NOAA Technical Memorandum NMFS-AFSC-144
doi:10.7289/V5/TM-AFSC-144

Alaska Marine Mammal Stock Assessments, 2003

by
R. P. Angliss and K. L. Lodge

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

August 2004

NOAA Technical Memorandum NMFS

The National Marine Fisheries Service's Alaska Fisheries Science Center uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series reflect sound professional work and may be referenced in the formal scientific and technical literature.

The NMFS-AFSC Technical Memorandum series of the Alaska Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest Fisheries Center. The NMFS-NWFSC series is currently used by the Northwest Fisheries Science Center.

This document should be cited as follows:

Angliss, R. P., and K. L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-144, 230 p. doi:10.7289/V5/TM-AFSC-144.

Cover photo: Northern fur seals (*Callorhinus ursinus*). Photographer: R. Ream, AFSC-NMML.

NOAA Technical Memorandum NMFS-AFSC-144
doi:10.7289/V5/TM-AFSC-144

Alaska Marine Mammal Stock Assessments, 2003

by
R. P. Angliss and K. L. Lodge

with contributions from
R. Hobbs, T. Loughlin, S. Moore, M. Perez, D. Rugh, J. Sease, K. Shelden, A. York,
and the Publications Unit of the Alaska Fisheries Science Center.

Alaska Fisheries Science Center
National Marine Mammal Laboratory
7600 Sand Point Way N.E.
Seattle, WA 98115

U.S. DEPARTMENT OF COMMERCE
Donald L. Evans, Secretary
National Oceanic and Atmospheric Administration
Vice Admiral Conrad C. Lautenbacher, Jr., U.S. Navy (ret.), Under Secretary and Administrator
National Marine Fisheries Service
William T. Hogarth, Assistant Administrator for Fisheries

August 2004

This document is available to the public through:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

www.ntis.gov

PREFACE

On April 30, 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.

This is a working document. This document represents the seventh revision since the original development of the stock assessment reports in 1995 (Small and DeMaster 1995). The first through fifth revisions were entitled the 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), and 2002 (Angliss and Lodge 2002) Alaska Marine Mammal Stock Assessment Reports, respectively. 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, sperm whales, humpback whales, fin whales, North Pacific right whales, and bowhead whales), were reviewed in late 2002. This review led to the revision of the following stock assessments for the 2003 document: Steller sea lion (western and eastern U.S. stocks), northern fur seal, Cook Inlet beluga whale, Pacific white-sided dolphin, Southeast Alaska harbor porpoise, Gulf of Alaska harbor porpoise, Bering Sea harbor porpoise, sperm whale, central and western stocks of humpback whales, fin whale, minke 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 the NMFS SARs 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 SRG members active in 2002: Brendan Kelly (chair), Lance Barrett-Lennard, Lloyd Lowry, John Gauvin, Sue Hills, Charlie Johnson, Beth Mathews, Craig Matkin, Jan Straley, 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

Revised 4/30/03

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); however, resighting data from branded animals have not yet been analyzed.

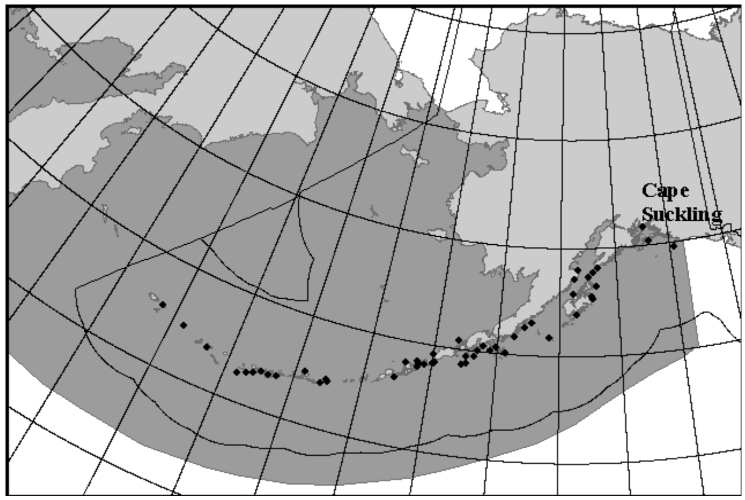

Figure 1. Approximate distribution of Steller sea lions in the eastern North Pacific (shaded area). Major haulouts and rookeries are also depicted (points).

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 are now 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).

POPULATION SIZE

The most recent comprehensive estimate (pups and non-pups) of the abundance of the western stock of Steller sea lions in Alaska is based on aerial surveys of non-pups in June 2002 and ground based pup counts in June and July of 2001 and 2002 (Sease and Gudmundson 2002). Data from these surveys represent actual counts of pups and non-pups at all rookeries and major haulout sites. During the 2002 survey, a total of 26,602 non-pups were counted at 259 rookeries and haul-out sites; 13,010 in the Gulf of Alaska and 13,592 in the Bering Sea/Aleutian Islands (Sease and Gudmondson 2002). A composite pup count for 2001 and 2002 includes counts from 24 sites in 2002 and from seven sites in 2001. There were 3,727 pups counted in the Gulf of Alaska and 4,450 pups counted in the Bering Sea/Aleutian Islands for a total of 8,177 for the stock. Combining the pup count data from 2001 to 2002 (8,177) and non-pup count data from 2002 (26,602) results in a minimum abundance estimate of 34,779 Steller sea lions in the western U.S. stock in 2001-2002.

Minimum Population Estimate

The 2002 count of non-pups (26,602) plus the number of pups in 2001-2002 (8,177) is 34,779, which will be used as the minimum population estimate (N_{MIN}) for the western U. S. 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 which 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 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. More recently, counts of Steller sea lions at trend sites for the western U. S. stock decreased 40% from 1990 to 2000 (Table 1). Counts at trend sites during 2000 indicate that the number of sea lions in the Bering Sea/Aleutian Islands region has declined 10.2% between 1998 and 2000. From 1991-00, an average annual decline of 5.4% in non-pup counts at trend sites was reported by Loughlin and York (2000).

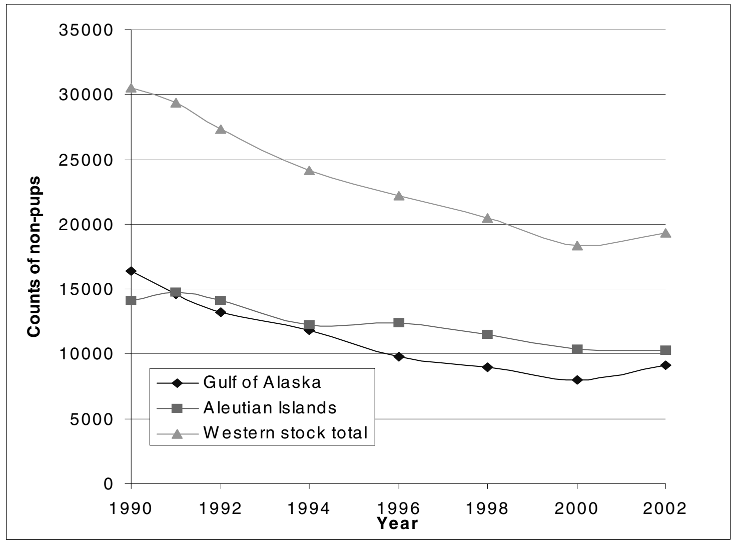

Figure 2. Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the western U.S. stock, 1990-2002.

Most recently, counts of non-pup Steller sea lions at trend sites for the western U.S. stock increased 5.5% from 2000 to 2002. This was the first region-wide increase for the western stock since standardized surveys began in the 1970s. However, the 2002 count was still 5.4% below the 1998 count and 36.7% below the 1990 count. The count for trend sites in the Gulf of Alaska increased 13.7% from 2000 to 2002, whereas those in the Aleutian Islands showed equivocal change (down 0.8%). The long-term, average decline for 1990-02 is 4.3% per year (NMML unpublished data).

Table 1. Counts of adult and juvenile Steller sea lions observed at rookery and haulout trend sites by year and geographical area for the western U. S. stock from the late 1970s through 1998 (NMFS 1995, Sease et al. 2001, NMML unpublished data). Counts from 1976 to 1979 (NMFS 1995) were combined to produce complete regional counts which are comparable to the 1990-02 data. The asterisk identifies 637 non-pups counted at six trend sites in 1999 in the eastern Gulf of Alaska which were not surveyed in 1998.

Area	**late 1970s**	**1990**	**1991**	**1992**	**1994**	**1996**	**1998**	**2000**	**2002**
Gulf of Alaska	65,296	16,409	14,598	13,193	11,862	9,784	8,937*	7,995	9,097
Bering Sea/Aleutians	44,584	14,116	14,807	14,106	12,274	12.426	11,501	10,330	10,250
Total	109,880	30,525	29,405	27,299	24,136	22,210	20,438*	18,325	19,337

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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. However, it should be noted that the PBR management approach was developed with the understanding 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. 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 western U. S. stock of Steller sea lions, PBR = 209 animals (34,779 × 0.06 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries operating within the range of the western U. S. stock of Steller sea lions were monitored for incidental take by fishery observers during 1990-01: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No sea lion mortality was observed by fishery observers in either pot fishery since 1990, nor in the BSAI longline fisheries during the past 5 years. For the fisheries with observed takes, the range of observer coverage over the 9-year period, as well as the annual observed and estimated mortalities, are presented in Table 2a. The mean annual (total) mortality for the most recent 5-year period was 9.6(CV = 0.10) for the Bering Sea groundfish trawl fishery, 0.6 (CV = 0.6) for the Gulf of Alaska groundfish trawl fishery, and 1.2 (CV = 0.9) for the Gulf of Alaska groundfish longline fishery. In 1996 (66% observer coverage), only 2 of the 4 observed mortalities in the Bering Sea trawl fishery occurred during monitored hauls, leading to an underestimate (3) of the extrapolated mortality for that fishery. As a result, 4 mortalities were used as both the observed and estimated mortalities for that year (Table 2a). The observed mortality in the 1993 Bering Sea longline fishery (30% observer coverage) also occurred during an unmonitored haul and therefore could not be used to estimate mortality for the entire fishery. Therefore, 1 mortality was used as both the observed mortality and estimated mortality in 1993 for that fishery, and should be considered a minimum estimate.

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. The observer coverage during both years was approximately 2-5%; precise coverage figures will be available when the contract report is provided to NMFS. There were no mortalities of marine mammals observed in either 1999 or 2000 (NMFS, unpublished data). Because information from observer programs is substantially more reliable than information from self-reported data, NMFS has removed the reference to self-reported data for these fisheries from Table 2b and will rely on the 1999-2000 observer program data as an accurate reflection of the level of Steller sea lion mortality in this fishery.

Combining the mortality estimates from the Bering Sea and Gulf of Alaska groundfish trawl and Gulf of Alaska longline fisheries presented above (9.6 + 0.6 + 1.2 = 11.4) 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 25.9 (CV = 0.6) sea lions per year from this stock.

Table 2a. Summary of incidental mortality of Steller sea lions (western U. S. stock) due to commercial fisheries from 1990 through 2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1997 to 2001 (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. * Data from the 1999 Cook Inlet observer program are preliminary.

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	97-01	obs data	62-77%	6, 6, 8, 6, 7	10, 9, 9, 7, 11	9.6 (CV = 0.10)
Gulf of Alaska (GOA) groundfish trawl	96-00	obs data	33-55%	0, 0, 1, 0, 0	0, 0, 3, 0, 0	0.6 (CV = 0.6)
GOA groundfish longline (incl. misc. finfish and sablefish fisheries)	97-01	obs data	11-14%	0, 0, 0, 1, 0	0, 0, 0, 6, 0	1.2 (CV = 0.9)
Prince William Sound salmon drift gillnet	90-91	obs data	4-5%	0, 2	0, 29	14.5 (CV = 1.0)
Prince William Sound salmon set gillnet	90	obs data	3%	0	0	0
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90	obs data	4%	0	0	0
Cook Inlet salmon set gillnet*	99-00	obs data	2-5%	0, 0	0, 0	0
Cook Inlet salmon drift gillnet*	99-00	obs data	2-5%	0, 0	0, 0	0
Observer program total						25.9 (CV = 0.64)
				Reported mortalities		
Alaska Peninsula/Aleutian Islands salmon set gillnet	90-01	self reports	n/a	0, 1, 1, 1, n/a n/a, n/a, n/a, n/a, n/a	n/a	[≥0.75]
Bristol Bay salmon drift gillnet	90-01	self reports	n/a	0, 4, 2, 8, n/a n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥3.5]

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 set gillnet	90-01	self reports	n/a	0, 0, 2, 0, n/a n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Alaska miscellaneous finfish set gillnet	90-01	self reports	n/a	0, 1, 0, 0, n/a n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.25]
Alaska halibut longline (state and federal waters)	90-01	self reports	n/a	0, 0, 0, 0, 1 n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.2]
Alaska sport salmon troll (non-commercial)	93-01	strand	n/a	0, 0, 0, 0, 1, 0, n/a, n/a, n/a	n/a	[≥0.2]
Minimum total annual mortality						≥31.3 (CV = 0.64)

An additional source of information on the number of Steller sea lions killed or injured incidental to commercial fishing operations is the self-reported fisheries information required of vessel operators by the MMPA. Some incidental takes of sea lions reported in the Gulf of Alaska fisheries were listed as "unknown species", indicating the animals could have been either Steller or California sea lions. Based on all logbook reports for both species within the Gulf of Alaska, California sea lions represented only 2.2% of all interactions. Thus, the reports of injured and killed "unknown" sea lions were considered to be Steller sea lions. During the period between 1990 and 2001, fisher self-reports from 6 unobserved fisheries (see Table 2a) resulted in an annual mean of 5.2 mortalities from interactions with commercial fishing gear. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. These totals are based on all available self-reports for Alaska fisheries, except the groundfish trawl and longline fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska, and the Prince William Sound salmon drift gillnet fishery for which observer data were presented above. The Bristol Bay salmon drift gillnet and set gillnet fisheries accounted for the majority of the reported incidental take in unobserved fisheries. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Strandings 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 1993 to 2000 the only fishery-related Steller sea lion (western stock) stranding was reported in August of 1997 in Prince William Sound. The animal had troll gear in its mouth and down its throat (considered a serious injury; see Angliss and DeMaster 1998). It is likely that this mortality occurred as a result of a sport fishery, not a commercial fishery (Table 2a). 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.). There was evidence of incidental fishery interactions with two stranded Steller sea lions in 1998; there have been no such incidences in stranding records from 1999 to 2002. Additional information on the nature of the fishery interactions is not currently available. Fishery-related strandings during 1997-02 result in an estimated annual mortality of 0.2 animals from this stock. This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found or reported.

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 commercial fisheries is 31.3 sea lions per year, based on observer data (25.9) and self-reported fisheries information (5.2) or stranding data (0.2) where observer data were not available. No observers have been assigned to several fisheries that are known to interact with this stock (self-reported data from these fisheries are provided in Table 2a), making the estimated mortality a minimum estimate.

Subsistence/Native Harvest Information

The 1992-96 subsistence harvest of Steller sea lions in Alaska was estimated by the Alaska Department of Fish and Game, under contract with the NMFS (Table 2b: Wolfe and Mishler 1993, 1994, 1995, 1996, 1997; Wolfe and Hutchinson-Scarbrough 1999; Wolfe et al. 2002). In 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 43 of the interviewed communities lie within the range of the western U. S. stock. The majority (79%) of sea lions were taken by Aleut hunters in the Aleutian and Pribilof Islands. A summary of the subsistence harvest of Steller sea lions from the western U. S. stock are provided in Table 2b. The great majority (approximately 99%) of the statewide subsistence take was from the western U. S. stock. The mean annual subsistence take from this stock over the 4-year period from 1998 to 2002 was 176 sea lions. The reported average age-composition of the harvest in 2001 was 42% adults, 39% juveniles, 1% pups, and 18% unknown age. The reported average sex composition of the harvest was approximately 58% males, 19% females, and 22% of unknown sex.

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 2 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 2002 (NMFS, Alaska Enforcement Division).

Table 2b. Summary of the subsistence harvest data for the western U. S. stock of Steller sea lions, 1992-01. Brackets indicate that the 1996 data remain in dispute and the 1997 data are preliminary. Subsistence harvest data were not collected in 1999. Source: Wolfe et al. 2002.

Year	Estimated total number taken	95% confidence interval	Number harvested	Number struck and lost
1992	549	452-712	370	179
1993	487	390-629	348	139
1994	416	330-554	336	80
1995	339	258-465	307	32
1996	[179]	[158-219]	[149]	[30]

Year	Estimated total number taken	95% confidence interval	Number harvested	Number struck and lost
1997	[164]	[129-227]	[146]	[18]
1998	178	137-257	131	47
2000	164	121-244	141	22
2001	198	162-282	156	42
Mean annual take 1997-01	176			

STATUS OF STOCK

The current annual level of incidental mortality (31.5) exceeds 10% of the PBR (21) 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 (31.5 + 176 = 208) is below the PBR level (209) for this stock. The western U. S. stock of Steller sea lion is also 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 is declining for unknown reasons that are not explained by the level of direct human-caused mortality, there is no guarantee that limiting those mortalities to the level of the PBR will reverse the decline.

A number of management actions have been implemented since 1990 to promote the recovery of the western U. S. stock of Steller sea lions including 3 nautical mile (nmi) no-entry zones around rookeries, prohibition of groundfish trawling within 10-20 nmi of certain rookeries, and spatial and temporal allocation of Gulf of Alaska pollock total allowable catch. More recent modifications began in 1999 and continued into 2002, including reductions in removals of Atka mackerel within areas designated as critical habitat in the central and western Aleutian Islands, greater temporal dispersion of the Atka mackerel harvest, further temporal and spatial dispersal of the Bering Sea and Gulf of Alaska pollock and cod fisheries, closure of the Aleutian Islands to pollock trawling, and expansion of the number and extent of buffer zones around sea lion rookeries and haulouts.

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 from "threatened" to" endangered" under the U. S. Endangered Species Act of 1973. There is currently no sign that the population decline since 1990 has slowed or stopped. Many theories have been suggested as causes of the decline, (overfishing, environmental change, disease, killer whale predation, etc.) but it is not clear what factor or factors are most important in causing the decline. However, competition for food, perhaps in conjunction with commercial fisheries, is a hypothesis currently receiving serious attention.

NMFS developed a Biological Opinion (BO) on the groundfish fisheries in the Bering Sea/Aleutian Islands and Gulf of Alaska regions in 2000. 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 is 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 which could contribute to the decline of the population, including a shift in a 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 4 seasonal catch limits inside critical habitat and two seasonal releases outside of critical habitat, and 5) establishment of a procedure for setting limits on removal levels in critical habitat based on the biomass of target species in critical habitat.

NMFS completed a draft Supplemental Environmental Impact Statement (SEIS) in September 2000 for the groundfish fisheries in the Bering Sea Aleutian Islands and the Gulf of Alaska. Based on the potential for indirect interactions between the groundfish fisheries and Steller sea lions, northern fur seals, and harbor seals, NMFS determined that the current practices involved in the management of the groundfish fishery in Alaska “may have adverse impacts on the western U. S. stock of Steller sea lions, northern fur seals in the Bering Sea, and both the GOA and western stocks of harbor seals”. However, the SEIS was determined to be incomplete in a Federal District Court ruling and remanded back to NMFS for further development.

In 2001, NMFS developed a new 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 groundfish fisheries and Steller sea lions, particularly in waters within 10 nmi of haulouts and rookeries. The suit of conservation measures actually 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 to further minimize overcapitalization of fisheries and concentration of fisheries in time and space. In addition, NMFS has agreed to revise the existing recovery plan for Steller sea lions, and is working towards the development of a co-management agreement with Alaska Native organizations for subsistence harvest of the western stock of Steller sea lions.

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.

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.

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.

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. 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.

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.

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., 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.

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 Dept. 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 NMFS by Alaska Dept. 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. Final report for year three, subsistence study and monitor system (no. 50ABNF20055). Prepared for NMFS by Alaska Dept. 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. Final report for year four, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 69 pp. + appendices.

Wolfe, R. J., and C. Mishler. 1997. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1996. Technical Paper 241. Draft Final report for year five, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 70 pp. + appendices.

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

Wolfe, R. J., J. A. Fall, and R. T. Stanek. 2002. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2001. Alaska Department of Fish and Game, Division of Subsistence Technical Paper No. 273. Juneau, Alaska.

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.

Note: January 2004: There are minor differences between the numbers of Steller sea lions reported in Table 3 and the numbers provided to the Steller sea lion recovery team for central California and northern California/Oregon. These numbers will be updated in the draft SARs for 2004.

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 (NMFS 1995); however, resighting data from branded animals have not yet been analyzed.

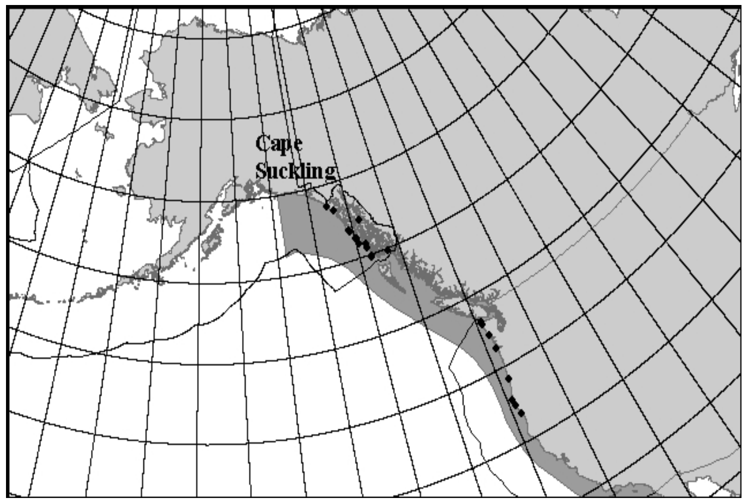

Figure 2. Approximate distribution of Steller sea lions in the eastern U.S. stock (shaded area). Major haulouts and rookeries are also depicted (points). Note: Haulouts and rookeries in British Columbia are not shown.

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 are now 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).

POPULATION SIZE

The previous estimate of Steller sea lion abundance in Southeast Alaska was based on comprehensive aerial surveys performed in June 1996 (Sease et al. 1999, Sease and Loughlin 1999). Data from these surveys represent actual counts of pups and non-pups at all rookeries and major haulout sites in Southeast Alaska. In 1996 a total of 14,621 Steller sea lions were counted in Southeast Alaska, including 10,907 non-pups and 3,714 pups. Aerial surveys in 1998 and 2000 included the trend sites and other major sites. There were some differences between which major sites were surveyed in 1998 and 2000, so the total counts for each survey are not entirely comparable. The counts for 1998 and 2000 were 10,939 and 12,417, respectively (Sease and Loughlin, 1999, Sease et al, 2001). Pup counts totaled 4,160 in 1997 and 4,257 in 1998 (Sease and Loughlin, 1999). The total count for Southeast Alaska in 1998 is 15,196 (10,939 non-pups plus 4,257 pups); if we assume that the pup count is roughly stable, the total count for 2000 would be 16,674 (12,417 non-pups plus 4,257 pups).

Aerial surveys and ground counts of California, Oregon, and Washington rookeries and major haulout sites were also conducted during the summer of 1996 (NMFS unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115; Southwest Fisheries Science Center, P. O. Box 271, La Jolla, CA 90238; ODF&W unpubl. data, Marine Science Drive, Newport, OR 97365). In 1996 a total of 6,555 Steller sea lions were counted in California (2,042), Oregon (3,990), and Washington (523), including 5,464 non-pups and 1,091 pups.

The eastern U. S. stock of Steller sea lions is a transboundary stock, including sea lions from British Columbia rookeries (see Wade and Angliss 1997 for discussion of transboundary stocks). Aerial surveys were last conducted in British Columbia during 1994 and produced counts of 8,091 non-pups and 1,186 pups, for a total count of 9,277 (Dept. Fisheries and Oceans, unpubl. data, Pacific Biological Station, Nanaimo, BC, V9R 5K6). Complete count data are not available for British Columbia in 1996. However, because the number of Steller sea lions in British Columbia is thought to have increased since 1994 (P. Olesiuk, pers. comm., Pacific Biological Station, Canada), the 1994 counts represent a conservative estimate for the 1996 counts. Combining the total counts for the three regions results in a minimum estimated abundance of 31,028 (15,196 + 6,555 + 9,277) Steller sea lions in this stock.

Slight changes in the non-pup numbers result from changes in the non-pup count database which occurred since publication of the results from the 1998 aerial survey (Sease and Loughlin 1999). The database underwent considerable review, verification, and editing; the most significant changes related to replicate counts of individual sites. For additional information on the minor changes in the non-pup numbers, see Sease et al. (2001).

The abundance estimate for the eastern U. S. stock is based on counts of all animals (pup and non-pup) at all sites and has not corrected for animals missed because they were at sea. A reliable correction factor to account for these animals is currently not available (J. Sease, pers. comm., National Marine Fisheries Service). As a result, this represents an underestimate for the total abundance of Steller sea lions in this stock.

Minimum Population Estimate

The minimum population estimate will be calculated by adding 1998 counts from Southeast Alaska (15,196), 1996 counts from WA/OR/CA (6,555), and Canadian counts from 1994 (9,277), which results in an N_{MIN} for the eastern U. S. stock of Steller sea lions of 31,028. Recall that this count has not been corrected for animals which were at sea, and also uses the 1994 data from British Columbia where Steller sea lion numbers are thought to have increased since 1994.

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 3,648 in 2001 (Brown and Reimer 1992; Brown et al. 2002).

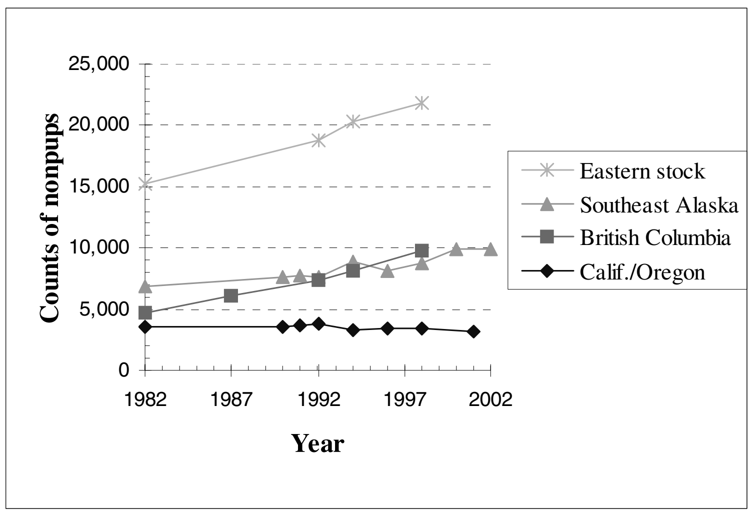

Figure 4. Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the eastern U.S. stock, 1982-0θ2. Data from British Columbia include all sites.

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 5,000 and 7,000 non-pups with no apparent trend, but have subsequently declined by over 50%, remaining between 1,500 and 2,000 non-pups during 1980-01. Limited information suggests that counts in northern California appear to be stable (NMFS 1995). At Año Nuevo in central California, a steady decline in ground counts started around 1970, resulting in an 85% reduction in the breeding population by 1987 (LeBoeuf et al. 1991). In vertical aerial photographic counts conducted at Año Nuevo, pups declined at a rate of 9.9% from 1990 to 1993, while non-pups declined at a rate of 31.5% over the same time period (Westlake et al. 1997). Pup counts at Año Nuevo have been steadily declining at about 5% annually since 1990 (W. Perryman, pers. comm., National Marine Fisheries Service). The most recent pup counts at Año Nuevo and the Farallons are 564 for 1999 and 349 in 2000 (M. Lowry, pers. comm). Overall, counts of non-pups at trend sites in California and Oregon have been relatively stable since the 1980s (Table 3, Fig. 4).

In Southeast Alaska, counts (no correction factors applied) of non-pups at trend sites increased by 30% from 1979-2000 from 6,376 to 9,862 (Merrick et al., 1992, Sease et al., 2001). During 1979-97, counts of pups on the three rookeries in Southeast Alaska increased by an average of 5.9% per year. Since 1989 pup counts on the three rookeries increased at a lower rate (+1.7% per year) than for the entire period (Calkins et al. 1999). A slightly lower increase in pup counts (3.3% per year from 1979-97) is reported by Sease et al. (2001). In British Columbia, counts (no correction factors applied) of non-pups throughout the Province increased at a rate of 2.8% annually during 1971-98 (Table 3, Fig. 4; P. Olesiuk, pers. comm., Pacific Biological Station, Canada). Counts of non-pups at trend sites throughout the range of the eastern U. S. Steller sea lion stock are shown in Figure 4.

Table 3. 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 the 1982 through 2000 (NMFS 1995, Strick et al. 1997, Sease et al. 1999, Sease and Loughlin 1999; P. Olesiuk, unpubl. data, Pacific Biological Station, Nanaimo, BC, V9R 5K6; ODF&W unpubl. data, 7118 NE Vandenberg Ave., Corvallis, OR 97330; Point Reyes Bird Observatory, unpubl. data, 4990 Shoreline Hwy., Stinson Beach, CA 94970; Sease et al., 2001). 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. [Note: There are minor differences between the numbers in Table 3 and the numbers provided to the Steller sea lion recovery team for central California and northern California/Oregon (italicized) . Revisions will be completed in 2004.]

Area	1982	1990	1991	1992	1994	1996	1998	2000	2002
Central CA	*511*[1]	*655*	*537*	*276*	*512*	*385*	*208*	*349*	
Northern CA/OR	*3,094*	*2,922*	*3,180*	*3,544*	*2,834*	*2,988*	*3,175*	*n/a*	
British Columbia	4,711	6,109[2]	no data	7,376	8,091	no data	9,818	n/a	n/a
Southeast Alaska	6,898	7,629	8,621	7,555	9,001	8,231	8,693	9,862	9,951
Total	15,214	--	--	18,754	20,263	--	21,864	n/a	n/a

[1] This count includes a 1983 count from Año Nuevo. [2] This count was conducted in 1987.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of maximum net productivity rates for Steller sea lions. 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 = 1,396 animals (31,028 × 0.06 × 0.75).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Fishery observers monitored three commercial fisheries during the period from 1990 to 2001 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, and Northern Washington (WA) marine set gillnet fisheries. The best data available on the rates of serious injury and mortality incidental to these fisheries is presented in Table 4. There have been no observed serious injuries or mortalities incidental to the CA/OR thresher shark and swordfish drift gillnet fishery in recent years. Two and one Steller sea lions were observed taken in the WA/OR/CA groundfish trawl in 1997 and 2001, respectively; 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 4). In 1996, one Steller sea lion mortality in the northern Washington marine set gillnet fishery was observed. The mortality was not extrapolated because the coastal portion of the fishery (the portion of the fishery most likely to interact with Steller sea lions) was monitored with 100% observer coverage during 1996. This single observed mortality results in a mean annual mortality of 0.2 (CV = 1.0) Steller sea lions for the Northern Washington marine set gillnet fishery. No observer program occurred during 1994 for this fishery, and no data available after 1998. These mortalities result in a mean annual mortality rate of 1.0 (CV = 1.0). 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 4. Summary of incidental mortality of Steller sea lions (eastern U. S. stock) due to commercial and tribal fisheries from 1990 to 2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information or stranding data. Data from 1997 to 2001 (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. * indicates a mortality seen by an observer, but during an unmonitored haul; because the haul was not monitored, no extrapolation can be done.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
CA/OR thresher shark and swordfish drift gillnet	96-00	obs data	4-27%	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0
WA/OR/CA groundfish trawl (Pacific whiting component)	97-01	obs data	66-96%	2, 0, 0, 0, 1	2, 0, 0, 1*, 1	0.8 (CV = n/a)
Northern WA marine set gillnet (tribal fishery)	94-98	obs data	47-98%	0, 0, 1, 0, 0	0, 0, 1, 0, 0	0.2 (CV = 1.0)
Observer program total						1.0 (CV = 1.0)
				Reported mortalities		
Southeast Alaska salmon drift gillnet	90-01	self reports	n/a	0, 1, 2, 2, n/a, n/a, n/a, n/a, n/a, n/a, n/a,	n/a	[≥1.25]
Alaska salmon troll	92-01	strand data	n/a	0, 0, 0, 1, 0, 0, n/a, n/a, n/a	n/a	[≥0.2]

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
British Columbia aquaculture predator control program	91-01	permit reports	n/a	14, 8, 10, 11, 6, 13, 34, 63, 91, n/a , n/a, n/a	n/a	41.4
Minimum total annual incidental mortality (estimate from observer programs plus estimates from self reports and stranding data; includes an estimate of 1.2 fishery-related strandings per year from 1996-00; see text)						3.65 (CV = 1.0)
Minimum total annual mortality (includes intentional mortalites in the BC predator control program)						45.25 (CV = 1.0)

An additional source of information on the number of Steller sea lions killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1998, fisher self-reports from the Southeast Alaska salmon drift gillnet fishery (Table 4) resulted in an annual mean of 1.25 mortalities from interactions with commercial fishing gear. This total is based on all available fisher self-reports for U. S. fisheries within the range of the stock, except the three fisheries for which observer data were presented above. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. During 1990, 11 Steller sea lion injuries incidental to the Alaska salmon troll fishery and 1 Steller sea lion injury incidental to the CA/OR/WA salmon troll fishery were reported. These injuries were not deemed serious (Angliss and DeMaster 1998) and have not been included in the Table 4. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Strandings 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 1995 to 1999 there were 4 fishery-related strandings in Southeast Alaska. One of these strandings has been attributed to the Alaska salmon troll fishery and has been included in Table 4. Details regarding which fishery may be responsible for other fishery-related strandings between 1994-99 is not available at this time. In 2000, there were reports of 3 Steller sea lions observed in southeast Alaska with “flashers” lodged in their mouths and one animal entangled in fishing line; all animals were alive when seen. It is not clear whether these entanglements resulted from the commercial or recreational fisheries, nor is it clear whether the interactions resulted in mortality. However, based on Angliss and DeMaster (1998), it would be appropriate to call these “serious injuries”. During the 5-year period from 1996-00, there were 6 fishery-related strandings; this results in an estimated annual mortality of 1.2 animals from this stock. This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found or reported.

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 fisheries (both U.S. and Canadian) is 3.65 sea lions per year, based on observer data (1.0), self-reported fisheries information (1.25), and stranding data (0.2 + 1.2 = 1.4).

Subsistence/Native Harvest Information

The subsistence harvest of Steller sea lions during 1997-01 is summarized in Wolfe et al. (2002). 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 2 animals/year.

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.

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 2 cases of illegal shootings of Steller sea lions in Southeast Alaska between 1995 and 1999: the cases involved the illegal shooting of one Steller sea lion near Sitka in 1998, and 3 Steller sea lions in Petersburg. Both cases were successfully prosecuted (NMFS, Alaska Enforcement Division).

Steller sea lions are taken in British Columbia during commercial salmon farming operations (Table 4). Preliminary figures from the British Columbia Aquaculture Predator Control Program indicated a mean annual mortality of 44 Steller sea lions from this stock over the period from 1995 to 1999 (P. Olesiuk, pers. comm., Pacific Biological Station, Canada). Note that the 1995 estimate includes one animal reported as an unidentified sea lion and the 1996 estimate is based on data from only the first three-quarters of 1996. The take of Steller sea lions has increased in recent years because of recent changes in sea lion distribution which have likely occurred in response to a shift in herring distribution (P. Olesiuk, pers. comm).

Strandings of Steller sea lions with gunshot wounds do still occur, along with strandings of animals entangled in gear that is not fishery-related. During the period from 1996 to 1999 human-related strandings of animals with gunshot wounds from this stock occurred in Oregon, Washington, and Alaska in 1996 (2 animals), 1997 (3 animals), 1998 (1 animal), and 1999 (2 animals), resulting in an estimated annual mortality of 2.0 Steller sea lions from this stock during 1996-99. 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 been included in the above estimates. However, 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). However, one of the two 1996 reports was from Alaska and has been included because there were no subsistence struck and lost reports during that year.

Stranding data may also provide information on additional sources of potential mortality. In 2000, 4 Steller sea lions were sighted entangled in some kind of rope or line that was not necessarily related to a commercial or recreational fishery, and one animal was seen entangled in a 14" tire. All of these animals were alive when sighted; the animal entangled in the tire was successfully released. It is not clear whether the occurrence of these interactions in stranding data in 2000 but not in previous years reflects an increase in these types of interactions or an increase in reporting. If the number of interactions is averaged over 5 years, the "other" interaction rate would be a minimum of one animal per year.

STATUS OF STOCK

Based on currently available data, the minimum estimated fishery mortality and serious injury for this stock (0.7 + 1.25 + 0.2 + 41.4 + 1.2 = 45.5) is less than that 10% of the calculated PBR (140) 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 from fishery interactions, subsistence harvests, and shootings (44 + 0 + 2 = 46) does not exceed the PBR (1,396) 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. Although the stock size has increased in recent years, the status of this stock relative to its Optimum Sustainable Population size is unknown.

Habitat Concerns

Unlike the observed decline in the western U. S. stock of Steller sea lion there has not been a concomitant decline in the eastern U. S. stock. Concerns regarding the possible impacts of commercial groundfish fisheries in the Gulf of Alaska and Bering Sea have been noted previously (see Habitat Concerns section in assessment report for the western U. S. stock). However, the eastern U. S. stock is stable or increasing in the northern portion of its range (Southeast Alaska and British Columbia). The stock has been declining in the southern end of its range (see Current Population Trend), where habitat concerns include reduced prey availability, contaminants, and disease (Sydeman and Allen 1997).

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.

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., and S. D. Reimer. 1992. Steller sea lion counts in Oregon during June and July, 1975-1991. In-house Rep., Nongame Wildlife Prog., Oregon Dept. Fish and Wildl., Newport, OR, 97365. 12 pp.

Calkins, D. G., D. C. McAllister, K. W. Pitcher, and G. W. Pendelton. 1999. Steller sea lion status and trend in Southeast Alaska: 1979-1997. Mar. Mammal Sci. 15(2):462-477.

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.

Julian, F. 1997. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1996. Unpubl. doc. submitted to Int. Whal. Comm. (SC/49/SM). 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. 96:271-284.

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. Department of Commerce, 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. 37p.

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.

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, 52p.

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.

Sydeman, W. J., and S. G. Allen. 1997. Trends and oceanographic correlates of pinniped populations in the Gulf of the Farallones, California. U.S. Dep. Commer., Southwest Fish. Sci. Cent., Admin. Rep. LJ-97-02C, 28 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.

Westlake, R. L., W. L. Perryman, and K. A. Ono. 1997. Comparison of vertical aerial photographic and ground censuses of Steller sea lions at Año Nuevo Island, July 1990-1993. Mar. Mammal Sci. 13(2): 207-218.

Wolfe, R. J., J. A. Fall, and R. T. Stanek. 2002. The subsistence harvest of harbor seals and sea lions by Alaska Natives in 2001. Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 90p + appendices.

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.

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 breeding season, approximately 74% of the worldwide population is found on the Pribilof Islands in the southern Bering Sea, with the remaining animals spread throughout the North Pacific Ocean (Lander and Kajimura 1982). Of the seals in U. S. waters outside of the Pribilof Islands, approximately 1% of the population is found on Bogoslof Island in the southern Bering Sea and on San Miguel Island off southern California (NMFS 1993). Northern fur seals may temporarily haul out onto land at other sites in Alaska, British Columbia, and on islets along the coast of the continental United States, but generally do so outside of the breeding season (Fiscus 1983).

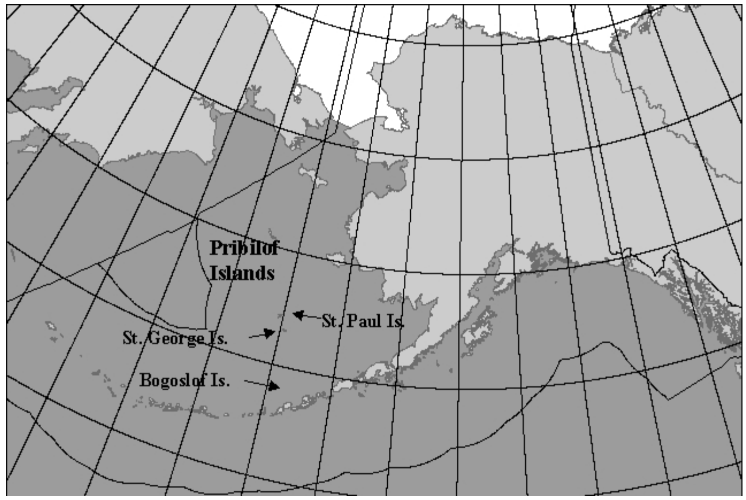

Figure 5. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

Due to differing requirements during the annual reproductive season, adult males and females typically occur ashore at different, though overlapping times. Adult males usually occur on shore during the 4-month period from May-August, though some may be present until November (well after giving up their territories). Adult females are found ashore for as long as 6 months (June-November). Following their respective times ashore, seals of both genders then migrate south and spend the next 7-8 months at sea (Roppel 1984). Adult females and pups from the Pribilof Islands migrate through the Aleutian Islands into the North Pacific Ocean, often to the Oregon and California offshore waters. Many pups may remain at sea for 22 months before returning to their rookery of birth. Adult males generally migrate only as far south as the Gulf of Alaska (Kajimura 1984). There is considerable interchange of individuals between rookeries.

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution is continuous during feeding, geographic separation during the breeding season, high natal site fidelity (DeLong 1982); 2) Population response data: substantial differences in population dynamics between Pribilof and San Miguel Islands (DeLong 1982, DeLong and Antonelis 1991, NMFS 1993); 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. Based on this information, two separate stocks of northern fur seals are recognized within U. S. waters: an Eastern Pacific stock and a San Miguel Island stock. 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 at rookeries 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 at least 4 years old (Lander 1981). The resulting population estimate is equal to the pup count 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 the Pribilof Islands, pup estimates are concentrated on these islands, though additional counts are made on Bogoslof Island. Since 1990, pup counts have occurred biennially on St. Paul and St. George Islands, although less frequently on Sea Lion Rock and Bogoslof Island (Table 5a). The most recent estimate for the number of fur seals in the Eastern Pacific stock, based on an average of counts from 1998, 2000, and

2002 is approximately 888,120 (4.5 × 197,360).

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): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 888,120 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 751,714.

	Haulout location				
Year	St. Paul	Sea Lion Rock	St. George	Bogoslof	Total
1992[1]	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
1996[2]	170,125 (21,244)	12,891 (989)	27,385 (294)	1,272 (N/A)	211,673 (0.10)
1998[3]	179,149 (6,193)	12,891 (989)	22,090 (222)	5,096 (33)	219,226 (0.029)
2000[4]	158,736 (17,284)	12,891 (989)	20,176 (271)	5,096 (33)	196,899 (0.089)
2002[4,*]	145,701 (1,629)	8,098 (191)	17,060 (527)	5,096 (33)	175,955 (0.010)

[1] Incorporates the 1990 est for Sea Lion Rock and the 1993 count for Bogoslof Is.
[2] Incorporates the 1994 est. for Sea Lion Rock and the 1995 count for Bogoslof Is.
[3] Incorporates the 1994 est. for Sea Lion Rock and the 1997 est. for Bogoslof Is.
[4] Incorporates the 1994 est. for Sea Lion Rock and the 1999 est. for Bogoslof Is.
[*] Preliminary data from 2002

Table 5a. Estimates and/or counts of northern fur seal pups born on the Pribilof Islands and Bogoslof Island. Standard errors and the CV for haulout locations and the total abundance estimate, respectively, are provided in parentheses.

Current Population Trend

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. 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 has remained relatively stable between 1981 and 1995 (Fig. 6a), indicating that stock size has not changed much in recent years (York and Fowler 1992). The 1996 estimate of number of pups born on St. Paul Island is not significantly different from the 1990, 1992, or 1994 estimates (York et al. 1997). However, the 2000 estimate of the number of pups born was 10% less than the 1992 count and 6% less than the 1996 count. 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. 6b). During 1998-02, pup production declined

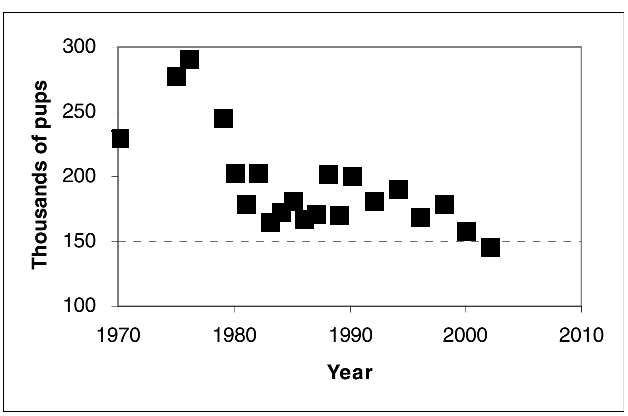

Figure 6a. Estimated number of northern fur seal pups born on St. Paul Island, 1970-02.

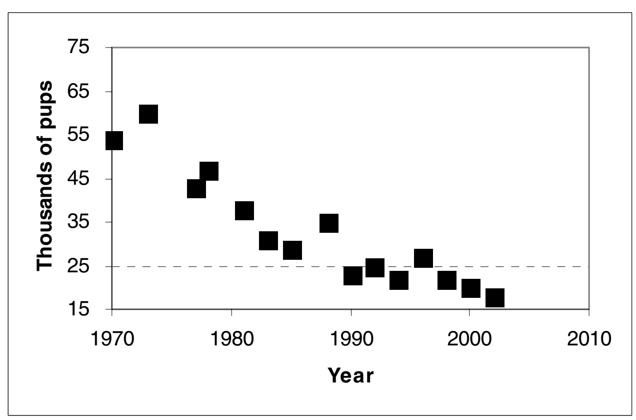

Figure 6b. Estimated number of northern fur seal pups born on St. George Island, 1970-02.

5.14% per year (SE = 0.26%) on St. Paul Island and 5.35% per year (SE = 0.19%) on St. George Island (A. York, pers. communication, October 2002). Counts in both 2000 and 2002 were lower than previous years; the estimated pup production is now below the 1921 level on St. Paul Island and below the 1916 level on St. George Island.

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 and there was no compelling evidence that carrying capacity (K) had changed substantially since the late 1950s (NMFS 1993). 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).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The northern fur seal population increased steadily during 1912-24 after the commercial harvest 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, 7600 Sand Point Way NE, Seattle, WA 98115), the maximum recorded for this species. This growth rate is similar and slightly higher than the 8.12% 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 = 16,162 animals (751,714 × 0.043 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

The NMFS estimate of the total number of northern fur seals killed incidental to both the foreign and the joint U. S.-foreign commercial groundfish trawl fisheries in the North Pacific from 1978 to 1988 was 246 (95% CI: 68 - 567), resulting in an estimated mean annual rate of 22 northern fur seals (Perez and Loughlin 1991). The foreign high seas driftnet fisheries also incidentally killed large numbers of northern fur seals, with an estimated 5,200 (95% CI: 4,500 - 6,000) animals taken during 1991 (Larntz and Garrott 1993). These estimates were not included in the mortality rate calculation 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 Fisheries Service).

Six different commercial fisheries in Alaska that could have interacted with northern fur seals were monitored for incidental take by fishery observers during 1990-01: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. The only observed fishery in which incidental mortality occurred was the Bering Sea and Aleutian Islands groundfish trawl (Table 5), with a mean annual (total) mortality of 1.5 (CV = 0.63). 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 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). During 1990, observers also boarded 59 (38.3%) 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). Although no interaction with northern fur seals was recorded by observers in 1990 and 1991 in these fisheries, due in part to the low level of observer coverage, mortalities did occur as recorded in fisher self-reports (see Table 5b).

An additional source of information on the number of northern fur seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA.

During the period between 1990 and 1999, fisher self-reports from three unobserved fisheries (see Table 5b) resulted in an annual mean of 14.5 mortalities from interactions with commercial fishing gear. While logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), the bias in these estimates are hard to quantify because at least in one area (Prince William Sound), it is unlikely that fur seals occur and reports of fur seal-fishery interactions are likely the result of species misidentification. The great majority of the incidental take in fisher self-reports occurred in the Bristol Bay salmon drift net fishery. In 1990, self-reports from the Bristol Bay set and drift gillnet fisheries were combined. As a result, some of the northern fur seal mortalities reported in 1990 may have occurred in the set net fishery. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Table 5b. Summary of incidental mortality of northern fur seals (Eastern Pacific stock) due to commercial fisheries from 1990 through 2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1997 to 2001 (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
Bering Sea/Aleutian Islands groundfish trawl	97-01	obs data	53-74%	0, 1, 1, 0, 1	0, 4, 2, 1, 2	1.5 (CV = 0.63)
Observer program total						1.5 (CV = 0.63)
				Reported mortalities		
Prince William Sound salmon drift gillnet	90-01	self reports	n/a	1, 1, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90-01	self reports		2, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Bristol Bay salmon drift gillnet	90-01	self reports	n/a	5, 0, 49, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥13.5]
Minimum total annual mortality						≥16.0 (CV = 0.63)

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, the large stock size 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 commercial fisheries is 16 fur seals per year based on observer data (1.5), and self-reported fisheries information (14.5) where observer data were not available.

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 determined from annual household surveys. From 1986 to 1996, the annual subsistence harvest level averaged 1,412 and 193 for St. Paul and St. George Islands, respectively, for a total of 1,605. The subsistence harvest levels from 1997 to 2001 were 1,380, 1,558, 1,193, 750, and 781. The average subsistence harvest level for 1997-01 is 1,132. Only juvenile males are taken in the subsistence harvest, which likely results in a much smaller impact on population growth than a harvest of equal proportions of males and females. A few females (3 in 1996, 3 in 1997, and 5 in 1998) were accidentally taken. Subsistence take in areas other than the Pribilof Islands is known to occur, though believed to be minimal (NMFS unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115).

Other Mortality

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

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). 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 lower than the rate of entanglement (0.4%) observed during 1976-85 (Fowler et al. 1994). During 1995-97, NMFS researchers in conjunction with members of the Aleut communities of St. Paul and St. George Islands captured and removed entangling debris (including trawl net, packing bands, twine, and miscellaneous items) from 88, 146 and 87 northern fur seals, respectively.

STATUS OF STOCK

Based on currently available data, the minimum estimated fishery mortality and serious injury for this stock (17) is less than 10% of the calculated PBR (1,790) 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 (17 + 1,132 = 1,149) is not known to exceed the PBR (16,162) for this stock. The Eastern Pacific stock of northern fur seal is classified as a strategic stock because it is designated as "depleted" under the MMPA. The Alaska SRG has noted that the multiplier used to convert pup counts to total population size is likely negatively biased and that the estimate of the current population size using the existing multiplier is only marginally less than 60% of the best available estimate of K (DeMaster 1996). Therefore, the Alaska SRG has recommended that the NMFS undertake research to evaluate the degree to which the currently used multiplier may be biased, and if necessary, consider re-evaluating the status of this stock relative to carrying capacity.

Habitat Concerns

Recent rapid development on the Pribilof Islands increases the potential for negatively affecting habitat used by northern fur seals. Associated with the development on the islands comes the nearshore discharge of seafood processing waste, oil and contaminant spills, increased direct human disturbance, and increased levels of noise and olfactory pollution. Preliminary data suggest that the development on St. Paul Island may be impacting fur seal rookeries as pup production has declined on two of the three rookeries in closest proximity to human habitation and to the sewer and processor outfalls. Studies designed to assess the potential impact of human and industrial development on the Pribilofs have been planned.

CITATIONS

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).

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.

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. 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. 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., NWAFC 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.

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

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.

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.

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.

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.

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

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

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

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

York, A. E. 1987. Northern fur seal, *Callorhinus ursinus*, eastern Pacific population (Pribilof Islands, Alaska, and San Miguel Island, California). Pp. 9-21, *In* J. P. Croxall and R. L. Gentry (eds.), Status, biology, and ecology of fur seals. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 51.

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

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

NOTE - August 2002: NMFS has new genetic information on harbor seals in Alaska which indicates that the current boundaries between the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks of harbor seals in Alaska need 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 2003. A complete revision of the harbor stock assessments will be postponed until new stocks are defined.

STOCK DEFINITION AND GE0OGRAPHIC 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 (Frost et al. 1996, Swain et al. 1996). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Frost et al. 1996). Strong fidelity of individuals for haulout sites in June and August also has been reported, although these studies considered only limited areas during a relatively short period of time (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

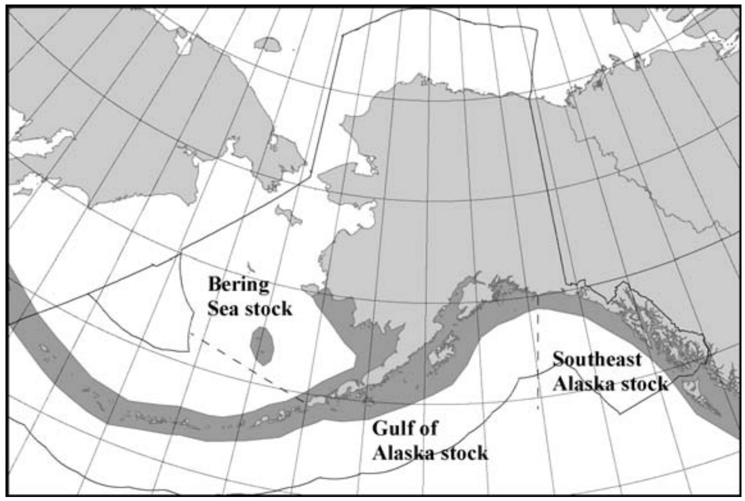

Figure7. Approximate distribution of harbor seals in Alaska waters (shaded area)

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous, natal dispersal characteristics unknown, breeding dispersal is presumed to be very limited, year-round site fidelity observed, seasonal movements greater than 300 km rare (Harvey 1987) except in western Alaska (Hoover-Miller 1994); 2) Population response data: substantial differences in population dynamics between Southeast Alaska and the rest of Alaska, and presumed differences between Gulf of Alaska and Bering Sea (Hoover 1988, Hoover-Miller 1994, Withrow and Loughlin 1996); 3) Phenotypic data: clinal variation in body size and color phase (Shaughnessy and Fay 1977, Kelly 1981); 4) Genotypic data: undetermined for Alaska, mitochondrial DNA analyses currently underway. Preliminary genetic data indicate substantial variation in mtDNA suggesting at least two genetically distinct stocks in Alaska (Westlake and O'Corry-Crowe 1997). However, until additional samples are analyzed the Alaska Scientific Review Group (SRG) recommended using the same stock boundaries as in the Stock Assessment Reports for 1996 (Hill et al. 1997).

The Alaska SRG concluded that the scientific data available to support three distinct biological stocks (i.e., genetically isolated populations) were equivocal. However, the Alaska SRG recommended that the available data were sufficient to justify the establishment of three management units for harbor seals in Alaska (DeMaster 1996). Further, the SRG recommended that, unlike the stock structure reported in Small and DeMaster (1995), animals in the Aleutian Islands should be included in the same management unit as animals in the Gulf of Alaska. As noted above, this recommendation has been adopted by NMFS with the caveat that management units and stocks are equivalent for the purposes of managing incidental take under section 118 of the Marine Mammal Protection Act (Wade and Angliss 1997). Therefore, based primarily on the significant population decline of seals in the Gulf of Alaska, the possible decline in the Bering Sea, and the stable population in Southeast Alaska (see Current Population Trend section in the respective harbor seal report for details), three separate stocks are recognized in Alaska waters: 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. 7). 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 most recent comprehensive aerial survey of harbor seals in Southeast Alaska was conducted during the autumn molt in 1993. Eleven separate areas, with a mean of 39 (21-59) sites each, were surveyed 5-9 times each; the minimum number of surveys for each of the 427 sites was usually 4 or 5. Ten of 11 areas were surveyed during the third week of September; one area was surveyed from 31 August to 6 September. All known harbor seal haulout sites in each area were surveyed, and reconnaissance surveys were flown prior to photographic surveys to establish the location of additional sites. Aerial surveys were flown within 2 hours on either side of low tide, based on the assumption that at locations affected by tides, harbor seals haul out in greatest numbers at and around the time of low tide (Pitcher and Calkins 1979, Calambokidis et al. 1987). Some of the survey effort was conducted after the molt peak. If it is assumed that harbor seals decrease their amount of time hauled out after the molt, the counts from the 1993 surveys may have underestimated the number of seals. Mathews and Kelly (1996), for instance, suggested more than half of the estimated 6,000 seals found in Glacier Bay in August were not detected in the bay, or within a 60-km radius of the bay, during the September 1993 survey.

The sum of all mean counts was 21,523 with a combined CV = 0.026 (Loughlin 1994). This method of estimating abundance and its CV assumes that during the survey period no migration occurred between sites and that there was no trend in the number of animals ashore. The number of seals moving between areas was assumed to be small considering each area's large geographic size, though a small number of seals may have been counted twice, or not at all. Data collected from 36 tagged harbor seals in Southeast Alaska from 1 to 11 September 1994 resulted in a correction factor of 1.74 (CV = 0.068) to account for animals in the water which are thus missed during the aerial surveys (Withrow and Loughlin 1995). Although this correction factor (CF) was not derived during the actual survey in 1993, it was considered conservative because the data used to develop the CF were collected during a time period (early September) when seals are assumed to spend more time on haulouts than when the surveys were flown in 1993 (late September). Utilizing this correction factor results in a population estimate of 37,450 (21,523 × 1.74; CV = 0.073) for the Southeast Alaska stock of harbor seals.

It should be noted that the CF developed for tidally influenced rocky substrate may not apply to seals hauled on ice from tidewater glaciers (Alaska SRG, see DeMaster 1996). Given the relatively small number of harbor seals counted on glacial haulouts, the magnitude of any bias resulting from using an inappropriate CF is likely small. That is, if no CF were applied to the counts of seals hauled on glacial haulouts during the 1993 surveys, the resulting abundance estimate for Southeast Alaska would be reduced by approximately 3% or 1,000 animals. NMFS will attempt to capture and radio-tag seals that utilize glacial haulouts prior to the next survey in Southeast Alaska. If such efforts are unsuccessful, pending recommendations from the Alaska SRG, NMFS will reconsider the methods used to correct for the number of seals hauled on glacial haulouts.

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): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 37,450 and its associated CV(N) of 0.073, N_{MIN} for this stock of harbor seals is 35,226.

Current Population Trend

Population trend data have been collected in the vicinity of Sitka and Ketchikan since 1983. When counts from 1993 were compared with those made in the early 1980s, mean counts of harbor seals at both locations were lower. However, this is probably explained by the late survey dates in 1993. Mean counts from both trend routes have increased since 1983. The mean count for the Ketchikan trend route was 2,708 in 1996, an increase of 3.8% from the 1995 count. The number of harbor seals at the Ketchikan trend sites has increased 9.3% annually (95% CI: 7.5%-11.0%) from 1983 to 1996 (Small et al. 1997). The mean count for the Sitka trend route decreased 21.5% from the 1995 count of 2,041 to

1,602 in 1996. However, trend estimates based on modeling count data and environmental covariates indicate that the number of harbor seals at the Sitka trend sites has increased 3.0% annually (95% CI: 2.1%-3.9%) from 1983 to 1996 (Small et al. 1997). It should be clear that these data are from selected 'trend' sites and not complete census surveys. Further, both of these trend routes are for terrestrial haul outs, which may not be representative of animals that use glacial haul outs.

