Alaska Marine Mammal Stock Assessments 1998

by

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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 mortality and serious injury of marine mammals.

This is a working document. This document represents the second revision since the original development of the stock assessment reports in 1995 (Small and DeMaster 1995). Although the previous stock assessment reports were labeled "1996", they were not published until 1997 (Hill et al. 1997). To make the title more consistent with the planned publication date, we are calling this the "1998" stock assessment reports. Each stock assessment report is designed to stand alone and will be updated as new information becomes available. The MMPA requires stock assessment reports to be revised 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. The stock assessments revised for the 1998 document include all strategic stocks (Steller sea lions, northern fur seals, Cook Inlet beluga whales, sperm whales, humpback whales, fin whales, right whales, and bowhead whales), harbor seals, and killer whales. The stock assessment reports for all stocks, however, have been included in this document for completeness. 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, Brendan Kelly, Matt Kookesh, Denby Lloyd, Beth Mathews, Craig Matkin, Caleb Pungowiyi, 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.

Revised 12/30/98

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. 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).

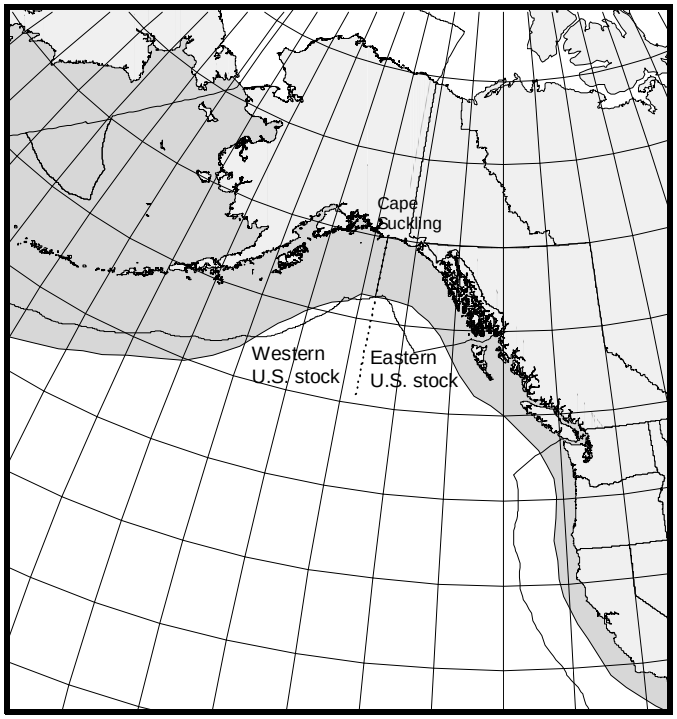

Figure 1. Approximate distribution of Steller sea lions in the eastern North Pacific (shaded area).

POPULATION SIZE

The most recent estimate of Steller sea lion abundance in Alaska is based on aerial surveys performed in June and July 1996 from Southeast Alaska to the western Aleutian Islands (Strick et al. in press). Data from these surveys represent actual counts of nonpups at 95 'trend sites', where sea lions have been monitored since the 1970s, and a few additional sites. Aerial and ship-based surveys of Steller sea lions conducted at these same trend sites during June and July 1992 resulted in coefficients of variation (CV) in counts from 0.025 to 0.12 for 7 distinct subareas of Alaska, with an overall CV of 0.0184 (Sease et al. 1993). As replicate counts were done only in 1992, a CV has not been recalculated since the 1992 survey. However, as survey methods have remained constant, we have assumed that the 1992 survey CV is an appropriate estimate for later surveys. Loughlin et al. (1992) derived correction factors for estimating total nonpup abundance (counted nonpups × 1.331) and for estimating total numbers of pups (counted nonpups ÷ 2.63). Using these correction factors and the 1996 counts for the Gulf of Alaska (9,782) and the Bering Sea/Aleutian Islands (13,320; this includes trend sites plus Attu Island, a major rookery in the western Aleutian Islands that has not been included in trend surveys for logistic reasons) resulted in an estimate of approximately 30,700 nonpups and 8,800 pups, for a total abundance estimate of 39,500 Steller sea lions in the Western U. S. stock.

A range wide survey for Steller sea lions is planned for the summer of 1998. Preliminary results from this survey will be available in the autumn of 1998.

Minimum Population Estimate

For the Western U. S. stock of Steller sea lions, the minimum population estimate (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 39,500 and an associated CV(N) of 0.0184, N_{MIN} for the Western U. S. stock is 38,893. Even though CVs are not currently available for the correction factors, this estimate of N_{MIN} is such that the true number of animals in the population is very likely to be greater than N_{MIN} because Loughlin et al. (1992) have commented that the actual counts of pups and non-pups are likely to be underestimated by 5-10%. This approach is consistent with recommendations of the Alaska Scientific Review Group (DeMaster 1995, 1996, 1997).

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 21% from 1990 to 1994 (Table 1). Counts at trend sites during 1996 indicate that the Western U. S. stock has continued to decline (7.9% since 1994, Table 1, Fig. 2).

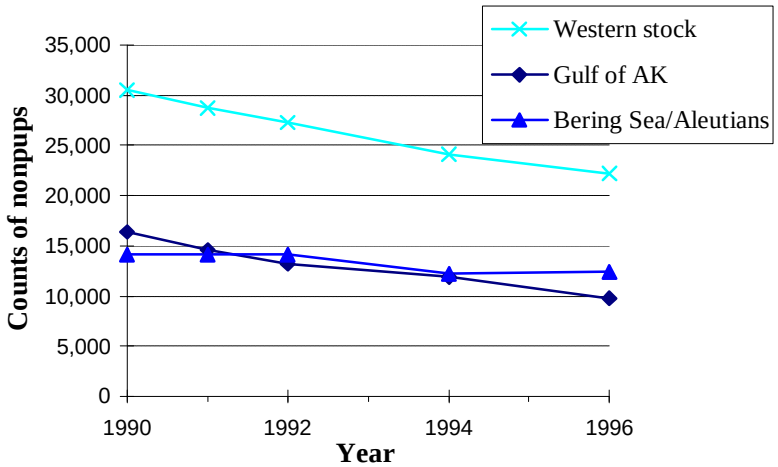

Figure 2. Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the Western U. S. stock, 1990- 96.

