Revised 11/6/04

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 3% of the population is found on Bogoslof Island in the southern Bering Sea and on San Miguel Island off southern California (NMFS 1993). Northern fur seals may temporarily haul out onto land at other sites in Alaska, British Columbia, and on islets along the coast of the continental United States, but generally do so outside of the breeding season (Fiscus 1983).

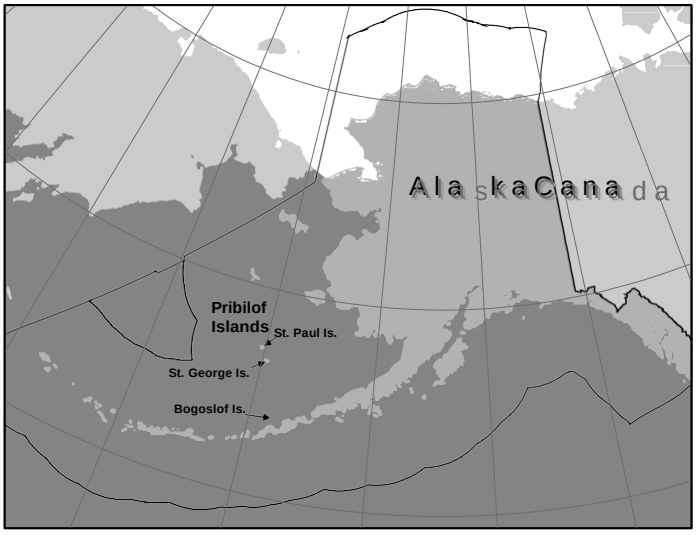

Figure 5. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

Due to differing requirements during the annual reproductive season, adult males and females typically occur ashore at different, though overlapping times. Adult males usually occur on shore during the 4-month period from May-August, though some may be present until November (well after giving up their territories). Adult females are found ashore for as long as 6 months (June-November). Following their respective times ashore, seals of both genders then migrate south and spend the next 7-8 months at sea (Roppel 1984). Adult females and pups from the Pribilof Islands migrate through the Aleutian Islands into the North Pacific Ocean, often to the Oregon and California offshore waters (Ream et al. 2005). 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 in the eastern North Pacific (Kajimura 1984) and the Kuril Islands in the western North Pacific (Loughlin et al. 1999). 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 (Baker et al. 1995; 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: little evidence of genetic differentiation among breeding islands in the Bering Sea (Ream 2002). Based on this information, two separate stocks of northern fur seals are recognized within U. S. waters: an Eastern Pacific stock and a San Miguel Island stock. The San Miguel Island stock is reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

The population estimate for the Eastern Pacific stock of northern fur seals is calculated as the estimated number of pups at rookeries multiplied by a series of different expansion factors determined from a life table analysis to estimate the number of yearlings, 2 year olds, 3 year olds, and animals at least 4 years old (Lander 1981). The resulting population estimate is equal to the pup count multiplied by 4.5. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. Currently, CVs are unavailable for the expansion factor. As the great majority of pups are born on the Pribilof Islands, pup estimates are concentrated on these islands, though additional counts have been made on Bogoslof Island. Since 1990, pup counts have occurred biennially on St. Paul and St. George Islands, although less frequently on Sea Lion Rock and Bogoslof

Island (Table 7). The most recent estimate for the number of fur seals in the Eastern Pacific stock, based on the preliminary pup count from 2004, is 688,028 (4.5 + 152,895).

Table 7. Estimates and/or counts of northern fur seal pups born on the Pribilof Islands and Bogoslof Island. Standard errors and the CV for haulout locations and the total abundance estimate, respectively, are provided in parentheses.