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. The combined effect of the recent divergent trend at glacial ice versus terrestrial haul outs is that numbers in Glacier Bay overall appear to be stable or possibly increasing (Mathews and Pendleton 1997). Results from the Sitka, Ketchikan, and Glacier Bay trend analyses provide a strong indication that the number of harbor seals in Southeast Alaska has been increasing since at least 1983 (Small et al. 1997).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reliable rates of maximum net productivity have not been estimated for the Southeast Alaska harbor seal stock. Population growth rates of 6% and 8% were observed between 1991 and 1992 in Oregon and Washington, respectively. 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 1.0 (Wade and Angliss 1997), as population levels have increased or remained stable with a known human take (Pitcher 1990, Small et al. 1997). Thus, for this stock of harbor seals, PBR = 2,114 animals (35,226 × 0.06 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Some fishing effort by vessels participating in the Gulf of Alaska (GOA) groundfish longline fishery occurs in the offshore waters of Southeast Alaska. Effort levels are insignificant for the portion of the GOA groundfish trawl and pot fisheries operating in these waters. During the period from 1990 to 1996, 21-31% of the GOA longline catch occurred within the range of the Southeast Alaska harbor seal stock. This fishery has been monitored for incidental take by fishery observers from 1990 to 1996 (8-21% observer coverage), although observer coverage has been very low in the offshore waters of Southeast Alaska (Table 6a). The only observed harbor seal mortality in this fishery occurred in 1995, resulting in a mean annual (total) mortality of 4 (CV = 1.0).

An additional source of information on the number of harbor seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1996, fisher self-reports from 2 unobserved fisheries (see Table 6a) resulted in an annual mean of 31.25 mortalities from interactions with commercial fishing gear. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. As recommended by the Alaska SRG, given that harbor seals are the only common phocid in Southeast Alaska, fisher self-reports of unidentified phocid mortalities have been included as incidental takes of harbor seals in Table 6a (DeMaster 1996: p. 8). The majority of self-reported incidental takes were reported in the Yakutat salmon set gillnet fishery. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 (see Appendix 7 for details).

Table 6a. Summary of incidental mortality of harbor seals (Southeast Alaska stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1992 to 1996 (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**
Gulf of Alaska groundfish longline (incl. misc. finfish and sablefish fisheries)	90-96	obs data	<1-5%	0, 0, 0, 0, 0, 1, 0	0, 0, 0, 0, 0, 20, 0	4 (CV = 1.0)
Observer program total						4 (CV = 1.0)
				Reported mortalities		
Southeast Alaska salmon drift gillnet	90-96	self reports	n/a	8, 1, 4, 2, n/a, n/a, n/a	n/a	[≥3.75]
Yakutat salmon set gillnet	90-96	self reports	n/a	0, 18, 31, 61, n/a, n/a, n/a	n/a	[≥27.5]
Minimum total annual mortality						≥35.25 (CV = 1.0)

The estimated minimum annual mortality rate incidental to commercial fisheries is 36 harbor seals, based on observer data (4) and self-reported fisheries information (rounded to 32). However, 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 mentioned above. The Yakutat salmon set gillnet fishery is scheduled to be observed in 2000 and 2001. The Southeast Alaska drift gillnet fishery is scheduled to be observed in 2005 and 2006.

Subsistence/Native Harvest Information

The 1992-96 subsistence harvest of harbor seals in Alaska was estimated by the Alaska Department of Fish and Game, under contract with NMFS (Table 6b: Wolfe and Mishler 1993, 1994, 1995, 1996, 1997). In 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 harbor seal in Alaska. Interviews were conducted in 18 communities in Southeast Alaska. The statewide total subsistence take of harbor seals in 1992 was estimated at 2,888 (95% CI 2,320-3,741), with 2,535 harvested and 353 struck and lost. The total subsistence take in 1993 was estimated at 2,736 (95% CI 2,334-3,471), with 2,365 harvested and 371 struck and lost. The total subsistence take in 1994 was estimated at 2,621 (95% CI 2,110-3,457), with 2,313 harvested and 308 struck and lost. The total subsistence take in 1995 was estimated at 2,742 (95% CI 2,184-3,679), with 2,499 harvested and 243 struck and lost. The total subsistence take in 1996 was estimated at 2,741 (95% CI 2,378-3,479), with 2,415 harvested and 327 struck and lost.

Table 6b provides a summary of the subsistence harvest information for the Southeast Alaska stock. 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 1,749 animals. The reported average age-specific kill of the harvest from the Southeast Alaska stock since 1992 was 85% adults, 7% juveniles, 1% pups, and 7% of unknown age. The reported average sex-specific kill of the harvest was 49% males, 24% females, and 27% of unknown sex.

Table 6b. Summary of the subsistence harvest data for the Southeast Alaska stock of harbor seals, 1992-96.

Year	Estimated total number taken	Percentage of statewide total	Number harvested	Number struck and lost
1992	1,670	58.3%	1, 481	189
1993	1,615	59.2%	1,425	190
1994	1,500	57.2%	1,348	152
1995	1,890	68.9%	1,719	171
1996	1,858	67.7%	1,642	216
Mean annual take (1994-96)	1,749			

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).

STATUS OF STOCK

Harbor seals are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. 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. At present, annual mortality levels less than 211 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 total human-caused mortality is 1,785 (36 + 1,749) harbor seals. Although considered unlikely due to stable or increasing trends, it is unknown if the estimated annual level of total human-caused mortality and serious injury exceeds the PBR (2,114) for this stock. Until additional information on mortality incidental to commercial fisheries becomes available, the Southeast Alaska stock of harbor seals is not classified as strategic. This classification is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1995: p. 14). 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.

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

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. 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. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group, Anchorage, Alaska. 20 pp. + appendices. (available upon request - D. P. DeMaster, 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.

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., 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. of Fish and Game, Division of Wildlife Conservation. Fairbanks, AK. 131 pp.

Harvey, J. T. 1987. Population dynamics, annual food consumption, movements, and diving behavior of harbor seals, *Phoca vitulina*, in Oregon. Ph.D. dissertation, Oregon State Univ., Corvalis, OR. 177 pp.

Hill, P. S., D. P. DeMaster, and R. J. Small. 1997. Alaska Marine Mammal Stock Assessments, 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-78, 150 pp.

Hoover, A. A. 1988. Harbor seal. Pp. 125-157, *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska: Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Hoover-Miller, A. A. 1994. Harbor seal (*Phoca vitulina*) biology and management in Alaska. Marine Mammal Commission, Washington D.C., Contract #T75134749.

Kelly, B. P. 1981. Pelage polymorphism in Pacific harbor seals. Can. J. Zool. 59:1212-1219.

Loughlin, T. R. 1994. Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) in Southeastern Alaska during 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Mathews, E. A., and B. P. Kelly. 1996. Extreme temporal variation in harbor seal (*Phoca vitulina richardsi*) numbers in Glacier Bay, a glacial fjord in Southeast Alaska. Mar. Mammal Sci. 12(3):483-489.

Mathews, E. A., and G. W. Pendelton. 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. of Fish and Game, Division of Wildlife Conservation. Anchorage, AK.

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.

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.

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.

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. Pendelton, and K. M. Wynne. 1997. Harbor seal population trends in the Ketchikan, Sitka, and Kodiak Island areas of Alaska. Pp. 7-32, *In* Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. of Fish and Game, Division of Wildlife Conservation. Anchorage, AK.

Swain, U., J. Lewis, G. Pendelton, 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. of 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. 1997. Genetic investigation of Alaskan harbor seal stock stricture using mtDNA. Pp. 205-234, *In* Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. of Fish and Game, Division of Wildlife Conservation. Anchorage, AK.

Withrow, D. E., and T. R. Loughlin. 1995. Haulout behavior and method to estimate the proportion of harbor seals missed during molt census surveys in Alaska. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Withrow, D. E., and T. R. Loughlin. 1996. Haulout behavior and a correction factor estimate for the proportion of harbor seals missed during molt census surveys near Cordova, Alaska. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

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. Final report for year three, subsistence study and monitor system (no. 50ABNF20055). Prepared for NMFS by Alaska Dept. 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. Final report for year four, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 69 pp. + appendices.

Wolfe, R. J., and C. Mishler. 1997. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1996. Technical Paper 241. Draft Final report for year five, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 70 pp. + appendices.

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

NOTE - August 2002: NMFS has new genetic information on harbor seals in Alaska which indicates that the current boundaries between the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks of harbor seals in Alaska need 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 2003. A complete revision of the harbor stock assessments will be postponed until new stocks are defined.

STOCK DEFINITION AND GEOGRAPHIC RANGE

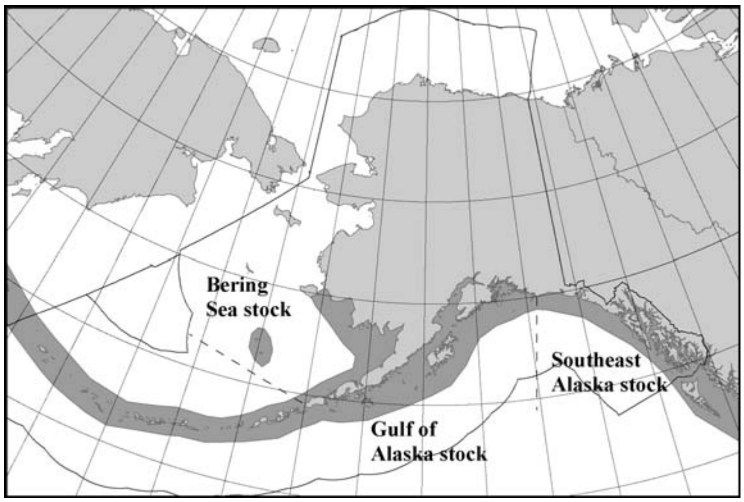

Figure 8. Approximate distribution of harbor seals in Alaska waters (shaded area).

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 northward 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 (Frost et al. 1996, Swain et al. 1996). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Frost et al. 1996). Strong fidelity of individuals for haulout sites in June and August also has been reported, although these studies considered only limited areas during a relatively short period of time (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous, natal dispersal characteristics unknown, breeding dispersal is presumed to be very limited, year-round site fidelity observed, seasonal movements greater than 300 km rare (Harvey 1987) except in western Alaska (Hoover-Miller 1994); 2) Population response data: substantial differences in population dynamics between Southeast Alaska and the rest of Alaska, and presumed differences between Gulf of Alaska and Bering Sea (Hoover 1988, Hoover-Miller 1994, Withrow and Loughlin 1996); 3) Phenotypic data: clinal variation in body size and color phase (Shaughnessy and Fay 1977, Kelly 1981); 4) Genotypic data: undetermined for Alaska, mitochondrial DNA analyses currently underway. Preliminary genetic data indicate substantial variation in mtDNA suggesting at least two genetically distinct stocks in Alaska (Westlake and O'Corry-Crowe 1997). However, until additional samples are analyzed the Alaska Scientific Review Group (SRG) recommended using the same stock boundaries as in the Stock Assessment Reports for 1996 (Hill et al. 1997).

The Alaska SRG concluded that the scientific data available to support three distinct biological stocks (i.e., genetically isolated populations) were equivocal. However, the Alaska SRG recommended that the available data were sufficient to justify the establishment of three management units for harbor seals in Alaska (DeMaster 1996). Further, the SRG recommended that, unlike the stock structure reported in Small and DeMaster (1995), animals in the Aleutian Islands should be included in the same management unit as animals in the Gulf of Alaska. As noted above, this recommendation has been adopted by NMFS with the caveat that management units and stocks are equivalent for the purposes of managing incidental take under section 118 of the Marine Mammal Protection Act (Wade and Angliss 1997). Therefore, based primarily on the significant population decline of seals in the Gulf of Alaska, the possible decline in the Bering Sea, and the stable population in Southeast Alaska (see Current Population Trend section in the respective harbor seal report for details), three separate stocks are recognized in Alaska waters: 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

Extensive photographic aerial surveys of harbor seals from the Gulf of Alaska stock were conducted during 1994 and 1996. The Aleutian Islands were surveyed from 29 August to 8 September of 1994 (Withrow and Loughlin 1995a). Between 25 August and 3 September of 1996 the south side of the Alaska Peninsula, Cook Inlet, Kenai Peninsula, Kodiak Archipelago, and Copper River Delta were surveyed (Withrow and Loughlin 1997). All known harbor seal haulout sites in each area were surveyed, and reconnaissance surveys were flown prior to photographic surveys to establish the location of additional sites. Aerial surveys were flown within 2 hours on either side of low tide, based on the assumption that at locations affected by tides, harbor seals haul out in greatest numbers at and around the time of low tide (Pitcher and Calkins 1979, Calambokidis et al. 1987). One to seven repetitive photographic counts were obtained for each major haulout site within each study area. Coefficients of variation (CV) were determined for multiple surveys and found to be <0.19 in all cases. This method of estimating abundance and its CV assumes that during the survey period no migration occurred between sites and that there was no trend in the number of animals ashore. The number of seals moving between areas was assumed to be small considering each area's large geographic size, though a small number of seals may have been counted twice or not at all.

During summer of 1996, two different aerial surveys covered portions of Prince William Sound. During August 17-26, surveys of trend route A in Prince William Sound resulted in an adjusted mean count of 984 (CV = 0.045) seals (Frost et al. 1997). Between August 27 and September 6, surveys of trend route B, excluding Columbia Bay (a tidewater glacial haulout system), in Prince William Sound resulted in a mean count of 1,261 (CV = 0.044) seals (unpubl. data, J. Burns, Living Resources Inc., P. O. Box 83570, Fairbanks, AK, 99708). During the route B surveys, the count data from Columbia Bay were considered unreliable due to difficult ice conditions and the widely scattered distribution of seals. Instead, a reasonable minimum estimate for the number of harbor seals using Columbia Bay at the time of the surveys (1,000 seals) will be added below (see Minimum Population Estimate section). Combining the counts from trend routes A and B results in a mean count of 2,245 (CV = 0.032) harbor seals in Prince William Sound, excluding Columbia Bay.

Due to the extreme difficulty in censusing harbor seals during the 1994 Aleutian Islands survey, it is recommended that the maximum count of 3,437 be used for an abundance estimate for that region (Withrow and Loughlin 1995a). The coefficient of variation for the mean count (CV = 0.059) should be used for the 1994 survey data because an estimate for the CV is not available for the maximum count. The mean count for the 1996 surveys was 16,013 (CV = 0.025) harbor seals, with the following mean counts for the major survey areas: Copper River Delta 3,174 (CV = 0.078); Prince William Sound 2,245; Kenai Peninsula 713 (CV = 0.072); Cook Inlet 2,244 (CV = 0.105); Kodiak Archipelago 4,437 (CV = 0.035); and the south side of the Alaska Peninsula 3,200 (CV = 0.034). Therefore, for the Gulf of Alaska stock of harbor seals, the total combined count from the 1994 and 1996 aerial surveys was 19,450 (CV = 0.023) animals.

Data collected from 36 tagged harbor seals in Southeast Alaska during 1994 resulted in a correction factor of 1.74 (CV = 0.068) to account for animals in the water which are thus missed during the aerial surveys (Withrow and Loughlin 1995b). In 1995, 25 harbor seals were tagged at a sand bar haulout near Cordova, AK (note: within the Gulf of Alaska). The haulout behavior of these seals was monitored from August 12 to 23, and a correction factor of 1.50 (CV = 0.047) was developed for the 1995 aerial survey in this area (Withrow and Loughlin 1996). Although much of the haulout substrate in the Gulf of Alaska area is rocky, the 1.50 CF (correction factor) from 1995 is considered to be the best available and most conservative CF for the 1996 survey data because the data used to estimate the CF were 1) collected in the survey area, 2) collected during a comparable low-tide survey window, and 3) collected more closely to the peak haul out time period (i.e., CF data collected from 12 August to 23 August versus the survey data from 23 August to 9 September). The Southeast Alaska correction factor of 1.74 was not employed for this stock because the data used to calculate the CF were 1) not collected from the Gulf of Alaska area and 2) collected to some extent after the survey period was completed (i.e., CF data from SE Alaska were collected from 1 September to 11

September)(Alaska SRG, see DeMaster 1996). Therefore, using the Gulf of Alaska correction factor results in an abundance estimate of 29,175 (19,450 × 1.50, CV = 0.052) for the Gulf of Alaska stock of harbor seals.

The next round of aerial surveys to assess the abundance of this stock will occur during the summers of 1999 (Aleutian Islands) and 2001 (Gulf of Alaska). Preliminary results of these surveys will be available in autumn of the respective survey year.

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): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 29,175 and its associated CV(N) of 0.052, N_{MIN} for this stock of harbor seals is 27,917. Including the minimum population estimate for Columbia Bay (1,000 animals) results in an N_{MIN} of 28,917 harbor seals for the Gulf of Alaska stock.

Current Population Trend

The population trend in the Aleutian Islands is unclear because the 1994 survey was the most complete census to date for that region. Previous harbor seal counts in that area are not comparable to the 1994 data because they were conducted incidental to surveys designed to assess other species (i.e., sea otters or Steller sea lions). However, a subset of the 1994 survey in the eastern Aleutian Islands indicated a count of 1,600 in an area that had counts of approximately 1,000-2,500 seals during 1975-77 (Small 1996).

In Prince William Sound, harbor seal numbers declined by 57% from 1984 to 1992 (Pitcher 1989, Frost and Lowry 1993). 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. 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 count has increased from 769 in 1992 to 1,420 in 1996 (Small 1996, Withrow and Loughlin 1997), although this still only represents a fraction of its historical size. The population around Kodiak Island, based on an aerial photographic route established in 1992, is estimated to have increased at 7.2% annually from 1992-96 (Small et al. 1997). Despite some positive signs of growth in certain areas, the overall Gulf of Alaska stock size remains small compared to its size 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 = 868 animals (28,917 × 0.06 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Three different commercial fisheries operating within the range of the Gulf of Alaska stock of harbor seals were monitored for incidental take by fishery observers during 1990-96: Gulf of Alaska groundfish trawl, longline, and pot fisheries. For the fisheries with observed takes, the range of observer coverage over the 7-year period, as well as the annual observed and estimated mortalities are presented in Table 7a. The mean annual (total) mortality rate was 0.4 (CV = 1.0) for the Gulf of Alaska groundfish trawl fishery and was 0.2 (CV = 1.0) Gulf of Alaska pot fishery. The harbor seal taken in the pot fishery in 1995 (7% observer coverage) occurred during an unmonitored haul and therefore could not be used to estimate mortality for the entire fishery. Therefore, 1 mortality was used as both the observed mortality and estimated mortality in 1995 for that fishery, and should be considered a minimum estimate.

Table 7a. Summary of incidental mortality of harbor seals (Gulf of Alaska stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information or stranding data. Data from 1992 to 1996 (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
Gulf of Alaska (GOA) groundfish trawl	90-96	obs data	33-55%	0, 1, 1, 0, 0, 0, 0	0, 3, 2, 0, 0, 0, 0	0.4 (CV = 1.0)
GOA finfish pot	90-96	obs data	5-13%	0, 0, 0, 0, 0, 1, 0	0, 0, 0, 0, 0, 1, 0	0.2 (CV = 1.0)
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
Observer program total						24.6 (CV = 0.49)
				Reported mortalities		
Cook Inlet salmon set gillnet	90-96	self reports	n/a	6, 0, 1, 0, n/a, n/a, n/a	n/a	[≥1.75]
Prince William Sound set gillnet	90-96	self reports	n/a	0, 0, 0, 1, n/a, n/a, n/a	n/a	[≥0.25]
Kodiak salmon set gillnet	90-96	self reports	n/a	3, 0, 0, 0, n/a, n/a, n/a	n/a	[≥0.75]
Alaska salmon purse seine (except for Southeast)	90-96	self reports	n/a	0, 0, 0, 2, n/a, n/a, n/a	n/a	[≥0.5]

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90-96	self reports	n/a	9, 2, 12, 5, n/a, n/a, n/a	n/a	[≥7.0]
unknown Gulf of Alaska fishery	92-96	strand data	n/a	0, 0, 0, 0, 1	n/a	[≥0.2]
Minimum total annual mortality						≥35.05 (CV = 0.49)

In the Prince William Sound salmon drift gillnet fishery, observers recorded 2 incidental mortalities of harbor seals in 1990 (Wynne et al. 1991), and 1 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 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. 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 7a. Combining the estimates from the groundfish trawl and pot fisheries presented above (0.4 + 0.2 = 0.6) with the estimate from the Prince William Sound salmon drift gillnet fishery (24) results in an estimated annual incidental kill rate in observed fisheries of 24.6 (CV = 0.49) harbor seals per year from this stock. It should be noted that in 1990, observers also boarded 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). Although no interaction with harbor seals was recorded by observers in 1990, due in part to the low level of observer coverage, mortalities did occur as recorded in fisher self-reports (see Table 7a).

An additional source of information on the number of harbor seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1996, fisher self-reports from 5 unobserved fisheries (see Table 7a) resulted in an annual mean of 10.25 mortalities from interactions with commercial fishing gear. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. These totals are based on all available self-reported fisheries information for Gulf of Alaska fisheries, except the Prince William Sound salmon drift gillnet fishery and the Gulf of Alaska groundfish trawl and pot fisheries for which observer data were presented above. In 1990, fisher self-reports from the Cook Inlet set and drift gillnet fisheries were combined. As a result, some of the harbor seal mortalities reported in 1990 may have occurred in the drift net fishery. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 (see Appendix 7 for details).

Strandings of harbor seals entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality data. During the 5-year period from 1992 to 1996 the only fishery-related harbor seal stranding was reported in June of 1996 on Middleton Island. The entanglement could not be attributed to a particular fishery and as a result has been included in Table 7a as occurring in an unknown fishery. Fishery-related strandings during 1992-96 result in an estimated annual mortality of 0.2 harbor seals from this stock. This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found or reported.

The estimated minimum annual mortality rate incidental to commercial fisheries is 36 (rounded up), based on observer data (24.6) and self-reported fisheries information (10.25) or stranding data (0.2) 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 placements in several fisheries mentioned above.

Subsistence/Native Harvest Information

The 1992-96 subsistence harvest of harbor seals in Alaska was estimated by the Alaska Department of Fish and Game, under contract with the NMFS (Table 7b: Wolfe and Mishler 1993, 1994, 1995, 1996, 1997). In 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 harbor seal in Alaska. Between 1992-96, interviews were conducted in approximately 29 communities that lie within the range of the Gulf of Alaska harbor seal stock. The statewide total subsistence take of harbor seals in 1992 was estimated at 2,888 (95% CI 2,320-3,741), with 2,535 harvested and 353 struck and lost. The total subsistence take in 1993 was estimated at 2,736 (95% CI 2,334-3,471), with 2,365 harvested and 371 struck and lost. The total subsistence take in 1994 was estimated at 2,621 (95% CI 2,110-3,457), with 2,313 harvested and 308 struck and lost. The total subsistence take in 1995 was estimated at 2,742 (95% CI 2,184-3,679), with 2,499 harvested and 243 struck and lost. The total subsistence take in 1996 was estimated at 2,741 (95% CI 2,378-3,479), with 2,415 harvested and 327 struck and lost.

Table 7b provides a summary of the subsistence harvest information for the Gulf of Alaska stock. 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. The reported average age-specific kill of the harvest from the Gulf of Alaska stock since 1992 was 58% adults, 27% juveniles, 2% pups, and 13% of unknown age. The reported average sex-specific kill of the harvest was 44% males, 18% females, and 38% of unknown sex.

Table 7b. Summary of the subsistence harvest data for the Gulf of Alaska stock of harbor seals, 1992-96.

Year	**Estimated total number taken**	**Percentage of statewide total**	**Number harvested**	**Number struck and lost**
1992	967	33.7%	884	83
1993	914	33.5%	812	102
1994	913	34.9%	819	94
1995	724	26.4%	683	41
1996	735	26.8%	679	56
Mean annual take (1994-96)	791			

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).

STATUS OF STOCK

Sustainable harvest levels for this stock will be determined from the analysis of information gathered through the cooperative management process, and will reflect the degree of uncertainty associated with the information obtained for this stock. Efforts were initiated in 1995 and 1996 to develop a cooperative approach for management of this stock; a final agreement was approved in 1999.

Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. 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. At present, annual fishery-related mortality levels less than 87 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 total human-caused mortality is 827 (36 + 791) harbor seals which does not exceed the PBR (868) 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. This classification is consistent with the recommendations of the Alaska SRG (DeMaster 1998). 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.

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

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

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 - D. P. DeMaster, 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.

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. of Fish and Game, Division of Wildlife Conservation. Fairbanks, AK. 131 pp.

Frost, K. F., L. F. Lowry, J. M. Ver Hoef, 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. of Fish and Game, Division of Wildlife Conservation. Fairbanks, AK. 56 pp.

Harvey, J. T. 1987. Population dynamics, annual food consumption, movements, and diving behavior of harbor seals, *Phoca vitulina*, in Oregon. Ph.D. dissertation, Oregon State Univ., Corvalis, OR. 177 pp.

Hill, P. S., D. P. DeMaster, and R. J. Small. 1997. Alaska Marine Mammal Stock Assessments, 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-78, 150 pp.

Hoover, A. A. 1988. Harbor seal. Pp. 125-157, *In* J. W. Lentfer (ed.), Selected marine mammals of Alaska: Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Hoover-Miller, A. A. 1994. Harbor seal (*Phoca vitulina*) biology and management in Alaska. Marine Mammal Commission, Washington D.C., Contract #T75134749.

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.

Kelly, B. P. 1981. Pelage polymorphism in Pacific harbor seals. Can. J. Zool. 59:1212-1219.

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.

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.

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.

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., 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. Pendelton, and K. M. Wynne. 1997. Harbor seal population trends in the Ketchikan, Sitka, and Kodiak Island areas of Alaska. Pp. 7-32, *In* Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. of Fish and Game, Division of Wildlife Conservation. Anchorage, AK.

Swain, U., J. Lewis, G. Pendelton, 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. of 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. 1997. Genetic investigation of Alaskan harbor seal stock stricture using mtDNA. Pp. 205-234, *In* Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. of Fish and Game, Division of Wildlife Conservation. Anchorage, AK.

Withrow, D. E., and T. R. Loughlin. 1995a. Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) along the Aleutian Islands during 1994. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Withrow, D. E., and T. R. Loughlin. 1995b. Haulout behavior and method to estimate the proportion of harbor seals missed during molt census surveys in Alaska. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Withrow, D. E., and T. R. Loughlin. 1996. Haulout behavior and a correction factor estimate for the proportion of harbor seals missed during molt census surveys near Cordova, Alaska. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Withrow, D. E., and T. R. Loughlin. 1997. Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) along the south side of the Alaska Peninsula, Shumagin Islands, Coon Inlet, Kenai Peninsula, and the Kodiak Archipelago in 1996. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

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. Final report for year three, subsistence study and monitor system (no. 50ABNF20055). Prepared for NMFS by Alaska Dept. 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. Final report for year four, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 69 pp. + appendices.

Wolfe, R. J., and C. Mishler. 1997. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1996. Technical Paper 241. Draft Final report for year five, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 70 pp. + appendices.

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 - August 2002: NMFS has new genetic information on harbor seals in Alaska which indicates that the current boundaries between the Southeast Alaska, Gulf of Alaska, and Bering Sea stocks of harbor seals in Alaska need 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 2003. A complete revision of the harbor 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 (Frost et al. 1996, Swain et al. 1996). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Frost et al. 1996). Strong fidelity of individuals for haulout sites in June and August also has been reported, although these studies considered only limited areas during a relatively short period of time (Pitcher and Calkins 1979, Pitcher and McAllister 1981).

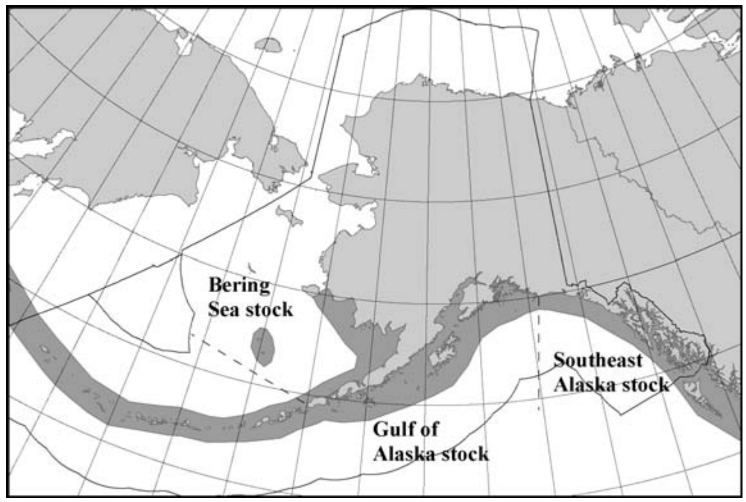

Figure 9. Approximate distribution on harbor seals in Alaska waters (shaded area).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous, natal dispersal characteristics unknown, breeding dispersal is presumed to be very limited, year-round site fidelity observed, seasonal movements greater than 300 km rare (Harvey 1987) except in western Alaska (Hoover-Miller 1994); 2) Population response data: substantial differences in population dynamics between Southeast Alaska and the rest of Alaska, and presumed differences between Gulf of Alaska and Bering Sea (Hoover 1988, Hoover-Miller 1994, Withrow and Loughlin 1996b); 3) Phenotypic data: clinal variation in body size and color phase (Shaughnessy and Fay 1977, Kelly 1981); 4) Genotypic data: undetermined for Alaska, mitochondrial DNA analyses currently underway. Preliminary genetic data indicate substantial variation in mtDNA suggesting at least two genetically distinct stocks in Alaska (Westlake and O'Corry-Crowe 1997). However, until additional samples are analyzed the Alaska Scientific Review Group (SRG) recommended using the same stock boundaries as in the Stock Assessment Reports for 1996 (Hill et al. 1997).

The Alaska SRG concluded that the scientific data available to support three distinct biological stocks (i.e., genetically isolated populations) were equivocal. However, the Alaska SRG recommended that the available data were sufficient to justify the establishment of three management units for harbor seals in Alaska (DeMaster 1996). Further, the SRG recommended that, unlike the stock structure reported in Small and DeMaster (1995), animals in the Aleutian Islands should be included in the same management unit as animals in the Gulf of Alaska. As noted above, this recommendation has been adopted by NMFS with the caveat that management units and stocks are equivalent for the purposes of managing incidental take under section 118 of the Marine Mammal Protection Act (Wade and Angliss 1997). Therefore, based primarily on the significant population decline of seals in the Gulf of Alaska, the possible decline in the Bering Sea, and the stable population in Southeast Alaska (see Current Population Trend section in the respective harbor seal report for details), three separate stocks are recognized in Alaska waters: 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. 9). 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

Extensive photographic aerial surveys of harbor seals in the Bering Sea were conducted during the autumn molt in 1995 (28 August - 10 September), throughout northern Bristol Bay and along the north side of the Alaska Peninsula (Withrow and Loughlin 1996a). All known harbor seal haulout sites in each area were surveyed, and reconnaissance surveys were flown prior to photographic surveys to establish the location of additional sites. Aerial surveys were flown within 2 hours on either side of low tide, based on the assumption that at locations affected by tides, harbor seals haul out in greatest numbers at and around the time of low tide (Pitcher and Calkins 1979, Calambokidis et al. 1987). At least four repetitive photographic counts were obtained for each major rookery and haulout site within each study area. Coefficients of variation were determined for multiple surveys and found to be <0.19 in all cases. This method of estimating abundance and its CV assumes that during the survey period no migration occurred between sites and that there was no trend in the number of animals ashore. The number of seals moving between areas was assumed to be small considering each area's large geographic size, though a small number of seals may have been counted twice or not at all.

The total mean count for the 1995 surveys was 8,740 (CV = 0.040) harbor seals, with mean counts of 955 (CV = 0.071) for northern Bristol Bay and 7,785 (CV = 0.044) for the north side of the Alaska Peninsula (Withrow and Loughlin 1996a). A correction factor based on data from animals from this stock is currently unavailable. A tagging experiment conducted from 17 to 23 August 1995 collected data from 25 harbor seals using a sand bar haul out near Cordova, Alaska (within the Gulf of Alaska), resulting in a correction factor of 1.50 (CV = 0.047) to account for animals in the water which are thus missed during the aerial surveys (Withrow and Loughlin 1996b). This correction factor was used for the Bering Sea stock due to the similarity in haulout habitat type (sand bar) to a majority of harbor seal haulout sites found in the Bering Sea. Further, this CF was considered conservative by the Alaska SRG (DeMaster 1996) because the timing of the aerial survey was later than the timing of the CF study and it is likely that the fraction of seals hauled out during the surveys was smaller. Multiplying these aerial survey counts by the correction factor results in an estimated abundance of 13,110 (8,740 × 1.50; CV = 0.062) harbor seals.

In 1995, daily land counts of harbor seals were conducted on Otter Island (one of the Pribilof Islands) from July 2 through August 8. The maximum count during this study was 202 seals (Withrow and Loughlin 1996a). Adding this count to the corrected estimated abundance from the aerial surveys results in an estimated abundance of 13,312 (13,110 + 202) harbor seals for the Bering Sea stock.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. Using the population estimate (N) of 13,110 from the aerial surveys and the associated CV(N) of 0.062, results in an estimate of 12,446 harbor seals. Adding the maximum count of 202 seals from the Otter Island survey results in an N_{MIN} of 12,648 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 1996a). 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 1996a).

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_{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). Thus, for the Bering Sea harbor seal stock, PBR = 379 animals ($12{,}648 \times 0.06 \times 0.5$).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Three different commercial fisheries operating within the range of the Bering Sea stock of harbor seals were monitored for incidental take by fishery observers during 1990-96: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. Harbor seal mortality was observed in all three fisheries at low levels. The range of observer coverage over the period, as well as the annual observed and estimated mortalities are presented in Table 8a. The mean annual (total) mortality rate was 2.2 (CV = 0.44) for the Bering Sea groundfish trawl fishery, 0.6 (CV = 1.0) for the Bering Sea longline fishery, and 1.2 (CV = 0.81) for the Bering Sea pot fishery. The harbor seal taken in the pot fishery in 1992 (34% observer coverage) occurred during an unmonitored haul and therefore could not be used to estimate mortality for the entire fishery. Therefore, 1 mortality was used as both the observed mortality and estimated mortality in 1992 for that fishery, and should be considered a minimum estimate. Combining the estimates from the Bering Sea groundfish trawl, longline, and pot fisheries presented above (2.2 + 0.6 + 1.2 = 4.0) results in an estimated annual incidental kill rate in observed fisheries of 4.0 (CV = 0.37) harbor seals per year from the Bering Sea stock.

An additional source of information on the number of harbor seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1996, fisher self-reports from the Bristol Bay salmon drift and set gillnet fisheries (see Table 8a) resulted in an annual mean of 26.75 mortalities from interactions with commercial fishing gear. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. These totals are based on all available self-reported fisheries information for Bering Sea fisheries, except the groundfish trawl, longline and pot fisheries for which observer data were presented above. In 1990, fisher self-reports from the Bristol Bay set and drift gillnet fisheries were combined. As a result, some of the harbor seal mortalities reported in 1990 may have occurred in the set net fishery. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 (see Appendix 7 for details).

The estimated minimum annual mortality rate incidental to commercial fisheries is 31, based on observer data (4) and self-reported fisheries information (27) 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 placements in the gillnet fisheries mentioned above. The Bristol Bay salmon set and drift gillnet fisheries are scheduled to be observed in 2005 and 2006.

Table 8a. Summary of incidental mortality of harbor seals (Bering Sea stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1992 to 1996 (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
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	90-96	obs data	53-74%	1, 1, 2, 0, 3, 0, 2	1, 1, 3, 0, 5, 0, 3	2.2 (CV = 0.44)
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	90-96	obs data	27-80%	0, 0, 0, 1, 0, 0, 0	0, 0, 0, 3, 0, 0, 0	0.6 (CV = 1.0)
BSAI finfish pot	90-96	obs data	17-43%	0, 0, 1, 0, 0, 1, 0	0, 0, 1, 0, 0, 5, 0	1.2 (CV = 0.81)
Observer program total						4.0 (CV = 0.37)
				Reported mortalities		
Bristol Bay salmon drift gillnet	90-96	self reports	n/a	38, 23, 2, 42, n/a, n/a, n/a	n/a	[≥26.25]
Bristol Bay salmon set gillnet	90-96	self reports	n/a	0, 0, 1, 1, n/a, n/a, n/a	n/a	[≥0.5]
Minimum total annual mortality						≥30.75 (CV = 0.37)

Subsistence/Native Harvest Information

The 1992-96 subsistence harvest of harbor seals in Alaska was estimated by the Alaska Department of Fish and Game, under contract with the NMFS (Table 8b: Wolfe and Mishler 1993, 1994, 1995, 1996, 1997). In 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 harbor seal in Alaska. Between 1992-96, interviews were conducted in approximately 14 communities that lie within the range of the Bering Sea harbor seal stock. The statewide total subsistence take of harbor seals in 1992 was estimated at 2,888 (95% CI 2,320-3,741), with 2,535 harvested and 353 struck and lost. The total subsistence take in 1993 was estimated at 2,736 (95% CI 2,334-3,471), with 2,365 harvested and 371 struck and lost. The total subsistence take in 1994 was estimated at 2,621 (95% CI 2,110-3,457), with 2,313 harvested and 308 struck and lost. The total subsistence take in 1995 was estimated at 2,742 (95% CI 2,184-3,679), with 2,499 harvested and 243 struck and lost. The total subsistence take in 1996 was estimated at 2,741 (95% CI 2,378-3,479), with 2,415 harvested and 327 struck and lost.

Table 8b provides a summary of the subsistence harvest information for the Bering Sea stock. 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 161 animals. The reported average age-specific kill of the harvest from the Bering Sea stock since 1992 was 69% adults, 14% juveniles, 4% pups, and 13% of unknown age. The reported average sex-specific kill of the harvest was 25% males, 8% females, and 67% of unknown sex.

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).

Table 8b. Summary of the subsistence harvest data for the Bering Sea stock of harbor seals, 1992-96.

Year	Estimated total number taken	Percentage of statewide total	Number harvested	Number struck and lost
1992	229	8.0%	160	59
1993	199	7.3%	122	77
1994	208	7.9%	145	63
1995	127	4.6%	97	30
1996	148	5.4%	94	54
Mean annual take (1994-96)	161			

STATUS OF STOCK

Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. 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. At present, annual mortality levels less than 38 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (31 + 161 = 192) is not known to exceed the PBR (379). 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.

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

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. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group, Anchorage, Alaska. 20 pp. + appendices. (available upon request - D. P. DeMaster, 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.

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., 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. of Fish and Game, Division of Wildlife Conservation. Fairbanks, AK. 131 pp.

Harvey, J. T. 1987. Population dynamics, annual food consumption, movements, and diving behavior of harbor seals, *Phoca vitulina*, in Oregon. Ph.D. dissertation, Oregon State Univ., Corvalis, OR. 177 pp.

Hill, P. S., D. P. DeMaster, and R. J. Small. 1997. Alaska Marine Mammal Stock Assessments, 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-78, 150 pp.

Hoover-Miller, A.A. 1994. Harbor seal (*Phoca vitulina*) biology and management in Alaska. Marine Mammal Commission, Washington D.C., Contract #T75134749.

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.

Kelly, B. P. 1981. Pelage polymorphism in Pacific harbor seals. Can. J. Zool. 59:1212-1219.

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.

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.

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.

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.

Swain, U., J. Lewis, G. Pendelton, 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. of 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. 1997. Genetic investigation of Alaskan harbor seal stock stricture using mtDNA. Pp. 205-234, *In* Annual Report: Harbor seal investigations in Alaska. NOAA Grant NA57FX0367. Alaska Dep. of Fish and Game, Division of Wildlife Conservation. Anchorage, AK.

Withrow, D. E., and T. R. Loughlin. 1996a. 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.

Withrow, D. E., and T. R. Loughlin. 1996b. Haulout behavior and a correction factor estimate for the proportion of harbor seals missed during molt census surveys near Cordova, Alaska. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

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 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 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. Final report for year three, subsistence study and monitor system (no. 50ABNF20055). Prepared for NMFS by Alaska Dept. 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. Final report for year four, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 69 pp. + appendices.

Wolfe, R. J., and C. Mishler. 1997. The subsistence harvest of harbor seal and sea lion by Alaska natives in 1996. Technical Paper 241. Draft Final report for year five, subsistence study and monitor system (no. 50ABNF400080). Prepared for NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 70 pp. + appendices.

SPOTTED SEAL (*Phoca largha*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Spotted seals are distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk Seas south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977, Fig. 10). Satellite tagging studies have recently provided considerable insight into the seasonal movements of spotted seals (Lowry et al. 1998, Lowry et al. 2000). These studies indicate that spotted seals migrate south from the Chukchi Sea in October and pass through the Bering Strait in November (Lowry et al. 1998). Seal overwinter in the Bering Sea along the ice edge and make rapid east-west movements along the edge (Lowry et al. 1998). During spring they 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). In summer and fall, spotted seals use coastal haulouts regularly, 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 8 known breeding areas, 3 occur in the Bering Sea, with the remaining 5 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 North Pacific harbor seals (*Phoca vitulina*). The 2 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 regularly associated with pack ice (Shaughnessy and Fay 1977). These and other ecological, behavioral, and morphological differences support their recognition as two separate species (Quakenbush 1988).

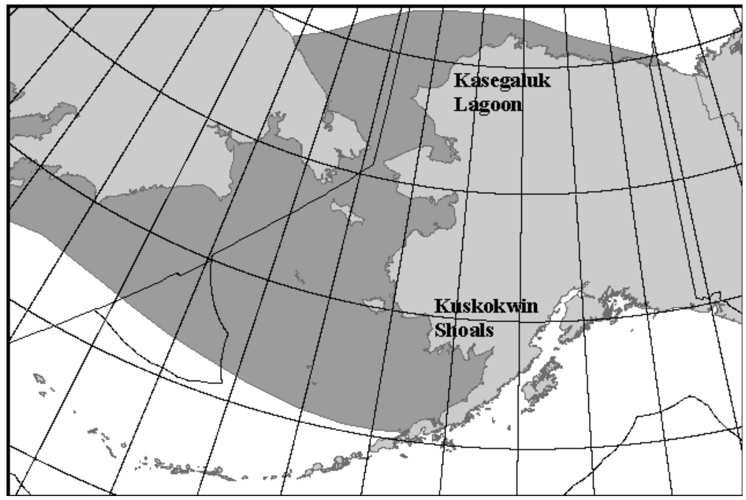

Figure 10. Approximate distribution of spotted seals in Alaska waters (shaded area)

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 radio transmitters on four spotted seals in Kasegaluk Lagoon to estimate the ratio of time hauled out versus time at sea. Preliminary results indicate that the proportion hauled out averages 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_{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 have been relatively stable at Kasegaluk Lagoon since the late 1970s. 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.

An element of concern is the potential for Arctic climate change, which will probably affect high northern latitudes more than elsewhere. There is evidence that over the last 10-15 years, there has been a shift in regional weather patterns in the Arctic region (Tynan and DeMaster 1996). Ice-associated seals, such as the spotted seal, are particularly sensitive to changes in weather and sea-surface temperatures in that these strongly affect their ice habitats. There are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska spotted seal stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5 R_{MAX} \times F_R$. 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_{MIN} is currently not available, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Three different commercial fisheries operating within the range of the Alaska stock of spotted seals were monitored for incidental take by NMFS observers during 1990-95: Bering Sea/Aleutian Islands groundfish trawl, longline, and pot fisheries. The only fishery for which incidental kill was reported was the Bering Sea/Aleutian Islands groundfish fishery, with 3 mortalities reported during 1996. These mortalities resulted in an estimated 5 mortalities during that year, and an average of 1 (CV = 1.0) mortality per year over the 1995-99 period.

An additional source of information on the number of spotted seals killed or injured incidental to commercial fishing operations is the logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990 and 1993, logbook reports from the Bristol Bay salmon drift gillnet and set gillnet fisheries (see Table 9) resulted in an annual mean of 1.5 mortalities from interactions with commercial fishing gear. However, because logbook records are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. These totals are based on all available logbook reports for Alaska fisheries through 1993. In 1990, logbook records from the Bristol Bay set and drift gillnet fisheries were combined. As a result, some of the spotted seal mortalities reported in 1990 may have occurred in the set net fishery. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

The estimated minimum mortality rate incidental to commercial fisheries is 2.5 animals per year based on logbook and observer data. Yet, it should be noted that most interactions with these fisheries are likely to be harbor seals rather than spotted seals, and that due to the difficulty of distinguishing between spotted and harbor seals, the reliability of these reports is questionable. 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. Because the PBR for this stock is unknown, it is currently not possible to determine what annual mortality level is considered to be insignificant and approaching zero mortality and serious injury rate.

Table 9. Summary of incidental mortality of spotted seals (Alaska stock) due to commercial fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbook reports.

Fishery name	Years	Data type	Range of observer coverage	Reported mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	90-99	obs data	31-74%	0, 0, 0, 0, 0, 0, 3, 0, 0, 0	0, 0, 0, 0, 0, 0, 5, 0, 0, 0	1 (CV = 1.0)
Bristol Bay salmon drift gillnet	90-93	logbook	n/a	5, 1, 0, 0	n/a	[≥ 1.5]
Minimum total annual mortality						≥2.5 (CV = 1.0)

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

A recent 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 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 5,265 spotted seals estimated by the Division of Subsistence is considerably higher than the previous minimum estimate of 244 per year based on reports from the northern Bristol Bay portion of the spotted seal's range. Although some of the more recent entries in the ADF&G 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 represents a mean estimate rather than a minimum estimate of subsistence harvest.

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. However, due to a lack of information suggesting subsistence hunting is adversely affecting this stock and because of the minimal interactions between spotted seals and any U. S. fishery, the Alaska stock of spotted seals is not classified as a strategic stock. This classification is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1995).

CITATIONS

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

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

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 Department of 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 Department of Fish and Game, Division of Subsistence, Juneau.

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

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 Department of Fish and Game, Division of Subsistence, Juneau.

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

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 seals sightings in Alaska 1992-93. 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.

Tynan, C., and D. P. DeMaster. 1996. Observations and predictions of Arctic climate change. Unpubl. doc. submitted to Int. Whal. Comm. (SC/48/O 21). 11 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.

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 Dept. 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 Dept. Fish and Game, Juneau, Alaska, 69 pp. + appendices.

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

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. 11). 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). Recent spring surveys along the Alaskan coast indicate that bearded seals 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). Many of the seals that winter in the Bering Sea migrate 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 do not migrate 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 migrates 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.

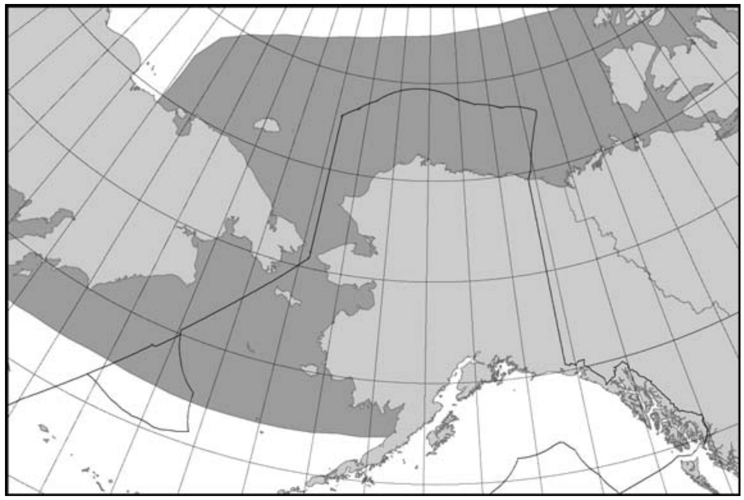

Figure 11. Approximate distribution of bearded seals in Alaska waters (shaded area). The combined summer and winter distributions are depicted.

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 the distribution of bearded seals into more than one stock. Therefore, 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 Shismaref to Barrow during May-June 1999 provided preliminary results indicating densities up to 0.149 bearded seals/km^2 and an estimated abundance of 4,862 in the eastern Chukchi Sea (NMML, unpublished data). However, preliminary results of surveys flown in 2000 indicate that the abundance may be much greater. Until this discrepancy is addressed and additional surveys are conducted, a reliable estimate of abundance for the Alaska stock of bearded seals is considered unavailable.

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 bearded seals are unavailable, though there is no evidence that population levels are declining.

An element of concern is the potential for Arctic climate change, which will probably affect high northern latitudes more than elsewhere. There is evidence that over the last 10-15 years, there has been a shift in regional weather patterns in the Arctic region (Tynan and DeMaster 1996). Ice-associated seals, such as the bearded seal, are particularly sensitive to changes in weather and sea-surface temperatures in that these strongly affect their ice habitats. There are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska bearded seal stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). However, because a reliable estimate of minimum abundance N_{MIN} is currently not available, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Three different commercial fisheries operating within the range of the Alaska stock of bearded seals were monitored for incidental take by NMFS observers during 1990-99: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. The only fishery for which incidental kill was observed was the Bering Sea groundfish trawl fishery, with 3 mortalities reported in 1991, 4 mortalities reported in 1994, 1 mortality reported in 1998, and 2 mortalities reported in 1999. These mortalities resulted in a mean annual (total) mortality rate of 0.6 (CV = 0.7) bearded seals per year. The range of observer coverage over the 5-year period from 1995-99, as well as the annual observed and estimated mortalities are presented in Table 10. It should be noted that one of the 1991 observed kills was later identified as a juvenile elephant seal (K. Wynne, pers. comm., University of Alaska). Further, only 1 mortality was reported during monitored hauls in 1994, which extrapolated to 2 mortalities for the entire fishery. Because NMFS observers recorded 3 additional bearded seal mortalities in unmonitored hauls, the estimated mortality in 1994 (2 seals) was known to be an underestimate. Accordingly, 4 was used as both the observed and estimated mortality for 1994 (Table 10). Similarly, while 2 mortalities were observed in 1999, the estimated mortality was calculated as 1; since this is clearly an underestimate, Table 10 incorporates the 2 observed mortalities as estimated mortalities for that year.

Table 10. Summary of incidental mortality of bearded seals (Alaska stock) due to commercial fisheries from 1990 through 1999 and calculation of the mean annual mortality rate. Data from 1995 to 1999 are used in the mortality calculation when more than 5 years of data are provided for a particular fishery.

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	90-99	obs data	31-74%	0, 3, 0, 0, 4, 0, 0, 0, 1, 2	0, 6, 0, 0, 4, 0, 0, 0, 1, 2	0.6 (CV = 0.67)
Observer program total						0.6
Total estimated annual mortality						0.6

An additional source of information on the number of bearded seals killed or injured incidental to commercial fishing operations is the logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990 and 1993, the only logbook reports for bearded seals detailed 14 mortalities and 31 injuries in the Bristol Bay salmon drift gillnet fishery in 1991. These reports are suspect because it is highly unlikely that bearded seals would have been in the Bristol Bay vicinity during the summer salmon fishing months. These logbook mortalities have not been included in Table 10. However, because logbook records are most likely negatively biased (Credle et al. 1994), the absence of mortality reports does not assure bearded seal mortality did not occur. These logbook totals (zero animals) are based on all available logbook reports for Alaska fisheries through 1993. Logbook data are available for part of 1989-94, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

The estimated minimum mortality rate incidental to commercial fisheries is 0.6 bearded seals per year, based exclusively on observer data. Because the PBR for this stock is unknown, it is currently not possible to determine what annual mortality level is insignificant and approaching zero mortality and serious injury rate.

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 (ADF&G 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-Scarbrough 1999) and a report from the Eskimo Walrus Commission (Sherrod 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990-1998 were used. As of August 2000; the subsistence harvest database indicated that the the estimated number of bearded seals harvested for subsistence use per year is 6,788.

A recent 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 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 ADF&G Division of Subsistence is considerably higher than the previous minimum estimate of 791 per year from 5 villages in the Bering Strait. Although some of the more recent entries in the ADF&G 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 represents a mean estimate rather than a minimum estimate of subsistence harvest.

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. Due to a lack of information suggesting subsistence hunting is adversely affecting this stock and because of the minimal interactions between bearded seals and any U. S. fishery, the Alaska stock of bearded seals is not classified as a strategic stock. This classification is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1995: p. 26).

CITATIONS

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

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

Bengtson, J. L., P. L. Boveng, L. M. Hiruki-Raring, K. L. Laidre, C. Pungowiyi, and M. A. Simpkins. 2000. Abundance and distribution of ringed seals (*Phoca hispida*) in the coastal Chukchi Sea. Pp. 149-160, *In* A. L. Lopez and D. P. DeMaster. Marine Mammal Protection Act and Endangered Species Act Implemention Program 1999. AFSC Processed Report 2000-11, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 89115.

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. 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 Department of 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 Department of Fish and Game, Division of Subsistence, Juneau.

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. 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).

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 Department of Fish and Game, Division of Subsistence, Juneau.

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.).

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.

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.

Tynan, C., and D. P. DeMaster. 1996. Observations and predictions of Arctic climate change. Unpubl. doc. submitted to Int. Whal. Comm. (SC/48/O 21). 11 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.

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

RINGED SEAL (*Phoca hispida*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

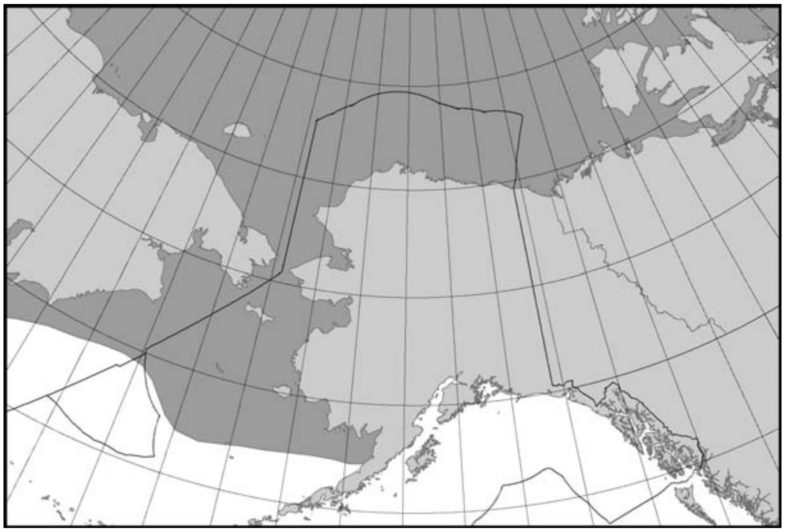

Figure 12. Approximate distribution of ringed seals in Alaska waters (shaded area). The combined summer and winter distribution is depicted.

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 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. 12). 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). Preliminary results from recent surveys conducted in the Chukchi Sea in May-June 1999 and 2000 indicate that ringed seal density is higher within 20 nmi from shore than 20-100 nmi from shore (Bengtson et al. 2000; NMML unpublished data). Results of surveys conducted in May and reported by Frost and Lowry (1999) indicate that, in the Alaskan Beaufort Sea, the density of ringed seals 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. 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 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. Crude estimates of the abundance of ringed seals in Alaska include 1-1.5 million (Frost 1985) or 3.3-3.6 million (Frost et al. 1988). One estimate of ringed seals is based on aerial surveys conducted in 1985, 1986, and 1987 by Frost et al. (1988). Survey effort was directed towards shorefast ice within 20 nmi of shore, though some areas of adjacent pack ice were also surveyed, in the Chukchi and Beaufort Seas from southern Kotzebue Sound north and east to the U. S. - Canada border. The abundance estimate from 1987 was 44,360±9,130 (95% CI). More recently, surveys were flown perpendicular to the Alaskan coast from Shishmaref to Barrow during May-June 1999 and 2000 (Bengtson et al. 2000; NMML unpublished data). Preliminary results from the 1999 survey indicate that the density of ringed seals in this area ranged from 0.39 - 3.67 seals/km^2; the total abundance in the area surveyed was estimated at 245,048 (Bengston et al. 2000). Although the analysis of data from 2000 is not yet complete, the abundance estimate is unlikely to be substantially different (L. Hiruki-Raring, pers. comm.). Densities of ringed seals in the Alaska Beaufort Sea in 1998 averaged 0.93 seals/km^2; seal densities were higher to the east of Flaxman Island than to the west of Flaxman Island (1.19 seals/km2 and 0.81 seals/km2, respectively). No population estimates have been calculated for the Alaska Beaufort Sea. While the preliminary estimate of 245,048 represents only a portion of the geographic range of the stock, as many ringed seals occur in the Beaufort Sea, in the pack ice, and along the coast of Russia, and has not been corrected for the numbers of ringed seals not hauled out at the time of the survey, 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. An element of concern is the potential for Arctic climate change, which will probably affect high northern latitudes more than elsewhere. There is evidence that over the last 10-15 years, there has been a shift in regional weather patterns in the Arctic region (Tynan and DeMaster 1996). Ice-associated seals, such as the ringed seal, are particularly sensitive to changes in weather and sea-surface temperatures in that these strongly affect their ice habitats. There are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska ringed seal stock.

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

Three different commercial fisheries operating within the range of the Alaska stock of ringed seals were monitored for incidental take by NMFS observers during 1990-99: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. The only fishery for which incidental kill was observed was the Bering Sea groundfish trawl fishery, with 2 mortalities reported in 1992. Because no mortalities have been observed since 1992, the mean annual mortality rate is 0. The range of observer coverage over the 10-year period, as well as the annual observed and estimated mortalities are presented in Table 11.

An additional source of information on the number of ringed seals killed or injured incidental to commercial fishing operations is the logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990 and 1993, logbook reports from all Alaska fisheries indicated no mortalities of ringed seals. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details). There have been no logbook reports of ringed seal mortalities or injuries.

Table 11. Summary of incidental mortality of ringed seals (Alaska stock) due to commercial fisheries from 1990 through 1999 and calculation of the mean annual mortality rate. Data from 1995 to 1999 are used in the mortality calculation when more than 5 years of data are provided for a particular fishery.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated morality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	90-99	obs data	9.7-74%	0, 0, 2, 0, 0, 0, 0, 0, 0, 0	0, 0, 3, 0, 0, 0, 0, 0, 0, 0	0
Total estimated annual mortality						0

Based on data from 1995-1999, there have been no mortalities of ringed seals incidental to commercial fishing operations. Because the PBR for this stock is unknown, it is currently not possible to determine what annual mortality level considered to be insignificant and approaching zero mortality and serious injury rate.

Subsistence/Native Harvest Information

Ringed seals are an important species for Alaska Native subsistence hunters. The 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 unpubl. report). 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 (ADF&G 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-Scarbrough 1999) and a report from the Eskimo Walrus Commission (Sherrod 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990-98 were used. As of August 2000; the subsistence harvest database indicated that the estimated number of ringed seals harvested for subsistence use per year is 9,567.