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 1996 (NMFS 1995, Strick et al. 1997, Strick et al. in press). Counts from 1976-79 (NMFS 1995) were combined to produce complete regional counts which are comparable to the 1990-96 data.

Area	late 1970s	1990	1991	1992	1994	1996
Gulf of Alaska	65,296	16,409	14,603	13,179	11,871	9,782
Bering Sea/ Aleutians	44,584	14,116	14,141	14,107	12,248	12,434
Total	109,880	30,525	28,744	27,286	24,119	22,216

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). However, it should also be noted that from a theoretical, single-species perspective, a population that has declined from over 200,000 individuals to less than 50,000 individuals and one with an estimated annual removal rate due to human activities on the order of 1-2% of the current abundance level, should not be declining at present. For this stock, the potential biological removal (PBR) approach, given its single-species perspective, is difficult to apply.

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 re-authorized Marine Mammal Protection Act (MMPA), the PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock has been changed from 0.3 (Small and DeMaster 1995) to 0.15. This F_R value was selected by NMFS after considering recommendations from the Alaska Scientific Review Group (DeMaster 1997), the Alaska Fisheries Science Center, the Alaska Regional Office, and public comment. Based on simulations reported in Wade (1998), the use of an F_R of 0.15 versus allowing no human-related removals at all will result in a negligible difference in the population dynamics of a stock. Thus, for the Western U. S. stock of Steller sea lions, PBR = 350 animals (38,893 × 0.06 × 0.15).

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 1990-96: 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. 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 2a. The mean annual (total) mortality was 9 (CV=0.37) for the Bering Sea groundfish trawl fishery, 1.2 (CV=0.61) for the Gulf of Alaska groundfish trawl fishery, 0.2 (CV=1.0) for the Bering Sea groundfish longline 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 longline fisheries presented above (9+1.2+0.2+1.0=11.4) with the mortality estimate from the Prince William Sound salmon drift gillnet fishery (14.5) results in an estimated mean annual mortality rate in the observed fisheries of 25.9 (CV=0.58) 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 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%	13, 13, 15, 4, 9, 2, 4	13, 19, 21, 6, 11, 3, 4	9 (CV=0.37)
Gulf of Alaska (GOA) groundfish trawl	90-96	obs data	33-55%	2, 0, 0, 1, 1, 0, 0	4, 0, 0, 3, 3, 0, 0	1.2 (CV=0.61)
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, 1, 0, 0, 0	0.2 (CV=1.0)
GOA groundfish longline (incl. misc. finfish and sablefish fisheries)	90-96	obs data	8-21%	1, 0, 0, 0, 0, 1, 0	2, 0, 0, 0, 1, 4, 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)
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90	obs data	4%	0	0	0
Observer program total						25.9 (CV=0.58)
				Reported mortalities		
Alaska Peninsula/Aleutian Islands salmon set gillnet	90-96	self reports	n/a	0, 1, 1, 1 n/a, n/a, n/a	n/a	[$0.75]
Cook Inlet salmon drift gillnet	90-96	self reports	n/a	0, 0, 0, 2 n/a, n/a, n/a	n/a	[$0.5]
Bristol Bay salmon drift gillnet	90-96	self reports	n/a	0, 4, 2, 8 n/a, n/a, n/a	n/a	[$3.5]
Prince William Sound set gillnet	90-96	self reports	n/a	0, 0, 2, 0 n/a, n/a, n/a	n/a	[$0.5]
Alaska miscellaneous finfish set gillnet	90-96	self reports	n/a	0, 1, 0, 0 n/a, n/a, n/a	n/a	[$0.25]
Alaska halibut longline (state and federal waters)	90-96	self reports	n/a	0, 0, 0, 0 1, n/a, n/a	n/a	[$0.2]
Minimum total annual mortality						$31.6 (CV=0.58)

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 1996, 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. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 (see Appendix 4).

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 32 sea lions per year, based on observer data (25.9) and self-reported fisheries information (5.7) 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 1992-95 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). 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 in the Pribilof Islands are in dispute.

Table 2b. Summary of the subsistence harvest data for the Western U. S. stock of Steller sea lions, 1992-95.

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
Mean annual take (1993-95)	412			

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 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).

STATUS OF STOCK

At present, estimated annual fishery mortality of less than 35 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching a zero mortality and serious injury rate. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), the current annual level of incidental mortality (32) 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 (32+412=444) is known to exceed the PBR (350) for this stock. The Western U. S. stock of Steller sea lion is currently listed as "endangered" under the ESA, and therefore designated as "depleted" under the MMPA. As a result, the stock is classified as a strategic stock.

A number of management actions have recently been implemented to safeguard the Western U. S. stock of Steller sea lion 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.

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." There is currently no sign that the decline in the population has slowed or stopped. Although many theories have been suggested (overfishing, environmental change, disease, etc.) it is not clear what factor or factors are causing the decline. The predicted El Niño of 1997 is also showing signs of affecting the environment in Alaska waters (e.g., die offs of large numbers of seabirds which appear to be unable to successfully find forage fish) that may not be favorable to Steller sea lions. However, it is unclear what affect, if any, this will have on the Western U. S. Steller sea lion stock.

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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. 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).

