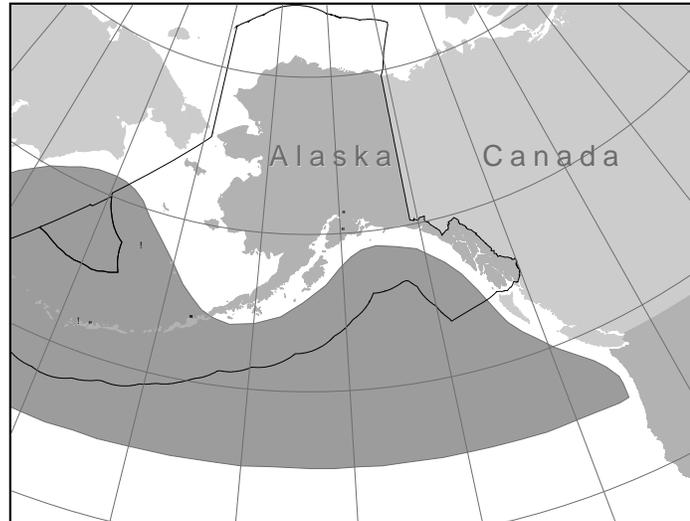
At this time, it is not possible to produce a reliable minimum population estimate ( $N_{MIN}$ ) for this stock, as current estimates of abundance are unavailable.

### Current Population Trend

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 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).



**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).

## 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

### Fisheries Information

Six different commercial fisheries operating within the range of the Alaska stock of Stejneger's beaked whale were monitored for incidental take by fishery observers from 1990 to 2002: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No Stejneger's beaked whale mortalities were observed. 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 listed 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 may prove to be an important habitat issue in some areas of this population's range, notably in areas of oil and gas activities or where shipping or naval activities are high.

## CITATIONS

- Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1, 96 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.
- Loughlin, T. R., and M. A. Perez. 1985. *Mesoplodon stejnegeri*. *Mammalian Species*, No. 250.
- 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.
- 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.
- 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.

## GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock

### STOCK DEFINITION AND GEOGRAPHIC RANGE

Gray whales formerly occurred in the North Atlantic Ocean (Fraser 1970, Mead and Mitchell 1984), but this species is currently found only in the North Pacific (Rice et al. 1984, Swartz et al. 2006). The following information was considered in classifying stock structure of gray whales based on the phylogeographic approach of Dizon et al. (1992): 1) Distributional data: two isolated geographic distributions in the North Pacific Ocean; 2) Population response data: the eastern North Pacific population has increased, and no evident increase in the western North Pacific; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. Based on this limited information, two stocks have been recognized in the North Pacific: the Eastern North Pacific stock, which lives along the west coast of North America (Fig. 35), and the Western North Pacific or "Korean" stock, which lives along the coast of eastern Asia (Rice 1981, Rice et al. 1984, Swartz et al. 2006).



**Figure 35.** Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area).

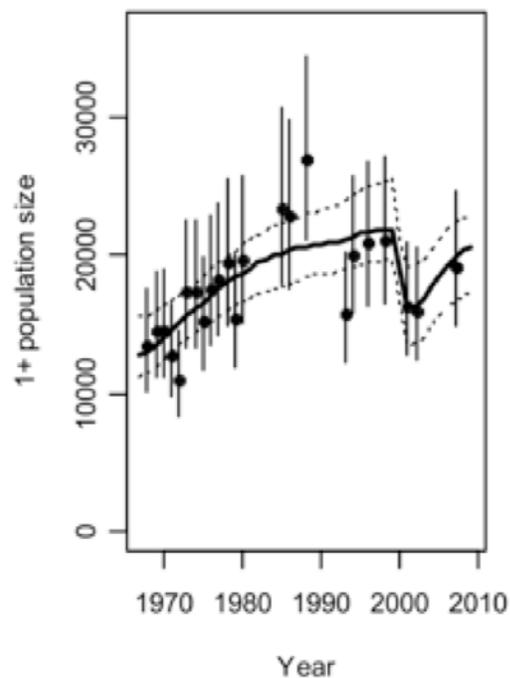
Most of the Eastern North Pacific stock spends the summer feeding in the northern and western Bering and Chukchi Seas (Rice and Wolman 1971, Berzin 1984, Nerini 1984). However, gray whales have been reported feeding in the summer in waters near Kodiak Island, Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971, Darling 1984, Nerini 1984, Rice et al. 1984, Moore et al. 2007). Photo-identification studies of these animals indicate that they move widely within and between areas on the Pacific coast, are not always observed in the same area each year, and may have several year gaps between resightings in studied areas (Calambokidis and Quan 1999, Quan 2000, Calambokidis et al. 2002, Calambokidis et al. 2004). The so-called "Pacific coast feeding aggregation" defines one of the areas where feeding groups occur. While some animals in this group demonstrate some site-fidelity, available information from sighting records (Calambokidis and Quan 1999, Quan 2000) and genetics (Ramakrishnan et al. 2001, Steeves 1998) indicates that this group is a component of the eastern North Pacific population and is not an isolated population unit. Each fall, the whales migrate south along the coast of North America from Alaska to Baja California, in Mexico (Rice and Wolman 1971), most of them starting in November or December (Rugh et al. 2001). The Eastern North Pacific stock winters mainly along the west coast of Baja California, using certain shallow, nearly landlocked lagoons and bays, and calves are born from early January to mid-February (Rice et al. 1981), often seen on the migration well north of Mexico (Shelden et al. 2004). The northbound migration generally begins in mid-February and continues through May (Rice et al. 1981, 1984; Poole 1984a), with cows and newborn calves migrating northward primarily between March and June along the U.S. West Coast.

### POPULATION SIZE

Systematic counts of gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967 (Fig. 36). The most recent abundance estimates are based on southbound counts were made during the 1997/98, 2000/01, and 2001/02, and 2006/07 southbound migrations. Analyses of these data resulted in abundance estimates of 29,758 for 1997/98, 19,448 for 2000/01, and 18,178 for 2001/02 (Rugh et al. 2005). Prior estimates were: 22,263 (CV = 9.25%) whales in 1995/96 (Hobbs et al. 2004), 23,109 (CV = 5.42%) whales in 1993/94 (Laake et al. 1994) and 21,296 (CV = 6.05%) whales in 1987/88

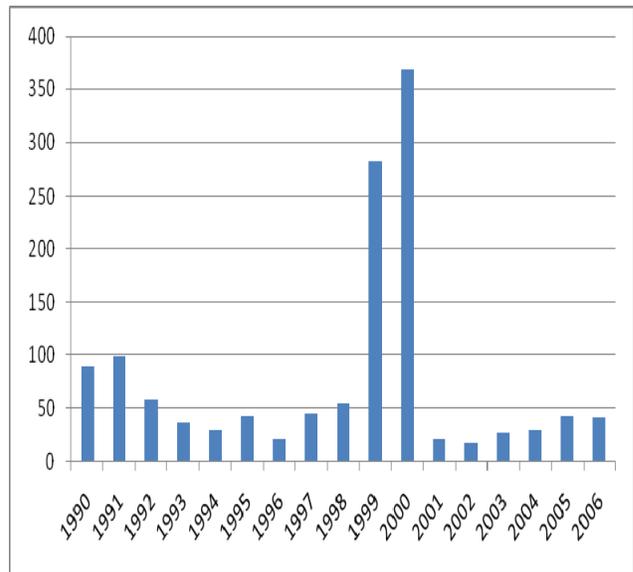
(Buckland et al. 1993). Variations in estimates may be due in part to undocumented sampling variation or to differences in the proportion of the gray whale stock migrating as far as the central California coast each year (Hobbs and Rugh 1999). The decline in the 2000/01 and 2001/02 abundance estimates may be an indication that the abundance was responding to environmental limitations as the population approaches the carrying capacity of its environment. Low encounter rates in 2000/01 and 2001/02 may have been due to an unusually high number of whales that did not migrate as far south as Granite Canyon or the abundance may have actually declined following high mortality rates observed in 1999 and 2000 (Gulland et al. 2005, Fig. 37). Visibly emaciated whales (LeBoeuf et al. 2000; Moore et al. 2001) suggest a decline in food resources, perhaps associated with unusually high sea temperatures in 1997 (Minobe 2002). Several factors since this mortality event suggest that the high mortality rate was a short term, acute event and not a chronic situation or trend: 1) counts of stranded dead gray whales dropped to levels below those seen prior to this event, 2) in 2001 living whales no longer appeared to be emaciated, and 3) calf counts in 2001/02, a year after the event ended, were similar to averages for previous years (W. Perryman, NMFS-SWFSC, pers. comm.; Rugh et al. 2005). Recently, Rugh *et al.* (2008b) evaluated the accuracy of various components of the shore-based survey method, with a focus on pod size estimation. They found that the correction factors that had been used to compensate for bias in pod size estimates have been calculated differently for different sets of years. In particular, the correction factors estimated by Laake *et al.* (1994) were substantially larger than those estimated by Reilly (1981). The pod size corrections of Reilly (1981) were used for the 1987/88 abundance estimate and the surveys prior to 1987 in the trend analysis were scaled based on the abundance estimate from 1987/88. The larger pod size correction factors of Laake (1992) were used for all of the surveys after 1987/88. This meant that the first 16 abundance estimates used one set of correction factors, and the more recent seven abundance estimates used different (and larger) correction factors which would influence the estimated trend and population trajectory. In addition, there have been other subtle differences in the analysis methods used for the sequence of abundance estimates. Thus, a re-evaluation of the analysis techniques and a reanalysis of the abundance estimates were warranted to apply a more uniform approach throughout the years. Laake *et al.* (2009) developed a more consistent, approach to abundance estimation that used a better model for pod size bias with weaker assumptions. They applied their estimation approach to re-estimate abundance for all 23 surveys; therefore, the abundance estimates presented here are different from those presented in previous Stock Assessment Reports.

The new abundance estimates between 1967 and 1987 were generally larger than previous abundance estimates; differences by year between the new abundance estimate and the old estimate range from -2.5% to 21%. However, the opposite was the case for survey years 1992 to 2006, with estimates smaller (-4.9% to -29%) than previous estimates. This pattern is largely explained by the differences in the correction for pod size bias which occurred because the pod sizes in the calibration data over-represented pods of two or more whales and underrepresented single whales relative to the estimated true pod size distribution. Re-evaluation of the correction for pod size bias and the other changes made to the estimation procedure yielded a somewhat different trajectory for population growth. The estimates still show the population increased steadily from the 1960s until the 1980s. Previously, the peak abundance estimate was in 1998 followed by a large drop in numbers (Rugh et al. 2008b). Now the peak estimate is a decade earlier in 1987/88. The revised estimates for the most recent years are 16,369 (CV=6.1%) in 2000/01, 16,033 (CV=6.9%) in 2001/02, and 19,126 (CV=7.1%) in 2006/07. Revised estimates from the three years prior are 20,103 (CV=5.6%) in 1993-94, 20,944 (CV=6.1%) in 1995-96, and 21,135 (CV=6.8%) in 1997-98 (Laake *et al.* 2009).



**Figure 36.** Estimated abundance of Eastern North Pacific gray whales from NMFS counts of migrating whales past Granite Canyon, California. Error bars indicated 90% probability intervals. The solid line represents the estimated trend of the population with 90% intervals as dashed lines (after Punt and Wade 2010).

The Eastern North Pacific population of gray whales experienced an unusual mortality event in 1999 and 2000. An unusually high number of gray whales were stranded along the west coast of North America in those years (Moore et al., 2001; Gulland et al., 2005). Over 60% of the dead whales were adults, and more adults and subadults stranded in 1999 and 2000 relative to the years prior to the mortality event (1996-98), when calf strandings were more common. Many of the stranded whales were in an emaciated condition, and aerial photogrammetry documented that gray whales were skinnier in girth in 1999 relative to previous years (Perryman and Lynn, 2002). In addition, calf production in 1999 and 2000 was less than 1/3 of that in the previous years (1996-98). Several factors since this mortality event suggest that the high mortality rate was a short-term, acute event and not a chronic situation or trend: 1) in 2001 and 2002, strandings of gray whales along the coast decreased to levels that were below their pre-1999 level (Gulland et al., 2005), 2) average calf production in 2002-2004 returned to the level seen in pre-1999 years, and 3) in 2001 living whales no longer appeared to be emaciated. A Working Group on Marine Mammal Unusual Mortality Events (Gulland et al., 2005)



**Figure 37.** Number of stranded gray whales recorded along the west coast of North America between 1990 and 2006 (data from Brownell et al. 2007).

concluded that the emaciated condition of many of the stranded whales supported the idea that starvation could have been a significant contributing factor to the higher number of strandings in 1999 and 2000. Perryman et al (2002) found a significant positive correlation between an index of the amount of ice-free area in gray whale feeding areas in the Bering Sea and their estimates of calf production for the following spring; the suggested mechanism is that more open water for a longer period of time provides greater feeding opportunities for gray whales. Unusual oceanographic conditions in 1997 may also have decreased productivity in the region (Minobe 2002). Regardless of the mechanism, visibly emaciated whales (LeBoeuf et al. 2000; Moore et al. 2001) suggest a decline in the availability of food resources, and it is clear that Eastern North Pacific gray whales were substantially affected in those years; whales were on average skinnier, they had a lower survival rate (particularly of adults), and calf production was dramatically lower. A modeling analysis estimates that 15.3% of the non-calf population died in each of the years of the mortality event, compared to about 2% in a normal year (Punt and Wade 2010). The most recent abundance estimate from 2006/07 suggests the population has nearly increased back up to the level seen in the 1990s before the mortality event in 1999 and 2000 (Figure 36).

Gray whale calves were counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year since 1994 (Perryman et al. 2002, 2004). In 1980 and 1981, calves passing this site comprised 4.7% to 5.2% of the population (Poole 1984b). From 1994-2000, calf production indices (calf estimate/total population estimate) were 4.2%, 2.7%, 4.8%, 5.8%, 5.5%, 1.7% and 1.1%, respectively (Perryman et al. 2002), and in 2004 the index was 9% (Perryman et al. 2004). Gray whale calves have also been counted from shore stations along the California coast during the southbound migration (Shelden et al. 2004). Those results have indicated significant increases in average annual calf counts near San Diego in the mid- to late-1970s compared to the 1950s and 1960s, and near Carmel in the mid-1980s through 2002 compared to late-1960s through 1980 (Shelden et al. 2004). This increase may be related to a trend toward later migrations over the observation period (Rugh et al. 2001, Buckland and Breiwick 2002), or it may be due to an increase in spatial and temporal distribution of calving as the population increased (Shelden et al. 2004).

### 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):  $N_{MIN} = N / \exp(0.842 \times [\ln(1 + [CV(N)]^2)]^{1/2})$ . Using the mean of the 2000/01 and 2001/02 abundance estimates (not significantly different) 2006/07 abundance estimate of 18,813, 19,126 and its associated CV of 0.069071,  $N_{MIN}$  for this stock is 17,752, 18,017.

### Current Population Trend

The population size of the Eastern North Pacific gray whale stock has been increasing over the past several decades despite an unusual mortality event in 1999 and 2000. The estimated annual rate of increase, based on shore counts of southward-migrating gray whales the unrevised abundance estimates between 1967 and 1988, is 3.3% with a standard error of 0.44% (Buckland et al. 1993); using the revised abundance time series from Laake et al. (2009) leads to an annual rate of increase for that same period of 3.2% with a standard error of 0.5% (Punt and Wade 2010). Taking account of the harvest catches, Wade and DeMaster (1996) estimated an underlying annual rate of increase of 4.4% (95% CI: 3.1%–5.6%) for this same time period. Incorporating the census data through the 1993/94 migration resulted in an annual rate of increase of 2.6% (SE = 0.4%; IWC 1995). Breiwick (1999) estimated the annual rate of increase from 1967/68 to 1997/98 at 2.52% (95% CI: 2.04%–3.12%), and Wade and DeMaster (1996) estimated the annual rate of increase from 1967/68 to 1995/96 at 2.4% (95% CI: 1.6%–3.2%). Rugh et al. (2005) estimated the rate of increase from 1967/69 through 2001/02 at 1.9% (SE = 0.32%). They also fit a discrete logistic model to the abundance estimates resulting in an estimate of  $K$  (carrying capacity) of 26,290 (CV = 0.059).

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The abundance time-series has been revised (Laake et al 2009), so estimates of productivity rates must be based on the revised time-series. Using abundance data through 1996/2006/07, an analysis of the Eastern North Pacific gray whale population led to an estimate of  $R_{\max}$  of 0.0762, with a 90% probability the value was between 0.0392 and 0.126 (Wade 2002) 088 (Punt and Wade 2010). This estimate came from the best fitting age- and sex-structured model, which was a density-dependent Leslie model including an additional variance term, with females and males modeled separately, that accounted for the mortality event in 1999-2000. This estimate was higher than the estimate of  $R_{\max}$  from a logistic model (0.053, 90% probability 0.031 to 0.113), which was not age- and sex-structured (Wade 2002). The Alaska Scientific Review Group recommended the use of the 0.053 point estimate for  $R_{\max}$ . The difference in the two estimates of  $R_{\max}$  is due to the bias in the harvest towards females, which is not accounted for in the logistic model. Therefore, NMFS has decided to use the estimate from the age- and sex-structured model, which had a lower 10th percentile of that estimate of 0.0470. This has the interpretation that there is a 90% probability that the true value of  $R_{\max}$  is greater than 0.0470. This is sufficient evidence that Therefore, the  $R_{\max}$  for Eastern North Pacific gray whales is greater than the same as the default value of 0.04. Therefore, NMFS will use an  $R_{\max}$  of 0.0470.

## 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 upper limit of the range (0.5-1.0) of values for non-listed stocks which are increasing while undergoing removals due to subsistence hunters (Wade and Angliss 1997) value for a stock estimated to be above MNPL and therefore not depleted. Thus, for the Eastern North Pacific stock of gray whales,  $PBR = 417360$  animals ( $47,75218,017 \times 0.0235 \times 1.0$ ).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

In previous stock assessments, there were six different observed federal commercial fisheries in Alaska that could have had incidental serious injuries or mortalities of gray whales. In 2004, the definitions of these commercial fisheries were changed to reflect target species: these new definitions have resulted in the identification of 22 observed fisheries in the Gulf of Alaska and Bering Sea that use trawl, longline, or pot gear (69 FR 70094, 2 December 2004). There were no observed serious injuries or mortalities of gray whales in any of those fisheries.

NMFS observers monitored the northern Washington marine set gillnet fishery (coastal + inland waters), otherwise known as the Makah tribal fishery for Chinook salmon, during 1990-98 and in 2000. There was no observer coverage in this fishery in 1999; however, the total fishing effort was only four net days (in inland waters), and no marine mammals were reported taken. One gray whale was observed taken in 1990 (Gearin et al. 1994) and one in 1995 (P. Gearin, unpubl. data). In July of 1996, one gray whale was entangled in the same tribal set gillnet fishery, but it was released unharmed (P. Gearin, AFSC-NMML, pers. comm.). Data from the most recent 5 years indicates that no gray whales were seriously injured or killed incidental to this fishery.

NMFS observers monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 1993 to 2003 (Table 33; Julian 1997; Cameron 1998; Julian and Beeson 1998; Cameron and Forney 1999, 2000; Carretta 2001, 2002; Carretta and Chivers 2003, 2004). One gray whale mortality was observed in this fishery in both 1998 and 1999. 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 on buoy lines (Barlow and Cameron 1999). Data from the most recent 5 years indicates that no gray whales were seriously injured or killed incidental to this fishery.