	Haulout location				
Year	**St. Paul**	**Sea Lion Rock**	**St. George**	**Bogoslof**	**Total**
1992*	182,437 (8,919)	10,217 (568)	25,160 (707)	898 (N/A)	218,712 (0.041)
1994	192,104 (8,180)	12,891 (989)	22,244 (410)	1,472 (N/A)	228,711 (0.036)
1996	170,125 (21,244)	"	27,385 (294)	1,272 (N/A)	211,673 (0.10)
1998	179,149 (6,193)	"	22,090 (222)	5,096 (33)	219,226 (0.029)
2000	158,736 (17,284)	"	20,176 (271)	"	196,899 (0.089)
2002	145,716 (1,629)	8,098 (191)	17,593 (527)	"	176,503 (0.01)
2004**	122,825 (1290)	"	16,876 (415)	"	152,895 (0.01)

* Incorporates the 1990 estimate for Sea Lion Rock and the 1993 count for Bogoslof Island
** Preliminary data from 2004

Minimum Population Estimate

A CV(N) that incorporates the variance due to the correction factor is not currently available. Consistent with a recommendation of the Alaska Scientific Review Group (SRG) and recommendations contained in Wade and Angliss (1997), a default CV(N) of 0.2 was used in the calculation of the minimum population estimate (N_{MIN}) for this stock (DeMaster 1998). N_{MIN} is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842+[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 688,028 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 676,540.

Current Population Trend

The Alaska population of northern fur seals increased to approximately 1.25 million in 1974 after the killing of females in the pelagic fur seal harvest was terminated in 1968. The population then began to decrease with pup production declining at a rate of 6.5-7.8% per year into the 1980s (York 1987). By 1983 the total stock estimate was 877,000 (Briggs and Fowler 1984). Annual pup production on St. Paul Island remained relatively stable between 1981 and 1996 (Fig. 6; York and Fowler 1992). There has been a decline in pup production on St. Paul Island since the mid-1990s. Although there was a slight increase in the number of pups born on St. George Island in 1996, the number of pups born declined between 1996 and 1998, and the 1998 counts were similar to those obtained in 1990, 1992, and 1994 (Fig. 7). During 1998-02, pup production declined 4.99% per year (SE = 0.27%; p = 0.03) on St. Paul Island and 5.29% per year (SE = 0.72%; p = 0.08) on St. George Island (NMML unpublished data). Based on preliminary data from 2004, the pup production estimate in 2004 was 15.7% and 4.1% below the 2002 estimates on St. Paul Island and St. George Island, respectively. Counts in 2000, 2002, and preliminary counts from 2004 were lower than previous years; the estimated pup production is now below the 1921 level on St. Paul Island and below the 1916 level on St. George Island.

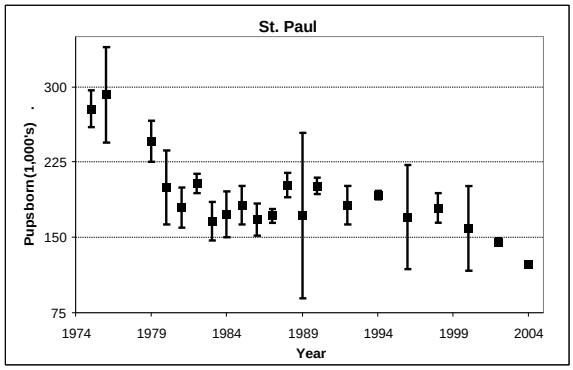

Figure 6. Estimated number of northern fur seal pups born on St. Paul Island, 1975-2004.

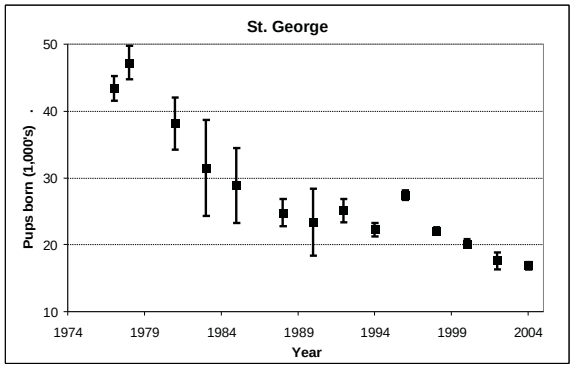

Figure 7. Estimated number of northern fur seal pups born on St. George Island, 1977-2004.