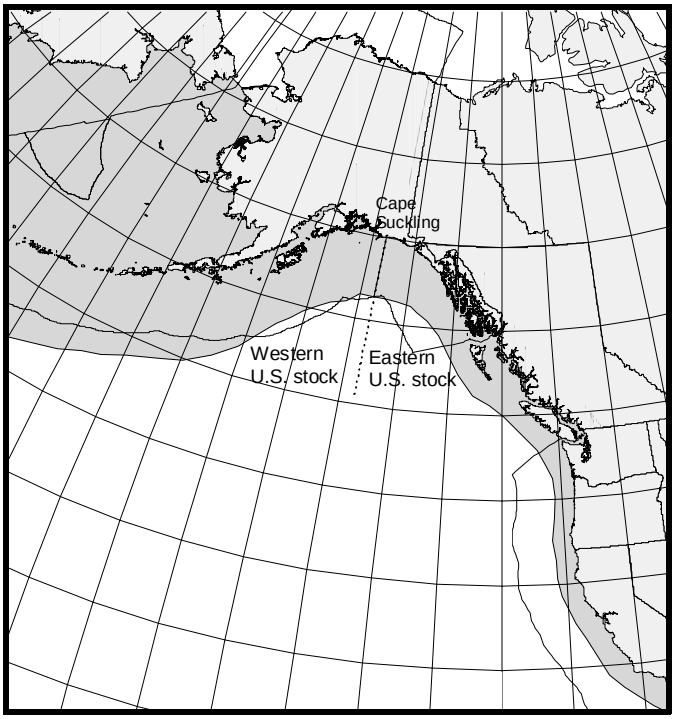

Figure 3. Approximate distribution of Steller sea lions in the eastern North Pacific (shaded area).

POPULATION SIZE

The most recent estimate of Steller sea lion abundance in Southeast Alaska is based on aerial surveys performed in June 1996 (Strick et al. in press). 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 is planned for the summer of 1998. Preliminary results from this survey, along with an appropriate correction factor, will be available in the autumn of 1998.

Minimum Population Estimate

The 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. Note that N_{MIN} is lower than reported in the 1996 stock assessment report (Hill et al. 1997). This is solely an artifact of the manner in which the abundance and N_{MIN} are calculated, as there is no indication that the abundance of the Eastern U. S. stock of Steller sea lions has declined (Fig. 4).

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 3,443 for 1994 (Brown and Reimer 1992, NMFS 1995). This increase may be an artifact of improved surveys in recent years (NMFS 1995). Steller sea lion numbers in California, especially in southern 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 1980-96. Limited information suggests that counts in northern California appear to be stable (NMFS 1995). At Año Nuevo, California, a steady decline in ground counts started around 1970, resulting in a 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). Overall, counts of nonpups at trend sites in California and Oregon have been relatively stable since the 1980s (Table 3, Fig. 4).

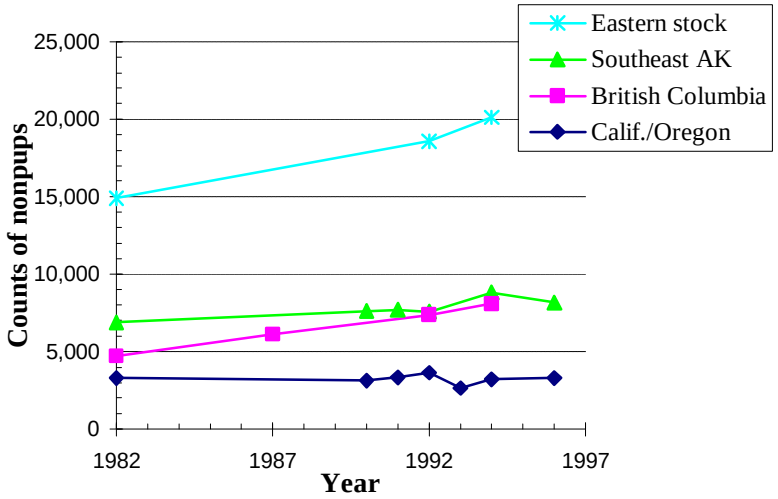

Figure 4. Counts of adult and juvenile Steller sea lions at rookery and haulout trend sites throughout the range of the Eastern U. S. stock, 1982-96. Data from British Columbia include all sites.

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, Strick et al. in press). In British Columbia, counts (no correction factors applied) of non-pups throughout the Province increased at a rate greater than 5% annually during 1982-94 (Table 3, Fig. 4). 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 1996 (NMFS 1995, Strick et al. 1997, Strick et al. in press; P. Olesiuk, unpubl. data, Pacific Biological Station, Nanaimo, BC, V9R 5K6). Trend site counts in California include only Año Nuevo Island and St. George Reef. Trend site counts in Oregon include only Rogue and Orford Reefs. British Columbia data include counts from all sites.

Area	1982	1990	1991	1992	1994	1996
California/Oregon	3,286	3,128	3,358	3,631	3,221	3,294
British Columbia	4,711	6,109*	no data	7,376	8,091	no data
Southeast Alaska	6,898	7,629	7,715	7,558	8,826	8,181
Total	14,895	--	--	18,565	20,176	--

*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 1996 in which Steller sea lions from this stock were taken incidentally: the California/Oregon thresher shark and swordfish drift gillnet, WA/OR/CA groundfish trawl, and Northern Washington marine set gillnet fisheries. In 1992 and 1994, 1 Steller sea lion mortality was observed incidental to the California/Oregon 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), and result in a mean annual mortality of 2.6 sea lions (CV=0.62) for that fishery (Table 4). One Steller sea lion mortality was observed in the WA/OR/CA groundfish trawl fishery during the 1994 season (53% observer coverage in 1994). As that mortality occurred in an unmonitored haul, it could not be used to calculate the estimated mortality for the fishery. Therefore, 1 mortality was used as both the observed mortality and estimated mortality in 1994 for that fishery, and is considered a minimum estimate. This single mortality results in a mean annual mortality of 0.2 (CV=1.0) 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 over the 7-year period, 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 3.0 (CV=0.55) 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.

