NOAA Technical Memorandum NMFS-AFSC-119

Alaska Marine Mammal Stock Assessments, 2000

by
R. C. Ferrero, D. P. DeMaster, P. S. Hill, M. M. Muto, and A. L. Lopez

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

December 2000

Notice to Users of this Document

In the process of converting the original printed document into an Adobe .PDF format, slight differences in formatting occur. The material presented in the original printed document and this .PDF, however, is the same.

Alaska Marine Mammal Stock Assessments 2000

by

R. C. Ferrero, D. P. DeMaster, P.S. Hill, M. M. Muto, and A. L. Lopez
National Marine Mammal Laboratory
Alaska Fisheries Science Center
7600 Sand Point Way, NE
Seattle, WA 98115

with contributions from
K. Brix, R. Brown, M. Dahlheim, B. Fadely, R. Hobbs, S. Jeffries,
J. Laake, T. Loughlin, R. Merrick, S. Mizroch, P. Olesiuk, M. Perez, D. Rice,
B. Robson, D. Rugh, J. Sease, K. Shelden, R. Small, P. Wade, J. Waite, D. Withrow, A. York,
S. Zimmerman, and the Publications Unit of the Alaska Fisheries Science Center.

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 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. Under the new regime, 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 fourth revision since the original development of the stock assessment reports in 1995 (Small and DeMaster 1995). The first, second and third revisions were entitled the 1996 (Hill et al. 1997), 1998 (Hill and DeMaster 1998), and 1999 (Hill and DeMaster 1999) 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, right whales, and bowhead whales), Pacific white-sided dolphins, harbor porpoise, Dall's porpoise, and gray whales were reviewed in late 1999. This review led to the revision of the following stock assessments for the 2000 document: Cook Inlet beluga whales, Pacific white-sided dolphins, harbor porpoise (3 stocks), Dall's porpoise, and gray whales. The stock assessment reports for all stocks, however, are included in this document to provide a complete reference. Those sections of each stock assessment report containing significant changes are listed in Appendix 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 may be obtained through USFWS, Marine Mammals Management, 1011 E. Tudor Road, Anchorage, AK, 99501.

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: Lloyd Lowry (chairman), Milo Adkison, John Gauvin, Carl Hild, Sue Hills, Charlie Johnson, Brendan Kelly, Matt Kookesh, Denby Lloyd, 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

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.

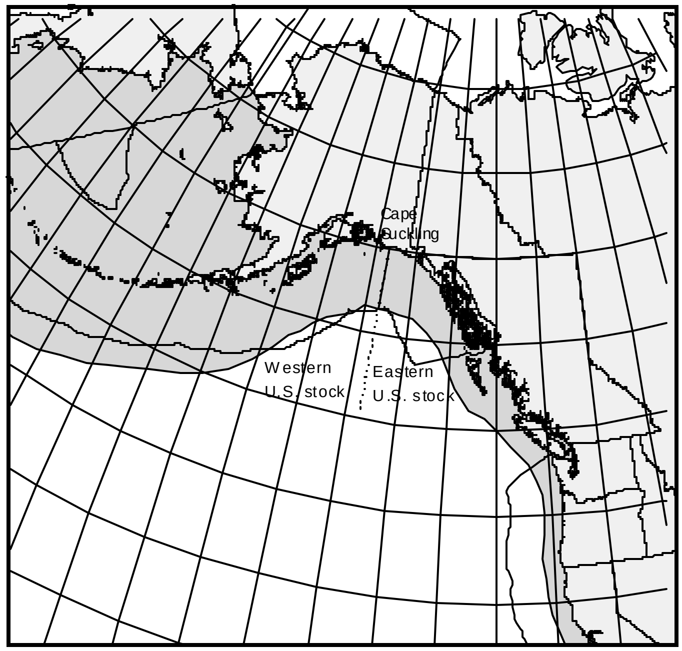

Figure 1. Approximate distribution of Steller sea lions in the eastern North Pacific (shaded area).

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 estimate of Steller sea lion abundance in Alaska is based on aerial surveys performed in June and ground based pup counts in June and July 1998 from Southeast Alaska to the western Aleutian Islands (Sease and Loughlin 1999). Data from these surveys represent actual counts of pups and nonpups at all rookeries and major haulout sites in Alaska. During the 1998 survey, a total of 28,658 nonpups were counted in the Gulf of Alaska (12,299) and the Bering Sea/Aleutian Islands (16,359). Note that the 1998 counts for the Gulf of Alaska (12,299) were incomplete because only three of the 25 sites in the eastern Gulf of Alaska were surveyed during 1998. These three sites, however, are major rookeries and included a majority of the animals counted in the eastern Gulf subarea during the 1994 and 1996 surveys (52% and 60%, respectively). It is estimated that 1,000 animals were not counted in the 22 un-surveyed sites (Sease and Loughlin 1999).

The pup counts were conducted at all known rookeries for this stock during 1998. There were 4,058 pups counted in the Gulf of Alaska and 5,315 pups counted in the Bering Sea/Aleutian Islands for a total of 9,373 for the stock. Combining the pup count data (9,373), nonpup count data (28,658), and estimate for un-surveyed sites (1,000) results in a minimum abundance estimate of 39,031 Steller sea lions in the western U. S. stock in 1998.

Minimum Population Estimate

The 1998 total count (39,031) 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 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 27% from 1990 to 1996 (Table 1). Counts at trend sites during 1998 indicate that the number of sea lions in the Bering Sea/Aleutian Island (BSAI) regions has continued to decline (7.8% since 1996, Table 1, Fig. 2).

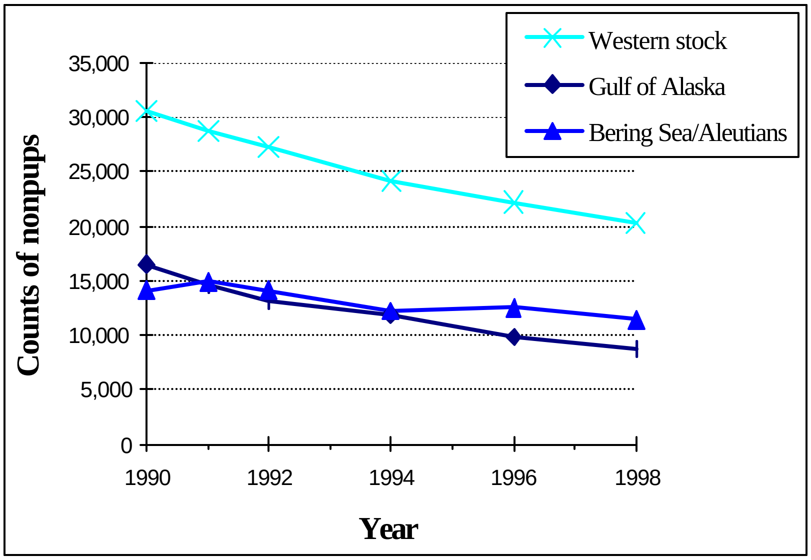

Figure 2. Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the western U. S. stock, 1990-98.

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, Strick et al. 1997, Sease et al. 1999, Sease and Loughlin 1999). Counts from 1976-79 (NMFS 1995) were combined to produce complete regional counts which are comparable to the 1990-98 data. The asterisk identifies counts in 1998 that include an estimate of 500 nonpups for 6 un-surveyed trend sites in the eastern Gulf of Alaska.

Area	**late 1970s**	**1990**	**1991**	**1992**	**1994**	**1996**	**1998**
Gulf of Alaska	65,296	16,409	14,603	13,179	11,871	9,789	8,680*
Bering Sea/Aleutians	44,584	14,116	14,815	14,107	12,248	12,434	11,521
Total	109,880	30,525	29,418	27,286	24,119	22,223	20,201*

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 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 = $N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 = 234 animals (39,031 × 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 1990-98: 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 7.4 (CV=0.22) for the Bering Sea groundfish trawl fishery, 1.2 (CV=0.61) for the Gulf of Alaska groundfish trawl fishery, and 1.0 (CV=0.77) 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). Fisher self-reports from this fishery detail 12, 5, 1, and 23 Steller sea lion mortalities in 1990, 1991, 1992, and 1993, respectively. The extrapolated (estimated) observer mortality accounts for these self-reported mortalities, so they do not appear in Table 2a. 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. Combining the mortality estimates from the Bering Sea and Gulf of Alaska groundfish trawl and Gulf of Alaska longline fisheries presented above (7.4+1.2+1.0=9.6) 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 24.1 (CV=0.61) 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 1998 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1994 to 1998 (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	90-98	obs data	53-74%	13, 13, 15, 4, 9, 2, 4, 6, 6	13, 19, 21, 6, 11, 3, 4, 10, 9	7.4 (CV=0.22)
Gulf of Alaska (GOA) groundfish trawl	90-98	obs data	33-55%	2, 0, 0, 1, 1, 0, 0, 0, 1	4, 0, 0, 3, 3, 0, 0, 0, 3	1.2 (CV= 0.61)
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	90-98	obs data	27-80%	0, 0, 0, 1, 0, 0, 0, 0, 0	0, 0, 0, 1, 0, 0, 0, 0, 0	0.0 (CV= 0.0)
GOA groundfish longline (incl. misc. finfish and sablefish fisheries)	90-98	obs data	8-21%	1, 0, 0, 0, 0, 1, 0, 0, 0	2, 0, 0, 0, 1, 4, 0, 0, 0	1.0 (CV=0.77)
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
Observer program total						24.1 (CV=0.61)
Fishery name	**Years**	**Data type**	**Range of observer coverage**	**Reported mortalities (in given yrs.)**	**Estimated mortality (in given yrs.)**	**Mean annual mortality**
Alaska Peninsula/Aleutian Islands salmon set gillnet	90-98	self reports	n/a	0, 1, 1, 1, n/a n/a, n/a, n/a	n/a	[$0.75]
Cook Inlet salmon drift gillnet	90-98	self reports	n/a	0, 0, 0, 2, n/a n/a, n/a, n/a	n/a	[$0.5]

Fishery name	Years	Data type	Range of observer coverage	Reported mortalities (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bristol Bay salmon drift gillnet	90-98	self reports	n/a	0, 4, 2, 8, n/a n/a, n/a, n/a	n/a	[$3.5]
Prince William Sound set gillnet	90-98	self reports	n/a	0, 0, 2, 0, n/a n/a, n/a, n/a	n/a	[$0.5]
Alaska miscellaneous finfish set gillnet	90-98	self reports	n/a	0, 1, 0, 0, n/a n/a, n/a, n/a	n/a	[$0.25]
Alaska halibut longline (state and federal waters)	90-98	self reports	n/a	0, 0, 0, 0, 1 n/a, n/a, n/a	n/a	[$0.2]
Alaska sport salmon troll (non-commercial)	93-98	strand	n/a	0, 0, 0, 0, 1	n/a	[$0.2]
Minimum total annual mortality						$30.0 (CV= 0.61)

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 1998, fisher self-reports from 6 unobserved fisheries (see Table 2a) resulted in an annual mean of 5.7 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 4 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 1997 the only fishery-related Steller sea lion 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). Fishery-related strandings during 1993-98 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 30 sea lions per year, based on observer data (24.1) and self-reported fisheries information (5.7) 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). 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. Between 1992-95 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. Details concerning 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 3-year period from 1993 to 1995 was 412 sea lions. The reported average age-specific kill of the harvest across all years was 31% adults, 62% juveniles, 3% pups, and 4% unknown age. The reported average sex-specific kill of the harvest was approximately 64% males, 19% females, and 17% of unknown sex. The 1993-95 subsistence harvest data were used in the mortality rate calculation because 1996 data for Steller sea lion takes for several communities in the Pribilof Islands are in dispute and the 1997 subsistence harvest data were considered preliminary as they have not been reviewed. The 1998 data were also not available when the draft SARs for 2000 were developed.

Other Mortality

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 where imminently necessary to protect human life).

Table 2b. Summary of the subsistence harvest data for the western U. S. stock of Steller sea lions, 1992-97. Brackets indicate that the 1996 data are in dispute and the 1997 data are preliminary.

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]
1997	[164]	[129-227]	[146]	[18]

Year	Estimated total number taken	95% confidence interval	Number harvested	Number struck and lost
Mean annual take (1993-95)	412			

STATUS OF STOCK

The current annual level of incidental mortality (30) exceeds 10% of the PBR (24) and, therefore, cannot be considered insignificant and approaching a zero mortality and serious injury rate. Based on available data, the estimated annual level of total human-caused mortality and serious injury (30 + 412 = 442) is known to exceed the PBR (234) 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 no-entry zones around rookeries, prohibition of groundfish trawling within 10-20 nautical miles of certain rookeries, and spatial and temporal allocation of Gulf of Alaska pollock total allowable catch. More recent modifications beginning in 1999 include 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 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 has caused a recent 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 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.

Regarding the possible adverse impacts of commercial groundfish fisheries in Alaska on the western U. S. stock of Steller sea lion, NMFS developed a Biological Opinion (BO) in December 1998, as required under Section 7(2) of the ESA, that describes potential effects on Steller sea lions by three separate actions: 1) authorization of an Atka mackerel fishery under the BSAI groundfish fishery management plan between 1999 and 2002, 2) authorization of a walleye pollock fishery under the BSAI groundfish fishery management plan between 1999 and 2002, and 3) authorization of a walleye pollock fishery under the Gulf of Alaska (GOA) groundfish fishery management plan between 1999 and 2002. The NMFS previously issued biological opinions on the groundfish fisheries off Alaska in 1991 and 1996. Those earlier opinions concluded that the fisheries were not likely to jeopardize the continued existence and recovery of the Steller sea lion. However, the December 1998 Biological Opinion concluded that both the BSAI and GOA pollock trawl fisheries were likely to cause jeopardy or modification of critical habitat. The Atka mackerel fishery, already modified in 1998, was not likely to cause jeopardy to the species (or stock) or modification of its critical habitat. Reasonable and prudent alternatives for the pollock fishery were discussed in the BO, while the final form of those measures is still in development, pending judicial review.

In addition, NMFS completed a draft Supplemental Environmental Impact Statement (SEIS) in September 1998 for the groundfish fisheries in the Bering Sea Aleutian Islands and the Gulf of Alaska. Of the 26 marine mammal species inhabiting Alaskan waters, only a subset have been shown to consume groundfish species as a large part of their diet, and to potentially do so in areas coincident with groundfish harvest operations: Steller sea lion, northern fur seal, and harbor seal. Based on the potential for indirect interactions, 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"(Draft SEIS September 1998).

However, the SEIS was determined to be incomplete in a Federal District Court ruling and remanded back to NMFS for further development. The revised SEIS is expected to be completed in 2000 or 2001.

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., Perlov, A. S., and V. A. Vladimirov. 1992. Range-wide survey and estimation of total number of Steller sea lions in 1989. Mar. Mammal Sci. 8:220-239.

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., 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., 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.

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.

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.

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.

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.

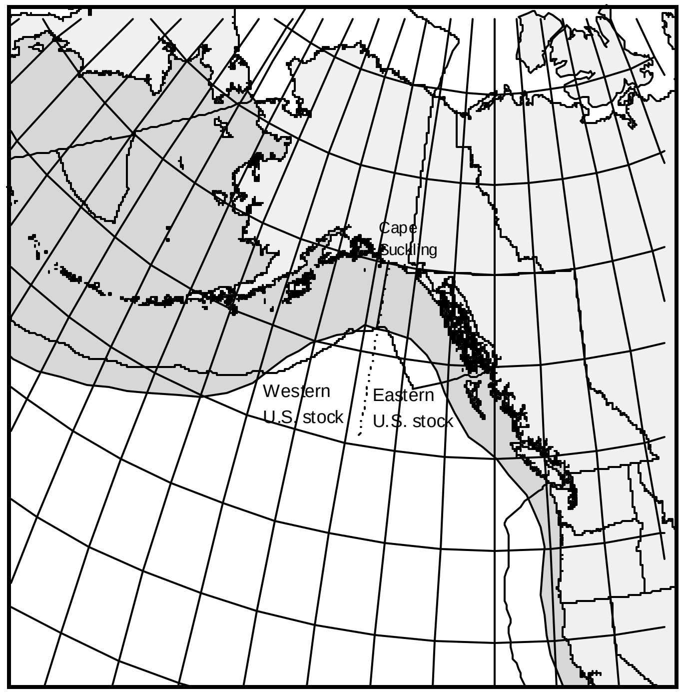

Figure 3. Approximate distribution of Steller sea lions in the eastern North Pacific (shaded area).

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 most recent estimate of Steller sea lion abundance in Southeast Alaska is based on aerial surveys performed in June 1996 (Sease et al. 1999). Data from these surveys represent actual counts of pups and nonpups at all rookeries and major haulout sites in Southeast Alaska. In 1996 a total of 14,571 Steller sea lions were counted in Southeast Alaska, including 10,857 nonpups and 3,714 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 nonpups 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 nonpups 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, Nanaimo, BC, V9R 5K6), 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 30,403 (14,571 + 6,555 + 9,277) Steller sea lions in this stock in 1996. The abundance estimate for the eastern U. S. stock is based on counts of all animals (pup and nonpup) 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, as it is for the western U. S. stock (J. Sease, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115). As a result, this represents an underestimate for the total abundance of Steller sea lions in this stock.

A range wide survey for Steller sea lions was planned for summer of 1998, but due to unforseen circumstances the survey of Southeast Alaska was incomplete. As a result, the abundance estimate for this stock has not been revised even though data from 1998 surveys are available in the California to British Columbia portion of this stock's range. The 1998 survey data will be used in conjunction with 1999 counts from Southeast Alaska to revise the abundance estimate for this stock.

Minimum Population Estimate

The 1996 total count (30,403) will be used as the minimum population estimate (N_{MIN}) for the eastern U. S. stock of Steller sea lions (Wade and Angliss 1997). Recall that this count has not been corrected for animals which were at sea, and also utilizes 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 3,971 for 1998 (Brown and Reimer 1992; ODF&W unpubl. data, 7118 NE Vandenberg Ave., Corvallis, OR 97330). This increase may be an artifact of improved surveys in recent years (NMFS 1995).

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 to 2,000 non-pups during 1980-98. Limited information suggests that counts in northern California appear to be stable (NMFS 1995). At Año Nuevo, (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., Southwest Fisheries Science Center, P. O. Box 271, La Jolla, CA, 92038). Overall, counts of nonpups 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 28% during 1979-96 from 6,376 to 8,181 (NMFS 1995, Sease et al. 1999). 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. In press). 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

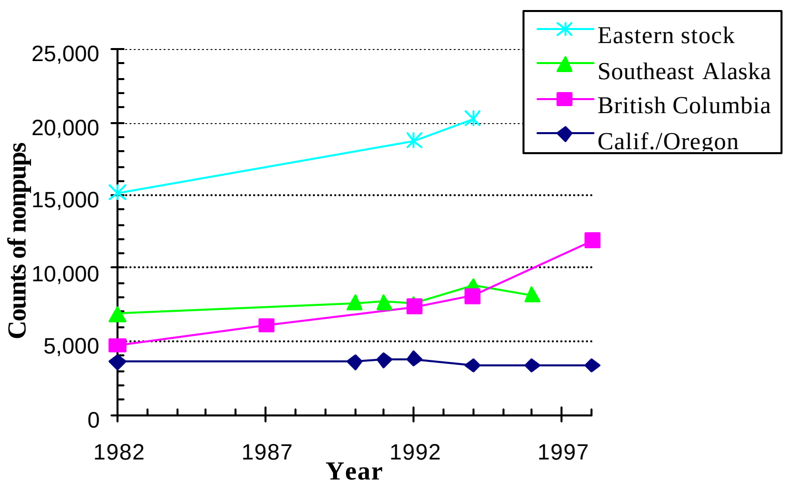

Figure 4. Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the eastern U. S. stock, 1982-98. Data from British Columbia include all sites.

Station, Nanaimo, BC, V9R 5K6). Counts of nonpups 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 1998 (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). Central California data include only Año Nuevo and Farallon Island. Trend site counts in northern California/Oregon include St. George, Rogue, and Orford Reefs. British Columbia data include counts from all sites.

Area	1982	1990	1991	1992	1994	1996	1998
Central CA	511[1]	655	537	276	512	385	208
Northern CA/OR	3,094	2,922	3,180	3,544	2,834	2,988	3,175
British Columbia	4,711	6,109[2]	no data	7,376	8,091	no data	9,818
Southeast Alaska	6,898	7,629	7,715	7,558	8,826	8,231	8,693
Total	15,214	--	--	18,754	20,263	--	21,864

[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 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 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 =1,368 animals (30,403 × 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 1998 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. In 1992 and 1994, 1 Steller sea lion mortality was observed incidental to the CA/OR thresher shark and swordfish drift gillnet fishery. These mortalities extrapolate to estimated total kills of 7 and 6 animals, respectively (Julian 1997, Julian and Beeson 1998). During the most recent 5-year period (1994-98), the mean annual mortality is 1.2 sea lions (CV=1.0) for that fishery (Table 4). One and two Steller sea lion mortalities were observed in the WA/OR/CA groundfish trawl fishery during 1994 (53% observer coverage in 1994) and 1997 (65% observer coverage in 1997), respectively. As these mortalities occurred in unmonitored hauls, they could not be used to calculate the estimated mortality for the fishery. Therefore, the observed mortalities were used as both the observed and estimated mortalities for that fishery, and should be considered minimum estimates (Table 4). These mortalities result in a mean annual mortality of 0.6 (CV=0.67) Steller sea lions for the WA/OR/CA groundfish trawl fishery. During 1996, one Steller sea lion mortality was observed in the Northern Washington marine set gillnet fishery. 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. For the fisheries with observed takes, the ranges of observer coverage since 1990, as well as the annual observed and estimated mortalities, are presented in Table 4. Averaging the incidental take data from these three observed fisheries results in an estimated incidental mortality rate of 2.0 (CV=0.64) Steller sea lions per year from this stock. 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 through 1998 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 1994 to 1998 (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**
CA/OR thresher shark and swordfish drift gillnet	90-98	obs data	4-27%	0, 0, 1, 0, 1, 0, 0, 0, 0	0, 0, 7, 0, 6, 0, 0, 0, 0	1.2 (CV=1.0)
WA/OR/CA groundfish trawl (Pacific whiting component)	90-98	obs data	44-72%	0, 0, 0, 0, 1, 0, 0, 2, 0	0, 0, 0, 0, 1, 0, 0, 2, 0	0.6 (CV=0.67)
Northern WA marine set gillnet (tribal fishery)	90-98	obs data	47-98%	0, 0, 0, 0, 0, 0, 1, 0, 0	0, 0, 0, 0, 0, 0, 1, 0, 0	0.2 (CV=1.0)
Observer program total						2.0 (CV=0.64)
				Reported mortalities		
Southeast Alaska salmon drift gillnet	90-98	self report s	n/a	0, 1, 2, 2, n/a, n/a, n/a, n/a, n/a	n/a	[$1.25]
Alaska salmon troll	92-98	strand data	n/a	0, 0, 0, 1, 0, 0, n/a	n/a	[$0.2]
British Columbia aquaculture predator control program	91-98	permit report s	n/a	14, 8, 10, 11, 6, 13, 22, n/a	n/a	12.4
Minimum total annual mortality						$15.85 (CV=0.64)

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 4 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 1998 the only fishery-related Steller sea lion stranding was reported in August of 1995 in Southeast Alaska. The mortality has been attributed to the Alaska salmon troll fishery and has been included in Table 4. Fishery-related strandings during 1993-98 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.

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 16 sea lions per year, based on observer data (2.0) and self-reported fisheries information (1.25), stranding data (0.2), and permit reports (12.4) where observer data were not available.

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 NMFS (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 Steller sea lion in Alaska. Between 1992-96 approximately 16 of the interviewed communities lie within the range of the eastern U. S. stock. Only a very small percentage (<1%) of the statewide subsistence take was typically from the eastern U. S. stock. The total subsistence take of Steller sea lions from this stock was estimated at 6, 1, 5, 0, 0, and 0 animals in 1992-97, respectively. These values for total take include 1 animal per year during 1992-94 that was reported struck and lost. The mean annual subsistence take from this stock over the 3-year period from 1995 to 1997 was zero sea lions from this stock.

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

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 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 where imminently necessary to protect human life).

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 12.4 Steller sea lions from this stock over the period from 1993 to 1997 (P. Olesiuk, pers. comm., Pacific Biological Station, Nanaimo, BC, V9R 5K6). 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.

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 1990 to 1997 human-related strandings of animals with gunshot wounds from this stock occurred in Oregon, Washington, and Alaska in 1990 (1 animal), 1993 (9 animals), 1996 (2 animals), and 1997 (3 animals), resulting in an estimated annual mortality of 2.8 Steller sea lions from this stock during 1993-97. This estimate is considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel). In addition, human-related stranding data are not available for British Columbia. Reports of stranded animals in Alaska with gunshot wounds have not been included because it is not possible to tell if such a report was the result of an animal struck and lost by subsistence hunters (in which case the mortality would have been 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.

STATUS OF STOCK

Based on currently available data, the minimum estimated fishery mortality and serious injury for this stock (14) is less that 10% of the calculated PBR (137) 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 (16 + 0 + 3 = 19) does not exceed the PBR (1,368) 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. In press. Steller sea lion status and trend in Southeast Alaska: 1979-1997. Mar. Mammal Sci.

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. A. Ono, and J. Reiter. 1991. History of the Steller sea lion population at Año Nuevo Island, 1961-1991. Southwest Fish. Sci. Cent. Admin. Rep. LJ-91-45c. 24 pp. (available upon request - SWFSC, P.O. Box 271, La Jolla, CA 92038).

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

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

National Marine Fisheries Service. 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.

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., Perryman, W. L., and Ono, K. A. 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., 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.

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).

