Revised 10/09/2014

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. 1) 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).

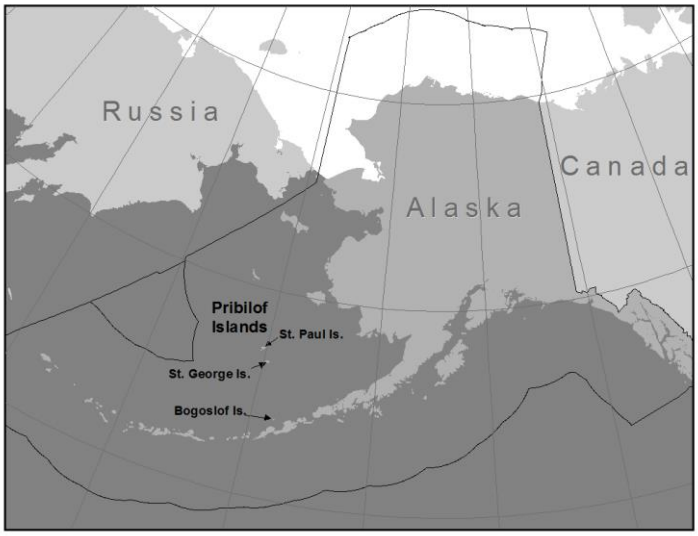

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area).

During the reproductive season, adult males usually are 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 ashore during a 6-month period (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). In Alaska, pups are born during summer months, leave the rookeries in the fall, on average around mid-November but ranging between late October to early December, 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 non-breeding season 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 Islands and San Miguel Island (DeLong 1982, DeLong and Antonelis 1991, NMFS 1993); 3) phenotypic differentiation: unknown and 4) genotypic differentiation: little evidence of genetic differentiation among breeding islands (Dickerson et al. 2010, 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 born at rookeries in the eastern Bering Sea 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 production estimate multiplied by 4.5. Juvenile northern fur seals are pelagic and are not included in the rookery counts. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. CVs are unavailable for the expansion factor. As the great majority of pups are born on St. Paul and St. George Islands, pup surveys are conducted biennially on these islands. Counts are available less frequently on Sea Lion Rock (adjacent to St. Paul Island) and Bogoslof Island (Table 1). The most recent estimate for the number of fur seals in the Eastern Pacific stock, based on pup counts on Sea Lion Rock (2008), on St. Paul and St. George Islands (mean of 2008, 2010, and 2012), and on Bogoslof Island (2011), is 648,534 (4.47 × 145,086).

Table 1. Estimates and/or counts of northern fur seal pups born on the Pribilof Islands and Bogoslof Island. Standard errors for pup estimates at rookery locations and the CV for total pup production estimates are provided in parentheses (direct counts do not have standard errors). 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*	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)	"	17,072 (144)	"	147,900 (0.011)
2007	"	"	"	17,574 (843)	152,867 (0.011)
2008	102,674 (1,084)	6,741 (80)	18,160 (288)	"	145,149 (0.009)
2010	94,502 (1,259)	"	17,973 (323)	"	136,790 (0.011)
2011	"	"	"	22,905 (921.5)	142,121 (0.011)
2012	96,828 (1,260)	"	16,184 (155)	"	142,658 (0.011)

*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 of the correction factor is not available. Consistent with a recommendation of the Alaska Scientific Review Group (SRG) in October 1997 (DeMaster 1998) 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. 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 3-year mean population estimate (N) of 648,534 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 548,919.

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 termination of commercial sealing on St. George in 1972 and pelagic sealing for science in 1974; commercial sealing on St. Paul continued until 1984. 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. 2; York and Fowler 1992). There has been a decline in pup production on St. Paul Island since the mid-1990s. Pup production at St. George Island had a less pronounced period of stabilization that was similarly followed by decline. However, pup production appeared to stabilize again on St. George Island beginning around 2002 (Fig. 3). During 1998-2012, pup production declined 4.84% per year (SE = 0.49%; $P < 0.01$) on St. Paul Island and 1.95% per year

(SE = 0.50%; P < 0.01) on St. George Island. The estimated pup production in 2012 was below the 1916 level on both St. Paul and St. George Islands (NMFS, unpubl. data). Northern fur seal pup production at Bogoslof Island has grown at an exponential rate since the 1990s. (R. Ream, pers. comm., National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, 5 February 2009). Despite continued growth at Bogoslof Island, recent estimates of pup production indicate that the rate of increase may be slowing. Between 2005 and 2011, pup production at Bogoslof Island increased 9.9% per year. Incorporation of the 2012 estimates from the Pribilofs shows an insignificant change in pup production on the Pribilof Islands since 2010. Temporary increases in the overall stock size are observed when opportunistic estimates are conducted at Bogoslof, but declines at the larger Pribilof colony (specifically St. Paul) continue to drive the overall stock estimate down over time.