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 1996, 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. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 (see Appendix 4).

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 1992 to 1996 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 1992-96 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.

Table 4. Summary of incidental mortality of Steller sea lions (Eastern U. S. 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
CA/OR thresher shark and swordfish drift gillnet	90-96	obs data	4-18%	0, 0, 1, 0, 1, 0, 0	0, 0, 7, 0, 6, 0, 0	2.6 (CV=0.62)
WA/OR/CA groundfish trawl (Pacific whiting component)	90-96	obs data	44-72%	0, 0, 0, 0, 1, 0, 0	0, 0, 0, 0, 1, 0, 0	0.2 (CV=1.0)
Northern WA marine set gillnet	90-96	obs data	47-87%	0, 0, 0, 0, n/a, 0, 1	0, 0, 0, 0, n/a, 0, 1	0.2 (CV=1.0)
Observer program total						3.0 (CV=0.55)
				Reported mortalities		
Southeast Alaska salmon drift gillnet	90-96	self reports	n/a	0, 1, 2, 2, n/a, n/a, n/a	n/a	[$1.25]
Alaska salmon troll	92-96	strand data	n/a	0, 0, 0, 0, 1	n/a	[$0.2]
British Columbia aquaculture predator control program	91-96	permit reports	n/a	14, 8, 10, 11, 6, 13	n/a	9.6
Minimum total annual mortality						$14.05 (CV=0.55)

Steller sea lions are taken in British Columbia incidental to commercial salmon farming operations (Table 4). Preliminary figures from the British Columbia Aquaculture Predator Control Program resulted in a mean annual mortality of 9.6 Steller sea lions from this stock over the period from 1992 to 1996 (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 upon data from only the first three-quarters of 1996. Due to a lack of observer programs, there are few data concerning the mortality of marine mammals incidental to other commercial fisheries in Canadian waters which are analogous to U.S. fisheries that are known to take Steller sea lions. As a result, the number of Steller sea lions taken in Canadian waters is not known.

No observers have been assigned to Canadian fisheries and several U.S. fisheries that are known to interact with this stock, making the estimated mortality unreliable. The minimum estimated mortality rate incidental to commercial fisheries is 15 (rounded from 14.05) sea lions per year, based on observer data (3.0) and self-reported fisheries information (1.25), stranding data (0.2), or permit reports (9.6) 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, and 0 animals in 1992-96, 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 1994 to 1996 was 2 sea lions (rounded from 1.67).

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). Strandings of Steller sea lions with gunshot wounds do still occur. During the period from 1990 to 1996 strandings of animals with gunshot wounds from this stock occurred in Oregon and Washington in 1990 (1 animal), 1993 (9 animals), and 1996 (2 animals), resulting in an estimated annual mortality of 2.2 Steller sea lions from this stock during 1992-96. This estimate is considered a minimum because not all stranded animals are found, reported, or cause of death determined (via necropsy by trained personnel). 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 (15) 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 (15 + 2 + 2 = 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 OSP 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. However, the predicted El Niño of 1997 is showing signs of affecting the environment in Alaska waters that may not be favorable to Steller sea lions. El Niño may affect this stock differentially throughout its range, perhaps being particularly severe towards the southern end of the range where the stock has been declining (see Current Population Trend). At this time it is unclear what affect, if any, this will have on the Eastern U. S. Steller sea lion stock.

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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 U. S., but generally do so outside of the breeding season (Fiscus 1983).

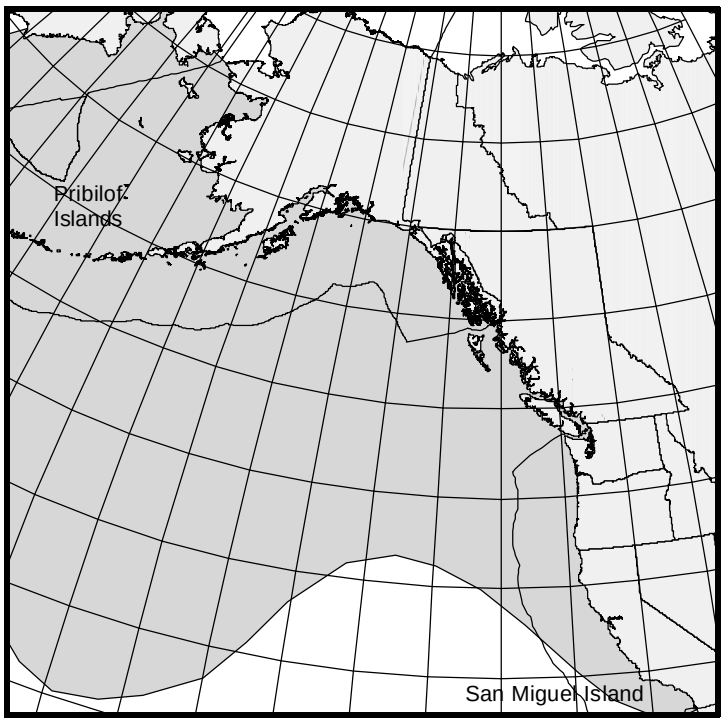

Figure 5. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

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 and recommendations contained in Wade and Angliss (1997), a default CV(N) of 0.2 was used in the calculation of the minimum population estimate (N_{MIN}) for this stock (DeMaster 1998). N_{MIN} is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{1/2})$. Using the population estimate (N) of 1,002,516 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 848,539.

