Revised 1/15/2008

NORTHERN FUR SEAL (*Callorhinus ursinus*): Eastern Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern fur seals occur from southern California north to the Bering Sea (Fig. 5) and west to the Okhotsk Sea and Honshu Island, Japan. During the summer breeding season, most of the worldwide population is found on the Pribilof Islands in the southern Bering Sea, with the remaining animals on rookeries in Russia, on Bogoslof Island in the southern Bering Sea, and on San Miguel Island off southern California (Lander and Kajimura 1982; NMFS 1993). Non-breeding northern fur seals may occasionally haul out on land at other sites in Alaska, British Columbia, and on islets along the west coast of the United States (Fiscus 1983).

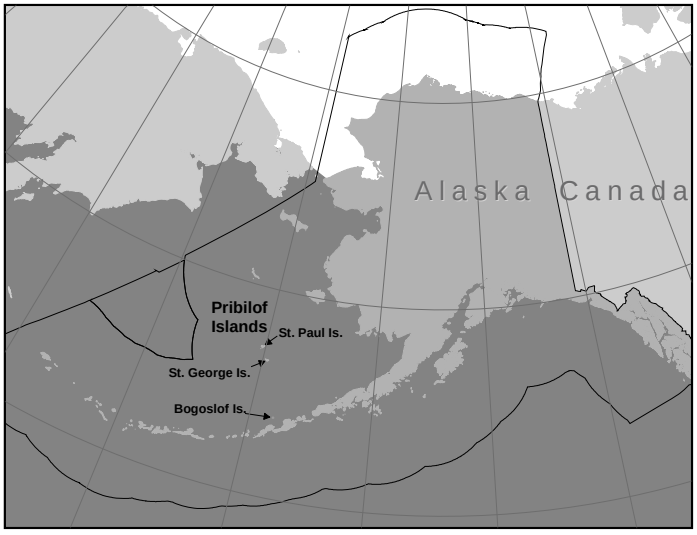

Figure 5. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

During the reproductive season, adult males usually are on shore during the four month period from May-August, though some may be present until November (well after giving up their territories). Adult females are ashore for as long as six months (June-November). Following their respective times ashore, seals of both genders then move south and remain at sea until the next breeding season (Roppel 1984). Adult females and pups from the Pribilof Islands move through the Aleutian Islands into the North Pacific Ocean, often to the waters offshore of Oregon and California. Adult males generally move only as far south as the Gulf of Alaska in the eastern North Pacific (Kajimura 1984) and the Kuril Islands in the western North Pacific (Loughlin et al. 1999). Pups are born during summer months, leave the rookeries in the fall, and generally remain at sea for 22 months before returning to their rookery of birth. There is considerable interchange of individuals between rookeries.

Two separate stocks of northern fur seals are recognized within U. S. waters based on the Dizon et al. (1992) phylogeographic approach: 1) Distribution: continuous during feeding and discontinuous during the breeding season, high natal site fidelity (Baker et al. 1995; DeLong 1982); 2) Population response: substantial differences in population dynamics between Pribilof and San Miguel Islands (DeLong 1982, DeLong and Antonelis 1991, NMFS 1993); 3) Phenotypic differentiation: unknown and 4) Genotypic differentiation: little evidence of genetic differentiation among breeding islands (Ream 2002). Thus, an Eastern Pacific stock and a San Miguel Island stock are recognized. The San Miguel Island stock is reported separately in the Stock Assessment Reports for the Pacific Region.

POPULATION SIZE

The population estimate for the Eastern Pacific stock of northern fur seals is calculated as the estimated number of pups 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 4 or more years old (Lander 1981). The resulting population estimate is equal to the pup estimate multiplied by 4.5. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. Currently, CVs are unavailable for the expansion factor. As the great majority of pups are born on St. Paul and St. George Islands, pup estimates are conducted biennially on these islands. Counts are made less frequently on Sea Lion Rock (adjacent to St. Paul Island) and Bogoslof Island (Table 7). The most recent estimate for the number of fur seals in the Eastern Pacific stock, based on pup counts from 2002 on Sea Lion Rock, from 2006 on St. Paul and St. George Islands, and from 2007 on Bogoslof Island, is 687,902 ($4.5 \times 152{,}867$).

Table 7. Estimates and/or counts of northern fur seal pups born on the Pribilof Islands and Bogoslof Island. Standard errors for pup estimates/ counts at rookery locations and the CV for total pup production estimates are provided in parentheses. The " symbol indicates that no new data are available for that year, and thus the most recent estimate/ count was used in determining total annual estimates.