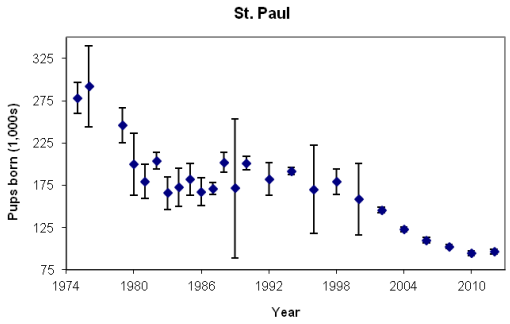

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, 1970-2012.

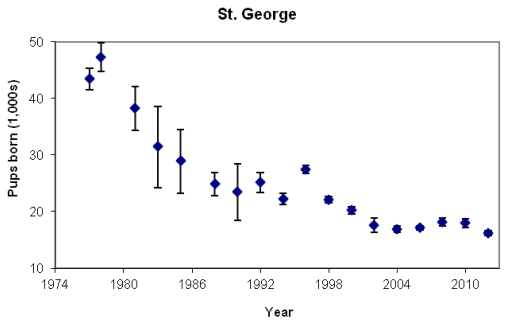

Figure 3. Estimated number of northern fur seal pups born on St. George Island, 1970-2012.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Pelagic sealing led to a decrease in the fur seal population; however, a moratorium on fur seal harvesting and termination of pelagic sealing resulted in a steady increase in the northern fur seal population during 1912-1924. 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 = 11,802 animals (548,919 × 0.043 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

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).

Between 2008 and 2012, there were incidental serious injuries and mortalities of northern fur seals observed in the following 3 fisheries of the 22 federally regulated commercial fisheries in Alaska monitored for incidental mortality by fisheries observers: Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod longline. The total estimated annual fishery-related incidental mortality in these fisheries from 2008 to 2012 is 1.7 (CV = 0.58) (Table 2).

Observer programs for five Alaska state 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 2. Summary of incidental mortality of northern fur seals from the eastern Pacific stock due to commercial fisheries from 2008 through 2012 and calculation of the mean annual mortality rate (Breiwick 2013). 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	2008 2009 2010 2011 2012	obs data	100 100 100 100 100	2 1 0 (+1)* 0 0	2.1 1.0 0 (1)** 0 0	0.82 (CV = 0.11)
Bering Sea/Aleutian Islands pollock trawl	2008 2009 2010 2011 2012	obs data	85 86 86 98 98	1 0 2 0 0	1.0 0 2.0 0 0	0.61 (CV = 0.06)

Bering Sea/Aleutian Islands Pacific cod longline	2008	obs data	63	0	0	0.28 (CV = 0.52)
	2009		61	0	0	
	2010		64	1	1.4	
	2011		57	0	0	
	2012		51	0	0	
Minimum total annual mortality						1.71 (CV = 0.11)

*Total mortalities observed in unsampled hauls.
**Total mortalities observed in sampled and unsampled hauls. Since the total known mortality (1) exceeds the estimated mortality (0) for 2010, the sum of actual mortalities observed (1) will be used as a minimum estimate for that year.

The estimated minimum annual mortality rate incidental to commercial fisheries is 1.7 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 an underestimate of the actual mortality level. 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. Zavadil et al. (2007) determined the juvenile male entanglement rate for 2005-2006 to be between 0.15-0.35%. The mean entanglement rate in this 2-year period for pups on St. George Island was 0.06-0.08%, with a potential maximum rate of up to 0.11% in October prior to weaning. Female entanglement rate on St. George Island increased during the course of the 2005-2006 breeding seasons, reaching a rate of 0.13% in October; this rate increase coincided with the arrival of progressively younger females on the rookery throughout the season (Zavadil et al. 2007).

Entanglements of northern fur seals have been observed on St. Paul, St. George, and Bogoslof Islands. In 2011, there was an increased effort to include entanglement reports in the Alaska Regional Office stranding database. A summary of circumferential neck entanglements of marine debris and fishing gear between 2008 and 2012 is provided in Table 3. Twenty northern fur seals with circumferential neck entanglements were reported to the stranding network between 2008 and 2012. The mean annual mortality and serious injury rate due to circumferential neck entanglement from trawl gear (0.4), fishing line (0.2), pot gear (0.2), and unknown fishing gear (0.8) is 1.6 for the 2008-2012 period. These entanglements cannot be assigned to a specific fishery, and it is unknown whether commercial, recreational, or Alaska Native subsistence fisheries are the source of the fishing debris. There is significantly higher observation effort on the rookeries during the years of pup production (even years) than during odd numbered years, so this difference in the level of effort should be taken into consideration with estimates of entanglement based on opportunistic reports.