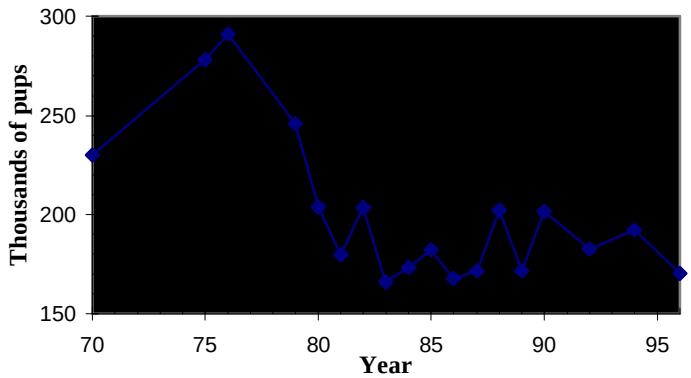

Figure 6a. Production of northern fur seal pups on St. Paul Island,
Alaska, 1970-96.

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

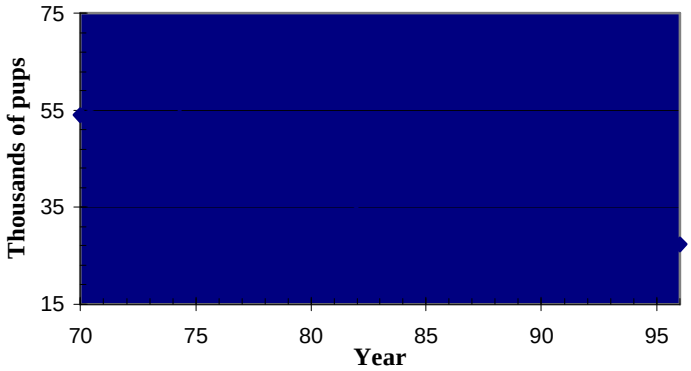

Figure 6b. Production of northern fur seal pups on St. George Island, Alaska, 1970-96.

stock will remain listed as depleted until population levels reach at least the lower limit of its optimum sustainable population (estimated at 60% of K).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The northern fur seal population increased steadily during 1912-24 after the commercial harvest no longer included pregnant females. During this period, the rate of population growth was approximately 8.6% (SE=1.47) per year (A. York unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115), the maximum recorded for this species. This growth rate is similar and slightly higher than the 8.12% rate of increase (approximate SE=1.29) estimated by Gerrodette et al. (1985). Though not as high as growth rates estimated for other fur seal species, the 8.6% rate of increase is considered a reliable estimate of R_{MAX} given the extremely low density of the population in the early 1900s.

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 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 2.2 (CV=0.39). 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 1996, 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. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 (see Appendix 4).

Table 5. Summary of incidental mortality of northern fur seals (Eastern Pacific 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 Islands groundfish trawl	90-96	obs data	53-74%	0, 3, 4, 1, 2, 0, 1	0, 6, 5, 1, 3, 0, 2	2.2 (CV=0.39)
Observer program total						2.2 (CV=0.39)
				Reported mortalities		
Prince William Sound salmon drift gillnet	90-96	self reports	n/a	1, 1, 0, 0, n/a, n/a, n/a	n/a	[$0.5]
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90-96	self reports		2, 0, 0, 0, n/a, n/a, n/a	n/a	[$0.5]
Bristol Bay salmon drift gillnet	90-96	self reports	n/a	5, 0, 49, 0, n/a, n/a, n/a	n/a	[$13.5]
Minimum total annual mortality						$16.7 (CV=0.39)

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 17 fur seals per year based on observer data (2), 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 (17) is less that 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 (17 + 1,708 = 1,725) 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 Scientific Review Group 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.

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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).

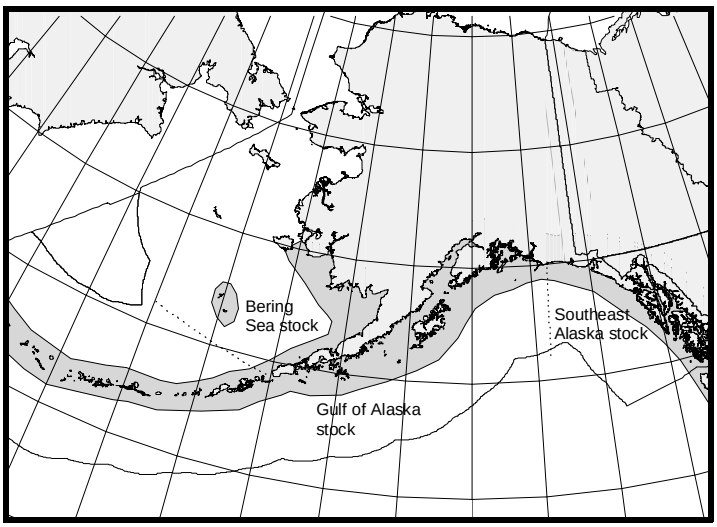

Figure 7. Approximate distribution of harbor seals in Alaska waters (shaded area).

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 (144EW), 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.

During August of 1997 aerial surveys of harbor seals in the northern portion of Southeast Alaska were completed. Aerial surveys for harbor seals in the southern portion of Southeast Alaska are scheduled for August of 1998. Results of these two surveys will be available in the Spring of 1999.