The northern fur seal was designated as "depleted" under the Marine Mammal Protection Act (MMPA) in 1988 because population levels had declined to less than 50% of levels observed in the late 1950s (1.8 million animals; 53 FR 17888, 18 May 1988) and there was no compelling evidence that carrying capacity (K) had changed substantially since the late 1950s (NMFS 1993). Under the MMPA, this stock will remain listed as depleted until population levels reach at least the lower limit of its optimum sustainable population (estimated at 60% of K; 1,080,000).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized MMPA, the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} + 0.5R_{MAX} + F_R$. 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 = 14,546 animals (676,540 + 0.043 + 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

The NMFS estimate of the total number of northern fur seals killed incidental to both the foreign and the joint U. S.-foreign commercial groundfish trawl fisheries in the North Pacific from 1978 to 1988 was 246 (95% CI: 68 - 567), resulting in an estimated mean annual rate of 22 northern fur seals (Perez and Loughlin 1991). The foreign high seas driftnet fisheries also incidentally killed large numbers of northern fur seals, with an estimated 5,200 (95% CI: 4,500 - 6,000) animals taken during 1991 (Larntz and Garrott 1993). These estimates were not included in the mortality rate calculation because the fisheries are no longer operative, although some low level of illegal fishing may still be occurring. Commercial net fisheries in international waters of the North Pacific Ocean have decreased significantly in recent years. The assumed level of incidental catch of northern fur seals in those fisheries, though unknown, is thought to be minimal (T. Loughlin, NMFS-NMML, pers. comm.).

Until 2003, there were six different federally-regulated commercial fisheries in Alaska that could have interacted with northern fur seals and were monitored for incidental mortality by fishery observers. As of 2003, changes in fishery definitions in the List of Fisheries have resulted in separating these six fisheries into 22 fisheries

(69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort, but provides managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (in review). The only federally observed fishery in which incidental mortality occurred was the Bering Sea and Aleutian Islands flatfish trawl (Table 8, with a mean annual (total) mortality of 0.48; 95% CI = 0.20 – 0.57; Perez, in review).

Observer programs for five Alaska commercial fisheries have not documented any takes of fur seals. In 1990 and 1991, observers monitored the Prince William Sound salmon drift gillnet fishery and recorded no mortalities of northern fur seals. In 1990, observers 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 8). Observer programs have recently been implemented in the Cook Inlet salmon set and drift gillnet fisheries (Manly in review) and in a portion of the Kodiak drift gillnet fishery (Manly et al. in review). Observer coverage in the Cook Inlet drift gillnet fishery was 1.75% and 3.73% in 1999 and 2000, respectively. The observer coverage in the Cook Inlet set gillnet fishery was 7.3% and 8.3% in 1999 and 2000, respectively (Manly in review). Observer coverage in the Kodiak drift gillnet fishery was 7.5% of the fishing permit days. No serious injuries or mortalities of northern fur seals were observed during the course of either observer program.

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 2003, fisher self-reports from three unobserved fisheries (see Table 8) resulted in an annual mean of 14.5 mortalities from interactions with commercial fishing gear. While logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), the bias in these estimates are hard to quantify because at least in one area (Prince William Sound), it is unlikely that fur seals occur and reports of fur seal-fishery interactions are likely the result of species misidentification. The great majority of the incidental take in fisher self-reports occurred in the Bristol Bay salmon drift net fishery. In 1990, self-reports from the Bristol Bay set and drift gillnet fisheries were combined. As a result, some of the northern fur seal mortalities reported in 1990 may have occurred in the set net fishery. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 for details).