It should be noted that no observers have been assigned to most Alaska gillnet fisheries, including those in Bristol Bay that are known to interact with this stock, making the estimated mortality from U.S. fisheries a minimum figure. Further, due to a lack of observer programs there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries, which are analogous to U.S. fisheries that are known to interact with gray whales. Data regarding the level of gray whale mortality related to commercial fisheries in Canadian waters, though thought to be small, are not readily available or reliable which results in an underestimate of the annual mortality for this stock. However, the large stock size and observed rate of increase over the past 20 years makes it

unlikely that unreported mortalities from those fisheries would be a significant source of mortality for the stock. The estimated minimum annual mortality rate incidental to U. S. commercial fisheries (6.7 whales) is not known to exceed 10% of the PBR (44.2) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

**Table 33.** Summary of incidental mortality of Eastern North Pacific gray whales due to commercial fisheries from 1993-2003 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from stranding data. Data from 1999-2003-2007 (or the most recent 5 years of available data) are used in the mortality calculation. 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
Unknown west coast fisheries	1993-2003-2007	strand data	N/A	0, 5, 3, 3, 6, 4, 3, 3, N/A, 2, N/A, 1, 1, 1, 0	N/A	[≥30.6]
AK salmon purse seine	1999-2003	strand data	N/A	1, N/A, N/A, N/A, N/A	N/A	[≥0.5]
Pot fisheries	1999-2003-2007	strand data	N/A	1, 2, N/A, N/A, 3, 0, 0, 1, 0	N/A	[≥1.20.8]
CA yellowtail/barracuda/white seabass gillnet fishery	1999-2003	strand data	N/A	N/A, 1, N/A, N/A, N/A	N/A	[≥0.2]
Other entanglements	1999-2003	strand data	N/A	1, 2, N/A, 2, 1	N/A	[≥1.2]
Minimum total annual mortality						≥6.73.3

### Strandings and Entanglements

Reports of entangled gray whales found swimming, floating, or stranded with fishing gear attached occur along the U.S. west coast and British Columbia. Details of strandings that occurred in 1993-95 and 1996-98 in the United States and British Columbia are described in Hill and DeMaster (1999) and Angliss et al. (2002), respectively. Table 34 presents data on strandings that occurred on the U. S. west coast from 1999 to 2003; these data are summarized in Table 33. The strandings resulting from commercial fishing are listed as unknown west coast fisheries in Table 34, unless they could be attributed to particular fisheries. During the 5-year period from 1999 to 2003 to 2007, stranding network data indicate a minimum annual mean of 6.73.3 gray whale mortalities resulting from interactions with commercial fishing gear.

**Table 34.** Human-related gray whale strandings and entanglements, 1999-2003. An asterisk in the “number” column indicates cases that were not considered serious injuries. Note: NMFS convened a workshop in 2007 to review and update the guidelines for what constitutes “serious injury”. Changes to the agency’s guidelines resulting from this workshop may affect whether injured animals identified are considered “seriously injured” in future SARs.

Year	Number	Area	Condition	Description
1999	1	Port Gravina, PWS, AK	Dead	Entangled in AK salmon purse seine net
1999	1	Bristol Bay, AK	Dead	Entangled
1999	1	Offshore North Coronado Is., CA	Non-fatal injury	Ship strike
1999	1	Wreck Creek, WA	Dead	Net wrapped around flukes
1999	1	Twin Harbors State Park, WA (Grayland)	Dead	Rope through mouth
1999	1	1.5 mi. offshore Rancho Palos Verdes, CA	Injury; status unknown	Pink gillnet & attached float wrapped around flukes; swimming w/difficulty; unable to dive

1999	1	10 mi. offshore Port Hueneme, CA	Dead	Wrapped in pot gear & associated floats
1999	1*	2 mi. offshore Crescent City, CA	Non-fatal injury	Crab pot line wrapped around flukes & mouth; disentangled by rescue team
1999	1*	3 mi. offshore Crescent City, CA	Released alive	Crab pot line wrapped around body; released from entangling gear
1999	1	Pt. Loma, CA	Dead	18 in. harpoon tip embedded in left dorsum
1999	1	Muir Beach, CA	Dead	Ship strike
2000	1	Depoe Bay, OR	Alive	Trailing fish line with longline buoys attached
2000	1	Brookings, OR	Alive	Head entangled in line
2000	1	Offshore Pt. Loma, CA	Status unknown	Trailing lobster pot gear
2000	1	Offshore San Clemente, CA	Status unknown	Yellow polypropylene line wrapped around flukes of free swimming whale
2000	1	Redwood National Park, CA	Dead	Ship strike
2000	1	Offshore Pt. Dume, CA	Status unknown	Line & buoys wrapped around flukes of free swimming whale
2000	1	Vandenberg AFB, CA	Dead	Lobster trap & rope wrapped around flukes
2000	1	Seal Beach, CA	Dead	White sea-bass gillnet wrapped around flukes
2000	1	Offshore Shelter Cove, CA	Injury; status unknown	Free-swimming whale with harpoon in back
2000	1	Offshore Aptos, CA	Status unknown	Fishing gear & floats wrapped around right pectoral flipper of free-swimming whale
2001	1	3 miles offshore Morro Bay	Live, likely mortality	Vessel collision with free-swimming abandoned calf; major injuries to caudal peduncle; flukes completely severed
2002	1*	Offshore Santa Barbara	Live, unknown	Free-swimming animal observed with yellow line wrapped around torso; no disentanglement initiated
2002	1	Offshore Pt. Vicente	Live, unknown	Free-swimming animal observed with yellow line wrapped around caudal peduncle; no disentanglement initiated
2002	1	Grays Harbor, WA	Dead	Yellow fishing gear (lines and net) wrapped around peduncle
2003	1	Offshore Morro Bay	Live, unknown	Free-swimming animal observed with crab pot gear trailing from right side of mouth (crab pot, 75 ft of yellow polypropylene line & 2 buoys); USCG vessel on site; no disentanglement initiated
2003	1	North Island Naval Air Station	Dead	15 foot calf with 3 foot length of yellow polypropylene line lodged in baleen
2003	1	2.5 miles off San Mateo Point	Live	Free-swimming animal observed with 150 ft of crab pot line and associated crab pot wrapped around head, torso & flukes; crew of commercial sportfishing vessel cut most of line and crab pot away; small amount of line remained wrapped around flukes (approximately 4 wraps); animal observed swimming strongly away after disentanglement

2003	1	Lands End Beach	Dead	25 ft calf; probable vessel collision; 2 propeller-like slashes through bone and baleen on right side of rostrum; broken rostrum
2003	1	Tillamook, OR	Dead	Crab pot line and buoy wrapped around flukes and caudal peduncle
2004	1	Driftwood Beach State Park, OR	Dead	Entanglement; rope marks found around both pecs and through mouth
2005	1	Grayland, WA	Dead	Entanglement lines on head
2005	1	Horsefall Beach, OR	Dead	Entanglement; fishing line wrapped around animal
2006	1	Grays Harbor, WA	Dead	Entangled in crab pot; rope wrapped around fluke, tailstock, mid-body, and through baleen; rope scarring on head and left side

In 1999 and 2000, a large number of gray whale strandings occurred along the west coast of North America between Baja California, Mexico, and the Bering Sea (Norman et al. 2000, Pérez-Cortés et al. 2000, Brownell et al. 2001, Gulland et al. 2005). A total of 273 gray whale strandings was reported in 1999 and 355 in 2000, compared to an average of 38 per year during the previous four years (Fig. 36). Gray whale strandings occurred throughout the year in both 1999 and 2000, but regional peaks of strandings occurred where and when the whales were in their migration cycle. Since then, stranding rates have been low (21, 18, 27, 30, 43, and 42 whales in 2001-2006, respectively; Brownell et al. 2007). Hypothesized reasons for the high stranding rate in 1999 and 2000 include starvation, effects of chemical contaminants, natural toxins, disease, direct anthropogenic factors (fishery interactions and ship strikes), increased survey/reporting effort, and effects of wind and currents on carcass deposition (Norman et al. 2000). Since only 16 animals showed conclusive evidence of direct human interaction in 1999-2000, it seems unreasonable that direct anthropogenic factors were responsible for the increase in strandings. In addition, although survey effort has varied considerably in Mexico and Alaska, it has been relatively constant in Washington, Oregon, and California, so the high rates were not a function of increased observational effort. The other hypotheses have not yet been conclusively eliminated. However, assuming a 5% mortality rate for gray whales (Wade and DeMaster 1996), it would be reasonable to expect that approximately 1,300 gray whales would die annually of natural causes; therefore, the high rate of strandings does not seem to be an area of concern.

#### Subsistence/Native Harvest Information

Subsistence hunters in Alaska and Russia have traditionally harvested whales from this stock. The only reported takes by subsistence hunters in Alaska during this decade occurred in 1995, with the take of two gray whales by Alaska Natives (IWC 1997). Russian subsistence hunters reported taking 43 whales from this stock in 1996 (IWC 1998a) and 79 in 1997 (IWC 1999). In 1997, the IWC approved a 5-year quota (1998-2002) of 620 gray whales, with an annual cap of 140, for Russian and U.S. (Makah Indian Tribe) aboriginals based on the aboriginal needs statements from each country (IWC 1998b). The U.S. and Russia have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russian Chukotka people and 4 whales by the Makah Indian Tribe. Total takes by Russian aboriginals harvested 121 (+2 struck and lost) in 1999 (IWC 2001), 113 (+2 struck and lost) in 2000 (Borodin 2001), 112 in 2001 (Borodin et al. 2002), 131 in 2002 (Borodin 2003), 126 (+2 struck and lost) in 2003 (Borodin 2004), and 115 in 2005 (IWC 2007), while the Makah Tribe harvested 1 whale in 1999 (IWC 2001) were 126 in 2003 (IWC 2005), 110 in 2004 (IWC 2006), 115 in 2005 (IWC 2007), 129 in 2006 (IWC 2008), and 126 in 2007 (IWC 2009). Based on this information, the annual subsistence take averaged 122 121 whales during the 5-year period from 1999 to 2003 to 2007.

#### Other Mortality

The nearshore migration route used by gray whales makes ship strikes another potential source of mortality. Between 1999 and 2003, the California stranding network reported 4 serious injuries or mortalities of gray whales caused by ship strikes: 1 each in 1999, 2000, 2001, and 2003 (J. Cordaro, NMFS-SWR, pers. comm.). One ship strike mortality was reported in Alaska in 1997 (B. Fadely, AFSC-NMML, pers. comm.). Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma. Therefore, it is not possible to quantify the actual mortality of gray whales from this source, and

the annual mortality rate of 1.2 gray whales per year due to collisions with vessels represents a minimum estimate from this source of mortality.

In 1999 and 2000, the California stranding network reported gray whale strandings due to harpoon injuries (Table 35). A Russian harpoon tip was found in a dead whale that stranded in 1999 (R. Brownell, NMFS-SWFSC, pers. comm.), and an injured whale with a harpoon in its back was sighted in 2000. Since these whales were likely harpooned during the aboriginal hunt in Russian waters, they would have been counted as “struck and lost” whales in the harvest data.

**In 2005 Makah tribal members unlawfully hunted and killed an ENP gray whale (CITE).**

## STATUS OF STOCK

In 1994, due to steady increases in population abundance, the eastern North Pacific stock of gray whales was removed from the List of Endangered and Threatened Wildlife (the List), as it was no longer considered endangered or threatened under the Endangered Species Act (ESA). As required by the ESA, NMFS monitored the status of this stock for 5 years following delisting. A workshop convened by NMFS on 16-17 March 1999 at the AFSC’s National Marine Mammal Laboratory in Seattle, WA, reviewed the status of the stock based on research conducted during the 5-year period following delisting. Invited workshop participants determined that the stock was neither in danger of extinction, nor likely to become endangered within the foreseeable future, therefore there was no apparent reason to reverse the previous decision to remove this stock from the List (Rugh et al. 1999). This recommendation was subsequently adopted by NMFS.

**Prior to the revised abundance estimates of Laake et al. (2009),** Wade (2002) conducted an assessment of the Eastern North Pacific gray whale stock using survey data through 1995-96. Wade and Perryman (2002) updated the assessment in Wade (2002) to incorporate the abundance estimates from 1997-1998, 2000-2001, and 2001-2002, as well as calf production estimates from the northward migration (1994 to 2001), into a more complete analysis that further increased the precision of the results. All analyses concluded that the population was within the stock’s optimum sustainable population (OSP) level (i.e., there was essentially zero probability that the population was below the stock’s maximum net population level), and estimated the population in 2002 was between 71% and 102% of current carrying capacity. Similar results were found in a separate assessment (Punt et al. 2004). The Scientific Committee of the International Whaling Commission reviewed both assessments and agreed that management advice could be formulated from the results. Both assessments indicated that the population was above MSYL, and was likely close to or above its unexploited equilibrium level (IWC 2003).

**Using assessment methods similar to those of Wade (2002), Wade and Perryman (2002), and Punt et al. (2004), Punt and Wade (2010) conducted the first assessment of the Eastern North Pacific gray whale stock to use the revised abundance estimates from Laake et al (2009). From that assessment, the population is estimated to be at 91% of K, and at 129% of MNPL, with a probability of 0.884 that the population is above MNPL. Those results were consistent across all the model runs. Therefore, the assessment using the revised abundance time-series is consistent with previous assessments, and estimates the population is within OSP.**

Even though the stock is within OSP, abundance will rise and fall as the population adjusts to natural and man-caused factors affecting the carrying capacity of the environment (Rugh et al. 2005). In fact, it is expected that a population close to or at the carrying capacity of the environment will be more susceptible to fluctuations in the environment (Moore et al. 2001). The recent correlation between gray whale calf production and environmental conditions in the Bering Sea (Perryman et al. 2002) may be an example of this. For this reason, it can be predicted that the population will undergo fluctuations in the future that may be similar to the 2-year event that occurred in 1999-2000 (Norman et al. 2000, Pérez-Cortés et al. 2000, Brownell et al. 2001, Gulland et al. 2005). Overall, the population increased (nearly doubled in size) over approximately the first 20 years of monitoring, and then has **fluctuated for the last 30 years around its average carrying capacity.** ~~been roughly stable for the last 230 years (since the mid-1980s). This is entirely consistent with a population approaching K, and is the interpretation of the trend data and assessment that is accepted by the Scientific Committee of the IWC.~~

Alter et al. (2007) used estimates of genetic diversity to infer that North Pacific gray whales may have numbered ~96,000, including animals in both the western and eastern populations, 1100-1600 years ago. The authors recommend that because the current estimate of the eastern stock of gray whales is at most 28-56% of this historic abundance, ~~that~~ the stock should be designed as “depleted” under the MMPA. NMFS does not accept the recommendation made by Alter et al (2007) for the following reasons. First, ~~the interpretation of the findings of Alter et al. (2007) are under debate in the scientific literature (Palsboll et al. 2007) and by the International Whaling Commission (IWC) Scientific Committee~~ **their analysis examines the population of the entire historical Pacific population of gray whales, while MMPA management occurs at the level of a stock, which in this case is the eastern**

north Pacific stock. It is speculative to try to determine what proportion of the estimated abundance may have been the eastern or western populations. It is also uncertain whether Alter et al.'s estimates include the Atlantic population (Palsboll et al. 2007). Second, the lower range of the confidence interval in Alter et al. (2007) is consistent with a historic abundance of about 30,000 whales each for the western and eastern North Pacific stocks of gray whales. An abundance of 30,000 gray whales in the Eastern North Pacific stock is well within the confidence limits for estimates of carrying capacity reported by Wade (2002). Finally, because it is likely that an abundance NMFS relies on current carrying capacity in making MMPA determinations. Ecosystem conditions change over time and with those changes the carrying capacity of the ecosystem for different species will also change. NMFS adopted the practice of interpreting carrying capacity to mean "current" carrying capacity in part because it is not reasonable to expect ecosystems to remain static over a time span of thousands of years, even in the absence of human activity. Thus an estimate of stock abundance 1,100-1,600 years ago is not relevant to the ocean's current carrying capacity, it is not reasonable to compare the current abundance estimate to an estimate that far in the past to assess current status under the MMPA decision-making, even if such an estimate were available.

At present, U.S. commercial fishery-related annual mortality levels less than 41.736.0 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. Based on currently available data, the estimated annual level of human-caused mortality and serious injury (43.126.5), which includes mortalities from commercial fisheries (6.73.3), Russian harvest (12.21), unlawful hunt (1), and ship strikes (1.2), does not exceed the PBR (41.736.0). Therefore, the Eastern North Pacific stock of gray whales is not classified as a strategic stock.

## HABITAT CONCERNS

Eastern North Pacific gray whales range from subtropical lagoons in Baja Mexico to arctic seas around Alaska and eastern Russia (Braham 1984). 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). These changes are likely to affect marine mammal species in the Arctic, including the gray whale, due to the impacts of a changing Arctic environment on the species' benthic food supply. With the increase in numbers of gray whales (Rugh et al. 2005), in combination with changes in prey distribution (Grebmeier et al. 2006; Moore et al. 2007), some gray whales have moved into new feeding areas, spreading their summer range (Rugh et al. 2001). There are insufficient data to make reliable predictions of the effects of Arctic climate change on gray whales. Moore and Huntington (2008) observed that "gray whales are perhaps the most adaptable and versatile of the mysticete species," are opportunistic foragers, and have recently been documented feeding year-round off Kodiak, Alaska. Bluhm and Gradinger (2008) examined likely trends in the availability of pelagic and benthic prey in the arctic and concluded that pelagic prey is likely to increase while benthic prey is likely to decrease. They noted that marine mammal species that feed both pelagically and benthically (such as gray whales) will fare better than those that only feed benthically. For gray whales, they observed that the composition of gray whale prey may be less important than the energy density at feeding sites.

Global climate change is also likely to lead to increased human activity in the arctic as sea ice decreases, including oil and gas exploration and shipping (Hovelsrud et al. 2008). This increased activity will increase the chance of oil spills and ship strikes in this portion of the whales' range. Shipping and some oil and gas activities have been occurring throughout the whales' range over the past several decades but have not prevented the species' recovery.

Ocean acidification is another future development that could affect gray whales by affecting their prey. Increased acidity in the ocean will reduce the abundance of shell-forming organisms (Fabry et al. 2008, Hall-Spencer et al. 2008), many of which are important in the gray whales' diet (Nerini 1984, Moore and Huntington 2008).

## CITATIONS

- Alter., S. A., E. Rynes, and S. R. Palumbi. 2007. DNA evidence for historic population size and past ecosystem impacts of gray whales. *Proc. Nat. Acad. Sci.* 104(38):15162-15167.
- Angliss, R. P., D. P. DeMaster, and A. Lopez. 2002. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124, 203 pp.
- Barlow, J., and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Unpubl. doc. submitted to *Int. Whal. Comm. (SC/51/SM2)*. 20 pp.