	Rookery location				
Year	**St. Paul**	**Sea Lion Rock**	**St. George**	**Bogoslof**	**Total**
1992[1]	182,437 (8,919)	10,217 (568)	25,160 (707)	898 (N/A)	218,712 (0.041)
1994	192,104 (8,180)	12,891 (989)	22,244 (410)	1,472 (N/A)	228,711 (0.036)
1996	170,125 (21,244)	"	27,385 (294)	1,272 (N/A)	211,673 (0.10)
1998	179,149 (6,193)	"	22,090 (222)	5,096 (33)	219,226 (0.029)
2000	158,736 (17,284)	"	20,176 (271)	"	196,899 (0.089)
2002	145,716 (1,629)	8,262 (191)	17,593 (527)	"	176,667 (0.01)
2004	122,825 (1,290)	"	16,876 (239)	"	153,059 (0.01)
2005	"	"	"	12,631 (335)	160,594 (0.01)
2006	109, 961 (1,520)	"	17,070 (144)	"	147,900 (0.011)
2007	"	"	"	17,574 (843)	152,867 (0.011)

[1] Incorporates the 1990 estimate for Sea Lion Rock and the 1993 count for Bogoslof Island.

Minimum Population Estimate

A CV(N) that incorporates the variance due to the correction factor is not currently available. Consistent with a recommendation of the Alaska Scientific Review Group (SRG) and recommendations contained in Wade and Angliss (1997), a default CV(N) of 0.2 was used in the calculation of the minimum population estimate (N_{MIN}) for this stock (DeMaster 1998). N_{MIN} is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 687,902 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 676,416.

Current Population Trend

Estimates of the size of the Alaska population of northern fur seals increased to approximately 1.25 million in 1974 after the killing of females in the pelagic fur seal harvest was terminated in 1968. The population then began to decrease with pup production declining at a rate of 6.5-7.8% per year into the 1980s (York 1987). By 1983 the total stock estimate was 877,000 (Briggs and Fowler 1984). Annual pup production on St. Paul Island remained stable between 1981 and 1996 (Fig. 6; York and Fowler 1992). There has been a decline in pup production on St. Paul Island since the mid-1990s. Although there was a slight increase in the number of pups born on St. George Island in 1996, the number of pups born declined between 1996 and 1998, and the 1998 counts were similar to those obtained in 1990, 1992, and 1994 (Fig. 7). During 1998-2006, pup production declined 6.1% per year (SE = 0.45%; $P < 0.01$) on St. Paul Island and 3.4% per year (SE = 0.60%; $P = 0.01$) on St. George Island. The estimated pup production in 2006 was below the 1918 level on St. Paul Island and below the 1916 level on St. George Island (Towell et al. 2006; NMFS unpubl. data). The population of northern fur seals at Bogoslof Island has grown at an exponential rate exponential rate since the 1990s. (R. Ream, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, 5 February 2009). The increase in counts from 2005 to 2007 at Bogoslof Island result in a slight increase in overall pup counts from 2006 to 2007; however, this slight increase in total counts is similar to the slight increase in total counts from 2004 to 2005 when new counts from Bogoslof were added to counts from the previous years in other areas to obtain the overall estimate. This slight increase in overall counts from 2006 to 2007 is not considered sufficient to determine an overall decline has ceased.

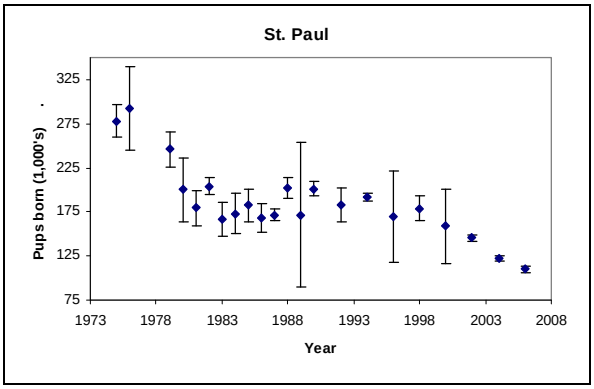

Figure 6. Estimated number of northern fur seal pups born on St. Paul Island, 1970-2006 (modified from Towell et al. 2006).