Table 3. Summary of northern fur seal, eastern Pacific stock, neck entanglements in marine debris by year and type reported to the NMFS Alaska Regional Office, marine mammal stranding database, for the 2008-2012 period (Allen et al. 2014, Helker et al. 2015). Only cases of serious injuries are reported in this table; animals that were disentangled and released with non-serious injuries have been excluded.

Cause of Injury	2008	2009	2010	2011*	2012*	Mean Annual Mortality
Entanglement (unknown fishing net)	0	0	0	0	1	0.2
Entanglement (unknown marine debris/gear)	0	0	0	0	1	0.2
Neck entanglement (fishing line)	0	0	0	1	0	0.2
Neck entanglement (fishing net)	0	0	0	0	2	0.4
Neck Entanglement (packing band)	0	0	0	2	0	0.4
Neck entanglement (pot gear)	0	0	0	1	0	0.2
Neck entanglement (trawl gear)	0	0	0	2	0	0.4

Cause of Injury	2008	2009	2010	2011*	2012*	Mean Annual Mortality
Neck entanglement (unknown fishing gear)	1	0	0	0	0	0.2
Neck entanglement (unknown marine debris/gear)	0	0	0	8	3	2.2
Sum of 2011, 2012 M/SI events				14	7	10.5
Minimum total annual mortality						4.4

*An increase in the number of reports is not necessarily an indication of an increase in occurrence of entanglements, but rather is a reflection of more thorough reporting of these events in the Alaska Regional Office stranding database as of 2011. The average of the sum of M/SI events reported in 2011 and 2012 may be a more accurate number of annual M/SI for management purposes due to more thorough reporting for those years.

Subsistence/Native Harvest Information

Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, with a 3-year take range based on historic local needs. Typically, only juvenile males are taken in the subsistence harvest, which results in a much smaller impact on population growth than a harvest that includes females. However, accidental harvesting of females and adult males does occur. Of the 331 fur seals taken for subsistence on St. Paul in 2008, 328 were sub-adult males and 3 were females (Zavadil 2008). A total of 113 sub-adult males and one female were harvested on St. George in 2009 (Lekanof 2009). Only juvenile males were harvested in 2010; no females were reported as accidentally killed. A single female was killed during the harvest on St. Paul in 2011 (Lestenkof et al. 2011). Between 2008 and 2012, there was an annual average of 461 seals harvested per year in the subsistence harvest (Table 4).

Table 4. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands for 2008-2012.

Year	St. Paul	St. George	Total harvested
2008	331[1]	170[2]	501
2009	341[3]	114[4]	455
2010	357[5]	78[6]	435
2011	323[7]	120[8]	443
2012	383[9]	64[10]	447
Mean annual take (2008-2012)			461

[1]Zavadil 2008, [2]Lekanof 2008, [3]Zavadil 2009, [4]Lekanof 2009, [5]Zavadil et al. 2011, [6]Merculief 2010, [7]Lestenkof et al. 2011, [8]Merculief 2011, [9]Lestenkof et al. 2012, [10]Lekanof 2013.

Other Mortality

Intentional killing of northern fur seals by commercial fishers, sport fishers, and others may occur, but the magnitude of that mortality is unknown. Such shooting has been illegal since the species was designated as "depleted" in 1988.

The mean annual mortality and serious injury rate due to circumferential neck entanglement from packing bands (0.4) and unknown marine debris or gear (2.4) is 2.8 for the 2008-2012 period (Table 3).

Mortalities may occasionally occur incidental to marine mammal research activities authorized under Marine Mammal Protection Act (MMPA) permits issued to a variety of government, academic, and other research organizations. Between 2008 and 2012, there was a single mortality resulting from research on this stock of northern fur seals in 2009, an average of 0.2 mortalities per year (T. Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910). The only fisheries research mortality of a northern fur seal for the 2008-2012 period occurred in 2009 during a groundfish bottom trawl research survey, resulting in an average of 0.2 mortalities per year. The total combined mortalities of northern fur seals from marine mammal (0.2) and fisheries (0.2) research activities is 0.4 per year for the 2008-2012 period.

STATUS OF STOCK

Based on currently available data, the minimum estimated U.S. commercial fishery-related mortality and serious injury for this stock (1.7) is less than 10% of the calculated PBR (1,180) 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 (1.7 [commercial fisheries] + 1.6 [unknown fisheries] + 461 [Alaska Native harvest] + 0.4 [research activities] + 2.8 [marine debris] = 468) does not exceed the PBR (11,802) 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 known direct human-caused mortality, there is no reason to believe that limiting mortalities to the level of the PBR will reverse the decline. 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 (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. 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 designated 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. Some historically relevant 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). Call et al. (2008) found northern fur seals had three types of individual foraging route tactics at the rookery, which is important to consider in the context of adaptation to changes in environmental conditions and prey distributions.

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, pup production declined on St. Paul and St. George Islands (Figs. 2 and 3). 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, such as an increase in vessel traffic in Alaska waters and an increased potential for oil spills, 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.

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