Table 8. Summary of incidental mortality of northern fur seals (Eastern Pacific stock) due to commercial fisheries from 1990 through 2003 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1997 to 2003 (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. Details of how percent observer coverage is measured is included in Appendix 6. N/A indicates that data are not available.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Islands flatfish trawl	1999 2000 2001 2002 2003	obs data	66.3 64.5 57.6 58.4 64.1	0 0 1 0 0	0 1 1 0 0	0.48 (CV = 0.53)
Observer program total						0.48 (CV = 0.53)

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
				Reported mortalities		
Prince William Sound salmon drift gillnet	90-03	self reports	N/A	1, 1, 0, 0 1994-2003: N/A	N/A	[Ķ0.5]
Alaska Peninsula/ Aleutian Islands salmon drift gillnet	90-03	self reports		2, 0, 0, 0 1994-2003: N/A	N/A	[Ķ0.5]
Bristol Bay salmon drift gillnet	90-03	self reports	N/A	5, 0, 49, 0 1994-2003: N/A	N/A	[Ķ13.5]
Minimum total annual mortality						15 (CV = 0.53)

There are several fisheries which are known to interact with northern fur seals and have not been observed (Appendices 4 and 5). Thus, the estimated mortality rate is likely a minimum estimate. However, the large stock size makes it unlikely that unreported mortalities from those fisheries would be a significant source of mortality for the stock. The estimated minimum annual mortality rate incidental to commercial fisheries is 15 fur seals per year based on observer data (0.48), and self-reported fisheries information (14.5) where observer data were not available.

Entanglement studies on the Pribilof Islands are another source of information on fishery-specific entanglements. Based on entanglement rates and sample sizes presented in Zavadil et al. (2003), an average of 1.1 fur seals/year on the rookeries was entangled in pieces of trawl netting and an average of 0.1 fur seal/year was entangled in monofilament net.

Anecdotal reports of northern fur 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 1998-02 the only fishery-related northern fur seal stranding was reported in September 2001 near Unalaska as entangled in 8-inch poly trawl web. The animal was cut free and was apparently healthy. The NMFS stranding database includes reports of 4 fur seals on St. George that were entangled in fishing gear in 2003; including these animals in an annual average will be delayed until comparisons between these data and those from entanglement studies (e.g., Zavadil et al. 2003) can be cross-referenced.

Subsistence/Native Harvest Information

Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, with a take range determined from annual household surveys. Only juvenile males are taken in the subsistence harvest, which likely results in a much smaller impact on population growth than a harvest of equal proportions of males and females. A few females were taken in 1996, 1997, and 1998, but no females are known to have been taken since the late 1990s (Alaska Regional Office 2005). 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). Between 1999 and 2003, there was an annual average of 869 seals harvested per year in the subsistence hunt (Table 9).

Table 9. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands St. Paul data provided in Lestenkof and Zavadil 2001, and Zavadil et al. 2003; St. George data provided by NMFS (D. Cormany, NMFS, pers. comm.)

Year	St. Paul	St. George	Total harvested
1999	1000	193	1193
2000	747	121	868
2001	597	184	781
2002	648	203	851
2003	522	132	654
Mean annual take (1999-2003)			869

Other Mortality

Intentional killing of northern fur seals by commercial fishers, sport fishers, and others may occur, but the magnitude of this mortality is unknown. Such shooting has been illegal since the species was listed as "depleted" in 1988. (Note: the 1994 Amendments to the MMPA made intentional lethal take of any marine mammal illegal except for subsistence hunting by Alaska Natives or where imminently necessary to protect human life).

Mortality resulting from entanglement in marine debris has been implicated as a contributing factor in the decline observed in the northern fur seal population on the Pribilof Islands during the 1970s and early 1980s (Fowler 1987, Swartzman et al. 1990, Fowler 2002). Surveys conducted from 1995 to 1997 on St. Paul Island indicate a rate of entanglement among subadult males comparable to the 0.2% rate observed from 1988 to 1992 (Fowler and Ragen 1990, Fowler et al. 1994), which is lower than the rate of entanglement (0.4%) observed during 1976-85 (Fowler et al. 1994). Between 1995 and 2000, responsibility for entanglement studies of northern fur seals shifted gradually from NMML to the Tribal Government of St. Paul's Ecosystem Conservation Office (ECO). ECO has managed the entanglement studies under a co-management agreement with NOAA for northern fur seals since 2000. Entanglement rates of male northern fur seals on St. Paul from 1998 to 2002 were 0.2, 0.26, 0.25, 0.3, and 0.37 (Zavadil et al. 2003). The recent rates of entanglements are close to those recorded in the mid-1980s; however, recent changes in methodology (counting juvenile males vs. all males) make direct comparisons between recent and historical data difficult (Zavadil et al. 2003). In 2002, the composition of entangling debris switched from predominantly packing bands to trawl net fragments (Zavadil et al. 2003). The NMFS stranding database includes reports of 5 fur seals on St. George that were entangled in debris in 2003; including these animals in an annual average will be delayed until comparisons between the NMFS data and those from entanglement studies (e.g., Zavadil et al. 2003) can be cross-referenced.