A recent 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 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 ADF&G 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 represents a mean estimate rather than a minimum estimate of subsistence harvest.

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. Due to a lack of information suggesting subsistence hunting is adversely affecting this stock and because of the minimal interactions between ringed seals and any U. S. fishery, the Alaska stock of ringed seals is not classified as a strategic stock. This classification is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1995).

CITATIONS

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

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

Bengtson, J. L., P. L. Boveng, L. M. Hiruki-Raring, K. L. Laidre, C. Pungowiyi, and M. A. Simpkins. 2000. Abundance and distribution of ringed seals (*Phoca hispida*) in the coastal Chukchi Sea. Pp. 149-160, *In* A. L. Lopez and D. P. DeMaster. Marine Mammal Protection Act and Endangered Species Act Implemention Program 1999. AFSC Processed Report 2000-11, 195 pp.

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., 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 Department of 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 Department of Fish and Game, Division of Subsistence, Juneau.

DeMaster, D. P. 1995. Minutes from the 4-5 and 11 January 1995 meeting of the Alaska Scientific Review Group, Anchorage, Alaska. 27 pp + appendices. (available upon request- D.P. DeMaster, Alaska Fisheries Science Cetner, 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.

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

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 Department of Fish and Game, Division of Subsistence, Juneau.

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. Mus. (Nat. Hist.), London. 240 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.

Tynan, C., and D. P. DeMaster. 1996. Observations and predictions of Arctic climate change. Unpubl. doc. submitted to Int. Whal. Comm. (SC/48/O 21). 11 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.

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

RIBBON SEAL (*Phoca fasciata*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Ribbon seals inhabit the North Pacific Ocean and adjacent fringes 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. 13). From late March to early May, ribbon seals inhabit the Bering Sea ice front (Burns 1970, Burns 1981, Braham et al. 1984). They are most abundant in the northern part of the ice front in the central and western parts of the Bering Sea (Burns 1970, Burns et al. 1981). As the ice recedes in May to mid-July the seals move farther to the north in the Bering Sea, where they haul out on the receding ice edge and remnant ice (Burns 1970, Burns 1981, Burns et al. 1981). There has been little agreement on the range of ribbon seals during the rest of the year. Recent sightings and a review of the literature suggest that many ribbon seals migrate into the Chukchi Sea for the summer (Kelly 1988).

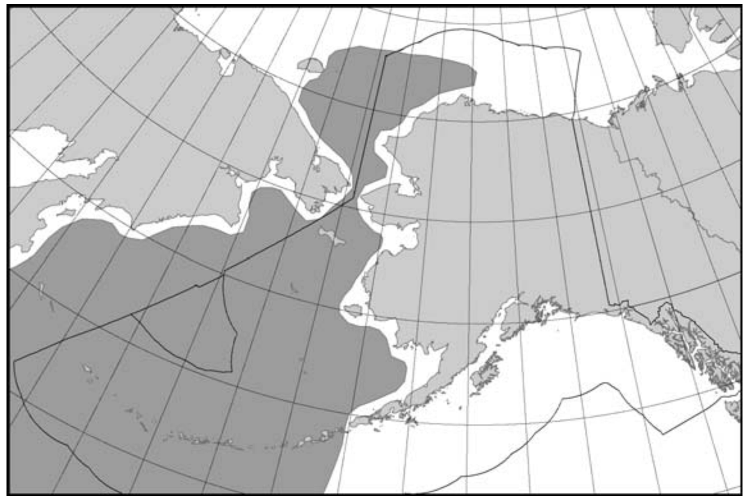

Figure 13. Approximate distribution of ribbon seals in Alaska waters (shaded area). The combined summer and winter distribution is depicted.

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

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.

An element of concern is the potential for Arctic climate change, which will probably affect high northern latitudes more than elsewhere. There is evidence that over the last 10-15 years, there has been a shift in regional weather patterns in the Arctic region (Tynan and DeMaster 1996). Ice-associated seals, such as the ribbon seal, are particularly sensitive to changes in weather and sea-surface temperatures in that these strongly affect their ice habitats. There are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska ribbon seal stock.

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

Three different commercial fisheries operating within the range of the Alaska stock of ribbon seals were monitored for incidental take by NMFS observers during 1990-99: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. The only fishery for which incidental kill was observed was the Bering Sea groundfish trawl fishery, with 1 mortality reported in 1990, 1991, and 1997. Averaging the estimated mortalities over the 1995-99 period results in a mean annual (total) mortality rate of 0.2 (CV = 1.0) ribbon seals per year. The range of observer coverage over the 10-year period, as well as the annual observed and estimated mortalities are presented in Table 12.

An additional source of information on the number of ribbon seals killed or injured incidental to commercial fishing operations is the logbook reports maintained by vessel operators as required by the MMPA interim exemption program. During the 4-year period between 1990 and 1993, logbook reports from all Alaska fisheries indicated no mortalities of ribbon seals. Logbook data are available for part of 1989-94, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details). There have been no logbook reports of ribbon seal mortalities or injuries.

Table 12. Summary of incidental mortality of ribbon seals (Alaska stock) due to commercial fisheries from 1990 through 1995 and calculation of the mean annual mortality rate. Data from 1991 to 1995 are used in the mortality calculation when more than 5 years of data are provided for a particular fishery.

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	90-99	obs data	53-74%	1, 1, 0, 0, 0, 0, 0, 1, 0, 0	1, 1, 0, 0, 0, 0, 0, 2, 0, 0	0.2 (CV = 1.0)
Total estimated annual mortality						0.2

The estimated minimum mortality rate incidental to commercial fisheries is 1 ribbon seal per year (rounded up from 0.2), based exclusively on observer data. Because the PBR for this stock is unknown, it is currently not possible to determine what annual mortality level is considered to be insignificant and approaching zero mortality and serious injury rate. However, if there were 50,000 ribbon seals the PBR would equal 1,500 ($50{,}000 \times 0.06 \times 0.5 = 1{,}500$), and annual mortality levels less than 150 animals (i.e., 10% of PBR) would be considered insignificant. Currently, there is no reason to believe there are less than 50,000 ribbon seals in U. S. waters.

Subsistence/Native Harvest Information

Ribbon seals are an important species for Alaska Native subsistence hunters, primarily from villages in the vicinity of the 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 (ADF&G 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-Scarbrough 1999) and a report from the Eskimo Walrus Commission (Sherrod 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. Harvest levels were estimated from data gathered in the 1980s for 16 villages; otherwise, data gathered from 1990-98 were used. As of August 2000; the subsistence harvest database indicated that the estimated number of ribbon seals harvested for subsistence use per year is 193.

A recent 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 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 considerably higher than the previous minimum estimate. Although some of the more recent entries in the ADF&G database have associated measures of uncertainty (Coffing et al. 1999, Georgette et al. 1998), the overall total does not. The estimate of 193 ribbon seals represents a mean estimate rather than a minimum estimate of subsistence harvest.

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. Due to a lack of information suggesting subsistence hunting is adversely affecting this stock and because of the minimal interactions between ribbon seals and any U. S. fishery, the Alaska stock of ribbon seals is not classified as a strategic stock. This classification is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1995).

CITATIONS

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

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

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.

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 Department of 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 Department of Fish and Game, Division of Subsistence, Juneau.

DeMaster, D. P. 1995. Minutes from the 4-5 and 11 January 1995 meeting of the Alaska Scientific Review Group, Anchorage, Alaska. 27 pp + appendices. (available upon request - D.P. DeMaster, Alaska Fisheries Science Cetner, 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.

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 Dept. Fish and Game, Juneau, Alaska, 79 pp. + appendices.

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.

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.

Tynan, C., and D. P. DeMaster. 1996. Observations and predictions of Arctic climate change. Unpubl. doc. submitted to Int. Whal. Comm. (SC/48/O 21). 11 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.

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

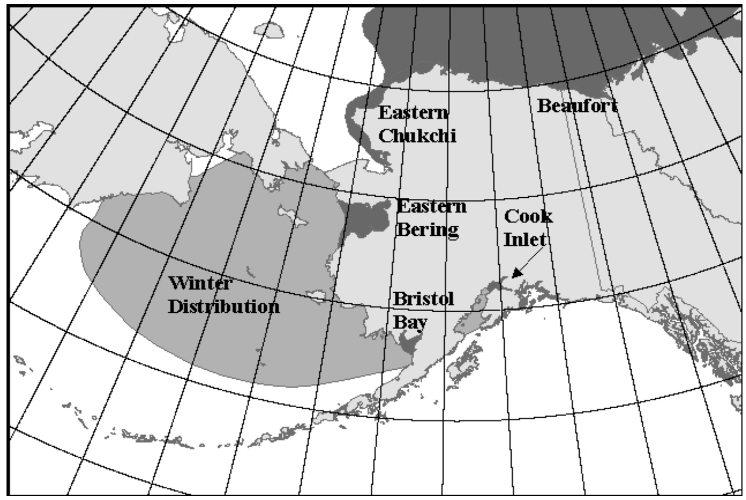

Figure 14. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

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, 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). During the winter, beluga whales occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers for molting (Finley 1982) and calving (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. 14).

POPULATION SIZE

The sources of information to estimate abundance for belugas in the waters of northern Alaska and western Canada have included both opportunistic and systematic observations. Duval (1993) reported an estimate of 21,000 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, when stock size was estimated to include 19,629 (CV = 0.229) beluga whales (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 CFs for this species typically range 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_{MIN}) is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Thus, $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 39,258 and an associated CV(N) of 0.229, N_{MIN} for this stock is 32,453.

Current Population Trend

The Beaufort Sea stock of beluga whales is considered to be stable or increasing (DeMaster 1995).

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 this stock is stable or increasing (DeMaster 1995), the recovery factor (F_R) for this stock is 1.0 (Wade and Angliss 1997). Thus, for the Beaufort Sea stock of beluga whales, PBR = 649 animals (32,453 × 0.02 × 1.0).

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 13a (Frost and Suydam 1995, Frost 1998). Given these data, the annual subsistence take by Alaska Natives averaged 68 belugas during the 5-year period from 1996-2000. Recent harvest reports are not considered negatively biased because they are based on on-site harvest monitoring and harvest reports from well established ABWC representatives. The 1993-95 data are negatively biased because reliable estimates for the number of animals struck and lost are not available prior to 1996.

Table 13a. Summary of the Alaska Native subsistence harvest from the Beaufort Sea stock of beluga whales, 1993-2000. Canadian subsistence takes are provided in Table 13b. n/a indicates the data are not available.

Year	Reported total number taken	Estimated range of total take	Reported number harvested	Estimated number struck and lost
1993	85[1,2]	n/a	85[2]	n/a
1994	63[2]	n/a	62	1[2]
1995	44[1]	n/a	44	n/a
1996	42	n/a	24	18
1997	71	69-73	43	26-30
1998	65	n/a	59	6
1999	45+	n/a	35	10+
2000	117	n/a	66	51
Mean annual take (1996-2000)	68			

[1] Does not include the number of struck and lost; [2] Indicates a lower bound.

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 13b (Harwood et al, in press; data for 2000 from FJMC Beluga Monitor Program, Fisheries Joint Management Committee, Inuvik, NT, Canada). Given these data, the annual subsistence take in Canada averaged 109 belugas during the 5-year period from 1996-00. Therefore, the mean estimated subsistence take in Canadian and U. S. waters from the Beaufort Sea beluga stock during 1996-00 is 177 (68 + 109) whales.

Table 13b. Summary of the Canadian subsistence harvest from the Beaufort Sea stock of beluga whales, 1993-2000. n/a indicates the data are not available.

Year	Reported total number taken	Estimated range of total take	Reported number harvested	Reported number struck and lost
1993	120	n/a	110	10
1994	149	n/a	141	8
1995	143	n/a	129	14
1996	139	n/a	120	19
1997	123	n/a	114	9
1998	93	n/a	86	7
1999	102	n/a	86	16
2000	89	n/a	82	7
Mean annual take (1996-2000)	109			

STATUS OF STOCK

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 fishery-related mortality (0) is not known to exceed 10% of the PBR (65) 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 (177) is not known to exceed the PBR (649). Therefore, the Beaufort Sea stock of beluga whales is not classified as a strategic stock. The population size is considered stable or increasing, however, at this time it is not possible to assess the status of this stock relative to its Optimum Sustainable Population size.

CITATIONS

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

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., 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. In press. The harvest of beluga whales in Canada's Western Arctic: hunter-based monitoring of the size and composition of the catch. Arctic.

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.

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 *Delphinapteras 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, 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). During the winter, beluga whales occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers for molting (Finley 1982) and calving (Sergeant and Brodie 1969). Annual migrations may cover thousands of kilometers (Reeves 1990).

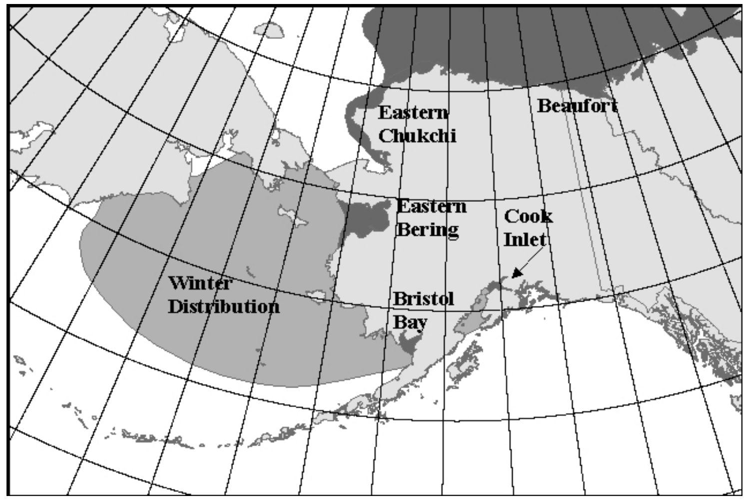

Figure 15. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

The 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. 15).

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 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).

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 utilized 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, 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). For the eastern Chukchi Sea stock of beluga whales, PBR = 74 animals (3,710 × 0.02 × 1.0).

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. An additional source of information on the number of beluga whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1997, fisher self-reports did not include any mortality to beluga whales from this stock as a result of interactions with commercial fishing operations. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 7 for details).

In the near shore waters of the eastern 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 14 (Frost and Suydam 1995, Frost 1998, Frost, pers. comm., 2001). Given these data, the annual subsistence take by Alaska Natives averaged 60 belugas during the 5-year period 1996-2000. This estimate is based on reports from ABWC representatives and on-site harvest monitoring. The 1993-95 data are negatively biased because reliable estimates for the number of animals struck and lost are not available prior to 1996.

Table 14. Summary of the Alaska Native subsistence harvest from the eastern Chukchi Sea stock of beluga whales, 1993-2000. n/a indicates the data are not available.

Year	Reported total number taken	Estimated range of total take	Reported number harvested	Estimated number struck and lost
1993	83[1]	n/a	80-83	n/a
1994	66[2]	n/a	63	3[2]
1995	42	n/a	36	6
1996	126	n/a	116	10
1997	19	n/a	16	3
1998	96	n/a	91	5
1999	52	n/a	52	0
2000	5	n/a	2	3
Mean annual take (1996-2000)	60			

[1] Does not include the number struck and lost; [2] Indicates a lower bound.

STATUS OF STOCK

The estimated minimum annual mortality rate incidental to 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 (60) is not known to exceed the PBR (74). 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.

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.

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. 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., 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).

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.

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 *Delphinapteras 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. Shelden, and D. J. Rugh. Beluga whale (*Delphinapterus leucas*) distribution and abundance in Cook Inlet, summer 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

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

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

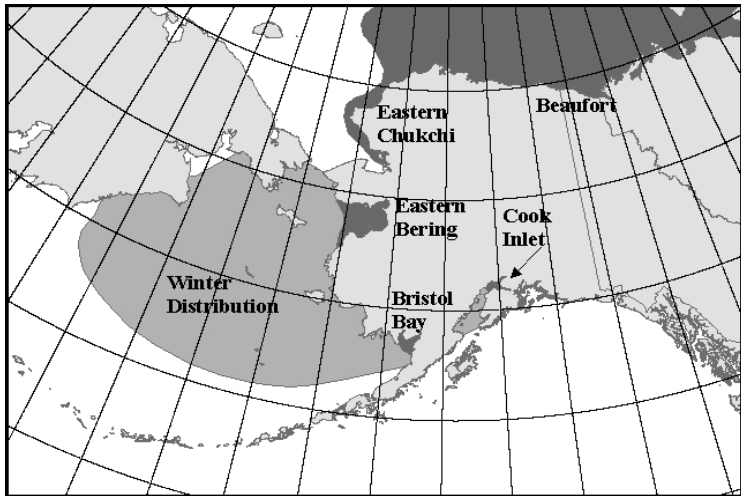

Figure 16. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

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, 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). During the winter, beluga whales occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers for molting (Finley 1982) and calving (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. 16).

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 June 22 of 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 × 2.62 × 1.18) beluga whales.

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

Minimum Population Estimate

For the eastern Bering Sea stock of beluga whales, the minimum population estimate (N_{MIN}) is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997). Therefore, N_{MIN} = $N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 18,142 and an associated CV(N) of 0.24, N_{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 (SRG) 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_{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_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for cetacean stocks that are thought to be stable in the presence of a subsistence harvest (Wade and Angliss 1997). The Alaska SRG recommended using a F_R of 1.0 for this stock as the Alaska Beluga Whale Committee (ABWC) intends to continue regular surveys (i.e., 3-5 years) 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 × 0.02 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Three different commercial fisheries that could have interacted with beluga whales in the eastern Bering Sea 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. An additional source of information on the number of beluga whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1997, fisher self-reports did not include any mortality to beluga whales from this stock as a result of interactions with commercial fishing operations. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 7).

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 whales and because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994).

In the near shore 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. This mortality results in an annual estimated mortality of 0.2 whales from this stock during 1996-2000. Note that this is not a commercial fishery. 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 utilized by Alaska Native subsistence users. It is not clear whether the 1996 entanglement was accounted for in the 1996 Alaska Native subsistence harvest report. If so, this particular mortality may have been double-counted.

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 15 (Frost and Suydam 1995, Frost 1998, Frost pers. comm. 2001). Given these data, the annual subsistence take by Alaska Natives averaged 164 belugas from the eastern Bering Sea stock during the 5-year period 1996-2000. These 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. Furthermore, an unknown proportion of the animals harvested each year by Alaska Native hunters in this region may belong to other beluga stocks migrating through Norton Sound in both the fall and spring (DeMaster 1995).

Table 15. Summary of the Alaska Native subsistence harvest from the eastern Bering Sea stock of beluga whales, 1993-2000. n/a indicates the data are not available.

Year	Reported total number taken	Estimated range of total take	Reported number harvested	Estimated number struck and lost
1993	136[1,2]	121-136[1]	121-136	n/a
1994	132[2]	126-132[2]	116-122	10[2]
1995	56[2]	51-61[2]	45-55[2]	6[2]
1996	120	113-126	97-108	16-18
1997	160	146-173	127-141	19-32
1998	168	n/a	143	27
1999	159	n/a	134	25
2000	212	n/a	188	24
Mean annual take (1996-2000)	164			

[1] Does not include the number struck and lost; [2] Indicates a lower bound.

STATUS OF STOCK

The estimated minimum annual mortality rate incidental to 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 1996-00, of human-caused mortality and serious injury (164, including the estimated mortality in non-commercial fisheries) is not known to exceed the PBR (298) for this stock. 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.

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. 1995. Minutes from the 16-17 February 1995 meeting of the Alaska Scientific Review Group. Anchorage, Alaska. 22 pp. (available upon request - D. P. DeMaster, Alaska Fisheries Science Center , 7600 Sand Point Way, NE, Seattle, WA 98115).

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 - D. P. DeMaster, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

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

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 *Delphinapteras 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.

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, 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). During the winter, beluga whales occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers for molting (Finley 1982) and calving (Sergeant and Brodie 1969). Annual migrations may cover thousands of kilometers (Reeves 1990).

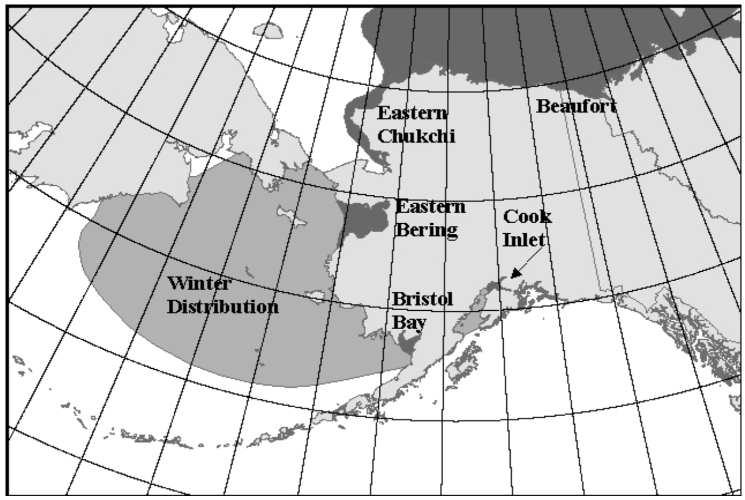

Figure 17. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

The 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

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 were expected to concentrate. Frost and Lowry (1990) reported an estimate of 1,000-1,500 for Bristol Bay, similar to that reported by Seaman et al. (1985). Most recently, the number of beluga whales in Bristol Bay was estimated at 1,555 in 1994 (Lowry and Frost 1998). This 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 1995b), and for the proportion of newborns and yearlings not observed due to their small size and dark coloration (1.18; Brodie 1971). Surveys flown by the ADF&G in 1999 and 2000 resulted in maximum counts of 690 and 531, which can be extrapolated to provide population estimates of 2,133 and 1,642, respectively (L. Lowry, 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 methodology, estimates of the variance of abundance are unavailable. In addition, the abundance estimate is thought to be conservative because 1) some whales may have been outside the survey area (i.e., Kuskokwim Bay), 2) no correction has been made for whales that were at the surface but were missed by the observers, and 3) the dive correction factor is probably negatively biased (Lowry and Frost 1998). Consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1997), a default CV(N) of 0.2 was used in the calculation of the minimum population estimate (N_{MIN}). N_{MIN} for this beluga whale stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. Using the average estimate for 1999 and 2000 of (N) of 1,888 and the default CV (0.2), N_{MIN} for the Bristol Bay stock of beluga whales is 1,619.

Current Population Trend

Population estimates from the 1950s (Brooks 1955, Lensink 1961) suggested there were about 1,000-1,500 belugas in Bristol Bay. The first abundance estimate (1,250) from aerial surveys was conducted in 1983. Consistency in count data and abundance estimates between 1993, 1994, and earlier surveys (Frost and Lowry 1990, 1995a, Lowry and Frost 1998), and the higher counts in 1999 and 2000 suggests that the Bristol Bay stock is at least stable, and may be increasing.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for the Bristol Bay 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 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 = 32 animals (1,619 × 0.02 × 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 (Table 16a).

An additional source of information on the number of beluga whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. Observers have never monitored the Bristol Bay salmon set gillnet and drift gillnet fisheries which combined had over 2,900 active permits in 1996. During the period between 1990-2000, fisher self-reports included 1 mortality in both 1990 and 1991 from these fisheries (see Table 16a) resulting in an annual mean of 0.5 mortalities from interactions with commercial gear. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. The 1990 logbook records from the Bristol Bay set and drift gillnet fisheries were combined. As a result, the 1990 mortality may have occurred in the drift net fishery. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 7). Larger fishery-related mortalities resulting from these fisheries have been recorded in the past. During the summer of 1983 the Alaska Department of Fish and Game documented 12 beluga whale mortalities in Bristol Bay related to drift and set gillnet fishing (Frost et al. 1984).

Table 16a. Summary of incidental mortality of beluga whales (Bristol Bay stock) due to commercial fisheries from 1990-00 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1996-2000 (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	Reported mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Observer program total	90-00					0
Bristol Bay salmon drift gillnet	90-00	self reports	n/a	0, 1, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.25]
Bristol Bay salmon set gillnet	90-00	self reports	n/a	1, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.25]
Minimum total annual mortality						≥0.5

The estimated minimum mortality rate incidental to commercial fisheries is 1 animal per year (rounded up from 0.5), based entirely on logbook data. However, 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 are known to interact with this stock.

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 16b (Frost and Suydam 1995, Frost 1998, Frost, pers. comm. 2001). Given these data, the annual subsistence take by Alaska Natives averaged 15 belugas from the Bristol Bay stock during the 5-year period 1996-2000. This estimate is based on reporting by ABWC representatives and is considered negatively biased because there is not a reliable estimate for the number of struck and lost prior to 1994.

Table 16b. Summary of the Alaska Native subsistence harvest from the Bristol Bay stock of beluga whales, 1993-2000. n/a indicates the data are not available.

Year	Reported total number taken	Estimated range of total take	Reported number harvested	Estimated number struck and lost
1993	35[1]	33-35[1]	33-35	n/a
1994	18	n/a	16	2
1995	10	n/a	6	4
1996	19	n/a	18	1
1997	11	n/a	11	0
1998	7	n/a	6	1

Year	Reported total number taken	Estimated range of total take	Reported number harvested	Estimated number struck and lost
1999	15	n/a	13	2
2000	23	n/a	22[2]	1
Mean annual take (1996-2000)	15			

[1] Does not include the number struck and lost.
[2] May include beluga taken in subsistence drift gillnet fishing for salmon.

There is substantial effort in a subsistence gillnet fishery for salmon in Bristol Bay. There were 7 reported mortalities of beluga in subsistence salmon gillnet fisheries in 2000. If this level of mortality is averaged over 5 years, an average of 1.4 beluga per year would be caught in subsistence gillnet fisheries in this area. However, it is not clear whether the "sudden" increase of mortalities in 2000 is a result of an actual increase or an increase in reporting such events. Note that these mortalities did not occur incidental to a commercial fishery. 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 utilized by Alaska Native subsistence users. It is not clear whether the mortalities reported in 2000 are accounted for in the 2000 Alaska Native subsistence harvest report. If so, this particular mortality may have been double-counted.

STATUS OF STOCK

At present, annual mortality levels less than 3.2 per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. However, it is unknown whether the mortality rate is insignificant because a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable. 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 (16, including subsistence harvests and fishery-related mortality) is not known to exceed the PBR (32). 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, therefore, likely to be underestimated. 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.

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.

Brooks, J. W. 1955. Beluga. Pp. 98-106, *In* Annual Rep. for 1955. ADF, Juneau, AK.

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. 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. 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., 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. 1995a. Distribution and abundance of beluga whales in Bristol Bay, Alaska, 1993-1994. Alaska Beluga Whale Committee Rep. 95-1. 14 pp.

Frost, K. J., and L. F. Lowry. 1995b. 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.

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.

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.

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 *Delphinapteras 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*): 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, Norton Sound, Kasegaluk Lagoon, and the Mackenzie Delta (Hazard 1988). Apparently most beluga whales from these summering areas overwinter in the Bering Sea, excluding those found in Cook Inlet (O'Corry-Crowe et al. 1997). Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Lowry 1985). During the winter, beluga whales occur in offshore waters associated with pack ice. In the spring, many migrate to warmer coastal estuaries, bays, and rivers for molting (Finley 1982) and calving (Sergeant and Brodie 1969). Annual migrations may cover thousands of kilometers (Reeves 1990, Suydam et al. 2001).

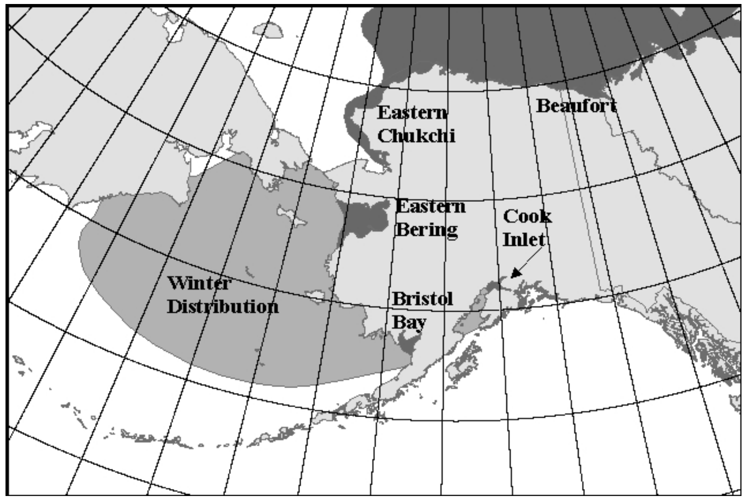

Figure 18. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distribution of the five stocks. Winter distributions are depicted with lighter shading.

During spring and summer months, beluga whales in Cook Inlet are typically concentrated near river mouths in northern Cook 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 (Hansen and Hubbard 1999, Rugh et al. 2000). Satellite tags have been attached to nine belugas in late summer in order to determine their distribution through the fall and winter. Of these, six have lasted through the fall and one lasted into March. None have gone south of Chinitna Bay. A review of all cetacean surveys conducted in the Gulf of Alaska from 1936-00 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 (under 20 animals) also occur at least seasonally in Yakutat Bay; these are considered part of the Cook Inlet stock (65 FR 34590; 31 May 2000).

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, 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 (Fig. 18).

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 documenting 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). Each 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 June 2001 aerial survey is 386 (CV = 0.087) animals (NMFS unpubl. data). Although the 2001 estimate of abundance is slightly lower than the estimate for 2000, the difference is not significant and is not believed to represent a decline in the population (NMFS unpublished data).

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): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 386 and its associated CV(N) of 0.087, N_{MIN} for the Cook Inlet stock of beluga whales is 359.

Current Population Trend

In general, uncorrected counts have ranged from 300 to 500 beluga whales within Cook Inlet between 1970 and 1996 (Rugh et al. 2000). However, median counts since 1996 have been below 300 animals (264 in 1997, 193 in 1998, 217 in 1999, and 184 in 2000). The corrected abundance estimates for the period 1994-00 are shown in Figure 19. A statistically significant trend in abundance was detected between 1994 and 1998 (Hobbs et al. 2000a), although the power was low due to the short time series. However, the 1998 abundance estimate (349) was approximately 50% lower than the 1994 abundance estimate (653). In addition, a review of beluga distribution data over the past three decades shows there has been a reduction in offshore sightings in upper Cook Inlet and a dramatic reduction in sightings in lower Cook Inlet (Rugh et al. 2000). Since 1998, this decline seems to have stopped (Hobbs et al. 2000a).

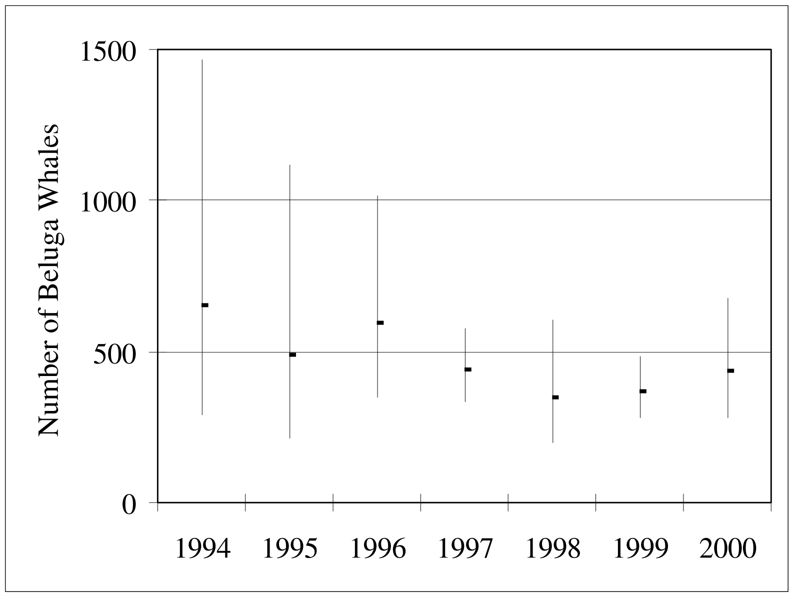

Figure 19. Abundance of beluga whales in Cook Inlet, Alaska 1994-2000. Error bars depict 95% confidence intervals

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).

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 F_R and PBR for the Cook Inlet stock of beluga whale were both undetermined in Small and DeMaster (1995), 1.0 and 15 in Hill et al. (1997), and 1.0 and 14 in Hill and DeMaster (1998). However, based on the recent information on stock size, trends in abundance, and level of the subsistence harvest, the Alaska Scientific Review Group (SRG) (Ferrero 1999) has recommended that NMFS reduce the F_R to the lowest value possible (0.1). Further, the Alaska SRG noted the resulting PBR would be 0.61 (assuming an N_{MIN} of 303 as the 1999 population size and an R_{MAX} of 0.04) and recommended that the agency use this value in managing interactions between Cook Inlet belugas and commercial fisheries in Cook Inlet.

NMFS has chosen not to accept the recommendation of the Alaska SRG at this time. Rather, NMFS has selected an F_R of 0.3 based on the following: this stock has been listed as "depleted" under the MMPA (65 Federal Register 34590, 31 May 2000; which typically is associated with a F_R of 0.5); and NMFS has not listed this stock as endangered under the Endangered Species Act (65 Federal Register 38778, 22 June 2000; a listing of endangered is typically associated with a F_R of 0.1, while a listing of depleted or threatened is associated with a F_R of 0.5). Furthermore, the major mortality factor for this stock, subsistence harvest, has been reduced through legislation and cooperative efforts by Alaskan Natives. Thus, the PBR = 2.2 animals (359 × 0.02 × 0.3) 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 incur incidental mortalities of beluga whales. No mortalities were observed in either year (Merkelein et al., in review). An additional source of information on the number of beluga whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990-00, fisher self-reports indicated no mortalities of beluga whales from interactions with commercial fishing operations (Table 17a). Logbook data are available for part of 1989-94, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Table 17a. Summary of incidental mortality of beluga whales (Cook Inlet stock) due to commercial fisheries for 1999-2001.

Fishery name	Years	Data type	Range of observer coverage	Reported mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Cook Inlet salmon drift gillnet	99-00	obs data		0, 0	0	0
Cook Inlet salmon set gillnet	99-00	obs data		0, 0	0	0
Observer program total	93-99					0
Minimum total annual mortality						0

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 subsistence take ranged from 30 animals to over 100 (Mahoney and Shelden 2000). The most thorough subsistence harvest surveys were completed by the Cook Inlet Marine Mammal Council during 1995-97; while some of the hunters believe the 1996 estimate was positively biased, the 1995-97 CIMMC take estimates are considered reliable. The average annual subsistence harvest between 1995 and 1997 was 87 whales.

Congress imposed a moratorium on beluga harvest in Cook Inlet because of the decline in the Cook Inlet beluga whale stock until NMFS developed a cooperative plan for harvest management with the local Alaska Native organizations. Thus, the best estimate of subsistence take in 1999 and 2000 is zero. Harvest is now conducted under a comanagement agreement between the Alaska Native organizations and NMFS; under that agreement, one whale taken in both 2001 and 2002. A summary of Cook Inlet beluga whale subsistence harvest data for 1999-01 is provided in Table 17b.

Table 17b. Summary of the Alaska Native subsistence harvest from the Cook Inlet stock of beluga whales, 1999-2001. n/a indicates the data are not available.

Year	**Reported total number taken**	**Estimated range of total take**	**Reported number harvested**	**Estimated number struck and lost**
1999	0	0	0	0
2000	0	0	0	0
2001	1	-	1	0
2002	1	-	1	0
Mean annual take, 2001-02	1			

[1] Estimated value (see text); [2] Represents a minimum value.

OTHER MORTALITY

Mortalities related to stranding events have been reported in Cook Inlet. In August 1996, 60 beluga whales stranded in Turnagin Arm and four of these animals are known to have died as a result of the stranding event (Moore et al. 2000). In September 1996, 20-30 beluga stranded in Turnagin Arm and one animal died. In August 1999, at least 60 beluga whales stranded in Turnagain Arm, of which, five were subsequently found dead (Moore et al. 2000). Because Turnagin Arm is a shallow, dangerous waterway, it is not frequented by motorized vessels; thus, it is highly unlikely that the strandings resulted from human interactions.

STATUS OF STOCK

An analysis of available data on the population size and dynamics of the Cook Inlet beluga whale stock led NMFS to conclude that this stock is currently below it's Optimum Sustainable Population level. Thus, this stock was designated as "depleted" under the MMPA (65 FR 34590; 31 May 2000). NMFS also made a determination that this stock should not be listed under the ESA at this time (65 FR 38778; 22 June 2000) primarily because the subsistence harvest, which appears to have been responsible for the majority of the decline in this stock, was prohibited in 1999 through an act of Congress. Preliminary results indicate that, once the subsistence harvest ceased, the decline in the stock ceased (65 FR 38778; 22 June 2000, Hobbs et al. 2000a). In addition, NMFS and local subsistence organizations are actively pursuing the development of a co-management agreement which would allow subsistence harvest, but at a level far below historical levels.

Two fisheries suspected of possibly incurring incidental serious injuries or mortalities of beluga whales were observed in 1999 and 2000, but no takes of beluga whales were observed. At present, annual commercial fishery-related mortality levels can be considered insignificant and approaching zero mortality and serious injury rate. In addition, based on the level of subsistence harvest in 1999 and the fact that there is currently a moratorium on the harvest, the total level of human-caused mortality does not exceed the PBR (1.8) level for this stock. However, because the Cook Inlet beluga whale stock has been designated as "depleted" under the MMPA, the Cook Inlet beluga whale stock is classified as strategic.

Efforts to develop co-management agreements with 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. In 1995, development of an umbrella agreement among the Indigenous People's Council for Marine Mammals, U.S. Fish and Wildlife Service, and NMFS was initiated. The agreement was ultimately signed in August 1997. During 1998, efforts were initiated to formalize a specific agreement with local Alaska Native organizations and NMFS regarding the management of Cook Inlet belugas, but without success. In the absence of a co-management agreement, Federal legislation was implemented in May 1999, placing a moratorium on beluga hunting in Cook Inlet until a co-management agreement is completed. Comanagement agreements between NMFS and the Cook Inlet Marine Mammal Council have since been signed in 2000, 2001, and 2002.

Habitat Concerns

NMFS recognizes that municipal, commercial, and industrial activites may be of concern and may affect the water quality and substrate in Cook Inlet. This includes commercial fishing, oil and gas development, municipal discharges, noise for aircraft and ships, shipping traffic, and tourism (Moore et al. 2000). However, no indication currently exists that these activities have had a quantifiable adverse impact on the beluga whale population. The best available information indicates that these activities, alone or cumulatively, have not caused the stock to be in danger of extinction (65 FR 38778; 22 June 2000;). Protection from industrial development is being provided at most locations where beluga whales commonly occur. However, susceptibility to adverse impacts may be greater now than previously because the stock, in its currently reduced state, occupies a more restricted portion of its prior range in Cook Inlet.

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.

Ferrero, R. C. 1999. Minutes from the tenth meeting of the Alaska Scientific Review Group, 6-8 October 1999, Juneau, Alaska. 42 p. (available upon request - National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115)

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.

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 Rept. OCS Study. MMS 99-0024. U.S. Dept. 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.

Hill, P. S., D. P. DeMaster, and R.J. Small (eds.) 1997. Alaska marine mammal stock assessments, 1996. U. S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-78. 150pp.

Hill, P. S. and D. P. DeMaster (eds.) 1998. Alaska marine mammal stock assessments, 1998. U. S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-97. 166pp.

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., 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.

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. 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.

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.

Merkelein, M., B. Fadely, and A. S. VanAtten. In review. Marine Mammal Protection Act observer program, Cook Inlet, Alaska.

Moore, S. E., K. E. Shelden, L. K. Litzky, B. A. Mahoney, and D. J. Rugh. 2000. Beluga whale, *Delphinapterus leucas*, habitat associations in Cook Inlet, Alaska. Mar. Fish. Rev. 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 *Delphinapteras leucas* in the western Nearctic revealed by mitochondrial DNA. Mol. Ecol. 6:955-970.

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

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.

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.

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

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

Stanek, R. T. 1994. The subsistence use of beluga whale in Cook Inlet by Alaska Natives, 1993. Draft Final Rep. Study No. 50ABNF200055, submitted to NMFS by Alaska Dep. Fish and Game, Juneau, AK. 24 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 into 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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

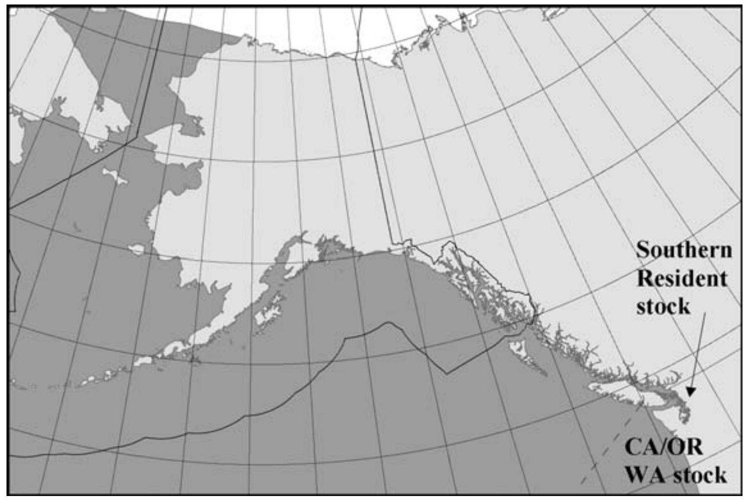

Figure 20. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

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 prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). In Alaska waters, killer whales occur along the entire Alaska coast from the Chukchi Sea, into the Bering Sea, along the Aleutian Islands, Gulf of Alaska, and into Southeast Alaska (Braham and Dahlheim 1982; Fig. 20). Their occurrence has been well documented throughout British Columbia and the inland waterways of Washington State (Bigg et al. 1990), as well as along the outer coasts of Washington, Oregon, and California (Green et al. 1992, Barlow 1995, 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 (Bigg et al. 1990). 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 (Heise et al. 1991) 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).

Killer whales along British Columbia and Washington State have been labeled as ‘resident’, ‘transient’, and ‘offshore’ (Bigg et al. 1990, Ford et al. 1994). Whales of a particular type have not been observed to associate with members of the other group types (Ford et al. 1994). Although less is known about killer whales in Alaska, it appears that all three types occur in Alaska waters (Dahlheim et al. 1997). The ‘resident’ and ‘transient’ types are believed to differ in several aspects of morphology, ecology, and behavior; that is, dorsal fin shape, saddle patch shape, pod size, home range size, diet, travel routes, dive duration, and social integrity of pods. For example, in Pacific Northwest waters, significant differences occur in call repertoires (Ford and Fisher 1982), saddle patch pigmentation (Baird and Stacey 1988), and diet (Baird et al. 1992). Studies on mtDNA restriction patterns provide evidence that the ‘resident’ and ‘transient’ types are genetically distinct (Stevens et al. 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel et al. 1998).

Less is known about the ‘offshore’ type killer whales, which typically travel in pods of 25-75 individuals and have been encountered primarily off the coasts of California, Oregon, British Columbia and, rarely, in Southeast Alaska (Ford et al. 1994, Black et al. 1997, Dahlheim et al. 1997). Studies indicate the ‘offshore’ group type, although distinct from the other types (‘resident’ and ‘transient’), appears to be more closely related genetically, morphologically, behaviorally, and vocally to the ‘resident’ type killer whales (Black et al. 1997, Hoelzel et al. 1998; J. Ford, pers. comm., Vancouver Aquarium, Canada; L. Barrett-Lennard, pers. comm., University of British Columbia, Canada).

Based primarily on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, five killer whale stocks are recognized along the west coast of North America from California to Alaska: 1) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 2) the Eastern North Pacific Southern Resident stock - occurring within the inland waters of Washington state and southern British Columbia, 3) the Eastern North Pacific Transient stock - occurring from Alaska to Cape Flattery, WA, 4) the California/Oregon/Washington Pacific Coast stock - occurring from Cape Flattery through California (Fig. 20), and 5) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California. Because the stock area for the Eastern North Pacific Northern Resident stock is defined as the waters from British Columbia through Alaska, 'resident' whales in Canadian waters are considered part of the Eastern North Pacific Northern Resident stock. The Stock Assessment Reports for the Pacific Region contain information concerning the Eastern North Pacific Southern Resident stock, the California/Oregon/Washington Pacific Coast stock, the Eastern North Pacific Offshore stock (to be included in the 1999 stock assessment revisions), and a Hawaiian stock. The stock structure recommended in this report should be considered preliminary pending a joint review by the Alaska and Pacific Scientific Review Groups.

POPULATION SIZE

The Eastern North Pacific Northern Resident stock is a transboundary stock, including killer whales from British Columbia. Preliminary analysis of photographic data resulted in the following minimum counts for 'resident' killer whales belonging to the Eastern North Pacific Northern Resident stock (Note: individual whales have been matched between geographical regions and missing animals likely to be dead have been subtracted). In British Columbia, 216 'resident' whales have been identified as of 1998 (Ford et al. 2000; Table 18a). In Southeast Alaska, 99 'resident' whales have been identified as of 1999 (M. Dahlheim, pers. comm., National Marine Fisheries Service). In Prince William Sound and Kenai Fjords, another 362 'resident' whales have been identified as of 1998 (Matkin et al. 1999). Based on data collected from all Alaska waters west of Seward (Dahlheim and Waite 1993, Dahlheim 1994, Dahlheim 1997), 68 whales are considered 'residents' as they have been linked by association to 'resident' whales from Prince William Sound (M. Dahlheim, pers. comm., National Marine Fisheries Service; G. Ellis, pers. comm., Pacific Biological Station, Canada).

In addition to "known" resident pods, there are some animals which have been identified as "provisional" resident killer whales. Dahlheim (1997) documented 174 animals in Alaska waters west of Seward. Recent analyses of photographs collected by observers on commercial fishing vessels in the Bering Sea has resulted in an additional 67 animals which have been classified as "provisional" resident (M. Dahlheim and D. Ellifrit, pers. comm., National Marine Fisheries Service). Provisional classifications were based primarily on morphological differences identified from the photographs. Accordingly, the numbers of 'residents' and 'transients' in Alaska waters west of Seward are considered preliminary at this time.

Combining the counts of known 'resident' whales gives a minimum number of 723 (BC + SEAK + PWS + Western; 216 + 99 + 341 + 68) killer whales belonging to the Eastern North Pacific Northern Resident stock (Table 18a).

Table 18a. Numbers of animals in each pod of killer whales belonging to the Eastern North Pacific Northern Resident stock of killer whales. A number followed by a "+" indicates a minimum count for that pod. Pods identified as "probable residents" by the authors are not included in the table.

Pod ID	**Previous Estimate in the SARs**	**1999/00 Estimate (And Source)**
Southeast Alaska	**Dahlheim et al., 1997**	
AF	42	49 (Matkin et al., 1999)
AG	24	27 (Matkin et al., 1999)
AZ	23+	23+ (Dahlheim, pers. comm.)
Total	**89+**	**99+**
Prince William Sound	**Matkin et al., 1998**	**Matkin et al., 1999**

Pod ID	**Previous Estimate in the SARs**	**1999/00 Estimate (And Source)**
AB	24	25
AD16	7	7
AD5	13	17
AE	15	16
AI	8	7
AJ	38	38
AK	10	12
AN10	19	20
AN20	9+	assume 9
AS	20	assume 20
AX	20 - 70	21
AY	11	assume 11
Unassigned to pods	88	138 (C. Matkin, pers. comm)
Total	**354+**	**341**

Pod ID	Previous Estimate in the SARs	1999/00 Estimate (And Source)
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	7
I1	10	10
I2	7	2
I18	19	16
G1	28	37
G12	11	5
I11	18	22
I31	10	12
R1	23	29
W1	3	3
Total	**204**	**216**
Unassigned to pods	**68**	**68**
Total, all areas	**647**	**723**

Minimum Population Estimate

The survey technique utilized for obtaining the abundance estimate of killer whales is a direct count of individually identifiable animals. 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 whales within Southeast Alaska and Prince William Sound is relatively low. In addition, the abundance estimate does not include 241 unclassified whales from western Alaska that have been provisionally classified as 'residents'.

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 Northern Resident stock of killer whales is 723 animals, which includes animals found in Canadian waters (see PBR Guidelines regarding the status of migratory transbounday 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 the recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

Mortality and recruitment rates for six 'resident' killer whale pods in Prince William Sound from 1985 to 1991 and for 16 pods in northern British Columbia from 1981 to 1986 indicate a 2% annual rate of increase for each region over the years examined (Matkin and Saulitis 1994). Although the current minimum population count of 723 is slightly higher than the last population count of 717, 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 Eastern North Pacific Northern 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). Recent analyses indicate that some pods in the Eastern North Pacific Northern Resident population had increased at approximately 3% per year and were apparently approaching carrying capacity since the rates of increase appeared to be slowing (P. Olesiuk as reported in Dahlheim et al., 2000). However, a population typically 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 (Wade and Angliss 1997). Thus, for the Eastern North Pacific Northern Resident killer whale stock, PBR = 7.2 animals (723 × 0.02 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries in Alaska that could have interacted with killer whales were monitored for incidental take by fishery observers from 1990 to 1999: Bering Sea (and Aleutian Islands) and Gulf of Alaska groundfish trawl, longline, and pot fisheries. Of the 6 observed fisheries, killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Table 18b). For the fisheries with observed takes, the range of observer coverage over the 10-year period, as well as the annual observed and estimated mortalities are presented in Table 18b. Both the 1991 and 1995 mortalities in the longline fishery occurred during unmonitored hauls and could not be used to estimate total mortality for the fishery in those years (80% and 28% observer coverage in 1991 and 1995, respectively). For computational purposes, the estimated mortality in 1991 and 1995 was set at 1, because at a minimum, one whale is known to have perished in each of those years. The 1993 mortality in the trawl fishery occurred under similar circumstances and was treated in the same manner (66% observer coverage in 1993). The mean annual (total) mortality for the most recent 5 years of observer coverage (1995-99) was 0.6 (CV = 0.67) for the Bering Sea groundfish trawl fishery and 0.8 (CV = 0.73) for the combined Bering Sea longline fishery, resulting in a mean annual mortality rate of 1.4 (CV = 0.51) killer whales per year from observed fisheries.

Table 18b. Summary of incidental mortality of killer whales (Eastern North Pacific Northern Resident stock) due to commercial fisheries from 1990 through 1999 and calculation of the mean annual mortality rate. Data from 1995 to 1999 are used in the mortality calculation when more than 5 years of data are provided for a particular fishery.

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	90-99	obs data	53-75%	0, 1, 1, 1, 0, 0, 0, 1, 0, 1	1, 2, 2, 1, 0, 0, 0, 2, 0, 1	0.6 (CV = 0.67)
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	90-99	obs data	27-80%	0, 1, 0, 0, 0, 1, 0, 0, 0, 1	0, 1, 0, 0, 0, 1, 0, 0, 0, 3	0.8 (CV = 0.73)
Estimated total annual mortality						1.4 (CV = 0.51)

An additional source of information on the number of killer whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1999, fisher self-reports from all Alaska fisheries indicated only one killer whale mortality, which occurred in the Bering Sea groundfish trawl fishery in 1990. That mortality has been included as an estimated mortality in Table 18b even though an observer program was in operation for that fishery (with 74% observer coverage) and did not report any killer whale mortalities during that year. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 to the present (see Appendix 7).

The estimated minimum mortality rate incidental to U. S. commercial fisheries recently monitored is 1.4 animals per year, based exclusively on observer data. As the animals which were taken incidental to commercial fisheries have not been identified genetically, it is not possible to determine whether they belonged to the Eastern North Pacific Northern Resident or the Eastern North Pacific Transient killer whale stock. Accordingly, these same mortalities can be found in the stock assessment report for the transient stock (Forney et al., 2000).

Due to limited Canadian observer program coverage, 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. 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 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

Since 1986, research efforts have been made to assess the nature and magnitude of killer whale/blackcod (sablefish; *Anoplopoma fimbria*) interactions (Dahlheim 1988; Yano and Dahlheim 1995). Fishery interactions have occurred each year in the Bering Sea and Prince William Sound, with the number of annual reports varying considerably. Data collected from the Japan/U. S. cooperative longline research surveys operating in the Bering Sea indicate that interactions may be increasing and expanding into the Aleutian Islands region (Yano and Dahlheim 1995). Interactions between killer whales and commercial fisheries remain prevalent in the Bering Sea and Aleutian Islands (M. Dahlheim, pers. comm., National Marine Fisheries Service). During the 1992 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 related to gunshot wounds or effects of the *Exxon Valdez* oil spill (Dahlheim and Matkin 1994).

The shooting of killer whales in Canadian waters has also 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, pers. comm., Pacific Biological Station, Canada).

Other Issues

Although only small numbers of killer whales are taken in the Bering Sea fisheries, there is considerable interaction between the whales and the fisheries. Interactions between killer whales and longline vessels have been well documented (Dahlheim 1988, Yano and Dahlheim 1995). However, less has been documented regarding interactions with the trawl fishery. Recently several 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, National Marine Fisheries Service).

STATUS OF STOCK

Killer whales are 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 resident killer whales in British Columbia as "threatened", and the designation appears to have been based on the fact that the resident population's small size and low potential growth rate makes it potentially 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. It is likely that both the human-caused mortality level and the population size for this stock are underestimated. The human-caused mortality has been underestimated due primarily to a lack of information on Canadian fisheries; however, a review of the status of killer whales in Canada indicates that the available evidence in Canada 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). The minimum abundance estimate is likely underestimated because researchers continue to encounter new whales and because unclassified whales from western Alaska were not included. Because the population estimate is likely to be conservative, the PBR is also conservative.

Based on currently available data, the estimated annual fishery-related mortality level (1.4) exceeds 10% of the PBR, (i.e., 0.72) 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 (1.4 animals per year) is not known to exceed the PBR (7.2). 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.

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. 42p.

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.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford, and K. C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Pp. 386-406, *In* P. S. Hammond, S. A. Mizroch, and G. P. Donovan (eds.), Individual recognition of cetaceans: use of photo-identification and other techniques to estimate population parameters. Rep. Int. Whal. Comm. (Special Issue) 12.

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

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

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

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. 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. 1994. Abundance and distribution of killer whales (*Orcinus orca*) in Alaska in 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Dahlheim, M. E. 1997. A photographic catalogue of killer whales (*Orcinus orca*) from the Central Gulf of Alaska to the southeastern Bering Sea. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 131, 54 pp.

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.

Dahlheim, M. E., D. Bain, D. P. DeMaster, and C. Simms. 2000. Report of the Southern Resident Killer Whale Workshop, 1-2 April 2000, National Marine Mammal Laboratory, Seattle, WA. AFSC Processed Report 2000-06.

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 - D. P. DeMaster, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

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., J. Barlow, M. M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C. Stinchcomb, and J. V. Caretta. U.S. Pacific Marine Mammal Stock Assessments: 2000. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-300

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, 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.

Heise, K., G. Ellis, and C. Matkin. 1991. A catalogue of Prince William Sound killer whales. North Gulf Oceanic Society, Homer, AK. Published for the National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Hoelzel, A. R. 1991. Analysis of regional mitochondrial DNA variation in the killer whale; implications for cetacean conservation. Rep. Int. Whal. Comm. (Special Issue 13): 225-233.

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.

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., and E. L. Saulitis. 1994. Killer whale (*Orcinus orca*) biology and management in Alaska. Contract report T75135023, Marine Mammal Commission, Washington, DC. 46 pp.

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. Scheel, G. Ellis, L.Barrett-Lennard, H. Jurk, and E. Saulitis. 1998. Comprehensive Killer Whale Investigation, Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 97012), North Gulf Oceanic Society, Homer, Alaska. 58 pp.

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

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.

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.

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.

Revised 12/15/2000

KILLER WHALE (*Orcinus orca*): Eastern North Pacific 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 prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). 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. 1994) 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). 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).

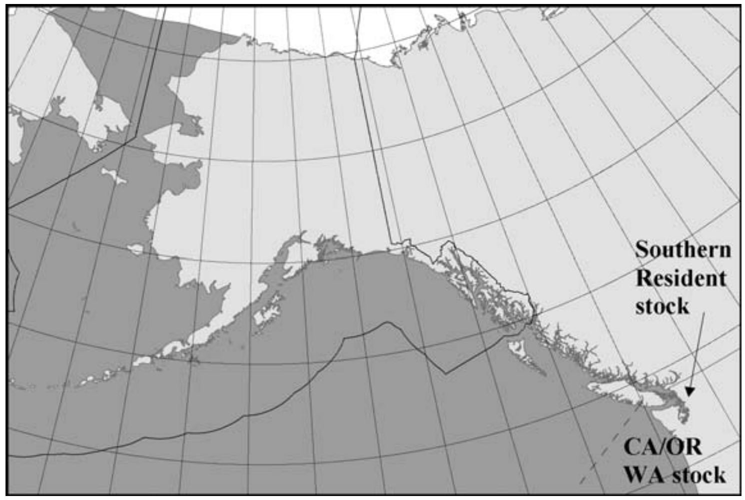

Figure 21. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text).

Studies on mtDNA restriction patterns provide evidence that the 'resident' and 'transient' types are genetically distinct (Stevens et al. 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel et al. 1998). Analysis of 73 samples collected from eastern North Pacific killer whales from California to Alaska has demonstrated significant genetic differences among 'transient' whales from California through Alaska, 'resident' whales from the inland waters of Washington, and 'resident' whales ranging from British Columbia to the Aleutian Islands and Bering Sea (Hoelzel et al. 1998).

Based on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, five killer whale stocks are recognized within the Pacific U.S. EEZ: 1) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 2) the Eastern North Pacific 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, 3) the Eastern North Pacific Transient stock - occurring from Alaska through California (see Fig. 21), 4) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California, and 5) the Hawaiian stock. 'Transient' whales in Canadian waters are considered part of the Eastern North Pacific Transient stock. The Stock Assessment Reports for the Alaska Region contain information concerning the Eastern North Pacific Northern Resident stock

POPULATION SIZE

The Eastern North Pacific 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 Eastern North Pacific 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 Alaska, 219 'transient' whales have been cataloged (Ford and Ellis 1999). In the Gulf of Alaska, 21 'transient' killer whales have been identified genetically and/or acoustically (Matkin et al. 1999). The 'transient' group AT1, commonly seen in Prince William Sound/Kenai Fjords, had only 11 remaining whales in 1998 (Matkin et al. 1999). Based on data collected from all Alaska waters west of Seward (Dahlheim and Waite 1993; Dahlheim 1994, 1997), 68 whales are considered 'residents' as they have been linked by association to 'resident' whales from Prince William Sound (G. Ellis, pers. comm.), and the remainder are provisionally classified as 174 'residents' and 53 'transients'. Provisional classifications were based primarily on morphological differences identified from the photographs. Accordingly, the numbers of 'residents' and 'transients' in Alaska waters west of Seward are considered preliminary at this time. 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, pers. comm.) have been provisionally classified as 'transient' whales by association. Combining the counts of cataloged 'transient' whales gives a minimum number of 346 (219 + 21 + 11 + 95) killer whales belonging to the Eastern North Pacific Transient stock.