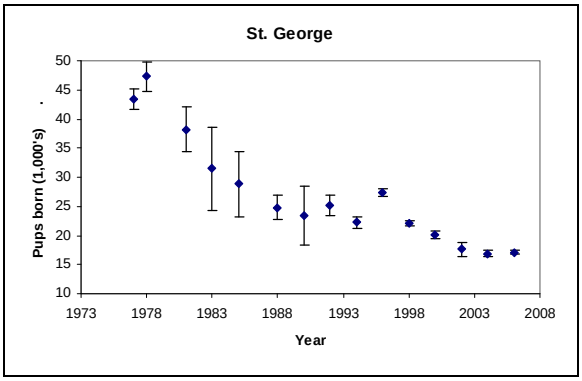

Figure 7. Estimated number of northern fur seal pups born on St. George Island, 1970-2006 (modified from Towell et al. 2006).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The northern fur seal population increased steadily during 1912-1924 after the commercial harvest no longer included pregnant females. During this period, the rate of population growth was approximately 8.6% (SE = 1.47) per year (A. York, unpubl. data, National Marine Mammal Laboratory (retired), 7600 Sand Point Way NE, Seattle, WA 98115), the maximum recorded for this species. This growth rate is similar and slightly higher than the 8.1% rate of increase (approximate SE = 1.29) estimated by Gerrodette et al. (1985). Though not as high as growth rates estimated for other fur seal species, the 8.6% rate of increase is considered a reliable estimate of R_{MAX} given the extremely low density of the population in the early 1900s.

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized MMPA, the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for depleted stocks under the MMPA (Wade and Angliss 1997). Thus, for the Eastern Pacific stock of northern fur seals, PBR = 14,543 animals ($676{,}416 \times 0.043 \times 0.5$).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Historically, northern fur seals were known to be killed incidentally by both the foreign and the joint U. S.-foreign commercial groundfish trawl fisheries (total estimate of 246 northern fur seals killed between 1978 and 1988), as well as the foreign high seas driftnet fisheries (total take estimate in 1991 was 5,200; 95% CI: 4,500-6,000) (Perez and Loughlin 1991; Larntz and Garrott 1993). These estimates are not included in the mortality rate calculation in this SAR because the fisheries are no longer operative, although some low level of illegal fishing may still be occurring. Commercial net fisheries in international waters of the North Pacific Ocean have decreased significantly in recent years. The assumed level of incidental catch of northern fur seals in those fisheries, though unknown, is thought to be minimal (T. Loughlin, pers. comm., National Marine Mammal Laboratory (retired), 7600 Sand Point Way NE, Seattle, WA 98115).

In 2003, changes in fishery definitions in the List of Fisheries resulted in separating six federally-regulated fisheries into 22 fisheries (69 FR 70094, 2 December 2004). This change did not represent a change in fishing effort, but provided managers with better information on the component of each fishery that is responsible for the incidental serious injury or mortality of marine mammal stocks in Alaska. Estimates of marine mammal serious injury/mortality in each of these observed fisheries are provided in Perez (2006) and Perez (unpubl. ms.). The total estimated annual fishery-related incidental mortality in these fisheries is 1.59 (Table 8). More current data on estimated fishery-related serious injury and mortality are being analyzed and will be available for inclusion in the 2010 SARs.

Observer programs for five Alaska commercial fisheries have not documented any takes of fur seals. In 1990 and 1991, observers monitored the Prince William Sound salmon drift gillnet fishery and recorded no

mortalities of northern fur seals. In 1990, observers were on board 300 of the 524 vessels that fished in the Prince William Sound salmon drift gillnet fishery, monitoring a total of 3,166 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). In 1991, observers were on board 531 of the 611 registered vessels and monitored a total of 5,875 sets, or roughly 5% of the estimated sets made by the fleet (Wynne et al. 1992). During 1990, observers also were on board 59 of the 154 vessels participating in the Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery, monitoring a total of 373 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). More recently, observer programs have been conducted in the Cook Inlet salmon set and drift gillnet fisheries (Manly 2006) and in a portion of the Kodiak set gillnet fishery (Manly 2007). Observer coverage in the Cook Inlet drift gillnet fishery was 1.8% and 3.7% in 1999 and 2000, respectively. The observer coverage in the Cook Inlet set gillnet fishery was 7.3% and 8.3% in 1999 and 2000, respectively (Manly 2006). Observer coverage in the Kodiak set gillnet fishery was 6.0% (2002) and 4.9% (2005) of the fishing permit days. No serious injuries or mortalities of northern fur seals were observed during the course of any observer program.