STATUS OF STOCK

Based on currently available data, the minimum estimated fishery mortality and serious injury for this stock (15) is less than 10% of the calculated PBR (1455) 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 (15 + 869 + 1.1 = 885.1) is not known to exceed the PBR (14,546) 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.

Habitat Concerns

Northern fur seals forage on a variety of fish species, including pollock (34% of fish species consumed between 1958 and 1974; Perez 1997). As of the 1990s, some prey items, such as capelin, have disappeared entirely from fur seal diet and pollock consumption has tripled (Sinclair et al. 1994, Sinclair et al. 1996, Antonelis et al. 1997). Fishing effort displaced by Steller sea lion protection measures may have moved to areas important to fur seals; recent tagging studies have shown that lactating female fur seals from St. Paul and St. George Islands forage in specific and very different areas (Robson et al. 2004). The proportion of the total June-October pollock catch in fur seal foraging habitat (defined as the combined home ranges of females from the Pribilofs) increased from an average of 40% between 1995 and 1998 to 65% from 1999 to 2002 (NMFS unpublished data). The impact, if any, of this shift in fishing effort on the northern fur seal population is unknown.

There is concern that a variety of human activities other than commercial fishing may impact northern fur seals. These activities will be identified in a conservation plan that is currently being developed by NMFS and research projects to address the levels of impact will be recommended in that document.

CITATIONS

Alaska Regional Office. 2005. Setting the annual subsistence harvest of the northern fur seals on the Pribilof Islands, Final Environmental Impact Statement. U.S. Dep. Commer., NMFS, Alaska Regional Office, P.O. Box 21668, Juneau, AK 99802, 208 pp.

Antonelis, G. A., E. H. Sinclair, R. R. Ream, and B. W. Robson. 1997. Inter-island variation in the diet of female northern fur seals (*Callorhinus ursinus*) in the Bering Sea. J. Zool., Lond. 242: 435-451.

Baker, J. D., G. A. Antonelis, C. W. Fowler, and A. E. York. 1995. Natal site fidelity in northern fur seals, *Callorhinus ursinus*. Anim. Behav. 50(1): 237-247.

Briggs, L., and C. W. Fowler. 1984. Table and figures of the basic population data for northern fur seals of the Pribilof Islands. *In* Background papers submitted by the United States to the 27th annual meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, March 29-April 9, 1984, Moscow, U.S.S.R. (available on request - National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA, 98115).

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1, 96 pp.

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

DeLong, R. L., and G. A. Antonelis. 1991. Impacts of the 1982-1983 El Niño on the northern fur seal population at San Miguel Island, California. Pp. 75-83 *In* F. Trillmich and K. Ono (eds.), Pinnipeds and El Niño: responses to environmental stress. University of California Press: Berkeley, CA.

DeMaster, D. P. 1998. Minutes from sixth meeting of the Alaska Scientific Review Group, 21-23 October 1997, Seattle, Washington. 40 pp. (Available upon request - National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

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

Fiscus, C.F. 1983. Fur seals. *In* Background papers submitted by the United States to the 26th annual meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, Washington, D.C., 28 March -5 April, 1983. (available upon request - National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.)

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

Fowler, C. W., and T. J. Ragen. 1990. Entanglement studies, St. Paul Island, 1989; Juvenile male roundups. U.S. Dep. Commer., NWAFC Processed Rep. 90-06, 39 pp. (Available upon request - Alaska Fish. Sci. Cent., NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115).

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

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

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

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal, *Callorhinus ursinus*, in the eastern North Pacific Ocean and eastern Bering Sea. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-779, 49 pp.