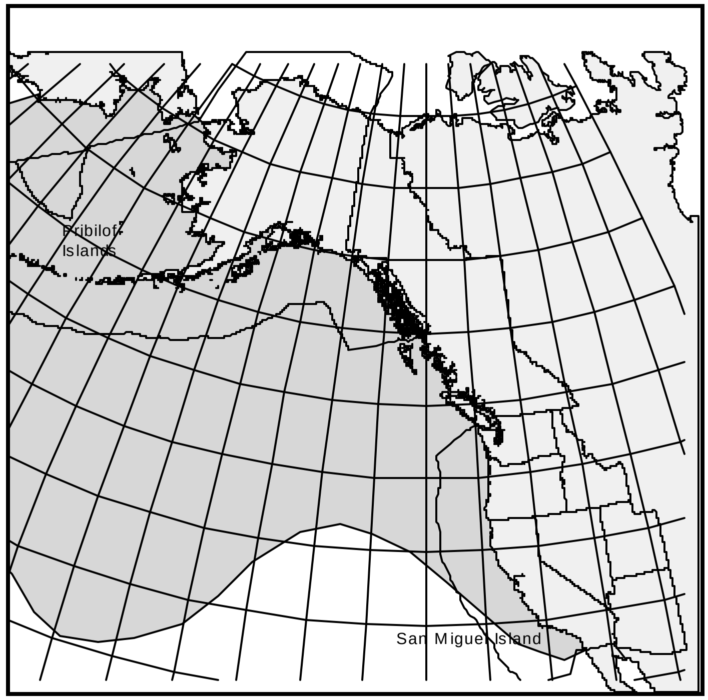

Figure 5. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

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 4.475. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. A preliminary analysis indicated that the dynamics of the population have not changed in the last 15 years, so the 4.475 expansion factor remains appropriate (J. Baker, pers. comm., Southwest Fisheries Science Center, 2570 Dole St., Honolulu, HI 96822). 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. In 1992, 1994, and 1996 pup counts on the Pribilof Islands were 219,151 (CV=0.041), 227,239 (CV=0.036) and 210,401 (CV=0.101), respectively (Antonelis et al. 1994, Antonelis et al. 1996, York et al. 1997). The average mean pup count from these three years of Pribilof Islands data is 218,930 (CV=0.065). In 1997, the number of pups born on Bogoslof Island was 5,096 (NMFS unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115). Therefore, the most recent estimate for the number of fur seals in the Eastern Pacific stock is approximately 1,002,516 (4.475×[218,930+5,096]).

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 (SAR)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 1,002,516 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 848,539.

Current Population Trend

The Alaska population of northern fur seals recovered 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 since 1981 (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). The 1996 estimate of number of pups born on St. George Island is the highest since 1985 (Fig. 6b). The northern fur seal was designated as depleted under the MMPA in 1988 because population levels had declined to less than 50% of levels observed in the late 1950s and there was no compelling evidence that carrying capacity (K) had changed substantially since the late 1950s (NMFS 1993). Under the Marine Mammal Protection Act (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).

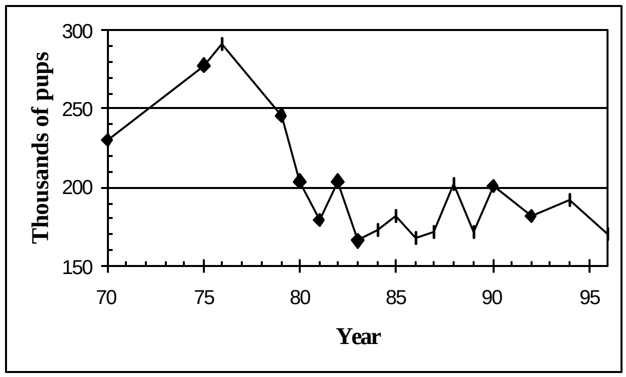

Figure 6a. Production of northern fur seal pups on St. Paul Island, Alaska, 1970-96.

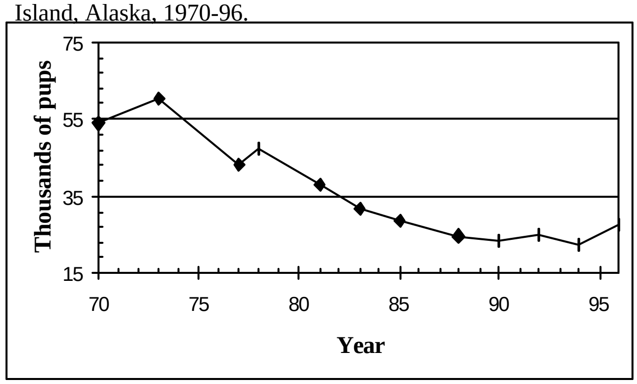

Figure 6b. Production of northern fur seal pups on St. George Island, Alaska, 1970-96.

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 re-authorized 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 = 18,244 animals (848,539 x 0.043 x 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. Commercial net fisheries in international waters of the North Pacific Ocean have decreased significantly in recent years. The assumed level of incidental catch of northern fur seals in those fisheries, though unknown, is thought to be minimal (T. Loughlin, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA, 98115).

Six different commercial fisheries in Alaska that could have interacted with northern fur seals were monitored for incidental take by fishery observers during 1990-96: 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 1.4 (CV=0.43). 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 5).

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 1998, fisher self-reports from 3 unobserved fisheries (see Table 5) 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 4 for details).

Table 5. Summary of incidental mortality of northern fur seals (Eastern 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 self-reported fisheries information. Data from 1994 to 1998 (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	90-98	obs data	53-74%	0, 3, 4, 1, 2, 0, 1, 0, 0	0, 6, 5, 1, 3, 0, 2, 2, 0	1.4 (CV=0.43)
Observer program total						1.4 (CV=0.43)
				Reported mortalities		
Prince William Sound salmon drift gillnet	90-98	self reports	n/a	1, 1, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$0.5]
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90-98	self reports		2, 0, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$0.5]
Bristol Bay salmon drift gillnet	90-98	self reports	n/a	5, 0, 49, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$13.5]
Minimum total annual mortality						$15.9 (CV=0.43)

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), and self-reported fisheries information (15) 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 in 1994 was 1,616 and 161 on St. Paul and St. George Islands, respectively, for a total of 1,777. The subsistence harvest in 1995 was 1,265 and 260 on St. Paul and St. George, respectively, for a total of 1,525. The subsistence harvest in 1996 was 1,591 (including 3 females accidentally harvested) and 232 on St. Paul and St. George Islands, respectively, for a total of 1,823. Thus, the mean annual subsistence take of northern fur seals from this stock during the 3-year period from 1994 to 1996 was 1,708 animals. 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. 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 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 (16) is less than 10% of the calculated PBR (1,824) 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 (16 + 1,708 = 1,724) is not known to exceed the PBR (18,244) 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

Antonelis, G. A., A. E. York, and C. W. Fowler. 1994. Population assessment, Pribilof Islands, Alaska. Pp. 29-47, *In* E. H. Sinclair (ed.), Fur seal investigations, 1992. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-45.

Antonelis, G. A., A. E. York, B. W. Robson, R. G. Towell, and C. W. Fowler. 1996. Population assessment, Pribilof Islands, Alaska. Pp. 9-30, *In* E. H. Sinclair (ed.), Fur seal investigations, 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-69.

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 - 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.

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. (ed.), 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.

York, A. E., J. D. Baker, R. G. Towell, and C. W. Fowler. 1997. Population assessment, Pribilof Islands, Alaska. Pp. 9-28, *In* E. H. Sinclair (ed.), Fur seal investigations, 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-87.

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

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).

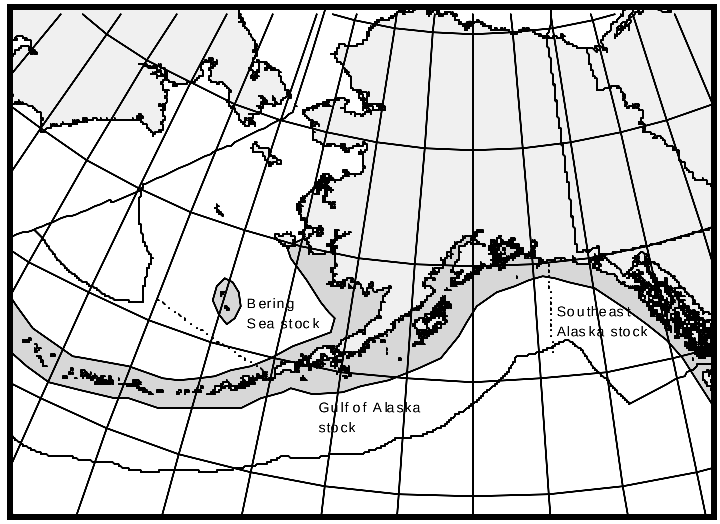

Figure 7. Approximate distribution of harbor seals in Alaska waters (shaded area).

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 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 (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 4).

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 report s	n/a	8, 1, 4, 2, n/a, n/a, n/a	n/a	[$3.75]
Yakutat salmon set gillnet	90-96	self report s	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

STOCK DEFINITION AND GEOGRAPHIC RANGE

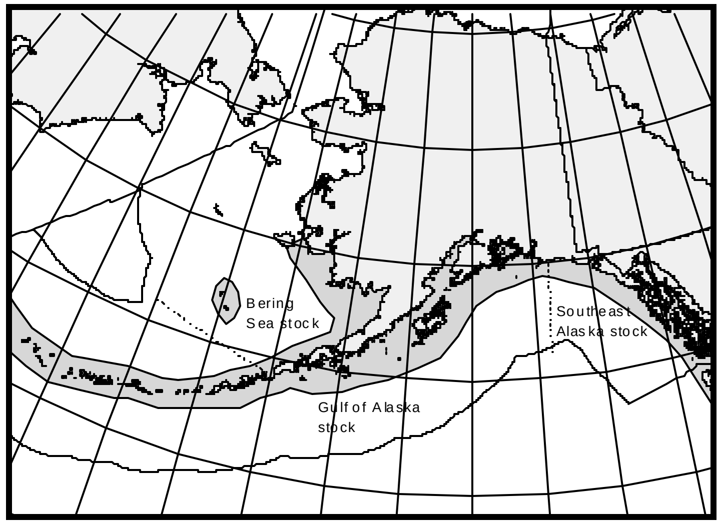

Figure 8. Approximate distribution of harbor seals in Alaska waters (shaded area).

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 sandbar 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): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. 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 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 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, one 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 4).

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).

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

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).

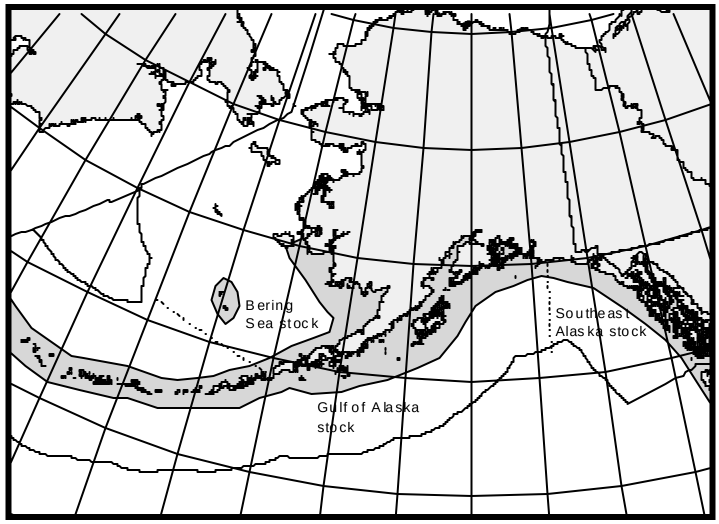

Figure 9. Approximate distribution of harbor seals in Alaska waters (shaded area).

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 1996a); 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 sandbar 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 (sandbar) 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): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. 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 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 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 × 0.06 × 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 4).

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, A. 1988. Harbor seal (*Phonca vitulina*). In: J.W. Lenter, ed., Selected Marine Mammals of AK: Species recounts w/research and management recommendations pp. 125-157. Marine Mammal Commission. 275pp.

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. 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. 1996b. Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) along the north side of the Alaska Peninsula and Bristol Bay during 1995. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Wolfe, R. J., 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). Little is known of their winter distribution and migration routes, although satellite tagging studies on a small number of animals in Alaska have been completed. These studies indicate that spotted seals migrate south from the Chukchi Sea utilizing haul outs in both Russia and Alaska and overwinter in the Bering Sea along the ice edge (Lowry et al. 1994). 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, spotted seals 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 two species are often seen together and are partially sympatric, as their ranges overlap in the southern part of the Bering Sea (Quakenbush 1988). Yet, spotted seals breed earlier and are less social during the breeding season, and only spotted seals are 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).

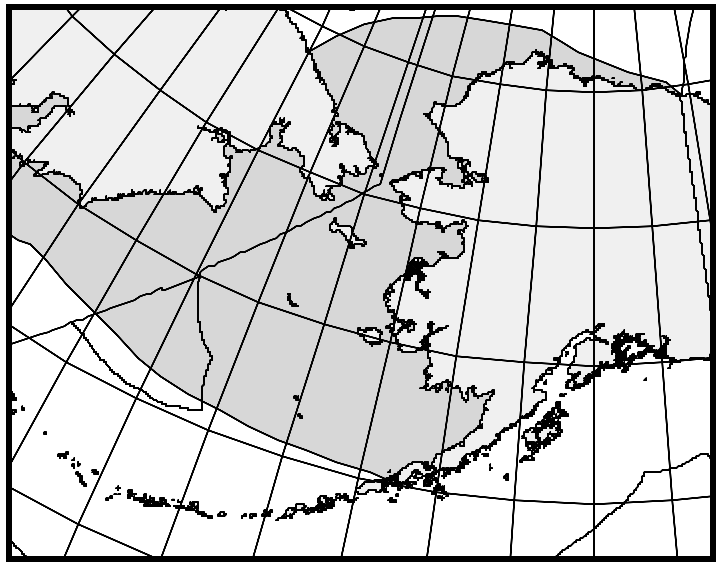

Figure 10. Approximate distribution of spotted seals in Alaska waters (shaded area).

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 4 spotted seals in Kasegaluk Lagoon to estimate the ratio of time hauled out vs. time at sea. Preliminary results indicate that the proportion hauled out averages about 6.8% (CV=0.85) (Lowry et al. 1994b). Using this correction factor with the maximum count of 4,145 from 1992 results in an estimate of 59,214. However, the estimate must be considered equivocal because it resulted from a survey which covered only the eastern portion of the spotted seal's geographic range and may have included harbor seals. In addition, the correction factor data have not been stratified by season, tide, and time of day.

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 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 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 (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. Observers did not report any mortality or serious injury of spotted seals incidental to these groundfish fisheries.

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. Complete logbook data after 1993 are not available.

The estimated minimum mortality rate incidental to commercial fisheries is 2 animals per year (rounded from 1.5), based solely upon logbook 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 such logbook data is questionable. Further, no observers have been assigned the Bristol Bay 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. However, if there were 50,000 spotted seals the PBR would equal 1,500 (50,000 x 0.06 x 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 spotted seals in U. S. waters.

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
Observer program total	90-95					0
Bristol Bay salmon drift gillnet	90-93	logbook	n/a	5, 1, 0, 0	n/a	[$1.5]
Minimum total annual mortality						$1.5

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. Reliable information on subsistence harvests from the remainder of Alaska during the 1993-95 period are not available. Therefore, 244 is considered an underestimate for the statewide total of the annual subsistence take.

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: pp. 26).

CITATIONS

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.

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.

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.

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.

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.

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.

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 shelves 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). 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.

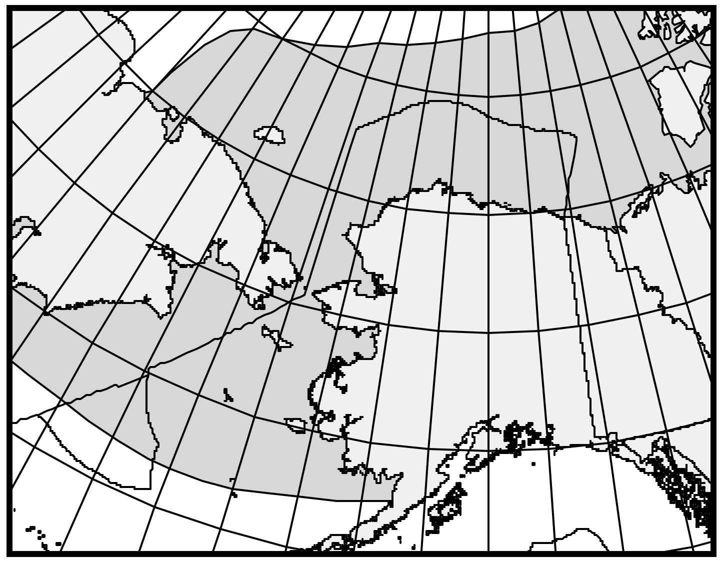

Figure 11. Approximate distribution of bearded seals in Alaska waters (shaded area). The combined summer and winter distributions are depicted.

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). Until additional surveys are conducted, reliable estimates of abundance for the Alaska stock of bearded seals are 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 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 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 1990-95: 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 and 4 mortalities reported in 1994. These mortalities resulted in a mean annual (total) mortality rate of 2 (CV=0.63) bearded seals per year. The range of observer coverage over the 5-year period, 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., Univ. AK, 900 Trident Way, Kodiak, AK 99615). 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).

Table 10. Summary of incidental mortality of bearded 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. (BSA) groundfish trawl	90-95	obs data	53-74%	0, 3, 0, 0, 4, 0	0, 6, 0, 0, 4, 0	2 (CV=.63)
Observer program total						2
Total estimated annual mortality						2

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 (0 animals) are based on all available logbook reports for Alaska fisheries through 1993. Complete logbook data after 1993 are not available.

The estimated minimum mortality rate incidental to commercial fisheries is 2 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. However, if there were 50,000 bearded seals the PBR would equal 1,500 (50,000 x 0.06 x 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 bearded seals in U. S. waters.

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). A reliable estimate of the annual number of bearded seals currently taken by Alaska Natives for subsistence is unavailable.

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: pp. 26).

CITATIONS

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.

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.

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.

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.

RINGED SEAL (*Phoca hispida*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Ringed seals have a circumpolar distribution from approximately 35/N to the North Pole, occurring in all seas of the Arctic Ocean (King 1983). In the eastern 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). 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 seasonal migrations of seals wintering in the northern Chukchi and Beaufort Seas presumably are less extensive.

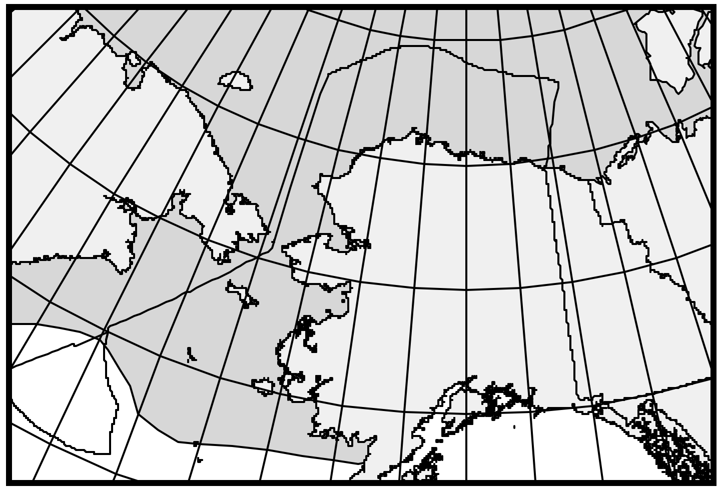

Figure 12. Approximate distribution of ringed seals in Alaska waters (shaded area). The combined summer and winter distribution is depicted.

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 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 Alaska stock of ringed seals is currently not available. Crude estimates of the world population have ranged from 2.3 to 7 million, with 1 to 1.5 million in Alaska waters (Kelly 1988). The most recent abundance estimates of ringed seals are based on aerial surveys conducted in 1985, 1986, and 1987 by Frost et al. (1988). Survey effort was directed towards shorefast ice, 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). However, this estimate represents only a portion of the geographic range of the stock, as many ringed seals occur in the pack ice and along the coast of Russia.

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, though there is no evidence 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 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 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 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 1990-95: 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. These mortalities resulted in a mean annual (total) mortality rate of .6 (CV=1.0) ringed seals per year. The range of observer coverage over the 6-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. Complete logbook data after 1993 are not available.

Table 11. Summary of incidental mortality of ringed 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 morality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. (BSA) groundfish trawl	90-95	obs data	53-74%	0, 0, 2, 0, 0, 0	0, 0, 3, 0, 0, 0	0.6 (CV=1.0)
Total estimated annual mortality						0.6

The estimated minimum average mortality rate incidental to commercial fisheries is 1 ringed seal per year (rounded up from 0.6), based exclusively on observer data. 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. However, if there were 50,000 ringed seals the PBR would equal 1,500 (50,000 x 0.06 x 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 ringed seals in U. S. waters.

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). A reliable estimate of the annual number of ringed seals currently taken by Alaska Natives for subsistence is unavailable.

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: p. 26).

CITATIONS

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. Comer., 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.

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.

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.

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.

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.

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).

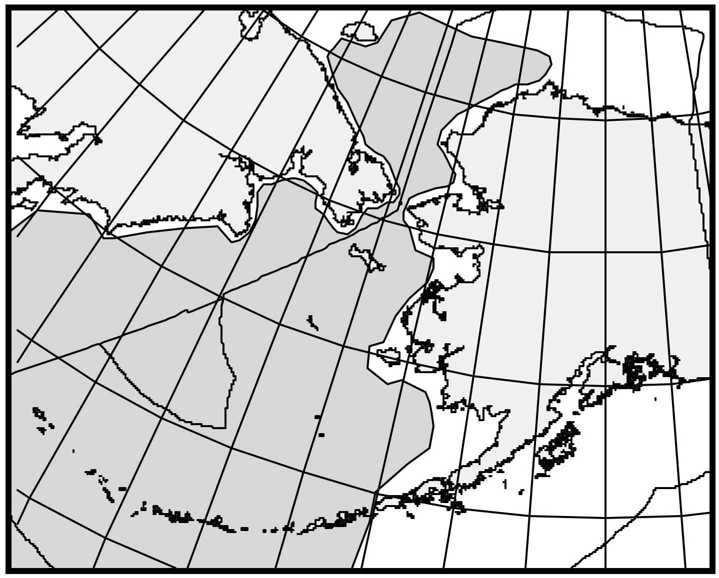

Figure 13. Approximate distribution of ribbon seals in Alaska waters (shaded area). The combined summer and winter distribution is depicted.

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, though there is no evidence 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 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 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 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 1990-95: 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 both in 1990 and 1991. Averaging the estimated mortalities over the 1991-95 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 6-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. Complete logbook data after 1993 are not available.

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. (BSA) groundfish trawl	90-95	obs data	53-74%	1, 1, 0, 0, 0, 0	1, 1, 0, 0, 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 x 0.06 x 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). A reliable estimate of the annual number of ribbon seals currently taken by Alaska Natives for subsistence is unavailable.

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: p. 26).

CITATIONS

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.

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.

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.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters, with concentrations in Cook Inlet, Bristol Bay, 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).

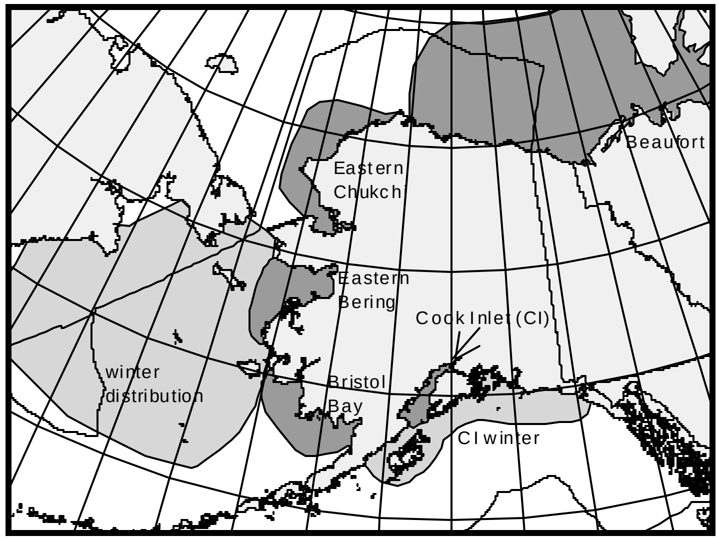

Figure 14. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distributions of the five stocks. Winter distributions are depicted with lighter shading.

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 (G. 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: p. 16).

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 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. As this stock is stable or increasing (DeMaster 1995: p. 16), 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 61 belugas during the 5-year period from 1993 to 1997. 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 1993-97 average is 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, 1993-97. 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
Mean annual take (1993-97)	61			

[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 (Norton et al. in press; FJMC unpubl. data, FJMC, Box 2120, Inuvik, NT, Canada, X0E 0T0). Given these data, the annual subsistence take in Canada averaged 123 belugas during the 5-year period from 1993 to 1997. Therefore, the mean estimated subsistence take in Canadian and U. S. waters from the Beaufort Sea beluga stock during 1993-97 is 184 (61 + 123) whales.

Table 13b. Summary of the Canadian subsistence harvest from the Beaufort Sea stock of beluga whales, 1993-97. Alaska Native subsistence takes are provided in Table 13a. 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	117	n/a	107	10
1994	140	n/a	133	7
1995	132	n/a	118	14
1996	106	n/a	95	11
1997	119	n/a	114	5
Mean annual take (1993-97)	123			

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 (184) 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, 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.

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.

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.

Norton, P., B. Day, and L. A. Harwood. In press. Monitoring of the Inuvialuit subsistence harvest of beluga whales in the western Arctic, 1977-1996. Arctic.

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).

