Revised 12/30/2015

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, on San Miguel Island off southern California (Lander and Kajimura 1982, NMFS 1993), and on the Farallon Islands off central California. 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).

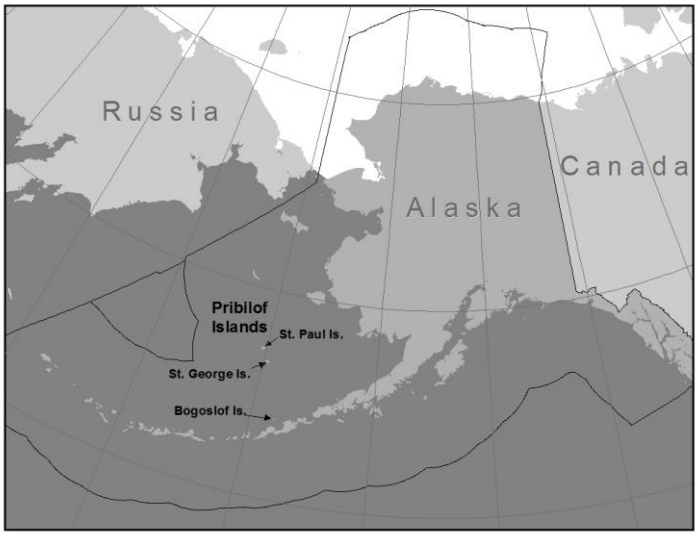

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area).

During the reproductive season, adult males usually are on shore during the 4-month period from May to 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 from 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 (Ream 2002, Dickerson et al. 2010). Thus, an Eastern Pacific stock and a California stock are recognized. The California stock is reported separately in the Stock Assessment Reports for the U.S. 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. Coefficients of variation (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 potential biological removal (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 548,926.

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, NMFS-AFSC-NMML, 7600 Sand Point Way NE, Seattle, WA 98115, pers. comm., 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.

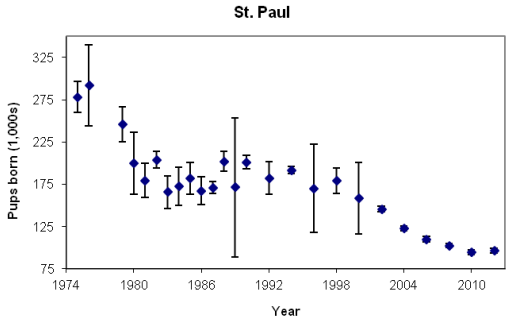

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, 1970-2012.

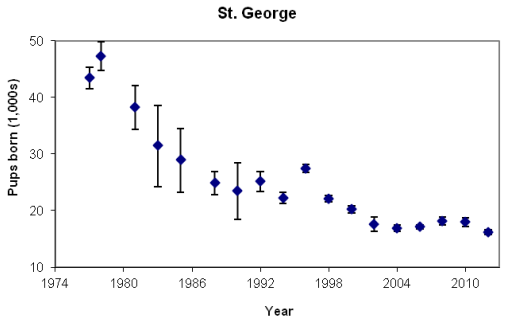

Figure 3. Estimated number of northern fur seal pups born on St. George Island, 1970-2012.

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, NMFS-AFSC-NMML (retired), 7600 Sand Point Way NE, Seattle, WA 98115, unpubl. data), 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 Marine Mammal Protection Act (MMPA), the PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock 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 (548,926 × 0.043 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Detailed information on U.S. commercial fisheries in Alaska waters (including observer programs, observer coverage, and observed incidental takes of marine mammals) is presented in Appendices 3-6 of the Alaska Stock Assessment Reports.

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 and serious injury rate calculation in this Stock Assessment Report 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-AFSC-NMML (retired), 7600 Sand Point Way NE, Seattle, WA 98115, pers. comm.).

Between 2009 and 2013, incidental mortality and serious injury of northern fur seals was 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, and Bering Sea/Aleutian Islands Pacific cod longline fisheries. The total estimated mean annual fishery-related incidental mortality and serious injury rate in these fisheries from 2009 to 2013 is 1.1 (CV = 0.23) northern fur seals (Breiwick 2013; NMML, unpubl. data; Table 2).

Observer programs for Alaska State-managed commercial fisheries have not documented any mortality or serious injury of northern fur seals (Wynne et al. 1991, 1992; Manly 2006, 2007).