- Berzin, A. A. 1984. Soviet studies on the distribution and numbers of the gray whale in the Bering and Chukchi Seas from 1968 to 1982. Pp. 409-419 In M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), *The Gray Whale, Eschrichtius robustus*. Academic Press, Inc., Orlando. xxiv + 600 pp.
- Bluhm, B. and Gradinger, R. 2008. Regional variability in food availability for arctic marine mammals. *Ecol. Appl.* 18: S77-96.
- Borodin, R. G. 2001. Aboriginal whaling in Chukotka waters in 2000. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/BRG23). 10 pp.
- Borodin, R. G. 2003. Report on the aboriginal subsistence whale harvest of the Russian Federation in 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/55/BRG22). 22 pp.
- Borodin, R. G. 2004. Subsistence whale harvest of the Russian Federation in 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/56/BRG49). 7 pp.
- Borodin, R. G., Blokhin, and D. Litovka. 2002. Historical and present information about the aboriginal whale harvest of gray whales in Chukotka, Russia. Unpubl. doc. submitted to Int. Whal. Comm. (SC/54/BRG27). 10 pp.
- Braham, H. W. 1984. Distribution and migration of gray whales in Alaska. In: *The Gray Whale* (Ed. by Jones, M. L., Swartz, S. L. & Leatherwood, S.), pp. 249-266. London: Academic Press.
- Breiwick, J. W. 1999. Gray whale abundance estimates, 1967/68 - 1997/98: ROI, RY, and K. Pp. 62 In D. J. Rugh, M. M. Muto, S. E. Moore, and D. P. DeMaster, Status review of the Eastern North Pacific stock of gray whales. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-103, 96 pp.
- Brownell, R. L., Jr., L. Rojas Bracho, S. L. Swartz, J. Urban R., M. L. Jones, H. Perez-Cortes, W. Perryman, and D. P. DeMaster. 2001. Status of the eastern gray whale population: past and future monitoring. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/BRG21). 11 pp.
- Brownell, R. L., Jr., C. A. F. Makeyev, and T. K. Rowles. 2007. Stranding trends for Eastern Gray Whales, *Eschrichtius robustus*: 1975-2006. Unpubl. doc. submitted to Int. Whal. Comm. (SC/59/BRG40). 7 pp.
- Buckland, S. T., and J. M. Breiwick. 2002. Estimated trends in abundance of eastern Pacific gray whales from shore counts (1967/68 to 1995/96). *J. Cetacean Res. Manage.* 4(1):41-48.
- Buckland, S. T., J. M. Breiwick, K. L. Cattanach, and J. L. Laake. 1993. Estimated population size of the California gray whale. *Mar. Mammal Sci.* 9(3):235-249.
- Calambokidis, J., J. D. Darling, V. Deeke, P. Gearin, M. Gosho, W. Megill, C. M. Tombach, D. Goley, C. Toropova and B. Gisbourne. 2002. Abundance, range and movements of a feeding aggregation of gray whales (*Eschrichtius robustus*) from California and southeastern Alaska in 1998. *J. Cetacean Res. Manage.* 4(3):267-276.
- Calambokidis, J., R. Lumper, J. Laake, M. Gosho, and P. Gearin. 2004. Gray whale photographic identification in 1998-2003: Collaborative research in the Pacific Northwest. Final report to National Marine Mammal Laboratory, Seattle, WA. Available from Cascadia Research ([www.cascadiaresearch.org](http://www.cascadiaresearch.org)), 218½ W Fourth Ave., Olympia, WA 98501. 48pp.
- Calambokidis, J., and J. Quan. 1999. Photographic identification research on seasonal resident whales in Washington State. Unpubl. doc. submitted to the Workshop to Review the Status of the Eastern North Pacific Stock of Gray Whales, 16-17 March 1999, Seattle, WA.
- Cameron, G. 1998. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1997. Unpubl. doc. submitted to Int. Whal. Comm. (SC/50/SM2). 15 pp.
- Cameron, G. A., and K. A. Forney. 1999. Preliminary estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Unpubl. doc. submitted to Int. Whal. Comm. (SC/51/O4). 14 pp.
- Cameron, G. A., and K. A. Forney. 2000. Preliminary estimates of cetacean mortality in California/Oregon gillnet fisheries for 1999. Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/O24). 12 pp.
- Carretta, J. V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/SM9). 21 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.

- Clarke, J. T., Moore, S. E. & Ljungblad, D. K. 1989. Observations on gray whale (*Eschrichtius robustus*) utilization patterns in the northeastern Chukchi Sea, July- October 1982- 1987. *Canadian Journal of Zoology*, 67, 2646-2654.
- Darling, J. D. 1984. Gray whales off Vancouver Island, British Columbia. Pp. 267-287 In M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), *The Gray Whale, Eschrichtius robustus*. Academic Press, Inc., Orlando. xxiv + 600 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.
- Fabry, V. J., B. A. Seibel, R. A. Feely, and J. C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. – *ICES Journal of Marine Science*, 65(3): 414–432.
- Fraser, F. C. 1970. An early 17th century record of the California gray whale in Icelandic waters. *Invest. Cetacea* 2:13-20.
- Gardner, S. C. & Chavez Rosales, S. 2000. Changes in the relative abundance and distribution of gray whales (*Eschrichtius robustus*) in Magdalena Bay, Mexico during an El Nino event. *Marine Mammal Science*, 16, 728-738.
- Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a Chinook salmon set-net fishery in Washington State. *Rep. Int. Whal. Comm. (Special Issue 15):*427-438.
- Gill, R. E. & Hall, J. D. 1983. Use of nearshore and estuarine areas of the southeastern Bering Sea by gray whales (*Eschrichtius robustus*). *Arctic*, 36, 275-281.
- Grebmeier, J. M., Overland, J. E., Moore, S. E., Farley, E. V., Carmack, E. C., Cooper, L. W., Frey, K. E., Helle, J. H., McLaughlin, F. A. & McNutt, S. L. 2006. A major ecosystem shift in the northern Bering Sea. *Science*, 311, 1461-1464.
- Gulland, F.M.D., H. Pérez-Cortés M., J. Urgán R., L. Rojas-Bracho, G. Ylitalo, J. Weir, S.A. Norman, M.M. Muto, D.J. Rugh, C. Kreuder, and T. Rowles. 2005. Eastern North Pacific gray whale (*Eschrichtius robustus*) unusual mortality event, 1999-2000. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-150, 33 pp.
- Hall-Spencer, J. M., R. Rodolfo-Metalpa, S. Martin, E. Ransome, M. Fine, S. M. Turner, S. J. Rowley, D. Tedesco, and M. C. Buia. 2008. Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature* 454: 96-99.
- Hill, P. S., and D. P. DeMaster. 1999. Alaska marine mammal stock assessments, 1999. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-110, 166 pp.
- Hobbs, R. C., and D. J. Rugh. 1999. The abundance of gray whales in the 1997/98 southbound migration in the eastern North Pacific. Unpubl. doc. submitted to Int. Whal. Comm. (SC/51/AS10). 18 pp.
- Hobbs, R.C., D.J. Rugh, J.M. Waite, J.M. Breiwick and D.P. DeMaster. 2004. Abundance of eastern North Pacific gray whales in the 1995/96 southbound migration. *J. Cetacean Res. Manage.* 6(2):115-120.
- Hovelsrud, G.K., McKenna, M. and Huntington, H.P. 2008. Marine mammal harvests and other interactions with humans. *Ecol. Appl.* 18(2 Supplement): S135-S47.
- International Whaling Commission. 1995. Report of the Scientific Committee. *Rep. Int. Whal. Comm.* 45:53-95.
- International Whaling Commission. 1997. Chairman's Report of the 48th Annual Meeting. *Rep. Int. Whal. Comm.* 47:17-55.
- International Whaling Commission. 1998a. International Whaling Commission Report 1996-97. *Rep. Int. Whal. Comm.* 48:1-2.
- International Whaling Commission. 1998b. Chairman's Report of the 49th Annual Meeting. *Rep. Int. Whal. Comm.* 48:17-51.
- International Whaling Commission. 1999. International Whaling Commission Report 1997-98. Annual Report of the International Whaling Commission 1998:1-2.
- International Whaling Commission. 2001. International Whaling Commission Report 1999-2000. Annual Report of the International Whaling Commission 2000:1-3.
- International Whaling Commission. 2003. Report of the Scientific Committee of the International Whaling Commission. *J. Cetacean Res. Manage.* 5(Suppl.):30-31.
- International Whaling Commission. 2005. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. *J. Cetacean Res. Manage. (Suppl.)* 7:204-205.
- International Whaling Commission. 2006. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. *J. Cetacean Res. Manage. (Suppl.)* 8:118-119.
- International Whaling Commission. 2007. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. *J. Cetacean Res. Manage. (Suppl.)* 9:142-155.

- International Whaling Commission. 2008. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. *J. Cetacean Res. Manage. (Suppl.)* 10:162-163.
- International Whaling Commission. 2009. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. *J. Cetacean Res. Manage. (Suppl.)* 11:169-175.
- Julian, F. 1997. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1996. Unpubl. doc. submitted to Int. Whal. Comm. (SC/49/SM2). 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.
- Kochnev, A. A. 1998. Death of whales (Cetacea) in the Chukchi Sea and the Long Strait: Species composition, distribution and causes of death. *Zoologicheskyy Zhurnal*, 77, 601-605.
- Laake, J., Punt, A., Hobbs, R., Ferguson, M., Rugh, D. and J. Breiwick. 2009. Re-analysis of gray whale southbound migration surveys 1967-2006. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-203, 55 p.
- Laake, J. L., D. J. Rugh, J. A. Lerczak, and S. T. Buckland. 1994. Preliminary estimates of population size of gray whales from the 1992/93 and 1993/94 shore-based surveys. Unpubl. doc. submitted to Int. Whal. Comm. (SC/46/AS7). 13 pp.
- LeBoeuf, B. J., M. H. Perez Cortes, R. J. Urban, B. R. Mate, and U. F. Ollervides. 2000. High gray whale mortality and low recruitment in 1999: Potential causes and implications. *J. Cetacean Res. Manage.* 2(2): 85-99.
- Mead, J.G., and E.D. Mitchell. 1984. Atlantic gray whales. Pp. 33-53 In M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), *The Gray Whale, Eschrichtius robustus*. Academic Press, Inc., Orlando. Xxiv + 600 pp.
- Miller, R. V., Johnson, J. H. & Doroshenko, N. V. 1985. Gray whales (*Eschrichtius robustus*) in the western Chukchi and East Siberian seas. *Arctic*, 38, 58-60.
- Minobe, S. 2002. Interannual to interdecadal changes in the Bering Sea and concurrent 1998/99 changes over the North Pacific. *Progr. Oceanogr.* 55(1-2):45-64.
- Moore, S. E. & DeMaster, D. P. 1997. Cetacean habitats in the Alaskan arctic. *Journal of Northwest Atlantic Fishery Science*, 22, 55-69.
- Moore, S. E., DeMaster, D. P. & Dayton, P. K. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. *Arctic*, 53, 432-447.
- Moore, S. E. and H. P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience. *Ecological Applications* 18(Suppl.):157-165.
- Moore, S. E. & Ljungblad, D. K. 1984. Gray whales in the Beaufort, Chukchi, and Bering seas: Distribution and sound production. In: *The Gray Whale* (Ed. by Jones, M. L., Swartz, S. L. & Leatherwood, S.), pp. 543-559. London: Academic Press.
- Moore, S.E., J. Urbán R., W.L. Perryman, F. Gulland, H. Pérez-Cortés M., P.R. Wade, L. Rojas-Bracho and T. Rowles. 2001. Are gray whales hitting 'K' hard? *Mar. Mammal Sci.* 17(4):954-958.
- Moore, S.E., K.M. Wynne, J.C. Kinney, J.M. Grebmeier. 2007. Gray whale occurrence and forage southeast of Kodiak, Island, Alaska. *Mar. Mammal Sci.* 23 (2): 419-428.
- Nerini, M. 1984. A review of gray whale feeding ecology. Pp. 423-450 In M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), *The Gray Whale, Eschrichtius robustus*. Academic Press, Inc., Orlando. xxiv + 600 pp.
- Norman, S. A., M. M. Muto, D. J. Rugh, and S. E. Moore. 2000. Gray whale strandings in 1999 and a review of stranding records in 1995-1998. Final Draft, Unusual Mortality Event Report to the National Marine Fisheries Service. Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/AS5). 36 pp.
- Pérez-Cortés, H., J. Urbán R., F. Ollervides, A. Gómez-Gallardo, J. I. Solis, and A. Eslimán. 2000. Report of the high gray whale mortality in the Baja California Peninsula during the 2000 season. Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/AS16). 7 pp.
- Perryman, W. L., M. A. Donahue, P. C. Perkins, and S. B. Reilly. 2002. Gray whale calf production 1994-2000: are observed fluctuations related to changes in seasonal ice cover? *Mar. Mammal Sci.* 18(1):121-144.
- Perryman, W.L., G.M. Watters, L.K. Swartz and R.A. Rowlett. 2004. Preliminary results from shore-based surveys of northbound gray whale calves in 2003 and 2004, with a comparison to predicted numbers based on the distribution of seasonal ice. Paper SC/56/BRG43 presented to the IWC Scientific Committee, June 2004 (unpublished). 7pp.

- Poole, M. M. 1984a. Migration corridors of gray whales along the central California coast, 1980-1982. Pp. 389-407 *In* M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), *The Gray Whale, Eschrichtius robustus*. Academic Press, Inc., Orlando. xxiv + 600 pp.
- Poole, M. M. 1984b. Preliminary assessment of annual calf production in the gray whale, *Eschrichtius robustus*, from Pt. Piedras Blancas, California. *Rep. Int. Whal. Comm. (Special Issue 6)*:223-231.
- Punt, A. E., C. Allison and G. Fay. 2004. An examination of assessment models for the eastern North Pacific gray whale based on inertial dynamics. *J. Cetacean Res. Manage.* 6(2):121-132.
- Punt, A. E., and P. R. Wade. 2010. Population status of the eastern North Pacific stock of gray whales in 2009. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-xxx, yy p.
- Quan, J. 2000. Summer resident gray whales of Washington State: Policy, biological and management implications of Makah whaling. MS. Thesis. School of Marine Affairs, University of Washington. Seattle, WA.
- Ramakrishnan, U., R. G. LeDuc, J. Darling, B. L. Taylor, P. Gearin, M. Goshu, J. Calambokidis, R. L. Brownell, J. Hyde, and T. E. Steeves. 2001. Are the southern feeding group of Eastern Pacific gray whales a maternal genetic isolate? *Rep. Int. Whal. Comm.* SC53/SD8 5pp.
- Rice, D. W. 1981. Status of the eastern Pacific (California) stock of the gray whale. Pp. 181-187 *In* Food and Agriculture Organization. 1981. *Mammals in the Seas. Vol. III. General Papers and Large Cetaceans*. Food and Agriculture Organization, Rome, Italy.
- Rice, D. W., and A. A. Wolman. 1971. The life history and ecology of the gray whale, *Eschrichtius robustus*. *Am. Soc. Mammal. Special Publication* 3. 142 pp.
- Rice, D. W., A. A. Wolman, D. E. Withrow, and L. A. Fleischer. 1981. Gray whales on the winter grounds in Baja California. *Rep. Int. Whal. Comm.* 31:477-493.
- Rice, D. W., A. A. Wolman, and H. W. Braham. 1984. The gray whale, *Eschrichtius robustus*. *Mar. Fish. Rev.* 46(4):7-14.
- Rugh, D., J. Breiwick, M. M. Muto, R. Hobbs, K. Shelden, C. D'vincent, I. M. Laursen, S. Reif, S. Maher, and S. Nilson. 2008a. Report of the 2006-2007 census of the eastern north Pacific stock of gray whales. AFSC Processed Rep. 2008-03, 157 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.
- Rugh, D. J. & Fraker, M. A. 1981. Gray whale (*Eschrichtius robustus*) sightings in eastern Beaufort Sea. *Arctic*, 34, 186-187.
- Rugh, D.J., R.C. Hobbs, J.A. Lerczak and J.M. Breiwick. 2005. Estimates of abundance of the eastern North Pacific stock of gray whales 1997-2002. *J. Cetacean Res. Manage.* 7(1):1-12.
- Rugh, D.J., Muto, M.M., Hobbs, R.C. and J.A. Lerczak. 2008b. An assessment of shore-based counts of gray whales. *Mar. Mammal Sci.* 24: 864-880.
- Rugh, D. J., M. M. Muto, S. E. Moore, and D. P. DeMaster. 1999. Status review of the Eastern North Pacific stock of gray whales. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-103, 96 pp.
- Rugh, D. J., K. E. W. Shelden, and A. Schulman-Janiger. 2001. Timing of the southbound migration of gray whales. *J. Cetacean Res. Manage.* 3(1):31-39.
- Shelden, K.E.W., A. Schulman-Janiger, and D.J. Rugh. 2004. Gray whales born north of Mexico: indicator of recovery or consequence of regime shift? *Ecological Applications* 14(6):1789-1805.
- Stafford, K. M., Moore, S. E., Spillane, M. & Wiggins, S. 2007. Gray whale calls recorded near Barrow, Alaska, throughout the winter of 2003-04. *Arctic*, 60, 167-172.
- Steeves, T. E. 1998. Genetic population structure of gray whales (*Eschrichtius robustus*) that summer in Clayoquot Sound, British Columbia. M.S. Diss. American University, Washington, D.C.
- Swartz, S.L. (1986) Gray whale migratory, social and breeding behavior. *Report of the International Whaling Commission* (special issue), 8, 207-229.
- Swartz, S.L., B.L. Taylor, and D.J. Rugh. 2006. Gray whale *Eschrichtius robustus* population and stock identity. *Mammal Review.* 36(1):66-84. Wade, P. R. 2002. A Bayesian stock assessment of the eastern North Pacific gray whale using abundance and harvest data from 1967 to 1996. *J. Cetacean Res. Manage.* 4(1):85-98.
- Wade, P. R. 2002. A Bayesian stock assessment of the eastern North Pacific gray whale using abundance and harvest data from 1967 to 1996. *J. Cetacean Res. Manage.* 4(1):85-98.
- 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., and D. P. DeMaster. 1996. A Bayesian analysis of eastern Pacific gray whale population dynamics. Unpubl. doc. submitted to Int. Whal. Comm. (SC/48/AS3). 21 pp.
- Wade, P. R., and W. Perryman. 2002. An assessment of the eastern gray whale population in 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/54/BRG7). 16 pp.

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

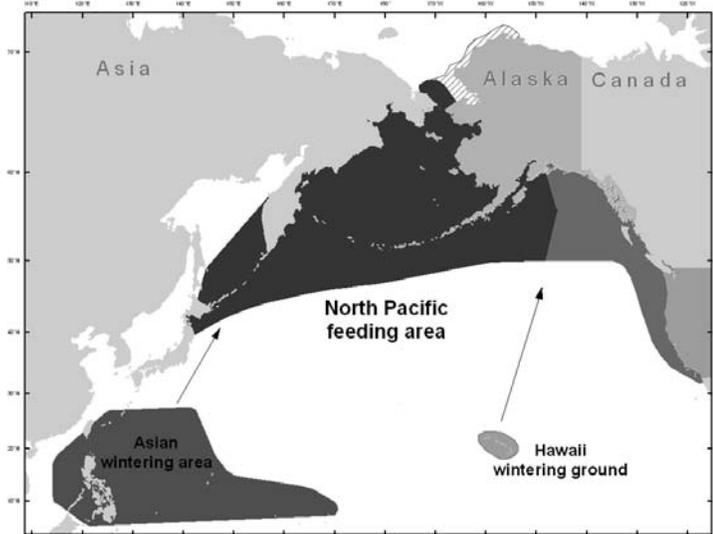
### STOCK DEFINITION AND GEOGRAPHIC RANGE

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 20<sup>th</sup> 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, or SPLASH, project). Initial results from this project (Calambokidis et al. 2008), including abundance estimates and movement information, are used in this report. Genetic results, which may provide a more comprehensive understanding of humpback whale population structure in the North Pacific, should be available in the near future.

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 Phillipines, 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; 1993; Mizroch pers. comm., North Pacific Humpback Whale Working Group, unpublished data). 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



**Figure 38.** 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 39 for humpback whale distribution in the eastern North Pacific.

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 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 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, 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 ~50-70km. SPLASH sampling in Okinawa (southwest of Honshu) occurred at the Okinawa mainland and Zamami in the Kerama Islands (40km 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 well 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 pers. Comm.), far offshore southeast of the Kamchatka Peninsula and south of the Commander Islands (Japanese IWC reference), and along the north coast of the Chukotka Peninsula in the Chukchi Sea (Melnikov IWC reference).

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 900-1100, 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 (6000-14,000) 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 & the Philippines to the coast of Central America & 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. submitted). 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. submitted). 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%).