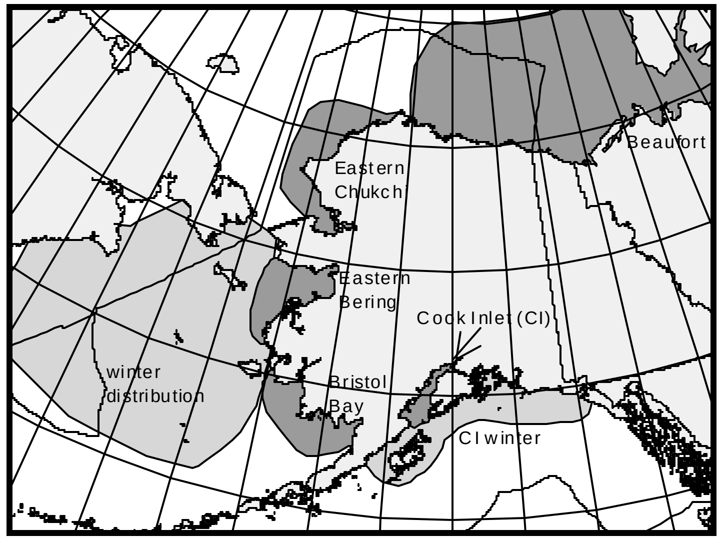

Figure 15. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distributions of the five stocks. Winter distributions are depicted with lighter shading.

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 (G. 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 × 2.62 × 1.18).

During 25 June to 6 July, 1998, aerial surveys were conducted in the eastern Chukchi Sea (DeMaster et al. 1998). The maximum single day count (1,172 whales) was derived from a photographic count of a large aggregation near Icy Cape (1,018), 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 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. 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: p. 17, 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 4).

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). Given these data, the annual subsistence take by Alaska Natives averaged 68 belugas during the 5-year period 1993-97. This estimate is based on reports from ABWC representatives and on-site harvest monitoring. The 1993-97 average is negatively biased because there are not reliable estimates for the number of struck and lost prior to 1995.

Table 14. Summary of the Alaska Native subsistence harvest from the eastern Chukchi Sea stock of beluga whales, 1993-97. 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
Mean annual take (1993-97)	68			

[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 (68) 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

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).

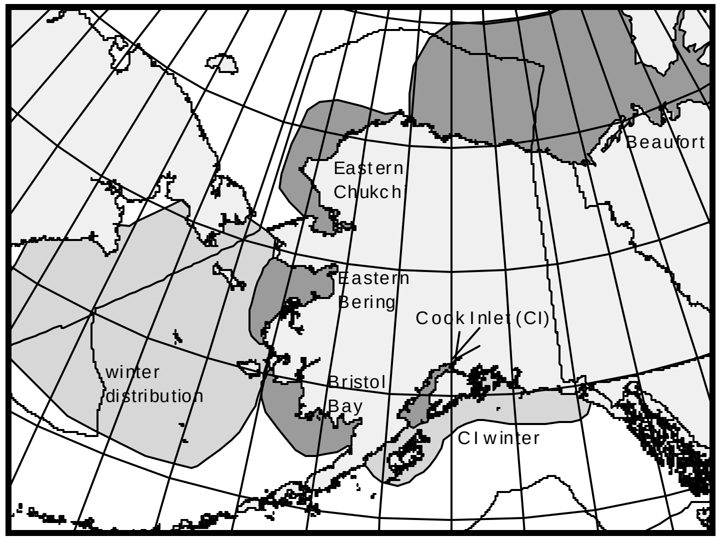

Figure 16. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distributions of the five stocks. Winter distributions are depicted with lighter shading.

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 (G. 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 three 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.

An aerial survey of Norton Sound is scheduled to occur during the summer of 1999. Preliminary results from this survey are expected to be available in 2000.

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} = $N/exp(0.842×[ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 7,986 and an associated CV(N) of 0.26, N_{MIN} for this stock is 6,439 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=0.26) as adequate in calculating a minimum population estimate (DeMaster 1996, 1997; see discussion of N_{MIN} for the eastern Chukchi stock of beluga whales). Due to foggy conditions encountered during the 1995 surveys, it was not possible to survey the entire Norton Sound area occupied by belugas during a continuous time period. As a result, the 1995 abundance estimate is considered to be conservative (Lowry and DeMaster 1996).

The Alaska SRG recommended using the abundance estimate (7,986 whales) as N_{MIN} for this stock. They considered the estimate to be adequately conservative because 1) the June 22 survey covered only the Yukon Delta area, 2) fog precluded surveying the entire area where whales may have been encountered, and 3) the Beaufort sea state during the survey was less than ideal (DeMaster et al. In review). However, pending completion of an analysis on the effects of Beaufort sea state on beluga whale sighting rate, NMFS has decided to continue to use the N_{MIN} as calculated according to the PBR Guidelines above (6,439 whales).

Current Population Trend

Surveys to estimate population abundance in Norton Sound were not conducted prior to 1992. However, between 1992 and 1995, survey data indicate that the population is less likely to be declining than it is to be stable or increasing.

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 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 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 = 129 animals (6,439 × 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 4).

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 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 1993-97. 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). Given these data, the annual subsistence take by Alaska Natives averaged 121 belugas from the eastern Bering Sea stock during the 5-year period 1993-97. These estimates are based on reports from ABWC representatives. The 1993-97 average is 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: p. 4).

Table 15. Summary of the Alaska Native subsistence harvest from the eastern Bering Sea stock of beluga whales, 1993-97. 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
Mean annual take (1993-97)	121			

[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 (16) 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 1993 to 1997, of human-caused mortality and serious injury (122, including the estimated mortality in non-commercial fisheries) is not known to exceed the PBR (129) 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, 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. (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., L. F. Lowry, K. J. Frost, and R. A. Paulson. In review. The effect of sea state on estimates of abundance for beluga whales (*Delphinapterus leucas*) in Norton Sound, Alaska. Fish. Bull. (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.

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).

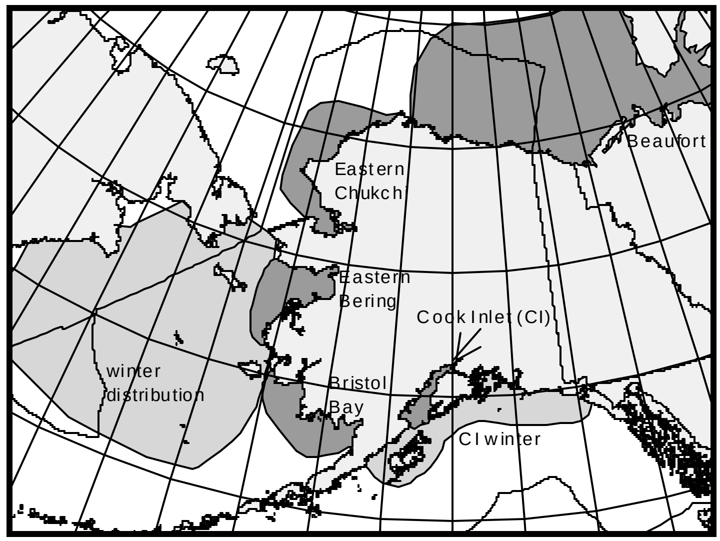

Figure 17. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distributions of the five stocks. Winter distributions are depicted with lighter shading.

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 (G. 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 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).

An aerial survey of Bristol Bay is scheduled to occur during the summer of 1999. Preliminary results from this survey are expected to be available in 2000.

Minimum Population Estimate

The survey technique utilized for estimating the abundance of beluga whales in this stock is a direct count which incorporates correction factors. Given this survey methodology, an estimate of the variance of abundance is 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 population estimate (N) of 1,555 and the default CV (0.2), N_{MIN} for the Bristol Bay stock of beluga whales is 1,316.

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 suggests that the Bristol Bay stock is stable, and at or near its historic size (Frost and Lowry 1990, 1995a, Lowry and Frost 1998).

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 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. 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 = 26 animals (1,316 × 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 and 1997, 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 4). 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 through 1997 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1993 to 1997 (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	90-97					0
Bristol Bay salmon drift gillnet	90-97	self report s	n/a	0, 1, 0, 0, n/a, n/a, n/a, n/a	n/a	[$0.25]
Bristol Bay salmon set gillnet	90-97	self report s	n/a	1, 0, 0, 0, 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

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). Given these data, the annual subsistence take by Alaska Natives averaged 19 belugas from the Bristol Bay stock during the 5-year period 1993-97. 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, 1993-97. 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
Mean annual take (1993-97)	19			

[1] Does not include the number struck and lost.

STATUS OF STOCK

At present, annual mortality levels less than 2.6 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 (20, including subsistence harvests and fishery-related mortality) is not known to exceed the PBR (26). 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, 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.

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.

L. F. Lowry, 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). 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).

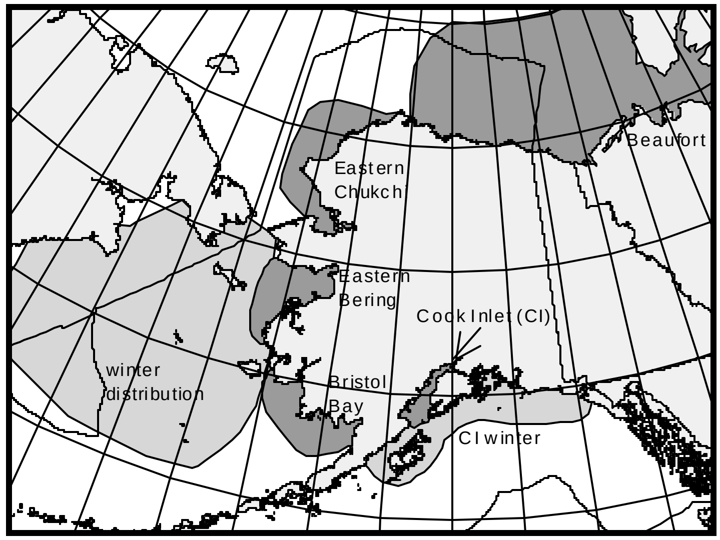

Figure 18. Approximate distribution of beluga whales in Alaska waters. The dark shading displays the summer distributions of the five stocks. Winter distributions are depicted with lighter shading.

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. 18).

POPULATION SIZE

Aerial surveys for beluga whales in Cook Inlet were conducted annually in June or July during 1994-99 using an ‘approach’ survey technique that involves repeated circling of observed groups, and videotape recording. The approach technique differs from ‘passing mode’ surveys performed for belugas in other stocks, in that during passing surveys the aircraft maintains a straight flight path. The approach technique allows each group of whales observed and recorded on video to be corrected for 1) animals that were under the surface, and 2) animals missed by observers yet recorded on video. The sum of median counts for all groups observed in the 1994-99 surveys is 281, 324, 307, 264, 193, and 217 whales, respectively (Rugh et al. In Press). Median counts are appropriate for comparisons between surveys since the effects of outliers (extremes in high or low counts) are reduced, they can be compared to other surveys which lack multiple passes over whale groups, and are more appropriate than maximums corrected for missed whales (Rugh et al. 1996).

The abundance of beluga whales in Cook Inlet is estimated from aerial observer counts and aerial video group size estimates. The group size estimates are corrected for subsurface animals (availability) and animals at the surface that were missed (sightability) based on an analysis of the video tapes. Observer 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. In Press). The most recent abundance estimate of beluga whales in Cook Inlet resulting from the June 1999 aerial survey is 375 (CV=0.20) animals (Hobbs et al. In Review).

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 357 and its associated CV(N) of 0.20, N_{MIN} for the Cook Inlet stock of beluga whales is 303.

Current Population Trend

In general, uncorrected counts have ranged from 300 to 500 beluga whales within Cook Inlet between 1970 and 1996. However, median counts since 1996 have been below 300 animals (264 in 1997, 193 in 1998, and 217 in 1999). The abundance estimates for the period 1994-99 are shown in Figure 19 (Hobbs et al. In Review). A statistically significant trend in abundance has been detected, although the power was low due to the short time series. However, the 1999 abundance estimate (357) is approximately 45% lower than the 1994 abundance estimate (653). In addition, a review of beluga distribution data suggest there has been a reduction in offshore sightings in upper Cook Inlet and a reduction in sightings in lower Cook Inlet (Rugh et al. In Review).

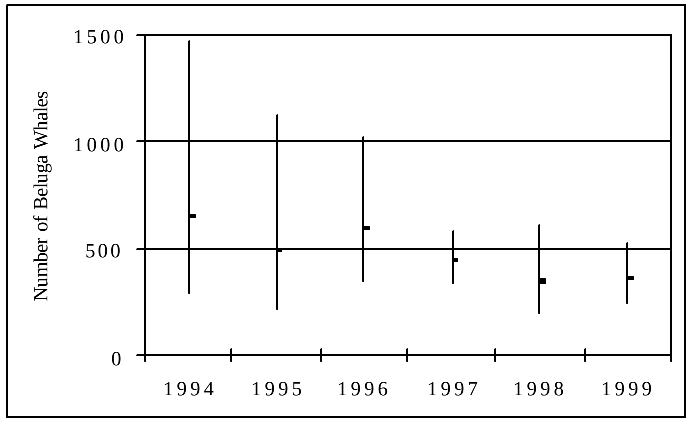

Figure 19. Abundance of beluga whales in Cook Inlet, Alaska 1994-98 (adapted from Hobbs et al. 1998). Error bars depict 95% confidence intervals

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 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: $PBR = N_{MIN} \times 0.5R_{MAX} \text{ x } F_R$. The F_R and PBR for the Cook Inlet stock of beluga whale in Small and DeMaster (1995), Hill et al. (1997), and Hill and DeMaster (1998) were “undetermined” and “undetermined”; 1.0 and 15; and 1.0 and 14, respectively. However, based on the recent information on stock size, trends in abundance, and level of the subsistence harvest, the Alaska Scientific Review Group (ASRG) (Ferrero 1999) has recommended that NMFS reduce the FR to the lowest value possible (i.e., 0.1). Further, the ASRG noted the resulting PBR would be 0.54 (assuming an N_{min} of 273 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 ASRG at this time. Rather, NMFS has selected an F_R of 0.3 based on the following: 1) this stock has formally been proposed for listing as depleted under the MMPA (which typically is associated with a F_R of 0.5), 2) in March 1999, NMFS was petitioned to list this stock as endangered under the Endangered Species Act, where NMFS has a period of 1 year to make an evaluation as to the merits of the petition (note: a listing of endangered is typically associated with a FR 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 = 1.8 animals (303 x 0.02 x 0.3) for the Cook Inlet stock of beluga whale. Additional data were collected on this stock in 1999.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Three types of commercial fishing gear, (purse seine, drift gillnet, and set gillnet) could possibly entangle beluga whales in Cook Inlet. These netsare used to catch each of the five species of Pacific salmon, as well as Pacific herring. There are no observer data prior to 1998, as fishery observers had not monitored any of these fisheries within Cook Inlet. However, in 1999 observers were placed on Cook inlet set and drift gillnet vessels. No mortalities were observed. 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 1998 fisher self-reports indicated no mortalities of beluga whales from interactions with commercial fishing operations (Table 17a). Logbook data are available for part of 1989-1994, 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 4 for details).

Table 17a. Summary of incidental mortality of beluga whales (Cook Inlet 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 self-reported fisheries information. Data from 1994 to 1998 (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. Observer data for two Cook Inlet fisheries were also available for 1999.

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	1999	obs data		0	0	0
Cook Inlet salmon set gillnet	1999	obs data		0	0	0
Observer program total	93-99					0
Cook Inlet salmon drift gillnet	90-98	logbooks/ self reports	n/a	0, 0, 0, 0, n/a n/a, n/a, n/a, n/a	n/a	[0]
Cook Inlet salmon set gillnet	90-98	logbooks/ self reports	n/a	0, 0, 0, 0, n/a n/a, n/a, n/a, n/a	n/a	[0]
Minimum total annual mortality						0

In the past, beluga mortalities have been attributed to Cook Inlet fisheries with the fishing-related mortality during the 3-year period from 1981 to 1983 estimated at 3-6 animals per year (Burns and Seaman 1986). Accordingly, though there were no self-reported fishery mortalities of beluga whales, the Cook Inlet gillnet fisheries (having a combined total of over 1,325 active permits in 1997) have been included in Table 17a because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994).

Based on a lack of reported mortalities, the estimated minimum mortality rate incidental to commercial fisheries is zero belugas per year from this stock. However, a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in the Cook Inlet fisheries mentioned above. The Cook Inlet salmon set and drift gillnet fisheries are scheduled to be observed again in 2000.

Subsistence/Native Harvest Information

A study conducted by the Alaska Department of Fish and Game (ADF&G), in cooperation with the Alaska Beluga Whale Committee (ABWC) and the Indigenous People's Council for Marine Mammals, estimated the subsistence take in 1993 at 17 whales based on surveys of 16 of 19 households known to have hunted in 1993 (Table 17b: Stanek 1994). This was considered a minimum estimate, and was increased by adding the estimated number of whales taken from households not surveyed (3) and by hunters from areas outside of Cook Inlet (10) resulting in an estimated total take of 30 (17 + 3 + 10) whales. However, in consultation with native elders from the Cook Inlet region, the Cook Inlet Marine Mammal Council (CIMMC) estimated the annual number of belugas taken by subsistence hunters to be greater than 30 animals (DeMaster 1995: p. 5).

There was no systematic Cook Inlet beluga harvest survey in 1994. Instead, Cook Inlet harvest data for 1994 were compiled at the November 1994 ABWC meeting. Representatives of the CIMMC, ADF&G Division of Subsistence, and an active Cook Inlet hunter each presented harvest information they knew about. They discussed the information among themselves to eliminate redundancy, and agreed upon a final 1994 harvest estimate of 19 retrieved and 2 struck and lost. This included 2 belugas taken in Cook Inlet by hunters from Kotzebue Sound. The ADF&G representative estimated that there were 35-50 active beluga hunting households in the Cook Inlet region.

Table 17b. Summary of the Alaska Native subsistence harvest from the Cook Inlet stock of beluga whales, 1993-99. 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	30[1]	n/a	n/a	n/a
1994	21[1]	n/a	19[1]	2[1]
1995	70	n/a	42	26
1996	123	98-147	49	49-98
1997	70[2]	n/a	35[2]	35[2]
1998	44[2]	n/a	21	21
1999	0	0	0	0
Mean annual take (based on 1996, 1997 and 1999)	65			

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

A summary of Cook Inlet beluga whale subsistence harvest data is provided in Table 17b (ABWC unpubl. data, ABWC, P.O. Box 69, Barrow, AK, 99723; CIMMC unpubl. data, 26339 Eklutna Village Rd., Chugiak, AK, 99567). The most thorough subsistence harvest surveys were completed in Cook Inlet by the CIMMC during 1995-97. While some of the local hunters believe the 1996 estimate of struck and lost is positively biased, the 1995-97 CIMMC take estimates are considered reliable. The annual subsistence take by Alaska Natives during this period averaged 87 whales. In 1998, NMFS only received reports of hunter's taking 21whales in Cook Inlet which was considered a minimum estimate lacking a complete harvest report from CIMMC. Given the struck and lost estimate for Cook Inlet of 1:1, the harvest for 1998 was estimated to be at least 42 beluga whales. Lacking reliable data throughout the time series from 1993 to 1998, it is not possible to determine the trend in subsistence take. Similarly, subsistence mortality for the Cook Inlet stock has been averaged over the last three reliable estimates (1996, 1997 and 1999) instead of a 5-year period as used for the other four beluga whale stocks addressed in this document.

OTHER MORTALITY

Mortalities related to stranding events have been reported in Cook Inlet. For example, in June of 1996, 63 animals stranded in the Susitna Delta (Rugh et al. 1997). Four of these animals are known to have died as a result of the stranding event (B. Smith, pers. comm., NMFS, 222 W 7th Ave., Anchorage, AK, 99513). Such mortalities are not likely to be associated with human-related activities. In September, 1999, at least 60 beluga whales stranded in Turnagain Arm, of which, six were subsequently found dead. There were no indications that the stranding event had 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 its Optimum Sustainable Population level. Thus, this stock was listed as “depleted” under the MMPA (56 FR 34590; May 31, 2000). NMFS also made a determination that this stock should not be listed under the ESA at this time (65 FR 38778; June 22, 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; June 22, 2000). In addition, NMFS and local subsistence groups are actively pursuing the development of a comanagement agreement which would allow subsistence harvest, but at a level far below historical levels.

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 commercial fishery-related mortality levels, less than 0.18 per year (i.e., 10% of PBR), can be considered insignificant and approaching zero mortality and serious injury rate. However, based on currently available data, the estimated annual level of total human-caused mortality through 1999, 65 beluga whales (estimated exclusively from subsistence harvest data), exceeds the PBR (1.8) for this stock. Thus, the Cook Inlet beluga whale stock is classified as strategic. The estimated level of human-caused removals in 1998 is not sustainable.

Efforts to develop co-management agreements with Native organizations for several marine mammal stocks utilized 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. Prior to the expiration of the moratorium, a co-management agreement is expected to be completed, through which a longer term rule for managing harvests will be proposed. Determination of sustainable harvest levels for this stock will be based on analysis of information gathered under the co-management agreement, once in place.

Habitat Concerns

NMFS recognizes that municipal, commercial, and industrial activies are 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. 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. 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 in the early 1990s because the stock, in its currently reduced state, occupies a more restricted portion of its prior range in Cook Inlet.

CITATIONS

Burns, J. J., and G. A. Seaman. 1986. Investigations of belukha whales in coastal waters of western and northern Alaska. II. Biology and ecology. U. S. Dep. Commer., NOAA, OCSEAP Final Rep. 56(1988):221-357.

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 third meeting of the Alaska Scientific Review Group, 16-17 February 1995, Anchorage, Alaska. 21 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.

Ferrero, R.C. 1999. Minutes: ninth meeting of the Alaska scientific review group (15-16 April, 1999). NMML, NMFS, NOAA, 7600 Sand Point Way, NE, Bldg. 4, Seattle, WA 98115. 16p.

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.

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. 1997. Alaska Marine Mammal Stock Assessments, 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-78, 150 pp.

Hill, P. S., and D. P. DeMaster. 1998. Alaska Marine Mammal Stock Assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-97, 166 pp.

Hobbs, R. C, D. J. Rugh, and D. P. DeMaster. In Review. Abundance of beluga whales in Cook Inlet, Alaska, 1994-1999. Unpubl. doc. (available upon request - R. C. Hobbs, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

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.

Rugh, D. J., K. E. W. Shelden, R. P. Angliss, and D. P. DeMaster. 1996. Aerial surveys of beluga whales in Cook Inlet, Alaska, July 1995. Unpubl. doc. submitted to Int. Whal. Comm. (SC/48/SM8). 13 pp.

Rugh, D. J., K. E. W. Shelden, J. M. Waite, R. C. Hobbs, and B. Mahoney. 1997. Aerial surveys of beluga whales in Cook Inlet, Alaska, June 1996. Unpubl. doc. submitted to Int. Whal. Comm. (SC/49/SM19). 22 pp.

Rugh, D. J., K. E. W. Shelden, and B. Mahoney. In Press. Distribution of beluga whales in Cook Inlet, Alaska, during June and July, 1993/1998. Marine Fisheries Review (available upon request - D. J. Rugh, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

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.

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.

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

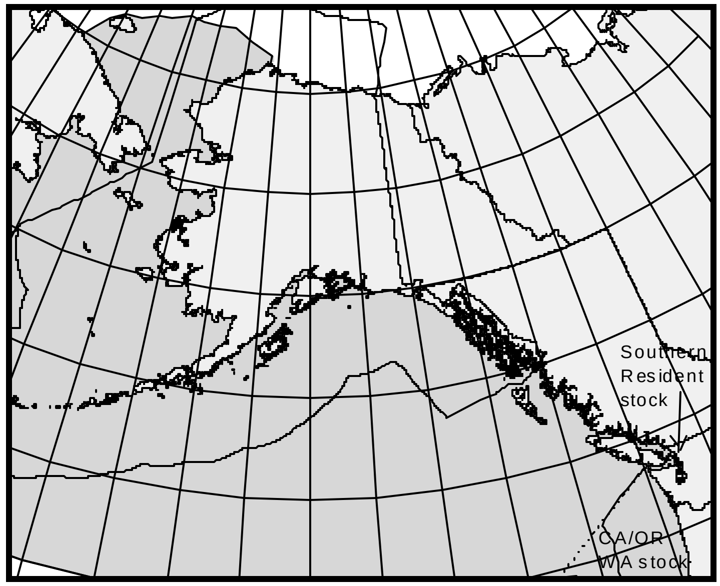

Figure 20. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the Eastern North Pacific Northern Resident and Transient stocks are largely overlapping (see text).

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). 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). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994).

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,

P. O. Box 3232, Vancouver, B.C. V6B3X8; L. Barrett-Lennard, pers. comm., Univ. of British Columbia, 6270 University Blvd., Vancouver, B.C. V6T1Z4).

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, 200 'resident' whales have been identified (Ford et al. 1994). In Southeast Alaska, an additional 89 'resident' whales have been identified (Dahlheim et al. 1997). In Prince William Sound and Kenai Fjords, another 360 'resident' whales have been identified (Matkin et al. 1998). 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 (G. Ellis, pers. comm., Pacific Biological Station, Nanaimo, BC, V9R 5K6), and an additional 174 have been provisionally classified as 'residents' and 53 as '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. Combining the counts of 'resident' whales gives a minimum number of 717 (200 + 89 + 360 + 68) killer whales belonging to the Eastern North Pacific Northern Resident stock.

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 174 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 717 animals, which includes animals found in Canadian waters (see PBR Guidelines regarding the status of migratory transboundary 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). However, 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). 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 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 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 (717 × 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 1996: 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. 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 18. 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 similarly circumstances and was treated in the same manner (66% observer coverage in 1993). The mean annual (total) mortality was 0.6 (CV=0.67) for the Bering Sea groundfish trawl fishery and 0.2 (CV=1.0) for the combined Bering Sea longline fishery, resulting in a mean annual mortality rate of 0.8 (CV=0.56) killer whales per year from observed fisheries.

Table 18. Summary of incidental mortality of killer whales (Eastern North Pacific Northern Resident stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Data from 1992 to 1996 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	90-96	obs data	53-74%	0, 1, 1, 1, 0, 0, 0	1, 2, 2, 1, 0, 0, 0	0.6 (CV=0.67)
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	90-96	obs data	27-80%	0, 1, 0, 0, 0, 1, 0	0, 1, 0, 0, 0, 1, 0	0.2 (CV=1.0)
Estimated total annual mortality						0.8 (CV=0.56)

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 1996, 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 15 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 (see Appendix 4).

The estimated minimum mortality rate incidental to U. S. commercial fisheries recently monitored is 0.8 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.