Minimum Population Estimate

The abundance estimate of killer whales is a direct count of individually identifiable animals. However, the number of cataloged whales does not necessarily represent the number of live animals. Some animals may have died, but whales can not be presumed dead if not resighted because long periods of time between sightings is 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 whales within Southeast Alaska and Prince William Sound is relatively low. In addition, the abundance estimate does not include 53 whales from western Alaska, 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 Transient stock of killer whales is 346 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 the recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

At present, reliable data on trends in population abundance for the Eastern North Pacific 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). 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 0.4, 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 Transient killer whale stock, PBR = 2.8 animals ($346 \times 0.02 \times 0.4$). The proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, pers. comm.)

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries in Alaska that could have interacted with killer whales were monitored for incidental take by fishery observers from 1994 to 1998: Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska groundfish trawl, longline, and pot fisheries. Of the six observed fisheries, killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Table 19; Perez in prep.). From 1994 to 1998, one killer whale mortality was observed in 1997 in the Bering Sea groundfish trawl fishery. The 1995 mortality in the longline fishery occurred during an unmonitored haul and could not be used to estimate total mortality for the fishery.

NMFS observers also monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 1994 to 1998 (Table 19; Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999). The observed mortality in this fishery, in 1995, was a transient whale as determined by genetic testing (S. Chivers, 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 of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 19 are based only on 1997-98 data. Additional fisheries that could interact with the Eastern North Pacific Transient stock of killer whales are listed in Appendix 3.

The mean annual mortality was 0.4 (CV=1.0) for the Bering Sea groundfish trawl fishery, 0.2 (0 from monitored hauls + 0.2 from unmonitored haul data) for the combined Bering Sea longline fishery, and zero for the California/Oregon thresher shark/swordfish drift gillnet fishery (1997-98 data), resulting in a mean annual mortality rate of 0.6 killer whales per year from observed fisheries.

An additional source of information on the number of killer whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 1998, there were no fisher self-reports of killer whale mortalities from any Alaska fisheries operating within the range of this stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 7 for details.)

The estimated minimum mortality rate incidental to recently monitored U.S. commercial fisheries is 0.6 animals per year, based on observer data (0.4 from monitored hauls + 0.2 from unmonitored hauls). As the animals which were taken incidental to commercial fisheries in Alaska have not been identified genetically, it is not possible to determine whether they belonged to the Eastern North Pacific Northern Resident or the Eastern North Pacific Transient killer whale stock. Accordingly, these same mortalities can be found in the stock assessment report for the Northern Resident stock.

Table 19. 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 1994-98 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	94-98	obs data	64-67% 67.3% 66.2% 63.9% 67.0%	0, 0, 0, 1, 0	0, 0, 0, 2, 0	0.4 (1.0)
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	94-98	obs data	27-36%	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0
	95	unmonit-ored haul		1		0.2

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
CA/OR thresher shark/ swordfish drift gillnet	94-98	obs data	12-23%	0, 1, 0, 0, 0	0, 6, 0, 0, 0	0*
Estimated total annual takes						0.6 (1.0)

* Only 1997-98 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

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

There is considerable interaction between killer whales and longline vessels in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez in prep.; M. Perez, unpubl. data), as well as reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (M. Perez, unpubl. data). However, it most likely is the 'resident' stock of killer whales that is 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.

The shooting of killer whales in Canadian waters has also 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, 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, resulting in an estimated annual mortality of 0.2 killer whales from this stock in 1994-98.

STATUS OF STOCK

Killer whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Recall that the human-caused mortality has 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 western Alaska, southeastern Alaska, and off the coast of California were not included), resulting in a conservative PBR estimate. Based on currently available data, the estimated annual fishery-related mortality level (0.6) exceeds 10% of the PBR (0.28) and, therefore, can not be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (0.6 + 0.2 = 0.8 animals per year) is not known to exceed the PBR (2.8). Therefore, the Eastern North Pacific 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. 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.

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. Commn. 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. Commn. 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.

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. 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. 1994. Abundance and distribution of killer whales, *Orcinus orca*, in Alaska, 1993. 1993 Annual Report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Dahlheim, M. E. 1997. A photographic catalogue of killer whales (*Orcinus orca*) from the Central Gulf of Alaska to the southeastern Bering Sea. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-131. 54 pp.

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

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 - D. P. DeMaster, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

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. Commn. 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.

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. 93:15-26.

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

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, 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. 1991. Analysis of regional mitochondrial DNA variation in the killer whale; implications for cetacean conservation. Rep. Int. Whal. Commn. Special Issue 13:225-233.

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.

Julian, F. 1997. Cetacean mortality in California gill net fisheries: preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 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. 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. Commn. Special Issue 12:209-242.

Perez, M. A. In prep. Compilation of marine mammal-fisheries interaction data from the domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-99.

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.

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. 93:355-372.

PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The Pacific white-sided dolphin is found throughout the temperate North Pacific Ocean, north of the coasts of Japan and Baja California, Mexico. In the eastern North Pacific the species occurs from the southern Gulf of California, north to the Gulf of Alaska, west to Amchitka in the Aleutian Islands, and is rarely encountered in the southern Bering Sea. The species is common both on the high seas and along the continental margins, and animals are known to enter the inshore passes of Alaska, British Columbia, and Washington (Ferrero and Walker 1996)

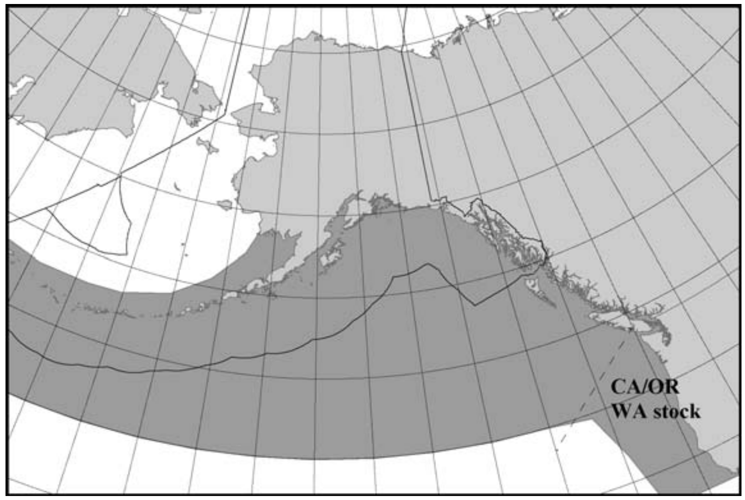

Figure 22. Approximate distribution of Pacific white-sided dolphins in the eastern North Pacific (shaded area).

The following information was considered in classifying Pacific white-sided dolphin stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution is continuous; 2) Population response data: unknown; 3) Phenotypic data: two morphological forms are recognized (Walker et al. 1986, Chivers et al. 1993); and 4) Genotypic data: preliminary genetic analyses on 116 Pacific white-sided dolphin collected in four areas (Baja California, the U.S. west coast, British Columbia/southeast Alaska, and offshore) were not statistically significant to support phylogeographic partitioning, though they support the hypothesis that animals from the different regions are sufficiently isolated to treat them as separate management units (Lux et al. 1997). Given this limited information, stock structure throughout the North Pacific is poorly defined, but 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. 22). The California/Oregon/ Washington stock is reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

The most complete population abundance estimate for Pacific white-sided dolphins was calculated from line transect analyses applied to the 1987-90 central North Pacific marine mammal sightings survey data (Buckland et al. 1993). The Buckland et al. (1993) abundance estimate, 931,000 (CV = 0.90) animals, more closely reflects a range-wide estimate rather than one that can be applied to either of the two management stocks off the west coast of North America. Furthermore, Buckland et al. (1993) suggested that Pacific white-sided dolphins show strong vessel attraction but that a correction factor was not available to apply to the estimate. While the Buckland et al. (1993) abundance estimate is not considered appropriate to apply to the management stock in Alaskan waters, the portion of the estimate derived from sightings north of 45°N in the Gulf of Alaska can be used as the population estimate for this area (26,880). For comparison, Hobbs and Lerczak (1993) estimated 15,200 Pacific white-sided dolphins in the Gulf of Alaska based on a single sighting of 20 animals. Small cetacean aerial surveys in the Gulf of Alaska during 1997 sighted one group of 164 Pacific white-sided dolphins off Dixon entrance, while similar surveys in Bristol Bay in 1999 made 18 sightings of a school or parts thereof off Port Moller (R. Hobbs, pers. comm., National Marine Fisheries Service).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is 26,880, based on the sum of abundance estimates for 4 separate 5 × 5° blocks north of 45°N (1,970+6,427+6,101+12,382 = 26,880) reported in Buckland et al. (1993). This is considered a minimum estimate because the abundance of animals in a fifth 5° by 5° block (53,885) which straddled the boundary of the two coastal management stocks were not included in the estimate for the North Pacific stock and because much of the potential habitat for this stock was not surveyed between 1987 - 1990.

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks of unknown status (Wade and Angliss 1997). Thus, for the North Pacific stock of Pacific white-sided dolphin, PBR would be 269 animals (26,880 × 0.02 × 0.5). 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 undefined.

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.

Six different commercial fisheries in Alaska that could have interacted with Pacific white-sided dolphins were monitored for incidental take by NMFS observers from 1990 to 1998: Bering Sea (and Aleutian Islands) and Gulf of Alaska groundfish trawl, longline, and pot fisheries. For the fisheries with observed takes, the range of observer coverage over the 9-year period, as well as the annual observed and estimated mortalities are presented in Table 20. The mean annual (total) mortality was 0 in the Bering Sea groundfish trawl fishery and 0.8 (CV = 1.0) in the Bering Sea groundfish longline fishery. Combining the estimates results in a mean annual (total) mortality rate of 1 (rounded up from 0.8) Pacific white-sided dolphin in observed fisheries.

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). The low level of observer coverage for this fishery apparently missed interaction with Pacific-white sided dolphins which had occurred, as logbook mortalities were reported in both years (see Table 20) which were not recorded by the observer program.

An additional source of information on the number of Pacific white-sided dolphins killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period from 1990 to 1998, fisher self- reports from 3 unobserved fisheries (see Table 20) resulted in an annual mean of 2.25 mortalities from interactions with commercial fishing gear. It is unclear exactly which Bristol Bay fishery caused the 1990 mortalities because the logbook records from the Bristol Bay set and drift gillnet fisheries were combined. They have been attributed to the Bristol Bay drift gillnet fishery due to the more pelagic nature of the fishery. However, because logbook records (i.e., the self-reports required during 1990-94) are most likely negatively biased

(Credle et al. 1994), these are considered to be minimum estimates. These totals are based on all available logbook reports for all Alaska fisheries. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

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. The estimated minimum annual mortality rate incidental to commercial fisheries (4; based on observer data (rounded up to 1) and fisher self-reports (rounded up to 3) where observer data were not available) is less than 10% of the PBR (269). The estimated annual mortality, therefore, can be considered insignificant and approaching zero.

Table 20. Summary of incidental mortality of Pacific white-sided dolphins (North Pacific stock) due to commercial fisheries from 1990 through 1998 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from fisher self-reports. Data from 1994 to 1998 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**
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	94-98	obs data	53-74%	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries	94-98	obs data	27-80%	0, 1, 0, 0, 0	0, 4, 0, 0, 0	0.8 (CV = 1.0)
Observer program total						0.8
				Reported mortalities		
Prince William Sound salmon drift gillnet	90-01	logbooks/ self-reports	n/a	1, 4, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥1.25]
Southeast Alaska salmon drift gillnet	90-01	logbooks/ self-reports	n/a	0, 0, 1, 0 n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥.25]
Bristol Bay salmon drift gillnet	90-01	logbooks/ self reports	n/a	3, 0, 0, 0 n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥.75]
Minimum total annual mortality						3.05

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. Based on currently available data, the level of human-caused mortality and serious injury (4) exceeds the PBR (0). Therefore, the North Pacific stock of Pacific white-sided dolphins is 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.

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.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

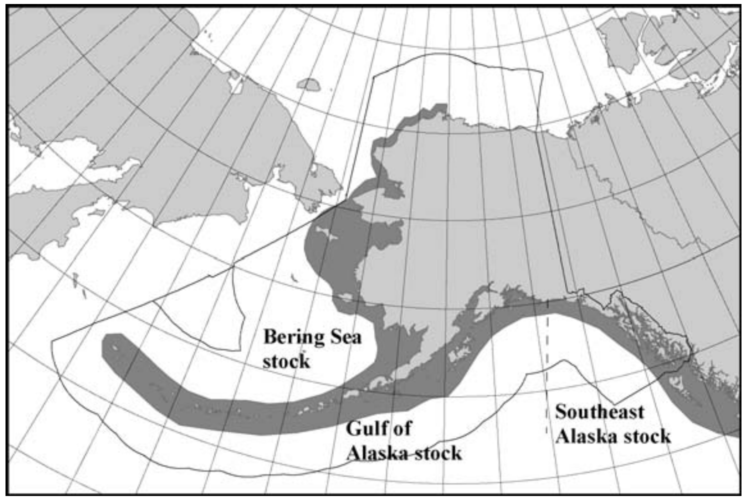

Figure 23. Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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, they occur most frequently in waters less than 100 m in depth (Waite and Hobbs, in review). 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, Yakutat Bay, Copper River Delta, and Sitkalidak Strait (Dahlheim et al. 2000; Waite and Hobbs, in review). Stock discreteness in the eastern North Pacific was analyzed using mitochondrial DNA from samples collected along the west coast (Rosel 1992) and is summarized in Osmek et al. (1994). Two distinct mitochondrial DNA groupings or clades exist. One clade is present in California, Washington, British Columbia and 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). Further genetic testing of the same data mentioned above along with additional samples found significant genetic differences for 4 of the 6 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 or migratory, and that movement is sufficiently restricted to evolve genetic differences. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimen from the North Atlantic. Numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles. Unfortunately, no conclusions can be drawn about the genetic structure of harbor porpoise within Alaska because of insufficient samples. Only 19 samples are available from Alaska porpoise and 12 of these come from a single area (Copper River Delta). 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 SRG concurred that while the available data were insufficient to justify recognizing three biological stocks of harbor porpoise in Alaska, it did not recommend against the establishment of three management units in Alaska (DeMaster 1996, 1997). Accordingly, from the above information, three 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 border 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. 23). Information concerning the 4 harbor porpoise stocks occurring along the west coast of the continental United States (Central California, Northern California, Oregon/Washington Coast, and Inland Washington) can be found 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 uncorrected abundance estimate of 3,698 (CV = 0.162) animals (Waite and Hobbs, in review). Included were 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^2. Only a fraction of the small bays and inlets (<5.5 km wide) of Southeast Alaska were surveyed and included in this abundance estimate, although the areas omitted represent only a small fraction of the total survey area. The observed abundance estimate was multiplied by correction factors for availability bias (to correct for animals not available to be seen because they were diving) and perception bias (to correct for animals not seen because they were missed) to obtain a corrected abundance estimate. 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 perception bias. A second independent observer was used to estimate the average availability bias as 1.56 (CV = 0.108). The estimated corrected abundance from this survey is 10,947 (3,698 × 2.96; CV = 0.242) harbor porpoise for 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 calculated separately, using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimates (N) of 10,947 and its associated CV (0.242), N_{MIN} for this stock is 8,954.

Current Population Trend

The abundance of harbor porpoise in Southeast Alaska was estimated for 1993 and 1997. The 1993 estimate was 10,301 (Dahlheim et al. 2000). The 1997 estimate of 10,947 is not significantly different from the 1993 estimate (Waite and Hobbs, in review). However, these estimates are not directly comparable because the area surveyed in 1997 was larger than that in 1993, 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. Thus, while the estimates are not significantly different, there is no reliable information on trends in abundance for the Southeast 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 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, for the Southeast Alaska stock of harbor porpoise, PBR = 90 animals (8,954 × 0.02 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Some fishing effort by vessels participating in the Gulf of Alaska (GOA) groundfish longline fishery occurs in the offshore waters of Southeast Alaska. The levels of fishing effort levels are insignificant for the portion of the GOA groundfish trawl and pot fisheries operating in these waters. However, during the period from 1990 to 1998, 21-31% of the GOA longline catch occurred within the range of the Southeast Alaska harbor porpoise stock. This fishery has been monitored for incidental take by NMFS observers from 1990 to 1998 (8-21% observer coverage), although observer coverage has been very low in the offshore waters of Southeast Alaska (<1-5% observer coverage). No mortalities from this stock of harbor porpoise incidental to commercial groundfish fisheries have been observed.

The only source of information on the number of harbor porpoise killed or injured incidental to commercial fishery operations is the self-reported fisheries information required by the MMPA. During the period between 1990 and 1998, fisher self-reports from the Southeast Alaska salmon drift gillnet fishery (Table 21) resulted in an annual mean of 3.25 mortalities from interactions with commercial fishing gear. However, because logbook records (i.e., fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), this is considered to be a minimum estimate. There were no other fisher self-report mortalities for any other fishery within the range of the Southeast Alaska harbor porpoise stock. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Table 21. Summary of incidental mortality of harbor porpoise (Southeast Alaska stock) due to commercial fisheries from 1990 through 1998 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from fisher self-reports. Mean annual mortality was based on the fisher self-reports from 1991to 2001 where more than 5 years of data were available. n/a indicates that data are not available.

Fishery name	Years	Data type	Range of observer coverage	Reported mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Observer program total	90-01					0
Southeast Alaska salmon drift gillnet	90-01	logbooks/ self-reports	n/a	2, 2, 7, 2, n/a, n/a, 2, n/a, 1, n/a, n/a, n/a	n/a	[≥2.8]
Minimum total annual mortality						≥2.8

For this stock of harbor porpoise, the estimated minimum annual mortality rate incidental to commercial fisheries is 3 animals (rounded up from 2.8), based entirely on fisher self-report data. However, 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. At present, annual mortality levels less than 9 animals per year (i.e., 10% of PBR) can be considered to be insignificant and approaching a zero mortality and serious injury rate.

Subsistence/Native Harvest Information

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

STATUS OF STOCK

Harbor porpoise are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. Logbook records are most likely negatively biased (Credle et al. 1994) resulting in an underestimate of incidental kill. However, based on the best scientific information available, the estimated level of human-caused mortality and serious injury (3) is not known to exceed the PBR (90). Therefore, the Southeast Alaska stock of harbor porpoise is not classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

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. 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. NMFS, NOAA Technical Rep. NMFS 98: 101-110.

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

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., 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.

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

Osmek, S., P. E. Rosel, A. E. Dizon, and R. L. DeLong. 1994. Harbor porpoise, *Phocoena phocoena*, population assessment studies for Oregon and Washington in 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 14 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.

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.

Waite, J.M. and R.C. Hobbs. In review. Harbor porpoise abundance in Alaska, 1997-1999. Available upon request from J. Waite, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

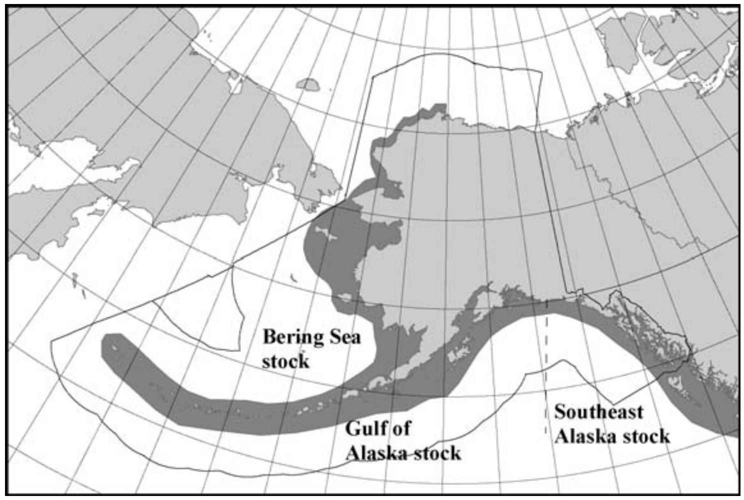

Figure 24. Approximate distribution of harbor porpoise in Alaska waters (shaded area).

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, they occur most frequently in waters less than 100 m in depth (Waite and Hobbs, in review). 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, Yakutat Bay, Copper River Delta, and Sitkalidak Strait. Stock discreteness in the eastern North Pacific was analyzed using mitochondrial DNA from samples collected along the west coast (Rosel 1992) and is summarized in Osmek et al. (1994). Two distinct mitochondrial DNA groupings or clades exist. One clade is present in California, Washington, British Columbia and 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). Further genetic testing of the same data mentioned above along with additional samples found significant genetic differences for 4 of the 6 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 or migratory, and that movement is sufficiently restricted to evolve genetic differences. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimen from the North Atlantic. Numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles. Unfortunately, no conclusions can be drawn about the genetic structure of harbor porpoise within Alaska because of insufficient samples. Only 19 samples are available from Alaska porpoise and 12 of these come from a single area (Copper River Delta). 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 SRG concurred that while the available data were insufficient to justify recognizing three biological stocks of harbor porpoise in Alaska, it did not recommend against the establishment of three management units in Alaska (DeMaster 1996, 1997). Accordingly, from the above information, three 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 border 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. 24). Information concerning the 4 harbor porpoise stocks occurring along the west coast of the continental United States (Central California, Northern California, Oregon/Washington Coast, and Inland Washington) can be found 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 1000 fathom depth contour resulted in an uncorrected abundance estimate for the Gulf of Alaska harbor porpoise stock of 10,306 (CV = 0.115) animals (Waite and Hobbs, in review). The uncorrected abundance estimate was multiplied by correction factors for availability bias (to correct for animals not available to be seen because they were diving) and perception bias (to correct for animals not seen because they were missed) to obtain a corrected abundance estimate. 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. A second independent observer was used to estimate the average perception bias as 1.372 (CV = 0.066). The estimated corrected abundance estimate from this survey is 30,506 (10,306 × 2.96 = 30,506; CV=0.214).

The latest estimate of abundance (30,506; CV = 0.0.214) is based on surveys conducted in 1998, and is considerably higher than the previous estimate in the 1999 SAR (8,271; CV = 0.309). This disparity largely stems from changes in the area covered by the two surveys and differences in harbor porpoise density encountered in areas added to, or dropped from, the 1998 survey, relative to the 1991-93 surveys . The survey area in 1998 (119,183 km^2) was greater than the area covered in the composited portions of the 1991,1992 and 1993 surveys (106,600 km^2). 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 Waite and Hobbs (in review) empirically estimate the perception bias, and use this in addition to the correction factor for availability bias. And 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. 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): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 30,506 and its associated CV of 0.214, N_{MIN} for the Gulf of Alaska stock of harbor porpoise is 25,536.

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, for the Gulf of Alaska stock of harbor porpoise, PBR = 255 animals (25,536 × 0.02 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Three different commercial fisheries operating within the range of the Gulf of Alaska stock of harbor porpoise were monitored for incidental take by NMFS observers during 1990-95: Gulf of Alaska groundfish trawl, longline, and pot fisheries. No incidental mortality of harbor porpoise was observed in these fisheries. Observers also monitored the

Prince William Sound salmon drift gillnet fishery in 1990 and 1991, recording 1 mortality in 1990 and 3 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). Logbook reports from this fishery detail 6, 5, 6, and 1 harbor porpoise mortalities in 1990, 1991, 1992, and 1993, respectively. The extrapolated (estimated) observer mortality accounts for these mortalities, so they do not appear in Table 22. The Prince William Sound salmon drift gillnet fishery has not been observed since 1991; therefore, no additional data are available for that fishery.

An additional source of information on the number of harbor porpoise mortalities incidental to commercial fishing operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1998, fisher self-reports from 2 unobserved fisheries (see Table 22) resulted in an annual mean of 4.5 mortalities from interactions with commercial fishing gear. In 1990, logbook records from the Cook Inlet set and drift gillnet fisheries were combined. As it is not possible to determine which fishery was responsible for the harbor porpoise mortalities reported in 1990, both fisheries have been included in Table 22. In 1990, observers also boarded 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). The low level of observer coverage for this fishery apparently missed interactions with harbor porpoise which had occurred, as logbook mortalities were reported in 1990 (see Table 22) which were not recorded by the observer program. Note that this fishery operates south of the Aleutian Islands, but had been incorrectly addressed in earlier versions of the SAR as an interaction with the Bering Sea stock of harbor porpoise. Because logbook records (i.e., fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. These totals are based on all available fisher self-reports for Gulf of Alaska fisheries, except the Prince William Sound salmon drift gillnet fishery for which observer data were presented above. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Table 22. Summary of incidental mortality of harbor porpoise (Gulf of Alaska stock) due to commercial fisheries from 1990 through 1998 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from fisher self-reports or stranding data. n/a indicates that data were 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%	1, 3	8, 32	20 (CV = .60)
Cook Inlet salmon drift gillnet	1999	obs data		0	0	0
Cook Inlet salmon set gillnet	1999	obs data		0	0	0
Observer program total						20

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
				Reported mortalities		
Cook Inlet salmon drift and set gillnet fisheries	90-01	logbooks/ self-reports	n/a	3, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.75]
AK Peninsula/Aleutian Island salmon drift gillnet	90-01	logbooks/ self-reports	n/a	2, 0, 1, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.75]
Kodiak salmon set gillnet	90-01	logbooks/ self-reports	n/a	8, 4, 2, 1, n/a, n/a, n/a. n/a, 1, n/a, n/a, n/a	n/a	[≥3.2]
Minimum total annual mortality						≥24.7

Strandings of marine mammals with fishing gear attached or with injuries caused by interactions with fishing gear are a 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 22.

A reliable estimate of the mortality rate incidental to commercial fisheries is considered unavailable because of the absence of observer placements in several gillnet fisheries mentioned above. However, the estimated minimum annual mortality rate incidental to commercial fisheries is 25 based on observer data (20), and logbook reports (rounded to 5) where observer data were not available. This estimated annual mortality rate is greater than 10% of the PBR (16.6) and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate.

Subsistence/Native Harvest Information

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

Other Mortality

In 1995, 2 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. Logbook records are most likely negatively biased (Credle et al. 1994) resulting in an underestimate of incidental mortality. However, based on the best scientific information available, the estimated level of human-caused mortality and serious injury (27; 25 mortalities in commercial fisheries plus 2 in subsistence gillnets) is not known to exceed the PBR (255). Therefore, the Gulf of Alaska stock of harbor porpoise is not classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

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. 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. NMFS, NOAA Technical Rep. NMFS 98: 101-110.

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

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. 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.

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

Osmek, S., P. E. Rosel, A. E. Dizon, and R. L. DeLong. 1994. Harbor porpoise, *Phocoena phocoena*, population assessment studies for Oregon and Washington in 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 14 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.

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. and R.C. Hobbs. In review. Harbor porpoise abundance in Alaska, 1997-1999. Available upon request from J. Waite, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Wynne, K. M., D. Hicks, and N. Munro. 1991. 1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak Alaska. Annual 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

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, they occur most frequently in waters less than 100 m in depth (Waite and Hobbs, in review). 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, Yakutat Bay, Copper River Delta, and Sitkalidak Strait. Stock discreteness in the eastern North Pacific was analyzed using mitochondrial DNA from samples collected along the west coast (Rosel 1992) and is summarized in Osmek et al. (1994). Two distinct mitochondrial DNA groupings or clades exist. One clade is present in California, Washington, British Columbia and 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). Further genetic testing of the same data mentioned above along with additional samples found significant genetic differences for 4 of the 6 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 or migratory, and that movement is sufficiently restricted to evolve genetic differences. This is consistent with low movement suggested by genetic analysis of harbor porpoise specimen from the North Atlantic. Numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles. Unfortunately, no conclusions can be drawn about the genetic structure of harbor porpoise within Alaska because of insufficient samples. Only 19 samples are available from Alaska porpoise and 12 of these come from a single area (Copper River Delta). Accordingly, harbor porpoise stock structure in Alaska remains unknown at this time.

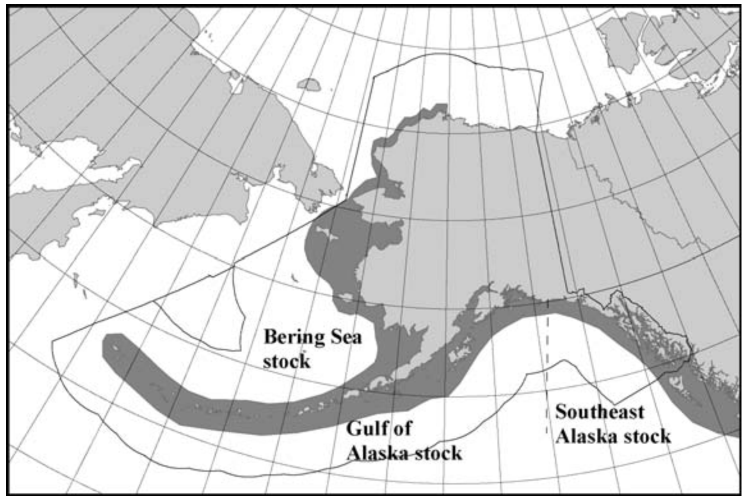

Figure 25. Approximate distribution of harbor porpoise in Alaska waters (shaded area).

Although it is difficult to determine the true stock structure of harbor porpoise populations in the northeast Pacific, from a management standpoint, it would be prudent to assume that regional populations exist and that they should be managed independently (Rosel et al. 1995, Taylor et al. 1996). The Alaska SRG concurred that while the available data were insufficient to justify recognizing three biological stocks of harbor porpoise in Alaska, it did not recommend against the establishment of three management units in Alaska (DeMaster 1996, 1997). Accordingly, from the above information, three 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 border 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. 25). Information concerning the 4 harbor porpoise stocks occurring along the west coast of the continental United States (Central California, Northern California, Oregon/Washington Coast, and Inland Washington) can be found 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 abundance estimate of 47,356 (CV = 0.223). This estimate incorporated the Laake et al. (1997) correction factor for availability bias (2.96; CV = 0.18), and an estimate of 1.337 for average perception bias (CV = 0.062; Waite and Hobbs, in review). 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).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 47,356 and its associated CV of 0.223), N_{MIN} for the Bering Sea stock of harbor porpoise is 39,328.

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 47,356 is significantly higher than the 1991 estimate (Waite and Hobbs 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 Waite and Hobbs (in review) 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 reported in 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, for the Bering Sea stock of harbor porpoise, PBR = 393 animals (39,328 × 0.02 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

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. The harbor porpoise mortality was observed only in the Bering Sea groundfish trawl fishery. The range of observer coverage over the 9-year period, as well as the annual observed and estimated mortalities are presented in Table 23. The mean annual (total) mortality rate resulting from observed mortalities was 1.1 (CV = 0.39).

An additional source of information on the number of harbor porpoise mortalities incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period from 1990 to 1998, fisher self-reports from 2 unobserved fisheries (see Table 23) resulted in an annual mean of 0.5 mortalities from interactions with commercial fishing gear. However, because logbook records (i.e., fisher self-reports required during 1990-94)are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. These totals are based on all available fisher self-reports for fisheries occurring within the range of the Bering Sea harbor porpoise stock, except the Bering Sea groundfish fisheries for which observer data were presented above. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Fisher self-reports for three fisheries listed in Table 23 did not report any harbor porpoise mortality over the 1990-93 period. These fisheries have been included above because of the large number of participants and the significant potential for interaction with harbor porpoise.

Table 23. Summary of incidental mortality of harbor porpoise (Bering Sea stock) due to commercial fisheries from 1990 through 2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbook reports. Data from 1994 to 1998 are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. n/a indicates that data were not available.

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	97-01	obs data	62-77%	1, 1, 0, 0, 1	2, 1, 0, 0, 2	1.1 (CV = 0.39)
Observer program total						1.1
				Reported mortalities		
AK Peninsula/Aleutian Island salmon set gillnet	90-01	logbooks/ self-reports	n/a	0, 0, 2, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Bristol Bay salmon drift gillnet	90-01	logbooks/ self-reports	n/a	0, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[0]
Bristol Bay salmon set gillnet	90-01	logbooks/ self-reports	n/a	0, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[0]
AK Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	90-01	logbooks/ self-reports	n/a	0, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[0]
Minimum total annual mortality						≥1.6

The estimated minimum annual mortality rate incidental to commercial fisheries is rounded up to 2 animals, based on observer data (1.1) and logbook reports (0.5) 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 placements in the gillnet fisheries discussed above. Therefore, it is unknown whether the kill rate is insignificant. At present, annual mortality levels, less than 39 animals per year (i.e., 10% of PBR), can be considered to be insignificant and approaching zero.

Subsistence/Native Harvest Information

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

Other Mortality

During the period from 1981 to 1987, 7 harbor porpoise mortalities have resulted from gillnet entanglement in the area from Nome to Unalakleet, 3 were reported near Kotzebue from 1989 to 1990, and some take of harbor porpoise is likely in the Bristol Bay gillnet fisheries (Barlow et al. 1994). A similar set gillnet fishery conducted by subsistence fishers incidentally took 6 harbor porpoise in 1991 near Point Barrow, Alaska (Suydam and George 1992). When averaged over the period from 1981 to 1990, the resulting annual mortality attributable to subsistence gillnets is 1.4 porpoise ((7 + 3 + 6)/11 = 1.4)

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. Logbook records are most likely negatively biased (Credle et al. 1994) resulting in an underestimate of incidental kill. However, based on the best scientific information available, the estimated level of human-caused mortality and serious injury (4, based on 2 mortalities in commercial fisheries plus 2 (rounded up from 1.4) in subsistence gillnets) is not known to exceed the PBR (86). Therefore, the Bering Sea stock of harbor porpoise is not classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

CITATIONS

Barlow, J. 1988. Harbor porpoise, *Phocoena phocoena,* abundance estimation for California, Oregon and Washington: I. Ship Surveys. Fishery Bulletin 86:417-432.

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.

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. NMFS, NOAA Technical Rep. NMFS 98: 101-110.

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., 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.

Osmek, S., P. E. Rosel, A. E. Dizon, and R. L. DeLong. 1994. Harbor Porpoise, *Phocoena phocoena*, population assessment studies for Oregon and Washington in 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. 14 pp.

Rosel, P. E. 1992. Geneticpopulation 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.

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. and J. C. George. 1992. Recent sightings of harbour porpoises, *Phocoena phocoena*, near Point Barrow, Alaska. Canadian 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.

Waite, J.M. and R.C. Hobbs. In review. Harbor porpoise abundance in Alaska, 1997-1999. Available upon request from J. Waite, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

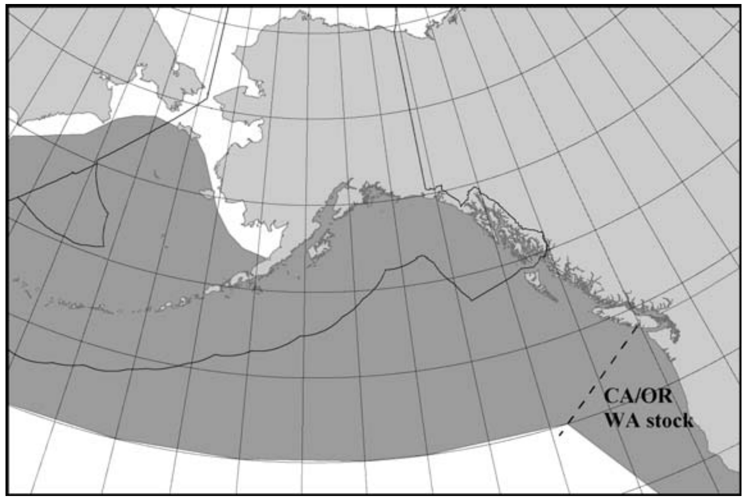

Figure 26. Approximate distribution of Dall's porpoise in the eastern North Pacific (shaded area).

Dall's porpoise are widely distributed across the entire North Pacific Ocean (Fig. 26). 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).

Recent surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 (see Fig. 35 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 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, because these surveys did not cover the entire range of Dall's porpoise, they cannot be used to determine a minimum population estimate.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842*[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 83,400 and its associated CV of 0.097, N_{MIN} for the Alaska stock of Dall's porpoise is 76,874.

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. As this stock is considered to be within optimum sustainable population (Buckland et al. 1993), the recovery factor (F_R) for this stock is 1.0 (Wade and Angliss 1997). The PBR reported in the previous SAR 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. However, recent estimates of abundance are available for a portion of this stock's range (Moore et al. 2002) and new estimates of abundance will be developed from 1997 to 1999 aerial surveys within the next few months. Thus, because some information is available and new information is forthcoming, the PBR level will not be designated as undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries operating within the range of the Alaska stock of Dall's porpoise were monitored for incidental take by NMFS observers during 1997-01: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No mortalities of Dall's porpoise were observed by NMFS observers in either pot fishery or the Gulf of Alaska longline fishery. For the fisheries with observed takes, the range of observer coverage over the 5-year period, as well as the annual observed and estimated mortalities are presented in Table 20. The mean annual (total) mortality was 5.4 (CV = 0.18) for the Bering Sea groundfish trawl fishery, 0.3 (CV = 0.61) for the Gulf of Alaska groundfish trawl fishery, and 0.2 (CV = n/a) for the Bering Sea groundfish longline fishery.

The Alaska Peninsula and Aleutian Island salmon driftnet fishery was monitored in 1990. Observers boarded 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 (5.4 + 0.3 + 0.2 =5.9) 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 33.9 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). The low level of observer coverage for this fishery apparently missed interaction with Dall's porpoise which had occurred, as logbook mortalities were reported in 1991 (see Table 24) which were not recorded by the observer program.

An additional source of information on the number of Dall's porpoise killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990and 2001, fisher self-reports from 4 unobserved fisheries (see Table 24) resulted in an estimated annual mean of 3.6 mortalities from interactions with commercial fishing gear. In 1990, logbook records from the Cook Inlet set and drift gillnet fisheries were combined. As a result, the Dall's porpoise mortality reported in 1990 may have occurred in the Cook Inlet set gillnet fishery and not in the drift gillnet fishery as reported in Table 24. However, because logbook records are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. These estimates are based on all available fisher self-reports for Alaska fisheries, except for those fisheries which observer data were presented above. The Southeast Alaska salmon drift gillnet fishery accounted for the majority of the reported incidental take in unobserved fisheries. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Table 24. Summary of incidental mortality of Dall's porpoise (Alaska stock) due to commercial fisheries from 1997to 2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbook reports. Data from 1997 to 2001 are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. n/a indicates that data were not available.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated morality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	97-01	obs data	62-77%	5, 3, 2, 3, 2	8, 4, 5, 4, 3	5.4 (CV = 1.8)
Gulf of Alaska (GOA) groundfish trawl	97-01	obs data	27-32%	0, 1, 0, 0, 0	0, 3, 0, 0, 0	0.3 (CV = 0.61)
BSAI groundfish longline (incl. misc finfish and sablefish fisheries)	97-01	obs data	30-31%	1, 1, 0, 0, 0	4, 4, 1, 0, 0	0.2 (CV = n/a)
AK Peninsula/ Aleutian Island salmon drift gillnet	90	obs data	4%	1	28	28 (CI 1-81)
Observer program total						33.9
				Reported mortalities		

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated morality (in given yrs.)	Mean annual mortality
Prince William Sound salmon drift gillnet	90-01	logbooks/ self-reports	n/a	0, 2, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Southeast Alaska salmon drift gillnet	90-01	logbooks/ self-reports	n/a	6, 6, 4, 6, n/a, n/a, n/a, 1, n/a, 1, n/a, 1	n/a	[≥2.6]
Cook Inlet set and drift gillnet fisheries	90-01	logbooks/ self-reports	n/a	1, 0, 1, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Minimum total annual mortality						≥37.5

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. The estimated minimum annual mortality rate incidental to commercial fisheries (rounded to 38 animals; based on observer data (rounded to 34) and logbook reports (rounded to 4) where observer data were not available) is not known to exceed 10% of the PBR (154) and, therefore can be considered to be insignificant and approaching zero mortality and serious injury rate.

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. Based on currently available data, the level of human-caused mortality and serious injury (38) does not exceed the PBR (1,537). Therefore, 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.

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.

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, L. L. Mazzuca, and R. C. Hobbs. 2000. Provisional estimates of mysticete whale abundance on the central Bering Sea shelf. J. Cet. 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.

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 may also feed on large demersal and mesopelagic sharks, skates, and fishes (Gosho et al. 1984). In the North Pacific, sperm whales are distributed widely (Fig. 27), with the northernmost boundary extending from Cape Navarin (62°N) to the Pribilof Islands (Omura 1955). The shallow continental shelf apparently bars their movement into the north-eastern Bering Sea and Arctic Ocean (Rice 1989). Females and young sperm whales usually remain in tropical and temperate waters year-round, 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. In the winter, sperm whales are typically distributed south of 40°N (Gosho et al. 1984). However, discovery tag data from the days of commercial whaling revealed a great deal of east-west movement between Alaska waters and the western North Pacific (Japan and the Bonin Islands), with little evidence of north-south movement in the eastern North Pacific. For example, of several hundred sperm whales tagged off San Francisco (CA), none were recovered north of 53° in the Gulf of Alaska despite large takes there (B. Taylor, pers. comm., National Marine Fisheries Service). Therefore, seasonal movement of sperm whales in the North Pacific is unclear at this time.

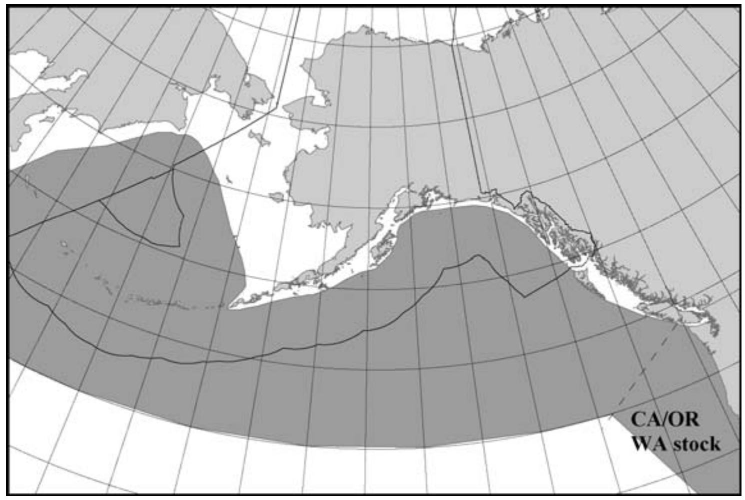

Figure 27. Approximate distribution of sperm whales in the eastern North Pacific (shaded area).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous though indicates 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.

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, preliminary analysis indicates 102,112 (CV = 0.155) sperm whales in the western North Pacific. In the eastern temperate North Pacific a preliminary estimate indicates 39,200 (CV = 0.60) sperm whales (Barlow and Taylor, 1998). 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 well over 5 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 are 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

Six different commercial fisheries operating within the range of the North Pacific stock of sperm whale were monitored for incidental take by fishery observers during 1990-01: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. However, it appears that sperm whale interactions with longline fisheries operating in the Gulf of Alaska are known to occur and may be increasing in frequency (Hill and Mitchell 1998). NMFS observers aboard longline vessels targeting both sablefish and halibut have documented sperm whales feeding off the longline gear in the Gulf of Alaska. 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). The first entanglement (not classified as a serious injury according to Angliss and DeMaster 1998) of a sperm whale in a Gulf of Alaska longline was documented in June of 1997 (Fishery Observer Program, unpubl. data, NMFS, AFSC, 7600 Sand Point Way NE, Seattle, WA 98115).

Table 25. Summary of incidental mortality of sperm whales due to commercial fisheries from 1997-01 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
Gulf of Alaska groundfish longline	97-01	obs data	11-14%	0, 0, 0, 1, 0	0, 0, 0, 3, 0	0.4 (CV = 0.75)
Estimated total annual mortality						0.4 (CV = 0.75)

The total estimated mortality and serious injury incurred by this stock as a result of interactions with commercial fisheries is 0.4 (CV = 0.75).

An additional source of information on the number of sperm whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 2001, fisher self-reports from all Alaska fisheries indicated no mortalities of sperm whales from interactions with commercial fishing gear. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable or a minimum estimate after 1996 (see Appendix 7).

Therefore, the minimum estimated annual mortality rate incidental to commercial fisheries is 0.4. An estimate of the current population size is currently unavailable, thus, a PBR level cannot be calculated and it is unknown whether the human-caused mortality and serious injury level could be considered to be insignificant and approaching a zero mortality and serious injury rate.

Subsistence/Native Harvest Information

Sperm whales have never been reported to be taken by subsistence hunters (Rice 1989).

Other Mortality

The population of sperm whales in the Pacific was likely well below pre-whaling levels before modern whaling for them became especially intense in the late 1940s (Reeves and Whitehead 1997). A total of 258,000 sperm whales were reported to have been taken by commercial whalers operating in the North Pacific between 1947 and 1987 (C. Allison, pers. comm., International Whaling Commission, United Kingdom). This value underestimates the actual kill in the North Pacific as a result of under-reporting by U.S.S.R. pelagic whaling operations, which are estimated to have under-reported catches during 1949-71 by 60% (Brownell et al. 1998). 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 Japanese officially stopped catching sperm whales in the North Pacific in 1988 (Reeves and Whitehead 1997).

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 or threatened with becoming endangered in the foreseeable future (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. There are no known habitat issues that are of particular concern for this stock.

CITATIONS

Angliss, R. P., and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: 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.

Barlow, J., and B. L. Taylor. 1998. Preliminary abundance of sperm whales in the northeastern temperate Pacific estimated from a combined visual and acoustic survey. Unpubl. report submitted to Int. Whal. Comm. (SC/50/CAWS/20). 19 pp.

Brownell, R. L., A. V. Yablokov, and V. A. Zemsky. 1998. USSR pelagic catches of North Pacific sperm whales, 1949-1979: conservation implications. Unpubl. report submitted to Int. Whal. Comm. (SC/50/CAWS/27). 12 pp.

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).

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.

Gosho, M. E., D. W. Rice, and J. M. Breiwick. 1984. The sperm whale, *Physeter macrocephalus*. Mar. Fish. Rev. 46(4):54-64.

Hill, P. S. and E. Mitchell. 1998. Sperm whale interactions with longline vessels in Alaska waters during 1997. Unpubl. doc. Submitted to Fish. Bull. (available upon request - P. S. Hill, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

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

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.

Omura, H. 1955. Whales in the northern part of the North Pacific. Nor. Hvalfangst-Tidende 44(6):323-345.

Reeves, R. R., and H. Whitehead. 1997. Status of the sperm whale, *Physeter macrocephalus*, in Canada. Can. Field Naturalist 111(2):293-307.

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.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

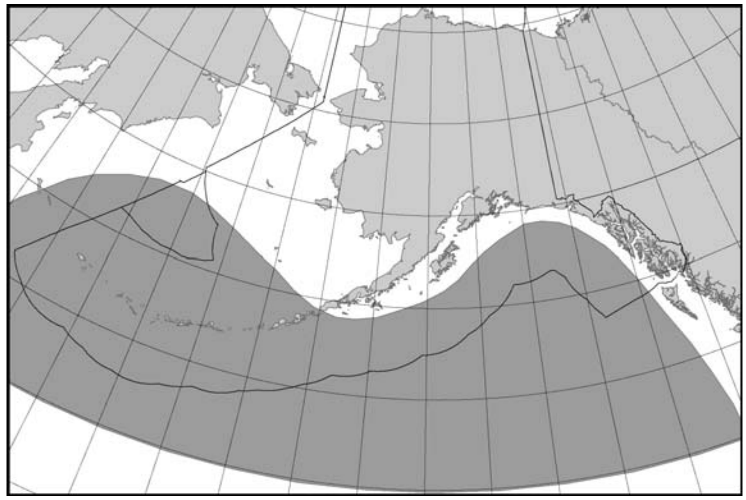

Figure 28. Approximate distribution of Baird's beaked whales in the eastern North Pacific (shaded area).

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 35°N, particularly in regions with submarine escarpments and seamounts (Ohsumi 1983, Kasuya and Ohsumi 1984). The range of the species extends north to at least the Pribilof Islands where individuals have been found stranded (Rice 1986, Fig. 28). 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). Tomilin (1957) reported that in the Sea of Okhotsk and the Bering Sea, Baird's beaked whales arrive in April-May and are particularly numerous during the summer. 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, which makes 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.

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 during 1990-97: 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 by observers in any observed fishery.

An additional source of information on the number of Baird's beaked whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1997, there were no fisher self-reports of Baird's beaked whale mortalities from any fisheries operating within the range of this stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 7 for details)

The estimated annual mortality rate incidental to commercial fisheries is zero. 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

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

Other Mortality

The Japanese have reported taking 54 Baird's beaked whales annually off their coasts during the 6-year period between 1992 and 1997 (IWC 1996, 1997a, 1997b, 1998). 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. 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.

CITATIONS

Balcomb, K. C. 1989. Baird's beaked whale, *Berardius bairdii* Stejneger, 1883: Arnoux's beaked whale *Iberardius arnouxii* Douvernoy, 1851. Pp. 261-288, *In* S. H. Ridgway and R. Harrison (eds.), Handbook of marine mammals: River dolphins and the larger toothed whales. Academic Press, New York.

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.

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.
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., 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.
Ohsumi, S. 1983. Population assessment of Baird's beaked whales in the waters adjacent to Japan. Rep. Int. Whal. Comm. 33:633-641.
Rice, D. W. 1986. Beaked whales. Pp. 102-109, *In* D. Haley (ed.), Marine mammals of the eastern North Pacific and Arctic waters. Pacific Search Press, Seattle.
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. 29) 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 southeastern Alaska, the Aleutian Islands, and the Commander Islands (Rice 1986). 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).

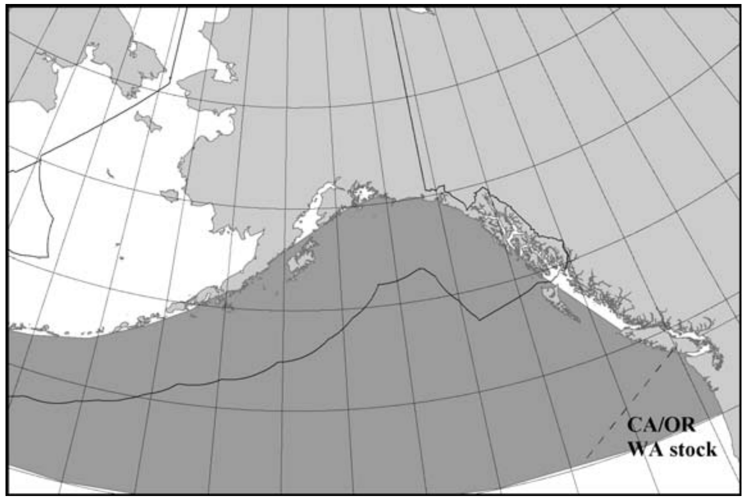

Figure 29. Approximate distribution of Cuvier's beaked whales in the eastern North Pacific (shaded area).

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

POPULATION SIZE

Reliable estimates of abundance for this stock are currently unavailable.

Minimum Population Estimate

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

Current Population Trend

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 during 1990-97: 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 by observers in any observed fishery.

An additional source of information on the number of Cuvier's beaked whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1997, there were no fisher self-reports of Cuvier's beaked whale mortalities from any fisheries operating within the range of this stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable after 1995 (see Appendix 7 for details).

The estimated annual mortality rate incidental to commercial fisheries is zero. 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

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. 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.

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.

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.

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). 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. 30). 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).

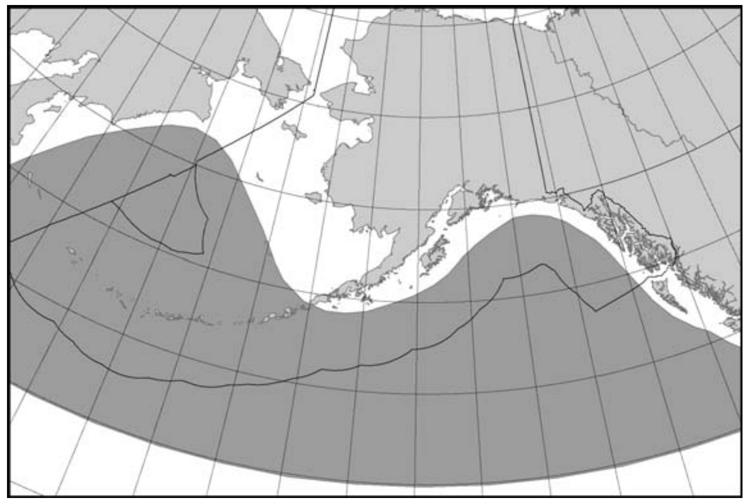

Figure 30. Approximate distribution of Stejneger's beaked whales in the eastern North Pacific (shaded area).

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).

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 during 1990-97: 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 by observers in any observed fishery.

An additional source of information on the number of Stejneger's beaked whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1997, there were no fisher self-reports of Stejneger's beaked whale mortalities from any fisheries operating within the range of this stock. However, because logbook records (fisher self-reports required during 1990-94) were most likely negatively biased (Credle et al. 1994), these were considered to be minimum estimates. Self-reported fisheries data were incomplete for 1994, not available for 1995, and considered unreliable after 1995 (See Appendix 7 for details).

The estimated annual mortality rate incidental to commercial fisheries is zero. 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

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. 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.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Gray whales formerly occurred in the North Atlantic Ocean (Fraser 1970), but this species is currently found only in the North Pacific (Rice et al. 1984). The following information was considered in classifying stock structure of gray whales based on the phylogeographic approach by Dizon et al. (1992) : 1) Distributional data: two isolated geographic distributions in the North Pacific Ocean; 2) Population response data: there is an increase in the eastern North Pacific, 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. 31), and the Western North Pacific or "Korean" stock, which lives along the coast of eastern Asia (Rice 1981, Rice et al. 1984). Most of the Eastern North Pacific stock spends the summer feeding in the northern Bering and Chukchi Seas (Rice and Wolman 1971, Berzin 1984, Nerini 1984). However, gray whales have been reported feeding in the summer in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971, Darling 1984, Nerini 1984, Rice et al. 1984). 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). 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.

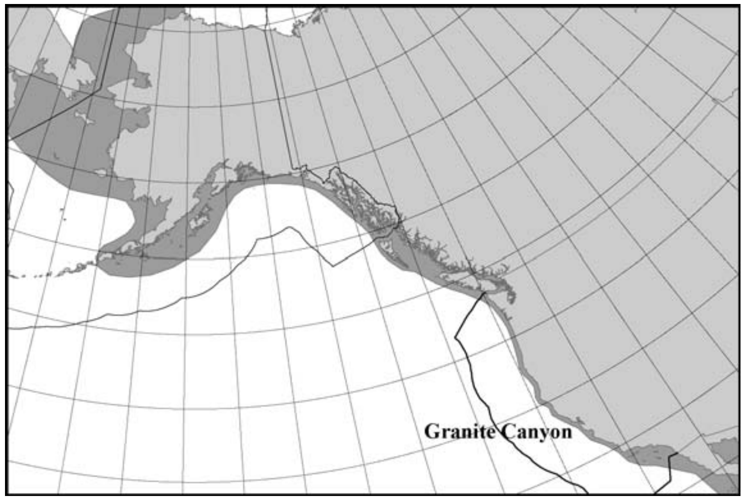

Figure 31. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area). Excluding some Mexican waters, the entire of the entire range of this stock is depicted.

There has been some speculation that discrete stocks of gray whales occur in coastal areas, such as Puget Sound. Although some localized, seasonal site fidelity has been confirmed, animals in Puget Sound have also been seen using coastal areas from northern California to Southeast Alaska in spring and fall (Calambokidis and Quan 1999, Gosho et al. 1999). At this time, available information indicates that the Eastern North Pacific stock of gray whales should be managed as a single stock (Swartz et al. 2000).

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. The latest abundance estimate (26,635; CV = 0.1006) is based on counts made during the 1997/98 southbound migration (Hobbs and Rugh 1999). This estimate is not significantly larger than the previous estimates of 22,263 (CV = 0.0925) whales in 1995/96 (Hobbs et al. in press); 23,109 (CV = 0.0542) whales in 1993/94 (Laake et al. 1994); and 21,296 (CV = 0.0605) whales in 1987/88 (Buckland et al. 1993); but it is significantly higher than the estimate of 17,674 (CV = 0.0587) whales in 1992/93 (Laake et al. 1994). 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 1997/98 abundance estimate is the most recent and is considered a reliable estimate of abundance for this stock. The most recent survey to determine abundance was carried out during the winter of 2000/01. An abundance estimate based on these data will be available in the 2003 SARs.

Gray whale calves have been counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year since 1994 (Perryman et al. 2002). In 1980 and 1981, calves passing this site comprised 4.7% to 5.2% of the population, respectively (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). Gray whale calves have also been counted from the shore station at Granite Canyon during the southbound migration (Shelden et al. 1995, Shelden and Rugh 2001). These results have indicated an apparent increase in the percentage of calf sightings from 0.0%-0.2% during 1952-74, 0.1%-0.9% during 1984-95 (Shelden et al. 1995), and 0.3%-1.5% during 1996-2001 (Shelden and Rugh 2001). This increase may be related to a trend toward later migrations over the observation period (Rugh et al. 2001, Buckland and Breiwick in press), or it may be due to an increase in spatial and temporal distribution of calving as the population increased.

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 1997/98 population estimate of 26,635 and its associated CV of 0.1006, N_{MIN} for this stock is 24,477.

Current Population Trend

The population size of the Eastern North Pacific gray whale stock has been increasing over the past several decades. The estimated annual rate of increase, based on shore counts of southward migrating gray whales between 1967 and 1988, is 3.29% with a standard error of 0.44% (Buckland et al. 1993). Taking account of the harvest, 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 2.57% (SE = 0.4%: IWC 1995a). Most recently, 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%).

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). 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. 32). Gray whale strandings occurred throughout the year in both 1999 and 2000, but regional peaks of strandings occurred where the whales were in their migration cycle. Hypothesized reasons for the increased stranding rate in recent years 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. The other hypotheses indicated 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. Thus, while the stranding rate was certainly much higher in 1999 and 2000 than in previous years, it may not indicate a higher mortality rate. Preliminary stranding data indicate that the stranding event in 1999 and 2000 is over, as only 21 gray whale strandings were reported in 2001 (T. Rowles, pers. comm.).