Table 8. Summary of incidental mortality of northern fur seals from the eastern Pacific stock due to commercial fisheries from 2002 through 2006 and calculation of the mean annual mortality rate. Details of how percent observer coverage is measured are included in Appendix 6.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Islands flatfish trawl	2002 2003 2004 2005 2006	obs data	58.4 64.1 64.3 68.3 64.7	0 0 0 1 0	0 0 0 1.5 0	0.30 (CV = 0.23)
Bering Sea/Aleutian Islands pollock trawl	2002 2003 2004 2005 2006	obs data	80.0 82.2 92.8 77.3 73.0	0 0 0 1 0	0 0 0 1 0	0.21 (CV = 0.21)
Bering Sea/Aleutian Islands Pacific cod longline	2002 2003 2004 2005 2006	obs data		0 0 0 0 1	0 0 0 0 6.2	1.08 (CV = 0.89)
Minimum total annual mortality						1.59 (CV = 0.61)

The estimated minimum annual mortality rate incidental to commercial fisheries is 1.9 fur seals per year based on observer data. There are several fisheries that are known to interact with northern fur seals and have not been observed (Appendices 4 and 5). Thus, the estimated mortality rate is likely a minimum estimate. However, the large stock size makes it unlikely that unreported mortalities from those fisheries would be a significant source of mortality for the stock.

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

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

Subsistence/Native Harvest Information

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

Table 9. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands for 2003-2007.

Year	St. Paul	St. George	Total harvested
2003	522[1]	132[2]	654
2004	493[3]	123[4]	616
2005	466[4]	139[4]	605
2006	396[5]	212[6]	608
2007	272[7]	210[8]	482
Mean annual take (2002-2006)			593

[1] Zavadil and Lestenkof 2003; [2] D. Cormany, NMFS, pers. comm.; [3] Malavansky et al. 2005; [4] Lestenkof et al. 2006; [5] Lestenkof and Zavadil 2006; [6] Malavansky and Malavansky 2006, [7] Lestenkof and Zavadil 2007, [8] Malavansky 2007.

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.

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 methods (counting juvenile males vs. all males) make direct comparisons between recent and historical data difficult (Zavadil et al. 2003). In 2002, the composition of entangling debris switched from predominantly packing bands to trawl net fragments (Zavadil et al. 2003).

Mortalities may occasionally occur incidental to marine mammal research activities authorized under MMPA permits issued to a variety of government, academic, and other research organizations. Between 2003-2007, there was a total of 7 mortalities resulting from research on northern fur seals, an average of 1.4 mortalities per year from this stock (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

Based on currently available data, the minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock (1.6) is less than 10% of the calculated PBR (1,454) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The estimated annual level of total human-caused mortality and serious injury (1.6 + 593 + 1.4 = 596) is not known to exceed the PBR (14,543) for this stock. However, given that the population is declining for unknown reasons, and this decline is not explained by the relatively low level of direct human-caused mortality, there is no guarantee that limiting mortalities to the level of the PBR will reverse the decline. The northern fur seal was designated as "depleted" under the Marine Mammal Protection Act (MMPA) in 1988 because population levels had declined to less than 50% of levels observed in the

late 1950s (1.8 million animals; 53 FR 17888, 18 May 1988) and there was no compelling evidence that carrying capacity (K; 1.8 million) had changed substantially since the late 1950s. The Eastern Pacific stock of northern fur seal is classified as a strategic stock because it is designated as "depleted" under the MMPA. This stock will remain listed as depleted until population levels reach at least the lower limit of its optimum sustainable population (estimated at 60% of K; 1,080,000).

Habitat Concerns

Northern fur seals forage on a variety of fish species, including pollock. As of the 1990s, some prey items, such as capelin, have disappeared entirely from fur seal diet and pollock consumption has increased (Sinclair et al. 1994, Sinclair et al. 1996, Antonelis et al. 1997). Analyses of scats collected from Pribilof Island rookeries during 1987-2000 found that pollock (46-75% by frequency of occurrence, FO) and gonatid squids dominated in the diet and that other primary prey (FO>5%) included Pacific sand lance, Pacific herring, northern smoothtongue, Atka mackerel, and Pacific salmon (Zeppelin and Ream 2006). These analyses also found that diets associated with rookery complexes reflected patterns associated with foraging in the specific hydrographic domains identified by Robson et al. (2004). Comparison of ingested prey sizes based on scat and spew analysis indicate a much larger overlap between sizes of pollock consumed by fur seals and those caught by the commercial trawl fishery than was previously known (Gudmundson et al. 2006).