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). 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, Nanaimo, BC, V9R 5K6).

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, NMFS, AFSC, 7600 Sand Point Way NE, Seattle, WA 98115).

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 due primarily 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 unclassified whales from western Alaska were not included), resulting in a conservative PBR estimate. However, based on currently available data, the estimated annual fishery-related mortality level (0.8) 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 (0.8 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.

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.

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.

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

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

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

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.

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)

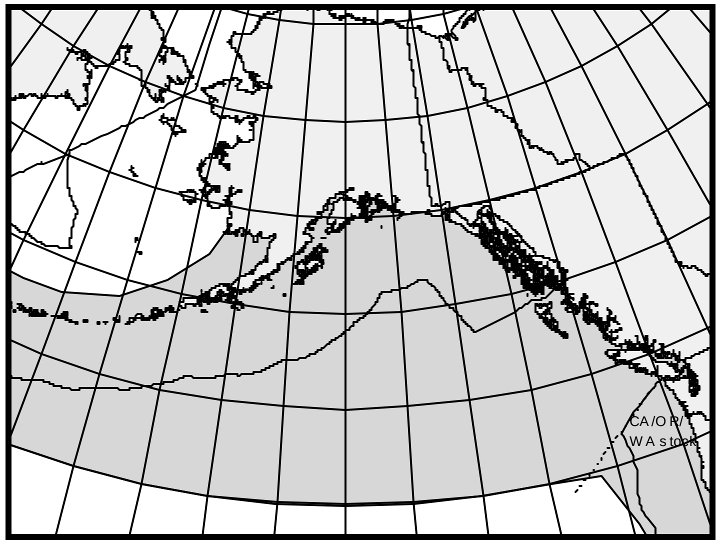

Figure 21. Approximate distribution of Pacific white-sided dolphins in the eastern North Pacific (shaded area).

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 west coast of the U. S., 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. 21). 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=0.900) 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., NMML, NMFS, 7600 Sand Point Way, NE, Bldg. 4, Seattle, WA 98115).

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°x5°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°x5° 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 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 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 = 269 animals (26,880 x 0.02 x 0.5).

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 19. 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 19) 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 19) 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 4 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 a zero mortality and serious injury rate.

Table 19. Summary of incidental mortality of Pacific white-sided dolphins (Central 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	90-98	obs data	53-74%	0, 0, 1, 0, 0, 0, 0, 0, 0	0, 0, 1, 0, 0, 0, 0, 0, 0	0
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries	90-98	obs data	27-80%	0, 0, 0, 0 0, 1, 0, 0, 0	0, 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	90-98	logbooks/ self-reports	n/a	1, 4, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$1.25]
Southeast Alaska salmon drift gillnet	90-98	logbooks/ self-reports	n/a	0, 0, 1, 0 n/a, n/a, n/a, n/a, n/a	n/a	[$.25]
Bristol Bay salmon drift gillnet	90-98	logbooks/ self reports	n/a	3, 0, 0, 0 n/a, n/a, n/a, n/a, n/a	n/a	[$.75]

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
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) does not exceed the PBR (269). Therefore, the Central North Pacific stock of Pacific white-sided dolphins is not classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

CITATIONS

Buckland, S.T., K. L. Cattanach, and R. C. Hobbs. 1993. Abundance estimates of Pacific white sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987/90. Pp. 387-407, *In* W. Shaw, R. L. Burgner, and J. Ito (eds.), Biology, Distribution and Stock Assessment of Species Caught in the High Seas Driftnet Fisheries in the North Pacific Ocean. Intl. North Pac. Fish. Comm. Symposium; 4-6 November 1991, Tokyo, Japan.

Chivers, S. J., K. M. Peltier, W. T. Norman, P. A. Akin, and J. Heyning. 1993. Population structure of cetaceans in California coastal waters. Paper SOCCS9 presented at the Status of California Cetacean Stocks Workshop, held in La Jolla, California, March 31-April 2, 1993. 49 pp.

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

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. Relatively high densities of harbor porpoise have been recorded along the coasts of Washington and northern Oregon and California. Relative to the waters off the U.S. West Coast, harbor porpoise do not occur in high densities in Alaska waters (Dahlheim et al. submitted). 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.

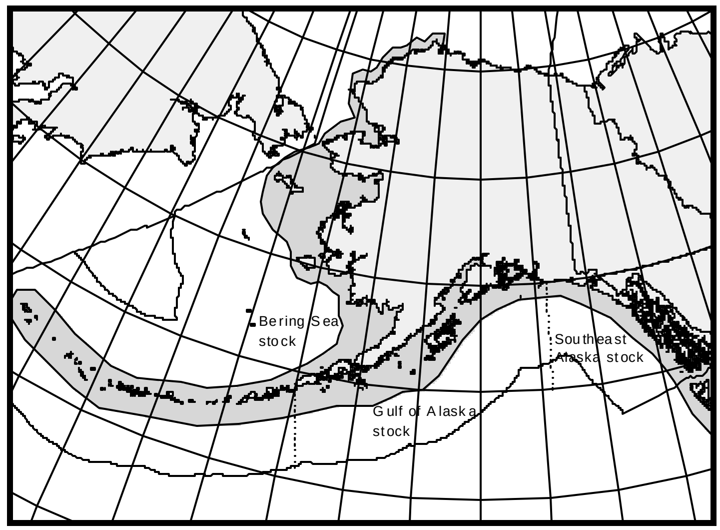

Figure 22. Approximate distribution of harbor porpoise in Alaska waters (shaded area). The distributions of all three stocks found in Alaska waters are shown.

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. 22). Information concerning the 4 harbor porpoise stocks occurring along the U. S. West Coast(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 3,550 (CV=0.207) animals. Included were the inside waters Southeast Alaska, Yakutat Bay, and Icy Bay. The total area surveyed across inside waters, within the range of the Southeast Alaska stock, was 3,826 km^2. The areas surveyed previously were stratified into high and low density areas using the data from the 1991-1993 aerial and vessel surveys. Areas that were not surveyed previously were assigned the average density and stratified accordingly. However, 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. Correction factors for availability bias in aerial surveys of harbor porpoise have been estimated at 2.96 (CV=0.180) (Laake et al. 1997) from Puget Sound, Washington, and 3.2 (Barlow et al. 1988) from the U.S. West Coast. A correction factor for both perception and availability bias has been estimated at 3.1 (CV=0.171) (Calambokidis et al. 1993) from Puget Sound, Washington. Perception bias was estimated within the survey, so only a correction for availability bias is necessary thus the correction of Calambokidis et al. (1993) is not appropriate. The correction factor of 3.2 of Barlow et al. (1988) includes untested assumptions regarding observer behavior and visibility of harbor porpoise during surfacing intervals which though reasonable are not necessary in the treatment of Laake et al. (1997). The correction of 2.96 for availability bias should then be used for this harbor porpoise stock, as it is the result of an empirical estimate of this factor. Thus, the estimated corrected abundance from this survey is 10,508 (3550 X 2.96; CV=0.274) harbor porpoise for all waters surveyed.

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 10,058 and its associated CV (0.274), N_{MIN} for this stock is 8,376.

Current Population Trend

At present, 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 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 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 =83 animals (8,376 x 0.02 x 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 20) 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 4 for details).

Table 20. 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 1991-1998 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	90-98					0
Southeast Alaska salmon drift gillnet	90-98	logbooks/ self-reports	n/a	2, 2, 7, 2, n/a, n/a, 2, n/a, 1	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 8.3 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 (83). 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. Pp. 101-110, In J. E. Reynolds III and D. K. Odell, (eds.). Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987. Miami, Florida. NMFS, NOAA Technical Rep. NMFS 98.

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

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. 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).

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, D.J. Rugh. 1997. Propability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manag. 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.

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.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

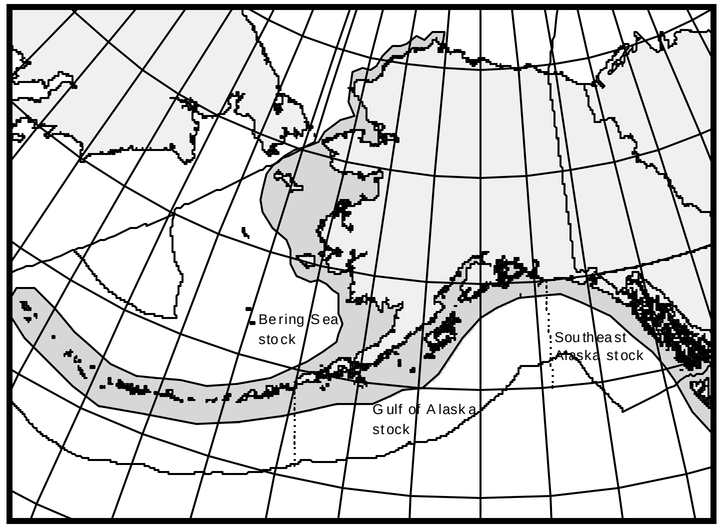

Figure 23. Approximate distribution of harbor porpoise in Alaska waters (shaded area). The distributions of all three stocks found in Alaska waters are shown.

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. Relatively high densities of harbor porpoise have been recorded along the coasts of Washington and northern Oregon and California. Relative to the waters off the U. S. West Coast, harbor porpoise do not occur in high densities in Alaska waters (Dahlheim et al. submitted). 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 U. S. West Coast (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 1,000 fathom depth contour resulted in a corrected abundance estimate for the Gulf of Alaska harbor porpoise stock of 21,451 (CV=0.309) animals. The uncorrected abundance estimate (7,247 CV=0.252) was adjusted for availability bias using the Laake et al. (1997) value of 2.96 (CV=0.180) (i.e, 7,247 x 2.96=21,451). The previous SAR for this stock used the Calambokidis et al. (1993) 3.1 (CV=0.171) correction factor for both perception and availability bias, based on work in Puget Sound, Washington. A perception bias was estimated within the most recent survey, however, so only a correction for availability bias was necessary. The Barlow et al. (1988) correction factor of 3.2 was not used because it includes untested assumptions regarding observer behavior and visibility of harbor porpoise during surfacing intervals which though reasonable are not necessary in the treatment of Laake et al. (1997).

The latest estimate of abundance (21,451; CV=0.309) 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. The earlier survey also included Cook Inlet, a low density harbor porpoise area, which was not included in the 1998 survey. The 1998 aerial survey resulted in an uncorrected abundance estimate of 7,247 (CV=0.252) compared to 2,741 (CV=0.134) in 1993. 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 21,451 and its associated CV of 0.309, N_{MIN} for the Gulf of Alaska stock of harbor porpoise is 16,630.

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 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} x $0.5R_{MAX}$ x 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 = 166 animals (16,630 x 0.02 x 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 21. 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 21) 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 21. 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 21) 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 4 for details).

Table 21. 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	Reported mortalities (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Cook Inlet salmon drift and set gillnet fisheries	90-98	logbooks/ self-reports	n/a	3, 0, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$0.75]
AK Peninsula/Aleutian Island salmon drift gillnet	90-98	logbooks/ self-reports	n/a	2, 0, 1, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$0.75]
Kodiak salmon set gillnet	90-98	logbooks/ self-reports	n/a	8, 4, 2, 1, n/a, n/a, n/a. n/a, 1	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 21.

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. The lack of surveys in a significant portion of the Gulf of Alaska 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 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 (166). 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. Pp. 101-110, In J. E. Reynolds III and D. K. Odell, (eds.). Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987. Miami, Florida. NMFS, NOAA Technical Rep. NMFS 98.

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

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, and J. Waite. Submitted. Abundance and distribution of Alaska harbor porpoise based on aerial surveys: Bristol Bay to Southeast Alaska. Mar. Mamm. Sci. (available upon request - 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. + 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).

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, D.J. Rugh. 1997. Propability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manag. 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.

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. Relatively high densities of harbor porpoise have been recorded along the coasts of Washington and northern Oregon and California. Relative to the waters off the U. S. West Coast, harbor porpoise do not occur in high densities in Alaska waters (Dahlheim et al. submitted). 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.

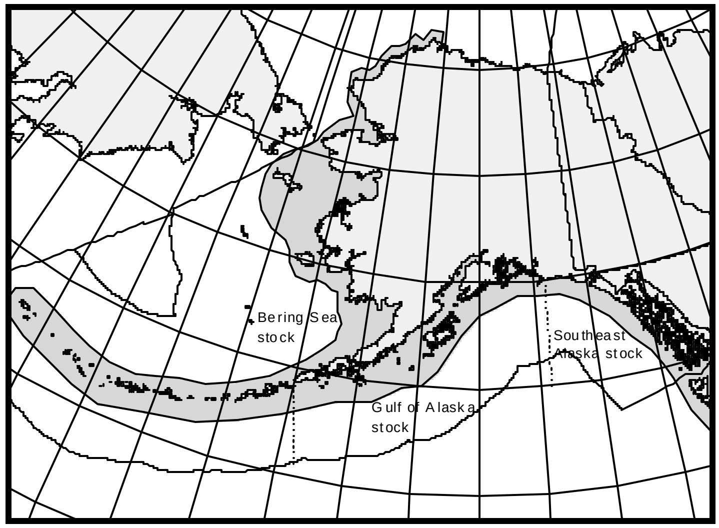

Figure 24. Approximate distribution of harbor porpoise in Alaska waters (shaded area). The distributions of all three stocks found in Alaska waters are shown.

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 U. S. West Coast (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 the summer of 1991, an aerial survey covering the Bristol Bay region was conducted resulting in a corrected abundance estimate of 10,946 (CV=0.300). The uncorrected abundance estimate (3,531 (CV=0.243) was adjusted for availability bias using the Calambokidis et al. (1993) 3.1 (CV=0.171) correction factor for both perception and availability bias based on work in Puget Sound, Washington. The Barlow et al. (1988) correction factor of 3.2 was not used because it includes untested assumptions regarding observer behavior and visibility of harbor porpoise during surfacing intervals. No survey effort was conducted in the vicinity of the Pribilof Islands or along the Aleutian Islands because of the lack of commercial fisheries that could potentially affect harbor porpoise in those areas (Dahlheim et al. 1992). In addition, no survey effort was conducted north of Cape Newenham (approximately 59°N), when harbor porpoise are regular visitors as far north as Point Barrow during the summer months (Suydam and George 1992). The 1991 survey, therefore, covered less than one tenth of the range occupied by the Bering Sea stock of 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 10,946 and its associated CV of 0.300, N_{MIN} for the Bering Sea stock of harbor porpoise is 8,549.

Current Population Trend

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 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 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 = 86 animals (8,549 x 0.02 x 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 22. The mean annual (total) mortality rate resulting from observed mortalities was 1.2 (CV=0.31).

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 22) 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 4 for details).

Fisher self-reports for three fisheries listed in Table 22 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 22. Summary of incidental mortality of harbor porpoise (Bering Sea 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 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	90-98	obs data	53-74%	0, 0, 0, 0, 1, 1, 0, 1, 1	0, 0, 0, 0, 2, 1, 0, 2, 1	1.2 (CV=.31)
Observer program total						1.2
				Reported mortalities		
AK Peninsula/Aleutian Island salmon set gillnet	90-98	logbooks/ self-reports	n/a	0, 0, 2, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$0.5]
Bristol Bay salmon drift gillnet	90-98	logbooks/ self-reports	n/a	0, 0, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[0]
Bristol Bay salmon set gillnet	90-98	logbooks/ self-reports	n/a	0, 0, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[0]
AK Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	90-98	logbooks/ self-reports	n/a	0, 0, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[0]
Minimum total annual mortality						$1.7

The estimated minimum annual mortality rate incidental to commercial fisheries is rounded up to 2 animals, based on observer data (1.2) 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 8.6 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., 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.

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. Pp. 101-110, In J. E. Reynolds III and D. K. Odell, (eds.). Proceedings of the Second Marine Mammal Stranding Workshop: 3-5 December 1987. Miami, Florida. NMFS, NOAA Technical Rep. NMFS 98.

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

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, J. Waite, and C. Goebel-Diaz. 1992. Abundance and distribution of harbor porpoise (*Phocoena phocoena*) in Southeast Alaska, Cook Inlet and Bristol Bay. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Dahlheim, M., A. York, R. Towell, and J. Waite. Submitted. Abundance and distribution of Alaska harbor porpoise based on aerial surveys: Bristol Bay to Southeast Alaska. Mar. Mamm. Sci. (available upon request - 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. + 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).

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. 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.

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.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dall's porpoise are widely distributed across the entire North Pacific Ocean (Fig. 25). 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 U. S. West Coast(Loeb 1972, Leatherwood and Fielding 1974), and winter movements of populations out of Prince William Sound (Hall 1979) and areas in the Gulf of Alaska and Bering Sea (NMFS unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

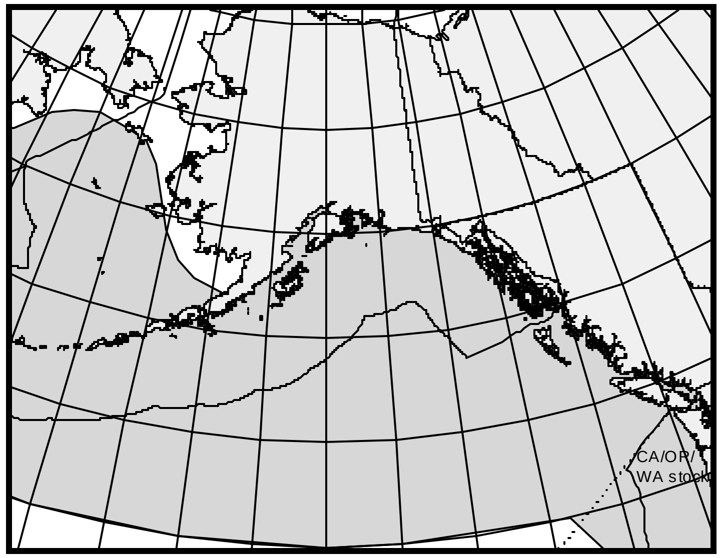

Figure 25. Approximate distribution of Dall's porpoise in the eastern North Pacific (shaded area).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous, 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 U. S. West Coast 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 x 0.2) for this stock. No reliable abundance estimates for British Columbia are currently available.

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 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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. 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). Thus, for the Alaska stock of Dall's porpoise, PBR = 1,537 animals (76,874 x 0.02 x 1.0).

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 1990-98: 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 9-year period, as well as the annual observed and estimated mortalities are presented in Table 20. The mean annual (total) mortality was 6.0 (CV=0.17) for the Bering Sea groundfish trawl fishery, 1.2 (CV=0.61) for the Gulf of Alaska groundfish trawl fishery, and 1.6 (CV=0.61) for the Bering Sea groundfish longline fishery.

The Alaska Peninsula and Aleutian Islands 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 (6.0+1.2+1.6=8.8) 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 36.8 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 23) 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 1990 and 1998, fisher self-reports from 4 unobserved fisheries (see Table 23) resulted in an estimated annual mean of 5.6 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 23. 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 4 for details).

Table 23. Summary of incidental mortality of Dall's porpoise (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 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 morality (in given yrs.)**	**Mean annual mortality**
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	90-98	obs data	53-74%	6, 1, 5, 4, 4, 2, 5, 5, 3	7, 2, 6, 5, 7, 3, 8, 8, 4	6.0 (CV=1.7)
Gulf of Alaska (GOA) groundfish trawl	90-98	obs data	33-55%	0, 0, 0, 1, 0, 0, 1, 0, 1	0, 0, 0, 3, 0, 0, 3, 0, 3	1.2 (CV=0.61)
BSAI groundfish longline (incl. misc finfish and sablefish fisheries)	90-98	obs data	27-80%	0, 0, 0, 0, 1, 1	0, 0, 0, 0, 4, 4	1.6 (CV=.61)
AK Peninsula/ Aleutian Island salmon drift gillnet	90	obs data	4%	1	28	28 (CI 1-81)
Observer program total						36.8
				Reported mortalities		
Prince William Sound salmon drift gillnet	90-98	logbooks/ self-reports	n/a	0, 2, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$0.5]
Southeast Alaska salmon drift gillnet	90-98	logbooks/ self-reports	n/a	6, 6, 4, 6, n/a, n/a, n/a, 1, n/a	n/a	[$4.6]
Cook Inlet set and drift gillnet fisheries	90-98	logbooks/ self-reports	n/a	1, 0, 1, 0, n/a, n/a, n/a, n/a, n/a	n/a	[$0.5]
Minimum total annual mortality						$41.9

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 42 animals; based on observer data (rounded to 37) and logbook reports (rounded to 6) 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 (42) 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.

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.

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.

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 II. 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. 26), 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 (Calif.), none were recovered north of 53/ in the Gulf of Alaska despite large takes there (B. Taylor, pers. comm., Southwest Fisheries Science Center, P. O. Box 271, La Jolla, CA 92038). Therefore, seasonal movement of sperm whales in the North Pacific is unclear at this time.

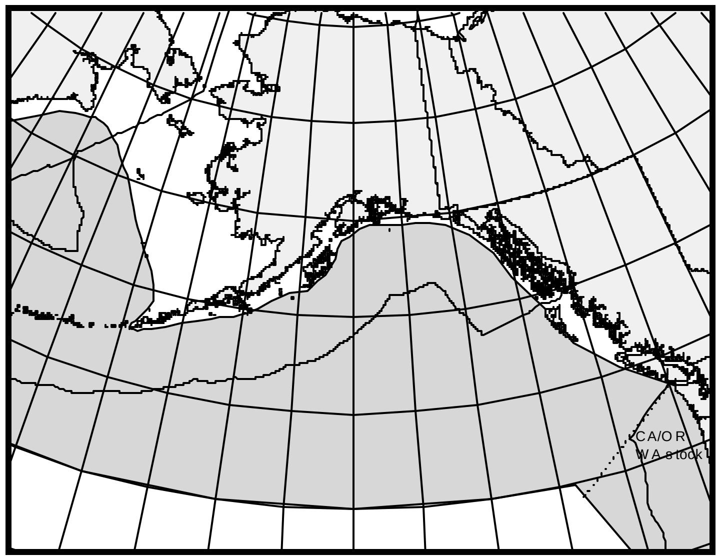

Figure 26. Approximate distribution of sperm whales in the eastern North Pacific (shaded area).

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 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 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 1990-96: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No mortalities of sperm whale were observed by NMFS observers in any observed fishery. 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).

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 1996, 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 for 1996 (see Appendix 4).

Therefore, based on the lack of reported mortalities, the estimated annual mortality rate incidental to commercial fisheries is zero. As a result, the annual human-caused mortality level is 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, The Red House, Station Road, Histon, Cambridge, UK). 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 1998). 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. 1998. Evidence of statistical manipulations in Japanese coastal sperm whale fishery. Unpubl. report submitted to Int. Whal. Comm. (SC/50/CAWS/10). 21 pp.

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. 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

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. 27). 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).

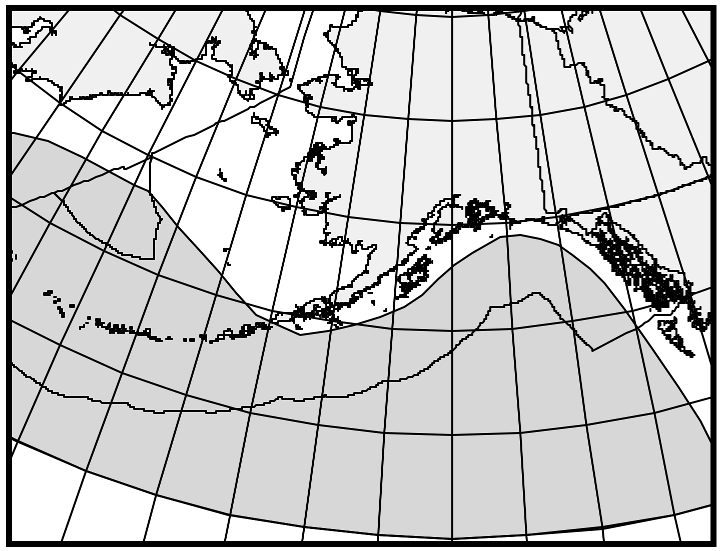

Figure 27. Approximate distribution of Baird's beaked whales in the eastern North Pacific (shaded area).

There are insufficient data to apply the phylogeographic approach to stock structure (Dizon et al. 1992) for 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 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 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 4)

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. 28) 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).

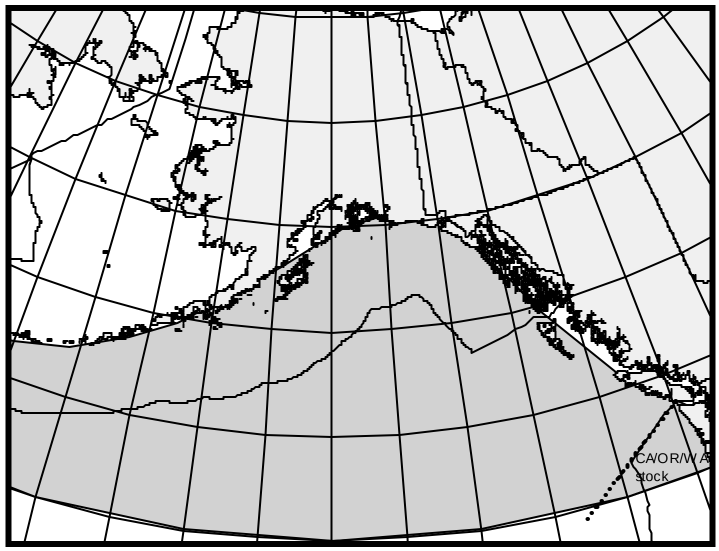

Figure 28. Approximate distribution of Cuvier's beaked whales in the eastern North Pacific (shaded area).

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 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 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 4).

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. 29). 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).