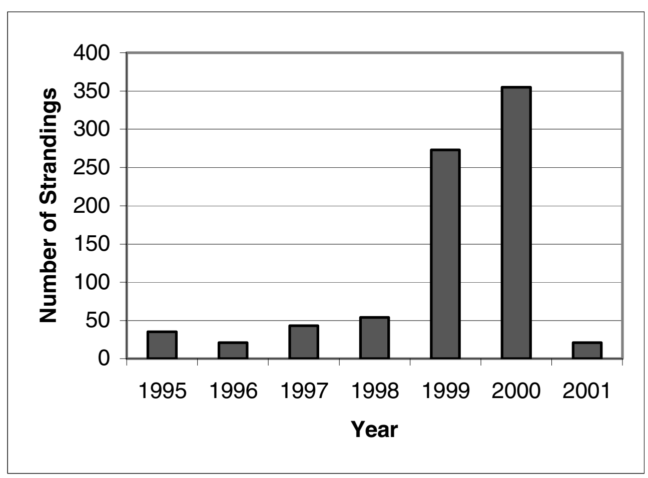

Figure 32. Number of strandings of gray whales along the west coast of North America, 1995-2001.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Using abundance data through 1996, an analysis of the Eastern North Pacific gray whale population led to an estimate of R_{max} of 0.072, with a 90% probability the value was between 0.039 and 0.126 (Wade 2002). 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. 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 0.047. This has the interpretation that there is a 90% probability that the true value of R_{max} is greater than 0.047. This is sufficient evidence that R_{max} for Eastern North Pacific gray whales is greater than the default value of 0.04. Therefore, NMFS will use a R_{max} of 0.047.

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 re-authorized 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). Thus, for the Eastern North Pacific stock of gray whales, PBR = 575 animals (24,477 × 0.0235 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries operating in Alaska waters within the range of the Eastern North Pacific gray whale stock were monitored for incidental take by NMFS observers during 1990-00: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No gray whale mortalities were observed for any of these Alaska 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 4 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, pers. comm.). Data from 1990-00 are included in Table 25a, although the mean estimated annual mortality is calculated using only the most recent 5 years of available data.

NMFS observers also monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 1993 to 2000 (Table 25a; Julian 1997; Cameron 1998; Julian and Beeson 1998; Cameron and Forney 1999, 2000; Carretta 2001). 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 (Barlow and Cameron 1999). Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 25a are based only on 1997-2000 data.

The mean annual mortality was 0.2 (CV = 1.0) for the northern Washington marine set gillnet fishery and 2.5 (CV = 0.58) for the California/Oregon thresher shark/swordfish drift gillnet fishery, resulting in a mean annual mortality rate of 2.7 (CV = 0.54) gray whales per year from observed fisheries.

An additional source of information on the number of gray whales killed or injured incidental to commercial fishery operations is the logbook/self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 2000, logbook/fisher self-reports indicated 2 gray whale mortalities related to the Bristol Bay gillnet fisheries in 1990, resulting in an annual mean of 0.5 gray whale mortalities from interactions with commercial fishing gear. In 1990, logbook records from the Bristol Bay set and drift gillnet fisheries were combined. As it is not possible to determine which fishery was responsible for the gray whale mortalities reported in 1990, both fisheries have been included in Table 25a. However, because logbook records are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Logbook data are available for part of 1989-94, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Table 25a. Summary of incidental mortality of Eastern North Pacific gray whales due to commercial and tribal fisheries from 1990-2000 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbook/self-reports or stranding data. Data from 1996-2000 (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	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Northern Washington marine set gillnet (tribal: coastal + inland waters)	90-00	obs data	33-98%	1, 0, 0, 0, 0, 1, 0, 0, 0, n/a, 0	1, 0, 0, 0, 0, 1, 0, 0, 0, n/a, 0	0.2 (CV = 1.0)
CA/OR thresher shark/swordfish drift gillnet	93-00	obs data	12-25%	0, 0, 0, 0, 0, 1, 1, 0	0, 0, 0, 0, 0, 5, 5, 0	2.5* (CV = 0.58)
Observer program total						2.7 (CV = 0.54)
				Reported mortalities		
Bristol Bay salmon drift and set gillnet fisheries	90-00	logbook /self-reports	n/a	2, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Unknown west coast fisheries	93-00	strand data	n/a	0, 5, 3, 3, 6, 4, 5, 8	n/a	[≥5.2]
AK salmon purse seine	99-00	strand data	n/a	1, 0	n/a	[≥0.5]
Minimum total annual mortality						≥8.9

* Only 1997-2000 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

Reports of entangled gray whales found swimming, floating, or stranded with fishing gear attached occurs 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; while Table 25b presents data on strandings that occurred on the U. S. west coast from 1999-00. The strandings resulting from commercial fishing are listed as unknown west coast fisheries in Table 25a, unless they could be attributed to a particular fisheries. During the 5-year period from 1996-2000, stranding network data indicate a minimum annual mean of 5.7 gray whale mortalities resulting from interactions with commercial fishing gear.

Table 25b. Human-related gray whale strandings and entanglements, 1999-2000. An asterisk in the "number" column indicates cases that were not considered serious injuries.

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	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" 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

It should be noted that no observers have been assigned to most Alaska gillnet fisheries, including those in Bristol Bay which 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 commercial fisheries (8.9 whales; based on observer data (2.7) and logbook/self-reports (0.5) or stranding reports (5.7) where observer data were not available) is not known to exceed 10% of the PBR (58) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

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 Alaskan 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. Russian aboriginals harvested 123 (+2 struck and lost) gray whales in 1998 (IWC 2000), 121 (+2 struck and lost) in 1999 (IWC 2001), and 113 (+2 struck and lost) in 2000 (Borodin 2001), while the Makah Tribe harvested 1 whale in 1999 (IWC 2001). Based on this information, the annual subsistence take averaged 97 whales during the 5-year period from 1996-00. This level of take is well below the 1968-93 average of 159 whales per year (IWC 1995), during which time the population size increased.

Other Mortality

The near shore migration route used by gray whales makes ship strikes another potential source of mortality. Between 1996 and 2000, the California stranding network reported 5 serious injuries or mortalities of gray whales caused by ship strikes: 3 in 1998 and 1 per year in 1999 and 2000 (J. Cordaro, pers. comm.). One ship strike mortality was reported in Alaska in 1997 (B. Fadely, 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 25b). A Russian harpoon tip was found in a dead whale that stranded in 1999 (R. Brownell, 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.

STATUS OF STOCK

The Eastern North Pacific stock of gray whales has been increasing in recent years while being subjected to known harvests. Based on currently available data, the estimated annual level of human-caused mortality and serious injury (107), which includes mortalities from commercial fisheries (9), Russian harvest (97), and ship strikes (1) does not exceed the PBR (575). Therefore, the Eastern North Pacific stock of gray whales is not classified as a strategic stock. In 1994 this stock 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, followed a review of 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.

On 28 March 2001, NMFS received a petition from D. J. Schubert, on behalf of Australians for Animals, The Fund for Animals and several other organizations, to list the Eastern North Pacific stock of gray whales as threatened or endangered under the ESA. On 21 May 2001, NMFS determined that the petition did not present substantial scientific or commercial information sufficient to warrant the listing of this stock (66 FR 32305).

CITATIONS

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.

Borodin, R. G. 2001. Aboriginal whaling in Chukotka waters in 2000. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/BRG23). 10 pp.

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.

Buckland, S. T., and J. M. Breiwick. In press. Estimated trends in abundance of eastern Pacific gray whales from shore counts, 1967/68 to 1995/96. J. Cetacean Res. Manage. (SC/A90/G9).

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.

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.

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.

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.

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.

Fraser, F. C. 1970. An early 17th century record of the California gray whale in Icelandic waters. Invest. Cetacea 2:13-20.

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.

Gosho, M. E., P. J. Gearin, J. Calambokidis, K. M. Hughes, L. Cooke, and V. E. Cooke. 1999. Gray whales in the waters of northwestern Washington in 1996 and 1997. Unpubl. doc. submitted to Int. Whal. Comm. (SC/51/AS9). 15 pp.

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. In press. Abundance of gray whales in the 1995/96 southbound migration in the eastern North Pacific. J. Cetacean Res. Manage. (SC/48/AS9).

International Whaling Commission. 1995a. Report of the Scientific Committee. Rep. Int. Whal. Comm. 45:53-95.

International Whaling Commission. 1995b. Report of the Sub-Committee on Aboriginal Subsistence Whaling. Rep. Int. Whal. Comm. 45:142-164.

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. 2000. International Whaling Commission Report 1998-99. Annual Report of the International Whaling Commission 1999:1-3.

International Whaling Commission. 2001. International Whaling Commission Report 1999-2000. Annual Report of the International Whaling Commission 2000:1-3.

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. 96(2):271-284.

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.

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(l):121-144.

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.

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., 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., and D. J. Rugh. 2001. Gray whale calf sightings in California during southbound migrations, 1995-2001. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/BRG4). 7 pp.

Shelden, K. E. W., D. J. Rugh, and S. A. Boeve. 1995. Gray whale calf sightings during southbound migrations, 1952-95. Unpubl. doc. submitted to Int. Whal. Comm. (SC/47/AS4).

Swartz, S. L., B. L. Taylor, and D. J. Rugh. 2000. Review of studies on stock identity in the gray whale (*Eschrichtius robustus*). Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/SD03). 30 pp.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

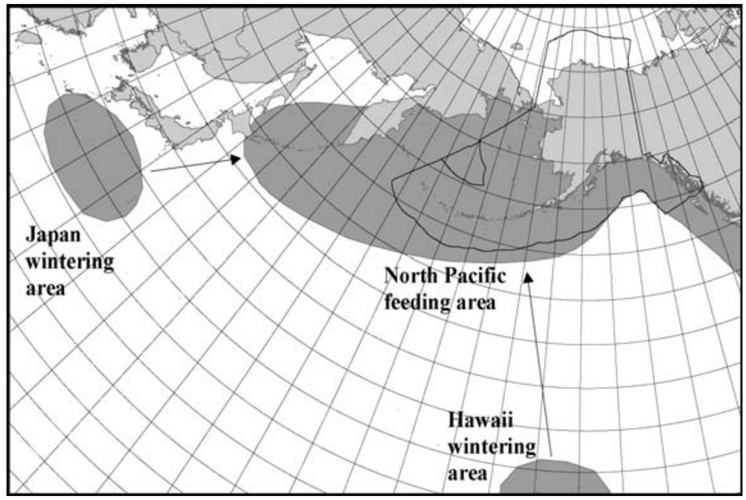

Figure 33. Approximate distribution of humpback whales in the western North Pacific (shaded area). Feeding and wintering grounds are presented above (see text). See Figure 34 for humpback whale distribution in the eastern North Pacific.

The humpback whale is distributed worldwide in all ocean basins, though it is less common in Arctic waters. In winter, most humpback whales occur in the temperate and tropical waters of the North and South Hemispheres (from 10°-23° latitude). Humpback whales in the North Pacific are seasonal migrants that feed on zooplankton and small schooling fishes in the cool, coastal waters of the western United States, western Canada, and the Russian Far East (NMFS 1991). The historic 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 (Nemoto 1957, Tomlin 1967, Johnson and Wolman 1984). These recent sightings clearly demonstrate that the Bering Sea remains an important feeding area. Humpback whales have been known to enter the Chukchi Sea (Johnson and Wolman 1984). The humpback whale population in much of this range was considerably reduced as a result of intensive commercial exploitation during the 20th century.

Recent surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 resulted in new information about the distribution of humpback whales in these areas (Moore et al. 2002). The only sightings of humpback whales in the central-eastern Bering Sea was southwest of St. Lawrence Island; animals co-occurred with a group of killer whales and a large aggregation of Arctic cod. A few sightings occurred in the southeast Bering Sea, primarily outside Bristol Bay (Moore et al. 2002).

Aerial, vessel, and photo-identification surveys and genetic analyses indicate that within the U. S. Exclusive Economic Zone (EEZ) there are at least three relatively separate populations that migrate between their respective summer/fall feeding areas to winter/spring calving and mating areas (Calambokidis et al. 1997, Baker et al. 1998, Figs. 33 and 34): 1) winter/spring populations in coastal Central America and 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) - referred to as the California/Oregon/Washington and Mexico stock; 2) winter/spring populations of the Hawaiian Islands which migrate to northern British Columbia/Southeast Alaska and Prince William Sound west to Kodiak (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997) - referred to as the Central North Pacific stock; and 3) winter/spring populations of Japan which, based on Discovery Tag information, probably migrate to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall (Berzin and Rovnin 1966, Nishiwaki 1966, Darling 1991) - referred to as the Western North Pacific stock. Winter/spring populations of humpback whales also occur near Mexico's offshore islands. The migratory destination of these whales is not well known (Calambokidis et al. 1993, Calambokidis et al. 1997). Some recent exchange between winter/spring areas has been documented (Darling and McSweeney 1985, Baker et al. 1986, Darling and Cerchio 1993), as well as movement between Japan and British Columbia, and Japan and the Kodiak Archipelago (Darling et al. 1996, Calambokidis et al. 1997).

Currently, there are insufficient data to apply the Dizon et al.(1992) phylogeographic approach to classify population structure in humpback whales. Until further information becomes available, three stocks of humpback whales (as described above) are recognized within the U.S. EEZ of the North Pacific: one in the Eastern North Pacific (the

California/Oregon/Washington - Mexico stock), one in the Central North Pacific, and one in the Western North Pacific. The California/Oregon/Washington - Mexico humpback whale stock is reported separately in the Stock Assessment Reports for the Pacific Region.

Little is known about the feeding areas located in U.S. waters for the western North Pacific humpback whale stock. There has only been one study designed to photo-identify individual animals in the North Pacific waters west of the Kodiak Archipelago (Waite et al. 1999). Over 3 years, this study collected photographs of 127 individuals located near Kodiak Island, 22 individuals located near the Shumagin Islands, 8 individuals located offshore to the southeast of the Shumagin Islands, and 7 individuals located near Akutan Island in the eastern Aleutian Islands. Only 7 of these individuals have been documented in Prince William Sound or Southeast Alaska. Waite et al. (1999) provide strong evidence that the waters around Kodiak support a discrete feeding aggregation, and it is unknown where these whales spend the winters. The lack of effort in the waters west of the Kodiak Archipelago is likely responsible for the fact that none of the whales identified off Japan have been resighted in the historical feeding areas of the stock (Bering Sea and Aleutian Islands). Individuals identified off Japan, however, have been resighted in the eastern North Pacific (Darling et al. 1996, Calambokidis et al. 1997). This may indicate that the western North Pacific humpback whale stock did not exclusively use the feeding areas in the western Pacific, or that a shift in the migratory destination of this stock has occurred. Thus, some unknown fraction of whales from the wintering grounds off Japan spend their summers feeding in areas typically utilized by whales from the central North Pacific stock.

POPULATION SIZE

The abundance estimate of humpback whales in the North Pacific is based on data collected by nine independent research groups that conducted photo-identification studies of humpback whales in the three wintering areas (Mexico, Hawaii, and Japan). Photographs taken between 1991 and 1993 were used to estimate abundance because samples throughout the entire North Pacific were the largest and most complete during this period. Using Darroch's (1961) method, which utilizes only data from wintering areas (in this case data provided by two Japanese research groups), and averaging the 1991-92, 1992-93, and 1991-93 winter release-recovery information results in an abundance estimate of 394 (CV = 0.084) for the Western North Pacific humpback whale stock (Calambokidis et al. 1997).

A vessel survey conducted in August of 1994 covered 2,050 nautical miles of trackline south of the Aleutian Islands encountered humpback whales in scattered aggregations (57 sightings) throughout the study area (Forney and Brownell 1996). It is unknown whether the humpback whales encountered during this survey belonged to the Western or Central North Pacific stock.

A vessel survey for cetaceans was conducted in the central Bering Sea in July-August 1999 in cooperation with research on commercial fisheries (Moore et al. 2000). The survey included 6,043 nmi of tracklines, most of which were West of St. Matthew Island, north of the 200m bathymetric contour, and south of the U.S./Russia Convention Line. Ten on-effort sightings of humpback whales occurred during this survey, the majority of which took place along the eastern Aleutian chain and near the U.S./Russian Convention Line just south of St. Lawrence Island. If these localized sightings are extrapolated to the entire survey area, an estimated abundance of 1,175 humpback whales (95% CI 197-7,009) occur in the central Bering Sea during the summer. However, Moore et al. (2002) determined that these sightings were too clumped in the central-eastern Bering Sea to be used to provide a reliable estimate for the area. Sightings of humpback whales also occurred during the survey conducted in the eastern Bering Sea in 2000; these sightings resulted in an estimated abundance of 102 (95% CI = 40-262). It is unknown whether these animals belong to the central or western North Pacific stock of humpback whales.

Photo-identification studies initiated to the west of Kodiak Island in 1999 have identified approximately 350 individual humpback whales, and matches between these animals and animals documented in Hawaii, Japan and Mexico have occurred (B. Witteveen, unpublished report). It is not known how many animals occurring to the west of Kodiak Island belong to the western or central North Pacific stock.

There are no reliable estimates for the abundance of humpback whales at feeding areas for this stock because the specific feeding areas are largely unknown.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 394 and its associated CV(N) of 0.084, N_{MIN} for this humpback whale stock is 367.

Current Population Trend

Reliable information on trends in abundance for the Western North Pacific humpback whale stock are currently not available.

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. However, there are no estimates of the growth rate of humpback whale populations in the North Pacific (Best 1993). Hence, until additional data become available from this or other North Pacific humpback whale stocks, it is recommended that the cetacean maximum net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.1, the value for cetacean stocks listed as endangered under the Endangered Species Act (Wade and Angliss 1997). Thus, for the Western North Pacific stock of humpback whale, PBR = 0.7 animals (367 × 0.02 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries operating in Alaska waters within the range of this stock were monitored for incidental take by fishery observers during 1990-2000: Bering Sea/Aleutian Islands groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. One humpback whale mortality was observed in the Bering Sea/Aleutian Islands groundfish trawl fishery during both 1998 and 1999. Average annual mortality from observed fisheries was 0.6 humpbacks from this stock (Table 26). Note, however, that the stock identification is uncertain and the mortality may have been attributable to the central North Pacific stock of humpback whales. Thus, this mortality is assigned to both the central and western stocks.

An additional source of information on the number of humpback whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 2001, there were no fisher self-reports of humpback whale injuries or mortalities from interactions with commercial fishing gear in any Alaska fishery within the presumed range of the Western North Pacific humpback whale stock. Logbook data are available for part of 1989-94, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

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). Averaging this mortality over the 5-year period 1994-99 results in an estimated annual mortality of 0.2 humpback whales from this stock. This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found, or reported.

Table 26. Summary of incidental mortality of humpback whales (western North Pacific stock) due to commercial fisheries from 1990-2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate. For a particular fishery, the most recent 5 years of available data are used in the mortality calculation when more than 5 years of data are provided. *The humpback whale mortality from 1998 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. 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
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	97-01	obs data	62-77%	0, 0, 1, 0, 0	0, 1*, 1, 0, 0	0.6 (CV = 0.44)
Observer program total						0.6
				Reported mortalities		
Unknown fishery (Bering Sea)	94-01	strand data	n/a	0, 0, 0, 1, 0, 0, 0	≥0.2	[≥0.2]
Minimum total annual mortality						[≥0.8]

The estimated annual mortality rate incidental to commercial fisheries is 0.8 (0.6 from observed fisheries plus 0.2 from the stranding data) whales per year from this stock. 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 the only known matches to feeding areas come from areas typically used by the Central North Pacific stock.

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.

Subsistence/Native Harvest Information

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

HISTORIC WHALING

The number of humpback whales in the North Pacific may have numbered approximately 15,000 individuals prior to exploitation (Rice 1978). Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century (Rice 1978). This mortality estimate likely underestimates the actual kill as a result of under-reporting of the Soviet catches (Yablokov 1994).

STATUS OF STOCK

The estimated human-related annual mortality rate (0.8) exceeds the PRB level for this stock (0.7). At least one of the mortalities occurred in a U. S. fishery; therefore, the estimated fishery mortality and serious injury rate exceeds 10% of the PBR (0.07). 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 humpback whale stock is classified as a strategic stock. Reliable population trend data and the status of this stock relative to its Optimum Sustainable Population size are currently unknown. Noise pollution from the U. S. Navy's Low Frequency Active sonar program and other anthropogenic sources (i.e., shipping) is a potential concern as to the health of 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, 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.)

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

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. 5p.

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

Calambokidis, J., G. H. Steiger, and J. R. Evenson. 1993. Photographic identification and abundance estimates of humpback and blue whales off California in 1991-92. Final Contract Report 50ABNF100137 to Southwest Fisheries Science Center, 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 Zeigesar, 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.

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., and D. J. McSweeney. 1985. Observations on the migrations of North Pacific humpback whales (*Megaptera novaeangliae*). Can. J. Zool. 63:308-314.

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.

Darroch, J. N. 1961. The two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48:241-260.

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/O 11). 15 pp.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish. Rev. 46(4):30-37.

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. Manag. 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.

National Marine Fisheries Service. 1991. Recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the humpback recovery team for the National Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. Tokyo 12:33-89.

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.

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.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mammal Sci. 7:306-310.

Tomlin, A. G. 1967. Mammals of the USSR and adjacent countries. vol. 9, Cetacea. Israel Program Sci. Transl. No. 1124, Natl. Tech. Info. Serv. TT 65-50086. Springfield, VA. 717 pp. (Translation of Russian text published in 1957).

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

Waite, J. M., M. E. Dahlheim, R. C. Hobbs, S. A. Mizroch, O. 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, AK. Mar. Mammal Sci. 15(1):210-219.

Witteveen, B. H. 2003. A catalogue of western Alaska humpback whales. Unpublished report submitted to the National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA.

Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

The humpback whale is distributed worldwide in all ocean basins, though it is less common in Arctic waters. In winter, most humpback whales occur in the temperate and tropical waters of the North and South Hemispheres (from 10°-23° latitude). Humpback whales in the North Pacific are seasonal migrants that feed on zooplankton and small schooling fishes in the cool, coastal waters of the western United States, western Canada, and the Russian Far East (NMFS 1991). The historic 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 (Nemoto 1957, Tomlin 1967, Johnson and Wolman 1984). A recent vessel survey in the central Bering Sea in July of 1999 documented 17 humpback whale sightings, most of which were distributed along the eastern Aleutian Island chain and along the U.S.-Russia Convention Line south of St. Lawrence Island (Moore et al. 2000). These recent sightings clearly demonstrate that the Bering Sea remains an important feeding area. Humpback whales have been known to enter the Chukchi Sea (Johnson and Wolman 1984). The humpback whale population in much of this range was considerably reduced as a result of intensive commercial exploitation during the 20th century.

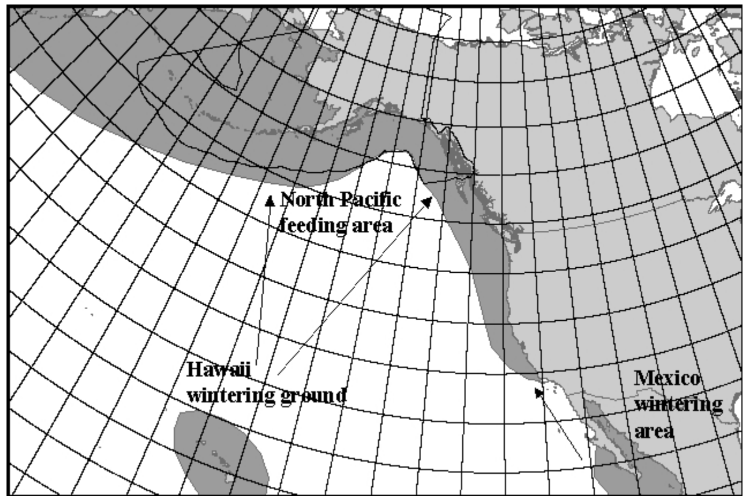

Figure 34. Approximate distribution of humpback whales in the eastern North Pacific (shaded area). Feeding and wintering areas are presented above (see text). See Figure 33 for distribution of humpback whales in the western North Pacific.

Aerial, vessel, and photo-identification surveys and genetic analyses indicate that within the U. S. Exclusive Economic Zone (EEZ) there are at least three relatively separate populations that migrate between their respective summer/fall feeding areas to winter/spring calving and mating areas (Calambokidis et al. 1997, Baker et al. 1998, Figs. 33 and 32): 1) winter/spring populations in coastal Central America and Mexico which migrate to the coast of California4 to southern British Columbia in summer/fall (Calambokidis et al. 1989, Steiger et al. 1991, Calambokidis et al. 1993) - referred to as the California/Oregon/Washington and Mexico stock; 2) winter/spring populations of the Hawaiian Islands which migrate to northern British Columbia/Southeast Alaska and Prince William Sound west to Kodiak (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997) - referred to as the Central North Pacific stock; and 3) winter/spring populations of Japan which, based on Discovery Tag information, probably migrate to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall (Berzin and Rovnin 1966, Nishiwaki 1966, Darling 1991) - referred to as the Western North Pacific stock. Winter/spring populations of humpback whales also occur in Mexico's offshore islands. The migratory destination of these whales is not well known (Calambokidis et al. 1993, Calambokidis et al. 1997). Some recent exchange between winter/spring areas has been documented (Darling and McSweeney 1985, Baker et al. 1986, Darling and Cerchio 1993), as well as movement between Japan and British Columbia, and Japan and the Kodiak Archipelago (Darling et al. 1996, Calambokidis et al. 1997).

Currently, there are insufficient data to apply the Dizon et al. (1992) phylogeographic approach to classify population structure in humpback whales. Until further information becomes available, 3 stocks of humpback whales (as described above) are recognized within the U. S. EEZ of the North Pacific: one in the Eastern North Pacific (the California/Oregon/Washington - Mexico stock), one in the Central North Pacific, and one in the Western North Pacific. The California/Oregon/Washington - Mexico humpback whale stock is reported separately in the Stock Assessment Reports for the Pacific Region.

The central North Pacific stock of humpback whales consists of feeding aggregations along the northern Pacific rim, and some humpbacks are present offshore in the Gulf of Alaska (Brueggeman et al., 1989). Humpback whales are also present in the Bering Sea (Moore et al. 2002); it is not conclusively known whether these animals belong to the western or central North Pacific stocks. Three feeding areas for the Central North Pacific stock that have been studied using photo-identification techniques are southeastern Alaska, Prince William Sound, and Kodiak Island. There has been some exchange of individual whales between these locations. For example, six whales have been sighted in Prince William Sound and southeastern Alaska since studies began in 1977 (Perry et al. 1990, von Ziegesar et al. 1994; S. Baker, D. McSweeny, J. Straley, O. von Ziegesar, unpubl. data, Mizroch et al., in review); nine whales have been sighted between Kodiak Island, including the area adjacent to Kodiak along the Kenai Peninsula, and Prince William Sound; and two whales have been sighted between Kodiak and southeastern Alaska (Waite et al. 1999). Calambokidis et al. (2001) reports interchange between Kodiak, Prince William Sound, and Southeast Alaska, although the number of individuals seen in multiple locations is small. No interchange was reported between the Shumagin Islands and any other feeding area; however, given that the number of animals photographed in the vicinity of the Shumagin Islands was very small (15), this result may not be surprising. Mizroch et al. (in review) examined photographs from 1979 to 1996 and reported that under 1% of the individual whales photographed in either Southeast Alaska or Prince William Sound moved between areas. Fidelity to feeding areasis maternally directed; that is, whales return to the feeding areas where their mothers first brought them as calves (Martin et al. 1984, Baker et al. 1987).

As noted above, there is very little interchange documented between the Southeast Alaska feeding area and the Prince William Sound, Kodiak, and Shumagin Islands feeding areas to the north. Because of the documented lack of interchange, it is possible that a severe reduction in the population in the Southeast Alaska feeding area would not be augmented by animals frequenting other feeding areas within a timeframe relevant to managers. Thus, NMFS is considering whether the Southeast Alaska feeding area, and possibly other feeding areas in the North Pacific, should be formally designated as separate stocks under the MMPA. In preparation for this decision, a PBR level and annual mortality rates will be calculated for the Southeast Alaska feeding area and included in the report for the entire central North Pacific humpback whale stock in order to guide managers in prioritizing conservation actions.

POPULATION SIZE

This stock of humpback whales winters in Hawaiian waters (Baker et al. 1986). Baker and Herman (1987) used capture-recapture methodology in Hawaii to estimate the population at 1,407 (95% CI 1,113-1,701), which they considered an estimate for the entire stock (NMFS 1991). However, the robustness of this estimate is questionable due to the opportunistic nature of the survey methodology in conjunction with a small sample size. Further, the data used to produce this estimate were collected between 1980 and 1983.

The current abundance estimate of humpback whales in the North Pacific is based on data collected by nine independent research groups that conducted photo-identification studies of humpback whales in the three wintering areas (Mexico, Hawaii, and Japan). Photographs taken between 1991 and 1993 were used to estimate abundance because samples throughout the entire North Pacific were the largest and most complete during this period. Using Darroch's (1961) method, which utilizes only data from wintering areas, and averaging the 1991-92, 1992-93, and 1991-93 winter release-recovery information results in an abundance estimate of 4,005 (CV = 0.095) for the entire central North Pacific humpback whale stock (Calambokidis et al. 1997).

Photo-identification methods were used to identify 149 individual humpback whales identified in Prince William Sound from 1977 to 1993 (von Ziegesar 1992, Waite et al. 1999). The abundance of the Prince William Sound feeding aggregation is thought to be less than 200 whales (Waite et al. 1999). Waite et al. (1999) identified 127 individuals in the Kodiak area between 1991 and 1994, and calculated a total annual abundance estimate of 651 (95% CI: 356-1,523) for the Kodiak region.

Photo-identification studies initiated to the west of Kodiak Island in 1999 have identified approximately 350 individual humpback whales, and matches between these animals and animals documented in Hawaii, Japan and Mexico have occurred (B. Witteveen, unpublished report). It is not known how many animals occurring to the west of Kodiak Island belong to the western or central North Pacific stock.

In the Northern British Columbia region (primarily near Langara Island), 275 humpback whales were identified from 1992 to 1998 (G. Ellis, pers. comm., Pacific Biological Station, Nanaimo, BC, V9R 5K6).

Different studies have used different approaches to estimate the abundance of animals 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 an 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 southeastern Alaska was 404 animals (95% CI:350-458). Straley et al. (2002) examined data for the northern portion of Southeast Alaska from 1994-00 and provided and updated abundance estimate of 961 (95% CI: 657-1,076). The sum of the available estimates for the known feeding areas is 2,036 (149 in PWS, 651 in Kodiak, 961 in Southeast, and 275 in British Columbia), which is well below the Calambokidis et al. (1997) estimate of 4,005 based on data collected from 1991to 1993. However, the estimate for Southeast Alaska is known to be a minimum estimate because there is little to no photo-identification effort in the lower half of Southeast Alaska (south of Frederick Sound). In addition, many humpback whales feed seasonally near the Shumagin Islands, where photo-identification studies have only recently been initiated, and humpbacks are seen pelagically in the Gulf of Alaska. Finally, Moore et al. (in press) has documented humpback whales in the Bering Sea, and it is not conclusively known whether these animals belong to the central or western North Pacific humpback whale stock.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated according to Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. Using the population estimate (N) of 4,005 and its associated CV(N) of 0.095, N_{MIN} for the entire central North Pacific humpback whale stock is 3,698.

Although the Southeast Alaska feeding aggregation cannot be considered a stock, the calculation of a PBR for this area may be useful for management purposes. Using the population estimate (N) of 961 and its associated CV(N) of 0.12, N_{MIN} for this aggregation is 868.

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 the stock has increased in abundance between the early 1980s and early 1990s. However, the robustness of the Baker and Herman (1987) estimate is questionable due to the small sample size and opportunistic nature of the survey. As a result, although data support an increasing population size for this stock, it is not possible to assess the rate of increase.

The estimated number of animals in the Southeast Alaska portion of this stock has increased. The 2000 estimate of 961 (Straley et al. 2002) is substantially higher than estimates from the early and mid-1980s. A trend for the Southeast Alaska portion of this stock cannot be estimated from the data, however, because of differences in methods and areas covered.

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 no estimates of the growth rate of the entire humpback whale population in the North Pacific , it is clear that the abundance has increased in Southeast Alaska in recent years. The available information indicates that the rate of increase between 1979 and 2000 is estimated at 0.088, which is a more accurate estimate of the maximum net productivity rate than the default estimate. Thus, it seems reasonable to use a 0.088 as a new, conservative estimate of the current rate of increase as the maximum net productivity rate.

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). An estimate of the maximum net productivity rate is not available for the entire stock, so the default value of 0.04 will be used for both the entire stock and the portion of the stock which occurs in Southeast Alaksa. Thus, for the entire Central North Pacific stock of humpback whale, PBR = 7.4 animals (3,698 × 0.02 × 0.1). The PBR level for the Southeast Alaska portion of this stock, PBR = 3.5 animals (868 × 0.04 × 0.1), and the PBR level for the northern portion of the stock is 3.9 animals (7.4 - 3.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Four different commercial fisheries operating in Alaska waters within the range of the Central North Pacific humpback whale stock were monitored for incidental take by fishery observers during 1990-01: Bering Sea/Aleutian Island groundfish trawl, Gulf of Alaska groundfish trawl, longline, and pot fisheries. One humpback whale mortality was observed in the Bering Sea/Aleutian Islands groundfish trawl fishery in 1998 and one in 1999. Average annual mortality from the observed fisheries in Alaska was 0.6 humpbacks from this stock (Table 27a). Note, however, that the stock identification is uncertain and the mortality may have been attributable to the western stock of humpback whales. Thus, this mortality is assigned to both the central and western stocks. Fishery observers also monitored the Hawaii swordfish, tuna, billfish, mahi mahi, wahoo, oceanic shark longline/setline fishery during the same period. The range of observer coverage for this fishery, as well as the annual observed and estimated mortalities, are presented in Table 27a. The observer program in the Hawaii fishery was voluntary from 1990 through 1993, leading to very low levels of observer coverage during those years (<1%). In 1994, the observer program became mandatory and observer coverage has been approximately 4-5% since that time. Fishery observers recorded one humpback whale entangled in longline gear in 1991. The fate of this animal is unknown, though it is presumed to have died. The mortality rate was not estimated from the 1991 mortality due to the low level of observer coverage in that year (<1%). Therefore, that single mortality also appears as the estimated mortality for 1991 and should be considered a minimum estimate. Note that another humpback whale was reported by fishers and whalewatch operators entangled in longline gear off Maui during 1993 (E. Nitta, pers. comm., National Marine Fisheries Service). This report was never confirmed and the fate of this animal is also unknown. The estimated mean annual mortality rate in all observed fisheries during the 5-year period from 1997 to 2001 is 0.4 humpback whales per year from this entire stock.

An additional source of information on the number of humpback whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the 4-year period between 1990 and 1993, there were no fisher self-reports of humpback whale injuries or mortalities from interactions with commercial fishing gear in any Alaska fishery within the range of the Central North Pacific humpback whale stock. Logbook data are available for part of 1989-94, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details). In 1994, the incidental take of a humpback whale was reported in the Southeast Alaska salmon purse seine fishery. Another humpback whale is known to have been taken incidentally in this fishery in 1989, but due to its historic nature has not been included in Table 27a. In 1996, a humpback whale was reported entangled and trailing gear as a result of interacting with the Southeast Alaska drift gillnet fishery. This whale is presumed to have died. Together, these two mortalities result in an annual mortality rate of 0.4 (0.2 + 0.2) humpback whales based on self-reported fisheries information (Table 27a). This is considered to be a minimum estimate because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994).

Table 27a. Summary of incidental mortality of humpback whales (Central North Pacific stock) due to commercial fisheries from 1990 through 2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate. For a particular fishery, the most recent 5 years of available data are used in the mortality calculation when more than 5 years of data are provided. 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
Hawaii swordfish, tuna, billfish, mahi mahi, oceanic shark longline/setline	90-00	obs data	<1-5%	0, 0, 0, 0, 0	0, 0, 0, 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
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	97-01	obs data	62-77%	0, 0, 1, 0, 0	0, 2, 2, 0, 0	0.6 (CV = 0.44)
Observer program total						0.6
				Reported mortalities		
Southeast Alaska salmon drift gillnet	90-01	self reports	n/a	0, 0, 0, 0, n/a, n/a, 1, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.2]
Southeast Alaska salmon purse seine	90-01	self reports	n/a	0, 0, 0, 0, 1, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.2]
Minimum total annual mortality from observer programs and self reports						North: [≥0.6] SE: [≥0.4]

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 1997 to 2001 are provided in Table 27b and a summary of the information is provided in Table 27c. Overall, there were 34 reports of human-related mortalities or injuries during this 5-year period. Of these, there were 27 incidents which involved commercial fishing gear, and 24 of these incidents involved serious injuries or mortalities. An additional seven incidents of human-related mortality or injury involved ship strikes and will be discussed in a forthcoming section. 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 27b. Human-related strandings and entanglements of humpback whales (central North Pacific stock) from stranding reports, 1997-2001. Areas are designated "SE" for Southeast Alaska or "North" for all other feeding areas; "Unk" indicates that the feeding area to which a whale belongs is unknown; it is assumed that the entanglement was reported in the area where the entanglement occurred, and that duplicate sightings have been removed. An asterisk in the "number" column indicates cases that were not considered serious injuries and thus were not included in the summarized information included in Table 27c.

Year	Number	Area	Condition	Description	Area
1997	1*	Island of Hawaii	Released alive	Alaska crab pot floats removed by U.S. Coast Guard	Unk
1997	1	57 30 N 135 13 W NW Shelter Island	Alive	Collision with skiff	SE
1997	1	Peril Straits, AK	Injured	Entangled in line; attempt to disentangle failed	SE

Year	Number	Area	Condition	Description	Area
1997	1	58 18 N 134 24 W NW Shelter Island	Injured	Tail wrapped in crab pot line	SE
1997	1	58 21N 134 57 W NW Admiralty Island	Alive; entangled	Line and 2' diameter buoy attached	SE
1998	1	Maalaea Bay, Lanai	Alive; entangled	Disentangled from gear, but some line still attached	Unk
1998	1	Sitka, AK	Alive; entangled	Commercial gillnet around flippers	SE
1998	1*	Jakolof Bay	Alive	Disentangled from personal use pot gear	North
1998	1	Ketchikan, AK	Injury; status unknown	Salmon purse seiner net (commercial) torn through, thought to have died	SE
1998	1	Juneau, AK	Injured	Ship strike (8/11)	SE
1998	1	Juneau, AK	Entangled	No details available	SE
1998	1*	Wrangell, AK	Alive	Commercial crab pot buoy removed	SE
1998	1*	Homer, AK	Alive	Tanner crab pot cut loose	North
1998	1	Juneau, AK	Injured	Ship strike (9/24)	SE
1998	1*	Sitka, AK	Alive	Commercial crab pot line cut free	SE
1998	1	Ketchikan	Entangled	Swimming freely with pot gear attached	SE
1999	1	Homer	Entangled	In crab pot gear; released	North
1999	1	Prince of Wales Island	Entangled	In unknown pot gear, released	SE
1999	1	Metlakatla	Injury; status unknown	Ship strike	SE
2000	1*	Lynn Canal	Entangled, released alive, status unknown	Purse seine gear	SE
2000	1*	Skagway	Entangled, released alive	Shrimp pot gear	SE
2000	1	Uyak Bay	Entangled	Unknown gear	North

Year	Number	Area	Condition	Description	Area
1/28/01	1	Hawaii	Injured	Entangled in line/buoy from an AK fishery; released, injured - extent unknown	Unk
6/19/01	1	Dixon Entrance	Possibly injured	Ship strike	SE
5/28/01	1	Resurrection Bay	Entangled, released alive	Swimming freely with multiple lines and buoys attached	North
6/15/01	2	Kodiak	Entangled	Attempt to disentangle failed; mother/calf pair	North
7/12/01	1	Yakutat	Found dead	Entangled in salmon set gillnet	North
7/16/01	1	Glacier Bay	Found dead, decomposed	Ship strike	SE
July 01	1	Bering Glacier	Found dead, decomposed	Entangled in fishing gear	North
8/13/01	1*	Hoonah	Entangled, released alive	Shrimp pot gear	SE
9/18/01	1	Anchorage	Dead	Ship strike	North
9/19/01	1*	Lynn Canal	Entangled, release alive, status unknown	Shrimp pot gear	SE
10/30/01	1*	Sitka	Entangled, release alive, status unknown	Longline gear	SE

Table 27c: Summary of central North Pacific humpback whale mortalities and serious injuries caused by entanglement and ship strikes from stranding reports, 1997-2001. Information used to determine whether an injury was serious or non-serious is included in Table 27b; all animals not identified with an asterisk in Table 27b are considered serious injuries or mortalities.

Area	Human activity/Fishery	Mortalities	Serious injuries	Average annual serious injury/mortality rate, 1997-2001
Northern				
	Ship strikes	0, 0, 0, 0, 1	0, 0, 0, 0, 0	0.2
	Crab gear	0, 0, 0, 0, 0	0, 0, 1, 0, 0	0.2
	Unspecified fishing gear/line	0, 0, 0, 0, 1	0, 0, 0, 1, 3	1.0
	Salmon set gillnet	0, 0, 0, 0, 1	0, 0, 0, 0, 0	0.2
			Total	1.4/year fishery only 1.6/year total
Southeast				
	Ship strikes	0, 0, 0, 0, 1	1, 2, 1, 0, 1	1.2
	Crab pot gear	0, 0, 0, 0, 0	1, 0, 0, 0, 0	0.2
	Unspecified fishing gear/line	0, 0, 0, 0, 0	2, 2, 1, 0, 0	1.2
	Unspecified gillnet	0, 0, 0, 0, 0	0, 1, 0, 0, 0	0.2
	Salmon purse seine	0, 0, 0, 0, 0	0, 1, 0, 0, 0	0.2
			Total	1.8/year fishery only 3.0/year total
Hawaii - summer feeding area unknown				
	Unspecified fishing gear	0, 0, 0, 0, 0	0, 1, 0, 0, 1	0.4/year

The estimated minimum mortality and serious injury rate incidental to commercial fisheries for the northern portion of the stock is 2.0 humpback whales per year, based on observer data (0.6), and stranding records (1.4) Tables 27b and 27c). The estimated minimum mortality and serious injury rate incidental to the commercial fisheries in Southeast Alaska is 2.2 humpback whales per year, based on observer data (0.4) and stranding records (1.8; Tables 27b and 27c). As mentioned previously, these estimates 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, the lack of data regarding the level of humpback whale mortality related to commercial fisheries in northern British Columbia are not available, again reinforcing the point that the estimated mortality incidental to commercial fisheries is underestimated for this stock.

Subsistence/Native Harvest Information

Subsistence hunters in Alaska have not been reported to take from this stock of humpback whales.

Other Mortality

Ship strikes and interactions with vessels unrelated to fisheries have also occurred to humpback whales. These cases are included in Table 27b and summarized in Table 27c. Of those, seven ship strikes constitute "other sources" of mortality; six 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 5 year period from 1997to 2001, these account for an additional 1.4 humpback whale mortalities per year.

HISTORIC WHALING

The number of humpback whales in the North Pacific may have numbered approximately 15,000 individuals prior to exploitation (Rice 1978). Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century and may have reduced this population to as few as 1,000 before it was placed under international protection after the 1965 hunting season (Rice 1978). This mortality estimate likely underestimates the actual kill as a result of under-reporting of the Soviet catches (Yablokov 1994).

STATUS OF STOCK

As the estimated annual mortality and serious injury rate for the entire stock (5.0; 3.6 of which was fishery-related) is considered a minimum, it is unclear whether the level of human-caused mortality and serious injury exceeds the PBR level (7.4) for the entire stock. However, the estimated annual mortality and serious injury rate in Southeast Alaska (3.0, of which 1.8 was fishery-related) is greater than the PBR level if calculated only for the Southeast Alaska portion of the population (3.8). The minimum estimated fishery mortality and serious injury for this stock is not less that 10% of the calculated PBR for either the entire stock 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. At least some portions of the stock have increased in abundance between the early 1980s and 2000, and the fact that the current rate of increase in Southeast Alaska may have recently declined may indicate that the Southeast Alaska portion of the stock is approaching its carrying capacity. However, the status of the entire stock relative to its Optimum Sustainable Population size is unknown.

Habitat Concerns

This stock is the focus of a large whalewatching industry in its wintering grounds (Hawaii) and a growing whalewatching 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 whalewatching. In 2001, NMFS issued regulations to prohibit most approaches to humpback whales in Alaska within 100 yards (91.4m; (66 FR 29502; May 31, 2001)). The growth of the whalewatching industry, however, is a concern as preferred habitats may be abandoned if disturbance levels are too high.

Noise 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 whalewatching) in Hawaii waters is another 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 noise (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., and L. M. Herman. 1987. Alternative population estimates of humpback whales (*Megaptera novaeangliae*) in Hawaiian waters. Can. J. Zool. 65:2818-2821.

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., 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, 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.)

Brueggeman, J. J., G. A. Green, R. A. Grotefendt, and R. W. Tressler. 1989. Marine mammal habitat use on the north Aleutian Basin, St. George Basin, and Gulf of Alaska. Pp. 97-108, *In* L. E. Jarvela and L. K. Thorsteinson (eds.), Proceedings of the Gulf of Alaska, Cook Inlet, and North Aleutian Basin Information Update Meeting. U.S. Dep. Commer., NOAA, NOS, Office of Ocean. and Mar. Assess., 222 W. Eighth Ave., Anchorage, AK.

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

Calambokidis, J., G. H. Steiger, and J. R. Evenson. 1993. Photographic identification and abundance estimates of humpback and blue whales off California in 1991-92. Final Contract Report 50ABNF100137 to Southwest Fisheries Science Center, 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 Zeigesar, 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.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urban, 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, 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.

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.

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., 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.

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., and D. J. McSweeney. 1985. Observations on the migrations of North Pacific humpback whales (*Megaptera novaeangliae*). Can. J. Zool. 63:308-314.

Darroch, J. N. 1961. The two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48:241-260.

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.

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. Mam. Sci. 18(3):644-662.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish. Rev. 46:30-37.

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 Ziegesar. Estimating the adult survival rate of central North Pacific humpback whales. Unpublished manuscript, in review.

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.

National Marine Fisheries Service. 1991. Recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the humpback recovery team for the National Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. Tokyo 12:33-89.

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. Academic Press, New York.

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.

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 novaengliae*) in southeastern Alaska. Pages 229-237 in D. R. Engstrom, ed. Proceedings of the Third Glacier Bay Science Symposium, 1993. National Park Service, Anchorage, AK.

Straley, J. M., T. J. Quinn II, and C. Gabriele. 2002. Estimate of the abundance of humpback whales in Southeastern Alaska 1994-2000. Unpublished final report submitted to NOAA Fisheries. 19 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 Zeigesar, O. , E. Miller, and M. E. Dahlheim. 1994. Impacts on humpback whales in Prince William Sound. Pp. 173-191, *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez.* Academic Press Inc., San Diego, CA.

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. 2003. A catalogue of western Alaska humpback whales. Unpublished report submitted to the National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA.
Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

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 Hawaii, and in the Bering Sea during the summer (Fig. 35). 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; Watkins et al. 2000). Moore et al. (1998) and Watkins et al. (2000) 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 this may be an important feeding area 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 a few calls recorded during the summer months. 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). Fin whale calls have also been well-documented off of Hawaii during the winter (McDonald and Fox 1999), although aerial and shipboard surveys have found relatively few animals in Hawaiian waters (Mobley et al. 1996).

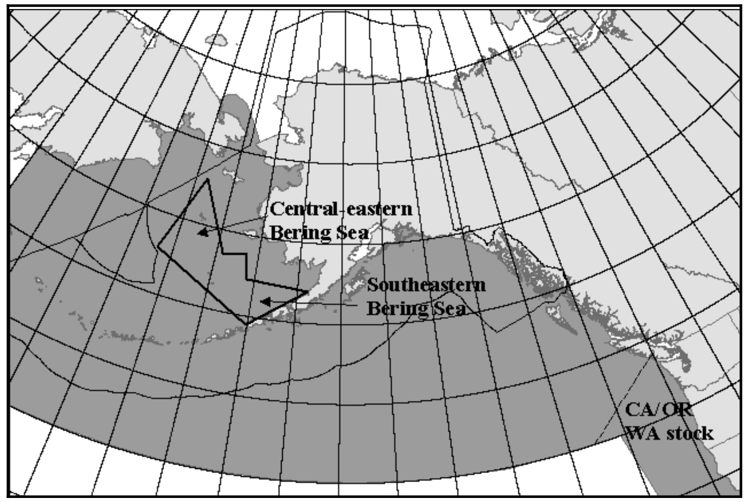

Figure 35. Approximate distribution of fin whales in the eastern North Pacific (shaded area). Enclosed area indicates general location of the 1999 and 2000 pollock surveys in the Bering Sea from which regional estimates of the fin whale population was made.

Recent surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 resulted in new information about the distribution and relative abundance of fin whales in these areas (Moore et al. 2000; 2002). 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 the authors cited additional evidence that supports the establishment of subpopulations in the North Pacific. Further, Fujino (1960) describes an eastern and a western group, which are isolated though may intermingle around the Aleutian Islands. Tag 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 central Baja California (Leatherwood et al. 1982). As a result, stock structure of fin whales is considered equivocal. Based on a conservative management approach, three stocks are recognized: 1) Alaska (Northeast Pacific), 2) California/Washington/Oregon, and 3) Hawaii. 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. Ranges of population estimates for the entire North Pacific prior to exploitation and in the early 1970s are 42,000 to 45,000 and 14,620 to 18,630, respectively (Ohsumi and Wada 1974), representing 32% to 44% of the precommercial whaling population size (Braham 1984). These estimates were based on population modeling, which incorporated catch and observation data. These estimates also include whales from the California/Oregon/Washington stock for which a separate abundance estimate is currently available.

Two recent studies provide some information on presence 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 4 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/1000km^2 from peak call rates during the winter (McDonald and Fox 1999). This density estimate is well below the population density of 1.1 animals/1000km^2 documented off the coast of California (Barlow, 1995; Forney et al. 1995), but does indicate that Hawaii is used seasonally by fin whales.

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, euphausids, 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 south-eastern 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.

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 the Northeast Pacific stock of fin whales are currently not available. There is no indication whether recovery of this stock has or is taking place (Braham 1992; Perry et al. 1999).

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.1, the recommended value for cetacean stocks which are listed as endangered (Wade and Angliss 1997). However, because a reliable estimate of minimum abundance is currently not available, the PBR for this stock is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Prior to 1999, there were no observed or reported mortalities of fin whales incidental to commercial fishing operations within the range of this stock. However, in 1999, one fin whale was killed incidental to the Bering Sea/Aleutian Island groundfish trawl fishery (Table 28). This single mortality results in an estimate of 3 mortalities in 1999, and an average 0.6 (CV =.0.8) mortalities over the 5-year period from 1997 to 2001. Although there have been a few strandings of fin whales recorded in recent years (2 and 1 in 1998 and 1999, respectively; NMFS unpublished data), none of these have been noted as having evidence of fishery interactions.

Table 28. Summary of incidental mortality of fin whales (Northeast Pacific stock) due to commercial fisheries from 1997 to 2001 and calculation of the mean annual mortality rate.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	97-01	obs data	27-32%	0, 0, 1, 0, 0	0, 0, 3, 0, 0	0.6 (CV = 0.8)
Estimated total annual mortality						0.6 (CV = 0.8)

The total estimated mortality and serious injury incurred by this stock as a result of interactions with commercial fisheries is 0.6 (CV = 0.8).

Subsistence/Native Harvest Information

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

Other Mortality

Between 1946 and 1975, 46,032 fin whales were reported killed throughout the North Pacific (International Whaling Commission BIWS data, 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). In 2000, a fin whale was struck by a vessel in Uyak Bay. Assuming this was the only ship strike which occurred during the 5-year period from 1997 to 2001, the average number of ship strikes per year is 0.2. Thus, the total estimated mortality and serious injury incurred by this stock is 0.8.

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. Reliable estimates of the minimum population size, population trends, PBR, and status of the stock relative to its Optimum Sustainable Population size are currently not available. The estimated annual rate of human-caused mortality and serious injury seems minimal for this stock; however, because of the estimated annual take of 0.6 animals, the minimum estimated mortality and serious injury cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. 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. 93:1-14.

Braham, H. 1984. The status of endangered whales: an overview. Mar. Fish. Rev. 46(4):2-6.

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).

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. 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. 93:15-26.

Fujino, K. 1960. Immunogenetic 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.

McDonald, M. A. and C. G. Fox. 1999. Passive acoustic methods applied to fin whale population density estimatation. 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., 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. Manag. 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.

Ohsumi, S., and S. Wada. 1974. Status of whale stocks in the North Pacific. 1972. Rep. Int. Whal. Comm. 24:114-126.

Perry, S. L., D. P. DeMaster, and G. K. Silber. 1999. The Great Whales: History and Status of Six Species Listed as Endangered under the U.S. Endangered Species Act fo 1973. Mar. Fish. Rev. 61(1)

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.

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.

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 180ºN, 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).

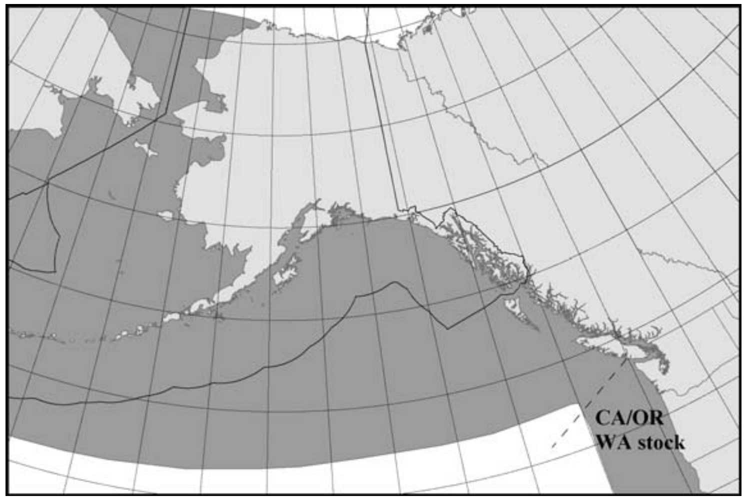

Figure 36. Approximate distribution of minke whales in the eastern North Pacific (shaded area).

Recent 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. 35 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. in press). 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. 36). 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. 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. 35 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. in press). 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. These estimates cannot be used as an estimate of the entire Alaska stock of minke whales because only a portion of the stock's range was surveyed.

Minimum Population

At this time, it is not possible to produce a reliable estimate of minimum abundance for this stock, as current estimates of abundance are not available.

Current Population Trend

There are no data on trends in minke whale abundance in Alaska waters.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of minke whale populations in the North Pacific (Best 1993). Hence, until additional data become available, it is recommended that the cetacean maximum net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{min} \times 0.5R_{Max} \times F_R$. Given the status of this stock is unknown, the appropriate recovery factor is 0.5 (Wade and Angliss 1997). However, because an estimate of minimum abundance is not available, it is not possible to estimate a PBR for the Alaska minke whale stock 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 1990-99: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No minke whale mortalities were observed for any of these fisheries. In 1989, one minke whale mortality (extrapolated to 2 mortalities) was observed in the Bering Sea/Gulf of Alaska joint-venture groundfish trawl fishery, the predecessor to the current Alaska groundfish trawl fishery.

Table 29. Summary of incidental mortality and serious injury of minke whales due to commercial fisheries from 1997 to 2001 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	97-01	obs data	62-77%	0, 0, 0, 1, 0	0, 0, 0, 2, 0	0.3 (CV = 0.61)
Estimated total annual mortality						0.3 (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 2 minke whale mortalities for that year (Table 29). The total estimated mortality and serious injury incurred by this stock as a result of interactions with commercial fisheries is 0.3 (CV = 0.61).

Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

There have been no logbook reports or self-reports of minke whales seriously injured or killed incidental to any fishery in Alaska.

Subsistence/Native Harvest Information

No minke whales were ever taken by the modern shore-based whale fishery in the eastern North Pacific which lasted from 1905 to 1971 (Rice 1974). Subsistence takes of minke whales by Alaska Natives are rare, but have been known to occur. Only seven minke whales are reported the have been taken for subsistence by Alaska Natives between 1930 and 1987 (C. Allison, pers. comm., International Whaling Commission, United Kingdom). 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.

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. Manag. 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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Whaling records indicate that right whales in the North Pacific ranged across the entire North Pacific north of 35°N and occasionally as far south as 20°N (Rosenbaum et al. 2000; Fig. 37). Before right whales in the North Pacific were heavily exploited by commercial whalers, concentrations were found in the Gulf of Alaska, eastern Aleutian Islands, southcentral Bering Sea, Sea of Okhotsk, and Sea of Japan (Braham and Rice 1984). During 1958-82, there were only 32-36 sightings of right whales in the central North Pacific and Bering Sea (Braham 1986). In the eastern North Pacific, south of 50°N, only 29 reliable sightings were recorded between 1900 and 1994 (Scarff 1986, Scarff 1991, Carretta et al. 1994), and one in 1996 off the tip of Baja, California (Gendron 1999). 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, NMFS 1991).

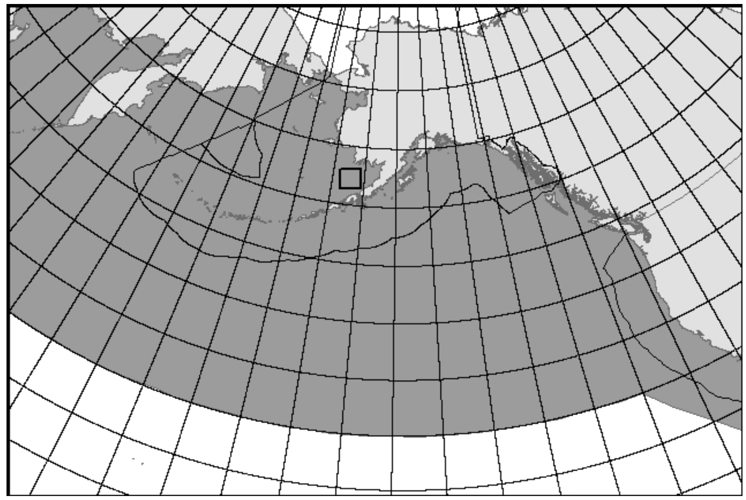

Figure 37. Approximate distribution of North Pacific right whales in the eastern North Pacific (shaded area). The box outlines the area in Bristol Bay where intensive aerial and vessel surveys for right whales have occurred from 1999 to 2002.

Right whales calve in coastal waters during the winter months. However, in the eastern North Pacific no such calving grounds were ever found (Scarff 1986). Migratory patterns of the North Pacific stock are unknown, although it is thought the whales spend the summer on high-latitude feeding grounds and migrate to more temperate waters during the winter (Braham and Rice 1984).

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 Bristol Bay where right whales have been observed each summer since 1996 (Fig. 37). North Pacific right whales are observed consistently in this area, and are not observed on dedicated vessel or aerial survey tracklines along the periphery of the area or outside the area (Tynan 1999; LeDuc et al. 2000; Moore et al. 2000; NMFS unpublished data). Bottom-mounted acoustic recorders were deployed in Bristol Bay and the northern Gulf of Alaska in 2000 to document the seasonal distribution of right whale calls. Preliminary analysis of the data from the recorders indicates that right whales remain in the southeastern Bering Sea at least through October (L. Munger, Scripps Institute of Oceanography, pers. com.). 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. 35 for locations of tracklines for these surveys).

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 Sea of Othotsk stock and an eastern North Pacific Stock (Rosenbaum et al. 2000).