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 reports	n/a	8, 1, 4, 2, n/a, n/a, n/a	n/a	[$3.75]
Yakutat salmon set gillnet	90-96	self reports	n/a	0, 18, 31, 61, n/a, n/a, n/a	n/a	[$27.5]
Minimum total annual mortality						$35.25 (CV=1.0)

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

Subsistence/Native Harvest Information

The 1992-96 subsistence harvest of harbor seals in Alaska was estimated by the Alaska Department of Fish and Game, under contract with NMFS (Table 6b: Wolfe and Mishler 1993, 1994, 1995, 1996, 1997). In each year, data were collected through systematic interviews with hunters and users of marine mammals in approximately 2,100 households in about 60 coastal communities within the geographic range of the harbor seal in Alaska. Interviews were conducted in 18 communities in Southeast Alaska. The statewide total subsistence take of harbor seals in 1992 was estimated at 2,888 (95% CI 2,320-3,741), with 2,535 harvested and 353 struck and lost. The total subsistence take in 1993 was estimated at 2,736 (95% CI 2,334-3,471), with 2,365 harvested and 371 struck and lost. The total subsistence take in 1994 was estimated at 2,621 (95% CI 2,110-3,457), with 2,313 harvested and 308 struck and lost. The total subsistence take in 1995 was estimated at 2,742 (95% CI 2,184-3,679), with 2,499 harvested and 243 struck and lost. The total subsistence take in 1996 was estimated at 2,741 (95% CI 2,378-3,479), with 2,415 harvested and 327 struck and lost.

Table 6b provides a summary of the subsistence harvest information for the Southeast Alaska stock. The mean annual subsistence take from this stock of harbor seals, including struck and lost, over the 3-year period from 1994 to 1996 was 1,749 animals. The reported average age-specific kill of the harvest from the Southeast Alaska stock since 1992 was 85% adults, 7% juveniles, 1% pups, and 7% of unknown age. The reported average sex-specific kill of the harvest was 49% males, 24% females, and 27% of unknown sex.

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

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

Other Mortality

Illegal intentional killing of harbor seals occurs, but the magnitude of this mortality is unknown (Note: the 1994 Amendments to the MMPA made intentional lethal take of any marine mammal illegal except where imminently necessary to protect human life).

STATUS OF STOCK

Harbor seals are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. A reliable estimate of the annual rate of mortality incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the kill rate is insignificant. At present, annual mortality levels less than 211 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. Based on currently available data, the estimated annual level of total human-caused mortality is 1,785 (36 + 1,749) harbor seals. Although considered unlikely due to stable or increasing trends, it is unknown if the estimated annual level of total human-caused mortality and serious injury exceeds the PBR (2,114) for this stock. Until additional information on mortality incidental to commercial fisheries becomes available, the Southeast Alaska stock of harbor seals is not classified as strategic. This classification is consistent with the recommendations of the Alaska Scientific Review Group (DeMaster 1995: p. 14). The status of this stock relative to its Optimum Sustainable Population size is unknown.

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HARBOR SEAL (*Phoca vitulina richardsi*): Gulf of 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 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).

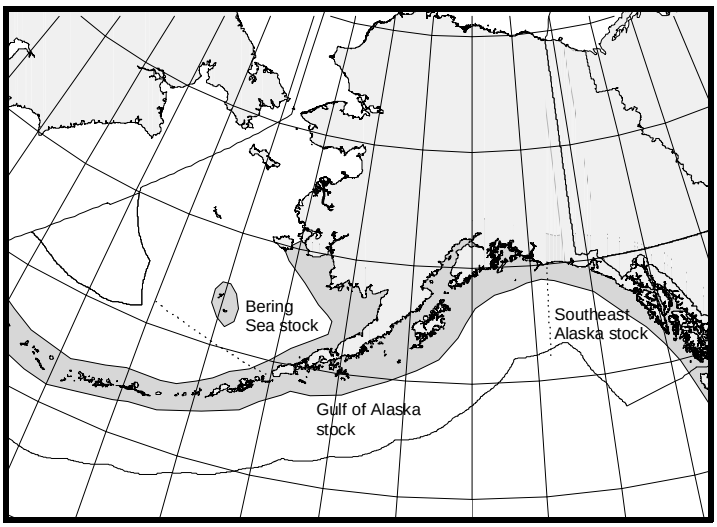

Figure 8. Approximate distribution of harbor seals in Alaska waters (shaded area).

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 (144EW), 2) the Gulf of Alaska

stock - occurring from Cape Suckling to Unimak Pass, including animals throughout the Aleutian Islands, and 3) the Bering Sea stock - including all waters north of Unimak Pass (Fig. 8). Information concerning the three harbor seal stocks recognized along the West Coast of the continental United States can be found in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

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

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

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

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

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

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

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 29,175 and its associated CV(N) of 0.052, N_{MIN} for this stock of harbor seals is 27,917. Including the minimum population estimate for Columbia Bay (1,000 animals) results in an N_{MIN} of 28,917 harbor seals for the Gulf of Alaska stock.

Current Population Trend

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

In Prince William Sound, harbor seal numbers declined by 57% from 1984 to 1992 (Pitcher 1989, Frost and Lowry 1993). The decline began before the 1989 *Exxon Valdez* oil spill, was greatest in the year of the spill, and may have lessened thereafter. Between 1989 and 1995 aerial survey counts of 25 haulout sites in Prince William Sound (trend route A) showed significant declines in the number of seals during the molt (19%) and during pupping (31%) (Frost et al. 1996). Adjusted molt period counts for 1996 were 15% lower than the 1995 counts, indicating that harbor seal numbers in Prince William Sound have not yet recovered from the spill or whatever was causing the decline and that the long-term decline has not ended (Frost et al. 1997).