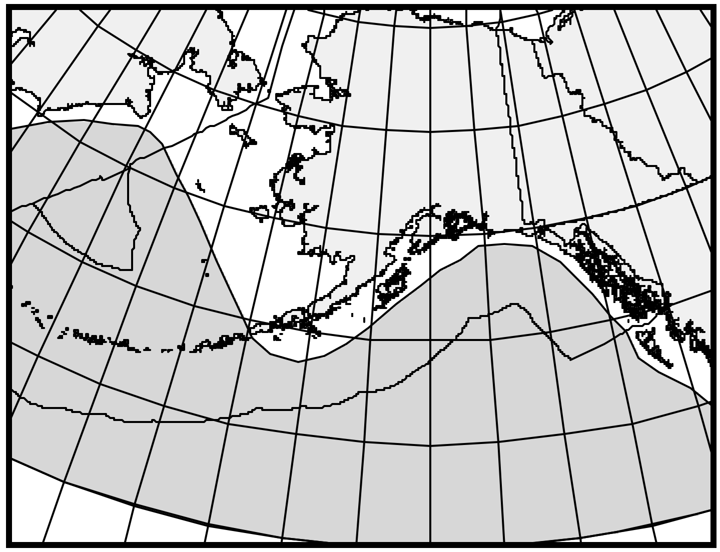

Figure 29. Approximate distribution of Stejneger's beaked whales in the eastern North Pacific (shaded area).

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 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 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 4).

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

The gray whale formerly occurred in the North Atlantic Ocean (Fraser 1970), but is currently only found in the North Pacific (Rice et al. 1984). The following information was considered in classifying stock structure of gray whales based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: two isolated geographic distributions in the North Pacific Ocean; 2) Population response data: increasing in the eastern North Pacific, unknown 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 breeds along the west coast of North America (Fig. 30), and the Western North Pacific or "Korean" stock, which apparently breeds off 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, Chukchi, and Beaufort Seas (Rice and Wolman 1971, 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). The whales migrate near shore along the coast of North America from Alaska to the central California coast (Rice and Wolman 1971) starting in October or November. After passing Point Conception, California, Rice et al. (1984) reported the majority of the animals take a more direct offshore route across the southern California Bight to northern Baja California, Mexico. 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). A small, but increasing proportion of newborn calves has been sighted along the California coast during the southward migration (Shelden et al. in press). According to Shelden et al. (in press), the apparent increase in the percentage of calf sightings may be related to a trend toward successively later migrations over the 43-year observation period (see Rugh et al. 1999a, Buckland and Breiwick in press) or it may be due to an increase in spatial and temporal distribution of calving as the population has increased. The northbound migration generally begins in mid-February and continues through May (Rice et al. 1981, 1984; Poole 1984) with cows and newborn calves primarily migrating northward between March and June along the U.S. West Coast.

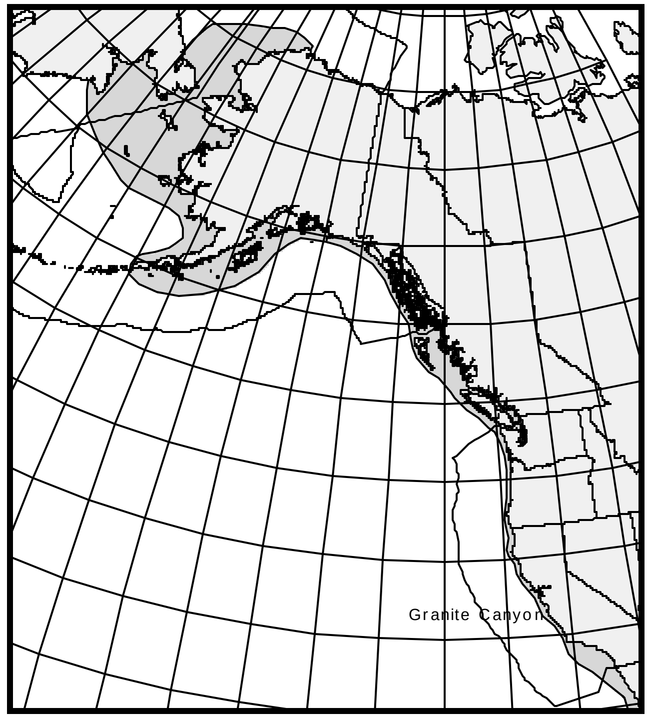

Figure 30. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area). Excluding some Mexican waters, the entire range of this stock is depicted in the figure.

POPULATION SIZE

Systematic counts of gray whales migrating along the central California coast were conducted by shore-based observers (at Granite Canyon) during the 1997/98 southbound migration (Hobbs and Rugh 1999). The abundance estimate resulting from the 1997/98 census is 26,635(CV=0.1006) whales. 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.

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): $N_{MIN} = N/\exp(0.842*[\ln(1 +[CV(N)]^2)]^{½})$. 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 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 0.044 (95% CI: 0.031-0.056) 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%).

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 in press). 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 in press). The AK SRG 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, the preferred estimate is from the age- and sex-structured model, which had a lower 10th percentile of 0.047. This has the interpretation 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 x 0.0235 x 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 1990-98: 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, otherwise known as the Makah tribal fishery for chinook salmon, during 1990-98. Data from 1990-98 are included in Table 24a, although the mean estimated annual mortality is calculated using the most recent 5 years of available data. One gray whale was observed taken in 1990 (Gearin et al. 1994) and one observed taken 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., National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-0070.).

NMFS observers also monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 1993 to 1998 (Table 24a; Julian 1997, Cameron 1998, Julian and Beeson 1998, Cameron and Forney 1999). One gray whale mortality was observed in this fishery in 1998.

The mean annual mortality was 0.2 (CV=1.0) for the northern Washington marine set gillnet fishery and 1.0 (CV=1.0) for the California/Oregon thresher shark/swordfish drift gillnet fishery, resulting in a mean annual mortality rate of 1.2 (CV=0.85) 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 1998, 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 24a. 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 1989-1994, 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 4 for details).

Table 24a. Summary of incidental mortality of gray whales (Eastern North Pacific stock) due to commercial and tribal fisheries from 1990 through 1998 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 1994 to 1998 (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
Northern Washington marine set gillnet (tribal)	90-98	obs data	47-98%	1, 0, 0, 0, 0, 1, 0, 0, 0	1, 0, 0, 0, 0, 1, 0, 0, 0	0.2 (CV=1.0)
CA/OR thresher shark/swordfish drift gillnet	93-98	obs data	12-23%	0, 0, 0, 0, 0, 1	0, 0, 0, 0, 0, 5	1.0 (CV=1.0)
Observer program total						1.2 (CV=0.85)
				Reported mortalities		
Bristol Bay salmon drift and set gillnet fisheries	90-98	logbook/self-reports	n/a	2, 0, 0, 0, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Unknown west coast fisheries	93-98	strand data	n/a	0, 5, 3, 3, 6, 4	n/a	[≥4.2]

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Minimum total annual mortality						$5.9

Reports of entangled gray whales found swimming, floating, or stranded with fishing gear attached also occurs along the west coast of the continental U.S. and British Columbia. Details of strandings that occurred between 1993 and 1995 in the U.S. and British Columbia are described in Hill and DeMaster (1999), while Table 24b presents data on strandings that occurred on the U. S. West Coast from 1996 to 1998. These stranding data are included in Table 24a (listed as unknown west coast fisheries) as they resulted from commercial fishing; however, the mortalities have not been attributed to particular fisheries. An additional 1995 mortality, caused by entanglement in gear from an unknown west coast fishery, was discovered in the Washington stranding database and has been added to Table 24a, resulting in a total of 3 mortalities for 1995 (1 in California and 2 in Washington state) Therefore, during the 5-year period from 1994 to 1998, stranding network data indicate a minimum annual mean of 4.2 gray whale mortalities resulting from interactions with commercial fishing gear.

Table 24b. Human-related gray whale strandings and entanglements, 1996-1998. An asterisk in the "number" column indicates cases that were not considered serious injuries.

Year	Number	Area	Condition	Description
1996	1	Del Norte County, CA	Dead	Floating offshore entangled in crab pot gear.
1996	1*	Orange County, CA	Released alive	Released from gillnet trailing from flukes.
1996	2	Santa Barbara County, CA	Dead	Cow/calf pair entangled in gillnets.
1996	1*	Humboldt County, CA	Released alive	Released from crab pot line.
1997	1	55°02'N, 131°00'W, Kah Shakes Cove, AK	Dead	Ship strike
1997	1	60°34'N, 148°10.3'W, AK	Dead	Commercial netting from unknown fishery wrapped around tail peduncle (apparently before death).
1997	1	20 mi. north of U.S. - Mexico border	Possible injury; status unknown	Towing pot gear.
1997	1	Offshore El Capitan State Park, CA	Injury; status unknown	Towing 50 ft. of gillnet gear and buoy.
1997	1	1 mi. offshore Goleta Pier, CA	Injury; status unknown	Gillnet wrapped around flukes.

1997	1	Offshore Patrick's Pt., CA	Possible injury; status unknown	Towing pot gear.
1997	1*	3 mi. offshore Anacapa Is., CA	Non-fatal injury; released alive	Released from gillnet wrapped around flukes.
1997	1	Vandenberg AFB, CA	Dead	Carcass wrapped in gillnet.
1998	1	Yakutat, AK	Dead	Pot gear/buoy/line embedded in tail stock.
1998	1	Nome, AK	Alive, entangled	Trailing net + 2 buoys.
1998	1	Kodiak, AK	Dead	Entangled in pot/line gear (tentatively dungeness pot lines).
1998	1	Offshore Pt. Fermin, CA	Injury; status unknown	Ship strike; six 1-ft. gashes on side.
1998	1	Between San Pedro & Catalina Is., CA	Injury; status unknown	Entangled in gillnet or pot gear.
1998	1	Offshore Pt. Loma, CA	Dead	Ship strike (USN-USS *Shiloh*)
1998	1	Offshore Pt. Loma, CA	Dead	Ship strike (USN-USS *Milius*)
1998	1*	Los Angeles Harbor, CA	Non-fatal injury	Released from pot gear.
1998	1*	Mission Bay, CA	Non-fatal injury	Released from lobster pot gear.

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 unreliable. 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 (rounded to 6; based on observer data (1.2) and logbook/self-reports (0.5) or stranding reports (4.2) where observer data were not available) is not known to exceed 10% of the PBR (49) 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 no whales from this stock during 1993 (IWC 1995a), 44 in 1994 (IWC 1996), 90 in 1995 (Russian Federation 1997, Blokhin in press) [the IWC reports a take of 85 for 1995 (IWC 1997)], 43 in 1996 (IWC 1998a), 79 in 1997 (IWC 1999), and 122 in 1998 (R. Brownell, pers. comm.). Based on this information, the annual subsistence take averaged 76 whales during the 5-year period from 1994 to 1998. This level of take is well below the 1968-93 average of 159 whales per year (IWC 1995b), during which time the population size increased.

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 United States 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. In 1998, Russian aboriginals harvested gray whales and none were harvested by the Makah Tribe.

Other Mortality

The near shore migration route used by gray whales makes ship strikes another potential source of mortality. Between 1993 and 1998, the California stranding network reported 5 gray whale mortalities caused by ship strikes: 1 per year from 1993 to 1995 and 2 in 1998 (J. Cordaro, pers. comm., National Marine Fisheries Service, 501 West Ocean Blvd. Long Beach, CA 90802-4213). And 1 ship strike mortality was reported in Alaska in 1997 (B. Fadely, pers. comm., National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-0070.). 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 gray whale per year due to collisions with vessels represents a minimum estimate from this source of mortality.

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 (83), which includes mortalities from commercial fisheries (6), Russian harvest (76), and ship strikes (1) does not exceed the PBR (649). 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. 1999b). This recommendation was subsequently adopted by NMFS.

CITATIONS

Blokhin, S. A. In press. Some aspects of modern whaling of gray whales by natives of Chukotka. J. Cetacean Res. Manage. (Special Issue 2). (SC/49/AS16).

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. Southwest Fisheries Science Center, NMFS, P.O. Box 271, La Jolla, CA 92038-0271.

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. (Special Issue 2). (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.

Cameron, G. 1998. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1997. Unpubl. doc. submitted to Int. Whal. Comm. (SC/50/SM2). 15pp.

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.

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.

Cordaro, J. NMFS Southwest Region, 501 West Ocean Blvd., Long Beach, CA, 90802.

Darling, J. D. 1984. Gray whales off Vancouver Island, British Columbia. Pp. 267-287, *In* M. L. Jones, S. L. Swartz, and S. Leatherwood, 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.

Fadely, B. NMFS Alaska Region, P.O. Box 21668, Juneau, AK 99802-1668.

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.

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 Sci. Comm. 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. (Special Issue 2). (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. 1996. Report of the Scientific Committee. Rep. Int. Whal. Comm. 46:51-97.

International Whaling Commission. 1997. International Whaling Commission Report 1995-96. Rep. Int. Whal. Comm. 47:1-2.

International Whaling Commission. 1998a. International Whaling Commission Report 1996-97. Rep. Int. Whal. Comm. 48:1-2.

International Whaling Commission. 1999. International Whaling Commission Report 1997-98. Annual Report of the International Whaling Commission 1998:1-2.

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, The Gray Whale, *Eschrichtius robustus.* Academic Press, Inc., Orlando. xxiv + 600 pp.

Poole, M. M. 1984. Migration corriders of gray whales along the central California coast, 1980-1982. Pp. 389-407, *In* M. L. Jones, S. L. Swartz, and S. Leatherwood, The Gray Whale, *Eschrichtius robustus*. Academic Press, Inc., Orlando. xxiv + 600 pp.

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. Whaling 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., K. E. W. Shelden, and A. Schulman-Janiger. 1999a. Timing of the southbound migration of gray whales in 1998/99. Unpubl. doc. submitted to Int. Whal. Comm. (SC/51/AS11). 11 pp.

Rugh, D. J., M. M. Muto, S. E. Moore, and D. P. DeMaster. 1999b. Status review of the Eastern North Pacific stock of gray whales. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-103, 96 pp.

Russian Federation. 1997. Feasibility study for the aboriginal gray whaling in 1998-2002. Unpubl. doc. submitted to Sci. Comm. of Int. Whal. Comm. (IWC/49/AS2). 26 pp.

Shelden, K. E. W., D. J. Rugh, and S. A. Boeve. In press. Gray whale calf sightings during southbound migrations, 1952-95. J. Cetacean Res. Manage. (Special Issue 2). (SC/47/AS 4).

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

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). 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 this century.

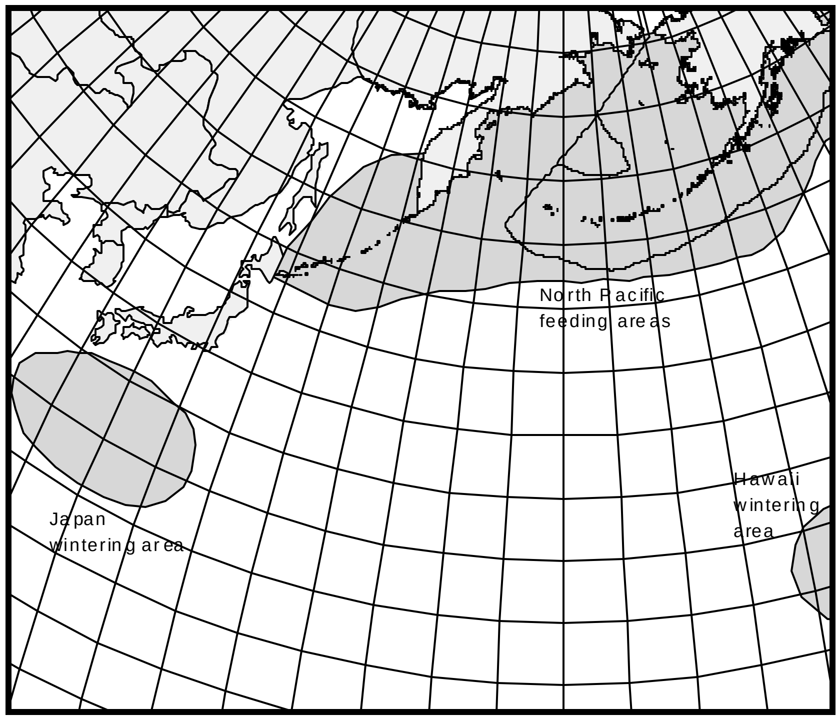

Figure 31. Approximate distribution of humpback whales in the western North Pacific (shaded area). Feeding and wintering areas are presented above (see text). See Figure 32 for humpback whale distribution in the eastern North Pacific.

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. 31 and 32): 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 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 management units 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 feeding areas for the Western North Pacific humpback whale stock are largely unknown. There has been little to no effort to photo-identify individual humpback whales in the North Pacific waters west of the Kodiak Archipelago. As a result, 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 (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, perhaps, 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.

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 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 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 1990-98: Bering Sea/Aleutian Islands groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. One humpback whale mortality wasobserved in the Bering Sea/Aleutian Islands groundfish trawl fishery in 1998. Average annual mortality from observed fisheries was 0.2 humpbacks from this stock (Table 25). Note, however, that the stock identification is uncertain and the mortality may have been attributable to the central 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 1998, 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 1989-1994, 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 4 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 for certain (i.e., it may have belonged to the Central North Pacific stock). Averaging this mortality over the 5-year period 1994-98 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 25. Summary of incidental mortality of humpback whales (Western 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. 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
Bering Sea/Aleutian Is. (BSA) groundfish trawl	90-98	obs data	53-74%	0, 0, 0, 0, 0, 0, 0, 0, 0	0, 0, 0, 0, 0, 0, 0, 0,1	0.2 (CV=1.0)
Observer program total						0
				Reported mortalities		
unknown fishery (Bering Sea)	94-98	strand data	n/a	0, 0, 0, 1, 0	$0.2	[$0.2]

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Minimum total annual mortality						[$0.4]

The estimated annual mortality rate incidental to commercial fisheries is 0.4 (0.2 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.

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

As the estimated annual mortality rate (0.4) is considered a minimum, it is unclear whether the level of human-caused mortality and serious injury exceeds the PBR (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.

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.

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.

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). 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 this century.

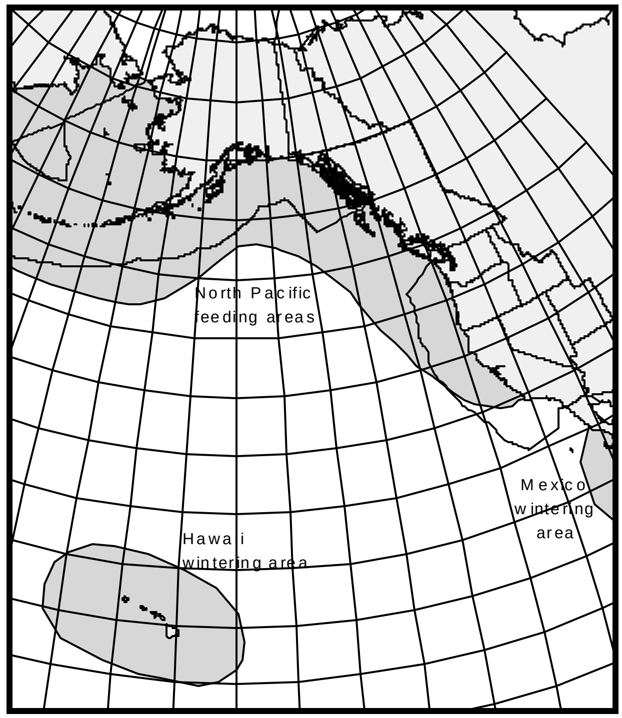

Figure 32. Approximate distribution of humpback whales in the eastern North Pacific (shaded area). Feeding and wintering areas are presented above (see text). See Figure 31 for distribution of humpback whales in the western North Pacific.

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. 31 and 32): 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 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 management units 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.

POPULATION SIZE

This stock of humpback whales winters in Hawaiian waters (Baker et al. 1986). Baker and Herman (1987) used capture-recapture methodology 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 Central North Pacific humpback whale stock (Calambokidis et al. 1997).

The Central North Pacific stock of humpback whales consists of feeding aggregations along the northern Pacific rim. Humpback whale distribution in summer is continuous from British Columbia to the Russian Far East, and humpbacks are present offshore in the Gulf of Alaska (Brueggeman et al. 1989, Forney and Brownell 1996). The three feeding areas for the Central North Pacific stock that have been studied using photographs to identify individual whales 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, and O. von Ziegesar, unpubl. data); 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 between Kodiak and southeastern Alaska (Waite et al. 1999). The humpback whales of the Central North Pacific stock show some degree of fidelity to feeding areas, with this fidelity 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). However, the degree of this fidelity to a specific area is unknown for many whales and given the continuous distribution in the North Pacific, and the known interchange among areas, setting distinct boundaries between feeding areas may not be possible.

Using photographs of the unique markings on the underside of each whales' flukes, there were 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). In southeastern Alaska, 648 individual humpback whales were identified from 1985 to 1992, resulting in an annual abundance estimate of 404 whales (95% CI:350-458) (Straley 1994). In the Kodiak Island region, 127 individual humpback whales were identified from 1991 to 1994 (Waite et al. 1999), resulting in an annual abundance estimate of 651 whales (95% CI:356-1,523). 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). These estimates represent minimum estimates for these feeding areas because the study areas did not include the entire geographic region (i.e., the Southeast Alaska study area did not include waters to the south of Chatham Strait). In addition, little is known regarding humpback whale abundance between feeding areas, south of Chatham Strait, and west of Kodiak Island. As a result, the sum of the estimates from these feeding aggregations (approximately 1,530) is considerably less than 4,005 animals.

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 4,005 and its associated CV(N) of 0.095, N_{MIN} for this humpback whale stock is 3,698.

Current Population Trend

Comparison of the estimate 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 methodology. As a result, although data support an increasing population size for this stock, it is not possible to assess the rate of increase.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Utilizing a birth-interval model, Barlow and Clapham (1997) have estimated a population growth rate of 6.5% (SE=1.2%) for the well-studied humpback whale population in the Gulf of Maine. 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 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 0.1, the value for cetacean stocks listed as endangered under the Endangered Species Act (Wade and Angliss 1997). Thus, for the Central North Pacific stock of humpback whale, PBR = 7.4 animals (3,698 × 0.02 × 0.1).

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 1990-98: 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. Average annual mortality from the observed fisheries in Alaska was 0.2 humpbacks from this stock (Table 26a). 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 26a. 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., Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole St., Honolulu, HI, 96822). 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 1994-98 is 0.2 humpback whales per year from this 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 1989-1994, 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 4 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 26. 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 of 0.4 (0.2 + 0.2) humpback whales based on self-reported fisheries information (Table 26a). 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 26a. Summary of incidental mortality of humpback whales (Central 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. 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	90-98	obs data	<1-5%	0, 1, 0, 0, 0, 0, 0, 0, 0	0, 1, 0, 0, 0, 0, 0, 0, 0	0
Bering Sea/Aleutian Is. (BSA) groundfish trawl	90-98	obs data	53-74%	0, 0, 0, 0, 0, 0, 0, 0, 0	0, 0, 0, 0, 0, 0, 0, 0,1	0.2 (CV=1.0)
Observer program total						0.2
				Reported mortalities		
Southeast Alaska salmon drift gillnet	90-98	self reports	n/a	0, 0, 0, 0, n/a, n/a, 1, n/a, n/a	n/a	[$0.2]
Southeast Alaska salmon purse seine	90-98	self reports	n/a	0, 0, 0, 0, 1, n/a, n/a, n/a, n/a	n/a	[$0.2]
Southeast Alaska salmon drift gillnet	90-98	stranding records	n/a	0, 0, 1, 0, 1, 0, 0, 0, 0	n/a	[$0.2]
Minimum total annual mortality						[$0.8]

Reports of entangled humpback whales found swimming, floating, or stranded with fishing gear attached occur in both Alaskan and Hawaiian waters. Two such reports from Alaska are included in Table 26a because they could be attributed to a particular fishery, namely the Southeast Alaska salmon drift gillnet fishery. An entanglement of a humpback whale occurred in this fishery in 1992 but was reported as a stranding. In 1994, a humpback whale was reported in a weakened condition entangled in a fishing net with floats attached and is presumed to have died. Given the location of this animal (Chatham Strait), the mortality was attributed to the Southeast Alaska salmon drift gillnet fishery. Details of other strandings that occurred between 1992 and 1998 in these areas are presented in Table 26b. Fishery-related strandings from Hawaii and Alaska during 1994-98 as listed in Table 26b result in an estimated annual mortality of 2.0 humpback whales from this stock. 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 26b. Human-related strandings and entanglements of humpback whales (central North Pacific stock), 1992-1998. An asterisk in the "number" column indicates cases that were not considered serious injuries.

Year	Number	Area	Condition	Description
1992	1*	Island of Hawaii	Released alive	Disentangled from commercial longline set gear
1995	1*	"Hawaiian waters"	Released alive	Disentangled from non-fishing lines; subsequently killed by sharks
1996	1*	"Hawaiian waters"	Released alive	Disentangled from non-fishing gear
1996	1	Oahu, HI	Injured; status unknown	Ship strike
1996	1	Oahu	Injured; status unknown	Partial disentanglement from Hawaiian crab fishery gear; some gear around pectoral fin and mouth still attached
1996	1	Sand Point, AK	Injured; status unknown	Released from fishing gear, but appeared injured; thought to have died
1996	1*	Alitak Beach, Kodiak Island, AK	Released alive	Released from commercial purse seine net
1997	1*	Island of Hawaii	Released alive	Alaska crab pot floats removed by U.S. Coast Guard
1997	1*	57 30 N 135 13 W NW Shelter Island	Alive	Collision with skiff
1997	1	Peril Straits, AK	Injured	Entangled in line; attempt to disentangle failed
1997	1	58 18 N 134 24 W NW Shelter Island	Injured	Tail wrapped in crab pot line
1997	1	58 21N 134 57 W NW Admiralty Island	Alive; entangled	Line and 2' diameter buoy attached
1998	1	Maalaea Bay, Lanai	Alive; entangled	Disentangled from gear, but some line still attached
1998	1	Sitka, AK	Alive; entangled	Commercial gillnet around flippers
1998	1*	Jakolof Bay	Alive	Disentangled from personal use pot gear
1998	1	Ketchikan, AK	Injury; status unknown	Salmon purse seiner net (commercial) torn through, thought to have died
1998	1	Juneau, AK	Injured	Ship strike (8/11)
1998	1	Juneau, AK	Entangled	No details available

1998	1*	Wrangell, AK	Alive	Commercial crab pot buoy removed
1998	1*	Homer, AK	Alive	Tanner crab pot cut loose
1998	1	Juneau, AK	Injured	Ship strike (9/24)
1998	1*	Sitka, AK	Alive	Commercial crab pot line cut free
1998	1	Ketchikan	Entangled	Swimming freely with pot gear attached

The estimated minimum mortality rate incidental to commercial fisheries is 2.8 humpback whales per year, based on observer data (0.2), and self-reported fisheries information (0.4) , stranding records traceable to a specific fishery (0.2) and other stranding records indicating mortality or serious injury (Table 26b) (2.0). As mentioned previously, this estimate 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 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 26b. Of those, three ship strikes (one in 1996 and 2 in 1998) constitute “other sources” of mortality. Averaged over the 5 year period from 1994-1998, these account for an additional 0.6 humpback 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 rate (3.4; 2.8 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 (7.4). The minimum estimated fishery mortality and serious injury for this stock is not less that 10% of the calculated PBR (0.7) 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. The stock appears to have increased in abundance between the early 1980s and early 1990s; however, the status of this 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. Similar, although more general, marine mammal viewing guidelines have also been developed for Alaska waters. The growth of the industry, however, is a concern as preferred habitats may be abandoned if disturbance levels are too high.