POPULATION SIZE

The pre-exploitation size of this stock exceeded 11,000 animals (NMFS 1991). 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 cow with calf have been confirmed since 1900 (D. Rice, pers. comm., National Marine Fisheries Service). A reliable estimate of abundance for the North Pacific right whale stock is currently not available.

There have been several recent sightings of right whales in the North Pacific. On April 2, 1996 a right whale was sighted off of Maui (D. Salden, pers. comm., Hawaii Whale Research Foundation). This was the first documented sighting of a right whale in Hawaiian waters since 1979 (Herman et al. 1980, Rowntree et al. 1980). More importantly, a group of 3-4 right whales was sighted in western Bristol Bay, southeastern Bering Sea (July 30, 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 July 1998, July 1999, and July 2000, six, five, and eight right whales, respectively, were again found in the same general region of the southeastern Bering Sea (Leduc et al. 2000 and W. Perryman. pers. comm., National Marine Fisheries Service). Genetic analyses on samples from all 5 whales seen in 1999 determined that the animals were all male (LeDuc et al., 2000). Aerial photogrammetric analyses indicated that one of the animals seen in 1999 was also seen in 1998 (LeDuc et al., 2000). Two right whales were recorded during a vessel-based survey in the central Bering Sea in July of 1999 (Moore et al., 2000). Of the eight whales seen during the July 2000 aerial survey, 6 were new animals which had not been seen previously, one was a re-sight, and one could not be reliably identified (R. LeDuc, pers. comm., National Marine Fisheries Service). Preliminary information from the Bristol Bay survey in 2002 indicates that there were seven sightings of right whales; it is not yet known how many of these animals were seen in previous years (NMFS, unpublished data). One of the sightings included a right whale calf; this is the first confirmed sighting of a calf in decades (a possible calf or juvenile sighting was reported in Goddard and Rugh 1998). It is notable that, with the exception of one right whale observed south of Kodiak Island in 1998 (Waite et al. 2002), all recent right whale sightings in Alaskan waters have occurred in this box, despite substantially increased aerial and vessel survey effort in other parts of the Bering Sea and Gulf of Alaska in recent years.

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. However, it is worth noting that, although only 14 individual animals have been photographed during aerial surveys during 1998, 1999, and 2000, there have already been two occurrences of animals which have been photographed in more than one year. This "mark-recapture" success rate is consistent with a very small population size.

Current Population Trend

A reliable 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% be employed for this stock (Wade and Angliss 1997). However, this default rate is likely an underestimate based on the work reported by Best (1993).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.1, the recommended value for cetacean stocks which are listed as endangered (Wade and Angliss 1997). However, because a reliable estimate of minimum abundance is currently not available, the PBR for this stock is unknown.

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. Any mortality incidental to commercial fisheries would be considered significant.

Based on the lack of reported mortalities, the estimated annual mortality rate incidental to commercial fisheries is 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, tend to congregate in coastal areas, and have a thick layer of blubber which enables them to float when killed. These attributes made them an easy and profitable species for early (pre-modern) whalers. By the time the modern (harpoon cannons and steam powered catcher boats) whale fishery began in the late 1800s, right whales were rarely encountered (Braham and Rice 1984). Between 1835 and 1909, an estimated 15,374 right whales were taken from the North Pacific by American-registered whaling vessels, with most of those animals taken prior to 1875 (Best 1987, IWC 1986). In addition, 28 right whales were killed between 1914 and 1951 in Alaskan and British Columbian waters (Reeves et al. 1985). The estimated mortality likely underestimates the actual kill as a result of under-reporting of the Soviet catches (Yablokov 1994).

Ship strikes and entanglement in fishing gear 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 these sources of mortality. However, due to their rare occurrence and scattered distribution it is impossible to assess the threat of ship strikes or entanglement 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. NMFS now considers the North Pacific animals to be distinct at the species level from North Atlantic animals. 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.

On 4 October 2000, NMFS received a petition from the Center for Biological Diversity to designate critical habitat for this stock. Petitioners asserted that the southeast Bering Sea shelf from 55-60° N latitude should be considered critical habitat. On 1 June 2001, NMFS found the petition to have merit (66 FR 29773). On 20 February 2002, NMFS announced a decision to not designate critical habitat for North Pacific right whales (67 FR 7660) at this time. NMFS concluded that the information available did not indicate that the physical or biological features essential to the conservation of the species exist throughout the petitioned area, and that a smaller area may contain essential physical and biological features, but the boundary of this smaller area could not yet be defined. Thus, NMFS determined that critical habitat was undeterminable at this time. However, NMFS will be evaluating new information collected during field studies conducted in 2002, and may propose to designate critical habitat at that time if the new information indicates that certain areas are critical for the conservation of the species and require special management considerations.

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. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci 50:169-86.

Best, P. B. 1987. Estimates of the landed catch of right whale (and other whalebone) whales in the American fishery. Fishery Bulletin 85(3):403-418.

Braham, H. W. 1986. An annotated bibliography of right whales, *Eubalaena glacialis*, in the North Pacific. Rep. Int. Whal. Comm. (Special Issue 10):65-77.

Braham, H. W., and D. W. Rice. 1984. The right whale, *Balaena glacialis*. Mar. Fish. Rev. 46(4):38-44.

Carretta, J. V., M. S. Lynn, and C. A. LeDuc. 1994. Right whale, *Eubalaena glacialis*, sighting off San Clemente Island, California. Mar. Mammal Sci. 10(1):101-104.

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.

Gendron, D., S. Lanham, and M. Carwardine. 1999. North Pacific right whale (*Eubalaena glacialis*) sightings south of Baja California. Aquatic Mammals 25(1): 31-34.

Goddard, P. C., and D. J. Rugh. 1998. A group of right whales seen in the Bering Sea in July 1996. Mar. Mammal Sci. 14(2):344-349.

Herman, L. M., C. S. Baker, P. H. Forestell, and R. C. Antinoja. 1980. Right whale, *Balaena glacialis,* sightings near Hawaii: a clue to the wintering grounds? Mar. Ecol. Prog. Ser. 2:271-275.

International Whaling Commission. 1986. Report of the workshop on the status of right whales. Rep. Int. Whal. Comm. (Special Issue 10):1-33.

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., W. L. Perryman, M. MacDonald, J. Hyde, and R. L. Brownell, Jr. 2000. Progress report on the eastern North Pacific right whale research during July 1999. Paper SC/52/OS13 presented to the International Whaling Commission. 7p.

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.

National Marine Fisheries Service. 1991. Recovery Plan for the Northern Right Whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 86 pp.

Reeves, R. R., S. Leatherwood, S.A. Karl, and E.R. Yohe. 1985. Whaling results at Akutan (1912-39) and Port Hobron (1927-37.), Alaska. Rep. Int. Whal. Commn 35:441-457.

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. Molecular Ecology 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.

Scarff, J. E. 1986. Historic and present distribution of the right whale, *Eubalaena glacialis*, in the eastern North Pacific south of 50˚N and east of 180˚W. Rep. Int. Whal. Comm. (Special Issue 10):43-63.

Scarff, J. E. 1991. Historic distribution and abundance of the right whale, *Eubalaena glacialis*, in the North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan from the Maury Whale Charts. Rep. Int. Whal. Comm. 41:467-487.

Tynan, C. 1999. Redistribution of cetaceans in the southeast Bering Sea relative to anamolous 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.

Waite, J. M., N. A. Friday, and S. E. Moore. 2002. Killer whale (Orcinus orca) distribution and abundance in the central and southeastern Bering Sea, July 1999 and June 2000. Mar. Mamm. Sci. 18(3): 779-786.

Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 54°N and south of 75°N in the western Arctic Basin (Braham 1984). For management purposes, five stocks are currently recognized by the International Whaling Commission (IWC 1992). Small stocks occur in the Sea of Okhotsk, Davis Strait, Hudson Bay, and the offshore waters of Spitsbergen. These small bowhead stocks are comprised of only a few tens to a few hundreds of individuals (Braham 1984, Shelden and Rugh 1995). The largest population, and the only stock that is found within U. S. waters, is the Western Arctic stock (Fig. 38). 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 where they spend much of the summer (mid-May through September) before returning again to the Bering Sea in the fall (September through November) to overwinter (Braham et al. 1980, 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 polar pack ice. There is evidence of whales following each other, even when their route does not take advantage of large ice-free areas, such as polynyas (Rugh and Cubbage 1980). As the whales travel east past Point Barrow, Alaska, their migration is somewhat funneled between shore and the polar pack ice, making for an optimal location from which to study this stock (Krogman 1980). Most of the year, bowhead whales are closely associated with sea ice (Moore and Reeves 1993). Only during the summer is this population 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. 1985, Treacy 2002). 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. 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. 2000).

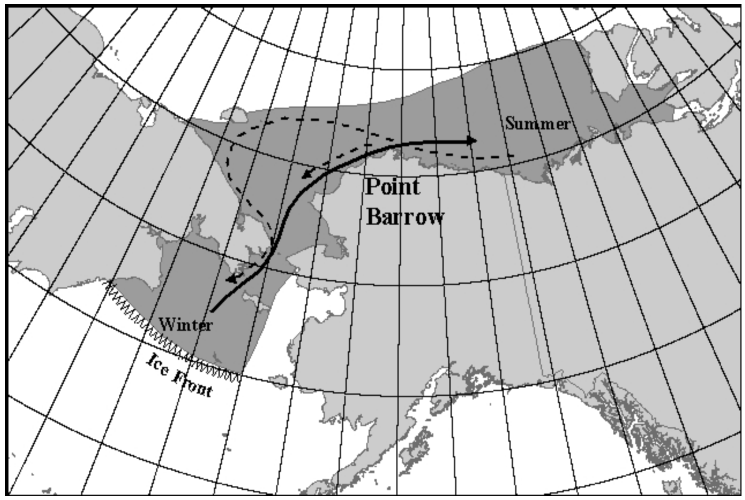

Figure 38. Approximate distribution of the Western Arctic stock of bowhead whales (shaded area). Winter, summer, and spring/fall distributions are depicted (see text).

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 and spreading to the Bering Sea in the mid-19th century (Braham 1984). 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).

Since 1978, 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, and whales missed during a watch (estimated as a function of visibility, number of observers, and distance offshore; Zeh et al. 1994). A summary of the abundance estimates determined using ice-based census techniques corrected by acoustic methods is provided in Table 30. However, these estimates of abundance have not been corrected for a small portion of the population that may not migrate past Point Barrow in spring. In 1993, the census resulted in a population estimate of 8,000 (CV = 0.073), with a 95% confidence interval from 6,900 to 9,200 (Zeh et al. 1994). A refined and larger sample of acoustic data from 1993 resulted in an estimate of 8,200 animals (CV = 0.069; 95% CI = 7,200-9,400), which is considered the best estimate for the population in 1993 (IWC 1996, Zeh et al. 1995). The bowhead census in 2001 resulted in a preliminary estimate of 9,860 (95% CI = 7,700-12,600; CV = 0.12), despite poor visibility conditions, an increase in whale distance from shore, and an increase in variability in offshore distribution relative to conditions during the 1993 census (George et al. 2002). This estimate will be further refined by incorporating additional information on acoustic locations.

Aerial photo-identification of bowhead whales and a capture-recapture analytical approach provides an alternative method for estimating abundance. This approach provided estimates of 4,719 (95% CI = 2,382-9,343) to 7,022 (95% CI = 4,701-12,561), 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 visual and acoustic estimates of 6,039 and 7,734, for 1985 and 1986, respectively (Raftery and Zeh 1994). Although this study does not provide an update to the abundance estimate provided in Zeh et al. (1995), it does demonstrate that the use of aerial photo-identification to estimate a population size for bowhead whales provides a reasonable alternative to the traditional approach of using ice-based and acoustic census techniques.

Table 30: Summary of population abundance estimates for the western Arctic stock of bowhead whales. The 95% confidence interval, when available, is provided in parentheses. The historical estimates were made by back-projecting a simple recruitment model. All other estimates were developed by correcting ice-based census counts using acoustic methods. An asterisk (*) identifies those estimates which result from an ice based census, but are not corrected by acoustic methods. Other methods have been used to estimate population size; these are discussed in the text.

Year	**Population Estimate (95% CI)**	**Source**
Historical estimate	10,400-23,000	Woodby and Botkin 1993
End of commercial whaling	1000-3000	Woodby and Botkin 1993
1978	5,189	Raftery et al. 1995
1980	4,198	Raftery et al. 1995
1981	4,956	Raftery et al. 1995
1982	7,074	Raftery et al. 1995
1983	6,747	Raftery et al. 1995
1985	6,039 (3,300-11,100)*	Zeh et al. 1995
1986	10,300 (8,100-12,900)	Raftery and Zeh 1994
1988	6,579 (5,300-8,200)	Raftery and Zeh 1994
1993	8,200 (7,200-9,400)	Zeh et al. 1995
2001	9,860 (7,700-12,600)*	George et al. 2002

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the preliminary population estimate (N) of 9,860 and its associated CV(N) of 0.124, N_{MIN} for the Western Arctic stock of bowhead whales is 8,886.

Current Population Trend

Raftery et al. (1995) reported the Western Arctic stock of bowhead whales increased at a rate of 3.1% (95% CI = 1.4-4.7%) from 1978 to 1993, during which time abundance increased from approximately 5,000 to approximately 8,000 whales. This rate of increase takes into account whales that passed beyond the viewing range of the ice-based observers. Inclusion of the revised 1993 abundance estimate results in a similar, though slightly higher rate of 3.2% population increase (95% CI = 1.4-5.1%) during the 1978-93 period (IWC 1996). The inclusion of the new preliminary estimate for 2001 results in a rate of increase of 3.3% (95% CI 2-4.7%), which is essentially identical to previous estimates. The count of 121 calves during the 2001 census was the highest yet recorded, was likely caused by a combination of variable recruitment and the large population size (George et al. 2002), and 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 (3.3%) 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 employed 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 is 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 = 89 animals (8,886 × 0.02 × 0.5). The development of a PBR level for the Western Arctic bowhead stock is required by the MMPA even though the subsistence harvest 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 2002-07, a block quota of 280 bowhead strikes will be 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, including those summarized in Table 28 (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, pers. comm., Department of Wildlife Management, North Slope Borough). There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska. Logbook data are available for part of 1989-94, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

New information on entanglements of bowhead whales indicate that animals do have interactions with crab pot gear (Table 31). There have been two confirmed occurrences of entanglement in crab pot gear, one in 1993 and one in 1999; the average rate of entanglement in crab pot gear for 1997-2001 is 0.2.

Table 31. Reported scarring of bowhead whales attributed to entanglement in ropes and description of observations collected during subsistence harvests in Alaska since 1978 (Philo et al. 1993; * D. Rugh, personal communication, National Marine Fisheries Service; ** C. George, personal communication, North Slope Borough

Year	Number of Whales	Location	Description
1978	1	Wainwright	6 scars on caudal peduncle
1986	1	Kaktovik	Scars on caudal peduncle and anterior margin of flukes

1989	1	Barrow	12 scars on ridges of caudal peduncle
1989	1	south of Gambell	Rope wrapped around head, through mouth and baleen
1989*	1	Barrow	Rope ~32m long trailing from mouth
1990	1	Barrow	Scars on caudal peduncle; 2 ropes trailing from mouth.
1991*	1	Barrow	Apparent rope scar from mouth, across back
1993**	1	Barrow	Large female; with crab pot line wrapped around flukes
1998**	1	NW of Kotzebue; near Red Dog Mine dock	Stranded - dead with line on it
1999**	1	Barrow	Whale entangled in confirmed crab gear. Line wrapped through gape of mouth, flipper, and peduncle. Severe injuries.

Subsistence/Native Harvest Information

Eskimos have been taking bowhead whales for at least 2,000 years (Marquette and Bockstoce 1980, Stoker and Krupnik 1993). Subsistence takes have been regulated by a quota system under the authority of the IWC since 1977. Alaska Native subsistence hunters take approximately 0.1-0.5% of the population per annum, primarily from nine Alaska communities (Philo et al. 1993). Under this quota, the number of kills has ranged between 14-72 per year, depending in part on changes in management strategy and in part on higher abundance estimates in recent years (Stoker and Krupnik 1993). The following statistics were compiled from animals taken in the subsistence harvest between 1973 and 1992: 1) the sex ratio of bowheads taken in the hunt was equal; 2) the proportion of adult females taken in the hunt increased from 5% in the early 1970s to over 20% in the late 1980s and early 1990s; 3) approximately 80% of the catch was immature animals prior to 1978 and since has been approximately 60%; and 4) modern Native whalers appear to harvest larger bowheads than precontact (prior to 1849) Native whalers (Braham 1995).

The total take by Alaska Natives, including struck and lost, was reported to be 66 in 1997, 54 in 1998, 47 in 1999, 47 in 2000, and 75 in 2001 (Alaska Eskimo Whaling Commission, unpubl. data, AEWC, P. O. Box 570, Point Barrow, AK 99723; 2001 data provided by Suydam et al. 2002). Canadian Natives are also known to take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik killed one whale in 1991 and one in 1996. The annual average subsistence take (by Natives of Alaska and Canada) during the 5-year period from 1997 to 2001 is 58 bowhead whales. One animal was harvested by Russian subsistence hunters in each of 1999 and 2000 (IWC, In press).

Other Mortality

Pelagic commercial whaling for bowheads principally occurred in the Bering Sea from 1848 to 1919. Within the first two decades of the fishery (1850-1870), over 60% of the stock 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., Canadian, and Russian shores) 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 estimated mortality likely underestimates the actual kill as a result of under-reporting of the Soviet catches (Yablokov 1994), and the lack of reports on struck and lost animals.

STATUS OF STOCK

Based on currently available data, the estimated annual mortality rate incidental to commercial fisheries (0.2) is not known to exceed 10% of the PBR (8.9) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The annual level of human-caused mortality and serious injury (58) is not known to exceed the PBR (89) nor the IWC quota (67). The Western Arctic bowhead whale stock has been increasing in recent years; the current preliminary estimate of 9,860 is between 43% and 95% of the estimated pre-exploitation abundance of 10,400-23,000. However, the stock is classified as a strategic stock because bowhead whale is listed as "endangered" under the Endangered Species Act (ESA), and therefore also designated as "depleted" under the MMPA. The development of criteria for recovery of large whales in general (Angliss et al. 2002) and bowhead whales in particular (Shelden et al. 2001) and will be used in the next 5-year evaluation of stock status.

Habitat Issues

Increasing oil and gas development in the Arctic will lead to an increased risk of various forms of pollution to bowhead whale habitat, including oil spills, toxic and nontoxic waste, and noise due to higher levels of traffic as well as exploration and drilling operations. Evidence indicates that bowhead whales are sensitive to noise from offshore drilling platforms and seismic survey operations (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 cause bowhead whales to avoid the vicinity. Figure 2b in Schick and Urban (2000) demonstrates, however, that the area of disturbance is localized. However, since the bowhead whale population is approaching its pre-exploitation population size and has been increasing at a roughly constant rate for over 20 years, the impacts of oil and gas industry on individual survival and reproduction are likely to be minor.

Another element of concern is the potential for Arctic climate change, which will probably affect high northern latitudes more than elsewhere. There is evidence that over the last 10-15 years, there has been 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. There are insufficient data to make reliable predictions of the effects of Arctic climate change on bowhead whales.

On 22 February 2000, NMFS received a petition from the Center for Biological Diversity and Marine Biodiversity Protection Center to designate critical habitat for this stock. Petitioners asserted that the nearshore areas from the US-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 approaching its pre-commercial whaling population size, the population is increasing, there are no known habitat issues which are slowing the growth of the population, and because activities which occur in the petitioned area are currently 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. Dept. Commer., NOAA Tech. Memo. NMFS-OPR-21. 32p

Braham, H. W. 1984. The bowhead whale, *Balaena mysticetus*. Mar. Fish. Rev. 46(4):45-53.

Braham, H. W. 1995. Sex and size composition of bowhead whales landed by Alaskan Eskimo whalers. Pp. 281-313, *In* A. P. McCartney (ed.), Hunting the largest animals: Native whaling in the western Arctic and subarctic. Studies in whaling No. 3, Occ. Publ. No. 36, Canadian Circumpolar Institute, Univ. of Alberta, Alberta, Canada. 345 pp.

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.

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.

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. Manag. 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.

George, J. C., J. Zeh, R. Suydam, C. Clark. 2002. Population size of the Bering-Chukchi-Beaufort Seas stock of bowhead whales, *Balaena mysticetus*, based on the 2001 census off Point Barrow, Alaska. Paper SC/54/BRG5, presented to the IWC Scientific Committee, Shimonoseki, Japan, 27 Apr - 9 May 2002. 13 p.

International Whaling Commission. 1992. Chairman's Report of the forty-third annual meeting. Rep. Int. Whal. Comm. 42:11-50.

International Whaling Commission. 1996. Report of the Scientific Committee. Rep. Int. Whal. Comm. 46:51-97.

International Whaling Commission. 1997. Report of the Sub-committee on Aboriginal Subsistence Whaling. Rep. Int. Whal. Comm. 47:153-162.

International Whaling Commission. In press. Report of the Scientific Committee. J. Cet. Res. Manage. V. 4 Supplement

Krogman, B. D. 1980. Sampling strategy for enumerating the western Arctic population of the bowhead whale. Mar. Fish. Rev. 42(9-10):30-36.

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.

Marquette, W. M., and J. R. Bockstoce. 1980. Historical shore-based catch of bowhead whales in the Bering, Chukchi, and Beaufort Seas. Mar. Fish. Rev. 42(9-10):5-19.

Miller, G. W., R. E. Elliot, W. R. Koski, V. D. Moulton, and W. J. Richardson. 1999. Whales. *In* W. J. Richardson (ed.). Marine Mammal and Acoustical Monitoring of Western Geophysical's Open-Water Seismic Program in the Alaskan Beaufort Sea, 1998.

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. Mammalogy, 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.

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. Mammalogy, Spec. Publ. No. 2.

Raftery, A.E. and J.E, Zeh,. 1994. Bowhead whale, *Balaena mysticetus*, population size estimated from acoustic and visual census data collected near Barrow, Alaska, in 1993. Paper SC/46/AS13 presented to the IWC ScientificCommittee (unpublished). 25pp.

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., R. A. Davis, C. R. Evans, and P. Norton. 1985. Distribution of bowhead and industrial activity, 1980-84. Pp. 255-306, *In* W. J. Richardson (ed.), Behavior, disturbance responses and distribution of bowhead whales, *Balaena mysticetus*, in the eastern Beaufort Sea, 1980-84. Rept. for U.S. Minerals Mgt. Serv. by LGL Inc., NTIS PB87 124376/AS. 306 pp.

Rugh, D. J., and J. C. Cubbage. 1980. Migration of bowhead whales past Cape Lisburne, Alaska. Mar. Fish. Rev. 42(9-10):46-51.

Rugh, D., D. DeMaster, A. Rooney, J. Breiwick, K. Shelden, and S. Moore. 2000. Review of studies on stock identity in the bowhead whale (*Balaena mysticetus*). Paper SC/52/SD4 presented to the IWC Scientific Committee in June 2000 (unpublished). 27pp.

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. Cons. Bio. 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. Mammalogy, Spec. Publ. No. 2.

Suydam, R.S., T.M. O'Hara, J.C. George, V.M. Woshner, and G. Sheffield. 2002. Subsistence harvest of bowhead whales by Alaskan Eskimos during 2001. Paper SC/54/BRG20, presented to the IWC Scientific Committee, Shimonoseki, Japan, 27 Apr - 9 May 2002. 5p.

Treacy, S.D. 2002. Aerial survey of endangered whales in the Beaufort Sea, Fall 2000. (OCS Study MMS 2002-014) U. S. Dept. Inter., Anchorage, AK, 111p.

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.

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. Mammalogy, Spec. Publ. No. 2.

Yablokov, A. V. 1994. Validity of whaling data. Nature 367:108.

Zeh, J. E., J. C. George, and R. Suydam. 1994. Rate of increase, 1978-1993, of bowhead whales, *Balaena mysticetus*. Rep. Int. Whal. *Comm.*45:339-344.

Zeh, J. E., A. E. Raftery, and A. A. Schaffner. 1995. Revised estimates of bowhead population size and rate of increase. Unpubl. report submitted to Int. Whal. Comm. (SC/47/AS/10). 26 pp.

APPENDICES

Appendix 1.--Summary of changes to the 2003 stock assessments. An 'X' indicates sections where the information presented has been updated since the 2002 SAR was released (last revised 3/04).

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

Appendix 2: Stock summary table (last revised 6/12/03). Stock assessment reports for those stocks in boldface were updated in the 2003 draft SARs.

Species	Stock	N (est)	CV	C.F.	CV C.F.	Comb. CV	N(min)	0.5 Rmax	F(r)	PBR	Fishery mort.	Subsist mort.	Status
Baird's beaked whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	see txt	NS
Bearded seal	Alaska	n/a					n/a	0.06	0.50	n/a	1	6,788	NS
Beluga whale	Beaufort Sea	39,258	0.229	2.00	n/a	0.229	32,453	0.02	1.00	649	0	177	NS
Beluga whale	E. Chukchi Sea	3,710	n/a	3.09	n/a	n/a	3,710	0.02	1.00	74	0	60	NS
Beluga whale	E. Bering Sea	18,142	0.24	3.09	n/a	0.24	14,898	0.02	1.00	298	1*	164	NS
Beluga whale	Bristol Bay	1,888	n/a	3.09	n/a	0.20	1,619	0.02	1.00	32	1*	15	NS
Beluga whale	**Cook Inlet**	**386**	**0.087**			**0.087**	**359**	**0.02**	**0.30**	**2.2**	**0**	**0**	**S**
Bowhead whale	**W. Arctic**	**9,860**	**0.124**			**0.124**	**8,886**	**0.02**	**0.50**	**89**	**0.2**	**58**	**S**
Cuvier's beaked whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	0	NS
Dall's porpoise	**Alaska**	**83,400**	**0.097**			**0.097**	**76,874**	**0.02**	**1.00**	**1,537**	**37.5**	**0**	**NS**
Fin whale	**NE Pacific**	**n/a**					**n/a**	**0.02**	**0.10**	**n/a**	**0.8**	**0**	**S**
Gray whale	E. N. Pacific	26,635	0.1006			0.1006	24,477	0.0235	1.00	575	8.9	97	NS
Harbor porpoise	**SE Alaska**	**10,947**	**0.242**	**1.56[+]**	**0.108[+]**	**0.274**	**8,954**	**0.02**	**0.50**	**90**	**3***	**0**	**NS**
Harbor porpoise	**Gulf of Alaska**	**30,506**	**0.214**	**1.37[+]**	**0.066[+]**	**0.304**	**25,536**	**0.02**	**0.50**	**255**	**25**	**0**	**NS**
Harbor porpoise	**Bering Sea**	**47,356**	**0.223**	**1.337[+]**	**0.062[+]**	**0.300**	**39,328**	**0.02**	**0.50**	**393**	**2**	**0**	**NS**
Harbor seal	SE Alaska	37,450	0.026	1.74	0.068	0.073	35,226	0.06	1.00	2,114	36	1,749	NS
Harbor seal	Gulf of Alaska	29,175	0.023	1.50	0.047	0.052	28,917	0.06	0.50	868	36	791	NS
Harbor seal	Bering Sea	13,312	0.062	1.50	0.047	see txt	12,648	0.06	0.50	379	31	161	NS

Appendix 2 (cont.).

Species	Stock	N (est)	CV	C.F.	CV C.F.	Comb. CV	N(min)	0.5 Rmax	F(r)	PBR	Fishery mort.	Subsist mort.	Status
Humpback whale	**W. N. Pacific**	**394**	**0.084**			**0.084**	**367**	**0.02**	**0.10**	**0.7**	**0.8**	**0**	**S**
Humpback whale	**CNP - entire stock**	**4,005**	**0.095**			**0.095**	**3,698**	**0.02**	**0.10**	**7.4**	**4.2**	**0**	**S**
	CNP - SEAK feeding area	**961**	**0.12**			**0.12**	**868**	**0.02**	**0.10**	**3.5**	**2.2**	**0**	
Killer whale	E. N. Pacific N. resident	723	n/a			see txt	723	0.02	0.50	7.2	1.4	0	NS
Killer whale	E. N. Pacific transient	346	1.0				346	0.04	0.04	2.8	0.6	0	NS
Minke whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	0	NS
North Pacific right whale	**E. N. Pacific**	**n/a**					**n/a**	**0.02**	**0.10**	**n/a**	**0**	**0**	**S**
Northern fur seal	**E. North Pacific**	**888,120**		**4.475**	**n/a**	**0.2**	**751,714**	**0.043**	**0.50**	**16,162**	**16**	**1,132**	**S**
Pacific white-sided dolphin	Cent.N. Pacific	26,880					26,880	0.02	0.50	n/a	4	0	NS
Ribbon seal	Alaska	n/a					n/a	0.06	0.50	n/a	1	193	NS
Ringed seal	Alaska	n/a					n/a	0.06	0.50	n/a	0	9,567	NS
Sperm whale	**N. Pacific**	**n/a**					**n/a**	**0.02**	**0.10**	**n/a**	**0.4**	**0**	**S**
Spotted seal	Alaska	n/a					n/a	0.06	0.50	n/a	3	5,265	NS
Stejneger's beaked whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	0	NS
Steller sea lion	**E. U. S.**	**31,028**					**31,028**	**0.06**	**0.75**	**1,396**	**3.7**	**2**	**S**
Steller sea lion	**W.U. S.**	**34,775**					**34,775**	**0.06**	**0.10**	**209**	**25.9**	**176**	**S**

C.F. = correction factor; CV C.F. = CV of correction factor; Comb. CV = combined CV; Status: S=Strategic, NS=Not Strategic, n/a = not available.
* = No or minimal reported take by fishery observers; however, observer coverage was minimal or nonexistent.
** = this does not include intentional take in British Columbia
[+] = There are two correction factors involved in the estimation of harbor porpoise abundance. One factor is 2.96 (CV = 0.18), which corrects for availability bias, is used for all three estimates for Alaska harbor porpoise stocks, and is from Laake et al (1997). The correction factor included in this table corrects for animals missed on the trackline. Because this number differed for different stocks, this factor is included in the summary table.
see txt = see text for details.

Appendix 3.--Summary table for Alaska **Category 2** commercial fisheries. Source: 67 FR 2410; January 17, 2002. Notice of continuing effect of list of fisheries. [Note: This table will be updated when the numbers of participants in each fishery is updated in the 2004 List of Fisheries.]

Fishery (area and gear type)	Target species	Permits issued or fished (2000)	Soak time	Landings per day	Sets per day	Season duration	Fishery trends (1990-1997)
Southeast AK drift gillnet	salmon	481	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	416	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	170	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	541	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	576	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	745	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	164	2 -5 hrs; day / night	1	3 - 8	mid - June to mid - Sept	# vessels stable; catch up
AK Peninsula/Aleutians set gillnet	salmon	116	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	1903	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	1014	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	misc finfish	2					new fishery

Appendix 4.--Interaction table for Alaska **Category 2** commercial fisheries. Source: 67 FR 2410; January 17, 2002. Notice of continuing effect of list of fisheries. [Note: This table will be updated when the numbers of participants in each fishery is updated in the 2004 List of Fisheries.]

Fishery (area and gear type)	Observer program	Species recorded as taken incidentally in this fishery (records dating back to 1988)	Data type
Southeast AK drift gillnet	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	never observed	humpback whale	self reports and stranding
Yakutat set gillnet	never observed	harbor seal, gray whale (stranding)	logbook and stranding
Prince William Sound drift gillnet	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	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	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	2002	harbor seal, harbor porpoise, sea otter; preliminary results not yet available for 2002 observer program	logbook
Alaska Peninsula/Aleutians drift gillnet	1990	northern fur seal, harbor seal, harbor porpoise, Dall's porpoise (obs)	observer and logbook
Alaska Peninsula/Aleutians set gillnet	never observed	Steller sea lion, harbor porpoise	logbook
Bristol Bay drift gillnet	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	never observed	northern fur seal, harbor seal, spotted seal, beluga whale, gray whale	logbook
Metkatla/Annette Island drift gillnet	never observed	none documented	none
AK pair trawl	never observed	none documented	none

Note: Only species with positive records of being taken incidentally in a fishery since 1988 (the first year of the MMPA 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.

Appendix 5.--Interaction table for Alaska **Category 3** commercial fisheries. 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: 67 FR 2410; January 17, 2002. Notice of continuing effect of list of fisheries. [Note: This table will be updated when the numbers of participants in each fishery is updated in the 2004 List of Fisheries.]

Fishery name	# of permits issued or fished 1999	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	1922	never observed	harbor porpoise	none
AK roe herring and food/bait herring gillnet	2034	never observed	none documented	none
AK miscellaneous finfish set gillnet	3	never observed	Steller sea lion	logbook
AK salmon purse seine (except for Southeast AK)	953	never observed	harbor seal	logbook
AK salmon beach seine	34	never observed	none documented	none
AK roe herring and food/bait herring purse seine	624	never observed	none documented	none
AK roe herring and food/bait herring beach seine	8	never observed	none documented	none
Metlakatla purse seine and drift gillnet (tribal)	10 (seine) 60 (drift)	never observed	none documented	none
AK octopus/squid purse seine	2	never observed	none documented	none
AK miscellaneous finfish purse seine	3	never observed	none documented	none
AK miscellaneous finfish beach seine	1	never observed	none documented	none
AK salmon troll (includes hand and power troll)	2335	never observed	Steller sea lion	logbook
AK north Pacific halibut/bottom FISH TROLL	330	never observed	NONE DOCUMENTED	NONE
AK state waters groundfish longline /set line (incl. sablefish/ rockfish/misc.finfish)	731	never observed	none documented	none
Gulf of AK groundfish longline/set line (incl. misc. finfish/sablefish)	876	1989- present	Steller sea lion, harbor seal, northern elephant seal, Dall's porpoise	observer
BSAI groundfish longline/set line (incl. misc. finfish/sablefish)	115	1989- present	Steller sea lion (SR), killer whale (obs), Pacific white sided dolphin (obs), Dall's porpoise (obs) , northern elephant seal (log)	observer, logbook, and self reports (SR)
AK halibut longline/set line (state and federal waters)	3079	never observed	Steller sea lion	self reports
AK octopus/squid longline	7	never observed	none documented	none
AK shrimp otter and beam trawl (statewide and Cook Inlet)	58	never observed	none documented	none
Gulf of Alaska groundfish trawl	198	1989 to present	Steller sea lion, harbor seal, northern elephant seal, Dall's porpoise	observer

Bering Sea and Aleutian Island groundfish trawl	166	1989 to present	Steller sea lion, northern fur seal, harbor seal, spotted seal, bearded seal, ribbon seal, ringed seal, northern elephant seal, Dall's porpoise, harbor porpoise, Pacific white-sided dolphin, killer whale, walrus, sea otter	observer
State waters of Kachemak Bay Cook Inlet, Prince William Sound, Southeast AK groundfish trawl	2	never observed	none documented	none
AK miscellaneous finfish otter or beam trawl	6	never observed	none documented	none
AK food/bait herring trawl (Kodiak area only)	3	never observed	none documented	none
AK crustacean pot	1852	1988 to present	harbor porpoise, humpback whale	stranding
AK Bering Sea and Gulf of Alaska finfish pot	257	1990 to present	harbor seal, sea otter	observer
AK octopus/squid pot	72	never observed	none documented	none
AK snail pot	2	never observed	none documented	none
AK North Pacific halibut handline and mechanical jig	93	never observed	none documented	none
AK other finfish handline and mechanical jig	100	never observed	none documented	none
AK octopus/squid handline	2 issued # fished n/a	never observed	none documented	none
AK Prince William Sound herring roe/food/bait pound net	452	never observed	none documented	none
Southeast AK herring food/bait pound net	3	never observed	none documented	none
Coastwise scallop dredge	12*	never observed	none documented	none
AK dungeness crab (hand pick/dive)	3	never observed	none documented	none
AK herring spawn-on-kelp (hand pick/dive)	452	never observed	none documented	none
AK urchin and other fish/shellfish (hand pick/dive)	471	never observed	none documented	none
AK commercial passenger fishing vessel	1107	never observed	none documented	none
AK OCTOPUS/SQUID "OTHER"	19	NEVER OBSERVE D	NONE DOCUMENTED	NONE

The 106 permits reflected in the previous SAR included all permits for this fishery in AK/WA/OR/CA. The new number of permits reflects only those permits for fishing in AK waters.

Appendix 6.--Observer coverage in Alaska commercial fisheries 1990-01.

Fishery name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gulf of Alaska (GOA) groundfish trawl	55%	38%	41%	37%	33%	44%	37%	33%	36%	32%	32%	27%
GOA longline	21%	15%	13%	13%	8%	18%	16%	15%	16%	13%	14%	11%
GOA finfish pots	13%	9%	9%	7%	7%	7%	5%	4%	7%	6%	7%	5.5%
Bering Sea/Aleutian Islands (BSAI) groundfish trawl	74%	53%	63%	66%	64%	67%	66%	64%	67%	75%	71%	77%
BSAI longline	80%	54%	35%	30%	27%	28%	29%	33%	36%	35%	39%	30%
BSAI finfish pots	43%	36%	34%	41%	27%	20%	17%	18%	15%	17%	9%	15%
Prince William Sound salmon drift gillnet	4%	5%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Prince William Sound salmon set gillnet	3%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Alaska Peninsula/Aleutian Islands salmon drift gillnet (South Unimak area only)	4%	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.
Cook Inlet salmon set and drift gillnet	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	not obs.	no est.*	no est.*	not obs.

Note: Observer coverages in the groundfish fisheries (trawl, longline, and pots) were determined by the percentage of tons caught which were observed. Observer coverage in the groundfish fisheries is assigned according to vessel length; where vessels greater then 125' have 100% coverage, vessels 60-125' have 30% coverage, and vessels less than 60' 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.

* The Cook Inlet salmon set and drift gillnet fisheries were observed in 1999 and 2000. Precise estimates of observer coverage for these fisheries are not yet available.

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).

Self-reported fisheries information, where available, have been incorporated in the stock assessment reports contained in this document. Refer to the individual stock assessment reports for summaries of self-reported fisheries information on a stock-specific basis.

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 - D. P. DeMaster, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98115).

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

Revised: 8/23/2002

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

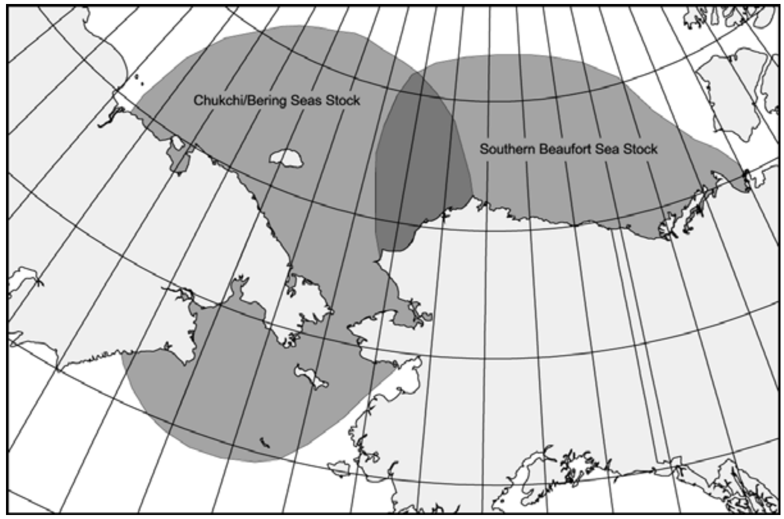

Figure 1. Approximate distribution of the Chukchi/Bering Seas polar bear stock. Dark shaded area represents distribution overlap with the Southern Beaufort Sea stock.

Polar bears are circumpolar in their distribution in the northern hemisphere. They occur in several largely discrete stocks or populations (Harington 1968). Polar bear movements are extensive and individual activity areas are enormous (Garner *et al.* 1990). The parameters used by Dizon *et al.* (1992) to classify stocks based on the phylogeographic approach were considered in the determination of stock separation in Alaska. Several polar bear stocks are known to be shared between countries (Amstrup *et al.* 1986, Amstrup and DeMaster 1988). Lentfer hypothesized that in Alaska two stocks exist, the Beaufort Sea and the Chukchi/Bering seas, based upon: (a) variations in levels of heavy metal contaminants of organ tissues (Lentfer 1976, Lentfer and Galster 1987); (b) morphological characteristics (Manning 1971, Lentfer 1974, Wilson 1976); (c) physical oceanographic features which segregate the Chukchi Sea and Bering Sea stocks from the Beaufort Sea stock (Lentfer 1974) and; (d) movement information collected from mark and recapture studies of adult female bears (Lentfer 1974, 1983, Amstrup 1995) (Fig. 1).

Past studies (Garner *et al.* 1990, Amstrup 1995) have shown that the eastern boundary of the Chukchi/Bering seas stock is near Point Barrow, and very limited movement occurs sporadically into the Beaufort Sea. The western bound of the stock is near the eastern portion of the Eastern Siberian Sea. The boundary between the Eastern Siberian Sea stock and the Chukchi Sea stock is designated on the basis of movements of adult female polar bears captured in the Bering and Chukchi seas region. Female polar bears initially captured and radio collared on Wrangel Island exhibited no movement into the Eastern Siberian Sea, while female polar bears captured and radio collared in the Eastern Siberian Sea, exhibited only limited short term movement into the western Chukchi Sea. The Chukchi/Bering seas stock extends into the Bering Sea and its southern boundary is determined by the annual extent of pack ice (Garner *et al.* 1990). Adult female polar bears captured in the Beaufort Sea may make seasonal movements into the Chukchi Sea in an area of overlap located between Point Barrow and Point Hope, centered near Point Lay (Garner *et al.* 1990, Garner *et al.* 1994, Amstrup 1995). Telemetry data indicate that these bears, marked in the Beaufort Sea, spend about 25% of their time in the northeastern Chukchi Sea, whereas females captured in the Chukchi Sea spend only 6% of their time in the Beaufort Sea (Amstrup 1995). Activity areas of females in the Chukchi/Bering seas (mean 244,463 km^2, range 144,659 - 351,369 km^2) were more extensive than the Beaufort Sea (mean 162,124 km^2, range 9,739-269,622 km^2) (Garner *et al.* 1990). Radio collared adult females spent a greater proportion of their time in the Russian region than in the American region (Garner *et al.* 1990). Historically polar bears ranged as far south as St. Matthew Island (Hanna 1920) and the Pribilof Islands (Ray 1971) in the Bering Sea.

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

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

POPULATION SIZE

Polar bears occur at low densities throughout their circumpolar range (DeMaster and Stirling 1981). They are long lived, mature late, have an extended breeding interval, and have small litters (Lentfer *et al.* 1980, DeMaster and Stirling 1981). Historically polar bear population size in Alaska has been difficult to estimate because of inaccessibility of the habitat, movement of bears across international boundaries, and budget limitations (Amstrup and DeMaster 1988; Garner *et al.* 1992).

Minimum Population Estimate

A reliable population estimate for the Chukchi/Bering seas population currently does not exist. Lentfer in the Administrative Law Judge (ALJ) proceeding to waive the MMPA moratorium on taking and return management to the State of Alaska (ALJ 1977) estimated that the Chukchi/Bering seas population stock (Wrangel Island to western Alaska) was 7,000 and Chapman estimated the Alaska population (both stocks) at 5,550 to 5,700 (ALJ 1977). Lentfer's and Chapman's estimates (ALJ 1977), however, were not based on rigorous statistical analysis of population data and variance estimates could not be calculated. Amstrup *et al.* (1986) estimated densities based on mark and recapture of 266 polar bears near Cape Lisburne on the Chukchi Sea, but a population estimate for the Chukchi Sea was not developed at that time. However, in 1988 Amstrup and DeMaster (1988) estimated the Alaska population (both stocks) at 3,000 to 5,000 animals based on densities calculated by Amstrup *et al.* (1986). The area that the estimate applied and the variance associated with the estimate were not provided for the 1988 population estimate (Amstrup and DeMaster 1988). A crude population estimate for the Chukchi/Bering seas stock of 1,200 to 3,200 animals was derived by subtracting the Beaufort Sea population estimate of 1,800 animals (Amstrup 1995) from the total Alaska statewide estimate, 3,000 to 5,000, (Amstrup and DeMaster 1988). The IUCN Polar Bear Specialist Group (IUCN, 1998) estimated this population to be approximately 2,000 to 5,000 based on extrapolation of multiple years of denning data for Wrangel Island, assuming a known fraction of the population dens annually as adult females. During August 2000, an aerial survey of polar bears in the Eastern Chukchi Sea was conducted by the USFWS from the U.S. Coast Guard icebreaker, Polar Star. Estimates of the density of bears inhabiting this area were develop (0.00748 bear/km^2, or 147 km^2/bear cv. 0.38) (Evans et al. in prep.). A population estimate was not derived from this density since the study area included only a portion of the total area of the population. Future aerial surveys in the Russian and U.S. Chukchi Sea are being planned. Since a reliable estimate for the size of this stock is currently unavailable, a minimum population estimate (N_{min}) was not calculated.

Current Population Trend

Prior to the 20th century, when Alaska's polar bears were hunted primarily by Alaskan Natives, both stocks probably existed near carrying capacity (K). The size of the Beaufort Sea stock appeared to decline substantially in the late 1960's and early 1970's (Amstrup *et al.* 1986) due to excessive harvest rates when sport hunting was legal. Similar declines could reasonably have occurred in the Chukchi Sea, although there are no data with which to test this assumption. Since passage of the Marine Mammal Protection Act (MMPA) in 1972, harvest rates have declined and both stocks seem to have grown --- judging from (a) mark and recapture data, although recapture data are too sparse for the Chukchi stock to quantify its growth; (b) observations by Natives and residents of coastal Alaska and Russia; (c) catch per unit effort indices (Amstrup et al. unpublished reports); (d) reports from Russian scientists (Uspenski and Belikov 1991); (e) aerial survey observations and density estimates (Evans et al. in prep.) and (f) changes in the age composition of the harvest (Schliebe *et al*. 1995). The most recent analysis confirms that the Southern Beaufort Sea population experienced growth during the late 1970's and 1980's and then stabilized during the 1990's (Amstrup et al. 2001). Until 1992 it may have been realistic to infer that the Chukchi/Bering seas stock mimicked the growth pattern and later stability of Beaufort Sea stock, since both stocks experienced similar management and harvest histories. However, the size of the Chukchi/Being seas population has not been accurately determined and the combined effect of the ongoing Alaska harvest and the recent Chukotka harvest of an unknown number of bears can not be accurately assessed. Similarly other potential determinants of population growth or trend, such as disease and prey availability, are not evaluated. Consequently, although there is some evidence to suggest growth for this stock in the past, the lack of current scientific information does not allow for an accurate assessment of trend.

MAXIMUM NET PRODUCTIVITY RATES

Default values for the maximum net productivity rates (R_{MAX}) for Alaska polar bear stocks were not established at the La Jolla PBR workshop (Wade and Angliss 1997). Taylor et al. (1987) estimated the maximum sustainable yield for adult female polar bears from a hunted population to be < 1.6% per annum based upon modeling. However, recent modeling efforts acknowledge that sustainable harvest rates are prone to effects from anthropogenic and natural changes as well as shortcomings in population knowledge. Issues involving global climate change and potential effects of persistent organic pollutants have also highlighted the uncertainty and risks inherent in making management decisions for polar bear populations. Population/stock specific scientific data to estimate R_{MAX} are not available for the Chukchi/Bering seas stock of polar bears. As a default, the R_{MAX} for this stock is assigned to 6.03 percent as reported for the Southern Beaufort Sea polar bear stock.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

Under the 1994 re-authorized MMPA, the potential biological removal (PBR) level is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $(N_{min})(\frac{1}{2} R_{MAX})(F_R)$. Although a recovery factor of 1.0 is probably most accurate, the stock was assigned a recovery rate F_R of 0.5 following the guidelines of the PBR workshop (Wade and Angliss 1997) since the status of the population is unknown (Wade and Angliss 1997). The PBR level cannot be calculated for the Chukchi/Bering seas stock in the absence of a reliable estimate of minimum abundance. Increased efforts are necessary to estimate the size, harvest and life history data for this stock.

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities.

Sport and Native Subsistence Harvest

Historically, polar bears have been killed for subsistence, handicrafts and recreation. Based upon records of skins shipped from Alaska, the estimated annual statewide harvest for 1925-53 averaged 120 bears, taken primarily by Native hunters. Recreational hunting using aircraft was common from 1951-72, increasing statewide annual harvest to 150 during 1951-60 and to 260 during 1960-72 (Amstrup *et al.* 1986; Schliebe *et al.* 1995). Aerial hunting by non-Natives was been prohibited in 1972. This reduced the mean annual harvest for both populations to 105 during 1980-2001 (SD=53; range 41-297) (USFWS unpubl. data). Figure 2 illustrates harvest rates and trend for the Chukchi/Bering seas stock from 1961-2001. From 1980-2001, harvests from the Chukchi/Bering seas stock accounted for 66% (mean=65) of the annual Alaska kill.

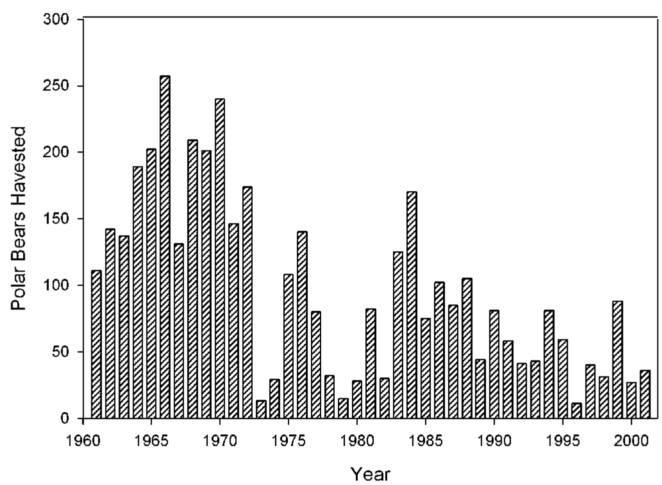

Figure 2. Annual Alaska polar bear harvest from the Chukchi/Bering seas stock, 1961-2001.

Recently, harvest levels by Alaska Natives from this stock have been declining. The 1996-2000 mean U.S. harvest was 44.8 bears and the sex ratio was 64M:36F (Schliebe et al. in prep). The number of unreported kills since 1980 to the present time is thought to be negligible based on: (a) the presence of local assistants contracted to tag parts from harvested bears; (b) active efforts to communicate the requirement for tagging harvest polar bears; (c) frequent interviews with local hunters; and (d) law enforcement investigations. In western Alaska, presently there is no local or government control on the number of bears taken providing the population is not depleted and the taking is not wasteful. On October 16, 2000, a management agreement for this stock between the United States and Russian governments was signed. The Alaska Nanuuq Commission was instrumental in developing this agreement which identifies a central role for Native people in future implementation. Harvest guidelines and quotas are essential elements of this agreement and will be determined in the future when the US-Russia agreement is implemented.

Other Removals

Russia prohibited all hunting of polar bears in 1956 in response to perceived population declines caused by over-harvest. In Russia, only a small number of animals, less than 3-5 per year, were removed for placement in zoos prior to 1986 (Uspenski 1986) and few were taken in defense of life. No bears were taken for zoos or circuses from 1993 to 1995 (Belikov 1997). The occurrence of increased problem bear take in Chukotka was acknowledged in 1992, and Belikov (1993) estimated that up to 10 "problem" bears were killed annually in all of the Russsian Arctic. Increased illegal hunting of polar bears in the Russian Arctic was also recognized to have begun in 1992, primarily in response to decentralization of management authority, entering a free market economy, and increased economic pressures. The magnitude of the illegal harvest in Russia from the Chukchi/Bering seas stock is unquantified, although anecdotal reports indicate that a substantial harvest of up to several hundred bears per year could be taking place.

In Alaska, one orphaned cub from the Chukchi/Bering seas population was placed in a zoo since 1989. In Alaska an illegal harvest, if it occurs, is so small as to be undetectable. The oil and gas industry is not active in this region within Alaska, and have not been responsible for any lethal take of polar bears.

STATUS OF STOCK

Polar bears in the Chukchi/Bering seas stock are not classified as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Reliable estimates of the minimum population, PBR level, and human-caused mortality (Chukotka) or serious injury are currently not available. The status of this stock can not be determined without better basic information on abundance and removal levels. There is a lack of information indicating that subsistence hunting in Alaska is or is not adversely affecting this population stock. No incidental loss due to any U.S. commercial fishery occurs. The status of the Chukchi/Bering seas polar bear stock is designated as uncertain due to the lack of reliable population information.

Management Actions

In the past, the shared Alaska-Chukotka polar bear population has been subject to different management strategies, and coordination of research and studies has been difficult. In the former Soviet Union hunting of polar bears was banned in 1956. Recently that level of protection has diminished due to an inability to enforce a 1956 nationwide ban on hunting polar bears. In Alaska, subsistence hunting by Natives is not restricted provided that the polar bear population is not depleted. In addition while several joint research and management projects have been successfully undertaken in the past comparable efforts are either no longer occurring, or are conducted unilaterally.

An Agreement on the Conservation and Management of the Alaska-Chukotka Polar Bear Population signed by the governments of the United States and the Russian Federation on October 16, 2000, recognizes the needs of Native people to harvest polar bears for subsistence purposes and includes provisions for developing sustainable harvest limits, allocation of the harvest between jurisdictions, and compliance and enforcement. Each jurisdiction is entitled to up to one-half of a harvest limit to be determined in the future by the joint Commission. The Agreement reiterates requirements of the 1973 multi-lateral agreement and includes restrictions on harvesting denning bears, females with cubs, or cubs less than one year old, prohibitions on the use of aircraft, large motorized vessels, and snares or poison for hunting polar bears. The Agreement does not allow hunting for commercial purposes nor commercial uses of polar bears or their parts. It also commitments the Parties to the conservation of ecosystems and important habitats, with a focus on conserving specific polar bear habitats such as feeding, congregating and denning areas.

In the U.S. a number of procedural steps are required in order to give this Agreement the effect of law. The U.S. Congress must enact legislation to provide for new authorities necessary to implement the agreement. Also the U.S. Senate must ratify the agreement. In Russia the need for legislative steps, if any, to provide authorities for implementation are being determined and the mechanism to coordinate management programs with the Chukotka government and with the Chukotka Native organizations are being determined. Once U.S. legislation is enacted, a joint Commission is expected to be named and actual implementation begun.

CITATIONS

Administrative Law Judge. 1977. Environmental Impact Statement: Consideration of a waiver of the moratorium and return of management of certain marine mammals to the State of Alaska. 2 Volumes.

Amstrup, S.C., and D.P. DeMaster. 1988. Polar bear, *Ursus maritimus*. Pages 39-45 *in* J.W. Lentfer, ed. Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, D.C.

Amstrup, S.C., I. Stirling, and J.W. Lentfer. 1986. Past and present status of polar bears in Alaska. Wildlife Society Bulletin. 14:241-254.

Amstrup, S.C. 1995. Movements, distribution, and population dynamics of polar bears in the Beaufort Sea. PhD Dissertation. University of Alaska-Fairbanks. Fairbanks, Alaska, 299 pp.

Amstrup, S.C., T.L. McDonald, and I. Stirling. 2001. Polar bears in the Beaufort Sea: A 30-year mark-recapture case history. Journal of Agricultural, Biological, and Environmental Statistics, Vol.(2): 221-234.

Amstrup, S.C., G. M. Durner, A. S. Fischbach, K. Simac, and G. Weston-York. (In preparation) Polar Bear Research in the Beaufort Sea. in N. Lunn, E. W. Born, and S. Schliebe (eds). Proceedings of the Thirteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. 23-28 June, 2001. Int. Union Conserv. Nature and Nat. Resour., Nuuk, Greenland.

Belikov, S.E. 1993. Status of polar bear populations in the Russian Arctic 1993. pp. 115-121. *in* O. Wiig, G.W. Garner (eds.) Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. v + 192 pp.

Belikov. 1997. Draft of Russian-American agreement on protection and management of the Chukchi-Alaskan polar bear population. (In preparation) in A.E. Derocher, G. Garner, N. Lunn, and O. Wiig (eds). Proceedings of the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. 3-7 February, 1997. Int. Union Conserv. Nature and Nat. Resour., Oslo, Norway.

Brower, C.D., A. Carpenter, M. Branigan, W. Calvert, T. Evans, A.S. Fischbach, J. Nagy, S. Schliebe, and I. Stirling. (Submitted to Arctic). The polar bear management agreement for the Southern Beaufort Sea: An evaluation of the first ten years of a unique conservation agreement.

Cronin, M.A., S.C. Amstrup, G.W. Garner, and E.R. Vyse. 1991. Interspecific and intraspecific mitochondrial DNA variation in North American bears (Ursus). Canadian Journal of Zoology. 69:12:2985-2992.

DeMaster, D. P., and I. Stirling. 1981. *Ursus maritimus*. Mammalian Species: 1-7.

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

Evans, T.F., A.S. Fischbach, S. Schliebe, S. Kalxdorff, G. York, B. Manly. In prep. Polar bear aerial survey in the Eastern Chukchi Sea.

Garner, G.W., S.T. Knick, and D.C. Douglas. 1990. Seasonal movements of adult female polar bears in the Bering and Chukchi seas. International Conference on Bear Research and Management 8:219-226.

Garner, G.W., L.L. McDonald, D.S. Robson, D.P. Young Jr., and S.M. Arthur. 1992. Literature review: population estimation methodologies applicable to the estimation of abundance of polar bears. Internal Report, U.S.F.W.S. 102pp.

Garner, G.W., L.L. McDonald, S.M. Arthur, and T.L. Olson. 1994. Operating procedures: Pilot polar bear survey Beaufort Sea: 1994. Internal Report, U.S.F.W.S., 39 pp.

Garner, G.W., S.E. Belikov, M.S. Stishov, V.G. Barnes, and S.A. Arthur. 1994. Dispersal patterns of maternal polar bears from the denning concentration on Wrangel Island. International Conference on Bear Research and Management 9(1):401-410.

Hanna, G.D. 1920. Mammals of the St. Matthew Islands, Bering sea. Journal of Mammalogy 1:118-122.

Harington, C.R. 1968. Denning habits of the polar bear (*Ursus maritimus*) Phipps. Canadian Wildlife Service Report, Series 5. 33 pp.

IUCN (1998). Status of polar bear. pp. 23-45. in A.E. Derocher, G. Garner, N. Lunn, and O. Wiig (eds). Proceedings of the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Swtizerland and Cambridge, UK. v + 159 pp.

Lentfer, J.W. 1974. Discreteness of Alaskan polar bear populations. Proceedings of the International Congress of Game Biologists 11:323-329.

Lentfer, J.W. 1976. Environmental contaminants and parasites in polar bears. Alaska Department of Fish and Game, Pittman-Robertson Project Report. W-17-4 and W-17-5. 22 pp.

Lentfer, J.W. 1983. Alaskan polar bear movements from mark and recovery. Arctic 36:282-288.