Prior to the SPLASH study the only abundance estimates available for humpback whales on the Asian wintering grounds were from 1991-93. An average of pair-wise estimates for the years 1991-92, 1992-93, and 1991-93 results in an abundance estimate of 394 (CV = 0.084) (Calambokidis et al. 1997). This was an estimate for the Ogasawara Islands and Okinawa, but no data from the Phillipines or other areas were included. During the SPLASH study surveys were conducted in three winter field seasons (2004-06). The total number of unique individuals found in each area during the study were 77 in the Phillipines, 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 1107. The model that fit the data the best (as selected by AICc) gave an estimate of 1107 for the Ogasawara Islands, Okinawa, and the Phillipines. 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 6000 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 1,899–3680) for coastal/shelf waters from the central Gulf of Alaska through the eastern Aleutian Islands. Although there is a small amount of overlap between 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 1107, 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 ( $N_{\text{MIN}}$ ) for this stock is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997):  $N_{\text{MIN}} = N/\exp(0.842 \times [\ln(1 + [\text{CV}(N)]^2)]^{1/2})$ . Using the population estimate (N) of 938 and an assumed conservative CV(N) of 0.30 would result in an  $N_{\text{MIN}}$  for this humpback whale stock of 732. 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 for Asia (Calambokidis et al. 2008). However, the 1991-93 estimate was for Ogaswara and Okinawa only, whereas the SPLASH estimate includes the Phillipines, 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. (2006) 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  $R_{\text{MAX}}$  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 ( $R_{\text{MAX}}$ ) 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 smallest 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 animals ( $732 \times 0.035 \times 0.1$ ). Alternatively, using the number of unique individuals seen during the SPLASH study results in a PBR of 2.0 ( $566 \times 0.035 \times 0.1$ ).

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### 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 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. Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006) and Perez (unpubl. ms.). Between 2002 and 2006, there were incidental serious injuries and mortalities of Western North Pacific humpback whales in the Bering Sea/Aleutian Islands sablefish pot fishery (Table 35). Average annual mortality from observed fisheries was 0.20 humpbacks from this stock (Table 35). Note, however, that the stock identification is uncertain and the mortality may have involved a whale from the central North Pacific stock of humpback whales. Thus, this mortality is assigned to both the central and western stocks. ~~More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

Strandings of humpback whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality data. The only fishery-related humpback stranding in an area thought to be occupied by animals from this stock was reported by a U. S. Coast Guard vessel in late June 1997 operating near the Bering Strait. The whale was found floating dead entangled in netting and trailing orange buoys (National Marine Mammal Laboratory, Platforms of Opportunity Program, unpubl. data, 7600 Sand Point Way NE, Seattle, WA 98115). With the given data it is not possible to determine which fishery (or even which country) caused the mortality. Note, that this mortality has been attributed the Western North Pacific stock, but without a tissue sample (for genetic analysis) or a photograph (for matching to known Japanese animals) it is not possible to be for certain (i.e., it may have belonged to the Central North Pacific stock). No strandings or sightings of entangled humpback whales of this stock were reported between 2001 and 2005; however, effort in western Alaska is low.

**Table 35.** Summary of incidental mortality and serious injury of humpback whales (Western North Pacific stock) due to commercial fisheries from 2002 to 2006 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate. 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
Bering Sea sablefish pot	2002	obs data	40.6	0	1 <sup>1</sup>	0.20 <sup>2</sup>
	2003		21.7	0	0	(N/A)
	2004		49.1	0	0	
	2005		39.2	0	0	
	2006		35.3	0	0	
Observer program total						0.20
Minimum total annual mortality						[≥0.2]

<sup>1</sup> Mortality was seen by an observer but not during an "observed set"; thus quantification of effort cannot be accomplished and the single record cannot be extrapolated to provide a total estimated mortality level.

<sup>2</sup> These mortalities occurred in an area of known overlap with the Central North Pacific stock of humpback whales. Since the stock identification is unknown, the mortalities are reflected in both stock assessments.

The estimated annual mortality rate incidental to U. S. commercial fisheries is 0.2 whales per year from this stock based on 0.2 from 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 in with the Central North Pacific stock. Finally, much information on fishery interaction with the Central North Pacific stock is based on information reported to the Alaska Region as stranding data. However, very few stranding reports are received from areas west of Kodiak.

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**

Subsistence hunters in Alaska have reported one subsistence take of a humpback whale in South Norton Sound in 2006. There have not been any additional reported takes of humpback whales from this stock by subsistence hunters in Alaska or Russia. The average annual mortality rate from subsistence takes for the 2003-2007 period is 0.2.

#### **HISTORICAL WHALING**

Rice (1978) estimated that the number of humpback whales in the North Pacific may have been approximately 15,000 individuals prior to exploitation; however, this was based upon incomplete data and, given the level of known catches (legal and illegal) since World War II, may be an underestimate. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century (Rice 1978). A total of 3,277 reported catches occurred in Asia between 1910 and 1964, with 817 catches from Ogasawara between 1924 and 1944 (Nishiwaki 1959, Rice 1978). After World War II, substantial catches occurred in Asia near Okinawa (including 970 between 1958 and 1961), as well as around the main islands of Japan and the Ogasawara Islands. On the feeding grounds, substantial catches occurred around the Commander Islands and western Aleutian Islands, as well as in the Gulf of Anadyr (Springer et al. 2006).

Humpback whales in the North Pacific were theoretically fully protected in 1965, but illegal catches by the 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**

The estimated human-related annual mortality rate ( $0.2 + 0.2 = 0.4$ ) is less than the calculated conservative PBR level for this stock (2.0). The estimated human-related mortality rate based solely on mortalities that occurred incidental to U. S. commercial fisheries is 0.2; therefore, the estimated fishery mortality and serious injury rate equals 10% of the PBR (0.2). The rate cannot be considered insignificant and approaching zero. 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 the U. S. Navy’s Low Frequency Active Sonar program and other anthropogenic sources (e.g., shipping) is a potential concern for humpback whales in the North Pacific, but no specific habitat concerns have been identified for this stock.

## CITATIONS

- Baker, C. S., L. M. Herman, A. Perry, W. S. Lawton, J. M. Straley, A. A. Wolman, G. D. Kaufman, H. E. Winn, J. D. Hall, J. M. Reinke, and J. Ostman. 1986. Migratory movement and population structure of humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. *Mar. Ecol. Prog. Ser.* 31:105-119.
- Baker, C. S., 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).
- Barlow, Calambokidis, Falcone, Baker, Burdin, Clapham, Ford, Gabriele, LeDuc, Mattila, Quinn, Rojas-Bracha, Straley, Taylor, Urban, Wade, Weller, Witteveen, Yamaguchi. In author review. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. *Marine Mammal Science*.
- Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. *Ecol.* 78(2):535-546.
- Berzin, A. A., and A. A. Rovnin. 1966. The distribution and migrations of whales in the northeastern part of the Pacific, Chukchi and Bering Seas. *Izvestiya Tikhookeanskogo Nauchno-Issledovatel'skogo Institut Rybnogo Khozyaistva I Okeanografii* 58:179-207. (Translated by Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Seattle, 1968, pp. 103-136. In K. I. Panin (ed.), *Soviet Research on Marine Mammals of the Far East*.)
- 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. Urban 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. Cabbage, 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. Manag.* 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.
- Gabriele, C. M., J. M. Straley, L. M. Herman, and R. J. Coleman. 1996. Fastest documented migration of a North Pacific humpback whale. *Marine Mammal Science* 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 Naturalist*, 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. *Russian Journal of Oceanology* 4:844-849.
- 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.
- Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, O. von Ziegeler. 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 17<sup>th</sup> Biennial Conference on the Biology of Marine Mammals, Cape Town, South Africa.
- 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. *Scientific 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.
- 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.
- 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.
- 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. Cabbage. 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. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. *Deep Sea Res. Part I*:1772-1790.

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

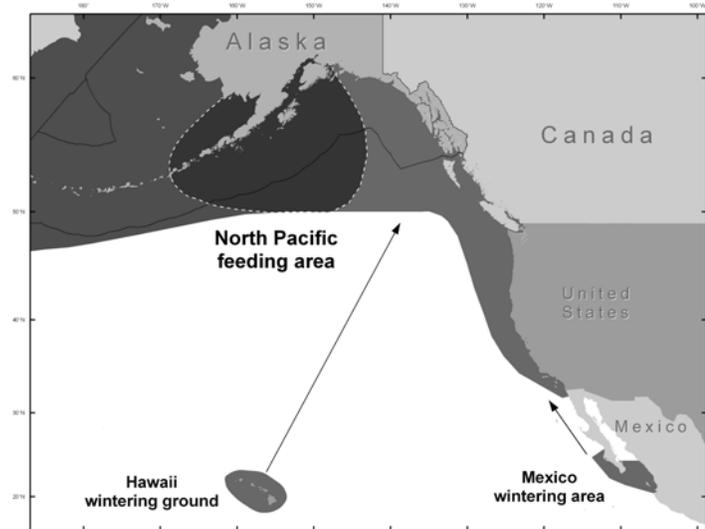
**STOCK DEFINITION AND GEOGRAPHIC RANGE**

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 20<sup>th</sup> 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), including abundance estimates and movement information, are used in this report. Genetic results, which may provide a more comprehensive understanding of humpback whale population structure in the North Pacific, should be available in 2010 or 2011.

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; Mizroch pers. comm., North Pacific Humpback Whale Working Group, unpublished data). 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



**Figure 39.** Approximate distribution of humpback whales in the western North Pacific (shaded area). Feeding and wintering grounds are presented above (see text). Area within the dotted line is known to be an area of overlap with the Central North Pacific stock. See Figure 39 for humpback whale distribution in the eastern North Pacific.

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 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 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, 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 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 Ogasawara Islands), the Marshall Islands (approximately half-way between the Marianas and Hawaiian Islands), and the Northwestern Hawaiian Islands. Indeed, humpback whales have been found to occur in the Northwestern Hawaiian Islands, though apparently at relatively low density (Johnston et al. 2007). 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. ~~Estimates of abundance for the entire North Pacific have been estimated from the SPLASH study using data pooled across all winter regions and across all summer regions. Pair wise Chapman Petersen mark-recapture estimates from adjacent seasons (e.g., winter 2004 to summer 2004, summer 2004 to winter 2005, et cetera) result in estimates of abundance of 18,347, 18,525, 20,052, and 21,452, with analytical CVs from 0.06-0.07, and jackknife CVs from 0.13-0.53. The average of the four estimates is 19,594, and the four estimates of abundance are so consistent that the CV of the average is 0.04 (Calambokidis et al. 2008).~~ 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 & the Philippines to the coast of Central America & 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. submitted). 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. submitted). 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: 2,925-4,627), 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. (2006) estimated abundance of humpback whales from line-transect surveys in 2001-03 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 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):  $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{1/2})$ . As a worst case, using the lowest population estimate (N) of 7,469 and an assumed conservative CV(N) of 0.30 results in an  $N_{MIN}$  for **this the central North Pacific humpback whale stock** of 5,833.

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 (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 and Herman (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. (2006) 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 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). 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 for 2004-06 for Hawaii of 7,469 with an assumed CV of 0.300 and its associated  $N_{MIN}$  of 5,833, PBR is calculated to be 20.461.2 animals ( $5,833 \times 0.035 \times 0.1 \times 0.3$ ). Alternatively, using the number of unique individuals seen in Hawaii during the SPLASH study results in a PBR of 8.3 ( $2,367 \times 0.035 \times 0.1$ ). A recovery factor of 0.3 is used in calculating the PBR based on the suggested guidelines of Taylor et al. (2003).

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  $N_{min}$  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  $N_{min}$  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 7.823.6 ( $2,251 \times 0.035 \times 0.1 \times 0.3$ ). Note also that the number of unique individuals seen in just Southeast Alaska can be used to calculate a PBR of 3.9 ( $1,115 \times 0.035 \times 0.1$ ). For the Aleutian Islands and Bering Sea, PBR is calculated to be 7.9 ( $2,256 \times 0.035 \times 0.1$ ). For the Gulf of Alaska, PBR is calculated to be 7.8 ( $2,222 \times 0.035 \times 0.1$ ).

### **ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY**

#### **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 2002 and 2006, there were incidental serious injuries and mortalities of central North Pacific humpback whales in the Bering Sea/Aleutian Islands sablefish pot fishery and in the Hawaii shallow set longline fishery (Table 36). Estimates of marine mammal serious injury/mortality in observed fisheries are provided in Perez (2006), and Perez (unpubl. ms.), and Forney (unpubl. ms.). ~~More current data on estimated fishery related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table 36.** Summary of observer reported incidental mortalities and serious injuries of humpback whales (Central North Pacific stock) due to commercial fisheries from 2002 to 2006 and calculation of the mean annual mortality rate. 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
Bering Sea sablefish pot	2002	obs data	40.6	0	1 <sup>1</sup>	0.20 <sup>2</sup> (N/A)
	2003		21.7	0	0	
	2004		49.1	0	0	
	2005		39.2	0	0	
	2006		35.3	0	0	
	2007		0	0	0	
	2008		0	0	0	
HI shallow set longline	2003	obs data	100	0	0	0.20
	2004		100	0	0	
	2005		100	0	0	
	2006		100	1	1	
	2007		100	0	0	
Minimum total annual mortality -				North: 0.2 SE: 0.0 HI: 0.2 Total: 0.24		

<sup>1</sup> Mortality was seen by an observer but not during an “observed set”; thus quantification of effort cannot be accomplished and the single record cannot be extrapolated to provide a total estimated mortality level.

<sup>2</sup> These mortalities occurred in an area of known overlap with the Western North Pacific stock of humpback whales. Since the stock identification is unknown, the mortalities are reflected in both stock assessments.

Reports of entangled humpback whales found swimming, floating, or stranded with fishing gear attached occur in both Alaskan and Hawaiian waters. All reports of mortalities or injuries of humpback whales from the central North Pacific stock from 2003 to 2007 are provided in Appendix 8 and a summary of the information is provided in Table 37. Overall, there were 86 reports of human-related mortalities or injuries during this 5-year period. Of these, there were 54 incidents which involved commercial fishing gear, and 23 of those incidents involved serious injuries or mortalities. This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found, reported, or cause of death determined.

**Table 37.** Summary of central North Pacific humpback whale mortalities and serious injuries caused by commercial and recreational fishery entanglement and ship strikes from stranding reports, 2003-2007. A summary of information used to determine whether an injury was serious or non-serious is included in Appendix 8. Fisheries with zero average annual mortality indicate historical marine mammal interactions.

Area	Human activity/fishery	Year	Mortality	Serious	Not determinable	Average annual serious injury/mortality rate (2003-2007)
North	Ship strike	2003	0	0	0	0.2
		2004	0	0	0	
		2005	1	0	1	

Area	Human activity/fishery	Year	Mortality	Serious	Not determinable	Average annual serious injury/mortality rate (2003-2007)
		2006	0	0	0	
		2007	0	0	1	
	Unspecified gear	2003	0	0	0	0.2
		2004	0	0	0	
		2005	0	0	1	
		2006	0	1	0	
		2007	0	0	1	
	Salmon set gillnet	2003	0	0	0	0
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Unspecified set gillnet	2003	0	0	0	0.2
		2004	0	0	0	
		2005	0	1	0	
		2006	0	0	0	
		2007	0	0	0	
	Purse seine	2003	0	0	0	0
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Unspecified pot gear	2003	0	0	0	0.2
		2004	0	0	0	
		2005	0	0	0	
		2006	0	1	0	
		2007	0	0	0	
	Crab pot gear	2003	0	0	0	0
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Yakutat salmon set gillnet	2003	0	0	0	0
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Cook Inlet salmon set gillnet	2003	N/A	N/A	N/A	0.2
		2004	N/A	N/A	N/A	
		2005	0	1	0	
		2006	0	0	0	
		2007	0	0	0	
	Kodiak salmon purse seine	2003	N/A	N/A	N/A	0.2
		2004	N/A	N/A	N/A	
		2005	1	0	0	

Area	Human activity/fishery	Year	Mortality	Serious	Not determinable	Average annual serious injury/mortality rate (2003-2007)
		2006	0	0	0	
		2007	0	0	0	
	Lower Cook Inlet salmon purse seine	2003	N/A	N/A	N/A	0.2
		2004	N/A	N/A	N/A	
		2005	1	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Average annual serious injury/mortality rate commercial fisheries only					1.02
	Average annual serious injury/mortality rate total					1.24
SE	Ship strike	2003	1	0	0	1.4
		2004	2	1	0	
		2005	1	1	0	
		2006	0	0	1	
		2007	1	0	1	
	Unspecified gear	2003	0	0	0	0.6
		2004	0	2	10	
		2005	0	0	1	
		2006	1	0	4	
		2007	0	0	2	
	Salmon set gillnet	2003	0	0	0	0.0
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Unspecified gillnet	2003	0	0	0	0.20
		2004	0	0	0	
		2005	0	10	1	
		2006	0	0	0	
		2007	0	0	1	
	Unspecified drift gillnet	2003	0	0	0	0.2
		2004	0	0	0	
		2005	0	1	0	
		2006	0	0	0	
		2007	0	0	0	
	Unspecified net gear	2003	1	0	0	0.2
		2004	0	0	0	
		2005	0	0	0	
2006		0	0	0		
2007		0	0	0		
Purse seine	2003	0	0	0	0.0	
	2004	0	0	0		
	2005	0	0	0		
	2006	0	0	0		
	2007	0	0	0		

Area	Human activity/fishery	Year	Mortality	Serious	Not determinable	Average annual serious injury/mortality rate (2003-2007)
	Unspecified pot gear	2003	0	0	0	0.02
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Crab pot gear	2003	0	1	0	0.6
		2004	0	0	0	
		2005	0	2	2	
		2006	0	0	1	
		2007	0	0	0	
	Recreational crab pot gear	2003	0	0	0	0.2
		2004	0	1	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
	Unspecified longline gear	2003	0	0	0	0.0
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	1	
		2007	0	0	0	
	Unspecified shrimp gear	2003	0	0	0	0.0
2004		0	0	0		
2005		0	0	0		
2006		0	0	0		
2007		0	0	1		
Halibut longline	2003	0	0	0	0.2	
	2004	0	0	0		
	2005	0	0	0		
	2006	0	1	0		
	2007	0	0	0		
SE salmon drift gillnet	2003	N/A	N/A	N/A	0.2	
	2004	N/A	N/A	N/A		
	2005	1	0	0		
	2006	0	0	0		
	2007	0	0	0		
Average annual serious injury/mortality rate fishery only						1.822
Average annual serious injury/mortality rate total						3.28
Hawaii	Unspecified gear	2001	0	0	1	0.0
		2002	0	0	0	
		2003	0	0	0	
		2004	0	0	0	
		2005	0	0	0	
		2006	0	0	0	
		2007	0	0	0	
		Average annual serious injury/mortality rate fishery only				
Average annual serious injury/mortality rate total						0.0

Summary of central North Pacific humpback whale mortalities and serious injuries caused by entanglement and ship strikes based on stranding reports, 2003-2007.

	Vessel collisions	Commercial Fishery related	Recreational Fishery Related	Total SI/M
Northern AK	0.2	<del>1.0</del> 1.2	0	<del>1.2</del> 1.4
Southeast AK	1.4	<del>1.8</del> 2.2	0.2	<del>3.2</del> 3.8
TOTAL	1.6	<del>2.8</del> 3.4	0.2	Average annual SI/M (2003-2007): <del>4.4</del> 5.2

The overall U. S. commercial fishery-related minimum mortality and serious injury rate for the entire stock is ~~3.0~~3 humpback whales per year, based on observer data from Alaska (0.2), ~~observer data from Hawaii (0.2)~~, stranding records from Alaska (~~2.8~~3.4), and stranding records from Hawaii (0). The estimated fishery-related minimum mortality and serious injury rate incidental to commercial fisheries for the northern portion of the stock is ~~1.2~~1.6 humpback whales per year, based on observer data from Alaska (0.2), stranding records from Alaska (~~1.0~~2), ~~observer data from Hawaii (0.2)~~, and stranding data from Hawaii (0) (Table 37). The estimated minimum mortality and serious injury rate incidental to the commercial fisheries in southeast Alaska is ~~1.8~~2.4 humpback whales per year, based on ~~observer data from Hawaii (0.2)~~, stranding records from Alaska (~~1.8~~2.2), and stranding data from Hawaii (0) (Table 37). ~~The single serious injury record from Hawaii was included in the minimum mortality and serious injury estimates for both the northern portion and southeast Alaska portion of this stock.~~

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. Those cases are included in Appendix 8 and summarized in Table 37. Of those, ~~nine~~eight ship strikes constitute “other sources” of mortality or serious injury; seven of these ship strikes occurred in Southeast Alaska and one occurred in the northern portion of this stock’s range. 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. Averaged over the year period from 2003 to 2007, these account for an additional 1.6 humpback whale mortalities per year for the entire stock (0.2 ship strikes/year for the northern portion of the stock, and 1.4 strikes/year for the Southeast portion).