Noise pollution 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). 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., 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., 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).

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.

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.

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.

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.

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.

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.

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. MS Thesis, Univ. of Alaska, Fairbanks, AK. 121 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.

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

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the North Pacific Ocean, fin whales can be found from above the Arctic Circle to lower latitudes of approximately 20°N (Leatherwood et al. 1982). There are few data concerning the location of the winter grounds of fin whales because migrations from summer feeding areas back to their winter grounds tend to occur in the open ocean rather than near the coast (Mizroch et al. 1984). Within U. S. waters in the Pacific, fin whales are distributed seasonally off the coast of North America (Fig. 33) and occasionally near and around the waters of Hawaii.

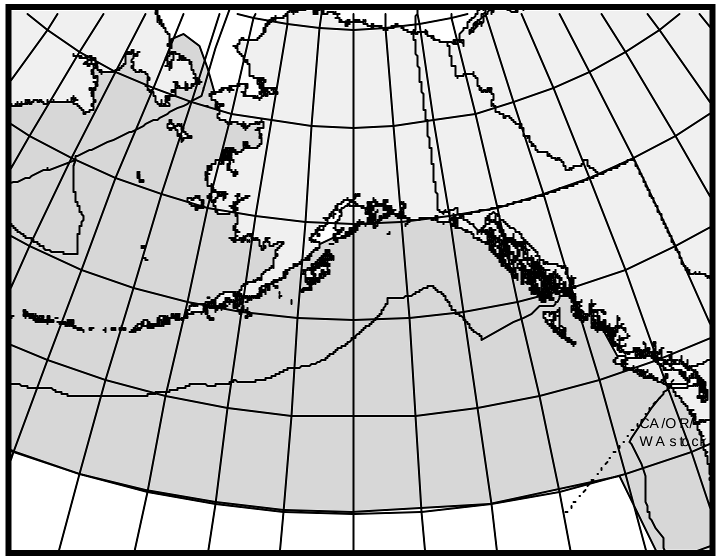

Figure 33. Approximate distribution of fin whales in the eastern North Pacific (shaded area).

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

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.

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 are no published reports indicating recovery of this stock has or is taking place (Braham 1992).

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 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 0.1, the 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

There have been no reports of incidental mortalities of fin whales related to commercial fishery operations in the North Pacific during this decade, from either observed fisheries or the self-reported fisheries information required of vessel operators by the MMPA. Therefore, based on the lack of reported mortalities, the estimated annual mortality rate incidental to commercial fisheries is zero. As a result, 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 have not been reported to take fin whales from this stock.

Other Mortality

In the North Pacific and Bering Sea, catches of fin whales ranged from 1,000 to 1,500 animals annually from the mid-1950s to the mid-1960s. Thereafter, catches declined sharply and ended altogether in 1976 when catches became prohibited (Mizroch et al. 1984). These mortality estimates likely underestimate the actual kill as a result of under-reporting of the Soviet catches (Yablokov 1994).

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. However, 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

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.

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.

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 physalis*. Mar. Fish. Rev. 46(4):20-24.

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

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.

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

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 3 stocks of minke whales in the North Pacific: one in the Sea of Japan/East China Sea, one in the rest of the western Pacific west of 180°N, and one in the "remainder" of the Pacific (Donovan 1991). The "remainder" stock designation reflects the lack of exploitation in the eastern Pacific and does not indicate that only one population exists in this area (Donovan 1991). In the "remainder" area, minke whales are relatively common in the Bering and Chukchi Seas and in the inshore waters of the Gulf of Alaska (Mizroch 1992), but are not considered abundant in any other part of the eastern Pacific (Leatherwood et al. 1982, Brueggeman et al. 1990). Minke whales are known to penetrate loose ice during the summer, and some individuals venture north of the Bering Strait (Leatherwood et al. 1982). 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. 34). The California/ Oregon/Washington minke whale stock is reported separately in the Stock Assessment Reports for the Pacific Region.

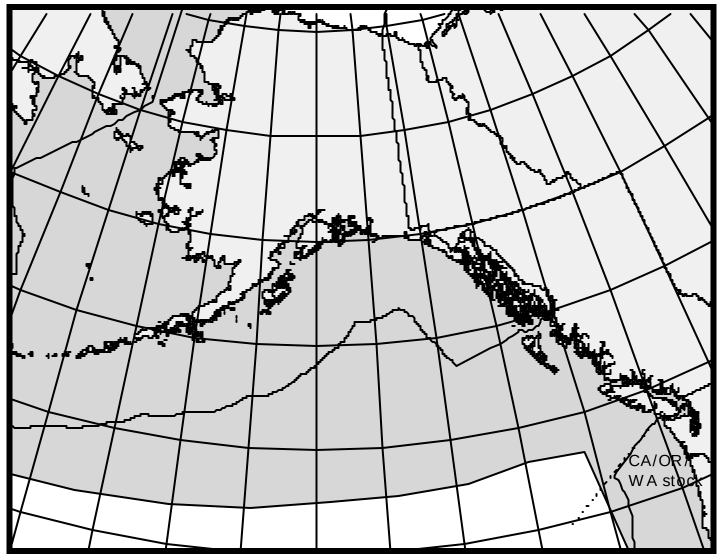

Figure 34. Approximate distribution of minke whales in the eastern North Pacific (shaded area).

POPULATION SIZE

No estimates have been made for the number of minke whales in the entire North Pacific nor are estimates available for the number of minke whales that occur within the waters of Alaska.

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

The potential biological removal (PBR) for this stock is calculated as the product of minimum population size, 0.5 maximum net productivity, and a recovery factor. 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 1990-95: 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.

In the past, minke whales have been caught in both coastal set gillnets and offshore drift gillnets (Small and DeMaster 1995). However, based on logbook reports maintained by vessel operators required by the MMPA interim exemption program during the 4-year period between 1990 and 1993, no injuries or mortalities of minke whales from interactions with commercial gear were reported for any Alaska fishery. Complete logbook data after 1993 are not available.

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

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, The Red House, Station Road, Histon, Cambridge, UK). The most recent harvest (2 whales) in Alaska occurred in 1989 (RIWC 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.

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.

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.

NORTHERN RIGHT WHALE (*Eubalaena glacialis*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Whaling records indicate that right whales in the North Pacific range across the entire North Pacific north of 35/N and occasionally occur as far south as 20/N (Fig. 35). 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 et al. 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).

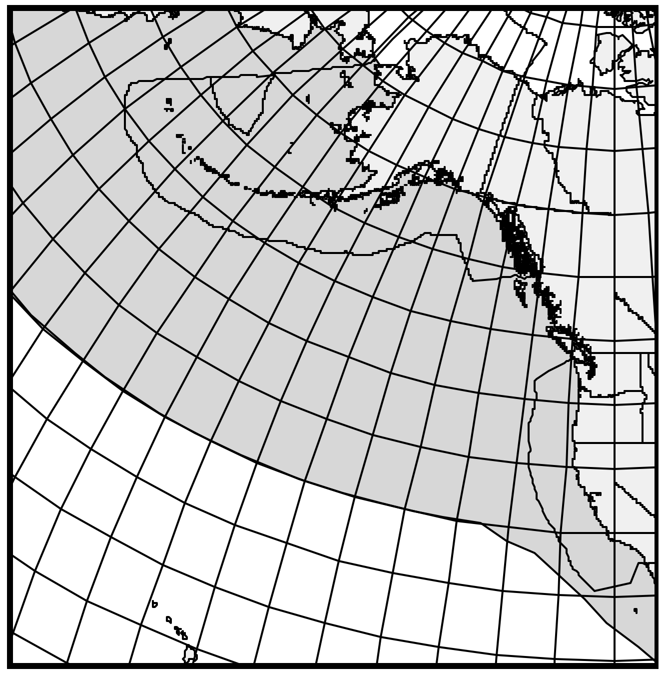

Figure 35. Approximate historical distribution of right whales in the eastern North Pacific (shaded area).

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).

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, two stocks of northern right whales are currently recognized: a North Atlantic stock and a North Pacific Stock (Scarff 1986, Schevill 1986).

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 was extinct because no sightings of a cow with calf have been confirmed since 1900 (D. Rice, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115). A reliable estimate of abundance for the North Pacific right whale stock is currently not available.

Several notable sightings of right whales in the North Pacific have recently occurred. On April 2, 1996 a right whale was sighted off of Maui (D. Salden, pers. comm., Hawaii Whale Research Foundation, P. O. Box 1296, Lahaina, HI 96767). 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 appears to 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 (C. Tynan, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115). During July 1998 and July 1999, six and five right whales, respectively, were again found in the same general region of the southeastern Bering Sea (Perryman et al. 1999 and W. Perryman. pers. comm., Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038)

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

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 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 0.1, the 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 a vast majority 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 are a significant source 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 ship strikes. However, due to the rare occurrence and scattered distribution it is impossible to assess the threat of ship strikes to the North Pacific stock of right whales at this time.

STATUS OF STOCK

The right whale is listed as "endangered" under the Endangered Species Act of 1973, and therefore designated as "depleted" under the MMPA. 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. There are no known habitat issues that are of particular concern for this stock.

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

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.

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. Lamham, and M. Carwandire. 1999. North Pacific right whale (*Eubalaena glacialis*) sighting south of Baja California. Aquat. 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.

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.

Perryman, W. L., R. LeDuc, and R.L. Brownell, Jr. 1999. Progress report on eastern N. Pacific right whale research during July 1998. Unpublished report to the IWC. 10pp.

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.

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.

Schevill, W. E. 1986. Right whale nomenclature. Pp. 19, *In* R. L. Brownell Jr., P. B. Best, and J. H. Prescott (eds.), Right whales: Past and present status. Rept. Int. Whal. Comm. (Special Issue 10).

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.
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 Spitsbergen. These small bowhead stocks are comprised of only a few tens to a few hundreds of individuals (Braham 1984, Shelden and Rugh 1996). The largest remnant population, and only stock that is found within U. S. waters, is the Western Arctic stock (Fig. 36). 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 DeMaster 1997). 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 (Richardson et al. 1985).

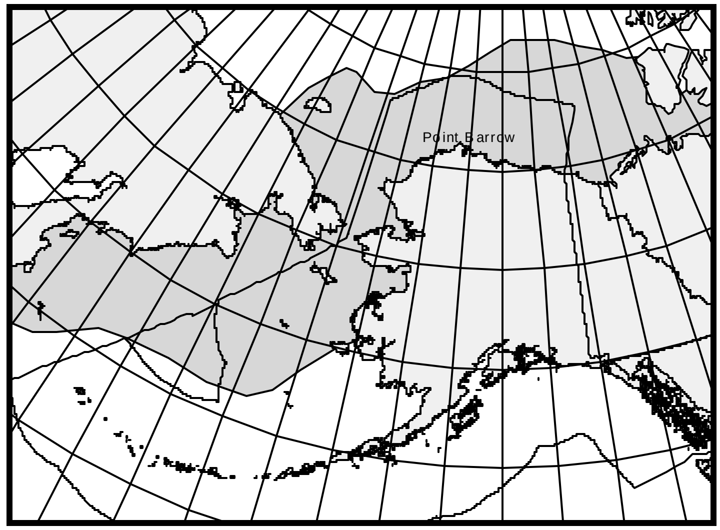

Figure 36. Approximate distribution of the Western Arctic stock of bowhead whales. The shaded area includes regions used during both the winter and summer by whales from this stock.

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, Alaska, 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). However, in some years a small proportion of the population may not migrate past Point Barrow in spring, resulting in estimates which could be negatively biased. In 1993, unusually good counting conditions resulted in a population estimate for this stock of 8,000 (CV = 0.073) animals, 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 has resulted in an estimate of 8,200 animals (95% CI = 7,200-9,400), and is considered a better abundance estimate for the Western Arctic stock (IWC 1996). The CV for this abundance estimate is 0.069 (Zeh et al. 1995).

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 population estimate (N) of 8,200 and its associated CV(N) of 0.069, N_{MIN} for the Western Arctic stock of bowhead whales is 7,738.

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, when abundance increased from approximately 5,000 to 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 population increase 3.2% (95% CI = 1.4-5.1%) during the 1978-93 period (IWC 1996).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The current estimate for the rate of increase for this stock of bowhead whales (3.2%) 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}. Thus, until additional data become available, 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 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 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 = 77 animals (7,738 × 0.02 × 0.5) for the Western Arctic stock of bowhead whale. The development of a PBR for the Western Arctic bowhead stock is required by the MMPA even though the Alaska Eskimo subsistence harvest of bowhead whales 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. The IWC quotas authorized Alaska Natives to strike up to 67 bowhead whales in 1996, and 66 in 1997, and 65 in 1998 (IWC 1995). For 1999 to 2002, a block quota of 280 bowhead strikes was allowed, of which 67 (plus up to 15 unharvested in the previous year) could be taken each year.

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 27 (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. Dept of Wildlife Mgt., North Slope Borough, Box 69, Barrow, AK 99723). There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska. In addition, the self-reported fisheries information required of vessel operators by the MMPA during the period between 1990-96 reported no injuries or mortalities of bowhead whales for any Alaska 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 4 for details).

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.

Table 27. Reported scarring of bowhead whales attributed to entanglement in ropes and description of observations collected during subsistence harvests in Alaska since 1978.

Year	Number of Whales	Location	Description
1978	1	Wainwright, AK	6 scars on caudal peduncle
1986	1	Kaktovik, AK	Scars on caudal peduncle and anterior margin of flukes
1989	1	Barrow, AK	12 scars on ridges of caudal peduncle
1989	1	south of Gambell, AK	Rope wrapped around head, through mouth and baleen
1990	1	Barrow, AK	Scars on caudal peduncle; 2 ropes trailing from mouth.

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 9 Alaska communities (Philo et al. 1993). Since 1977, the number of kills has ranged between 14-72 per year, depending in part on changes in management strategy and in part to higher estimates of bowhead whale abundance 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 51 whales in 1993 (Suydam et al. 1995), 46 in 1994 (IWC 1996), and 57 in 1995 (IWC 1997), and 44 in 1996 (Alaska Eskimo Whaling Commission, unpubl. data, AEWC, P. O. Box 570, Point Barrow, AK 99723). 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 3-year period from 1994 to 1996 is approximately 49 bowhead whales.

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 the same 1848-1919 period, 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 shore-based animals 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).

STATUS OF STOCK

Based on currently available data, the estimated annual mortality rate incidental to commercial fisheries (0) not known to exceed 10% of the PBR (8) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The level of human-caused mortality and serious injury (49) is not known to exceed the PBR (77) nor the IWC quota for 1996 (67). The Western Arctic bowhead whale stock has been increasing in recent years. However, the stock is classified as a strategic stock because bowhead whale is listed as “endangered” under the Endangered Species Act (ESA), and therefore designated as “depleted” under the MMPA. The development of criteria for classifying this stock under the ESA is currently underway and will be used in the next 5-year evaluation of stock status (Shelden and Rugh 1996).

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 non-toxic 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).

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. There are insufficient data to make reliable predictions of the effects of Arctic climate change on bowhead whales.

CITATIONS

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.

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.

International Whaling Commission. 1992. Chairman's Report of the forty-third annual meeting. Rep. Int. Whal. Comm. 42:11-50.

International Whaling Commission. 1995. Chairman's Report of the forty-sixth annual meeting. Rep. Int. Whal. Comm. 45:App. 21(p.52).

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.

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.

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. 1997. Cetacean habitats in the Alaskan Arctic. J. Northwest Atl. Fish. Sci. 22:55-69.

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., 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.

Shelden, K. E. W., and D. J. Rugh. 1996. 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. Spec. Publ. No. 2, Soc. Mar. Mammalogy.

Suydam, R., R. Angliss, J. C. George, S. Braund, and D. P. DeMaster. 1995. Revised data on the subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaska Eskimos, 1973-1993. Rep. Int. Whal. Comm. 45:335-338.

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 Table 1.--Summary of changes to the 2000 stock assessments. An 'X' indicates sections where the information presented has been updated since the 1999 SAR was released.

Stock	Stock definition	Population size	PBR	Fishery mortality	Subsistence mortality	Status
Steller sea lion (western US)				X		
Steller sea lion (eastern US)				X		
Northern fur seal				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	X	X
Killer whale (resident)*						
Pacific white-sided dolphin		X	X	X		
Harbor porpoise (SE Alaska)		X	X	X		
Harbor porpoise (GOA)		X	X	X		
Harbor porpoise (Bering Sea)				X		
Dall's porpoise				X		
Sperm whale						
Baird's beaked whale						
Cuvier's beaked whale						
Stejneger's beaked whale						
Gray whale		X	X	X	X	
Humpback whale (western)				X		
Humpback whale (central)				X		
Fin whale						
Minke whale						
Northern Right whale		X				
Bowhead whale				X		

Note: The transient killer whale stock assessment was revised in 1999 and moved to the document containing the U. S. Pacific Marine Mammal Stock Assessment reports.

Appendix Table 2.--Stock summary table.

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	2	n/a	NS
Beluga whale	Beaufort Sea	39,258	0.229	2.00	n/a	0.229	32,453	0.02	1.00	649	0	184	NS
Beluga whale	E. Chukchi Sea	3,710	n/a	3.09	n/a	n/a	3,710	0.02	1.00	74	0	68	NS
Beluga whale	E. Bering Sea	7,986	0.26	3.09	n/a	0.26	6,439	0.02	1.00	129	1*	121	NS
Beluga whale	Bristol Bay	1,555	n/a	3.09	n/a	0.20	1,316	0.02	1.00	26	1*	19	NS
Beluga whale	Cook Inlet	357	0.20			0.20	303	0.02	0.30	1.8	0	65	S
Bowhead whale	W. Arctic	8,200	0.069			0.069	7,738	0.02	0.50	77	0	49	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	42	0	NS
Fin whale	NE Pacific	n/a					n/a	0.02	0.10	n/a	0	0	S
Gray whale	E. N. Pacific	26,635	0.1006			0.1006	24,477	0.0235	1.00	575	64	76	NS
Harbor porpoise	SE Alaska	10,508	0.207	2.96	0.180	0.274	8,376	0.02	0.50	83	3*	0	NS
Harbor porpoise	Gulf of Alaska	21,451	0.252	2.96	0.180	0.304	16,630	0.02	0.50	166	25	0	NS
Harbor porpoise	Bering Sea	10,946	0.243	3.10	0.171	0.300	8,549	0.02	0.50	86	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 Table 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	0.4	0	S
Humpback whale	Cent.N. Pacific	4,005	0.095			0.095	3,698	0.02	0.10	7.4	2.8	0	S
Killer whale	E. N. Pacific N. resident	717	n/a			see txt	717	0.02	0.50	7.2	0.8	0	NS
Minke whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	0	NS
Northern right whale	N. Pacific	n/a					n/a	0.02	0.10	n/a	0	0	S
Northern fur seal	E. No Pacific	1,002,516	0.065	4.475	n/a	0.2	848,539	0.043	0.50	18,244	16	1,708	S
Pacific white-sided dolphin	Cent.N. Pacific	26,880					26,880	0.02	0.50	269	4	0	NS
Ribbon seal	Alaska	n/a					n/a	0.06	0.50	n/a	1	n/a	NS
Ringed seal	Alaska	n/a					n/a	0.06	0.50	n/a	1	n/a	NS
Sperm whale	N. Pacific	n/a					n/a	0.02	0.10	n/a	0	0	S
Spotted seal	Alaska	n/a					n/a	0.06	0.50	n/a	2*	see txt	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.	30,403					30,403	0.06	0.75	1,368	16	0	S
Steller sea lion	W.U. S.	39,031					39,031	0.06	0.10	234	30	412	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 reported take by fishery observers; however, observer coverage was minimal or nonexistent.
see txt = see text for details.

Appendix Table 3a.--Summary table for Alaska **category 2** commercial fisheries.

Fishery (area and gear type)	Target species	Permits (1997)	Soak time	Landings per day	Sets per day	Season duration	Fishery trends (1990-1997)
Southeast AK drift gillnet	salmon	482 issued 423 fished	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 issued 351 fished	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 issued 141 fished	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	540 issued 520 fished	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	581 issued 572 fished	15 min - 3 hrs or continuous; day only	1	6 - 18	June 25 to end of Aug	# vessels stable; catch - variable
Cook Inlet (CI) set gillnet	salmon	745 issued 603 fished	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 issued 174 fished	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 issued 157 fished	2 -5 hrs; day / night	1	3 - 8	mid - June to mid - Sept	# vessels stable; catch up
AK Peninsula/Aleutians set gillnet	salmon	121 issued 111 fished	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	1,899 issued 1,875 fished	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	1,019 issued 921 fished	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	1 issued # fished n/a					new fishery

Appendix Table 3b.--Interaction table for Alaska **category 2** commercial 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
Yakutat set gillnet	never observed	harbor seal, gray whale (strand)	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	observer and logbook
Cook Inlet set gillnet	1999	harbor seal, harbor porpoise, Dall's porpoise	observer and logbook
Kodiak set gillnet	never observed	harbor seal, harbor porpoise, sea otter	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
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 Table 3c.--Interaction table for Alaska **category 3** commercial fisheries.

Fishery name	# of permits issued/fished 1997	Observer program	Species recorded as taken incidentally in this fishery (records dating back to 1990)	Data type
Prince William Sound salmon set gillnet	30 issued 27 fished	1990	Steller sea lion, harbor seal	logbook
Kuskokwim, Yukon, Norton Sound, Kotzebue salmon gillnet	2,014 issued 1,533 fished	never observed	harbor porpoise	none
AK roe herring and food/bait herring gillnet	2,595 issued 1,519 fished	never observed	none documented	none
AK miscellaneous finfish set gillnet	3 issued # fished n/a	never observed	Steller sea lion	logbook
AK salmon purse seine (except for Southeast AK)	960 issued 578 fished	never observed	harbor seal	logbook
AK salmon beach seine	34 issued 5 fished	never observed	none documented	none
AK roe herring and food/bait herring purse seine	832 issued 540 fished	never observed	none documented	none
AK roe herring and food/bait herring beach seine	10 issued 6 fished	never observed	none documented	none
Metlakatla purse seine and drift gillnet (tribal)	10 fished (purse) 60 fished (drift)	never observed	none documented	none
AK octopus/squid purse seine	2 issued # fished n/a	never observed	none documented	none
AK miscellaneous finfish purse seine	10 issued # fished n/a	never observed	none documented	none
AK miscellaneous finfish beach seine	1 issued # fished n/a	never observed	none documented	none
AK salmon troll (includes hand and power troll)	2,427 issued 1,127 fished	never observed	Steller sea lion	logbook
AK north Pacific halibut/bottom fish troll	367 issued 168 fished	never observed	none documented	none
AK state waters groundfish longline /set line (incl. sablefish/ rockfish/misc.finfish)	2,637 issued 1,392 fished	never observed	none documented	none
Gulf of AK groundfish longline/set line (incl. misc. finfish/sablefish)	# issued n/a 975 fished	1989- present	Steller sea lion, harbor seal, northern elephant seal, Dall's porpoise	observer
BSAI groundfish longline/set line (incl. misc. finfish/sablefish)	# issued n/a 137 fished	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)	# issued n/a 2,180 fished	never observed	Steller sea lion	self reports

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.

Appendix Table 3c.--(cont.).

Fishery name	**# of permits issued/fished 1997**	**Observer program**	**Species recorded as taken incidentally in this fishery (records dating back to 1990)**	**Data type**
AK octopus/squid longline	2 issued 1 fished	never observed	none documented	none
AK shrimp otter and beam trawl (statewide and Cook Inlet)	91 issued 42 fished	never observed	none documented	none
Gulf of Alaska groundfish trawl	# issued n/a 203 fished	1989 to present	Steller sea lion, harbor seal, northern elephant seal, Dall's porpoise	observer
Bering Sea and Aleutian Island groundfish trawl	# issued n/a 167 fished	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	observer
State waters of Kachemak Bay Cook Inlet, Prince William Sound, Southeast AK groundfish trawl	26 issued 3 fished	never observed	none documented	none
AK miscellaneous finfish otter or beam trawl	382 issued 309 fished	never observed	none documented	none
AK food/bait herring trawl (Kodiak area only)	4 issued 4 fished	never observed	none documented	none
AK crustacean pot	1,963 issued 1,406 fished	1988 to present	harbor porpoise	stranding
AK Bering Sea and Gulf of Alaska finfish pot	# issued n/a 202 fished	1990 to present	harbor seal, sea otter	observer
AK octopus/squid pot	70 issued 16 fished	never observed	none documented	none
AK snail pot	18 issued 5 fished	never observed	none documented	none
AK North Pacific halibut handline and mechanical jig	66 issued 37 fished	never observed	none documented	none
AK other finfish handline and mechanical jig	934 issued 283 fished	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	128 issued 90 fished	never observed	none documented	none
Southeast AK herring food/bait pound net	337 issued 269 fished	never observed	none documented	none
Coastwise scallop dredge	30 issued 22 fished	never observed	none documented	none

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.

