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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 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). 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).

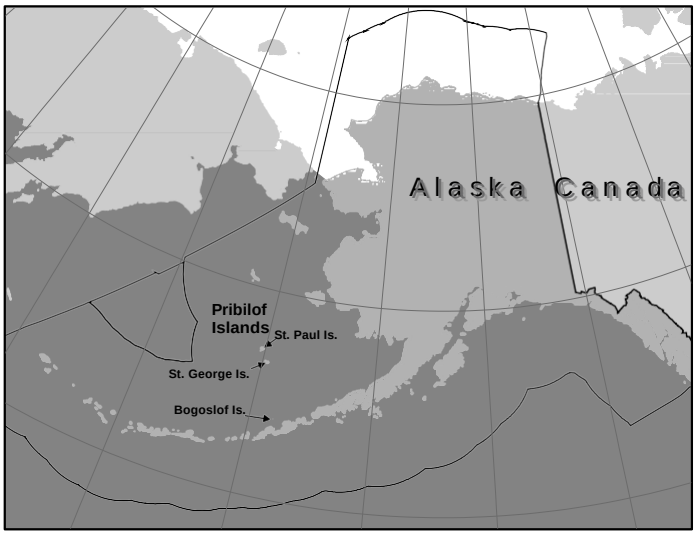

Figure 5. Approximate distribution of northern fur seals in the eastern North Pacific (shaded area).

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.

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 in the Bering Sea (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 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 (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 the Pribilof Islands, and from 2005 on Bogoslof Island, is 665,550 (4.5 H 147,900).

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

	Haulout location				
Year	**St. Paul**	**Sea Lion Rock**	**St. George**	**Bogoslof**	**Total**
1992[1]	182,437 (8,919)	10,217 (568)	25,160 (707)	898 (N/A)	218,712 (0.041)
1994	192,104 (8,180)	12,891 (989)	22,244 (410)	1,472 (N/A)	228,711 (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 (415)	"	153,059 (0.01)
2005	"	"	"	12,631 (335)	160,594 (0.01)
2006	109,937 (1,522)	"	17,070 (144)	"	147,900 (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): $N_{MIN} = N/\exp(0.842H[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 665,550 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 654,437. This estimate includes the first pup counts on Bogoslof Island in more than 5 years and does not indicate population increase.

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 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).

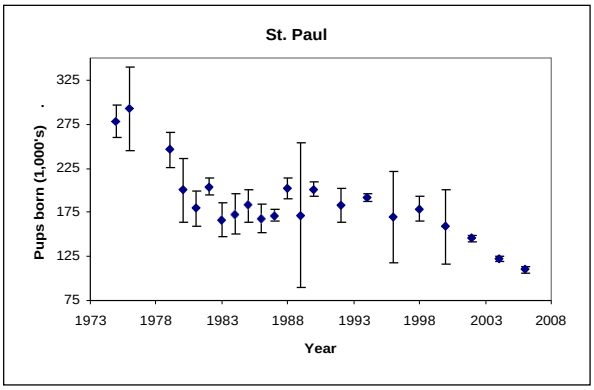

Figure 6. Estimated number of northern fur seal pups born on St. Paul Island, 1970-2006 (modified from Towell et al. 2006).

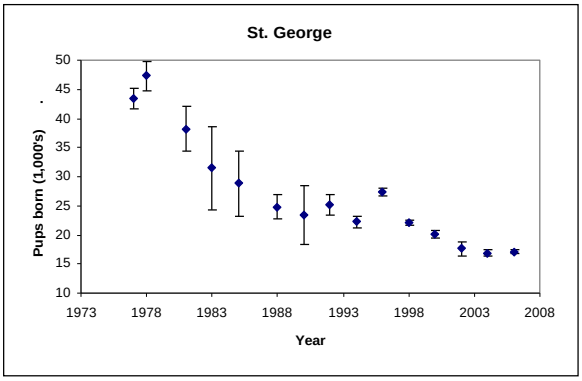

Figure 7. Estimated number of northern fur seal pups born on St. George Island, 1970-2006 (modified from Towell et al. 2006).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized MMPA, the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for depleted stocks under the MMPA (Wade and Angliss 1997). Thus, for the Eastern Pacific stock of northern fur seals, PBR = 14,070 animals (654,437 × 0.043 × 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 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.).

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 0.8 (Table 8).

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). Observer programs have recently been implemented 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 1.75% 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 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 either observer program.

Table 8. Summary of incidental mortality of northern fur seals (Eastern Pacific stock) due to commercial fisheries from 2001 through 2005 and calculation of the mean annual mortality rate. Details of how percent observer coverage is measured is included in Appendix 6. * There were no observed serious injuries or mortalities of northern fur seals incidental to this fishery in 2006; an updated mean annual mortality rate will be available in 2009.

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 *	2001	obs	57.6	1	1	0.57
	2002	data	58.4	0	0	(CV = 0.39)
	2003		64.1	0	0	
	2004		64.3	0	0	
	2005		68.3	1	1.5	
Bering Sea/Aleutian Islands pollock trawl	2002	obs	80.0	0	0	0.21
	2003	data	82.2	0	0	(CV = 0.21)
	2004		92.8	0	0	
	2005		77.3	1	1	
	2006		73.0	0	0	
Bering Sea/Aleutian Islands Pacific cod longline	2002	obs		0	0	1.08
	2003	data		0	0	(CV = 0.89)
	2004			0	0	
	2005			0	0	
	2006			1	6.2	
Minimum total annual mortality						1.86 (CV = 0.29)

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 1.9 fur seals per year based on observer data.

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 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. 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 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. Typically, 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. However, occasional harvest of adult males does occur: in 2004, there were two adult male northern fur seals that were struck but lost, and one was killed (Malavansky et al. 2005). In 2006, one adult male and four females were struck and killed (Lestenkof and Zavadil 2006). Between 2002 and 2006, there was an annual average of 667 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 2002-2006.

Year	St. Paul	St. George	Total harvested
2002	648[2]	203[1]	851
2003	522[3]	132[1]	654
2004	493[4]	123[5]	616
2005	466[5]	139[5]	605
2006	396[6]	212[7]	608
Mean annual take (2002-2006)			667

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

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).

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 2002-2006, there was a total of 7 mortalities resulting from research on northern fur seals, which results in an average of 1.4 mortalities per year from this stock.

STATUS OF STOCK

Based on currently available data, the minimum estimated U. S. commercial fishery-related mortality and serious injury for this stock (1.9) is less than 10% of the calculated PBR (1,407) 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 (0.8 + 667 + 1.2 = 669) is not known to exceed the PBR (14,070) 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 (NMFS 1993). 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 (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). 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 in 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). Relative rates of pollock harvest (catch divided by estimated biomass), which overlap with female foraging areas, by fisheries were approximately five times greater in St. George than St. Paul in summer from 1982 to 2002 (Robson and Fritz in review); this overlap may be result in resource competition between fisheries and foraging Northern 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 northern 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 undertake approximately 8 month long migrations into varied regions of the north Pacific Ocean during winter, and foraging areas are 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 fur seals breeding in Alaska.

There is concern that a variety of human activities other than commercial fishing may impact northern fur seals. A draft Conservation Plan for the eastern Pacific stock was released for public comment in May of 2006 (NMFS 2006). This Plan reviews known and potential threats to the recovery of fur seals in Alaska.

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