#### **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

As the estimated annual mortality and serious injury rate for the entire stock (4.65.6; 3.08 of which were commercial fishery-related; Table 38) is considered a minimum, it is unclear whether unlikely that the level of human-caused mortality and serious injury exceeds the PBR level (20.461.2) for the entire stock. The estimated annual mortality and serious injury rate in Southeast Alaska (3.24.0, of which 1.82.4 were commercial fishery-related) is less than the PBR level if calculated only for the Southeast Alaska portion of the population (3.923.3), or for the Southeast Alaska/northern British Columbia feeding aggregation (7.823.6). The estimated annual mortality and serious injury rate in the Northern area (Gulf of Alaska, Aleutian Islands, Bering Sea) is 1.8, which does not exceed the combined PBR for these feeding areas (15.7). The minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR for either the entire stock (6.1) or the portion of the stock in Southeast Alaska and, therefore, can not 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.

**Table 38.** Summary of average annual serious injury (SI) and mortality (M) levels for the central North Pacific (CNP) stock of humpback whales (2003-2007).

Area	Data types for fishery-related information						Ship strikes	Total	“PBR”
	AK Observer data	AK Strand.	HI Observer data	HI Strand.	Total Commercial fish.	Total Rec. fish.			
Northern	0.2	1.02	0.2 <sup>3</sup>	0	1.26	0	0.2	4.41.8	8.715.7
Southeast	N/A	1.82.2	0.2 <sup>3</sup>	0	1.82.4	0.2	1.4	3.24.0	3.923.3
Southeast Alaska/northern British Columbia									7.823.6
TOTAL	0.2	2.83.4	0.2 <sup>3</sup>	0 <sup>1</sup>	3.08 <sup>2,3</sup>	0.2	1.6	4.65.6 <sup>3</sup>	20.461.2

<sup>1</sup> The average annual SI/M in HI is 0.

<sup>2</sup> This is the sum of the observed SI/M (0.24), the AK strandings (2.83.4), and the average HI stranding rate (0).

<sup>3</sup> Total HI observed fisheries SI/M is 0.2. This value is included in the sum for both the northern and southeast portions of the stock; however, it is only counted once in the total SI/M for the entire stock.

## 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 Acoustic Thermometry of Ocean Climate (ATOC) program, 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

- 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.
- Barlow, Calambokidis, Falcone, Baker, Burdin, Clapham, Ford, Gabriele, LeDuc, Mattila, Quinn, Rojas-Bracha, Straley, Taylor, Urban, Wade, Weller, Witteveen, Yamaguchi. In author review. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. *Marine Mammal Science*.
- Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. *Ecol.* 78(2):535-546.
- 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. Urban 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. Cabbage, 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, P.O. Box 271, 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. Manag.* 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.
- Forney, K. A. unpubl. ms. Serious injury determinations for cetaceans caught in Hawaii longline fisheries during 1994-2008. Document presented to Pacific Scientific Review Group. 19 October 2009.
- 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. *Marine Mammal Science* 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., Identification of humpback whale wintering habitat in the Northwestern Hawaiian Islands using spatial habitat modeling, *Endangered Species Research*, 3:249-257.
- Martin, A. R., S. K. Katona, D. Mattila, D. Hembree, and T. D. Waters. 1984. Migration of humpback whales between the Caribbean and Iceland. *J. Mamm.* 65:330-333.
- Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, O. von Ziegeler. 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 Research and Management* 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.
- 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.
- 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.
- 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, 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. 2006. 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

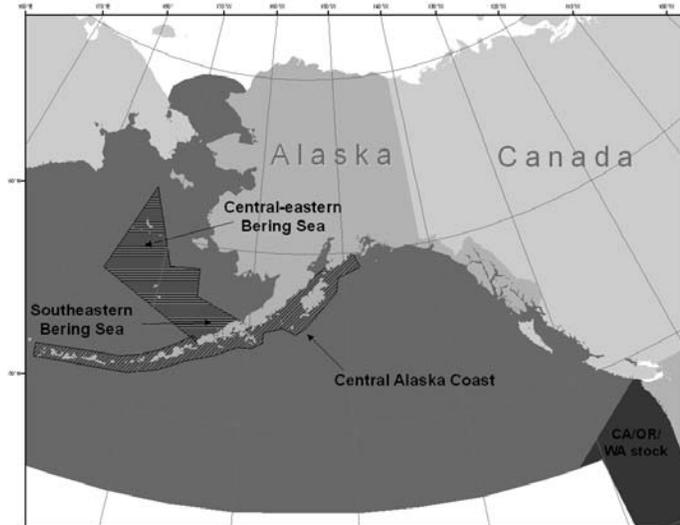
### STOCK DEFINITION AND GEOGRAPHIC RANGE

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. 40). 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 fall and winter in the central North Pacific and the Aleutian Islands, there were also calls recorded during the summer months in the Gulf of Alaska (Stafford et al. 2007). While seasonal differences in recorded call rates are generally

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 well-documented off of Hawaii during the winter (Thompson and Friedl 1982; McDonald and Fox 1999), although aerial and shipboard surveys have found relatively few animals in Hawaiian waters. 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) and a sighting during an aerial survey in 1994 (Mobley et al. 1996).

Recent surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 and in coastal waters of the Aleutian Islands and the Alaska Peninsula from 2001 to 2003 resulted in new information about the distribution and relative abundance of fin whales in these areas (Moore et al. 2000, 2002; Zerbini et al. 2006). Fin whale abundance estimates were nearly five times higher in the central-eastern Bering Sea than in the southeastern Bering Sea (Moore et al. 2002), and most sightings in the central-eastern Bering Sea occurred in a zone of particularly high productivity along the shelf break (Moore et al. 2000).

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 an eastern and a western group, which are isolated though may intermingle around the Aleutian Islands. Discovery mark recoveries reported by Rice (1974) indicate that animals wintering off the coast of southern California range from central California to the Gulf of Alaska during the summer months. Fin whales along the Pacific coast of North America have been reported during the summer months from the Bering Sea to as far south as southern Baja California (Leatherwood et al. 1982). As a result, stock structure of fin whales remains uncertain.



**Figure 40.** 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).

Mizroch et al. (submitted 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 46 populations of fin whales: 2 that are migratory (eastern and western North Pacific) and two or three to four more that are resident year-round in peripheral seas such as the Gulf of California, East China Sea, and the Sea of Japan/Sanriku-Hokkaido area/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—winter distribution and location of primary wintering areas (if any) are poorly known and need further study. 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.

For management purposes, three stocks of fin whales are currently recognized in U.S. waters: 1) Alaska (Northeast Pacific), 2) California/Washington/Oregon, and 3) Hawaii. New information from Mizroch et al. (submitted 2009) suggests that this structure should be reviewed and updated, if appropriate, to reflect 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 recent 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<sup>2</sup> 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<sup>2</sup> 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.

A visual survey for cetaceans was conducted in the central-eastern Bering Sea in July-August 1999 and in the southeastern Bering Sea in June-July 2000 in cooperation with research on commercial fisheries (Moore et al. 2002). The survey included 1,761 km and 2,194 km of effort in 1999 and 2000, respectively. Aggregations of fin whales were often sighted in 1999 in areas where the ship's echosounder identified large aggregations of zooplankton, euphausiids, or fish (Moore et al. 2000). One aggregation of fin whales which occurred during an off-effort period involved greater than 100 animals and occurred in an area of dense fish echosign. Results of the surveys in 1999 and 2000 in the central-eastern Bering Sea and southeastern Bering Sea provided provisional estimates of 3,368 (CV = 0.29) and 683 (CV = 0.32), 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, and responsive movement. However, the provisional estimate for fin whales in each area is expected to be robust as previous studies have shown that only small correction factors are needed for this species. The Moore et al. (2002) estimate for 1999 is different than that of Moore et al. (2000) because it covers the southeastern Bering Sea as well as the central-eastern Bering Sea. Additionally, the region covered by Moore et al. (2000) did not have consistent effort and thus could be inaccurate. 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

Information on abundance of fin whales in Alaskan waters has improved considerably in the past few years. 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 could include the sums of the estimates from Moore et al. (2002) and Zerbini et al. (2006). Using this approach, the provisional estimate of the fin whale

population west of the Kenai Peninsula would be 5,700. 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.

### 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.

### CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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:  $PBR = N_{MIN} \cdot 0.5R_{MAX} \times F_R$ . 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). Thus, the PBR level for this stock is 11.4 ( $5,700 \times 0.02 \times 0.1$ ).

### ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

#### Fisheries Information

Between 2002 and 2006, there was one observed incidental mortality of a fin whale in the Bering Sea/Aleutian Island pollock trawl fishery (Table 39). Estimates of marine mammal serious injury/mortality in observed fisheries are provided in Perez (unpubl. ms.). ~~More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.~~

**Table 39.** Summary of incidental serious injury and mortality of fin whales due to commercial fisheries and calculation of the mean annual mortality rate. Mean annual takes are based on 2002-2006 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)
BSAI pollock trawl	2002	obs data	73.0	0	0	0.23 (CV = 0.34)
	2003			0	0	
	2004			0	0	
	2005			0	0	
	2006			1	1.1	
Estimated total annual takes						0.23 (CV = 0.34)

#### Subsistence/Native Harvest Information

Subsistence hunters in Alaska and Russia have not been reported to take fin whales from this stock.

#### Other Mortality

Between 1925 and 1975, 47,645 fin whales were reported killed throughout the North Pacific (International Whaling Commission, BIWS catch data, February 2003 version, unpublished), 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). There are no reports of direct human-related injuries or

mortalities to fin whales in Alaska waters included in the Alaska Region stranding database for 2001-2005 (NMFS unpublished data).

### 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, population trends, and PBR 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 estimated annual rate of mortality and serious injury incidental to U. S. commercial fisheries for this stock (0.2) does not exceed the PBR level for the stock (11.4). Thus, fishery-related mortality levels can be determined to have met a zero mortality and serious injury rate.

### HABITAT CONCERNS

There are no known habitat issues that are of particular concern for this stock.

### CITATIONS

- 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.
- 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.
- 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.
- Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: a guide to their identification. U.S. Dep. Commer., NOAA Tech. Rep. NMFS Circular 444, 245 pp.
- 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. Submitted 2009. Distribution and movements of fin whales in the North Pacific Ocean. *Mammal Review.* 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. *Pacific Science.* 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.
- 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.
- 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.

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.

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., 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, the International Whaling Commission (IWC) recognizes 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 41.** 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. 40 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. Accordingly, two stocks of minke whales are recognized in U. S. waters: 1) Alaska, and 2) California/Washington/Oregon (Fig. 41). 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 the Bering Sea and 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 200m. 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<sub>MAX</sub>) 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 2000-2004: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries (Table 40). 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 2002-2006 is 0.

**Table 40.** Summary of incidental mortality and serious injury of minke whales due to commercial fisheries from 2000 to 2004 and calculation of the estimated 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 Is. (BSAI) groundfish trawl	2000	obs data	76.2	1	1.6	0.32 (CV=0.61)
	2001		79.0	0	0	
	2002		80.0	0	0	
	2003		82.2	0	0	
	2004		81.2	0	0	
Estimated total annual mortality						0.32 (CV=0.61)

The Bering Sea/Aleutian Islands groundfish trawl fishery incurred one mortality of a minke whale in 2000; this extrapolates to an estimated two minke whale mortalities for that year (Table 40). The total estimated mortality

and serious injury incurred by this stock as a result of interactions with U. S. commercial fisheries is 0.32 (CV = 0.61).

### **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 to have been taken for subsistence by Alaska Natives between 1930 and 1987 (C. Allison, International Whaling Commission, United Kingdom, pers. comm.). The most recent harvest (2 whales) in Alaska occurred in 1989 (Anonymous 1991). Based on this information, the annual subsistence take averaged zero minke whales during the 3-year period from 1993 to 1995.

### **STATUS OF STOCK**

Minke whales are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. The greatest uncertainty regarding the status of the Alaska minke whale stock has to do with the uncertainty pertaining to the stock structure of this species in the eastern North Pacific. Because minke whales are considered common in the waters off Alaska and because the number of human-related removals is currently thought to be minimal, this stock is not considered 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 Research I 53:1772–1790.

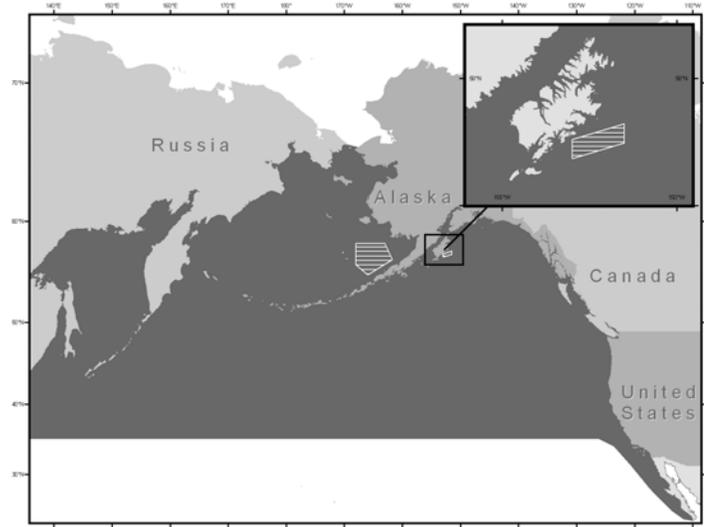
**NORTH PACIFIC RIGHT WHALE (*Eubalaena japonica*):  
Eastern North Pacific Stock**

**STOCK DEFINITION AND GEOGRAPHIC RANGE**

A comprehensive review of all 20<sup>th</sup> 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 (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. 42), 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 (1840's), right whale abundance was severely depleted, particularly in the eastern portion of their range. During 1965-99, following large illegal catches by the U.S.S.R., there were only 82 sightings of right whales in the entire eastern North Pacific, with the majority of these occurring in the Bering Sea and adjacent areas of the Aleutian Islands (Brownell et al. 2001). Sightings have been reported as far south as central Baja California 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, Berzin and Doroshenko 1982, Brownell et al. 2001).

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 the North Pacific stock 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).

Information on the current seasonal 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 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. 42) where right whales have been observed most summers since 1996 (Goddard and Rugh 1998). 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, NMFS unpublished data). Bottom-mounted acoustic recorders were deployed in the southeastern Bering Sea and the northern Gulf of Alaska starting in 1999 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). Recorders deployed from 2007 on have not yet been



**Figure 42.** 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).

analyzed. Use of this habitat may intensify in mid-summer through early fall based on higher monthly and daily call detection rates. Rates of detection on the middle shelf (<100 m depth) suggests that right whales pass through intermittently and typically do not remain longer than a few days (Munger and Hildebrand 2004, Munger et al. 2008). Right whale calls were rarely detected in the northwestern Gulf of Alaska in the late summer (Mellinger et al. 2004). Right whales have not been observed outside the localized area in the southeastern Bering Sea during surveys conducted for fishery management purposes which covered a broader area of Bristol Bay and the Bering Sea (Moore et al. 2000, 2002; see Fig. 40 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 (Phil Clapham, AFSC NMML, pers. comm., 29 October 2008). 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 2009).

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. 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 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, NOAA, AFSC, NMML, 7600 Sand Point Way, Seattle, WA; unpublished data). Acoustic monitoring from May 2000 to July 2001 at seven sites in the Gulf of Alaska has 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).

Many of the illegal Soviet catches of right whales occurred across a large area to the southeast of Kodiak, where right whales were found in tight feeding concentrations (primarily in 1963 and 1964, Doroshenko 2000). 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 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: unknown. 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). The former is believed to feed primarily in the Sea of Okhotsk.

## POPULATION SIZE

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 in 2004 in the Bering Sea 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". A reliable estimate of abundance for the North Pacific right whale stock is currently not available in preparation for the eastern stock (Paul Wade, AFSC-NMML, pers.comm., 9 October 2009), and will likely be published in 2010.

There were several sightings of North Pacific right whales in the mid-1990s which renewed interest in conducting dedicated surveys for this species. In April 1996 a right whale was sighted off Maui (Salden and Mickelsen 1999). This was the first documented sighting of a right whale in Hawaiian waters since 1979 (Herman et al. 1980, Rowntree et al. 1980), although 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). This individual was resighted in the southeastern Bering Sea later the same year (1996), and was observed again in 2008 (Amy Kennedy,

AFSC-NMML, pers. comm., 9 October 2009). A group of 3-4 right whales was sighted in western Bristol Bay, southeastern Bering Sea, in July 1996 which may have included a juvenile animal (Goddard and Rugh 1998). During 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 on 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). ~~Most recently,~~ In 2008, 9-12 right whales were sighted during NMFS vessel and aerial surveys of the southeastern Bering Sea and North Aleutian Basin; another 6 individuals were observed in the summer of 2009 (Amy Kennedy, AFSC-NMML, pers. comm. 13 November 2008; 9 October 2009).

Right whales can be individually identified by photographs of the unique callosity patterns on their heads. Aerial photogrammetric analyses indicated that the same individual was seen in 1997, 1998, and 1999 (LeDuc et al. 2001). Body lengths of 12 animals ranged from 14.7 to 17.6 m (LeDuc et al. 2001); since body length at sexual maturity has been estimated at about 15 m, LeDuc et al. (2001) suggest that all measured animals may have been sexually mature.

During the 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). The concentration of right whales found in the summer of 2004 (above) included a minimum of 17 individuals, as determined by both photo-identification and genotyping from skin biopsies. Among these, at least one male had been previously photographed and four animals biopsied in other years; the latter included the only female seen prior to this encounter (Wade et al. 2006). This concentration also included two probable calves. Currently, the catalogue of identified individuals (curated at AFSC-NMML) contains identification-quality images of at least 17 whales (Amy Kennedy, AFSC-NMML, pers. comm., 9 October 2009).

### Minimum Population Estimate

The minimum estimate of abundance of North Pacific right whales is 17 based on photo-identification of uniquely identifiable individuals. ~~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.~~ An estimate of abundance is not currently available; however, an estimate is being prepared and will likely be available in 2010 (Paul Wade, AFSC-NMML, pers. comm., 9 October 2009). Of 13 individual animals photographed during aerial surveys in 1998, 1999, and 2000, two have been re-photographed (LeDuc et al. 2001). This photographic recapture rate is consistent with a very small population size. This conclusion is supported by a preliminary genotype-based comparison of the 17 individuals biopsied in the Bering Sea in the summer of 2004 which also revealed at least four matches to animals biopsied in previous years (Wade et al. 2006). A high resighting rate (approximately 20%) was also observed between NMFS surveys in the southeastern Bering Sea in 2008 and 2009 (Amy Kennedy, AFSC-NMML, pers. comm. 9 October 2009). Of the 15 individual whales sighted in 2008 and 2009, six had been observed in previous years from 1979 to 2009, with the highest effort from 1998 onward (Amy Kennedy, AFSC-NMML, pers. comm. 15 December 2009).