Lander, R. H. 1981. A life table and biomass estimate for Alaskan fur seals. Fish. Res. (Amst.) 1:55-70.

Lander, R. H., and H. Kajimura. 1982. Status of northern fur seals. FAO Fisheries Series 5:319-345.

Larntz, K., and R. Garrott. 1993. Analysis of 1991 bycatch of selected mammal species in the North Pacific neon squid driftnet fishery. Final contract report prepared for the NMFS, 68 pp. + appendices.

Lestenkof, A.D., and P. A. Zavadil. 2001. 2001 subsistence fur seal harvest season report. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska.

Loughlin, T. R., W. J. Ingraham, Jr., N. Baba, and B. W. Robson. 1999. Use of a surface-current model and satellite telemetry to assess marine mammal movements in the Bering Sea. University of Alaska Sea Grant Press, AK-SG-99-03, Fairbanks, AK.

Manly, B. F. J. In review. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Draft report to NMFS Alaska Region. 83 pp.

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

National Marine Fisheries Service. 1993. Final Conservation Plan for the northern fur seal (*Callorhinus ursinus*). Prepared by the National Marine Mammal Laboratory/Alaska Fisheries Science Center, Seattle, Washington, and the Office of Protected Resources/National Marine Fisheries Service, Silver Spring, Maryland. 80 pp.

Perez, M. A., and T. R. Loughlin. 1991. Incidental catch of marine mammals by foreign-directed and joint-venture fishing vessels in the U.S. EEZ of the North Pacific, 1973-1988. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-104, 57 pp.

Perez, M. A. 1997. Data on the diet of northern fur seal (*Callorhinus ursinus*) with tags identifying island of origin collected by the United States and Canada during 1958-74 in the North Pacific and Bering Sea. Pp. 99-132. *In* E. H. Sinclair (ed.), Fur seal investigations, 1995. U.S. Dep. Commer., NOAA Tech. Memo. NMFS AFSC-86.

Perez, M. A. In review. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish species. NOAA Tech. Memo. NMFS-AFSC-xxx.

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

Ream, R. R., J. T. Sterling, and T. R. Loughlin. 2005. Oceanographic features related to northern fur seal migratory movements. Deep-Sea Research II 52: 823-843.

Robson, B. R., M. E. Goebel, J.D. Baker, R. R. Ream, T. R. Loughlin, R. C. Francis, G. A. Antonelis, and D. P. Costa. 2004. Separation of foraging habitat among breeding sites of a colonial marine predator, the northern fur seal (*Callorhinus ursinus*). Can. J. Zool. 82:20-29.

Roppel, A. Y. 1984. Management of northern fur seals on the Pribilof Islands, Alaska, 1786-1981. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-4, 32 pp.

Sinclair, E. H., G. A. Antonelis, B. W. Robson, R. R. Ream, and T. R. Loughlin. 1996. Northern fur seal, *Callorhinus ursinus*, predation on juvenile walleye pollock, *Theragra chalcogramma*. Pp. 167-178. *In* R. D. Brodeur, P. A. Livingston, T. R. Loughlin, and A. B. Hollowed (eds.), Ecology of walleye pollock, *Theragra chalcogramma*. U.S. Dep. Commer. NOAA Tech. Rep. NMFS 126.

Sinclair, E., T. Loughlin, and W. Pearcy. 1994. Prey selection by northern fur seals (*Callorhinus ursinus*) in the eastern Bering Sea. Fish. Bull., U.S. 92(1): 144-156.

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

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

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

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

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

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

Zavadil, P. A., and A. D. Lestenkof. 2003. The subsistence harvest of northern fur seals on St. Paul Island in 2003. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office. St. Paul Island, Pribilof Islands, Alaska. 6 pp.

Zavadil, P. A., A. D. Lestenkof, M. T. Williams, and S. A. MacLean. 2003. Assessment of northern fur seal entanglement in marine debris on St. Paul Island, Alaska in 2002. Unpublished report available from the Aleut Community of St. Paul Island, Ecosystem Conservation Office. 12 pp.