Appendix Table 3c.--(cont.).

Fishery name	**# of permits issued/fished 1997**	**Observer program**	**Species recorded as taken incidentally in this fishery (records dating back to 1990)**	**Data type**
AK abalone (hand pick/dive)	13 issued 0 fished	never observed	none documented	none
AK clam (hand pick/dive)	62 issued 53 fished	never observed	none documented	none
AK dungeness crab (hand pick/dive)	3 issued 0 fished	never observed	none documented	none
AK herring spawn-on-kelp (hand pick/dive)	492 issued 44 fished	never observed	none documented	none
AK urchin and other fish/shellfish (hand pick/dive)	788 issued 432 fished	never observed	none documented	none
AK commercial passenger fishing vessel	3,173 issued # fished n/a	never observed	none documented	none

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.

Appendix Table 3d.--Observer coverage in Alaska commercial fisheries 1990-98.

Fishery name	1990	1991	1992	1993	1994	1995	1996	1997	1998
Gulf of Alaska (GOA) groundfish trawl	55%	38%	41%	37%	33%	44%	37%	33%	36%
GOA longline	21%	15%	13%	13%	8%	18%	16%	15%	16%
GOA finfish pots	13%	9%	9%	7%	7%	7%	5%	4%	7%
Bering Sea/Aleutian Islands (BSAI) groundfish trawl	74%	53%	63%	66%	64%	67%	66%	64%	67%
BSAI longline	80%	54%	35%	30%	27%	28%	29%	33%	36%
BSAI finfish pots	43%	36%	34%	41%	27%	20%	17%	18%	15%
Prince William Sound salmon drift gillnet	4%	5%	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.
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.

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 coverages in the drift gillnet fisheries were calculated as the percentage of the estimated sets that were observed. Observer coverages in the set gillnet fis`hery was calculated as the percentage of estimated setnet hours (determined by number of permit holders and the available fishing time) that were observed.

Appendix 4.--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, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

Appendix 5: Stock Assessment Reports published by the U.S. Fish and Wildlife Service

Polar bear: Alaska Chukchi/Bering Seas

Polar bear: Alaska southern Beaufort Sea

Pacific walrus: Alaska

Sea otter: Alaska

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

U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska

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). 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 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).

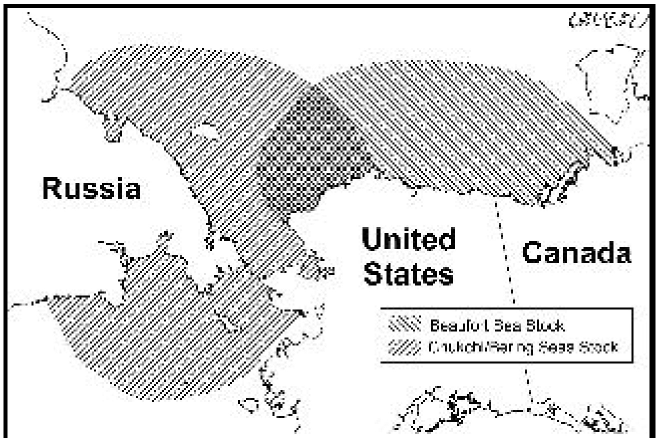

Figure 1. Polar bear distribution.

Recent studies (Garner *et al.* 1990; Amstrup 1995) have shown that the eastern bound of the Chukchi/Bering seas stock is not further than 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 and the Chukchi Sea is designated on the basis of movements of adult female polar bears captured in the Bering and Chukchi seas region with specific emphasis on those female polar bears initially captured on Wrangel Island (no movement into the Eastern Siberian Sea) and those captured in the Eastern Siberian Sea (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. Current analysis of mitochondrial DNA indicate little differentiation of the Alaska polar bear stocks (Cronin *et al.* 1991, Scribner *et al.* 1997). However, the use of microsatellites to differentiate polar bear populations in the Canadian Arctic (Paetkau *et al.* 1995) may prove to be a useful technique resolving future questions concerning stock separation and management units in Alaska.

Past management regimes have consistently distinguished between these stocks based upon the previous information. A management agreement with hunters of Alaska and the Northwest Territories, specific to the Beaufort Sea stock, has been in place since October, 1988. Similarly, a future management agreement between the U.S. and Russia governments and Native users of Alaska and Chukotka, specific to the Chukchi/Bering seas stock is currently being developed. The bounds of these stocks may be refined in the future based upon the availability of new information.

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 (ALJ 1977) estimated that the Chukchi/Bering seas population stock (Wrangel Island to western Alaska) to be 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 thus 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 Chuckchi 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 for which 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 (1997) estimated this population to be approximately 2,000 to 5,000. Other information with potential to estimate the size of this stock, such as extrapolation of denning data, have not been included due to large variation and uncertainty in the data. Since a reliable estimate for the size of this stock is unavailable, a minimum population estimate (N_{min}) has not been 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; (d) reports from Russian scientists (Uspenski and Belikov 1991); and (e) changes in the age composition of the harvest (Schliebe *et al*. 1995).

CURRENT AND 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). Population/stock specific scientific data to estimate R_{MAX} are not available for the Chukchi/Bering seas stock of polar bears. R_{MAX} for this stock may be similar to the 6.03 percent reported for the Southern Beaufort Sea polar bear stock. Taylor et. al. (1987) estimated the sustainable yield for adult female polar bears from a hunted population to be < 1.6% per annum based upon modeling.

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 $= (N_{min})(½\ R_{MAX})(F_R)$. 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.

Alaskan 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 harvest for 1925-53 averaged 120 bears and was 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 by non-Naitves has been prohibited since 1972. This reduced the mean annual harvest for both populations to 111 during 1980-96 (SD=56; range 41-297) (Schliebe *et al.* 1995) (Fig. 2). Harvests from the Chukchi/Bering seas stock accounted for 68% (mean=75) of the annual Alaska kill during this period.

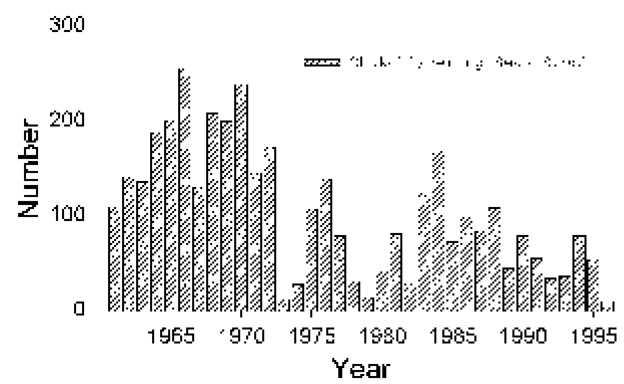

Figure 2. Annual harvest of polar bears from the Chukchi/Bering seas stock in Alaska (1960-1996).

Recently, harvest levels for this stock have been declining. The 1991-1996 mean U.S. harvest was 45.2 bears and the sex ratio was 63M:37F. Seven subsistence kills, taken for defense of life or property from 1991-1996, were recorded as subsistence takes. The number of unreported kills since 1980 to the present time is thought to be negligible. In western Alaska, there is presently no government control on the number of bears taken providing the population is not depleted and the taking is not wasteful. A formal self-imposed hunter management agreement, with harvest guidelines, similar to that of the North Slope Borough and Canadian Inuvialuit Game Council management agreement has not been developed. However development of a management agreement for this stock between Native representatives of both countries and between the United States and Russian governments is ongoing. In 1997, a Cooperative Agreement was developed between the U.S. Fish and Wildlife Service and the Alaska Nanuuq Commission to implement Section 119 of the MMPA Amendments of 1994. This Agreement facilitates local participation in activites related to the conservation and management of polar bears.

Other Removals

Russia prohibited all hunting of polar bears in 1956 in response to perceived population declines caused by over-harvest. In Russia, only a small number of animals, less than 3-5 per year, were removed for placement in zoos prior to 1986 (Uspenski 1986) and a few were taken in defense of life. No bears were taken for zoos or circuses from 1993 to 1995 (Belikov 1997). The demand for zoo animals has decreased in recent years. Prior to emergence of increased illegal take in 1992, Belikov (1993) estimated that up to 10 “problem” bears were killed annually in all of the Russian Arctic. Increased illegal hunting of polar bears in the Russian Arctic was recognized in 1992, primarily in response to decentralization of management authority, entering a free market economy, and increased economic pressures. Although the magnitude of the illegal harvest in Russia from the Chukchi/Bering seas stock is unsubstantiated, estimates range from 10 to 150 bears per year.

In Alaska, 3 orphaned cubs have been placed into zoos since 1989. In Alaska an illegal harvest, if it occurs, is so small as to be undetectable. Industry has not been responsible for any lethal take of polar bears in this region.

STATUS OF STOCK

Polar bears in the Chukchi/Bering seas stock are not listed as “depleted” under the MMPA or listed as “threatened” or “endangered” under the Endangered Species Act. Although reliable estimates of the minimum population, PBR level, and human-caused mortality and serious injury are currently not available, the stock appears to have increased during the past 27 years despite a substantial annual harvest. The stock appears to be increasing slightly or stabilizing at a relatively high level, however the relationship of this population to K cannot be determined with existing information. Due to the lack of information indicating that subsistence hunting is adversely affecting this population stock and no incidental loss due to any U.S. commercial fishery, the Chukchi/Bering seas polar bear stock is classified as a non-strategic stock.

REFERENCES

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.

Belikov, S.E. 1993. Status of polar bear populations in the Russian Arctic 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.

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.

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.

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. 1997 (In preparation). Status of polar bear. *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.

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. W. Calvert, I. Stirling, and C. Strobeck. 1995. Microsatellite analysis of population structure in Canadian polar bears. Molecular Ecology 4:347-354.

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. *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.

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.

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

U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska

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 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).

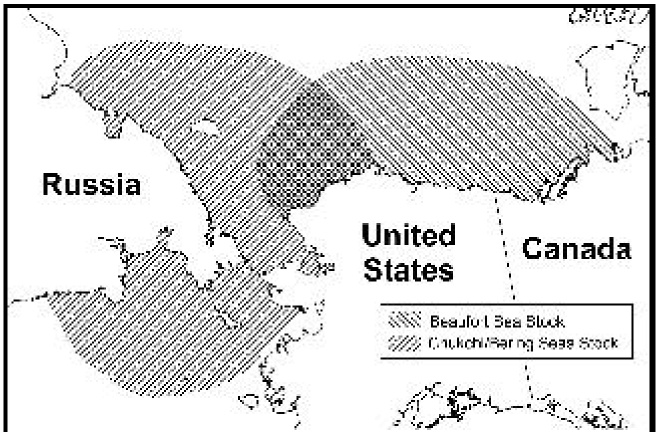

Figure 1. Polar bear distribution.

Recent studies (Amstrup 1995) have shown that the eastern bound of the Southern Beaufort Sea stock occurs south of Banks Island and east of the Bailie Islands, Canada. The western bound is near Point Hope. The southern boundary of the northern Beaufort Sea stock 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). Telemetry data further indicate 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). Current analysis of mitochondrial DNA indicate little differentiation of the Alaska polar bear stocks (Cronin *et al.* 1991, Scribner *et al.* 1977). However, the use of microsatellites to differentiate polar bear populations in the Canadian Arctic (Paetkau *et al.* 1995) may prove to be a useful technique resolving future questions concerning stock separation and management units in Alaska.

Past management regimes have consistently distinguished between the Alaskan stocks based upon the previous information. The Inuvialuit of the Inuvialuit Game Council (IGC), Northwest Territories, and the Inupiat of the North Slope Borough (NSB), Alaska, signed a Polar Bear Management Agreement for the Southern Beaufort Sea in January 1988. This agreement, which is similar in many respects to the international Agreement on the Conservation of Polar Bears signed by the five circumpolar nations of the Arctic, sets harvest guidelines based on the principles of sustained yield.

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) and Amstrup (1995) are the sources of populations estimates which include 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 1800 animals. Recent modeling and analysis of an expanded population data base, derived from capturing, marking and recapturing animals, provides potential estimates of abundance for this stock. Population size was estimated through a modified Lincoln-Petersen model incorporating independent measures of survival (Amstrup 1995). Estimates were developed for the entire population and also for the female component. The female population estimates were developed since capture bias excluding males occurred during some years. The modified Lincoln-Peterson estimate is corrected, based on radio telemetry, for animals unavailable for sampling. The population size estimate, judged most accurate for the early years of the mark and recapture study was obtained in 1976 (N=835, C.V.= 0.29). This was the lowest C.V. value for any of the early years of the study. The population size estimate for the later years judged most accurate was obtained in 1986 (N=1,417, C.V.=0.10). Growth rates based on changes in the female population during the same period, using the same data, changed from 598 (C.V.=0.45) to 744 (C.V.=0.13). This change suggested an instantaneous growth rate of 0.022. A Leslie matrix estimate of population growth of females based upon satellite telemetry data was 0.024 and collaborated the Lincoln-Petersen estimate. The 0.022 growth rate was selected and applied to the 1986 population estimate (1,417) to derive a 1996 population size projection.

The resultant population point estimate is 1,765. Thus the N_{MIN} value calculated here "provides reasonable assurance that the stock size is equal to or greater than the estimate" (following the 1994 reauthorization of the Marine Mammal Protection Act. For a population size of 1,765 and a corresponding C.V. of 0.10, the N_{MIN} is 1,611.

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; (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 indicate a population growth rate of 2.4% from 1981 to 1992 (Amstrup 1995). Comparisons of Southern Beaufort Sea data from 1967-74 and 1981-92 periods (Amstrup 1995) reveal no significant changes in age at first reproduction, numbers of cubs produced per female, or litter sizes for cubs-of-the-year (COYs) or 2-year-olds. However the sizes of yearling litters were greater in the period from 1967 - 1974. Small sample sizes in the first period and differences in sampling procedures between the two periods may mask any change in litter sizes for COYs and 2-year-olds. The age structure of the population was younger during the first period, when survival was greater for young and less for adults, compared to the second period. These later changes are consistent with populations approaching K. Scientific data indicates population growth and empirical observations by Native hunters of increasing numbers of bears observed on and near shore further supports this population trend. Consequently, this stock has been assigned a recovery rate F_R of 1.0.

CURRENT AND 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).

Currently, the Southern Beaufort Sea population may be approaching K (Amstrup 1995). A Leslie type matrix of recapture data, which incorporates 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). Since this calculation did not include human-caused mortalities it represented the “natural” survival rate. Survival rates for cubs and yearlings were also calculated with the assistance of radio telemetry. This mimics a situation in nature where environmental resistance is low and survival high. This rate of growth (6.03%) assumes human effects are absent. Further, the calculation assumes a 50M:50F population sex ratio.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

In the following calculation: $\mathbf{(N_{MIN})(½\ R_{MAX})(F_r) = PBR}$ (Wade and Angliss 1997) the minimum population estimate, N_{MIN} was 1,611; the maximum rate of increase R_{MAX} was 6.03 percent; 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 49 bears per year. In the Southern Beaufort Sea, however, the sex ratio of the harvest is approximately 2M:1F and thus the PBR level was adjusted to 73 bears per year with no more than 24 females harvested. The sex ratio of males to females in the population is assumed to be approximately 50/50. This figure is conservative and incorporates the best information available.

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities.

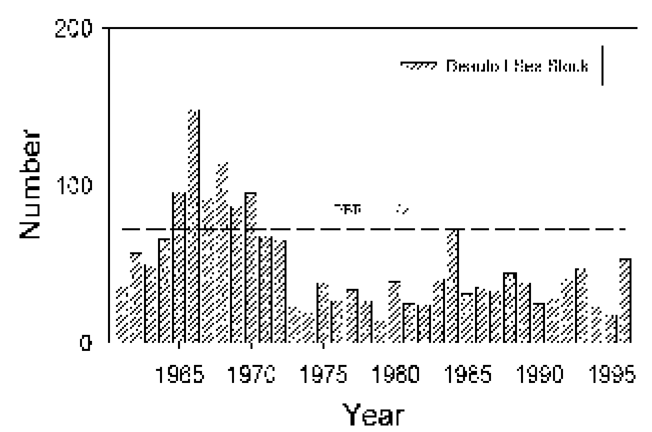

Figure 2. Annual harvest of polar bears from tbe Southern Beaufort Sea stock in Alaska (1960-1996).

Alaskan 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 harvest for 1925-53 averaged 120 bears and was 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 harvest to 111 during 1980-96 (SD=56; range 41-297) (Schliebe *et al.* 1995) (Figure 2). The Southern Beaufort Sea polar bear harvest accounted for 32% of the total Alaska kill (annual mean=36 bears). The sex ratio of the harvest from 1980-96 was 69M:31F.

A management agreement between Canadian Inuit and Alaskan Inupiat of the North Slope has been in place since 1988 (Nageak *et al.* 1990). Since initiation of this local user agreement, the combined Alaska/Canada mean harvest from this stock has been 58.8 bears per year which is less than of an annual allocation guideline of 80 and PBR level of 73. The harvest in Canada is regulated by a quota system. The harvest in Alaska is regulated by voluntary actions of local hunters. In 1997 a Cooperative Agreement was developed between the U.S. Fish and Wildlife Service and the Alaska Nanuuq Commission to implement Section 119 of the Marine Mammal Protection Act Amendments of 1994. This Agreement facilitates local participation in activites related to the conservation and management of polar bears.

The 1991-1996 mean harvest for the Southern Beaufort Sea in Alaska was 32.4 and the sex ratio is 71M:29F. Eleven recorded subsistence kills were taken for defense of life or property from 1991-1996 and are incorporated as subsistence takes. Approximately 7% of the documented harvest is comprised of bears which are not tagged in the Marking and Tagging Reporting Program (MTRP) established in 1988. Sex remains unreported for approximately 14% of the harvest, which includes 7% from both the documented and undocumented harvest, respectively.

Other Removals

Orphaned cubs are occasionally removed from the wild and placed into zoos: One cub was placed into public display facilities during the past five years. Authorized activities ("incidental take" regulations), associated with the exploration, development, production, and transportation of oil and gas, may potentially impact polar bears and their habitat. In recent time three lethal takes related to industrial activities and one at a remote radar defense site on the north slope have been documented.

STATUS OF STOCK

The Southern Beaufort Sea Stock has not been determined to be "depleted" under the MMPA or listed as "threatened" or "endangered" under terms of the Endangered Species Act. This stock is therefore within optimum sustainable population levels. The conservatively calculated PBR level is greater than the average human harvest. The stock does not experience any incidental loss to commercial fishing. Based on information prior to 1992 this stock appears to be increasing at an annual growth rate of 2.2% to 2.4% (Amstrup 1995). From 1991-1996 the Southern Beaufort Sea Stock has sustained a 1.9% harvest which is less than the maximum sustainable harvest. The Southern Beaufort Sea stock appears to be increasing slightly or stabilizing near K. The Southern Beaufort Sea stock of polar bears in Alaska is designated a "non-strategic stock."

REFERENCES

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.

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.

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. Amultiple 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.

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 charactersitics 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.

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. W. Calvert, I. Stirling, and C. Strobeck. 1995. Microsatellite 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

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., 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.

PACIFIC WALRUS (*Odobenus rosmarus divergens*): Alaska Stock

U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska

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*) (Mansfield 1958, Fay 1982). 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. Pacific walrus mainly inhabit the continental shelf waters of the Bering and Chukchi seas, occasionally moving into the eastern East Siberian Sea and the western Beaufort Sea (Figure 1).

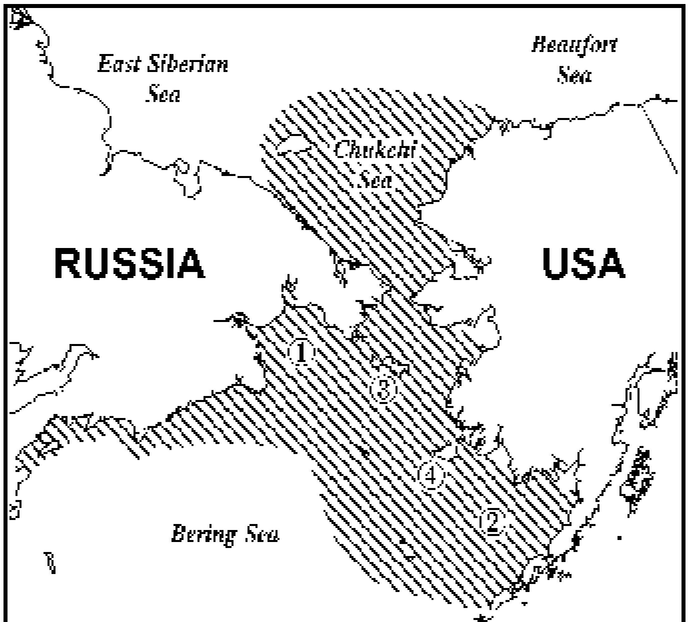

Figure 1. Distribution of the Pacific walrus. 1. Gulf of Anadyr. 2. Bristol Bay. 3. St. Lawrence Island. 4. Nunivak Island.

During the summer months, most of the population migrates into the Chukchi Sea, however thousands of animals, primarily adult males, congregate on or near terrestrial haulouts in the Gulf of Anadyr and in Bristol Bay. During the late winter breeding season, Pacific 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 yet genetically detectable (Scribner *et al.* 1997).

POPULATION SIZE

The current size of the Pacific walrus population is unknown. Fay (1957, 1982), Sease and Chapman (1988), and Fay *et al.* (1989), reviewed the history of population status and survey results from the beginning of commercial exploitation of Pacific walrus in the 18th century to the mid part of this century. More recently, Fay *et al.* (1997) estimated population status for the period 1950 to 1989. The actual size of the pre-exploitation population is unknown, but has been estimated to have been between 200,000-250,000 animals. Over the past 150 years, the size of the Pacific walrus population has fluctuated markedly, presumably in response to varying levels of commercial exploitation. Since the most recent reduction to an estimated 50,000-100,000 animals in the mid-1950s, the population has increased under various protective measures implemented by the U.S. and Russia (the former Soviet Union).

Cooperative aerial surveys by the U.S. and Soviet Union (now Russia) were initiated in 1975 under the auspices of the 1972 *Agreement on Cooperation in the Field of Environmental Protection.* The 1975 survey estimated the population size at 221,360 (Gol'tsev 1976, Estes and Gilbert 1978, Estes and Gol'tsev 1984). A second joint census, conducted in 1980, estimated population size at 246,360 (Johnson *et al.* 1982, Fedoseev 1984). A third survey, conducted in 1985, produced a population estimate of 234,020 (Gilbert 1986, 1989 a,b, Fedoseev and Razlivalov 1986). The most recent aerial survey, flown in 1990, produced an estimate of 201,039 (Gilbert *et al.* 1992), however a considerable portion of the eastern Chukchi Sea usually inhabited by walrus in more typical ice years was not surveyed because ice was not present. The estimates generated from these surveys should be viewed as conservative population estimates that are not useful for detecting population trends (Hills and Gilbert 1994, Gilbert *et al.* 1992). Cooperative aerial surveys were suspended in 1995 due to budget limitations and unresolved methodological problems (See Estes and Gilbert 1978 for a review).

Minimum Population Estimate

Following the guidelines of the Potential Biological Removal workshop (Wade and Angliss 1997), the minimum population estimate (N_{MIN}) for Pacific walrus was calculated based upon the most recent (1990) survey data. Direct counts of walrus on land haulouts in the U.S. and Russia were added to minimum abundance estimates for walrus on ice and in water to calculate N_{MIN}. Minimum abundance estimates for ice and water strata were based upon the lower bounds of the 20th percentile of a log normal distribution of stratum estimates with calculated coefficients of variation. Using this approach, N_{MIN} for Pacific walrus is 188,316 (Table 1).

Table 1. Calculation of estimated minimum population size for Pacific walrus based on 1990 survey information (Gilbert *et al.* 1992). For stratum estimates with calculated coefficients of variation (C.V.), the minimum estimate is the lower bound of the 20^{th} percentile of a log-normal distribution of the strata estimate.

Habitat	Stratum	Estimated Abundance	C.V.	Minimum Estimate
Ice	A	3,352	0.64	2,047
	B	256	0.48	174
	C	48	1,39	20
	D	1,639	0.81	901
	E	7,189	1.20	3,246
	F	3,603	0.58	2,290
	G	402	1.16	185
	Subtotal	**16,489**		**8,862**
Water	Y	2,403	0.86	1,284
	Z	10,734	0.59	6,757
	Coastal	9,366	-	9,366
	Subtotal	**22,503**	**-**	**17,406**
Land		**162,047**	**-**	**162,047**
Total		**201,039**	$\mathbf{N_{MIN}}$	**188,316**

Current Population Trend

Differences in survey design and methodologies preclude describing any clear trend in population size (Hills 1992, Hills and Gilbert 1994).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The current net productivity rate of the Pacific walrus population is unknown. Estimates of net productivity rates for walrus populations range 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.* 1990, Fay *et al.* 1997).

The theoretical maximum net productivity rate (R_{MAX}) for walrus is also unknown. Stock assessment guidelines recommend using a default R_{MAX} value of 12% for pinniped species when R_{MAX} is not known (Wade and Angliss 1997). An R_{MAX} value of 12% may be too high for walrus; although walrus are long-lived and appear to have low rates of natural mortality, they produce a maximum of one calf every two years while most other pinniped species are annual breeders

(Fay 1982). The Fish and Wildlife Service (FWS) and the Biological Resources Division of the U.S. Geological Survey are currently supporting research and modeling efforts to improve estimates of net productivity. Until additional data become available from which more accurate estimates of population growth can be determined, the FWS has adopted a theoretical R_{MAX} value of 8% for this stock. While there are currently no data to support this specific rate, the estimate appears reasonable considering the range of published estimates of net productivity for walrus populations (3-13%).

POTENTIAL BIOLOGICAL REMOVAL

Based on Wade and Angliss (1997), the potential biological removal (PBR) level was calculated as the product of the minimum population estimate (N_{MIN}), one-half the maximum theoretical net productivity rate (R_{MAX}) and a recovery factor. A recovery factor (F_R) of 1.0 was chosen for this stock since the population is believed to be within Optimal Sustainable Population (OSP) levels. The PBR level derived from this information is 7,533 walrus per year (188,316 x 0.04 x 1).