### Current Population Trend

~~A reliable~~ No estimate of trend in abundance is currently not available.

### CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Due to insufficient information, ~~it is recommended that~~ the default cetacean maximum net productivity rate ( $R_{MAX}$ ) of 4% would normally be employed for this stock (Wade and Angliss 1997). However, given the small apparent size and low observed calving rate of this population, this rate ~~may be~~ is almost certainly 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 is not available for this stock but it is certainly very small. The PBR level for this stock is considered zero.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

### Fisheries Information

Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989 (Kornev 1994). No other incidental takes of right whales are known to have occurred in the North Pacific. Vessel collisions are considered the primary source of human-caused mortality of right whales in the 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 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. From 1900 to 1999, a total of 742 right whales were known to have been killed by whaling; of those, 331 were killed in the western North Pacific and 411 in the eastern North Pacific (Brownell et al. 2001). The latter total includes 372 whales killed illegally by the U.S.S.R. in the period 1963-67, primarily in the Gulf of Alaska and Bering Sea (Doroshenko 2000, Brownell et al. 2001).

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.

## 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. Reliable estimates of the minimum population size, population trends, and PBR are currently not available. Though reliable numbers are not known, the abundance of this stock is considered to represent only a small fraction of its precommercial 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 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 (Nikolai V. Doroshenko, pers. comm.); 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 the principal habitat requirements for right whales were the 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. However, there has been recent interest in oil/gas exploration with possible development in the "North Aleutian Basin" area, which occurs in Bristol Bay and overlaps and extends beyond designated North Pacific right whale critical habitat. The Mineral Management Service is supporting 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

- 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, 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 19<sup>th</sup> and 20<sup>th</sup> 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. Antinaja. 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.
- Josephson, E., T.D. Smith, and R.R. Reeves. 2008a. Historical distribution of right whales in the North Pacific. Fish and Fisheries 24:4, 795-814.

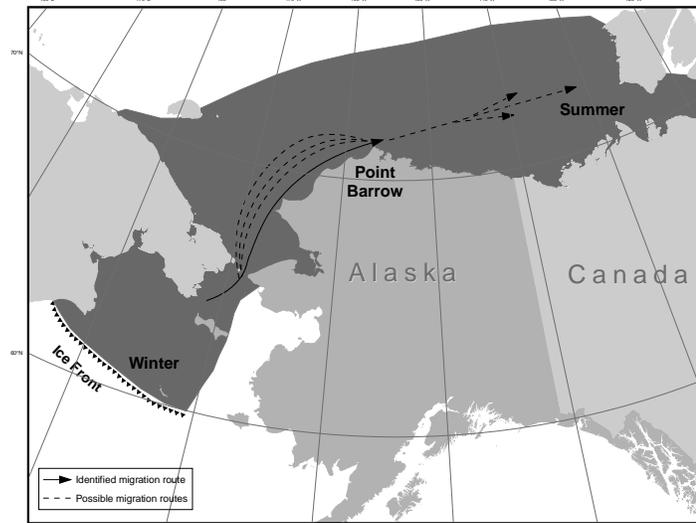
- Josephson, E.A., T.D. Smith and R.R. Reeves. 2008b. Depletion within a decade: the American 19<sup>th</sup>-century North Pacific right whale fishery. In: *Oceans Past: Management Insights from the History of Marine Animal Populations* (eds D.J. Starkey, P. Holm and M. Barnard). Earthscan, London, p. 133-147.
- 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. 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. 2004. Report of the results of the 2002 survey for North Pacific right whales. U.S. Dep. Commerce. NOAA Tech. Memo. NMFS-SWFSC-357, 58 pp.
- 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. NPRB Grant 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.
- 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.
- 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 19<sup>th</sup> 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.
- 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.
- 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, 300 pp.

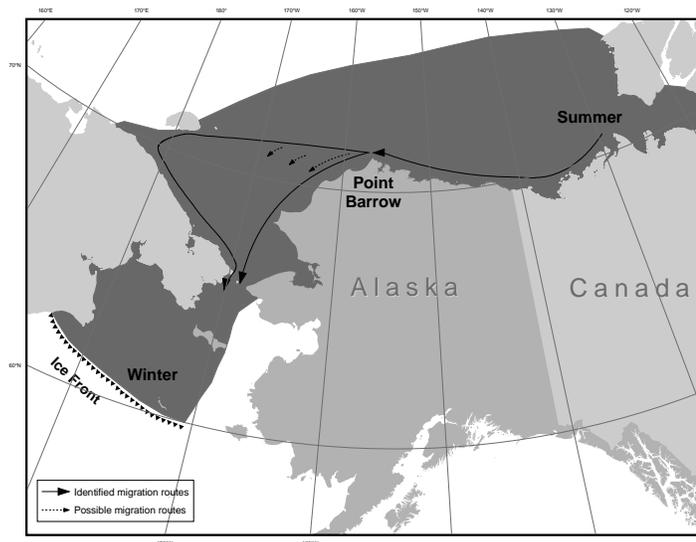
**BOWHEAD WHALE (*Balaena mysticetus*): Western Arctic Stock****STOCK DEFINITION AND GEOGRAPHIC RANGE**

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, five stocks of bowhead whales have been recognized worldwide by the International Whaling Commission (IWC 1992, Rugh et al. 2003). 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). Until recently, available evidence indicated that only a few hundred bowheads were in the Hudson Bay and Davis Strait stocks, but it now appears these should be considered one instead of two stocks based on genetics (Postma et al. 2006), aerial surveys (Cosens et al. 2006), and tagging data (Dueck et al. 2006; Heide-Jørgensen et al. 2006), and the abundance may be over a thousand (Heide-Jørgensen et al. 2007), [perhaps over 6,000 \(IWC 2008a\)](#). The only stock found within U. S. waters, is the Western Arctic stock (Figs. 43 and 44), also known as the Bering-Chukchi-Beaufort stock (Rugh et al. 2003) or Bering Sea stock (Burns et al. 1993). Although Jorde et al. (2004) suggested there might be multiple stocks of bowhead whales in US waters, ~~recent work~~ [several studies](#) (George et al. 2007, [Rugh et al. 2009](#), Taylor et al. 2007) concluded that data are most consistent with one bowhead stock that migrates around northern and western Alaska waters (IWC 2008).

The majority of the Western Arctic stock migrates annually from wintering areas (November to March) in the northern Bering Sea, through the Chukchi Sea in the spring (March through June), to the Beaufort Sea (Fig. 43) where they spend much of the summer (mid-May through September) before returning again to the Bering Sea (Fig. 44) in the fall (September through November) to overwinter (Braham et al. 1980, Moore and Reeves 1993). Most of the year, bowhead whales are closely associated with sea ice



**Figure 43.** 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 44.** Dark areas depict the approximate distribution of the western Arctic stock of bowhead whales. The fall migration of 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).

(Moore and Reeves 1993). 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 southern Beaufort Sea, an area often exposed to industrial activity related to petroleum exploration and extraction (e.g., Richardson et al. 1987, Davies 1997). During the autumn migration, bowheads select shelf waters in all but “heavy ice” conditions, when they select slope habitat (Moore 2000). Sightings of bowhead whales do occur in the summer near Barrow (Moore 1992, Moore and DeMaster 2000) and are consistent with suggestions that certain areas near Barrow are important feeding grounds (Lowry et al. 2004). High concentrations of prey have been found in this area (Okkonen et al. 2009). Some bowheads are found in the Chukchi and Bering Seas in summer, and these are thought to be a part of the expanding Western Arctic stock (Rugh et al. 2003).

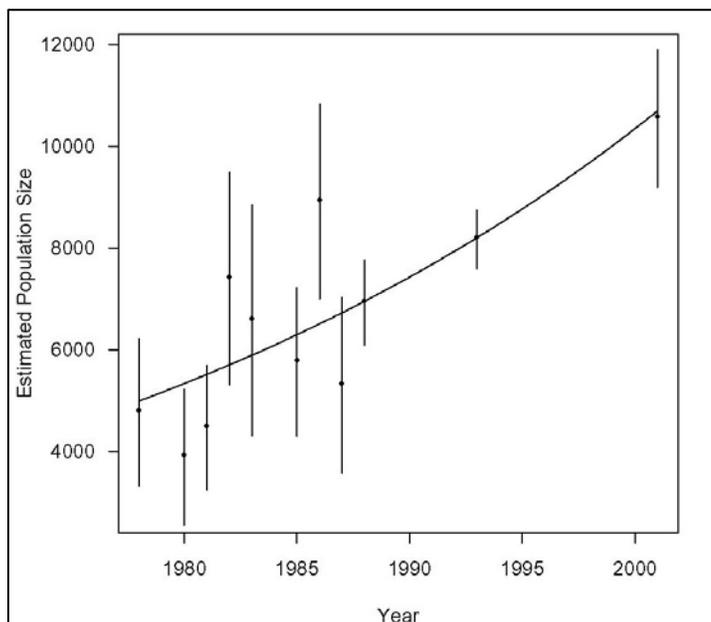
#### POPULATION SIZE

All stocks of bowhead whales were severely depleted during intense commercial whaling prior to the 20th century, 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 approximate 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 (2006) used Bayesian model averaging to estimate that the Western Arctic stock consisted of 10,960 (9,190-13,950; 5<sup>th</sup> and 9<sup>th</sup> percentiles, respectively) bowheads in 1848 at the start of commercial whaling.

Since 1978, systematic counts of bowhead whales have been conducted from sites on sea ice north of 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, 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

**Table 42.** 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).

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 (0.215)
1978	4,765 (0.305)	1987	5,298 (0.327)
1980	3,885 (0.343)	1988	6,928 (0.120)
1981	4,467 (0.273)	1993	8,167 (0.017)
1982	7,395 (0.281)	2001	10,545 (0.128)
1983	6,573 (0.345)		



**Figure 45.** Population abundance estimates for the western Arctic stock of bowhead whales, 1977-2001 (George et al. 2004), as computed from ice-based counts, acoustic locations, and aerial transect data collected during bowhead whale spring migrations past Barrow, AK. Error Vertical bars show +/- 1 standard error.

observers, and distance offshore; Zeh et al. 1993). A summary of the resulting abundance estimates is provided in Table 42 and Figure 45. 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. The most recent abundance estimate, based on surveys conducted in 2001, is 10,545 (CV = 0.128) (updated from George et al. 2004 by Zeh and Punt 2005).

Bowhead whales were identified from aerial photographs taken in 1985 and 1986, and the results were used in a capture-recapture 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 (5,762-6,039; SE 1,915) and 1986 (8,917-7,734; SE 1,450; Raftery and Zeh 1998). Aerial photographs provided another sampling of the bowhead population in 2003- and 2004 (Koski et al. 2008). Capture-recapture results provided a preliminary estimate of 11,836 whales (95% CI: 6,795 to 20,618), an estimate which that is consistent with trends in abundance estimates made from ice-based counts. The use of photo-identification to estimate bowhead whale population size provides a reasonable alternative to the traditional ice-based census and acoustic techniques.

### 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):  $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{1/2})$ . Using the 2001 population estimate (N) of 10,545 and its associated CV(N) of 0.128,  $N_{MIN}$  for the Western Arctic stock of bowhead whales is 9,472.

### Current Population Trend

RafteryGeorge et al. (19952004) reported that the Western Arctic stock of bowhead whales has increased at a rate of 3.1% (95% CI: 1.4-4.7%) from 1978 to 19933.4% (95% CI = 1.7-5%) from 1978 to 2001, during which time abundance increaseddoubled from approximately 5,000 to approximately 810,000 whales. This rate of increase takes into account whales that passed beyond the viewing range of the ice-based observers. The inclusion of the estimate for 2001 results in a rate of increase of 3.5% (95% CI: 2.2-4.9%; Brandon and Wade 2004) or 3.4% (95% CI: 1.7-5% George et al. 2004). The count of 121 calves during the 2001 census was the highest yet recorded and was likely caused by a combination of variable recruitment and the large population size (George et al. 2004). The calf count provides corroborating evidence for a healthy and increasing population.

### CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The current estimate for the rate of increase for this stock of bowhead whales (3.4-3.5%) should not be used as an estimate of ( $R_{MAX}$ ) because the population is currently being harvested and because the population has recovered to population levels where the growth is expected to be significantly less than  $R_{MAX}$ . It is recommended that the cetacean maximum theoretical net productivity rate ( $R_{MAX}$ ) of 4% be used for the Western Arctic stock of bowhead whale (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 ishas 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,  $PBR = 95$  animals ( $9,472 \times 0.02 \times 0.5$ ). The calculation of a PBR level for the Western Arctic bowhead stock is required by the MMPA even though the subsistence harvest quota is managed under the authority of the International Whaling Commission (IWC). Accordingly, 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 2008-2012, a block quota of 280 bowhead strikes will behas been allowed, of which 67 (plus up to 15 unharvested in the previous year) could be taken each year. This quota includes an allowance of 5 animals to be taken by Chukotka Natives in Russia.

### ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

## Fisheries Information

Several cases of rope or net entanglement have been reported from whales taken in the subsistence hunt (Philo et al. 1993). Further, preliminary counts of similar observations based on reexamination of bowhead harvest records indicate 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**. Alaska Region stranding reports document three bowhead whale entanglements between 2001 and 2005. 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 with fishing net and line around the head. The **estimated average annual rate of known entanglement rate** in U.S. commercial fisheries **is currently not available unknown**.

## Subsistence/Native Harvest Information

Eskimos have been taking bowhead whales for **subsistence purposes for** at least 2,000 years (Marquette and Bockstoe 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 ten Alaska communities (Philo et al. 1993). 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 and in part on higher abundance estimates in recent years (Stoker and Krupnik 1993). Suydam and George (2004) summarize Alaskan subsistence harvests of bowheads from 1974 to 2003 reporting a total of 832 whales landed by hunters from 11 villages with Barrow landing the most whales (n = 418) while Little Diomed and Shaktoolik each landed only one. ~~Since the summary done through 2003,~~ Alaska Natives landed **367** bowheads in 2004 (Suydam et al. 2005, 2006), **6855** in 2005 (Suydam et al. 2006), 31 in 2006 (Suydam et al. 2007), ~~and~~ 41 in 2007 (Suydam et al. 2008), **and 38 in 2008 (Suydam et al. 2009)**. 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% and ~~is currently~~ **it is** about **865%** (**mean for 1998-2007; Suydam et al. 2009**). ~~The size of landed whales differs among villages and is likely due to hunter selectivity and/or whale availability.~~

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. Eight whales were harvested by Russian subsistence hunters between 1999-2005 (Borodin 2004, ~~Borodin~~ 2005; IWC 2007). No catches were reported by either Canadian or Russian hunters for 2006-2007 (IWC ~~in press~~ 2008b), **but two bowheads were taken in Russia in 2008 (IWC 2009)**. The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from ~~2002 to 2006~~ **2004 to 2008 was 41.2** bowhead whales.

## Other Mortality

Pelagic commercial whaling for bowheads ~~principally occurred in the Bering Sea~~ **was conducted** from ~~1848 to 1919~~ **1849 to 1914 in the Bering, Chukchi, and Beaufort Seas (Bockstoe et al. 2007)**. Within the first two decades of the fishery (1850-1870), over 60% of the estimated pre-whaling abundance was harvested, although 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 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. ~~The e~~ **Estimates of** mortality likely underestimates the actual harvest as a result of under-reporting of the Soviet catches (Yablokov 1994) and ~~the lack of~~ **incomplete** reporting **of** struck and lost animals.

## STATUS OF STOCK

Based on currently available data, the estimated annual mortality rate incidental to U. S. commercial fisheries (0.2) is not known to exceed 10% of the PBR (9.4), and therefore can be considered to be insignificant. The annual level of human-caused mortality and serious injury (**431**) is not known to exceed the PBR (95) nor the IWC annual maximum **quota** (67). The Western Arctic bowhead whale stock has been increasing in recent years; the estimate of 10,545 is between 19% and 105% 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 Endangered Species Act and therefore also designated as “depleted” under the MMPA. NMFS intends to use recovery criteria developed for large whales in general (Angliss et al. 2002) and bowhead whales in particular (Shelden et al. 2001) in the next 5-year evaluation formal review of stock status.

### Habitat Issues

Increasing oil and gas development in the Arctic has led to an increased risk of various forms of pollution to bowhead whale habitat, including oil spills, toxic other pollutants, and nontoxic waste. Sound produced by increased levels of vessel traffic resulting from exploration and drilling operations and shipping is also of concern. Evidence indicates that bowhead whales are sensitive to sound 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) will may cause bowhead whales to avoid the vicinity. Figure 2b in Schick and Urban (2000) demonstrates, however, that the area of disturbance was localized in this instance. Studies conducted as part of a monitoring program for the Northstar project (a drilling facility located on an artificial island in the Beaufort Sea) indicate that in one of the 3 years of monitoring efforts, the southern edge of the bowhead whale fall migration path may have been slightly (2-3 mi) further offshore during periods when higher sound levels were recorded; there was no significant effect of sound detected on the migration path during the other two monitored years (Richardson et al. 2004). Evidence indicated that deflection of the southern portion of the migration in 2001 occurred during periods when there were certain vessels in the area and did not occur as a result of sound emanating from the Northstar facility itself. Because the bowhead whale population is approaching its pre-exploitation population size and has been documented to be increasing at a roughly constant rate for over 20 years, the impacts of oil and gas industry on individual survival and reproduction in the past have likely been minor. However, since 2006 there has been elevated interest in exploiting petroleum reserves in the seas around Alaska, including most areas where bowheads feed or migrate. The accumulation of impacts from vessels, seismic exploration, and drilling are of concern across the North Slope of Alaska.

Another concern is Arctic climate change in the Arctic, which has started to affecting high northern latitudes more than elsewhere. There is evidence that over the last 10-15 years, there has been of a shift in regional weather patterns in the Arctic region (Tynan and DeMaster 1997). 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. 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 for the moment at present.

On 22 February 2000, NMFS received a petition from the Center for Biological Diversity and Marine Biodiversity Protection Center to designate critical habitat for the Western Arctic bowhead stock. Petitioners asserted that the nearshore areas from the U. S.-Canada border to Barrow, Alaska, should be considered critical habitat. On 22 May 2001, NMFS found the petition to have merit (66 FR 28141). On 30 August 2002 (67 FR 55767), NMFS announced the decision to not designate critical habitat for this population. NMFS found that designation of critical habitat was not necessary because the population is known to be increasing and approaching its pre-commercial whaling population size, there are no known habitat issues which that are slowing the growth of the population, and because activities which that occur in the petitioned area are already managed to minimize impacts to the population.

### CITATIONS

- 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.
- 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, John R., Daniel B. Botkin, Alex Philp, Brian W. Collins, and John C. George. 2007. The geographic distribution of bowhead whales (*Balaena mysticetus*) in the Bering, Chukchi, and Beaufort Seas: Evidence from whaleship records, 1849-1914. *Marine Fisheries Review* 67(3): 1-43.