Fishing effort displaced by Steller sea lion protection measures may have moved to areas important to fur seals; recent tagging studies have shown that lactating female fur seals and juvenile males from St. Paul and St. George Islands forage in specific and very different areas (Robson et al. 2004, Sterling and Ream 2004). From 1982 to 2002 relative rates of pollock harvest (catch divided by estimated biomass) by fisheries were approximately five times greater where they overlap with summer foraging areas used by females from St. George compared with those from St. Paul (Robson and Fritz in prep); this overlap may result in resource competition between fisheries and foraging fur seals. At the same time, pup production declined on St. George and St. Paul Islands (Figs. 6 and 7). However, it remains unclear whether the pattern of declines in fur seal pup production on the two Pribilof Islands is related to the relative distribution of pollock fishery effort in summer on the eastern Bering Sea shelf. Adult female fur seals spend approximately eight months in varied regions of the north Pacific Ocean during winter, and forage in areas associated with eddies and the subarctic-subtropical transition region (Ream et al. 2005). Thus, environmental changes in the north Pacific Ocean could potentially have an effect on abundance and productivity of fur seals breeding in Alaska.

There is concern that a variety of human activities other than commercial fishing may impact northern fur seals. A Conservation Plan for the eastern Pacific stock was released in December of 2007 (NMFS 2007). This Plan reviews known and potential threats to the recovery of fur seals in Alaska.

CITATIONS

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

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

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

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

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

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

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

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

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

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

Fowler, C. W., and T. J. Ragen. 1990. Entanglement studies, St. Paul Island, 1989; Juvenile male roundups. U.S. Dep. Commer., 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.

Gudmundson, C. J., T. K. Zeppelin, and R. R. Ream. 2006. Application of two methods for determining diet of northern fur seals (*Callorhinus ursinus*). Fish. Bull. 104:445-455.

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

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

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

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

Lestenkof, A. D. and P. A. Zavadil. 2006. 2006 Subsistence Fur Seal Harvest on St. Paul Island. Memorandum for the Record, August 31, 2006. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska. 3 pp.

Lestenkof, A. D. and P. A. Zavadil. 2007. 2007 Subsistence Fur Seal Harvest on St. Paul Island. Memorandum for the Record, October 5, 2007. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska. 3 pp.

Lestenkof, A. D., P. A. Zavadil, A. Malavansky and M. Malavansky Jr. 2006. The Subsistence Harvest of Northern Fur Seals on the Pribilof Islands in 2005. Aleut Community of St. Paul Island, Tribal Government, Ecosystem Conservation Office, St. Paul Island, Pribilof Islands, Alaska. 24 pp.

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

Manly, B. F. J. 2006. Incidental catch and interactions of marine mammals and birds in the Cook Inlet salmon driftnet and setnet fisheries, 1999-2000. Draft report to NMFS Alaska Region. 98 pp.

Manly, B. F. J. 2007. Incidental take and interactions of marine mammals and birds in the Kodiak Island salmon set gillnet fishery, 2002 and 2005. Final report to Alaska Marine Mammal Observer Program, NMFS Alaska Region. 221 pp.

Malavansky, A. 2007. The subsistence harvest of northern fur seals on the St. George Island in 2007. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, Alaska. 8 pp.

Malavansky, A. and M. Malavansky Jr. 2006. The subsistence harvest of northern fur seals on the St. George Island in 2006. Aleut Community of St. George Island, St. George Traditional Council, Kayumixtax Eco-Office, St. George Island, Pribilof Islands, Alaska. 8 pp.

Malavansky, A., M. Malavansky Jr., P. A. Zavadil, A. D. Lestenkof, and P. G. Tetoff. 2005. The subsistence harvest of northern fur seals on the Pribilof Islands in 2004. St. George and St. Paul Islands, Pribilof Islands, Alaska. 12 pp.

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

National Marine Fisheries Service. 2007. Conservation plan for the Eastern Pacific stock of northern fur seal (*Callorhinus ursinus*). National Marine Fisheries Service, Juneau, Alaska.

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

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167.

Perez, M. A. Unpubl. ms. Bycatch of marine mammals by the groundfish fisheries in the U.S. EEZ of Alaska, 2005. 67 pp. Available NMML-AFSC.

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

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

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

Robson, B. R., and L. W. Fritz. In prep. The impact of habitat conservation measures for Steller sea lions on the distribution of fisheries in northern fur seal foraging habitat. Alaska Fish. Sci. Cent., 7600 Sand Point Way NE, Seattle, WA 98115.

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

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

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

Sterling, J. T., and R. R. Ream. 2004. At-sea behavior of juvenile male northern fur seals (C*allorhinus ursinus*). Can. J. Zool. 82:1621-1637.

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.

Towell, R. G., R. R. Ream, and A. E. York. 2006. Decline in northern fur seal (*Callorhinus ursinus*) pup production on the Pribilof Islands. Mar. Mamm. Sci. 22(2):486-491.

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

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

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

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

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

Zavadil, P. A., 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.

Zeppelin, T. K., and R. R. Ream. 2006. Foraging habitats based on the diet of female northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands, Alaska. J. of Zool. 270:565-576.