ANNUAL HUMAN CAUSED MORTALITY

Fisheries Information

Although there are no reliable data available concerning the incidental catch of Pacific walrus in fisheries operating in Russian waters, the level of take is believed to be small (*pers. comm.* Valeriy Vladimirov, VNIRO Marine Mammal Laboratory, Moscow). In the U.S. regulatory zone, walrus have been reported to be taken incidentally in the domestic groundfish trawl fisheries of the eastern Bering Sea (Appendix II Table c, Hill *et al.* 1997). Fisheries observer data collected by the National Marine Fisheries Service (NMFS) between 1992 and 1996 indicates that the mean number of walrus caught per year was 16.6 animals (range 8-25) (Unpublished data, Michael Perez, NMFS, NMML, 7600 Sand Pt. Way, NE, Seattle, WA 98115). In the cases where sex was identified, all of the take consisted of adult males. Most (80%) were already decomposed upon catch, indicating that at least a portion of the catch consisted of individuals whose mortality was unrelated to fisheries interactions (e.g. harvest loss or natural mortality). Only three live takes were recorded over this period. Based on these data, the estimated level of incidental take associated with commercial fisheries in U.S. waters is approximately 17 walrus per year (>1% of PBR). At the present time, this mortality rate is far below the 10% of PBR level proposed by NMFS as "insignificant levels of mortality and serious injury approaching a zero rate."

Subsistence Harvest

Fay and Bowlby (1994), present walrus harvest data for the U.S. and Russia between 1931 and 1988. Harvest data for the period 1989-1996 were collected by then FWS in U.S. waters, and by Magadan Okhotskrybvod (Fisheries Inspection Service) in Russia. An analysis of the number of walrus struck and lost during monitored subsistence hunts concluded that approximately 42% of the animals struck by bullets were lost, and that very few animals struck and lost recovered from their wounds (Fay *et al.* 1994). Overall, the combined total U.S./ Russian harvest (including an estimated 42% struck and lost) over the past 36 years has averaged 7,334 walrus per year (range 3,200-16,100). Harvest levels are substantially lower in the 1990s than in the previous decade (Figure 2). Possible factors affecting this decline include: the cessation of Russian ship-based harvests; changing political, economic, and social conditions affecting hunters; as well as the influence of weather and ice conditions on hunting success.

The FWS has adopted the average annual harvest over the past 5 years (1992 through 1996) as the estimate most representative of the current harvest level. Between 1992 and 1996, the combined annual harvest of the U.S. and Russia (including a 42% struck and lost rate) averaged 4,869 walrus per year (Table 2). The sex ratio of the reported U.S. harvest over this period was approximately equal. Unfortunately, the sex ratio of the Russian harvest was not recorded, and harvest data may have been

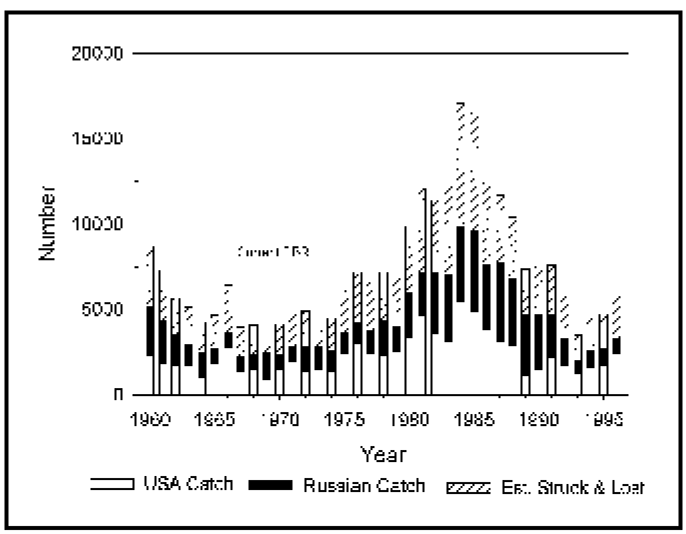

Figure 2. Harvest of Pacific walrus, 1960 - 1996.

under reported (*pers. comm.* Yuri Bukhtiyarov, TNIRO Marine Mammals Laboratory of Magadan). It is essential that harvest monitoring in both nations be maintained in order to accurately assess the impact of the harvest to this stock. In 1997, a Cooperative Agreement was developed between the FWS and the Eskimo Walrus Commission to implement Section 119 of the Marine Mammal Protection Act. This Agreement facilitates local participation in activities related to the conservation and management of walrus including participation in activities such as harvest monitoring. In the future, harvest monitoring programs in Russia may be strengthened through international conservation agreements between the United States and Russia.

Table 2. Estimated harvest of Pacific walrus, 1992-1996. Russian harvest information provided by Okhotskrybvod (Fisheries Inspection Service), Magadan, Russia. U.S. harvest information was collected by the U.S. Fish and Wildlife Service, Marine Mammals Management Office, Anchorage, Alaska, and are adjusted for unreported walrus (Garlich-Miller and Burn 1997). Corrected harvest incorporates a 42% struck and loss rate from Fay *et al.* (1994).

Year	Reported Russia Harvest	Reported U.S. Harvest	Total Reported Harvest	Total Corrected Harvest
1992	1,670	1,683	3,353	5,781
1993	856	1,183	2,039	3,516
1994	1,013	1,611	2,624	4,524
1995	1,071	1,674	2,745	4,732
1996	941	2,419	3,360	5,794
Mean	**1,110**	**1,714**	**2,824**	**4,869**

Other Removals

Other sources of human caused removal between 1992 and 1997 have included: the collection of 14 walrus calves (<3 calves/yr) for public display; the occasional rescue of stranded animals (<1 /yr); and the potential mortality from authorized ("small take" regulations) industrial activities in the Chukchi Sea (there has been only 1 documented mortality since 1988). Based on this information, approximately 4 walrus per year were taken due to "other" human activities.

Total Estimated Annual Human Caused Mortality

Based on the information above, the total estimated annual human caused mortality is calculated to be 4,890 walrus per year (17 due to fisheries, 4,869 due to harvest, 4 due to other removals).

STATUS OF STOCK

In spite of an inability to determine precisely the bounds of OSP as currently defined, the population is believed to be within OSP given the large 1990 population estimate (Fay *et al.* 1990, Gilbert *et al.* 1992, FWS 1994). The Pacific walrus currently has an estimated mean annual level of human mortality and serious injury of 4,890 walrus per year; that value is less than the calculated PBR rate of 7,533. Therefore the stock has been determined to be "non-strategic."

REFERENCES

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.

DeMaster, D.P. 1984. An analysis of a hypothetical population of walruses. Pages 77-80 *in* F.H. Fay and G.A. Fedoseev (eds.), Soviet-American Coop. Res. Marine Mammals, vol. 1. NOAA Tech. Rept. NMFS 12.

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. Pages 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. 1957. History and present status of the Pacific walrus population. Transactions North American Wildlife Conference 22:431-443.

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., and C.E. Bowlby. 1994. The harvest of Pacific walruses, 1931-1989. USFWS Technical Report MMM 94-2; 44 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., B.P. Kelly, and B.A. Fay (eds). 1990. The ecology and management of walrus populations. Marine Mammal Commission Report, NTIS PB91-100479. 186 pp.

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. Pages 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.

FWS. 1994. Conservation Plan for the Pacific Walrus in Alaska. FWS, Anchorage, AK. 79 pp.

Garlich-Miller, J.G. and D. M. Burn. 1997. Estimating the harvest of Pacific walrus in Alaska. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK. 5 pp. (Available upon request - J. Garlich-Miller, Marine Mammals Management, 1011 East Tudor Road, Anchorage, AK 99503).

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., 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.

Gol'tsev, V.N. 1976. Aerial surveys of the Pacific walrus in the Soviet sector during the autumn 1975. Unpublished report TINRO, Vladivostok; 22 pp.

Hill, P.S., D.P. DeMaster, and R.J. Small. 1997. Alaska Marine Mammal Stock Assessments, 1996. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-78, 150 p.

Hills, S. 1992. The effect of spatial and temporal variability on population assessment of Pacific walruses. University of Maine. Dissertation. 120 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 59:(in press).

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. Pages 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. Pages 189-204 *in* V.A. Arsen'ev and K.I. Panin (eds.), Lastonogie Severnoi Chasti Tikhogo Okeana. Pischevaya Promyshlennost', Moscow.

Mansfield, A.W. 1958. The biology of the Atlantic walrus, *Odobenus rosmarus rosmarus* (Linnaeus) in the Eastern Canadian Arctic. Fish. Res. Board Can. Ms. Rept. (Biol.) 653. 146pp.

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 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.

SEA OTTER (*Enhydra lutris*): ALASKA STOCK

U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska

A Conservation Plan for sea otters has been completed by the Fish and Wildlife Service (FWS 1994); all information contained in that plan is incorporated by reference in this stock assessment.

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters in North America occur from the Aleutian Islands to California. More than 90% of the world's sea otter population can be found in Alaska waters (Rotterman and Simon-Jackson 1988). Those animals which occur in Alaska are currently managed as a single stock. However, previous studies have suggested that sea otters can be separated into multiple stocks within Alaska based on the Dizon et al (1992) phylogeographic approach including distributional data (geographic separation) and genetic relationships (U.S. Departments of Commerce and Interior 1978; Rotterman and Simon-Jackson 1988; Cronin *et al* in review). This information will be used when evaluating the separation of Alaska sea otters into multiple stocks in the future.

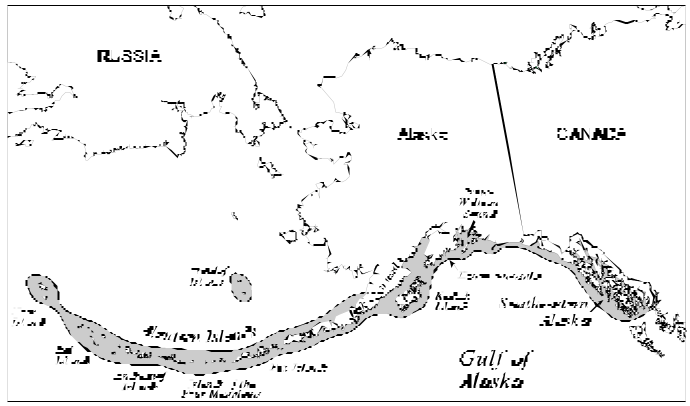

Figure 1. Sea Otter Distribution in Alaska.

Sea otters are widely distributed throughout Alaska from the Aleutian Islands to southeast Alaska and have reoccupied most of their historic range. However, they may not have reached equilibrium density in several areas including certain parts of the Aleutian Islands, Kodiak Archipelago, northern Gulf of Alaska and southeast Alaska. It is expected that sea otters will continue to move into new areas within their range that they currently do not occupy or where they are currently present in low densities.

POPULATION SIZE

Historically, sea otters occurred in nearshore waters around the North Pacific rim from Hokkaido, Japan, through the Kuril Islands, Kamchatka Peninsula, the Commander Islands, the Aleutian Islands, peninsular and south coastal Alaska, and southward to Baja California (Kenyon 1969). The worldwide population of sea otters in the early 1700s has been estimated at 150,000 (Kenyon 1969) to 300,000 (Johnson 1982). In Alaska, sea otters were commonly harvested by coastal Alaska Natives prior to the commercial exploitation of sea otters. Although this Native harvest may have caused local reductions of sea otters (Simenstad *et al*. 1978), the species was abundant throughout its range prior to commercial exploitation. Extensive commercial hunting of sea otters began following the arrival in Alaska of Russian explorers in 1741 and continued during the 18th and 19th century. This exploitation reduced the numbers of sea otters throughout the range, completely eliminating them in some areas. In 1911, international protection was given to the few remaining animals existing worldwide. At present, sea otters have made a remarkable recovery and have repopulated most of their range in Alaska.

Minimum Population Estimate

Calkins and Schneider (1985) estimated a 1976 Alaska sea otter population of 100,000 to 150,000 animals. Based on the best available data, the FWS believes the current population size is within that range and that 100,000 is the minimum population estimate for sea otters in Alaska (FWS 1994). Although the geographic coverage is incomplete, abundance information for certain geographic areas of Alaska is summarized in the table (DeGange and Bodkin in preparation). These surveys include a variety of techniques (direct counts or corrected counts) and platforms (boat, shore, fixed-wing and helicopter) with varying success. These numbers should be considered minimum counts or estimates for these areas. The FWS considers these estimates to be conservative and acknowledges that there are uncertainties associated with establishing a minimum population estimate. However, as required by NMFS guidelines (NMFS 1994), the FWS is reasonably assured that the stock size is equal to or greater than this estimate.

The Aleutian Island survey results from 1992 (FWS unpubl. data) were from aerial surveys (91m elevation, 51.4 m/s) with correction factors determined from simultaneous air and ground counts. The Prince William Sound and Kodiak survey results from 1994 (FWS unpubl. data) were from aerial surveys (91m elevation, 26.8 m/s) with correction factors determined from systematic intensive search units along the transect lines to account for diving behavior.

Table 1. Survey results from selected areas in Alaska.

Location	Count/ Estimate	Survey Year	Reference
Near Islands	2,259	1992	USFWS unpubl. data
Rat Islands	3,470	1992	USFWS unpubl. data
Andreanof and Delarof Islands	9,752	1992	USFWS unpubl. data
Islands of Four Mts	171	1992	USFWS unpubl. data
Fox Islands	3,451	1992	USFWS unpubl. data
Pribilof Islands	30	1991	Stephensen (pers. comm.)
N. AK Peninsula	13,091	1986	Brueggeman et al 1987;
S. AK Peninsula	27,335	1986; 1989	Brueggeman et al 1987; USFWS unpubl. data
Kodiak Islands	6,100	1994	USFWS unpubl. data
Kenai Peninsula	2,300	1989	USFWS unpubl. data
Prince Wm. Sound	14,352	1994	Bodkin (pers comm)
N. Gulf of AK	2,830	1987; 1988	Simon-Jackson and Hodges 1987; Monnett and Rotterman 1989
Southeastern AK	7,480	1986-1988	Pitcher 1989; DeGange and Bodkin in prep.

Current Population Trend

The observed trend in virtually all areas with persisting subpopulations since 1911 has been one of growth, with declines observed only as subpopulations exceeded available resources (DeGange and Bodkin in preparation). The state-wide population of sea otters is expected to continue to grow due to unoccupied areas within their range and the many areas where they have yet to attain equilibrium densities.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Estes (1990) estimated maximum net productivity for sea otters in certain areas of Alaska, British Columbia, and Washington State between 17 and 20% per year based on observed population changes. However, maximum net productivity rates have not been estimated throughout the sea otter's range in Alaska.

Maximum productivity rates throughout all areas of Alaska are unknown. In the absence of more detailed information for maximum net productivity rates throughout Alaska, the rate calculated by Estes (1990) of 20% was used for this stock assessment.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

In the following calculation, **$(N_{MIN})(1/2\ R_{MAX})(F_R) = PBR$** the minimum population estimate (N_{MIN}) is 100,000; the maximum rate of increase (R_{MAX}) is 0.20; and the recovery factor (F_R) was chosen as 1.0 because the stock is believed to be within the Optimum Sustainable Population (OSP) range (FWS 1994). The PBR derived from this information is 10,000 sea otters per year. However, a removal of 10,000 sea otters per year from the state-wide population can only realistically result in a non-adverse impact if the removal is allocated throughout the state, not concentrated in any local areas, and considers sex and age of harvested animals.

ANNUAL HUMAN CAUSED MORTALITY

Oil and Gas Development

Activities associated with the exploration, development, and transportation of oil and gas have the potential for adversely impacting sea otters and their habitat in Alaska. The *Exxon Valdez* oil spill in March, 1989, illustrates the impact that oil spills can have on sea otters. It is estimated that approximately 2,650 sea otters (95% CI = 500-5,000) in Prince William Sound (Garrott *et al.* 1993) or 3,905 sea otters (95% CI = 1,904-11,157) spill-wide (DeGange *et al*. 1994) died in Alaska as a result of the spill. Ballachey *et al* (1994) reported that by 1993 chronic damages to sea otters may have been subsiding and recovery of the affected sea otter population underway. Annual mortality due to oil and gas development activities including oil spills have not been estimated.

Subsistence Harvest

Hunting of sea otters, including hunting by Alaska Natives, was prohibited by the 1911 Fur Seal Treaty and later by Alaska State law. Between 1911 and 1972, relatively few sea otters are known to have been killed in Alaska. In 1972, the Marine Mammal Protection Act exempted Alaska Natives from the prohibition on hunting. Alaska Natives currently take sea otters for subsistence use or for creating and selling authentic Native articles of handicrafts. Between 1982 and 1986, a minimum of 1,049 sea otters was reported killed by Alaska Natives (Rotterman and Simon-Jackson 1988). The figure shows the harvest levels between 1989 and 1993 (Stephensen *et al.* 1994; FWS unpubl. data). This data is from a mandatory marking and tagging program implemented by the FWS since 1988. There is no evidence that the harvest by Alaska Natives has affected the Alaska population of sea otters or limited their distribution or productivity. However, it is necessary that harvest efforts be spread out throughout the stock to ensure that over-harvest does not occur within local areas of Alaska. The estimated annual take for 1993 due to Native hunting was approximately 1.2% of the estimated minimum state-wide population and 12% of the calculated PBR.

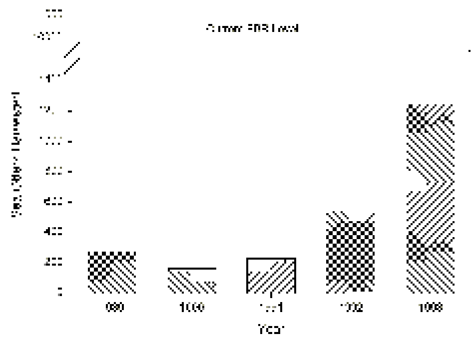

Figure 2. Sea otter harvest levels in Alaska, 1989-1993.

Research and Public Display

Between 1976 and 1994, nearly 150 sea otters were taken from Alaska waters for public display in aquaria including those that were deemed unreleasable after the *Exxon Valdez* oil spill. Hundreds more have been captured, handled, tagged and released as part of research projects. There have been no observed effects on sea otters populations from either of these activities.

Other Activities

Between 1968 and 1972, the Alaska Department of Fish and Game (ADFG) and the FWS took an average of 519 otters per year, with a peak of 1,088 in 1970 as part of an experimental harvest. This includes sea otters transplanted, harvested by ADFG and accidental mortalities. Additionally, in 1971 it is estimated that between 1,000 and 1,350 otters were killed in a nuclear bomb blast at Amchitka. (U.S. Departments of Commerce and Interior 1978)

Although specific data are lacking, it is likely that other human activities involving sea otters have resulted in negligible numbers of deaths.

FISHERIES INFORMATION

The NMFS program requiring certain fisheries to keep logbooks of marine mammal interactions and allow observers on vessels to track marine mammal interactions has provided data on sea otter interactions with certain Alaska fisheries. No sea otter kills were reported in 1990 or 1991 through the observer program. The observer program was discontinued after 1991. Logbook records are available from 1990 through 1992. The 1990 logbook records show 1 kill and 4 injuries due to gear interaction and 3 injuries due to deterrence in the Alaska Prince William Sound, Copper River and Bering River drift gillnet fishery. The 1991 logbook records show 1 kill due to gear interaction in the Alaska Kodiak salmon set gillnet fishery. No kills or injuries were reported in logbook records in any fishery in 1992. A lethal interaction was also reported from the Aleutian Islands Black Cod Single Pot fishery (a fishery not required to report interactions) where 2 sea otters were killed in 1992. Prior to the implementation of the NMFS program, studies were conducted on sea otter interactions with the drift net fishery in western Prince William Sound 1988-1990 and no mortalities were observed. Annual mortality rates due to commercial fishing are probably insignificant to the overall Alaska sea otter population.

The Alaska Prince William Sound, Copper River, Bering River Drift Gillnet Fishery had the following number of vessels registered: 1990-618, 1991-590, 1992-548. The Alaska Kodiak Salmon Set Gillnet fishery had the following number of vessels registered: 1990-115, 1991-117, 1992-115. (NMFS 1993)

Although lethal take was reported from the NMFS commercial fishery logbook data, the NMFS Observer Program estimated an overall zero kill rate based on observed kills and the total fishery effort (NMFS 1993). However, logbook data can only be considered as a minimum estimate of mortality (NMFS 1994). Because of the lack of data, seasonal or area differences in the fishery's incidental mortality rate and trends in mortality rate due to fishing are not possible to determine. However, based on the available data, sea otter populations in Alaska are not likely to be significantly affected due to commercial fishery interactions. The total fishery mortality and serious injury for the Alaska sea otter stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate (NMFS 1994).

STATUS OF STOCK

The Alaska sea otter population is currently managed as one stock and is estimated to be within its OSP range. Sea otters in Alaska are not listed as threatened or endangered under the Endangered Species Act. Sea otters have reoccupied the majority of their former range and the population is approaching carrying capacity in some regions. The Potential Biological Removal calculated for the stock is 10,000 sea otters annually. The known incidental take of sea otters in commercial fishing is less than 10% of the PBR, and therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. At this time, sea otters in Alaska are not considered a Strategic Stock as defined by the MMPA.

REFERENCES

Ballachey, B.E., J.L. Bodkin, A.R. DeGange. 1994. An overview of sea otter studies. pp. 47-59. *In* T.R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez* Oil Spill. Academic Press. San Diego, CA. 395 pp.

Brueggeman, J.J, G.A. Green, R. Gortefendt, and D. Chapman. In review. Aerial surveys of sea otters in the northwestern Gulf of Alaska and southeastern Bering Sea. Submitted to Marine Mammal Science.

Burn, D.M. 1994. Boat-based population surveys of sea otters in Prince William Sound. pp. 61-80. *In* T.R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez* Oil Spill. Academic Press. San Diego, CA. 395 pp.

Calkins, D.G. and K.B. Schneider. 1985. The sea otter (*Enhydra lutris*). pp. 37-45. *In* J. Burns, K.J. Frost, and L.F. Lowry (eds.), Marine Mammal Species Accounts, Alaska Department of Fish and Game Technical Bulletin 7.

Cronin, M.A., J.L. Bodkin, B. Ballachey, J. Estes and J.C. Patton. In review. Mitochondrial DNA variation among subspecies and populations of sea otters (*Enhydra lutris*). Submitted to Journal of Mammalogy, June 1994.

DeGange, A.R., A.M. Doroff and D.H. Monson. 1994. Experimental recovery of sea otter carcasses at Kodiak Island following the *Exxon Valdez* oil spill. Marine Mammal Science, 10(4):492-496.

DeGange, A.R. and J.L. Bodkin. In preparation. Distribution and abundance of sea otters in Alaska: a current view. U.S. Fish and Wildlife Service, Anchorage, AK.

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

Estes, J.A. 1977. Population estimates and feeding behavior of sea otters. pp. 511-526. *In* M.C. Merritt and R.G. Fuller (eds.), The Environment of Amchitka Island, Alaska. U.S. Department of Commerce, Technical Information Center, Springfield, VA.

Estes, J.A. 1990. Growth and equilibrium in sea otter populations. Journal of Animal Ecology, 59:385-401.

FWS. 1994. Conservation plan for the sea otter in Alaska. Marine Mammals Management, U.S. Fish and Wildlife Service, Anchorage, AK. 47 pp.

Garrott, R.A., L.L. Eberhardt, and D.M. Burn. 1993. Mortality of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Marine Mammal Science 9(4):343-359.

Johnson, A.M. 1982. Status of Alaska sea otter populations and developing conflicts with fisheries. Trans. 47th North American Wildlife and Natural Resources Conference:293-299.

Kenyon, K.W. 1969. The sea otter in the eastern Pacific Ocean. North American Fauna 68.

Monnett, C. and L.M. Rotterman. 1989. Distribution and abundance of sea otters in southeastern Prince William Sound. Unpubl. report to the Fish and Wildlife Service, Alaska Pacific University, Anchorage, AK.

NMFS. 1993. Report on implementation of the Marine Mammal Protection Act interim exemption program, 1988-1993. Office of Protected Resources, NMFS, NOAA. 63 pp.

NMFS. 1994. Report of the potential biological removal workshop. Draft report, La Jolla, CA. 30 pp.

Pitcher, K.W. 1989. Studies of southeastern Alaska sea otter populations: distribution, abundance, structure, range expansion, and potential conflicts with shellfisheries. Unpublished report, Alaska Department of Fish and Game, Anchorage, AK.

Rotterman, L.M. and T. Simon-Jackson. 1988. Sea otter (*Enhydra lutris*). pp. 237-275. *In* J.W. Lentfer (ed.). Selected marine mammals of Alaska: species accounts with research and management recommendations. Marine Mammal Commission, Wash. D.C.

Simenstad, C.A., J.A. Estes, and K.W. Kenyon. 1978. Aleuts, sea otters, and alternate stable-state communities. Science 200:403-411.

Simon-Jackson, T. and J. Hodges. 1987. Sea otter survey, Gulf of Alaska - 1987. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK. 11 pp.

Stephensen, W., D. Cramer, and D. Burn. 1994. Review of the marine mammal marking, tagging, and reporting program, 1988-1992. USFWS R7/MMM Technical report 94-1. 49 pp.

Wynne, K.M. 1990. Marine mammal interactions with the salmon drift gillnet fishery on the Copper River Delta, Alaska, 1988 and 1989. Alaska Sea Grant Technical Report AK-SG-90-05, 36 pp.

Wynne, K.M., D. Hicks, and N. Munro. 1991. 1990 Salmon Gillnet Fisheries Observer Programs in Prince William Sound and Unimak Alaska. Final report, Saltwater Inc., Anchorage, AK. 65 pp.

U.S. Departments of Commerce and Interior. 1978. Final environmental impact statement: consideration of a waiver and return of management of certain marine mammals to the state of Alaska. NMFS and USFWS, Washington, D.C.