Lentfer, J.W., R.J. Hensel, J.R. Gilbert, and F.E. Sorensen. 1980. Population characteristics of Alaskan polar bears. International Conference on Bear Research and Management 3: 109-115.

Lentfer, J.W., and W.A. Galster. 1987. Mercury in polar bears from Alaska. Jour. Wildl. Diseases 23:338-341.

Manning, T.H. 1971. Geographical variation in the polar bear *Ursus maritimus* Phipps. Canadian Wildlife Service Report Series No. 13. 27 pp.

Paetkau, D., S.C. Amstrup, E.W. Born, W. Calvert, A.E. Derocher, G.W. Garner, F. Messier, I. Stirling, M.K. Taylor, Ø. Wiig . , and C. Strobeck. 1999. Genetic Structrue of the world's polar bear populations. Molecular Ecology. 8:1571-1584.

Ray, C.E. 1971. Polar bear and mammoth on the Pribilof Islands. Arctic 24:9-19.

Schliebe, S.L., S.C. Amstrup, and G.W. Garner. 1995. The status of polar bear in Alaska, 1993. pp. 125-139. *in* O. Wiig, G.W. Garner (eds.) Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. v + 192 pp.

Schliebe, S.L., J.W. Bridges, T.J. Evans, A.S. Fischbach, S.B. Kalxdorff, and L. Lierheimer. (In preparation). Summary of polar bear management in Alaska. in N. Lunn, E.W. Born, and S. Schliebe (eds). Proceedings of the Thirteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. 23-28 June, 2001. Int. Union Conserv. Nature and Nat. Resour., Nuuk, Greenland.

Scribner, K.T., G.W. Garner, S.C. Amstrup, and M.A. Cronin. 1997. Population genetic studies of the polar bear (*Ursus marinimus*): a summary of available data and interpretation of results. Pp. 185-196, in 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. Spec. Pub. #3 of the Society of Marine Mammalogy.

Taylor, M.K., D.P. DeMaster, F.L. Bunnell, and R.E. Schweinsburg. 1987. Modeling the sustainable harvest of female polar bears. J. of Wildlife Management. 51:811-820.

Uspenski, S.M. 1986. Research and management of polar bear populations in the USSR 1981-85. Pages 133-136 *in* Proceedings of the Ninth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK

Uspenski, S.M., and S.E. Belikov. 1991. Polar Bear Populations in the Arctic: Current State, Studies, and Management (1985-87) *in* S.C. Amstrup and O. Wiig, eds. Proceedings of the Tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK

Wade, P. R. and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report in the GAMMS Workshop, April 3-5, 1996, Seattle, WA. 93pp.

Wilson, D.E. 1976. Cranial variation in polar bears. International Conference Bear Research and Management 3:447-453.

Revised: 8/23/2002

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Polar bears are circumpolar in their distribution in the northern hemisphere. They occur in several largely discrete stocks or populations (Harington 1968). Polar bear movements are extensive and individual activity areas are enormous (Garner *et al.* 1990, Amstrup 1995). The parameters used by Dizon *et al.* (1992) to classify stocks based on the phylogeographic approach were considered in the determination of stock separation in Alaska. Several polar bear stocks are known to be shared between countries (Amstrup *et al.* 1986, Amstrup and Demaster 1988). Lentfer hypothesized that two Alaska stocks exist, the Southern Beaufort Sea, and the Chukchi/Bering Seas, based upon: (a) variations in levels of heavy metal contaminants of organ tissues (Lentfer 1976, Lentfer and Galster 1987); (b) morphological characteristics (Manning 1971; Lentfer 1974; Wilson 1976); (c) physical oceanographic features which segregate stocks (Lentfer 1974) and; (d) movement information collected from mark and recapture studies of adult female bears (Lentfer, 1983, Amstrup 1995) (Figure 1).

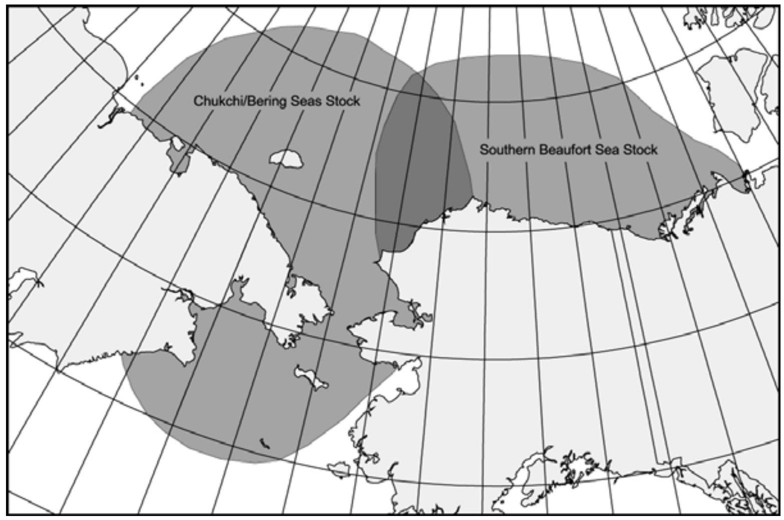

Figure 1. Approximate distribution of the Southern Beaufort Sea polar bear stock. Dark shaded area represents distribution overlap with the Chukchi/Bering seas stock.

Past studies (Amstrup 1995) have shown that the eastern boundary of the Southern Beaufort Sea stock occurs south of Banks Island and east of the Baillie Islands, Canada. The western boundary is near Point Hope. The southern boundary of the northern Beaufort Sea stock in the Canadian Arctic was delineated by Bethke *et al.* (1996). There is minimal overlap between the southern and northern Beaufort Sea populations (Amstrup and Durner In prep). An area of overlap between the Southern Beaufort Sea stock and the Chukchi/Bering seas stock occurs between Point Barrow and Point Hope, centered near Point Lay (Garner *et al.* 1990, Garner *et al.* 1994, Amstrup 1995). Also telemetry data indicates that adult female polar bears marked in the Southern Beaufort Sea spend about 25% of their time in the northeastern Chukchi Sea, whereas females captured in the Chukchi Sea spend only 6% of their time in the Southern Beaufort Sea (Amstrup 1995). Activity areas of Southern Beaufort Sea females averaged 162,124 km^2 (range 12,730 to 596,800 km^2) (Amstrup 1995).

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

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

POPULATION SIZE

Polar bears occur at low densities throughout their circumpolar range (DeMaster and Stirling 1981). They are long lived, mature late, have an extended breeding interval, and have small litters (Lentfer *et al.* 1980, DeMaster and Stirling 1981). Accurate population estimates for the Alaskan populations have been difficult to obtain because of low population densities, inaccessibility of the habitat, movement of bears across international boundaries, and budget limitations (Amstrup and DeMaster 1988, Garner *et al.* 1992).

Minimum Population Estimate

Amstrup *et al.* (1986), Amstrup (1995), Amstrup *et al.* 2001, and McDonald and Amstrup (2001) present population and variance estimates. Amstrup *et al*. (1986) estimated the Southern Beaufort Sea stock at 1,778 (S.D. $\pm$ 803; C.V. = 0.45) during the 1972-83 period. Amstrup (1995) estimated the Southern Beaufort Sea stock at around 1,480 animals in 1992.

Amstrup (unpublished data) using data for the 1986-98 period, excluding 4 years when sampling was not conducted, estimated the population size as 2,272 in 2001. This total population estimate was based on as estimate of 1,250 females (C.V. 0.17) and a sex ratio of 55% females from the best model (Amstrup and McDonald 2001). N_{min} is calculated as follows $N/\exp(0.842 * (\ln(1+CV(N)^2))^{½})$ and is 1,973 bears for population size of 2,272 and C.V. of 0.17. The female sex ratio estimate is treated as a constant and does not include an estimate of error. The population estimate applies to an area that extends from Pt. Barrow in the west, east to the Baillie Islands in Canada.

Current Population Trend

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

The most recent analysis confirms that the Southern Beaufort Sea stock experienced growth during the late 1970's and 1980's and then stabilized and experienced little or no growth during the 1990's (Amstrup et al. 2001). The indication that the population level appears to have stabilized is noteworthy. This stock has been assigned a recovery rate F_R of 1.0.

MAXIMUM NET PRODUCTIVITY RATES

Default values for R_{MAX} for Alaska polar bear stocks were not established at the La Jolla PBR workshop (Wade and Angliss 1997). Taylor et. al. (1987) estimated the sustainable yield of the female component of the population at < 1.6% per annum. The following information is used to understand the R_{MAX} determination. From 1981-92, vital rates of polar bears in the Southern Beaufort Sea were as follows: average age of sexual maturity (females) was 6 years; average COY litter size was 1.67; average reproductive interval was 3.68 years; and average annual natural mortality (nM), which varies by age class, ranged from 1-3% for adults (Amstrup, 1995). Natural mortality rates for juveniles are not available.

A Leslie type matrix of recapture data, which incorporated the best reproductive rates, and the best survival rates determined by the Kaplan Meir method, projected an annual intrinsic growth rate (including natural mortality but not human-caused mortality) of 6.03% for the Southern Beaufort Sea stock (Amstrup 1995). This calculation did not include human-caused mortalities and therefore represented the “natural” survival rate. This analysis mimics a life history scenario where environmental resistance is low and survival high. The calculation also assumes a 50M:50F population sex ratio which may result in a conservative estimate of R_{max} when populations are biased toward females (Amstrup, pers comm). More recent modeling efforts acknowledge that sustainable harvest rates are prone to effects from anthropogenic and natural changes as well as shortcomings in population knowledge. Issues involving global climate change and potential effects of persistent organic pollutants have also highlighted the uncertainty and risks inherent in making management decisions for polar bear populations.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

In the following calculation: $(N_{MIN})(½ R_{MAX})(F_r)$ = PBR (Wade and Angliss 1997) the minimum population estimate, N_{MIN} was 1,972; the maximum rate of increase R_{MAX} was 6%; and the recovery factor F_R was 1.0 since the population is believed to be within OSP. Assuming an equal sex ratio in the harvest, the PBR level for the Southern Beaufort Sea stock is 59 bears per year. In the Southern Beaufort Sea, the sex ratio of the harvest is approximately 2M:1F and thus the PBR level could be adjusted to 88 bears per year to account for male harvest bias. No more than 30 females may be harvested annually at the currently estimated population size.

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities.

Sport and Native Subsistence Harvest

Historically, polar bears have been killed for subsistence, handicrafts, and recreation. Based upon records of skins shipped from Alaska, the estimated annual statewide harvest for 1925-53 averaged 120 bears taken primarily by Native hunters. Recreational hunting using aircraft was common from 1951-72, increasing annual harvest to 150 during 1951-60 and to 260 during 1960-72 (Amstrup *et al.* 1986; Schliebe *et al.* 1995). Aerial hunting has been prohibited since 1972. This reduced the mean annual combined harvest for both stocks to 105 during 1980-2001 (SD=53; range 41-297) (FWS unpubl. data). Figure 2 illustrates harvest rates and trend for the Southern Beaufort Sea stock from 1961-2001.

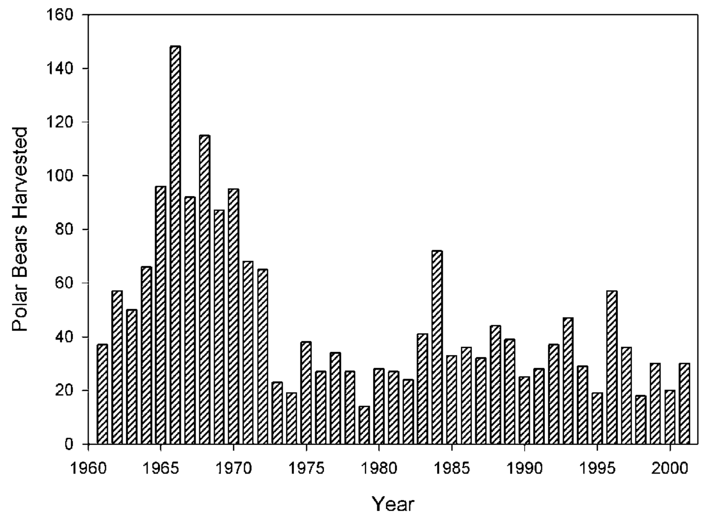

Figure 2. Annual Alaska polar bear harvest from the Southern Beaufort Sea stock, 1961-2001.

During the 1980-2001 period the Alaska harvest from the Southern Beaufort Sea accounted for 34% of the total Alaska kill (annual mean=33 bears). The sex ratio of the harvest from 1980-2001 was 68M:32F.

A management agreement between Canadian Inuit and Alaskan Inupiat of the North Slope has been in place since 1988 (Nageak et al. 1990, Brower et al. in prep). Since initiation of this local user agreement in 1988, the combined Alaska/Canada mean harvest from this stock has been 55.1 bears per year which is less than the previously calculated annual harvest guideline of 81 (Brower et al. in prep.) and a PBR level of 59 bears, or the adjusted PBR level of 88 bears, as reported here. The harvest in Canada is regulated by a quota system. The harvest in Alaska is regulated by voluntary actions of local hunters provided the population is not depleted.

More recently, the 1995-2000 average Alaska harvest for the Southern Beaufort Sea in Alaska was 32.2 and the sex ratio was 71M:29F. During the same time period the average Canadian harvest for the Southern Beaufort Sea was 19.6 and the sex ratio was 62M:38F. The combined average annual Alaska and Canada harvest during the past five years was 51.8.

Other Removals

Orphaned cubs are occasionally removed from the wild and placed in zoos: two cubs were placed into public display facilities during the past five years. Also one research mortality occurred. Activities authorized through "incidental take" regulations, associated with the exploration, development, production, and transportation of oil and gas, may potentially impact polar bears and their habitat. Regulations to authorize incidental take of polar bear by industry may be developed if the effects of the activity result in negligible impact to the population. During the past five years no lethal take of polar bears occurred. Historically, three lethal takes related to industrial activities have been documented in the Southern Beaufort Sea: one at an offshore drilling site in the Canadian Beaufort Sea (1968); one bear at the Stinson site in the Alaska Beaufort Sea (1990); and one bear that ingested ethylene glycol stored at an offshore island in the Alaska Beaufort Sea (1988). Also in 1993, a polar bear was killed at the Oliktok remote radar defense site when it broke into a residence and severely mauled a worker.

STATUS OF STOCK

The Southern Beaufort Sea Stock is not classified as "depleted" under the MMPA or listed as "threatened" or "endangered" under terms of the Endangered Species Act. This stock is assumed to be within optimum sustainable population levels. The calculated PBR levels (59 or 88 adjusted) are greater than the average annual human harvest (55) and greater than the annual harvest guidelines (81) of the user group agreement between the Inuvialuit of Canada and the Inupiat of Alaska. The stock does not experience any incidental loss to commercial fishing. The Southern Beaufort Sea stock appears to be stable and is experiencing little or no growth. The Southern Beaufort Sea stock of polar bears in Alaska is designated a "non-strategic stock."

CITATIONS

Amstrup, S.C., and D.P. DeMaster. 1988. Polar bear, *Ursus maritimus*. Pages 39-45 *in* J.W.Lentfer, ed. Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, D.C.

Amstrup, S.C., I. Stirling, and J.W. Lentfer. 1986. Past and present status of polar bears in Alaska. Wildlife Society Bulletin. 14:241-254.

Amstrup, S.C. 1995. Movements, distribution, and population dynamics of polar bears in the Beaufort Sea. PhD Dissertation. University of Alaska-Fairbanks, Fairbanks, Alaska, 299 pp.

Amstrup, S.C., T.L. McDonald, and I. Stirling. 2001. Polar bears in the Beaufort Sea: A 30-year mark-recapture case history. Journal of Agricultural, Biological, and Environmental Statistics, Vol. 6(2): 221-234.

Amstrup, S.C., G. M. Durner, A. S. Fischbach, K. Simac, and G. Weston-York. (In preparation) Polar Bear Research in the Beaufort Sea. *in* N. Lunn, E. W. Born, and S. Schliebe (eds). Proceedings of the Thirteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. 23-28 June, 2001. Int. Union Conserv. Nature and Nat. Resour., Nuuk, Greenland.

Bethke, R., M. Taylor, S. Amstrup, and F. Messier. 1996. Population delineation of polar bears using satellite collar data. Ecological Applications 6(1):311-317.

Brower, C. D., A. Carpenter, M. Branigan, W. Calvert, T. Evans, A. Fischbach, J. Nagy, S. Schliebe, and I. Stirling. The polar bear management agreement for the southern Beaufort Sea: An evaluation of the first ten years of a unique conservation agreement. *Submitted to*: Arctic.

Bunnell, F. L. and D. E. N. Tait. 1981. Population dynamics of bears -- implications. *In* C. W. Fowler and T. D. Smith, *eds.* Dynamics of Large Mammal Populations. J. Wiley and Sons, New York.

Cronin, M.A., S.C. Amstrup, G.W. Garner, and E.R. Vyse. 1991. Interspecific and intraspecific mitochondrial DNA variation in North American bears (Ursus). Canadian Journal of Zoology. 69:12:2985-2992.

DeMaster, D.P., M.C.S. Kingsley, and I. Stirling. 1980. A multiple mark and recapture estimate applied to polar bears. Can. J. Zool. 58:633-638.

DeMaster, D. P., and I. Stirling. 1981. *Ursus maritimus*. Mammalian Species:1-7.

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

FWS. 1994. Conservation plan for the polar bear in Alaska. Marine Mammals Management, U. S. Fish and Wildlife Service, Anchorage, AK. 79pp.

Garner, G.W., S.T. Knick, and D.C. Douglas. 1990. Seasonal movements of adult female polar bears in the Bering and Chukchi seas. International Conference on Bear Research and Management 8:219-226.

Garner, G.W., L.L. McDonald, D.S. Robson, D.P. Young Jr., and S.M. Arthur. 1992. Literature review: population estimation methodologies applicable to the estimation of abundance of polar bears. Internal Report, U.S.FWS. 102pp.

Garner, G.W., L.L. McDonald, S.M. Arthur, and T.L. Olson. 1994. Operating procedures: Pilot polar bear survey Beaufort Sea: 1994. Internal Report, U.S.FWS, 39 pp.

Harington, C.R. 1968. Denning habits of the polar bear (*Ursus maritimus*) Phipps. Canadian Wildlife Service Report, Series 5. 33 pp.

IUCN (In preparation). Status of polar bear. *in* N. Lunn, E.W. Born, and S. Schliebe (eds). Proceedings of the Thirteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group. 23-28 June, 2001. Int. Union Conserv. Nature and Nat. Resour., Nuuk, Greenland.

Lentfer, J.W. 1974. Discreteness of Alaskan polar bear populations. Proceedings of the International Congress of Game Biologists 11:323-329.

Lentfer, J.W. 1976. Environmental contaminants and parasites in polar bears. Alaska Department of Fish and Game, Pittman-Robertson Project Report. W-17-4 and W-17-5. 22 pp.

Lentfer, J.W. 1983. Alaskan polar bear movements from mark and recovery. Arctic 36:282-288.

Lentfer, J.W., R.J. Hensel, J.R. Gilbert, and F.E. Sorensen. 1980. Population characteristics of Alaskan polar bears. International Conference on Bear Research and Management 3: 109-115.

Lentfer, J.W., and W.A. Galster. 1987. Mercury in polar bears from Alaska. J. Wildlife Diseases 23:338-341.

Manning, T.H. 1971. Geographical variation in the polar bear *Ursus maritimus* Phipps. Canadian Wildlife Service Report Series No. 13. 27 pp.

McDonald T. and S.C. Amstrup. 2001. Estimation of population size using open capture-recapture models. Journal of Agricultural, Biological, and Environmental Statistics, Vol. 6(2): 206-220.

Nageak, B.P., C.D.N. Brower, and S.L. Schliebe. 1991. Polar bear management in the southern Beaufort Sea: An Agreement between the Inuvialuit Game Council and the North Slope Borough Fish and Game Committee. *in* Transactions of North American Wildlife and Natural Resources Conference. 56:337-343.

Paetkau, D., S.C. Amstrup, E.W. Born, W. Calvert, A.E. Derocher, G.W. Garner, F. Messier, I. Stirling, M.K. Taylor, Ø. Wiig . , and C. Strobeck. 1999. Genetic Structrue of the world's polar bear populations. Molecular Ecology. 8:1571-1584.

Paetkau, D. W. Calvert, I. Stirling, and C. Strobeck. 1995. Micro satellite analysis of population structure in Canadian polar bears. Molecular Ecology 4:347-354.

Schliebe, S.L., S.C. Amstrup, and G.W. Garner. 1995. The status of polar bear in Alaska, 1993. *in* O. Wiig, G.W. Garner (eds.) Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. v + 192 pp

Schliebe, S.L. and T.J. Evans 1998. Stock Assessment: Polar Bear (*Ursus maritimus*) - Alaska Chukchi/Bering seas stock and Southern Beaufort Sea Stock. Unpublished report. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Scribner, K.T., G.W. Garner, S.C. Amstrup, and M.A. Cronin. 1997. Population genetic studies of the Polar Bear (*Ursus marinimus*): a summary of available data and interpretation of results. Pp. 185-196, in 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. Spec. Pub. #3 of the Society of Marine Mammalogy.

Taylor, M.K., D.P. DeMaster, F.L. Bunnell, and R.E. Schweinsburg. 1987. Modeling the sustainable harvest of female polar bears. J. of Wildlife Management. 51:811-820.

Treseder, L. and A. Carpenter. 1989. Polar bear management in the Southern Beaufort Sea. Info. N. 15(4):2-4.

Uspenski, S.M., and S.E. Belikov. 1991. Polar bear populations in the Arctic: Current state, studies, and management (1985-87) in S.C. Amstrup and O. Wiig (eds). Proceedings of the Tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK.

Wilson, D.E. 1976. Cranial variation in polar bears. International Conference Bear Research and Management 3:447-453.

Revised: 07/12/2002

PACIFIC WALRUS (*Odobenus rosmarus divergens*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

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

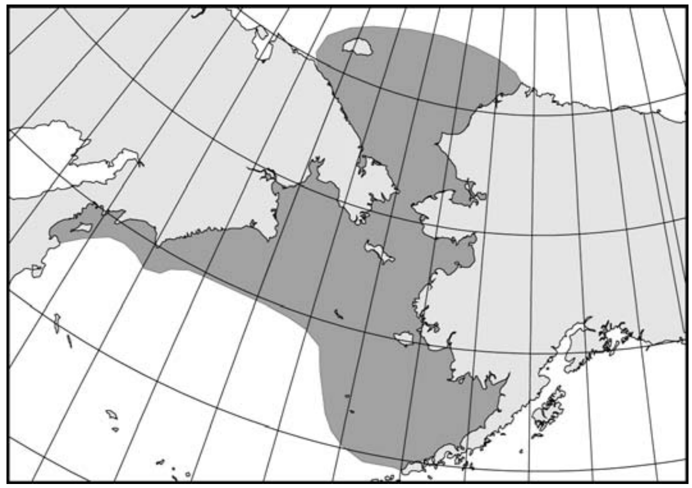

Figure 1. Approximate distribution of Pacific walrus in U.S. and Russian territorial waters. (shaded area). The combined summer and winter distributions are depicted.

Pacific walrus range throughout the continental shelf waters of the Bering and Chukchi seas, occasionally moving into the East Siberian Sea and the Beaufort Sea (Fig. 1). During the summer months most of the population migrates into the Chukchi Sea, however several thousand animals, primarily adult males, congregate near coastal haulouts in the Gulf of Anadyr and in Bristol Bay. During the late winter breeding season walrus are found in two major concentration areas of the Bering Sea where open leads, polynyas, or thin ice occur (Fay *et al.* 1984). While the specific location of these groups varies annually and seasonally depending upon the extent of the sea ice, generally one group ranges from the Gulf of Anadyr into a region southwest of St. Lawrence Island, and a second group is found in the southeastern Bering Sea from south of Nunivak Island into northwestern Bristol Bay. Currently, animals in these two regions are assumed to represent a single stock. Mitochondrial and nuclear DNA analysis of tissue samples taken from animals in the two areas in April (shortly after breeding season) indicate that either they are not discrete breeding groups, or, that separation took place so recently that it is not genetically detectable (Scribner *et al.* 1997).

POPULATION SIZE

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

Between 1975 and 1990, aerial surveys were carried out by the United States and Russia at five year intervals, producing population estimates ranging from 201,039 to 234,020 animals (Table 1). The estimates generated from these surveys are considered conservative population estimates and are not useful for detecting trends (Hills and Gilbert 1994, Gilbert *et al.* 1992). Efforts to survey the Pacific walrus population were suspended after 1990 due to unresolved problems with survey methods which produced population estimates with unacceptably large confidence intervals (Gilbert *et al.* 1992, Gilbert 1999). The current size of the Pacific walrus population is unknown.

In March 2000 the U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey hosted a workshop on walrus survey methods (Garlich-Miller and Jay 2000). Workshop participants reviewed past efforts to survey the Pacific walrus population and discussed various approaches to estimate population size and trend. The amount of survey effort required to achieve a population estimate with an acceptably small variance (CV <= 0.3) is expected to be extensive. Survey effort could be maximized by flying more transects, increasing survey swath width to sample a wider area, or both. Stratification could help focus survey area and reduce the amount of survey effort required, but will require additional research on the relationship between walrus distribution and environmental variables. Workshop participants recommended investing in research on walrus distribution and haulout patterns and exploring new survey tools, including remote sensing systems, prior to conducting another aerial survey.

Table 1. Aerial survey estimates of the Pacific walrus population, 1975-1990. Differences in survey design and methods preclude describing trends in population size.

Year	Population Estimate	References
1975	221,350	Estes and Gilbert 1978, Estes and Gol'tsev 1984
1980	246,360	Johnson *et al.* 1982, Fedoseev 1984
1985	234,020	Gilbert 1986, 1989, Fedoseev and Razlivalov 1986
1990	201,039	Gilbert *et al.* 1992

Minimum Population Estimate

A minimum population estimate (N_{MIN}) for this stock can not be determined because a reliable estimate of current population size is not available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Estimates of net productivity rates for walrus populations have ranged from 3-13% per year with most estimates falling between 5-10% (Chapskii 1936, Mansfield 1959, Krylov 1965, 1968, Fedoseev and Gol'tsev 1969, Sease 1986, DeMaster 1984, Sease and Chapman 1988, Fay *et al.* 1997).

Chivers (1999) developed an individual age based model of the Pacific walrus population using published estimates of survival and reproduction. The model yielded a maximum population growth rate (R_{MAX}) of 8%. This estimate remains theoretical because age-specific survival rates for free ranging walrus are poorly known.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) of a marine mammal stock is defined in the Marine Mammal Protection Act as the product of the minimum population estimate (N_{MIN}), one-half the maximum theoretical net productivity rate (R_{MAX}) and a recovery factor (F_R). Without a reliable estimate of N_{MIN} the PBR for this stock can not be determined.

ANNUAL HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

There are no data available concerning the incidental catch of walrus in fisheries operating in Russian waters. In the U.S. regulatory zone, walrus occasionally interact with trawl and longline gear of groundfish fisheries operating in the eastern Bering Sea. The USFWS has adopted the average annual fishery mortality rate over the past five years (1996-2000) as a representative estimate of the current rate of fishery related mortality in Alaska. Between 1996 and 2000, sixty-three interactions between commercial fishing gear and walrus were recorded through the National Marine Fisheries Services' fisheries observer program (mean: 12.6, range: 8-20 per year) (Unpublished fisheries observation data, Michael Perez, NMFS, 7600 Sand Pt. Way, NE, Seattle, WA 98115). Most (92%) of the observed interactions were with decomposed walrus carcasses or skeletal remains suggesting that the animals died prior to their interaction with the fishing gear. The only fishery for which incidental kill or injury was observed was the Bering Sea groundfish trawl fishery (non-pelagic). Five dead (not decomposed) walrus and one injured animal (released alive) were recorded over this time period. The range of observer coverage over the five year period (1996-2000), as well as the annual observed and estimated mortalities are presented in Table 2. A complete list of fisheries and marine mammal interactions is published annually by NMFS [67 FR 2410].

Another potential source of information on the number of walrus killed or injured incidental to commercial fisheries operations in Alaska is the NMFS fisher self reporting program. Although there were no walrus mortalities recorded through this program in 1996-2000, this reporting program may be negatively biased (Credle *et al.* 1994), therefore the absence of mortality reports does not necessarily assure that no mortalities occurred.

Table 2. Summary of incidental mortality of Pacific walrus (Alaska stock) due to commercial fisheries from 1996-2000 and estimated mean annual mortality rate. Fisheries observation data provided by NMFS.

Fishery name	Years	Data type	Range of observer coverage[a]	Observed mortality[b] (in given years)	Estimated mortality[c] (in given years)	Estimated mean annual mortality
Bering Sea Groundfish Trawl	1996-2000	Obs data	62.1-76.5%	0, 2, [1], 0,[2]	NE(0),3,NE(1),NE(0), NE(2)	1.2 (CV = 0.42)

[a] Based on total tonnage of the catch monitored by observers.
[b] Brackets indicate that the take was reported to or seen by the observer in an un-monitored haul.
[c] NE = no estimate because either zero take occurred, or, no takes occurred during monitored hauls. The number in parentheses are kills known to have occurred in all hauls on all vessels.

Based on the available fisheries observer data, the estimated mortality rate incidental to commercial fisheries in Alaska is approximately 1.2 walrus per year (CV = 0.42). Because the PBR for this stock is not known, it is not possible to quantify fishery mortalities relative to this standard. However, a fishery mortality level of 1.2 animals per year can be considered insignificant relative to other sources of human caused mortality affecting this stock.

Subsistence/Commercial Harvest

Over the past forty years the Pacific walrus population has sustained estimated annual harvest mortalities ranging from 3,200 to 16,100 animals per year (mean: 6,993) (Fig. 2). Recent harvest levels are lower than historic highs. It is not known whether lower harvest levels reflect changes in walrus abundance or hunting effort. Factors affecting harvest levels include the cessation of Russian commercial walrus harvests after 1991, changes in political, economic, and social conditions of subsistence hunters in Alaska and Chukotka, and the effects of variable weather and ice conditions on hunting success.

In 1997, a Cooperative Agreement was developed between the USFWS and the Alaska Eskimo Walrus Commission to facilitate the participation of subsistence hunters in activities related to the conservation and management of walrus stocks in Alaska. Specific activities carried out under this agreement have included the strengthening and expansion of harvest monitoring programs in Alaska and Chukotka as well as efforts to develop locally based subsistence harvest regulations.

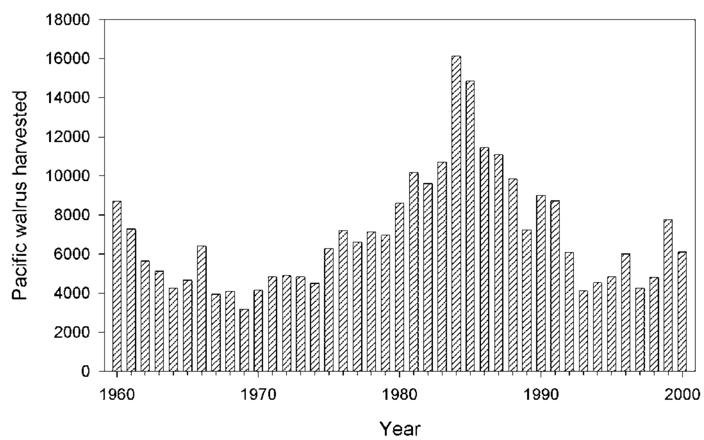

Figure 2. Harvest of Pacific walrus, 1960-2000. Data includes a 42% struck and lost rate applied to subsistence harvest totals (Fay *et al.* 1994).

The USFWS has adopted the average annual harvest over the past five years as a representative estimate of current harvest levels in Alaska and Chukotka. Based on 1996-2000 harvest statistics, adjusted for animals mortally wounded but not retrieved, harvest mortality levels are estimated at 5,789 animals per year (Table 3). Based on data collected through the USFWS Marking Tagging and Reporting Program, the sex-ratio of the reported U.S. walrus harvest over this time period was approximately equal. The sex-ratio of the reported Russian walrus harvest was approximately 0.5 female:male (based on harvest information collected Chukotka TINRO in 1999 and 2000 only).

Table 3. Estimated harvest of Pacific walrus, 1996-2000. Russian harvest information provided by Chukotka TINRO. U.S. harvest information collected by the U.S. Fish and Wildlife Service and are adjusted for unreported walrus (Garlich-Miller and Burn 1997). Corrected harvest incorporates a 42% struck and lost rate from Fay *et al.* (1994).

Year	Reported Russia Harvest	Reported U.S. Harvest	Total Reported Harvest	Total Corrected Harvest
1996	941	2,541	3,482	6,003
1997	731	1,739	2,470	4,259
1998	950	1,840	2,790	4,810
1999	1,670	2,829	4,499	7,757
2000	1,212	2,334	3,546	6,114
Mean	**1,101**	**2,257**	**3,357**	**5,789**

Other Removals

Between 1996 and 2000 there were 15 mortalities associated with research activities and 5 orphaned walrus calves collected for public display. Based on this information, an estimated 4 walrus per year were taken due to other human activities

Total Estimated Human Caused Mortality

The total estimated annual human caused mortality or removal is calculated to be 5,794 walrus per year (1 attributed to fisheries interactions, 5,789 due to harvest, and 4 due to other human activities).

STATUS OF STOCK

Pacific walrus are not listed as "depleted" under the Marine Mammal Protection Act, or as "threatened" or "endangered" under the Endangered Species act. Because of minimal interactions between walrus and any U.S. fishery the Pacific walrus population is not classified as a "strategic" stock with respect to managing incidental take under section 118 of the Marine Mammal Protection Act. The status of this stock relative to its Optimum Sustainable Population size is unknown.

Conservation Issues and Habitat Concerns

While recent harvest levels are lower than historical highs, a lack of information on population size or trend precludes any meaningful assessment of the impact of current harvest levels. Ensuring that harvest levels remain sustainable is a goal shared by subsistence hunters and resource managers in the U.S. and Russia. Achieving this management goal will require continued investments in population research, harvest monitoring programs, international coordination and co-management relationships.

Another element of concern is the potential for global climate change and associated changes in the distribution and extent of pack ice in the Bering and Chukchi Seas. The distribution of walrus is closely linked with the seasonal distribution of the pack ice because walrus rely on sea ice as a substrate for resting and giving birth. There are no data to make reliable predictions of the net impacts that changing climate conditions would have on the status and trend of the Pacific walrus population.

CITATIONS

Chapskii, K.K. 1936. The walrus of the Kara Sea. Results of an investigation of the life history, geographical distribution, and stock of walruses in the Kara Sea. Transactions of the Arctic Institute 67:1-124.

Chivers, S.J. 1999. Biological indices for monitoring population status of walrus evaluated with an individual-based model. Pp. *239-247 In* Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson (*EDS.*), Marine Mammal Survey and Assessment Methods. A. A. Balkema, Rotterdam, 287 pp.

Credle, V. A., D. P. DeMaster, M. M. Merlein, 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. Department of Commerce, NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

DeMaster, D.P. 1984. An analysis of a hypothetical population of walruses. Pp. 77-80 *In* F.H. Fay and G.A. Fedoseev (*EDS.*), Soviet-American Cooperative Research on Marine Mammals, vol. 1, Pinnipeds. NOAA Technical Report, NMFS 12, 104 pp.

Estes, J.A. and J.R. Gilbert. 1978. Evaluation of an aerial survey of Pacific walruses (*Odobenus rosmarus divergens*). Journal of the Fisheries Research Board of Canada 35:1130-1140.

Estes, J.A. and V.N. Gol'tsev. 1984. Abundance and distribution of the Pacific walrus (*Odobenus rosmarus divergens*): results of the first Soviet-American joint aerial survey, autumn 1975. Pp. 67-76 *In* F.H. Fay and G.A. Fedoseev (*EDS.*), Soviet-American Cooperative Research on Marine Mammals, vol. 1, Pinnipeds. NOAA Technical Report, NMFS 12, 104 pp.

Fay, F.H. 1982. Ecology and Biology of the Pacific Walrus (*Odobenus rosmarus divergens*). North American Fauna 74. U.S. Fish and Wildlife Service, Washington, DC., 279 pp.

Fay, F.H., B.P. Kelly, P.H. Gehnrich, J.L. Sease, and A.A. Hoover. 1984. Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus. Final Report R.U. #611. NOAA Outer Continental Shelf Environmental Assessment Program, Anchorage AK., 142 pp.

Fay, F.H., B.P. Kelly, and J.L. Sease. 1989. Managing the exploitation of Pacific walruses: a tragedy of delayed response and poor communication. Marine Mammal Science 5:1-16.

Fay, F.H., J.J. Burns, S.W. Stoker, and J.S. Grundy. 1994. The struck-and-lost factor in Alaskan walrus harvests. Arctic 47(4):368-373.

Fay, F.H., L.L. Eberhardt, B.P. Kelly, J.J. Burns, and L.T. Quakenbush. 1997. Status of the Pacific walrus Population, 1950-1989. Marine Mammal Science 13(4):537-565.

Fedoseev, G.A. 1984. Present status of the population of walruses (*Odobenus rosmarus*) in the eastern Arctic and Bering Sea. Pp. 73-85 *In* V.E. Rodin, A.S. Perlov, A.A. Berzin, G.M. Gavrilov, A.I. Shevchenko, N.S. Fadeev, and E.B. Kucheriavenko (*EDS.*), Marine Mammals of the Far East. TINRO, Vladivostok.

Fedoseev, G.A. and V.N. Gol'tsev. 1969. Age-sex structure and reproductive capacity of the Pacific walrus population. Zoological Journal 48:407-413.

Fedoseev, G.A. and E.V. Razlivalov. 1986. The distribution and abundance of walruses in the eastern Arctic and Bering Sea in autumn 1985. VNIRO, Magadan Branch. Mimeo report, 7 pp.

Garlich-Miller, J.G. and D.M. Burn. 1997. Estimating the harvest of Pacific walrus, *Odobenus rosmarus divergens*, in Alaska. Fish. Bull. 97 (4):1043-1046.

Garlich-Miller, J. and C.V Jay. 2000. Proceedings of a workshop concerning walrus survey methods. USFWS R7/MMM Technical Report 00-2, 92 pp.

Gilbert, J.R. 1986. Aerial survey of Pacific walrus in the Chukchi Sea, 1985. Mimeo report, 43 pp.

Gilbert, J.R. 1989a. Aerial census of Pacific walruses in the Chukchi Sea, 1985. Marine Mammal Science 5(1):17-28.

Gilbert, J.R. 1989b. Errata: Correction to the variance of products, estimates of Pacific walrus populations. Marine Mammal Science 5(4):411-412.

Gilbert, J.R. 1999. Review of previous Pacific walrus surveys to develop improved survey designs. In Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson *(EDS.*), Marine Mammal Survey and Assessment Methods. A. A. Balkema, Rotterdam, 287 pp.

Gilbert, J.R., G.A. Fedoseev, D. Seagars, E. Razlivalov, and A. LaChugin. 1992. Aerial census of Pacific walrus, 1990. USFWS R7/MMM Technical Report 92-1, 33 pp.

Hills, S. and J.R. Gilbert. 1994. Detecting Pacific walrus population trends with aerial survey - a review. Transactions North American Wildlife and Natural Resource Conference.

Johnson, A., J. Burns, W. Dusenberry, and R. Jones. 1982. Aerial survey of Pacific walrus, 1980. U.S. Fish and Wildlife Service, Anchorage, AK. Mimeo report, 32 pp.

Krylov, V.I. 1965. Determination of age, rate of growth, and analysis of the age structure of the catch of the Pacific walrus. Pp. 210-211 In E.N. Pavlovskii, B.A. Zenkovich, S.E. Kleinenber, and K.K. Chapskii *(EDS.*), Morskie Mlekopitaiushchie. Nauka, Moscow.

Krylov, V.I. 1968. On the present status of stocks of the Pacific walrus and prospects of their rational exploitation. Pp. 189-204 In V.A. Arsen'ev and K.I. Panin (*EDS.*), Lastonogie Severnoi Chasti Tikhogo Okeana. Pischevaya Promyshlennost', Moscow.

Mansfield, A.W. 1959. The walrus in the Canadian Arctic. Fisheries Research Board Canada, Circular 2, 13 pp.
Scribner, K.T., S. Hills, S.R. Fain, and M.A. Cronin. 1997. Population genetics studies of the walrus (Odobenus rosmarus): a summary and interpretation of results and research needs. *In* A.E. Dizon, S.J. Chivers and W.F. Perrin (*EDS*.), Molecular Genetics of Marine Mammals. Marine Mammal Science, Special publication 3:173-184.
Sease, J.L. 1986. Historical status and population dynamics of the Pacific walrus. Univ. Alaska, Fairbanks. Thesis, 213 pp.
Sease, J.L. and D.G. Chapman. 1988. Pacific walrus (*Odobenus rosmarus divergens*). Pgs. 17-38. *In* J.W. Lentfer (*EDS*.), Selected Marine Mammals of Alaska: species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C. NTIS PB88-178462.
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.

Revised: 08/20/2002

SEA OTTER (*Enhydra lutris*): Southeast Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

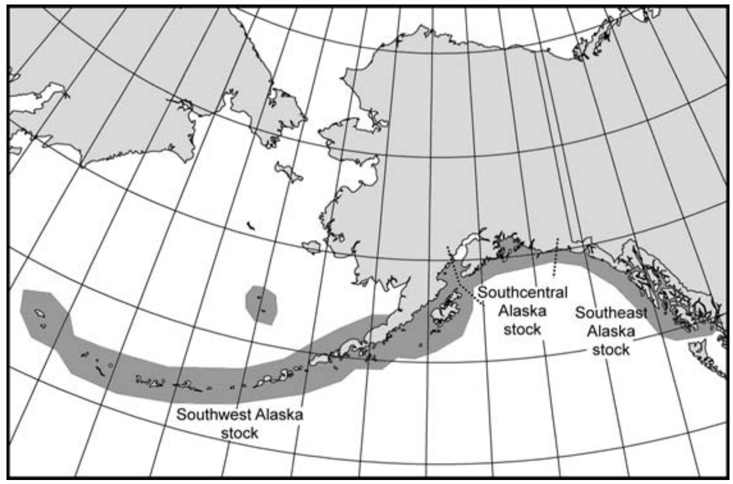

Figure 1. Approximate distribution of sea otters in Alaska waters (shaded area).

Sea otters occur in nearshore coastal waters of the U.S. along the North Pacific Rim from the Aleutian Islands to California. The species is most commonly observed within the 40 m depth contour since animals require frequent access to foraging habitat in subtidal and intertidal zones (Reidman and Estes 1990). Sea otters in Alaska are not migratory and generally do not disperse over long distances, although movements of tens of kilometers are normal (Garshelis and Garshelis 1984). Individuals are capable of long distance movements of >100 km (Garshelis *et al.* 1984), however movements of sea otters are likely limited by geographic barriers, high energy requirements of animals, and social behavior.

Applying the phylogeographic approach of Dizon *et al.* (1992), Gorbics and Bodkin (2001) identified three sea otter stocks in Alaska: southeast, southcentral,and southwest. The ranges of these stocks are defined as follows: (1) south stock extends from Dixon Entrance to Cape Yakataga; (2) southcentral stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai peninsula coast, and Kachemak Bay; and (3) southwest stock which includes Alaska Peninsula and Bristol Bay coasts, the Aleutian, Barren, Kodiak, and Pribilof Islands (Fig. 1). The phylogeographic approach of stock identification, which considers four types of data, is presented in greater detail below.

1) Distributional data: geographic distribution is continuous from Kachemak Bay to Cape Suckling, at which point 125 miles of vacant coastal habitat between Cape Suckling and Yakutat Bay separates the southeast and southcentral Alaska stocks (Doroff and Gorbics 1998). Sea otters in Yakutat Bay and southeast Alaska are the result of a translocation of 412 animals from Prince William Sound and Amchitka in the late 1960s (Pitcher 1989; Reidman and Estes 1990). Prior to translocation, sea otters had been absent from these habitats since the beginning of the 20th century. Distribution is nearly continuous from Attu Island in the western Aleutians to the Alaska Peninsula, although distances of >200 km between island groups in the Aleutians may effectively limit exchange of individuals. Sea otters do not occur in upper Cook Inlet, and population densities are currently low between the Kenai peninsula and the Alaska Peninsula, which suggests discontinuity in distribution at the stock boundary. Physical features that may limit movements of otters between the Kenai and Alaska peninsulas include approximately 100 km of open water across Cook Inlet with a maximum water depth of 100 m, and 70 km of open water between the Kenai Peninsula and the Kodiak Archipelago with a maximum water depth of 200 m. However, the open water between Kenai and Kodiak is interrupted mid-way by the Barren Islands (Gorbics and Bodkin 2001).

Contaminant levels may also indicate geographic isolation of stocks. In general, tissues from sea otters in Alaska contain relatively low levels of contaminants; however, higher levels of heavy metals and trace elements were found in animals from southcentral Alaska, with the general trend among groups being southcentral>southwest>southeast (Comerci *et al.*, in prep.). Patterns of contamination are consistent with distribution of pollutants from anthropogenic sources in populated areas. High levels of PCBs in some otters from the Aleutian Islands (southwest Alaska) likely reflect local "point sources," such as military installations (Estes *et al.* 1997; Bacon *et al.* 1999).

2) Population response data: variation in growth rates and reproductive characteristics among populations likely reflect local differences in habitat and resource availability rather than intrinsic differences between geographically distinct units (Gorbics and Bodkin 2001) .

3) Phenotypic data: significant differences in sea otter skull sizes exist between southwest and southcentral Alaska (Gorbics and Bodkin, 2001).

4) Genotypic data: the three stocks exhibit substantial differences in both mitochondrial and nuclear DNA (Cronin *et al.* 1996; Bodkin *et al.* 1992, 1999, Larson *et al.* in prep.). Significant differences in frequencies of mtDNA haplotypes and genetic differences among geographic areas show sufficient variation to indicate restricted gene flow (Gorbics and Bodkin 2001). A recent analyses of mitochondrial and nuclear DNA by Cronin *et al.* (2002) corroborates the stock structure proposed by Gorbics and Bodkin (2001).

POPULATION SIZE

Historically, sea otters occurred across the North Pacific Rim, ranging from Hokkaido Japan through the Kuril Islands, the Kamchatka Peninsula, the Commander Islands, the Aleutian islands, peninsular and south coastal Alaska and south to Baja, California, Mexico (Kenyon 1969). In the early 1700s, the worldwide population was estimated to be between 150,000 (Kenyon 1969) and 300,000 individuals (Johnson 1982). Prior to large-scale commercial exploitation, indigenous people of the North Pacific hunted sea otters. Although it appears that harvests periodically led to local reductions of sea otters (Simenstad *et al.* 1978), the species remained abundant throughout its range until the mid-1700s. Following the arrival in Alaska of Russian explorers in 1741, extensive commercial harvest of sea otters over the next 150 years resulted in the near extirpation of the species. When sea otters were afforded protection by the International Fur Seal Treaty in 1911, probably fewer than 2,000 animals remained in 13 remnant colonies (Kenyon, 1969). Population regrowth began following legal protection, and sea otters have since recolonized much of their historic range in Alaska.

The most recent population estimates for the southeast Alaska stock are presented in Table 1.

Table 1. Population estimates for the southeast Alaska stock of sea otters.

Survey Area	Year	Unadjusted Estimate	Adjusted Estimate	CV	N_{MIN}	Reference
Southeast Alaska	1994	8,180	11,697	0.398	8,467	Agler *et al.* (1995)
Yakutat Bay	1995		404	0.339	306	Doroff and Gorbics (1998)
North Gulf of Alaska	1996	223	531	0.087	493	Doroff and Gorbics (1998)
Total			12,632		9,266	

The survey of the southeast Archipelago conducted in 1994 ranged from Cape Spencer south to the Dixon Entrance. A ratio estimator was used to estimate a population size of 8,180 (CV = 0.392) sea otters. Applying a correction factor of 1.43 (CV = 0.071) for this type of boat survey (Udevitz *et al.* 1995) for sea otters not detected by observers produces an adjusted estimate of 11,697 (CV = 0.398).

An aerial survey of Yakutat Bay conducted in 1995 resulted in an adjusted population estimate of 404 (CV = 0.339) sea otters. The Yakutat Bay survey followed methodology described in Bodkin and Udevitz (1999) and included a survey-specific correction factor to account for undetected animals. A distribution survey of the Gulf Coast from Cape Yakataga to Cape Spencer excluding Yakutat Bay provided a minimum uncorrected count of 223 animals. Applying a correction factor of 2.38 (CV = 0.087) for sea otter aerial surveys using a twin-engine aircraft (Evans *et al.* 1997) produces an adjusted estimate of 531 (CV = 0.87). Combining the adjusted estimates for these three areas results in a total estimate of 12,632 sea otters for the southeast Alaska stock.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 * [\ln(1+[CV(N)]^2)]^{½})$. The N_{MIN} for each survey area is presented in Table 1; the estimated N_{MIN} for the southeast Alaska stock is 9,266 sea otters.

Current Population Trend

Although rates of population growth may vary among locations, the trend for this stock of sea otters has been one of growth (Pitcher 1989, Agler 1995). Sea otters inhabiting Yakutat Bay and southeast Alaska are the result of a translocation of 412 animals from Prince William Sound and Amchitka Island in the late 1960s. High rates of population growth reported for the southeast stock of sea otters are characteristic of translocated sea otter populations in Alaska (Bodkin *et al.* 1999). Regular aerial surveys of the Cross Sound/Icy Straight area and Glacier Bay have been conducted since 1994 (USGS unpublished data). Sea otter counts from these surveys suggest an average annual population growth rate of 12%, and indicate that animals in this portion of southeast are continuing to expand their range into Icy Strait and Glacier Bay, however this growth rate may not be representative of the entire stock. Preliminary information from recent aerial surveys recorded fewer sea otters than were previously expected. Therefore, the current population trend for the southeast Alaska stock is uncertain.

MAXIMUM NET PRODUCTIVITY RATE

Estes (1990) estimated a population growth rate of 17 to 20% per year for four northern sea otter populations expanding into unoccupied habitat. Pitcher (1989) estimated that annual rates of increase for the southeast Alaska sea otter stock ranged from 15.7 to 23.3% between 1966 (the time of re-establishment of the southeast stock) and 1988. However, the multiple surveys on which these growth rates were based were all attempts at total counts using varying techniques. Furthermore, no attempt was made to account for availability and sightability biases or for weather conditions. Consequently, the rate of 20% calculated by Estes (1990) was used to estimate 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 = $N_{MIN} \times 0.5 R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0 (Wade and Anglis 1997) as population levels have increased or remained stable with a known human take. Thus for the southeast stock of sea otters, PBR = 927 animals (9,266 x 0.5(0.2) x 1.0).

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

Each year, fishery observers monitor a percentage of commercial fisheries in Alaska and report injury and mortality of marine mammals incidental to these operations. Although no fisheries operating in the region of the southeast Alaska sea otter stock have been included in the NMFS observer programs to date, there are plans to conduct an observer program in southeast Alaska in 2004.

An additional source of information on the number of sea otters killed or injured incidental to commercial fishery operations in Alaska are fisher self-reports required of vessel-owners by NMFS. From 1990 to 1993, self-reported fisheries data reflected no sea otter kills or injuries in the southeast Alaska region. Self-reports were incomplete for 1994 and not available for 1995 or 1996. Between 1997 and 2000, there were no records of incidental take of sea otters by commercial fisheries in this region; thus, the estimated mean annual mortality reported is zero. Credle *et al.* (1994) considered this to be a minimum estimate as fisher self-reports and logbook records (self-reports required during 1990-1994) are most likely negatively biased.

Data available from other areas of the state suggest that rates of lethal interactions between sea otters and commercial fisheries are insignificant. Thus it is probably reasonable to assume that the southeast stock of sea otters is not likely to be significantly affected by fisheries at the present. The total fishery mortality and serious injury is less than 10% of the calculated PBR and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. A complete list of fisheries and marine mammal interactions is published annually by NMFS [67 FR 2410].

Oil and Gas Development

Exploration, development, and transport of oil and gas resources can adversely impact sea otters and nearshore coastal ecosystems in Alaska. Sea otters rely on air trapped in their fur for warmth and buoyancy. Contamination with oil drastically reduces the insulative value of the pelage, and consequently, sea otters are among the marine mammals most likely to be detrimentally affected by contact with oil. It is believed that sea otters can survive low levels of oil contamination (< 10% of body surface), but that greater levels (>25%) will lead to death (Costa and Kooyman 1981, Siniff *et al.* 1982). Vulnerability of sea otters to oiling was demonstrated by the 1989 *Exxon Valdez* oil spill in Prince William Sound. Total estimates of mortality for the Prince William Sound area vary from 750 (range 600-1,000) (Garshelis 1997) to 2,650 (range 500 - 5,000) (Garrot *et al.* 1993) otters. Statewide, it is estimated that 3,905 sea otters (range 1,904 - 11,257) died in Alaska as a result of the spill (DeGange *et al.* 1994). At present, abundance of sea otters in some oiled areas of Prince William Sound remains below pre-spill estimates, and evidence from ongoing studies suggests that sea otters and the nearshore ecosystem have not yet fully recovered from the spill (Bodkin *et al.*, in press, Stephensen *et al.* 2001).

There is currently no oil and gas development in southeast Alaska. In addition, tankers carrying oil south from the Trans-Alaska Pipeline typically travel offshore and therefore pose a minimal risk to sea otters in southeast Alaska. As a result, no mortalities due to oil and gas development have been documented within the range of the southeast Alaska sea otter stock.

Subsistence/Native Harvest Information

The Marine Mammal Protection Act of 1972 exempted Native Alaskans from the prohibition on hunting marine mammals. Alaska Natives are legally permitted to take sea otters for subsistence use or for creating and selling authentic handicrafts or clothing. Data for subsistence harvest of sea otters in southeast Alaska were collected by a mandatory Marking, Tagging and Reporting Program implemented by USFWS since 1988. Fig. 2 provides a summary of harvest information for the southeast stock from 1989-2000. The mean annual subsistence take during the past five years (1996-2000) was 301 animals. Reported age composition across during this period was 80% adults, 17% subadults, and 3% pups. Sex composition during the past five years was 65% males, 25% females and 10% of unknown sex.

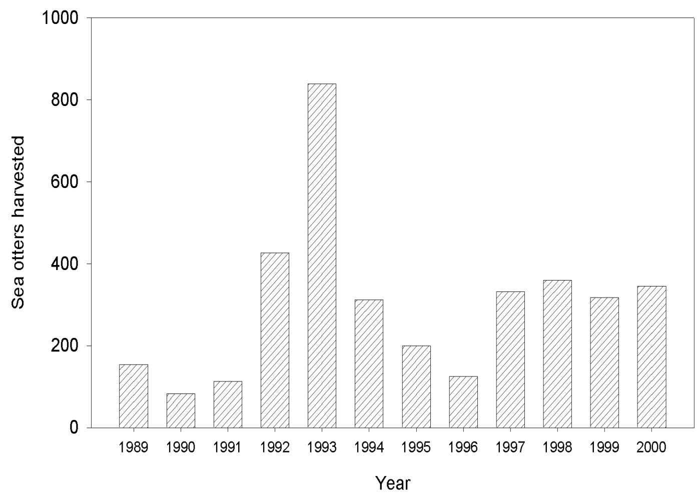

Figure 2. Estimated subsistence harvest of sea otters from the southeast Alaska stock, 1989-2000.

Since 1997, the USFWS and the Alaska Sea Otter and Steller Sea Lion Commission (TASSC) have signed cooperative agreements authorized under Section 119 of the MMPA for the conservation and co-management of sea otters in Alaska. Each of the six TASSC regions has a regional management plan that includes harvest guidelines. Several villages have also developed local management plans that address sea otter harvests.

Research and Public Display

In the past five years, no sea otters have been removed from the southeast Alaska stock for public display. Since 1996, a total of 64 sea otters have been captured and released for scientific research in Glacier Bay National Park. There have been no observed effects on sea otter populations in the southeast Alaska stock from these activities.

STATUS OF STOCK

Sea otters in the southeast Alaska stock 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 minimum mortality and injury incidental to commercial fisheries (0) is less than 10% of the calculated PBR and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. The estimated annual level of total human-caused mortality and serious injury over the 5-year period from 1996 through 2000 (301) does not exceed the PBR (927). As a result, the southeast Alaska sea otter stock is classified as non-strategic. This classification is consistent with the recommendations of the Alaska Regional Scientific Review Group (DeMaster 1995). The status of this stock relative to its Optimum Sustainable Population levels is unknown.

CITATIONS

Agler, B. A., S. J. Kendall, P. E. Seiser, and J. R. Lindell. 1995. Estimates of marine bird and sea otter abundance in southeast Alaska during summer 1994. Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, Alaska. 90pp.

Bacon, C. E., W. M. Jarman, J. A. Estes, M. Simon, and R. J. Norstrom. 1999. Comparison of organochlorine contaminants among sea otter (*Enhydra lutris*) populations in California and Alaska. Environmental Toxicology and Chemistry 18(3):452-458.

Bodkin, J. L., B. E. Ballachey, and M. A. Cronin. 1992. Mitochondrial DNA analysis in the conservation and management of sea otters. Research Information Bulletin, U.S. Department of the Interior 37:1-3.

Bodkin, J. L., R. J. Jameson, and J. A. Estes. 1995. Sea otters in the North Pacific Ocean. Pages 353-356 in LaRoe III, E. T., G. S. Farris, C. E. Pucket, and P. D. Doran, eds. Our Living Resources 1994: a report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems. U.S. Department of the Interior, National Biological Service, Washington D.C.

Bodkin, J. L., B. E. Ballachey, M. A. Cronin, and K. T. Scribner. 1999. Population demographics and genetic diversity in remnant and translocated populations of sea otters (*Enhydra lutris*). Conservation Biology 13(6):1378-1385.

Bodkin, J. L., and M. S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. Pages 13-26 in G.W. Garner *et al.*, editors. Marine Mammal Survey and Assessment Methods. Balekema, Rotterdam, Netherlands.

Bodkin, J. L., B. E. Ballachey, T. A. Dean, A. K. Fukuyama, S. C. Jewett, L. M. McDonald, D. H. Monson, C. E. O'Clair, and G. R. VanBlaricom. In press. Sea otter population status and the process of recovery from the *Exxon Valdez* spill. Marine Ecology Progress Series.

Comerci, L. R., C. S. Gorbis, A. Matz, and K. A. Trust (in prep.). Tissue concentrations of elemental and organochlorine compounds in sea otters in Alaska. U.S. Fish and Wildlife Service Technical Report, Anchorage, Alaska.

Costa, D. P., and G. L. Kooyman. 1981. Effects of oil contamination in the sea otter *Enhydra lutris.* Outer Continental Shelf Environmental Assessment Program. NOAA Final Report. La Jolla, California.