A steady decrease in numbers of harbor seals has been reported throughout the Kodiak Archipelago from the mid-1970s to the 1990s. On southwestern Tugidak Island, formally one of the largest concentrations of harbor seals in the world, counts declined 85% from 1976 (6,919) to 1988 (1,014) (Pitcher 1990). More recently, the Tugidak Island count has increased from 769 in 1992 to 1,420 in 1996 (Small 1996, Withrow and Loughlin 1997), although this still only represents a fraction of its historical size. The population around Kodiak Island, based on an aerial photographic route established in 1992, is estimated to have increased at 7.2% annually from 1992-96 (Small et al. 1997). Despite some positive signs of growth in certain areas, the overall Gulf of Alaska stock size remains small compared to its size in the 1970s and 1980s.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reliable rates of maximum net productivity have not been estimated for the Gulf of Alaska or Bering Sea harbor seal stock. Population growth rates were estimated at 6% and 8% between 1991 and 1992 in Oregon and Washington, respectively (Huber et al. 1994). Harbor seals have been protected in British Columbia since 1970, and the population has responded with an annual rate of increase of approximately 12.5% since 1973 (Olesiuk et al. 1990). However, until additional data become available from which more reliable estimates of population growth can be determined, it is recommended that the pinniped maximum theoretical net productivity rate (R_{MAX}) of 12% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 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, 1 mortality was used as both the observed mortality and estimated mortality in 1995 for that fishery, and should be considered a minimum estimate.

Table 7a. Summary of incidental mortality of harbor seals (Gulf of Alaska stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information or stranding data. Data from 1992 to 1996 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. n/a indicates that data are not available.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Gulf of Alaska (GOA) groundfish trawl	90-96	obs data	33-55%	0, 1, 1, 0, 0, 0, 0	0, 3, 2, 0, 0, 0, 0	0.4 (CV=1.0)
GOA finfish pot	90-96	obs data	5-13%	0, 0, 0, 0, 0, 1, 0	0, 0, 0, 0, 0, 1, 0	0.2 (CV=1.0)
Prince William Sound salmon drift gillnet	90-91	obs data	4-5%	2, 1	36, 12	24 (CV=0.50)
Alaska Peninsula/Aleutian Islands salmon drift gillnet	90	obs data	4%	0	0	0
Observer program total						24.6 (CV=0.49)
				Reported mortalities		
Cook Inlet salmon set gillnet	90-96	self reports	n/a	6, 0, 1, 0, n/a, n/a, n/a	n/a	[$1.75]
Prince William Sound set gillnet	90-96	self reports	n/a	0, 0, 0, 1, n/a, n/a, n/a	n/a	[$0.25]
Kodiak salmon set gillnet	90-96	self reports	n/a	3, 0, 0, 0, n/a, n/a, n/a	n/a	[$0.75]
Alaska salmon purse seine (except for Southeast)	90-96	self reports	n/a	0, 0, 0, 2, n/a, n/a, n/a	n/a	[$0.5]
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; however, a final agreement has not been approved to date.

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.

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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).

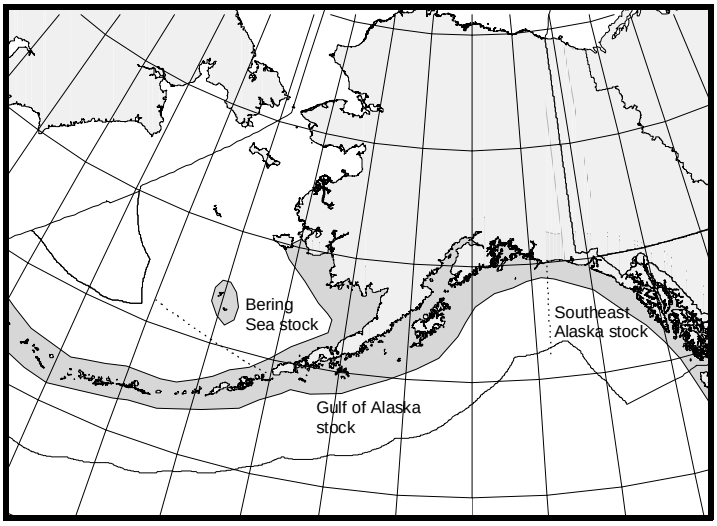

Figure 9. Approximate distribution of harbor seals in Alaska waters (shaded area).

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 1996b); 3) Phenotypic data: clinal variation in body size and color phase (Shaughnessy and Fay 1977, Kelly 1981); 4) Genotypic data: undetermined for Alaska, mitochondrial DNA analyses currently underway. Preliminary genetic data indicate substantial variation in mtDNA suggesting at least two genetically distinct stocks in Alaska (Westlake and O'Corry-Crowe 1997). However, until additional samples are analyzed the Alaska Scientific Review Group (SRG) recommended using the same stock boundaries as in the Stock Assessment Reports for 1996 (Hill et al. 1997).

The Alaska SRG concluded that the scientific data available to support three distinct biological stocks (i.e., genetically isolated populations) were equivocal. However, the Alaska SRG recommended that the available data were sufficient to justify the establishment of three management units for harbor seals in Alaska (DeMaster 1996). Further, the SRG recommended that, unlike the stock structure reported in Small and DeMaster (1995), animals in the Aleutian Islands should be included in the same management unit as animals in the Gulf of Alaska. As noted above, this recommendation has been adopted by NMFS with the caveat that management units and stocks are equivalent for the purposes of managing incidental take under section 118 of the Marine Mammal Protection Act (Wade and Angliss 1997). Therefore, based primarily on the significant population decline of seals in the Gulf of Alaska, the possible decline in the Bering Sea, and the stable population in Southeast Alaska (see Current Population Trend section in the respective harbor seal report for details), three separate stocks are recognized in Alaska waters: 1) the Southeast Alaska stock - occurring from the Alaska/British Columbia border to Cape Suckling, Alaska (144EW), 2) the Gulf of Alaska

stock - occurring from Cape Suckling to Unimak Pass, including animals throughout the Aleutian Islands, and 3) the Bering Sea stock - including all waters north of Unimak Pass (Fig. 9). Information concerning the three harbor seal stocks recognized along the West Coast of the continental United States can be found in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

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

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

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

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this stock is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. 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 be declining (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 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.

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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).