- Borodin, R. 2004. Subsistence whale harvest of the Russian Federation in 2003. Unpubl. report submitted to Int. Whal. Comm. (SC/56/BRG49). 7 pp.
- Borodin, R. G. 2005. Subsistence gray and bowhead whaling by native people of Chukotka in 2004. Unpubl. doc. submitted to Int. Whal. Comm. (SC/57/BRG24). 6 pp.
- 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.
- Burns, J.J., J.J. Montague, and C.J. Cowles (eds.). 1993. The Bowhead Whale. Soc. Mar. Mammal., Spec. Publ. No. 2. 787 pp.
- 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.
- 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.
- George, J. C., C. Nicolson, S. Drobot, J. Maslanik, and R. Suydam. 2006. Sea ice density and bowhead whale body condition preliminary findings. Poster presented to the Society for Marine Mammalogy, San Diego, CA.
- George, J. C., S. E. Moore, and R. Suydam. 2007. Summary of stock structure research on the Bering-Chukchi-Beaufort Seas stock of bowhead whales 2003-2007. Unpubl. report submitted to Int. Whal. Comm. (SC/59/BRG3). 15 pp.
- 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.
- 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.
- International Whaling Commission. 1992. Chairman's Report of the forty-third annual meeting. Rep. Int. Whal. Comm. 42:11-50.
- International Whaling Commission. 2007. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. J. Cetacean Res. Manage. (Suppl.) 9:142-155.
- International Whaling Commission. 2008a. Report of the Scientific Committee. J. Cetacean Res. Manage. (Suppl.) 10:1-74.
- International Whaling Commission. 2008b. Report of the Scientific Committee. Annex F. Report of the sub-committee on bowhead, right and gray whales. 25 pp.
- International Whaling Commission. 2009. Report of the Scientific Committee. (IWC/61/Rep 1) 108 pp.
- Jorde, P.E., T. Schweder, and N.C. Stenseth. 2004. The Bering-Chukchi-Beaufort stock of bowhead whales: one homogeneous population? Unpubl. report submitted to Int. Whal. Comm. (SC/56/BRG36) 21 pp.
- Koski, W., J. Mocklin, A. Davis, J. Zeh, D. Rugh, J.C. George, and R. Suydam. 2008. Preliminary estimates of 2003-2004 Bering-Chukchi-Beaufort bowhead whale (*Balaena mysticetus*) abundance from photo-identification data. Unpubl. report submitted to Int. Whal. Comm. (SC/60/BRG18). 7pp.
- 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.
- 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. Bockstoe. 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.
- 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. 1992. Summer records of bowhead whales in the northeastern Chukchi Sea. *Arctic*. 45(4):398-400.
- 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.
- Moore, S. E., and D. P. DeMaster. 2000. North Pacific right whale and bowhead whale habitat study: R/V *Alpha Helix* and CGC *Laurier* Cruises, July 1999. Annual Report. 3p.
- Okkonen, S.R., C. J. Ashjian, R.G. Campbell, D. Jones. 2009. Upwelling and aggregation of zooplankton on the western Beaufort shelf as inferred from moored acoustic Doppler current profiler measurements. Alaska Marine Science Symposium, Jan. 19-22, 2009, Anchorage, AK.
- 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.
- 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.
- ~~Raftery, A., J. Zeh, and G. Givens. 1995. Revised estimate of bowhead rate of increase. Rep. Int. Whal. Comm. 45:158.~~
- 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.
- 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. Interyear 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.
- 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. S., and George, J.C. 2004. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos, 1974 to 2003. Unpubl. report submitted to Int. Whal. Comm. (SC/56/BRG12). 12 pp.
- Suydam, R. S., J. C. George, C. Hanns and G. Sheffield. 2005. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2004. Unpubl. report submitted to Int. Whal. Comm. (SC/57/BRG15). 5 pp.

- Suydam, R. S., J. C. George, C. Hanns and G. Sheffield. 2006. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2005. Unpubl. report submitted to Int. Whal. Comm. (SC/58/BRG21). 6 pp.
- Suydam, R., J. C. George, C. Rosa, B. Person, C. Hanns, G. Sheffield, and J. Bacon. 2007. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2006. Unpubl. report submitted to Int. Whal. Comm. (SC/59/BRG4). 7pp.
- 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. Comm. (SC/60/BRG10). 7pp.
- 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. Comm. (SC/61/BRG6). 6pp.
- 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.
- Tynan, C. T., and D. P. DeMaster. 1997. Observations and predictions of Arctic climate change: potential effects on marine mammals. Arctic 50(4):308-322.
- 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.
- 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.
- 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.
- Zeh, J., D. Poole, G. Miller, W. Koski, L. Baraff, and D. Rugh. 2002. Survival of bowhead whales, *Balaena mysticetus*, estimated from 1981-1998 photoidentification data. Biometrics 58:832-840.

## **APPENDICES**

**Appendix 1.** Summary of changes to the 20109 stock assessments. An ‘X’ indicates sections where the information presented has been updated since the 20089 stock assessments were released (last revised 024/0927/20109).

Stock	Stock definition	Population size	PBR	Fishery mortality	Subsistence mortality	Status
Steller sea lion (western US)		X	X		X	
Steller sea lion (eastern US)		X	X	X	X	
Northern fur seal		X	X	X	X	
Harbor seal (SE Alaska)					X	
Harbor seal (GOA)					X	
Harbor seal (Bering Sea)				X	X	
Spotted seal				X	X	
Bearded seal				X	X	
Ringed seal				X	X	
Ribbon seal		X		X	X	
Beluga whale (Beaufort)						
Beluga whale (E. Chukchi)						
Beluga whale (E. Bering Sea)						
Beluga whale (Bristol Bay)						
Beluga whale (Cook Inlet)		X	X	X	X	X
Narwhal	X	X	X	X	X	X
Killer whale (Alaska Resident)		X	X	X		
Killer whale (Northern Resident)			X			
Killer whale (AT1 Transient)						
Killer whale (Gulf of Alaska, Bering Sea, Aleutian Islands Transient)		X	X			
Killer whale (West Coast Transient)		X	X			
Pacific white-sided dolphin		X				
Harbor porpoise (SE Alaska)						
Harbor porpoise (GOA)				X		
Harbor porpoise (Bering Sea)						
Dall’s porpoise				X		
Sperm whale						
Baird’s beaked whale						
Cuvier’s beaked whale						
Stejneger’s beaked whale						
Gray whale		X	X	X	X	
Humpback whale (western)	X	X	X		X	
Humpback whale (central)	X	X	X	X		
Fin whale						
Minke whale				X		
North Pacific right whale						X
Bowhead whale				X	X	

**Appendix 2.** Stock summary table (last revised 2/09/2009 **1/16/2010**). Stock assessment reports for those stocks in boldface were updated in the 2009 **10** 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/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
<b>Baird's beaked whale</b>	<b>Alaska</b>	<b>N/A</b>		<b>N/A</b>		<b>0.04</b>	<b>0.50</b>	<b>N/A</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NS</b>
Bearded seal	Alaska	N/A		N/A		0.12	0.50	N/A	1.0	6,788	6,789	NS
Beluga whale	Beaufort Sea	39,258	0.23	32,453	14/1992	0.04	0.50	UNDET	0	139	139	NS
Beluga whale	E. Chukchi Sea	3,710	N/A	3,710	17/1991	0.04	1.00	UNDET	0	59	59	NS
Beluga whale	E. Bering Sea	18,142	0.24	14,898	8/2000	0.04	1.00	298	0	197	197	NS
Beluga whale	Bristol Bay	2,877	0.2	2,467	8/2005	0.04	1.00	49	0	17	17	NS
<b>Beluga whale</b>	<b>Cook Inlet</b>	<b>375</b> <b>355</b>	<b>0.23</b> <b>0.10</b>	<b>314</b> <b>326</b>	<b>1/2008</b> <b>2009</b>	<b>0.04</b>	<b>0.30</b> <b>0.1</b>	<b>UNDET</b>	<b>0</b>	<b>0.4</b>	<b>0.4</b>	<b>S</b>
<b>Bowhead whale</b>	<b>W. Arctic</b>	<b>10,545</b>	<b>0.13</b>	<b>9,472</b>	<b>78/2001</b>	<b>0.04</b>	<b>0.50</b>	<b>95</b>	<b>0.2</b>	<b>41</b> <b>41.2</b>	<b>42</b> <b>41</b>	<b>S</b>
<b>Cuvier's beaked whale</b>	<b>Alaska</b>	<b>N/A</b>		<b>N/A</b>		<b>0.04</b>	<b>0.50</b>	<b>N/A</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NS</b>
Dall's porpoise	Alaska	83,400	0.097	N/A	15/1993	0.04	1.00	UNDET	30	0	30	NS
<b>Fin whale</b>	<b>NE Pacific</b>	<b>5,700</b>	<b>N/A</b>	<b>5,700</b>	<b>56/2003</b>	<b>0.04</b>	<b>0.10</b>	<b>11.4</b>	<b>0.23</b>	<b>0</b>	<b>0.23</b>	<b>S</b>
<b>Gray whale</b>	<b>E. N. Pacific</b>	<b>18,813</b> <b>19,126</b>	<b>0.07</b>	<b>17,752</b> <b>18,017</b>	<b>62/2002</b> <b>7</b>	<b>0.04</b> <b>7</b>	<b>1.00</b>	<b>417</b> <b>360</b>	<b>6.7</b> <b>3.3</b>	<b>122</b> <b>121</b>	<b>130</b> <b>127</b>	<b>NS</b>
<b>Harbor porpoise</b>	<b>SE Alaska</b>	<b>11,146</b>	<b>0.242</b>	<b>9,116</b>	<b>11</b> <b>12/1997</b>	<b>0.04</b>	<b>0.50</b>	<b>UNDET</b>	<b>0</b> <sup>1</sup>	<b>0</b>	<b>0</b> <b>01</b>	<b>S</b>
<b>Harbor porpoise</b>	<b>Gulf of Alaska</b>	<b>31,046</b>	<b>0.214</b>	<b>25,987</b>	<b>10</b> <b>11/1998</b>	<b>0.04</b>	<b>0.50</b>	<b>UNDET</b>	<b>71</b> <b>2</b>	<b>0</b>	<b>73</b> <b>4</b>	<b>S</b>
<b>Harbor porpoise</b>	<b>Bering Sea</b>	<b>48,215</b>	<b>0.223</b>	<b>40,039</b>	<b>9</b> <b>10/1999</b>	<b>0.04</b>	<b>0.50</b>	<b>UNDET</b>	<b>0</b>	<b>0</b>	<b>0</b> <b>02</b>	<b>S</b>
Harbor seal	SE Alaska	112,391 <sup>2</sup>	0.04	108,670	10/1997-1998	0.12	0.5	3,260	0	782	783	NS
Harbor seal	Gulf of Alaska	45,975 <sup>2</sup>	0.04	44,453	9/1996; 1999	0.12	0.50	1,334	24	807	832	NS

Species	Stock	N (est)	CV	N(min)	Survey interval/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
Harbor seal	Bering Sea	21,651 <sup>2</sup>	0.10	20,109	8/2000	0.12	0.50	603	2.9	96	100	NS
<b>Humpback whale</b>	<b>W. N. Pacific</b>	<b>938</b>	<b>0.30</b>	<b>732</b>	<b>1/2006</b>	<b>0.07</b>	<b>0.10</b>	<b>2.6/2.0</b>	<b>0.2</b>	<b>0.2</b>	<b>0.4</b>	<b>S</b>
<b>Humpback whale</b>	<b>CNP - entire stock</b>	<b>7,469</b>	<b>0.30</b>	<b>5,833</b>	<b>3/2004-2006</b>	<b>0.07</b>	<b>0.340</b>	<b>20.461.2</b>	<b>2.83.8</b>	<b>0</b>	<b>4.45.6<sup>4</sup></b>	<b>S</b>
	<b>CNP – SEAK/NBC feeding area</b>	<b>2,883</b>	<b>0.12 0.3</b>	<b>2,251</b>		<b>0.07</b>	<b>0.340</b>	<b>7.823.6</b>	<b>1.82.4</b>	<b>0</b>	<b>3.24.0<sup>4</sup></b>	<b>N/A</b>
	<b>CNP – GOA feeding area</b>	<b>2,845</b>	<b>0.3</b>	<b>2,222</b>		<b>0.07</b>	<b>0.10</b>	<b>7.8</b>	<b>1.6<sup>5</sup></b>		<b>1.8<sup>5</sup></b>	<b>N/A</b>
	<b>CNP – BS/AI feeding area</b>	<b>2,889</b>	<b>0.3</b>	<b>2,256</b>		<b>0.07</b>	<b>0.10</b>	<b>7.9</b>	<b>1.6<sup>5</sup></b>		<b>1.8<sup>5</sup></b>	<b>N/A</b>
<b>Killer whale</b>	<b>Alaska Resident</b>	<b>1,123 2,084<sup>3</sup></b>	<b>N/A</b>	<b>1,123 2,084</b>	<b>8+/2003<sup>9</sup></b>	<b>0.04</b>	<b>0.50</b>	<b>11.2 20.8</b>	<b>1.5 1.2</b>	<b>0</b>	<b>1.5 1.2</b>	<b>NS</b>
<b>Killer whale</b>	<b>Northern Resident (British Columbia)</b>	<b>216<sup>3</sup></b>	<b>N/A</b>	<b>216</b>	<b>10/2000</b>	<b>0.04 0.03</b>	<b>0.5</b>	<b>2.16 1.62</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NS</b>
<b>Killer whale</b>	<b>AT1 transient</b>	<b>7<sup>3</sup></b>	<b>N/A</b>	<b>7</b>		<b>0.04</b>	<b>0.10</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>S</b>
<b>Killer whale</b>	<b>GOA, AI, BS Transient</b>	<b>314 552<sup>3</sup></b>	<b>N/A</b>	<b>314 552</b>	<b>8+/2003</b>	<b>0.04</b>	<b>0.5</b>	<b>3.1 5.5</b>	<b>0.4</b>	<b>0</b>	<b>0.4</b>	<b>NS</b>
<b>Killer whale</b>	<b>West Coast Transient</b>	<b>314 354<sup>3</sup></b>	<b>N/A</b>	<b>314 354</b>		<b>0.04</b>	<b>0.5</b>	<b>3.1 3.5</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NS</b>
<b>Minke whale</b>	<b>Alaska</b>	<b>N/A</b>		<b>N/A</b>		<b>0.04</b>	<b>0.50</b>	<b>N/A</b>	<b>0.32 0</b>	<b>0</b>	<b>0.32 0</b>	<b>NS</b>
<b>Right whale</b>	<b>E. N. Pacific</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>0.04</b>	<b>0.10</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>S</b>
<b>Narwhal</b>	<b>Unidentified stock</b>	<b>N/A</b>		<b>N/A</b>		<b>0.04</b>	<b>0.50</b>	<b>N/A</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NS</b>
<b>Northern fur seal</b>	<b>E. North Pacific</b>	<b>687,902 653,171</b>	<b>N/A</b>	<b>676,416 642,265</b>	<b>1/2007<sup>8</sup></b>	<b>0.086</b>	<b>0.50</b>	<b>14,543 13,809</b>	<b>1.9 1.6</b>	<b>593 562</b>	<b>596 565</b>	<b>S</b>
<b>Pacific white-sided dolphin</b>	<b>Cent. N. Pacific</b>	<b>26,880</b>	<b>N/A</b>	<b>N/A</b>	<b>12+/1990</b>	<b>0.04</b>	<b>0.50</b>	<b>UNDET</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NS</b>
<b>Ribbon seal</b>	<b>Alaska</b>	<b>49,000 (provisional)</b>		<b>N/A</b>	<b>1/2008</b>	<b>0.12</b>	<b>0.50</b>	<b>N/A</b>	<b>0.3</b>	<b>193</b>	<b>194</b>	<b>NS</b>
<b>Right whale</b>	<b>E. N. Pacific</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>0.04</b>	<b>0.10</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>S</b>
<b>Ringed seal</b>	<b>Alaska</b>	<b>N/A</b>		<b>N/A</b>		<b>0.12</b>	<b>0.50</b>	<b>N/A</b>	<b>0.46</b>	<b>9,567</b>	<b>9,568</b>	<b>NS</b>
<b>Sperm whale</b>	<b>N. Pacific</b>	<b>N/A</b>		<b>N/A</b>		<b>0.04</b>	<b>0.10</b>	<b>N/A</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>S</b>
<b>Spotted seal</b>	<b>Alaska</b>	<b>N/A</b>		<b>N/A</b>		<b>0.12</b>	<b>0.50</b>	<b>N/A</b>	<b>1.2</b>	<b>5,265</b>	<b>5,266</b>	<b>NS</b>

Species	Stock	N (est)	CV	N(min)	Survey interval/ year of last survey	Rmax	F(r)	PBR	Fishery mort.	Subsist. mort.	Total mort.	Status
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.	45,095- 55,832 58,334- 72,223		44,404 52,847	34/20059	0.12	0.75	1,998 2,378	1.4 25.6 <sup>4</sup>	11 10	15.6 40.8	S
Steller sea lion	W. U. S.	41,197 42,366		41,197 42,366	3/2008 2/2009	0.12	0.10	247 254	26.2	206 197	233 223	S

C.F. = correction factor; CV C.F. = CV of correction factor; Comb. CV = combined CV; Status: S = Strategic, NS = Not Strategic.

<sup>1</sup> No or minimal reported take by fishery observers; however, observer coverage was minimal or nonexistent.

<sup>2</sup> 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.

<sup>3</sup> N(est) based on counts of individual animals identified from photo-identification catalogs. Surveys for abundance estimates of these stocks are conducted infrequently.

<sup>4</sup> Includes entanglements from recreational fisheries.

<sup>5</sup> 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 04/03/2008). Source: 72 FR 66048; 27 November 2007 and the Alaska Commercial Fisheries Entry Commission (2008). 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	476	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	415	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	166	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	571	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	738	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	115	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	1862	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	983	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). 2008. Fishery Participation & Earnings. Accessed on 04/02/2008. <http://www.cfec.state.ak.us/>.

**Appendix 4.** Interaction table for Alaska **Category 2** commercial fisheries (last revised 04/03/2008). Source: 72 FR 66048; 27 November 2007, Perez (2006), Manly (2006), Manly et al. (2003), and the Alaska Commercial Fisheries Entry Commission (2008). Notice of continuing effect of list of fisheries.

Fishery (area and gear type)	# of permits issued or fished (2007)	Observer program	Species recorded as taken incidentally in this fishery (records dating back to 1988)	Data type
Southeast AK drift gillnet	476	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	415	never observed	humpback whale	self reports and stranding
Yakutat set gillnet	166	never observed	harbor seal, gray whale (stranding)	logbook 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	571	1999	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	738	1999	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
Kodiak set gillnet	188	2002	harbor seal, harbor porpoise, sea otter	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	115	never observed	Steller sea lion, harbor porpoise	logbook
Bristol Bay drift gillnet	1862	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	983	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	2006	Bearded seal, harbor porpoise (Bering Sea), harbor seal (Bering Sea), killer whale (Alaska Resident), northern fur seal, spotted seal, Steller sea lion (Western U.S.), walrus	observer
AK Bering Sea, Aleutian Islands pollock trawl	95	2006	Dall's porpoise, harbor seal, humpback whale (Central North Pacific), Humpback whale (Western North Pacific), killer whale (GOA, Aleutian Islands, and Bering Sea Transient), minke whale, ribbon seal, spotted seal, Steller sea lion (western U.S.),	observer
AK Bering Sea, Aleutian Islands Pacific cod longline	54	2006	Killer whale (Alaska Resident), killer whale (GOA, Aleutian Islands, and Bering Sea Transient), ribbon seal, Steller sea lion (western U.S.)	observer
AK Bering Sea, Aleutian Islands sablefish pot	10	2006	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). 2006. Fishery Participation & Earnings. Accessed on 04/02/2008. <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., 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 04/03/2008). 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: 72 FR 66048; 27 November 2007, Perez (2006), and the Alaska Commercial Fisheries Entry Commission (2008). Notice of continuing effect of list of fisheries.