Credle, V. A., D. P. DeMaster, M. M. Merlein, 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. Department of Commerce, NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Cronin, M. A., J. L. Bodkin, B. E. Ballachey, J. A. Estes, and J. C. Patton. 1996. Mitochondrial-DNA variation among subspecies and populations of sea otters. Journal of Mammology 77(2):546-557.

Cronin, M. A., W. J. Spearman, W. Buchholz, S. Miller, L. Comerci, and L. Jack. 2002. Microsatellite DNA and mitochondrial DNA variation in Alaskan sea otters. Alaska Fisheries Technical Report.

DeGange, A. R., A. M. Doroff, and D. H. Monson. 1994. Experimental recovery of sea otter carcasses at Kodiak Island, Alaska, following the Exxon Valdez oil spill. Marine Mammal Science 10:492-496.

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 Mammals 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. Conservation Biology 6(1):24-36.

Doroff, A. M., and C. S. Gorbics. 1998. Sea Otter Surveys of Yakutat Bay and Adjacent Gulf of Alaska Coastal Areas - Cape Hinchinbrook to Cape Spencer 1995-1996. Minerals Management Service, OCS Study MMS 97-0026. 31 pp.

Estes, J. A. 1990. Growth and equilibrium in sea otter populations. Journal of Animal Ecology 59:385-401.

Estes, J. A., C. E. Bacon, W. M. Jarman, R. J. Norstrom, R. G. Anthony, and A. K. Miles. 1997. Organochlorines in sea otters and bald eagles from the Aleutian Archipelago. Marine Pollution Bulletin 34(6):486-490.

Evans, T.J., D.M. Burn, and A.R. DeGange. 1997. Distribution and relative abundance of sea otters in the Aleutian Archipelago. U.S. Fish & Wildlife Service, Marine Mammals Management Technical Report, MMM 97-5. 29 pp.

Garrott, R. A., L. L. Eberhard, and D. M. Burn. 1993. Mortality of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Marine Mammal Science 9:343-359.

Garshelis, D. L., and J. A. Garshelis. 1984. Movements and management of sea otters in Alaska. Journal of Wildlife Management 48(3):665-678.

Garshelis, D. L., A. M. Johnson, and J. A. Garshelis. 1984. Social organization of sea otters in Prince William Sound, Alaska. Canadian Journal of Zoology 62:2648-2658.

Garshelis, D. L. 1997. Sea otter mortality estimated from carcasses collected after the *Exxon Valdez* oil spill. Conservation Biology 11(4): 905-916.

Gorbics, C. S., and J. L. Bodkin. 2001. Stock structure of sea otters (*Enhydra lutris kenyoni*) in Alaska. Marine Mammal Science 17(3): 632-647.

Johnson, A. M. 1982. Status of Alaska sea otter populations and developing conflicts with fisheries. Pages 293-299 in: Transactions of the 47th North American Wildlife and Natural Resources Conference, Washington D.C.

Kenyon, K. W. 1969. The sea otter in the eastern Pacific Ocean. North American Fauna 68. U.S. Department of the Interior, Washington D.C.

Larson, S., R. Jameson, J. L. Bodkin, M. Staedler, and P. Bentzen (submitted to J. Mammalogy). Microsatellite and MtDNA sequence variation within and among remnant and translocated sea otter, *Enhydra lutris*, populations.

Pitcher, K. W. 1989. Studies of southeastern Alaska sea otter populations: distribution, abundance, structure, range expansion and potential conflicts with shellfisheries. Anchorage, Alaska. Alaska Department of Fish and Game, Cooperative Agreement 14-16-0009-954 with U.S. Fish and Wildlife Service. 24 pp.

Riedman, M. L., and J. A. Estes. 1990. The sea otter *Enhydra lutris*: behavior, ecology, and natural history. Biological Report; 90 (14). U.S. Fish and Wildlife Service.

Simenstad, C. A., J. A. Estes, and K. W. Kenyon. 1978. Aleuts, sea otters, and alternate stable-state communities. Science 200:403-411. 127 pp.

Siniff, D. B., T. D. Williams, A. M. Johnson, and D. L. Garshelis. 1982. Experiments on the response of sea otters *Enhydra lutris* to oil contamination. Biological Conservation 23: 261-272.

Stephensen, S. W., D. B. Irons, S. J. Kendall, B. K. Lance, and L. L. MacDonald. 2001. Marine bird and sea otter population abundance of Prince William Sound, Alaska: trends following the T/V *Exxon Valdez* oil spill, 1989-2000. Restoration Project 00159 Annual Report. USFWS Migratory Bird Management, Anchorage, Alaska. 114 pp.

Udevitz, M.S., J.L. Bodkin, and D.P. Costa. 1995. Detection of sea otters in boat-based surveys of Prince William Sound, Alaska. Marine Mammal Science, 11(1): 9-71.

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. Department of Commerce, NOAA Technical Memo. NMFS-OPR-12. 93 pp.

SEA OTTER (*Enhydra lutris*): Southcentral Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters occur in nearshore coastal waters of the U.S. along the North Pacific Rim from the Aleutian Islands to California. The species is most commonly observed within the 40 m depth contour since animals require frequent access to foraging habitat in subtidal and intertidal zones (Reidman and Estes 1990). Sea otters in Alaska are not migratory and generally do not disperse over long distances, although movements of tens of kilometers are normal (Garshelis and Garshelis 1984). Individuals are capable of long distance movements of >100 km (Garshelis *et al.* 1984), however movements of sea otters are likely limited by geographic barriers, high energy requirements of animals, and social behavior.

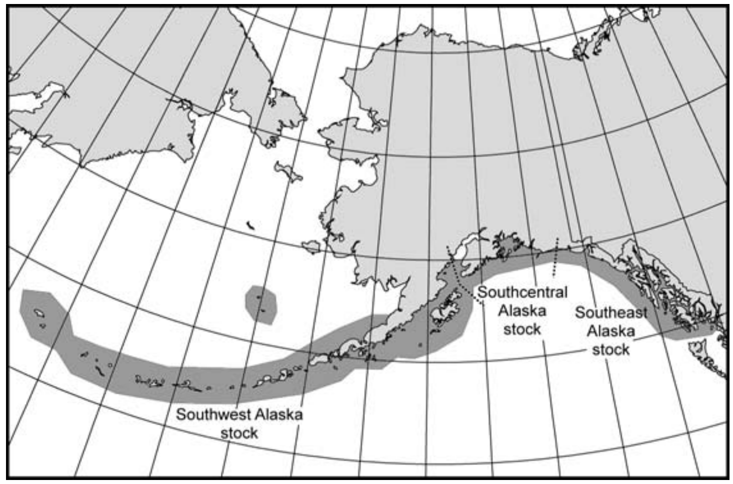

Figure 1. Approximate distribution of sea otters in Alaska waters (shaded area).

Applying the phylogeographic approach of Dizon *et al.* (1992), Gorbics and Bodkin (2001) identified three sea otter stocks in Alaska: southeast, southcentral,and southwest. The ranges of these stocks are defined as follows: (1) southeast stock extends from Dixon Entrance to Cape Yakataga; (2) southcentral stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai peninsula coast, and Kachemak Bay; and (3) southwest stock which includes Alaska Peninsula and Bristol Bay coasts, the Aleutian, Barren, Kodiak, and Pribilof Islands (Fig. 1). The phylogeographic approach of stock identification, which considers four types of data, is presented in greater detail below.

1) Distributional data: geographic distribution is continuous from Kachemak Bay to Cape Suckling, at which point 125 miles of vacant coastal habitat between Cape Suckling and Yakutat Bay separates the southeast and southcentral Alaska stocks (Doroff and Gorbics 1998). Sea otters in Yakutat Bay and southeast Alaska are the result of a translocation of 412 animals from Prince William Sound and Amchitka in the late 1960s (Pitcher 1989; Reidman and Estes 1990). Prior to translocation, sea otters had been absent from these habitats since the beginning of the 20th century. Distribution is nearly continuous from Attu Island in the western Aleutians to the Alaska Peninsula, although distances of >200 km between island groups in the Aleutians may effectively limit exchange of individuals. Sea otters do not occur in upper Cook Inlet, and population densities are currently low between the Kenai peninsula and the Alaska Peninsula, which suggests discontinuity in distribution at the stock boundary. Physical features that may limit movements of otters between the Kenai and Alaska peninsulas include approximately 100 km of open water across Cook Inlet with a maximum water depth of 100 m, and 70 km of open water between the Kenai Peninsula and the Kodiak Archipelago with a maximum water depth of 200 m. However, the open water between Kenai and Kodiak is interrupted mid-way by the Barren Islands (Gorbics and Bodkin 2001).

Contaminant levels may also indicate geographic isolation of stocks. In general, tissues from sea otters in Alaska contain relatively low levels of contaminants; however, higher levels of heavy metals and trace elements were found in animals from southcentral Alaska, with the general trend among groups being southcentral>southwest>southeast (Comerci *et al.*, in prep.). Patterns of contamination are consistent with distribution of pollutants from anthropogenic sources in populated areas. High levels of PCBs in some otters from the Aleutian Islands (southwest Alaska) likely reflect local "point sources," such as military installations (Estes *et al.* 1997; Bacon *et al.* 1999).

2) Population response data: variation in growth rates and reproductive characteristics among populations likely reflect local differences in habitat and resource availability rather than intrinsic differences between geographically distinct units (Gorbics and Bodkin 2001) .

3) Phenotypic data: significant differences in sea otter skull sizes exist between southwest and southcentral Alaska (Gorbics and Bodkin, 2001).

4) Genotypic data: the three stocks exhibit substantial differences in both mitochondrial and nuclear DNA (Cronin *et al.* 1996; Bodkin *et al.* 1992, 1999, Larson *et al.* in prep.). Significant differences in frequencies of mtDNA haplotypes and genetic differences among geographic areas show sufficient variation to indicate restricted gene flow (Gorbics and Bodkin 2001). A recent analyses of mitochondrial and nuclear DNA by Cronin *et al.* (2002) corroborates the stock structure proposed by Gorbics and Bodkin (2001).

POPULATION SIZE

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

The most recent population estimates for the southcentral Alaska stock are presented in Table 1.

Table 1. Population estimates for the southcentral Alaska stock of sea otters.

Survey Area	Year	Unadjusted Estimate	Adjusted Estimate	CV	N_{min}	Reference
North Gulf of Alaska	1996	271	645	0.087	600	Doroff and Gorbics (1998)
Prince William Sound	1999		13,234	0.198	11,220	USGS Unpublished data
Cook Inlet/Kenai Fiords	2002		2,673	0.271	2,136	USGS Unpublished data
Total			16,552		13,955	

In 1999, a survey of Prince William Sound resulted in an abundance estimate of 13,234 (CV = 0.198) animals (USGS unpublished data). This survey followed methodology described in Bodkin and Udevitz (1999) and included a survey-specific correction factor to account for undetected animals.

The survey of lower Cook Inlet and the Kenai Fiords area conducted in June and August 2002 also followed the methodology of Bodkin and Udevitz (1999) with an abundance estimate of 2,673 (CV = 0.271) (USGS unpublished data).

Finally, two aerial surveys of the northern Gulf of Alaska coastline flown in 1995 and 1996 provided a minimum uncorrected count of 271 sea otters between Cape Hinchinbrook and Cape Yakataga (Doroff and Gorbics 1998). Applying a correction factor of 2.38 (CV = 0.087) for sea otter aerial surveys using a twin-engine aircraft (Evans *et al.* 1997) produces an adjusted estimate of 645 (CV = 0.087). Combining the adjusted estimates for these three areas results in a total estimate of 16,552 sea otters for the southcentral Alaska stock.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. The N_{MIN} for each survey area is presented in Table 1; the estimated N_{MIN} for the southcentral Alaska stock is 13,955 sea otters.

Current Population Trend

Although rates of population growth may vary among locations, the trend for this stock of sea otters is generally one of growth (Irons *et al.* 1988, Bodkin and Udevitz 1999). Since 1911, when sea otters were protected from commercial hunting, remnant populations in southcentral Alaska have recolonized much of their former range. Persisting populations in Alaska have generally exhibited trends of growth, with declines occurring only when populations exceed available resources (Estes 1990, Bodkin *et al.* 1995). The 1989 *Exxon Valdez* oil spill resulted in an estimated sea otter mortality in Prince William Sound ranging from 750 (range 600-1,000) (Garshelis 1997) to 2,650 (range 500 - 5,000) otters (Garrot *et al.* 1993). Since the spill, sea otters in western Prince William Sound have increased by approximately 750 animals (Bodkin *et al.*, in press). However, overall sea otter abundance in Prince William Sound has not increased appreciably since 1994. The current population estimate for Kenai Fiords and eastern Cook Inlet is slightly higher than the previous estimate from 1989 (2,673 vs. 2,330), which suggests slight growth in this area. The overall trend for this stock appears to be either stable or slightly increasing.

MAXIMUM NET PRODUCTIVITY RATE

Estes (1990) estimated a population growth rate of 17 to 20% per year for four northern sea otter populations expanding into unoccupied habitat. However, in areas where resources are limiting or where populations are approaching equilibrium density, slower rates of growth are expected (Estes, 1990, Bodkin *et al.* 1995). Maximum productivity rates have not been measured through much of the sea otter's range in Alaska. In the absence of more detailed information for maximum productivity rates throughout southcentral Alaska, the rate of 20% calculated by Estes (1990) is considered a reliable estimate of R_{MAX}.

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: $PBR = N_{MIN} \times 0.5 R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0 (Wade and Anglis 1997) as population levels have increased or remained stable with a known human take. Thus for the southcentral stock of sea otters, PBR = 1,396 animals (13,955 x 0.5 (0.2) x1.0)

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

Each year, fishery observers monitor a percentage of commercial fisheries in Alaska and report injury and mortality of marine mammals incidental to these operations. Fisheries observers monitored the Cook Inlet set gillnet and drift gillnet fisheries from 1999-2000. The observer coverage during both years was approximately 2-5%. No mortalities or injuries of sea otters were reported by fisheries observers for the Cook Inlet set gillnet and drift gillnet fisheries for this period. On several occasions, sea otters were observed within 10 meters of the gillnet gear, but did not become entangled. No other fisheries operating in the region of the southcentral stock were monitored by observer programs from 1992 through 2000. From 1990 to 1991, fisheries observers in the southcentral Alaska region reported no mortalities or injuries of sea otters. Prior to the implementation of the NMFS observer program, studies were conducted on sea otter interactions with the drift net fisheries in western Prince William Sound from 1988 to1990 and no mortalities were observed (Wynne 1990, 1991).

An additional source of information on the number of sea otters killed or injured incidental to commercial fishery operations in Alaska are fisher self-reports required of vessel owners by NMFS. In 1990, fisher self-report records show 1 kill and 4 injuries due to gear interaction and 3 injuries due to deterrence in the Prince William Sound drift gillnet fishery. Self-reports were not available for 1994 and 1995. Between 1996 and 2000, there were no records of incidental take of sea otters by commercial fisheries in this region; thus, the estimated mean annual mortality reported for the 5-year period from 1996-2000 is zero. Credle *et al.* (1994) considered this to be a minimum estimate as fisher self-reports and logbook records (self-reports required during 1990-1994) are most likely negatively biased.

Based on the available data, sea otter abundance in the southcentral Alaska stock is not likely to be significantly affected by commercial fishery interaction at present. The total fishery mortality and serious injury is less than 10% of the calculated PBR (1,951) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate (Wade and Angliss 1997). A complete list of fisheries and marine mammal interactions is published annually by NMFS [67 FR 2410].

Oil and Gas Development

Exploration, development and transport of oil and gas resources can adversely impact sea otters and nearshore coastal ecosystems in Alaska. Sea otters rely on air trapped in their fur for warmth and buoyancy. Contamination with oil drastically reduces the insulative value of the pelage, and consequently, sea otters are among the marine mammals most likely to be detrimentally affected by contact with oil. It is believed that sea otters can survive low levels of oil contamination (< 10% of body surface), but that greater levels (>25%) will lead to death (Costa and Kooyman 1981, Siniff *et al.* 1982). Vulnerability of sea otters to oiling was demonstrated by the 1989 *Exxon Valdez* oil spill in Prince William Sound. Total estimates of mortality for the Prince William Sound area vary from 750 (range 600-1,000) (Garshelis 1997) to 2,650 (range 500 - 5,000) otters (Garrot *et al.* 1993). Statewide, it is estimated that 3,905 sea otters (range 1,904 - 11,257) died in Alaska as a result of the spill (DeGange *et al.*1994b). At present, abundance of sea otters in some oiled areas of Prince William Sound remains below pre-spill estimates, and evidence from ongoing studies suggests that sea otters and the nearshore ecosystem have not yet fully recovered from the 1989 oil spill (Bodkin *et al.*, in press, Stephensen *et al.* 2001).

In addition to tanker traffic in Prince William Sound, oil and gas development occurs in Cook Inlet. While the catastrophic release of oil has the potential to take large numbers of sea otters, there is no evidence that routine oil and gas development and transport have a direct impact on the southcentral Alaska sea otter stock.

Subsistence/Native Harvest Information

The Marine Mammal Protection Act of 1972 exempted Native Alaskans from the prohibition on hunting marine mammals. Alaska Natives are legally permitted to take sea otters for subsistence use or for creating and selling authentic handicrafts or clothing. Data for subsistence harvest of sea otters in southcentral Alaska were collected by a mandatory Marking, Tagging and Reporting Program implemented by USFWS since 1988. Fig. 2 provides a summary of harvest information for the southcentral stock from 1989-2000. The mean annual subsistence take during the past five years (1996-2000) was 297 animals. Age composition during this period was 93% adults,6% subadults, and 1% pups. Sex composition during the past five years was 81% males, 17% females and 2% of unknown sex.

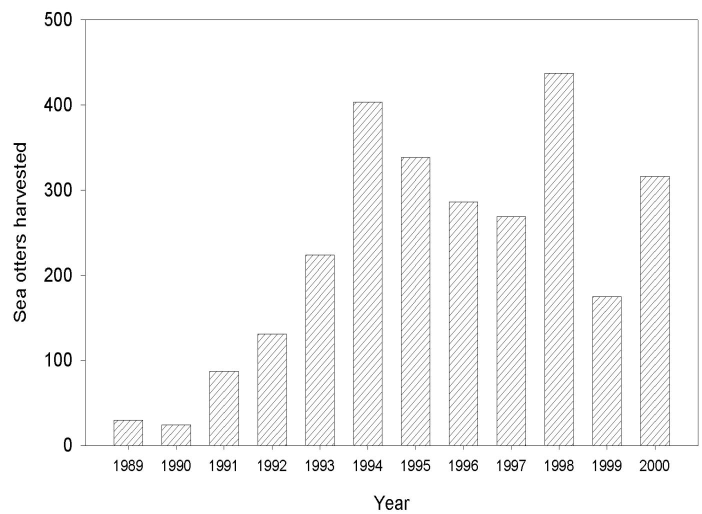

Figure 2. Estimated subsistence harvest of sea otters from the southcentral Alaska stock, 1989-2000.

Since 1997, the USFWS and the Alaska Sea Otter and Steller Sea Lion Commission (TASSC) have signed cooperative agreements authorized under Section 119 of the MMPA for the conservation and co-management of sea otters in Alaska. Each of the six TASSC regions has a regional management plan that includes harvest guidelines. Several villages have also developed local management plans that address sea otter harvests.

Research and Public Display

During the past five years there have been no live captures of sea otters for public display from the southcentral Alaska stock. Since 1996, 253 sea otters have been captured and released for scientific research in Prince William Sound. There have been no observed effects on sea otter populations in the southcentral Alaska stock from these activities.

STATUS OF STOCK

Sea otters in the southcentral Alaska stock 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 minimum mortality and serious injury incidental to commercial fisheries (0) is less than 10% of the calculated PBR, and therefore can be considered insignificant and approaching a zero mortality and serious injury rate. The estimated annual level of total human-caused mortality and serious injury over the 5-year period from 1996 through 2000 (297) does not exceed the PBR (1,396). As a result, the southcentral sea otter stock is classified as non-strategic. This classification is consistent with the recommendations of the Alaska Regional Scientific Review Group (DeMaster 1995). The status of this stock relative to its Optimum Sustainable Population size is unknown.

CITATIONS

Bacon, C. E., W. M. Jarman, J. A. Estes, M. Simon, and R. J. Norstrom. 1999. Comparison of organochlorine contaminants among sea otter (*Enhydra lutris*) populations in California and Alaska. Environmental Toxicology and Chemistry 18(3):452-458.

Bodkin, J. L., B. E. Ballachey, and M. A. Cronin. 1992. Mitochondrial DNA analysis in the conservation and management of sea otters. Research Information Bulletin, U.S. Department of the Interior 37:1-3.

Bodkin, J. L., R. J. Jameson, and J. A. Estes. 1995. Sea otters in the North Pacific Ocean. Pages 353-356 in LaRoe III, E. T., G. S. Farris, C. E. Pucket, and P. D. Doran, eds. Our Living Resources 1994: a report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems. U.S. Department of the Interior, National Biological Service, Washington D.C.

Bodkin, J. L., B. E. Ballachey, M. A. Cronin, and K. T. Scribner. 1999. Population demographics and genetic diversity in remnant and translocated populations of sea otters (*Enhydra lutris*). Conservation Biology 13(6):1378-1385.

Bodkin, J. L., and M. S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. Pages 13-26 in G.W. Garner *et al.*, editors. Marine Mammal Survey and Assessment Methods. Balekema, Rotterdam, Netherlands.

Bodkin, J. L., B. E. Ballachey, T. A. Dean, A. K. Fukuyama, S. C. Jewett, L. M. McDonald, D. H. Monson, C. E. O'Clair, and G. R. VanBlaricom. In press. Sea otter population status and the process of recovery from the *Exxon Valdez* spill. Marine Ecology Progress Series.

Comerci, L. R., C. S. Gorbis, A. Matz, and K. A. Trust (in prep.). Tissue concentrations of elemental and organochlorine compounds in sea otters in Alaska. U.S. Fish and Wildlife Service Technical Report, Anchorage, Alaska.

Costa, D. P., and G. L. Kooyman. 1981. Effects of oil contamination in the sea otter *Enhydra lutris.* Outer Continental Shelf Environmental Assessment Program. NOAA Final Report. La Jolla, California.

Credle, V. A., D. P. DeMaster, M. M. Merlein, 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. Department of Commerce, NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Cronin, M. A., J. L. Bodkin, B. E. Ballachey, J. A. Estes, and J. C. Patton. 1996. Mitochondrial-DNA variation among subspecies and populations of sea otters. Journal of Mammology 77(2):546-557.

Cronin, M. A., W. J. Spearman, W. Buchholz, S. Miller, L. Comerci, and L. Jack. 2002. Microsatellite DNA and mitochondrial DNA variation in Alaskan sea otters. Alaska Fisheries Technical Report.

DeGange, A.R., D.C. Douglas, D.H. Monson and C.M. Robbins. 1994a. Surveys of sea otters in the Gulf of Alaska in response to the *Exxon Valdez* oil spill. Final report to the Exxon Valdez Oil Spill Trustee Council, Marine Mammal Study 6-7. U.S. Fish and Wildlife Service, Anchorage, Alaska.

DeGange, A. R., A. M. Doroff, and D. H. Monson. 1994b. Experimental recovery of sea otter carcasses at Kodiak Island, Alaska, following the Exxon Valdez oil spill. Marine Mammal Science 10:492-496.

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 Mammals 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. Conservation Biology 6(1):24-36.

Doroff, A. M., and C. S. Gorbics. 1998. Sea Otter Surveys of Yakutat Bay and Adjacent Gulf of Alaska Coastal Areas - Cape Hinchinbrook to Cape Spencer 1995-1996. Minerals Management Service, OCS Study MMS 97-0026. 31 pp.

Estes, J. A. 1990. Growth and equilibrium in sea otter populations. Journal of Animal Ecology 59:385-401.

Estes, J. A., C. E. Bacon, W. M. Jarman, R. J. Norstrom, R. G. Anthony, and A. K. Miles. 1997. Organochlorines in sea otters and bald eagles from the Aleutian Archipelago. Marine Pollution Bulletin 34(6):486-490.

Evans, T.J., D.M. Burn, and A.R. DeGange. 1997. Distribution and relative abundance of sea otters in the Aleutian Archipelago. U.S. Fish & Wildlife Service, Marine Mammals Management Technical Report, MMM 97-5. 29 pp.

Garrott, R. A., L. L. Eberhard, and D. M. Burn. 1993. Mortality of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Marine Mammal Science 9:343-359.

Garshelis, D. L., and J. A. Garshelis. 1984. Movements and management of sea otters in Alaska. Journal of Wildlife Management 48(3):665-678.

Garshelis, D. L., A. M. Johnson, and J. A. Garshelis. 1984. Social organization of sea otters in Prince William Sound, Alaska. Canadian Journal of Zoology 62:2648-2658.

Garshelis, D. L. 1997. Sea otter mortality estimated from carcasses collected after the *Exxon Valdez* oil spill. Conservation Biology 11(4): 905-916.

Gorbics, C. S., and J. L. Bodkin. 2001. Stock structure of sea otters (*Enhydra lutris kenyoni*) in Alaska. Marine Mammal Science 17(3): 632-647

Irons, D. B., D. R. Nysewander, and J. L. Trapp. 1988. Prince William Sound sea otter distribution in respect to population growth and habitat type. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Johnson, A. M. 1982. Status of Alaska sea otter populations and developing conflicts with fisheries. Pages 293-299 in: Transactions of the 47th North American Wildlife and Natural Resources Conference, Washington D.C.

Kenyon, K. W. 1969. The sea otter in the eastern Pacific Ocean. North American Fauna 68. U.S. Department of the Interior, Washington D.C.

Larson, S., R. Jameson, J. L. Bodkin, M. Staedler, and P. Bentzen (submitted to J. Mammalogy). Microsatellite and MtDNA sequence variation within and among remnant and translocated sea otter, *Enhydra lutris*, populations.

Pitcher, K. W. 1989. Studies of southeastern Alaska sea otter populations: distribution, abundance, structure, range expansion and potential conflicts with shellfisheries. Anchorage, Alaska. Alaska Department of Fish and Game, Cooperative Agreement 14-16-0009-954 with U.S. Fish and Wildlife Service. 24 pp.

Riedman, M. L., and J. A. Estes. 1990. The sea otter *Enhydra lutris*: behavior, ecology, and natural history. Biological Report; 90 (14). U.S. Fish and Wildlife Service.

Simenstad, C. A., J. A. Estes, and K. W. Kenyon. 1978. Aleuts, sea otters, and alternate stable-state communities. Science 200:403-411. 127 pp.

Siniff, D. B., T. D. Williams, A. M. Johnson, and D. L. Garshelis. 1982. Experiments on the response of sea otters *Enhydra lutris* to oil contamination. Biological Conservation 23: 261-272.

Stephensen, S. W., D. B. Irons, S. J. Kendall, B. K. Lance, and L. L. MacDonald. 2001. Marine bird and sea otter population abundance of Prince William Sound, Alaska: trends following the T/V *Exxon Valdez* oil spill, 1989-2000. Restoration Project 00159 Annual Report. USFWS Migratory Bird Management, Anchorage, Alaska. 114 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. Department of Commerce, NOAA Technical 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. Final Report, Saltwater, Inc., Anchorage, Alaska. 65 pp.

Wynne, K. M. 1990. Marine mammal interactions with salmon drift gillnet fishery on the Copper River Delta, Alaska: 1988 and 1989. Alaska Sea Grant Technical Report AK-SG-90-05. 36 pp.

SEA OTTER (*Enhydra lutris*): Southwest Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters occur in nearshore coastal waters of the U.S. along the North Pacific Rim from the Aleutian Islands to California. The species is most commonly observed within the 40 m depth contour since animals require frequent access to foraging habitat in subtidal and intertidal zones (Reidman and Estes 1990). Sea otters in Alaska are not migratory and generally do not disperse over long distances, although movements of tens of kilometers are normal (Garshelis and Garshelis 1984). Individuals are capable of long distance movements of >100 km (Garshelis *et al.* 1984), however movements of sea otters are likely limited by geographic barriers, high energy requirements of animals, and social behavior.

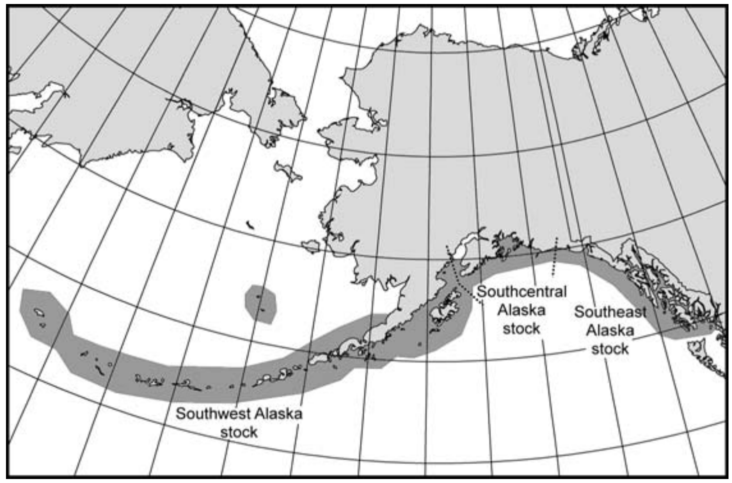

Figure 1. Approximate distribution of sea otters in Alaska waters (shaded area).

Applying the phylogeographic approach of Dizon *et al.* (1992), Gorbics and Bodkin (2001) identified three sea otter stocks in Alaska: southeast, southcentral,and southwest. The ranges of these stocks are defined as follows: (1) Southeast stock extends from Dixon Entrance to Cape Yakataga; (2) Southcentral stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai peninsula coast, and Kachemak Bay; and (3) Southwest stock which includes Alaska Peninsula and Bristol Bay coasts, the Aleutian, Barren, Kodiak, and Pribilof Islands (Fig. 1). The phylogeographic approach of stock identification, which considers four types of data, is presented in greater detail below.

1) Distributional data: geographic distribution is continuous from Kachemak Bay to Cape Suckling, at which point 125 miles of vacant coastal habitat between Cape Suckling and Yakutat Bay separates the southeast and southcentral Alaska stocks (Doroff and Gorbics 1998). Sea otters in Yakutat Bay and southeast Alaska are the result of a translocation of 412 animals from Prince William Sound and Amchitka in the late 1960s (Pitcher 1989; Reidman and Estes 1990). Prior to translocation, sea otters had been absent from these habitats since the beginning of the 20th century. Distribution is nearly continuous from Attu Island in the western Aleutians to the Alaska Peninsula, although distances of >200 km between island groups in the Aleutians may effectively limit exchange of individuals. Sea otters do not occur in upper Cook Inlet, and population densities are currently low between the Kenai peninsula and the Alaska Peninsula, which suggests discontinuity in distribution at the stock boundary. Physical features that may limit movements of otters between the Kenai and Alaska peninsulas include approximately 100 km of open water across Cook Inlet with a maximum water depth of 100 m, and 70 km of open water between the Kenai Peninsula and the Kodiak Archipelago with a maximum water depth of 200 m. However, the open water between Kenai and Kodiak is interrupted mid-way by the Barren Islands (Gorbics and Bodkin 2001).

Contaminant levels may also indicate geographic isolation of stocks. In general, tissues from sea otters in Alaska contain relatively low levels of contaminants; however, higher levels of heavy metals and trace elements were found in animals from southcentral Alaska, with the general trend among groups being southcentral>southwest>southeast (Comerci *et al.*, in prep.). Patterns of contamination are consistent with distribution of pollutants from anthropogenic sources in populated areas. High levels of PCBs in some otters from the Aleutian Islands (southwest Alaska) likely reflect local "point sources," such as military installations (Estes *et al.* 1997; Bacon *et al.* 1999).

2) Population response data: variation in growth rates and reproductive characteristics among populations likely reflect local differences in habitat and resource availability rather than intrinsic differences between geographically distinct units (Gorbics and Bodkin 2001) .

3) Phenotypic data: significant differences in sea otter skull sizes exist between Southwest and Southcentral Alaska (Gorbics and Bodkin, 2001).

4) Genotypic data: the three stocks exhibit substantial differences in both mitochondrial and nuclear DNA (Cronin *et al.* 1996; Bodkin *et al.* 1992, 1999, Larson *et al.* in prep.). Significant differences in frequencies of mtDNA haplotypes and genetic differences among geographic areas show sufficient variation to indicate restricted gene flow (Gorbics and Bodkin 2001). A recent analyses of mitochondrial and nuclear DNA by Cronin *et al.* (2002) corroborates the stock structure proposed by Gorbics and Bodkin (2001).

POPULATION SIZE

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

The most recent population estimates for the Southwest Alaska stock are presented in Table 1.

Table 1. Population estimates for the Southwest Alaska stock of sea otters.

Survey Area	Year	Unadjusted Estimate	Adjusted Estimate	CV	N_{min}	Reference
Aleutian Islands	2000	2,442	8,742	0.215	7,309	Doroff *et al.* (in press)
North Alaska Peninsula	2000	4,728	11,253	0.337	8,535	USFWS Unpublished data
South Alaska Peninsula - Offshore	2001	1,005	2,392	0.816	1,311	USFWS Unpublished data
South Alaska Peninsula - Shoreline	2001	2,190	5,212	0.087	4,845	USFWS Unpublished data
South Alaska Peninsula - Islands	2001	405	964	0.087	896	FWS Unpublished data
Unimak Island	2001	42	100	0.087	93	FWS Unpublished data
Kodiak Archipelago	2001		5,893	0.228	4,875	USFWS Unpublished data
Kamishak Bay	2002		6,918	0.315	5,340	USGS Unpublished data
Total			41,474		33,203	

Surveys of the Aleutian Islands in summer 2000 included the Near, Rat, Andreanof, Delarof, Four Mountain and Fox Island groups, and resulted in a population estimate of 8,742 (CV= 0.215) sea otters (Doroff *et al.*, in press). In the Aleutian Islands, aerial surveys consisted of shoreline counts that used a correction factor to account for sightability.

A survey of offshore area of the North Alaska Peninsula from Unimak Island to Cape Seniavin flown in summer 2000 produced an abundance estimate of 4,728 (CV= 0.326) sea otters (USFWS unpublished data). A similar survey of offshore areas of the south Alaska Peninsula from False Pass to Pavlov Bay conducted in summer 2001 resulted in a population estimate of 1,005 (CV= 0.811) animals. Applying a correction factor of 2.38 (CV = 0.087) for sea otter aerial surveys using a twin-engine aircraft (Evans *et al.* 1997) produces adjusted estimates of 11,253 (CV = 0.337) and 2,392 (CV = 0.816) for the north and south Alaska Peninsula offshore areas, respectively.

In 2001, aerial surveys along the shoreline of the South Alaska Peninsula from Seal Cape to Cape Douglas recorded 2,190 sea otters (USFWS unpublished data). Additional aerial surveys of the South Alaska Peninsula island groups (Sanak, Caton, and Deer Islands, and the Shumagin and Pavlov island groups) and a survey of Unimak Island, recorded 405 otters for the South Alaska Peninsula island groups and 42 animals for Unimak Island. Applying the same correction factor of 2.38 (CV = 0.087) for sea otter aerial surveys using a twin-engin aircraft produces adjusted estimates of 5,212 (CV = 0.087), 964 (CV = 0.087) and 100 (CV = 0.087) for the south Alaska Peninsula shoreline, south Alaska Peninsula islands, and Unimak Island, respectively.

An aerial survey of the Kodiak Archipelago conducted in 2001 provided a population estimate of 5,893 (CV = 0.228) sea otters (USFWS unpublished data). The population estimate was calculated by applying a ratio estimate of density to the entire study area, and a correction factor was applied to account for group size bias and undetected diving animals.

Finally, an aerial survey of Kamishak Bay conducted in June 2002 produced a population estimate of 6,918(CV = 0.315) sea otters. This population estimate was also calculated by applying a ratio estimate of density to the entire study area, and a correction factor was applied to account for group size bias and undetected diving animals.

Combining the adjusted estimates for these study areas areas results in a total estimate of 41,474 sea otters for the southwest Alaska stock.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. The N_{MIN} for each survey area is presented in Table 1; the estimated N_{MIN} for the southwest Alaska stock is 33,203.

Current Population Trend

The first systematic aerial surveys of sea otters in southwest Alaska were conducted from 1957 to 1965. These surveys indicated that sea otter populations were growing and that animals were recolonizing much of their former range. Additionally, surveys showed that the greatest concentration of sea otters in the world was located in the Aleutian Islands (Kenyon 1969). By the 1980s, sea otters were present in all the island groups in the Aleutians (Estes 1990), and the total population in the Aleutian Islands was estimated as 55,100 to 73,700 individuals (Calkins and Schneider 1985). In 1992, nearly three decades after the original aerial surveys, USFWS conducted another systematic aerial survey of the Aleutian Islands. The total uncorrected count for the entire area was 8,042 sea otters. Survey results showed that sea otter abundance had declined since 1965 by more than 50% in several island groups in the central Aleutians (Evans *et al.* 1997). Boat-based surveys conducted during the 1990s independently documented severe declines in sea otter abundance within portions of the central Aleutians (Estes *et al.* 1998). In spring 2000, USFWS repeated the 1992 aerial survey and observed widespread declines throughout the Aleutian Islands, with the greatest decreases occurring in the central Aleutians. The total uncorrected count for the area in 2000 was 2,442 animals, indicating that sea otter populations had declined 70% between 1992 and 2000. In August 2000, USFWS designated the northern sea otter in the Aleutian Islands (from Unimak Pass to Attu) as a candidate species under the Endangered Species Act.

As part of a continued effort to determine the full range of the sea otter decline in Western Alaska, USFWS conducted aerial surveys along the Alaska Peninsula and the Kodiak Archipelago in 2000 and 2001. Surveys of the Alaska Peninsula repeated methods used in a 1986 aerial survey by Brueggeman *et al.* (1988). When current results were compared with those from the previous study, declines of 93-94% were documented for the South Alaska Peninsula and declines of 27-49% were documented for the North Alaska Peninsula (USFWS unpublished data). In the Kodiak Archipelago, data from 2001 aerial surveys indicates that sea otter populations have decreased as much as 40% since 1994 (USFWS unpublished data).

A recent aerial survey of Kamishak Bay indicates nearly 7,000 sea otters inhabit this area. Kamishak Bay was previously surveyed as part of a boat-based survey of lower Cook Inlet (Agler *et al.* 1995). An estimate for just Kamishak Bay is not available, therefore the population trend for that area is unknown. Although large portions of the southwest Alaska stock appears to have undergone dramatic population declines, several areas do not appear to have been affected. Estimates from the Port Moller/Nelson Lagoon area and the Alaska Peninsula from Castle Cape to Cape Douglas show evidence of population increases. The magnitude of these increases however, does not offset the declines observed in the last 10-15 years.

MAXIMUM NET PRODUCTIVITY RATE

Estes (1990) estimated a population growth rate of 17 to 20% per year for four northern sea otter populations expanding into unoccupied habitat. However, in areas where resources are limiting or where populations are approaching equilibrium density, slower rates of growth are expected (Estes 1990, Bodkin *et al.* 1995). Maximum productivity rates have not been measured through much of the sea otter's range in Alaska. In the absence of more detailed information regarding maximum productivity rates throughout the state, the rate of 20% calculated by Estes (1990) is considered a reliable estimate of R_{MAX}.

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} x 0.5 R_{MAX} x F_R. Since 1992, sea otter counts in the Aleutians have declined by an average of 70%. In August 2000 sea otters in the Aleutian Islands were designated as a Candidate Species under the Endangered Species Act. Candidate species designation was expanded to encompass the entire southwest Alaska stock of sea otters in June 2002. Given the geographic extent and overall magnitude of the decline, along with the uncertainty regarding the cause, we have set the recovery factor (F_R) for this stock at 0.25. Thus, for the Southwest stock of sea otters, PBR = 830 animals (33,203 x 0.5 (0.2) x 0.25).

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

Each year, fishery observers monitor a percentage of commercial fisheries in Alaska and report injury and mortality of marine mammals incidental to these operations. In 1992, fisheries observers reported eight sea otters taken incidentally by the Aleutian Island Black Cod Pot Fishery. During that year, 33.8% of the Bering Sea area groundfish fisheries were observed, resulting in a total estimate of 24 ± 3 sea otter mortalities for the Bering Sea groundfish fisheries in 1992. No other sea otter kills were reported by observer programs operating in the region of the Southwest stock from 1993 through 2000 (Perez et al, 1999). The NMFS is currently conducting a marine mammal observer program for the Kodiak salmon set net fishery that will operate during the 2002 and 2003 fishing seasons.

An additional source of information on the number of sea otters killed or injured incidental to commercial fishery operations in Alaska are fisher self-reports required of vessel-owners by NMFS. In 1997, fisher self-reports indicated one sea otter kill in the Bering Sea and Aleutian Island groundfish trawl. Self-report records were incomplete for 1994, not available for 1995 and reported no kills or injuries in 1996. From 1998 through 2000, there were no further records of incidental take of sea otters by commercial fisheries in this region. Thus, during the period between 1996 and 2000, fisher self-reports resulted in an annual mean of 0.2 sea otter mortalities from interactions with commercial fishing gear. Credle *et al.* (1994), considered this to be a minimum estimate as fisher self-reports and logbook records (self-reports required during 1990-1994) are most likely negatively biased.

Based on the available data, sea otter abundance in the Southwest stock is not likely to be significantly affected by commercial fishery interactions at present. The total fishery mortality and serious injury (0.2) is less than 10% of the calculated PBR (830) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate (Wade and Angliss 1997). A complete list of fisheries and marine mammal interactions is published annually by NMFS [67 FR 2410].

Oil and Gas Development

Exploration, development and transport of oil and gas resources can adversely impact sea otters and nearshore coastal ecosystems in Alaska. Sea otters rely on air trapped in their fur for warmth and buoyancy. Contamination with oil drastically reduces the insulative value of the pelage, and consequently, sea otters are among the marine mammals most likely to be detrimentally affected by contact with oil. It is believed that sea otters can survive low levels of oil contamination (< 10% of body surface), but that greater levels (>25%) will lead to death (Costa and Kooyman 1981, Siniff *et al.* 1982). Vulnerability of sea otters to oiling was demonstrated by the 1989 *Exxon Valdez* oil spill in Prince William Sound. Total estimates of mortality for the Prince William Sound area vary from 750 (range 600-1,000) (Garshelis 1997) to 2,650 (range 500 - 5,000) (Garrot *et al.* 1993) otters. Statewide, it is estimated that 3,905 sea otters (range 1,904 - 11,257) died in Alaska as a result of the spill (DeGange *et al.* 1994). At present, abundance of sea otters in some oiled areas of Prince William Sound remains below pre-spill estimates, and evidence from ongoing studies suggests that sea otters and the nearshore ecosystem have not yet fully recovered from the 1989 oil spill (Bodkin *et al.*, in press, Stephensen *et al.* 2001). Other areas outside of Prince William Sound that were affected by the spill have not been intensively studied for long-term impacts.

Within the range of the Southwest Alaska sea otter stock, oil and gas development occurs only in Cook Inlet. Although the amount of oil transport in southwest Alaska is small, the *Exxon Valdez* oil spill demonstrated that spilled oil can travel long distances and take large numbers of sea otters far from the point of initial release. Annual mortality due to oil and gas development activities has not been estimated for the Southwest sea otter stock. While the catastrophic release of oil has the potential to take large numbers of sea otters, there is no evidence that routine oil and gas development and transport have a direct impact on the Southwest Alaska sea otter stock.

Subsistence/Native Harvest Information

The Marine Mammal Protection Act of 1972 exempted Native Alaskans from the prohibition on hunting marine mammals. Alaska Natives are legally permitted to take sea otters for subsistence use or for creating and selling authentic handicrafts or clothing. Data for subsistence harvest of sea otters in Southwest Alaska were collected by a mandatory Marking, Tagging and Reporting Program implemented by USFWS since 1988. Fig. 2 provides a summary of harvest information for the Southwest stock from 1989 through 2000. The mean annual subsistence take during the past five years (1996-2000) was 97 animals. Age composition during this period was 87% adults, 10.5% subadults, and 2.5% pups. Sex composition during the past five years was 62% males, 20% females and 18% unknown sex.

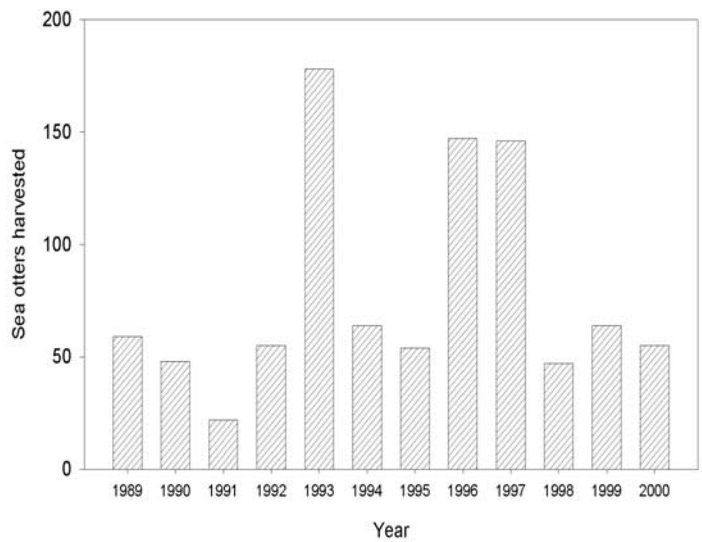

Figure 2. Estimated subsistence harvest of sea otters from the southwest Alaska stock, 1989-2000.

Since 1997, the USFWS and the Alaska Sea Otter and Steller Sea Lion Commission (TASSC) have signed cooperative agreements authorized under Section 119 of the MMPA for the conservation and co-management of sea otters in Alaska. Each of the six TASSC regions has a regional management plan that includes harvest guidelines. Several villages have also developed local management plans that address sea otter harvests.

Research and Public Display

In the past five years, 11 sea otters have been removed from the southwest Alaska stock for public display. A limited amount of live capture for scientific research has been conducted in the Aleutian Islands. There have been no observed effects on sea otter populations in the Southwest Alaska stock from these activities.

STATUS OF STOCK

Sea otters in southwest Alaska are not presently listed as "depleted" under the MMPA. However, based on the best available scientific information that indicates sea otter numbers across southwest Alaska are declining, USFWS designated the southwest Alaska Distinct Population Segment of the northern sea otter as a candidate species under the Endangered Species Act in June 2002. As a result, the southwest Alaska stock is classified as strategic.

In the Aleutians and the Alaska Peninsula, subsistence hunting of sea otters occurs at low levels and does not appear to be a major factor in the decline. Additionally, current levels of incidental take of sea otters by commercial fisheries in southwest Alaska can be considered insignificant and approaching a zero mortality rate. Thus, these populations are declining for unknown reasons that are not explained by the level of direct human-caused mortality.

Habitat Concerns

Potential threats to sea otter populations include natural fluctuations, such as disease or predation, and indirect effects of human activities. Population studies in the Aleutian Islands indicate that observed declines are the result of increased adult mortality. A current theory proposes that predation by transient killer whales may be a leading cause of the population decline (Estes *et al.* 1998). Studies show that disease, starvation and contaminants are not presently implicated in the Aleutians; however, further evaluation of these factors is warranted along with additional investigation of the predation hypothesis to better elucidate the cause of the decline.

Sea otters play an important role in maintaining the coastal ecosystems they inhabit. In near-shore kelp beds, sea otters function as keystone species, strongly influencing ecosystem functions. In the Aleutian archipelago, sea urchins are a dominant herbivore and an important food source for sea otters (Estes *et al.* 1978). If sea otters disappear from these areas, sea urchin populations will be released from the control of sea otter predation, and may soon overgraze the attachments of bull kelp. Detached kelp is swept away, exposing remaining fish, crustaceans and bivalves. A secondary consequence of the decline in sea otter populations in southwestern Alaska is that kelp forests in many areas may also be in decline (Estes *et al.* 1998).

CITATIONS

Agler, B. A., S. J. Kendall, P. E. Seiser, and D. B. Irons. 1995. Estimates of Marine Bird and Sea Otter Abundance in Lower Cook Inlet, Alaska During Summer 1993 and Winter 1994. Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, Alaska. 121 pp.

Bacon, C. E., W. M. Jarman, J. A. Estes, M. Simon, and R. J. Norstrom. 1999. Comparison of organochlorine contaminants among sea otter (*Enhydra lutris*) populations in California and Alaska. Environmental Toxicology and Chemistry 18(3):452-458.

Bodkin, J. L., B. E. Ballachey, and M. A. Cronin. 1992. Mitochondrial DNA analysis in the conservation and management of sea otters. Research Information Bulletin, U.S. Department of the Interior 37:1-3.

Bodkin, J. L., R. J. Jameson, and J. A. Estes. 1995. Sea otters in the North Pacific Ocean. Pages 353-356 in LaRoe III, E.T., G. S. Farris, C. E. Pucket, and P. D. Doran, eds. Our Living Resources 1994: a report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems. U.S. Department of the Interior, National Biological Service, Washington D.C.

Bodkin, J. L., B. E. Ballachey, M. A. Cronin, and K. T. Scribner. 1999. Population demographics and genetic diversity in remnant and translocated populations of sea otters (*Enhydra lutris*). Conservation Biology 13(6):1378-1385.

Bodkin, J. L., B. E. Ballachey, T. A. Dean, A. K. Fukuyama, S. C. Jewett, L. M. McDonald, D. H. Monson, C. E. O'Clair, and G. R. VanBlaricom. In press. Sea otter population status and the process of recovery from the *Exxon Valdez* spill. Marine Ecology Progress Series.

Brueggeman, J. J., G. A. Green, R. A. Grotefendt, and D. G. Chapman. 1988. Aerial surveys of sea otters in the northwestern Gulf of Alaska and the southeastern Bering Sea. Minerals Management Service and NOAA Final Report. Anchorage, Alaska.

Calkins D. G., and K. B. Schneider. 1985. The sea otter (*Enhydra lutris*). Pages 37-45. In: Marine Mammals Species Accounts. J. J. Burns, K. J. Frost, and L. F. Lowry (eds). Alaska Department of Fish and Game, Technical Bulletin 7.

Comerci, L. R., C. S. Gorbis, A. Matz, and K. A. Trust (in prep.). Tissue concentrations of elemental and organochlorine compounds in sea otters in Alaska. U.S. Fish and Wildlife Service Technical Report, Anchorage, Alaska.

Costa, D. P., and G. L. Kooyman. 1981. Effects of oil contamination in the sea otter *Enhydra lutris.* Outer Continental Shelf Environmental Assessment Program. NOAA Final Report. La Jolla, California.

Credle, V. A., D. P. DeMaster, M. M. Merlein, 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. Department of Commerce, NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Cronin, M. A., J. L. Bodkin, B. E. Ballachey, J. A. Estes, and J. C. Patton. 1996. Mitochondrial-DNA variation among subspecies and populations of sea otters. Journal of Mammology 77(2):546-557.

Cronin, M. A., W. J. Spearman, W. Buchholz, S. Miller, L. Comerci, and L. Jack. 2002. Microsatellite DNA and mitochondrial DNA variation in Alaskan sea otters. Alaska Fisheries Technical Report.

DeGange, A. R., A. M. Doroff, and D. H. Monson. 1994. Experimental recovery of sea otter carcasses at Kodiak Island, Alaska, following the Exxon Valdez oil spill. Marine Mammal Science 10:492-496.

DeMaster, D. P. 1997. Minutes from the fifth meeting of the Alaska Scientific Review Group, 7-9 May 1997, Seattle, Washington. 21 pp. (available upon request- D.P. DeMaster, National Marine Mammals 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. Conservation Biology 6(1):24-36.

Doroff, A. M., and C. S. Gorbics. 1998. Sea Otter Surveys of Yakutat Bay and Adjacent Gulf of Alaska Coastal Areas - Cape Hinchinbrook to Cape Spencer 1995-1996. Minerals Management Service, OCS Study MMS 97-0026. 31 pp.

Doroff, A. M., J. A. Estes, M. T. Tinker, D. M. Burn, and T. J. Evans. In press. Sea otter population declines in the Aleutian Archipelago. J. Mammalogy.

Estes, J. A., N. S. Smith, and J. F. Palmisano. 1978. Sea otter predation and community organization in the western Aleutian Islands, Alaska. Ecology 59(4):822-833.

Estes, J. A. 1990. Growth and equilibrium in sea otter populations. Journal of Animal Ecology 59:385-401.

Estes, J. A., C. E. Bacon, W. M. Jarman, R. J. Norstrom, R. G. Anthony, and A. K. Miles. 1997. Organochlorines in sea otters and bald eagles from the Aleutian Archipelago. Marine Pollution Bulletin 34(6):486-490.

Estes, J.A., M.T. Tinker, T.M. Williams and D.F. Doak. 1998. Killer whale predation on sea otters linking ocean and nearshore systems. Science 282:473-476.

Evans, T.J., D.M. Burn and A.R. DeGange. 1997. Distribution and Relative Abundance of Sea Otters in the Aleutian Archipelago. USFWS Marine Mammals Management Technical Report, MMM 97-5. 29 pp.

Garrott, R. A., L. L. Eberhard, and D. M. Burn. 1993. Mortality of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Marine Mammal Science 9:343-359.

Garshelis, D. L., and J. A. Garshelis. 1984. Movements and management of sea otters in Alaska. Journal of Wildlife Management 48(3):665-678.

Garshelis, D. L., A. M. Johnson, and J. A. Garshelis. 1984. Social organization of sea otters in Prince William Sound, Alaska. Canadian Journal of Zoology 62:2648-2658.

Garshelis, D. L. 1997. Sea otter mortality estimated from carcasses collected after the *Exxon Valdez* oil spill. Conservation Biology 11(4): 905-916.

Gorbics, C. S., and J. L. Bodkin. 2001. Stock structure of sea otters (*Enhydra lutris kenyoni*) in Alaska. Marine Mammal Science 17(3): 632-647

Johnson, A. M. 1982. Status of Alaska sea otter populations and developing conflicts with fisheries. Pages 293-299 in: Transactions of the 47th North American Wildlife and Natural Resources Conference, Washington D.C.

Kenyon, K. W. 1969. The sea otter in the eastern Pacific Ocean. North American Fauna 68. U.S. Department of the Interior, Washington D.C.

Larson, S., R. Jameson, J. L. Bodkin, M. Staedler, and P. Bentzen (submitted to J. Mammalogy). Microsatellite and MtDNA sequence variation within and among remnant and translocated sea otter, *Enhydra lutris*, populations.

Perez, M. A. 1999. Compilation of Marine mammal incidental catch data for domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-98. NOAA Technical Memorandum, Seattle, WA. 134 pp.

Pitcher, K. W. 1989. Studies of southeastern Alaska sea otter populations: distribution, abundance, structure, range expansion and potential conflicts with shellfisheries. Anchorage, Alaska. Alaska Department of Fish and Game, Cooperative Agreement 14-16-0009-954 with U.S. Fish and Wildlife Service. 24 pp.

Riedman, M. L., and J. A. Estes. 1990. The sea otter *Enhydra lutris*: behavior, ecology, and natural history. Biological Report; 90 (14). U.S. Fish and Wildlife Service.

Simenstad, C. A., J. A. Estes, and K. W. Kenyon. 1978. Aleuts, sea otters, and alternate stable-state communities. Science 200:403-411. 127 pp.

Siniff, D. B., T. D. Williams, A. M. Johnson, and D. L. Garshelis. 1982. Experiments on the response of sea otters *Enhydra lutris* to oil contamination. Biological Conservation 23: 261-272.

Stephensen, S. W., D. B. Irons, S. J. Kendall, B. K. Lance, and L. L. MacDonald. 2001. Marine bird and sea otter population abundance of Prince William Sound, Alaska: trends following the T/V *Exxon Valdez* oil spill, 1989-2000. Restoration Project 00159 Annual Report. USFWS Migratory Bird Management, Anchorage, Alaska. 114 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. Department of Commerce, NOAA Technical Memo. NMFS-OPR-12. 93 pp.

RECENT TECHNICAL MEMORANDUMS

Copies of this and other NOAA Technical Memorandums are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22167 (web site: *www.ntis.gov)*. Paper and microfiche copies vary in price.

AFSC-

143 ZENGER, H. H. JR. 2004. Data report: 2002 Aleutian Islands bottom trawl survey, 247 p. NTIS number pending.

142 STEVENSON, D. E. 2004. Identification of skates, sculpins, and smelts by observers in North Pacific groundfish fisheries (2002-2003), 67 p. NTIS number pending.

141 HOFF, G. R., and L. L. BRITT. 2003. The 2002 eastern Bering Sea upper continental slope survey of groundfish and invertebrate resources, 261 p. NTIS No. PB2004-101668.

140 STONE, R. P., and M. M. MASUDA. 2003. Characteristics of benthic sediments from areas open and closed to bottom trawling in the Gulf of Alaska., 40 p. + Appendices (111 p.). NTIS No. PB2004-100650

139 JOHNSON, S. W., M. L. MURPHY, D. J. CSEPP, P. M. HARRIS, and J. F. THEDINGA. 2003. A survey of fish assemblages in eelgrass and kelp habitats of southeastern Alaska, 39 p. NTIS No. PB2004-100139.

138 PEREZ, M. A. 2003. Compilation of marine mammal incidental take data from the domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-2001, 145 p. NTIS No. PB2004-100649

137 MASELKO, J. M., A. C. WERTHEIMER, and J. F. THEDINGA. 2003. Selection and application of a mark-and-recapture technique for estimating pink salmon escapements, 44 p. NTIS No. PB2003-107101.

136 BARBEAUX, S. J., and M. W. DORN. 2003. Spatial and temporal analysis of eastern Bering Sea echo integration-trawl survey and catch data of walleye pollock, *Theragra chalcogramma*, for 2001 and 2002, 34 p. NTIS No. PB2003-106479.

135 DIETER, B. E., D. A. WION, and R. A. MCCONNAUGHEY. 2003. Mobile fishing gear effects on benthic habitats: A bibliography (second edition), 207 p. NTIS No. PB2003-105080.

134 ROBSON, B. W. (editors). 2002. Fur seal investigations, 2000-2001, 80 p. NTIS No. PB2003-103825.

133 ANGLISS, R. A., and K. L. LODGE. 2002. Alaska marine mammal stock assessments, 2002, 224 p. NTIS PB2003-103793.

132 DOYLE, M. J.., M. S. BUSBY, J. T. DUFFY-ANDERSON, S. J. PICQUELLE, and A. C. MATARESE. 2002. Aspects of the early life history of capelin (*Mallotus villosus*) in the northwestern Gulf of Alaska: A historical perspective based on larval collections October 1977- March 1979, 32 p. NTIS No. PB2002-102535.

131 SEASE, J. L., and C. J. GUDMUNDSON. 2002. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) from the western stock in Alaska, June and July 2001 and 2002, 45 p. NTIS No. PB2003-102164.

130 AYDIN, K. Y., V. V. LAPKO, V. I. RADCHENKO, and P. A. LIVINGSTON. 2002. A comparison of the eastern and western Bering Sea shelf and slope ecosystems through the use of mass-balance food web models, 78 p. NTIS No. PB2003-100518.