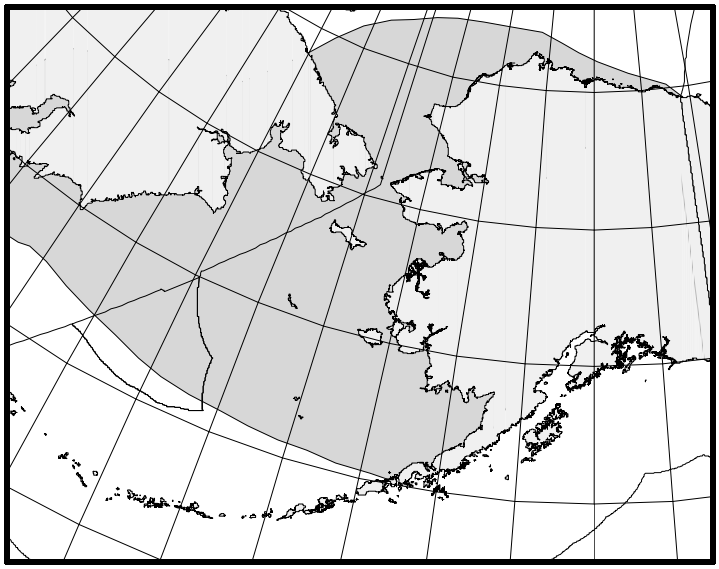

Figure 10. Approximate distribution of spotted seals in Alaska waters (shaded area).

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).

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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.

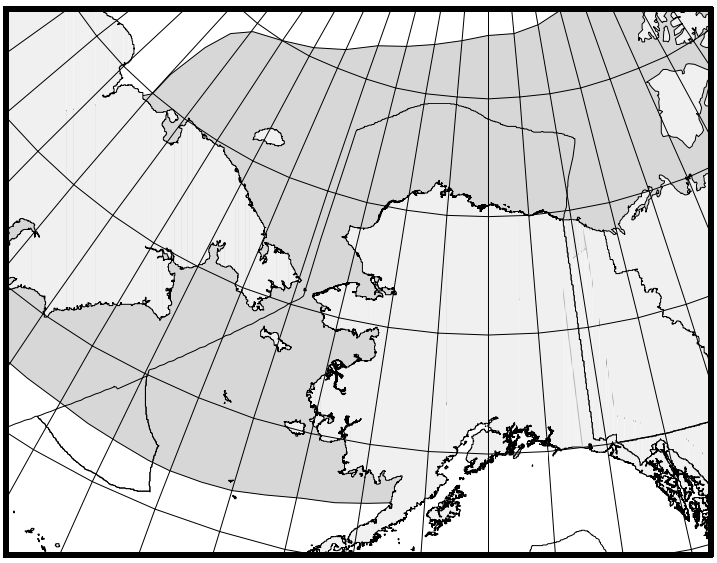

Figure 11. Approximate distribution of bearded seals in Alaska waters (shaded area). The combined summer and winter distributions are depicted.

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).

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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.

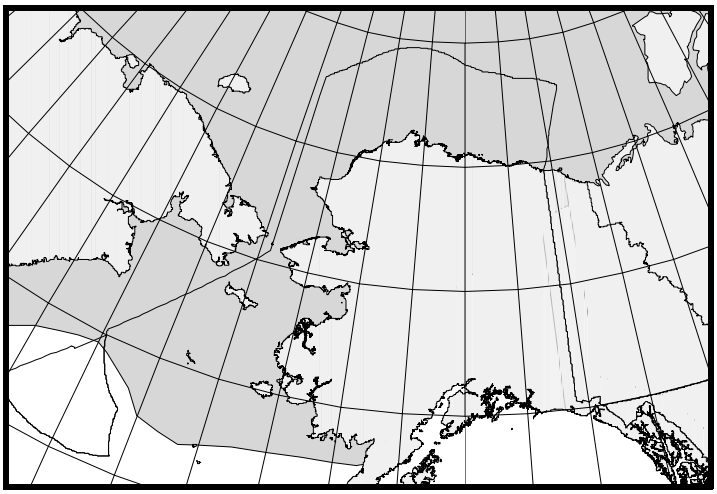

Figure 12. Approximate distribution of ringed seals in Alaska waters (shaded area). The combined summer and winter distribution is depicted.

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: pp. 26).

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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).

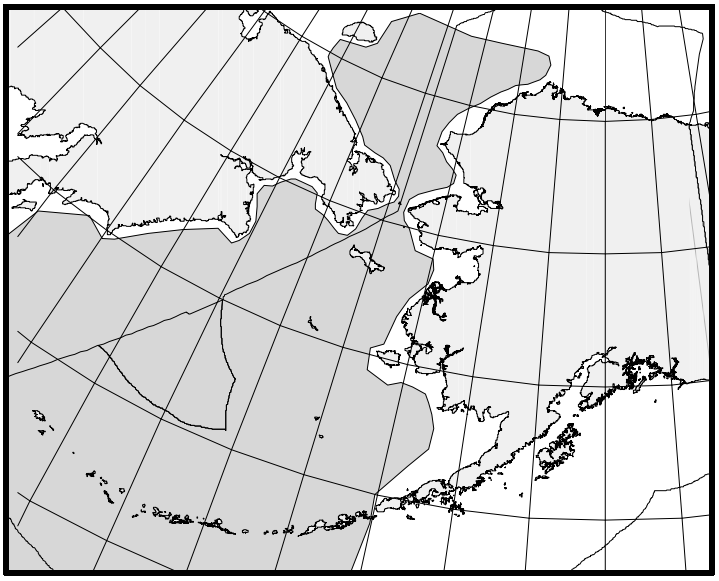

Figure 13. Approximate distribution of ribbon seals in Alaska waters (shaded area). The combined summer and winter distribution is depicted.

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: pp. 26).

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