Fishery name	# of permits issued or fished 2007	Observer program	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
Prince William Sound salmon set gillnet	30	1990	Steller sea lion, harbor seal	logbook
Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	1824	never observed	harbor porpoise	none
AK roe herring and food/bait herring gillnet	986	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)	936	never observed	harbor seal	logbook
AK salmon beach seine	31	never observed	none documented	none
AK roe herring and food/bait herring purse seine	361	never observed	none documented	none
AK roe herring and food/bait herring beach seine	4	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	3	never observed	none documented	none
AK miscellaneous finfish beach seine	0	never observed	none documented	none
AK salmon troll (includes hand and power troll)	2045	never observed	Steller sea lion	logbook
AK north Pacific halibut/bottom fish troll	102	never observed	none documented	none
AK state waters groundfish longline /set line (incl. sablefish/rockfish/misc. finfish)	1448	never observed	none documented	none
AK Gulf of Alaska halibut longline	1,302	2006	none documented	observer
AK Gulf of Alaska rockfish longline	0	2006	none documented	observer
AK Gulf of Alaska rockfish longline	0	2006	none documented	observer
AK Gulf of Alaska sablefish longline	291	2006	Steller sea lion, sperm whale	observer
AK Bering Sea, Aleutian Islands Greenland turbot longline	29	2006	Killer whale (Eastern North Pacific resident), Killer whale (Eastern North Pacific transient)	observer
AK Bering Sea, Aleutian islands rockfish longline	0	2006	none documented	observer
AK Bering Sea, Aleutian Islands sablefish longline	28	2006	none documented	observer
AK halibut longline/set line (state and federal waters)	2521	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)	32	never observed	none documented	none
AK Gulf of Alaska flatfish trawl	41	2006	none documented	observer
AK Gulf of Alaska Pacific cod trawl	62	2006	Steller sea lion	observer
AK Gulf of Alaska pollock trawl	62	2006	Steller sea lion, fin whale, northern elephant seal, Dall's porpoise	observer
AK Gulf of Alaska rockfish trawl	34	2006	none documented	observer
AK Bering Sea, Aleutian Islands Atka mackerel trawl	9	2006	Steller sea lion (Western U.S.)	observer
AK Bering Sea, Aleutian Islands Pacific cod trawl	93	2006	Harbor seal, Steller sea lion	observer
AK Bering Sea, Aleutian Islands rockfish trawl	10	2006	none documented	observer
State waters of Kachemak Bay Cook Inlet, Prince William Sound, Southeast AK groundfish trawl	2	never observed	none documented	none

Fishery name	# of permits issued or fished 2007	Observer program	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
AK miscellaneous finfish otter or beam trawl	317	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	2006	possible harbor seal	observer
AK Bering Sea, Aleutian Islands crab pot	297	2006	none documented	observer
AK Gulf of Alaska crab pot	300	2006	none documented	observer
AK Gulf of Alaska Pacific cod pot	154	2006	harbor seal	observer
AK Southeast Alaska crab pot	433	never observed	none documented	observer
AK Southeast Alaska shrimp pot	283	never observed	none documented	observer
AK octopus/squid pot	27	never observed	none documented	none
AK snail pot	1	never observed	none documented	none
AK statewide misc finfish pot	293	never observed	none documented	none
AK shrimp pot	15	never observed	none documented	none
AK North Pacific halibut handline and mechanical jig	228	never observed	none documented	none
AK other finfish handline and mechanical jig	445	never observed	none documented	none
AK octopus/squid handline	0	never observed	none documented	none
AK statewide Herring spawn on kelp (pound net)	415	never observed	none documented	none
Southeast AK herring food/bait pound net	16	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)	570	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 statewide herring spawn on kelp (pound net)	415	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). 2008. Fishery Participation & Earnings. Accessed on 04/02/2008. <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 1990-2005 (last revised 11/14/06). 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
Gulf of Alaska (GOA) groundfish trawl		55%	38%	41%	37%	33%	44%	37%	33%	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%
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%
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%
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%
GOA longline		21%	15%	13%	13%	8%	18%	16%	15%	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%
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%
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%
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%
GOA finfish pots		13%	9%	9%	7%	7%	7%	5%	4%	N/A							
BSAI finfish pots	% of observed biomass	43%	36%	34%	41%	27%	20%	17%	18%	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%
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%
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%
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%
Bering Sea/Aleutian Islands (BSAI) groundfish trawl		74%	53%	63%	66%	64%	67%	66%	64%								
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%
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%
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%
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%
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%
BSAI longline		80%	54%	35%	30%	27%	28%	29%	33%	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%
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%
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%
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%
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%
Prince William Sound salmon drift gillnet	% of estimated sets observed	4%	5%	not obs.													
Prince William Sound salmon set gillnet	% of estimated sets observed	3%	not obs.														
Alaska Peninsula/Aleutian Islands salmon drift gillnet (South Unimak area only)	% of estimated sets observed	4%	not obs.														

Fishery name	Method for calculating observer coverage	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cook Inlet salmon drift gillnet	% of fishing days observed	not obs.	1.8%	3.7%	not obs.												
Cook Inlet salmon set gillnet	% of fishing days observed	not obs.	7.3%	8.3%	not obs.												
Kodiak Island salmon set gillnet	% of fishing days observed	not obs.	6.0%	not obs.	not obs.	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 than 125 feet have 100% coverage, vessels 60-125 feet have 30% coverage, and vessels less than 60 feet are not observed. Observer coverage in the groundfish fisheries varies by statistical area; the pooled percent coverage for all areas is provided here. Observer 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. In review. 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 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.
- 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
<b>Steller sea lion (Western U.S. stock)</b>																
Alaska Peninsula/Aleutian Islands salmon set gillnet	0	1	1	1	N/A	0.75										
Bristol Bay salmon drift gillnet	0	4	2	8	N/A	3.5										
Prince William Sound set gillnet	0	0	2	0	N/A	0.5										
Alaska miscellaneous finfish set gillnet	0	1	0	0	N/A	0.25										
Alaska halibut longline (state and federal waters)	0	0	0	0	1	N/A	0.2									
Kodiak salmon set gillnet	N/A	2	2													
<b>Steller sea lion (Eastern U. S. stock)</b>																
Southeast Alaska salmon drift gillnet	0	1	2	2	N/A	1.25										
<b>Northern fur seal (Eastern Pacific stock)</b>																
Prince William Sound salmon drift gillnet	1	1	0	0	N/A	0.5										
Alaska Peninsula/Aleutian Islands salmon drift gillnet	2	0	0	0	N/A	0.5										
Bristol Bay salmon drift gillnet	5	0	49	0	N/A	13.5										
Alaska misc. finfish pair trawl	N/A	1	1													

Fishery	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Minimum estimated mortality
<b>Harbor seal (Southeast Alaska stock)</b>																
Southeast Alaska salmon drift gillnet	8	1	4	2	N/A	1	N/A	N/A	N/A	3.2						
Yakutat salmon set gillnet	0	18	31	61	N/A	27.5										
<b>Harbor seal (Gulf of Alaska stock)</b>																
Cook Inlet salmon set gillnet	6	0	1	0	N/A	1.75										
Prince William Sound set gillnet	0	0	0	1	N/A	0.25										
Kodiak salmon set gillnet	3	0	0	0	N/A	0.75										
Alaska salmon purse seine (except for Southeast)	0	0	0	2	N/A	0.5										
Alaska Peninsula/Aleutian Islands salmon drift gillnet	9	2	12	5	N/A	7										
<b>Harbor seal (Bering Sea stock)</b>																
Bristol Bay salmon drift gillnet	38	23	2	42	N/A	26.25										
Bristol Bay salmon set gillnet	0	0	1	1	N/A	0.5										
AK misc. finfish pair trawl	N/A	1	N/A	N/A	1											
<b>Spotted seal (Alaska stock)</b>																
Bristol Bay salmon drift gillnet	5	1	0	0	N/A	1.5										
<b>Beluga whale (Bristol Bay stock)</b>																
Bristol Bay salmon drift gillnet	0	1	0	0	N/A	0.25										
Bristol Bay salmon set gillnet	1	0	0	0	N/A	0.25										
<b>Pacific white-sided dolphin (North Pacific stock)</b>																
Prince William Sound salmon drift gillnet	1	4	0	0	N/A	1.25										
Southeast Alaska salmon drift gillnet	0	0	1	0	N/A	0.25										
Bristol Bay salmon drift gillnet	3	0	0	0	N/A	0.75										
<b>Harbor porpoise (Southeast Alaska stock)</b>																
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
<b>Harbor porpoise (Gulf of Alaska stock)</b>																
Cook Inlet salmon drift and set gillnet fisheries	3	0	0	0	N/A	1	N/A	0.8								
AK Peninsula/Aleutian Island salmon drift gillnet	2	0	1	0	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
<b>Harbor porpoise (Bering Sea stock)</b>																
AK Peninsula/Aleutian Island salmon set gillnet	0	0	2	0	N/A	0.5										
Bristol Bay salmon drift gillnet	0	0	0	0	N/A	0										
Bristol Bay salmon set gillnet	0	0	0	0	N/A	0										
AK Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	0	0	0	0	N/A	0										
<b>Dall's porpoise (Alaska stock)</b>																
Prince William Sound salmon drift gillnet	0	2	0	0	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	0.5										
<b>Eastern North Pacific gray whale</b>																
Bristol Bay salmon drift and set gillnet fisheries	2	0	0	0	N/A	0.5										
WA/OR/CA crab pot	0	N/A	1	N/A	N/A	N/A	N/A	0.5								
<b>Humpback whale (Central North Pacific stock)</b>																
Southeast Alaska salmon drift gillnet	0	0	0	0	N/A	0										

<b>Fishery</b>	<b>1990</b>	<b>1991</b>	<b>1992</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>Minimum estimated mortality</b>
Southeast Alaska salmon purse seine	0	0	0	0	1	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:** Humpback whale entanglement and other human impact records.

This appendix provides a list of human-related events involving injury or mortality of humpback whales (Central North Pacific stock) from reports provided to the NMFS Alaska Region, 2003-2007. Areas are designated “SE” for Southeast Alaska or “North” for all other feeding areas; it is assumed that the entanglement was reported in the area where the entanglement occurred, and that duplicate sightings have been removed. This table includes summaries of the information on each incident; for detailed reports, contact the NMFS Alaska Region. The determination whether each injury should be considered serious, not serious, or not determinable (ND) was made by a subcommittee of the Alaska Scientific Review Group (SRG) who reviewed the complete record for each incident. A subsequent review was conducted by NMFS Alaska Region staff to ensure consistency with NMFS’ existing guidelines for serious injury; this review resulted in one change from the SRG’s recommendations.

<b>Date</b>	<b>Area</b>	<b>Condition</b>	<b>Brief description</b>	<b>Area</b>	<b>Severity of injury</b>
3/13/05	Kenai River	Dead	Fresh stranding; confirmed collision/blunt trauma	North	Mortality
3/16/05	Sadie Cove; Kachemak Bay	Entangled	Fishing gear remnants and buoys attached to flukes; confirmed Pacific cod pot gear, fully disentangled	North	Not serious
6/14/05	Sadie Cove; Kachemak Bay	Entangled	Fishing net remnants and buoys attached to flukes; confirmed Cook Inlet salmon set gillnet	North	Serious
6/17/05	Stevenson Entrance; Kodiak	Entangled	Gillnet on head with three white, pink, orange buoys attached; unknown gillnet	North	Serious
6/21/05	Kachemak Bay	Collision	Whale surfaced by propeller, felt “thump”, and saw blood in water	North	Not determinable
6/25/05	Alitak Bay	Dead	Mesh or webbing scars of most of stranded body; confirmed Kodiak salmon purse seine	North	Mortality
7/8/05	Kachemak Bay	Dead	Animal killed in purse seine; confirmed lower Cook Inlet salmon purse seine	North	Mortality
7/26/05	Kodiak Harbor	Partially disentangled	Entangled and immobilized in crab pot gear	North	Not serious
9/14/05	Kodiak	Entangled	Animal entangled in long line gear; partially disentangled	North	Not determinable
6/6/06	Anton Larsen Bay	Disentangled	Disentangled from set gillnet	North	Not serious
7/14/06	Cook Inlet	Entangled	Entangled with net on head; possible gillnet	North	Serious
9/28/06	Dutch Harbor	Entangled	Trailing orange buoy from mouth with at least one pot attached; subsistence pot gear	North	Serious
6/10/07	Whittier	Ship strike	Ship strike; propeller struck animal, animal observed bleeding	North	Not determinable
6/27/07	Long Island	Possible entanglement	Possible entanglement in green gillnet	North	Not serious
9/23/07	Kachemak Bay	Entangled	1-2 ft. long white buoy on rostrum	North	Not determinable
5/03	Icy Bay	Dead	53 ft. female humpback with skull completely disarticulated from the vertebrae	SE	Mortality

<b>Date</b>	<b>Area</b>	<b>Condition</b>	<b>Brief description</b>	<b>Area</b>	<b>Severity of injury</b>
8/2/03	Auke Bay	Entangled, self release	Whale disentangled itself from crab pot.	SE	Not serious
8/28/03	Auke Bay	Entangled	Humpback calf entangled in crab pot line. Line across back, wrapped tightly on both sides, forward of pectoral fins, and just behind blowhole.	SE	Serious
8/31/03	Sitka Sound	Entangled	Humpback calf entangled in commercial fishing gear. Confirmed ID, sighted in October with ventral fluke scarring but no other signs of entanglement.	SE	Not serious
5/15/04	Pt. Couverden	Entangled	Humpback reported entangled with 250 ft. of rope, 2 cone-shaped buoys, and 1-2 ft. of wood between buoys.	SE	Serious
5/27/04	Benjamin Island	Collision	Humpback collided with drifting fishing boat. 18-24 in. piece of whale blubber retrieved from vessel and taken to NOAA enforcement.	SE	Serious
7/8/04	Cape Fanshaw	Entangled, released alive	Humpback calf entangled with ¼ in. poly pro line around its upper tail fluke and left pectoral fin. Calf was later disentangled.	SE	Not serious
7/30/04	Glacier Bay	Dead	Humpback calf found beached; died due to blunt trauma.	SE	Mortality
8/13/04	Douglas Island	Dead	Humpback calf found beached with severe trauma to right shoulder area.	SE	Mortality
8/17/04	Icy Strait	Entangled	Entangled humpback found floating and not swimming. Line around tail and 100 ft. trailing with red buoy. Multiple sightings/partial disentanglement.	SE	Not determinable
8/31/04	Keku Strait	Entangled	Entangled humpback with crab pot buoys trailing. Unable to relocate whale.	SE	Not determinable
11/11/04	Eckholms Islands	Entangled	Entangled humpback with 5/8 in. yellow poly line across body forward of dorsal fin, possibly dragging a pot	SE	Serious
5/18/05	Wrangell-Petersberg	Dead	Net entanglement with drift gillnet; confirmed SE salmon drift gillnet	SE	Mortality
5/30/05	George Inlet	Collision	Whale struck by ship	SE	Not serious
6/6/05	Juneau	Entangled	Green gillnet (approx. 3 in. mesh) wrapped around head/rostrum area	SE	Not determinable
6/19/05	Portage Bay	Entangled	Adult and calf entangled together in unknown crab pot gear	SE	Serious <sup>1</sup>
6/29/05	Olga Point	Entangled	Net and buoy wrapped around head and blowhole; unknown gillnet	SE	Serious
7/7/05	Icy Strait	Collision	Calf struck by 26 ft. fiberglass cabin cruiser	SE	Not serious
8/8/05	Juneau	Entangled	Whale swimming slowly, entangled in crab pot gear	SE	Not determinable
8/13/05	Frederick Sound	Collision	Whale struck by 28 ft. aluminum boat at approx 25 knots	SE	Not serious
8/15/05	Eastern Channel	Entangled, self release	Line and buoy wrapped around tail, came free while observer watched	SE	Not serious
8/15/05	N of Auke Bay	Entangled	Section of mooring line entangled around pectoral fin	SE	Not serious
8/16/05	Chatham Strait	Entangled	Entanglement around tail	SE	Not determinable
8/25/05	Stephens Passage	Collision	Vessel passenger reported "pretty hard" impact with animal	SE	Serious

<b>Date</b>	<b>Area</b>	<b>Condition</b>	<b>Brief description</b>	<b>Area</b>	<b>Severity of injury</b>
9/8/05	Stephens Passage	Collision	Possible ship strike, ship observed whale off bow and felt pressure wave hit hull	SE	Not serious
9/9/05	Favorite Channel	Entangled	Calf trailing recreational king crab pot gear	SE	Not serious
10/15/05	Peril Strait	Dead	Internal hemorrhaging – see necropsy report; confirmed collision	SE	Mortality
12/6/05	St. Nicholas Bay	Entangled	Two green buoys and one red/white torpedo crab buoy trailing from whale	SE	Not determinable
1/7/06	Sitka	Entangled	Observed towing 1-2ft white buoy 40-50 yards behind whale; gear unknown	SE	Not determinable
5/30/06	Petersburg	Disentangled	Disentangled from gillnet	SE	Not serious
6/6/06	Glacier Bay	Entangled, self release	Towing line and buoy, self release; sport Dungeness crab pot	SE	Not serious
6/9/06	Thorn Bay	Entangled	Swimming slowly at surface, not diving; trailing 20-50 yards of line with 2 light colored buoys; longline gear	SE	Not determinable
6/10/06	Saginaw Channel	Collision	Ferry report of possible shipstrike	SE	Not determinable
7/5/06	Portland Is	Entangled, self release	Calf in pot gear, swam away clear of gear	SE	Not serious
7/15/06	Craig	Entangled	Halibut longline gear with hooks around pectoral fin	SE	Serious
7/21/06	Hoonah	Possible entanglement	Thought saw rop around head	SI	Not determinable
8/6/06	Kake	Entangled	Trailing 100-150 ft. of lines and floats	SE	Not determinable
8/13/06	Stephens Passage	Entangled	Trailing line and 2 buoys, one red, one white	SE	Not determinable
8/15/06	Auke Bay	Collision	Auke Bay boat collision	SE	Not serious
8/20/06	Stephens Passage	Disentangled	Removed gillnet	SE	Not serious
8/25/06	Lynn Canal	Entangled	Towing 40' line with red poly ball; wraps on peduncle	SE	Not determinable
8/26/06	Frederick Sound	Dead	Large gauge yellow poly line, 1 in. diameter, on animal	SE	Mortality
8/28/06	Peril Strait	Entangled	Towing 40' line and faded orange poly ball; more line trailing behind buoy; crab pot gear	SE	Not determinable
8/31/06	Hoonah Sound	Entangled	Trailing 20-25 ft. of line with small orange round buoy	SE	Not serious

<b>Date</b>	<b>Area</b>	<b>Condition</b>	<b>Brief description</b>	<b>Area</b>	<b>Severity of injury</b>
9/14/06	Petersburg	Entangled, self release	Entangled, self release	SE	Not serious
6/10/07	Sitka Sound	Entangled	Swimming entangled but fluking; dragging several hundred feet heavy gauge line (>1/2 in.) and 2 ft. orange poly ball; no gear on flukes or peduncle; possible pot gear	SE	Not determinable
6/15/07	Tenakee	Entangled	Trailing small styrofoam floats; shrimp gear	SE	Not determinable
6/19/07	Spasski Island	Entangled	Calf trailing 50' gillnet	SE	Not determinable
6/22/07	Port Frederick	Entangled	Calf trailing 2 orange buoys	SE	Not determinable
7/1/07	Sitka	Collision	27' charter boat hit; felt jolt	SE	Not serious
7/1/07	Benjamin Is	Entangled; possible self-release	Calf in gillnet	SE	Not serious
7/4/07	Port Snettisham	Collision	26' aluminum skiff; hull impacted back of animal	SE	Not serious
7/8/07	Chatham Strait	Dead	Fresh dead, inflated tongue; fractured and dislocated right mandible, hemorrhage at necropsy; probable vessel collision		Mortality
8/9/07	Gustavus	Entangled	Fluke tip with monofilament	SE	Not serious
8/14/07	Spasski Is	Collision	32' landing craft collision at 17kt	SE	Not determinable
11/13/07	Petersburg	Disentangled	Disentangled from shrimp pot gear	SE	Not serious
1/28/01	Hawaii	Injured	Entangled in line/buoy from an AK fishery; released, injured - extent unknown	Unk	Not determinable

**Appendix 9.** Stock Assessment Reports published by the U.S. Fish and Wildlife Service.