Table 2. Summary of incidental mortality and serious injury of the Eastern Pacific stock of northern fur seals due to commercial fisheries in 2009-2013 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; NMML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 6 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	2009 2010 2011 2012 2013	obs data	99 99 99 99 99	1 0 (+1)[a] 0 0 0	1.0 0 (+1)[b] 0 0 0	0.4 (CV = N/A)
Bering Sea/Aleutian Is. pollock trawl	2009 2010 2011 2012 2013	obs data	86 86 98 98 97	0 2 0 0 0	0 2.0 0 0 0	0.4 (CV = 0.07)
Bering Sea/Aleutian Is. Pacific cod longline	2009 2010 2011 2012 2013	obs data	60 64 57 51 67	0 1 0 0 0	0 1.4 0 0 0	0.3 (CV = 0.52)
Minimum total estimated annual mortality						1.1 (CV = 0.23)

[a]Total mortality and serious injury observed in 2010: 0 in sampled hauls + 1 in an unsampled haul.
[b]Since the total known mortality and serious injury (0 observed in sampled hauls + 1 in an unsampled haul) exceeds the estimated mortality and serious injury (0) for 2010, the observed mortality and serious injury (in sampled + unsampled hauls) will be used as a minimum estimate for that year.

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 and 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 NMFS Alaska Region stranding database. A summary of entanglements in fishing gear between 2009 and 2013 is provided in Table 3. The mean annual mortality and serious injury rate due to entanglement in trawl gear (0.4), fishing line (0.2), pot gear (0.2), and fishing net (0.6) in Alaska waters in 2009-2013 is 1.4 northern fur seals. These entanglements cannot be assigned to a

specific fishery, and it is unknown whether commercial, recreational, or 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.

The Eastern Pacific stock can occur off the west coast of the continental U.S. in winter/spring; therefore, any mortality or serious injury of northern fur seals reported off the coasts of Washington, Oregon, or California during December through May will be assigned to both the Eastern Pacific and California stocks of northern fur seals. Between 2009 and 2013, two northern fur seal entanglements occurred off the Oregon coast during this time period: one in an unknown fishing net in February 2009 and one in trawl gear in April 2011 (Carretta et al. 2015), resulting in an average annual mortality and serious injury rate of 0.4 Eastern Pacific northern fur seals in these waters (Table 3). An additional northern fur seal that stranded with a serious injury, due to an unidentified fishery interaction, in May 2012 in California was treated and released with a non-serious injury (Carretta et al. 2015).

Table 3. Summary of mortality and serious injury of the Eastern Pacific stock of northern fur seals, by year and type, reported to the NMFS Alaska Region (Helker et al. 2015) and NMFS U.S. West Coast Region (Carretta et al. 2015), marine mammal stranding databases, in 2009-2013. 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	2009	2010	2011	2012	2013	Mean annual mortality
Entanglement (unknown fishing net)	1[a]	0	0	1	0	0.4
Entanglement (unknown marine debris/gear)	3[a]	0	0	1	0	0.8
Entanglement (trawl gear)	0	0	1[a]	0	0	0.2
Neck entanglement (fishing line)	0	0	1	0	0	0.2
Neck entanglement (fishing net)	0	0	0	2	0	0.4
Neck entanglement (packing band)	0	0	2	0	0	0.4
Neck entanglement (pot gear)	0	0	1	0	0	0.2
Neck entanglement (trawl gear)	0	0	2	0	0	0.4
Neck entanglement (unknown marine debris/gear)	0	0	8	3	1	2.4
Power plant entrainment	0	0	0	1[a]	0	0.2
Sum of 2011, 2012 M/SI events[b]			15	8		12

[a]Mortality or serious injury that occurred off the coasts of Washington, Oregon, or California in December through May was assigned to both the Eastern Pacific and California stocks of northern fur seals.
[b]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 NMFS Alaska Region stranding database as of 2011. The average of the sum of mortality/serious injury (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.

Alaska Native Subsistence/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. 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). One female was killed on St. George Island in 2012 (Lekanof 2013) and three females were killed on St. Paul Island in 2013 (Lestenkof et al. 2014). Between 2009 and 2013, there was an annual average of 432 seals harvested 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 in 2009-2013.

Year	St. Paul	St. George	Total harvested
2009	341[a]	114[b]	455
2010	357[c]	78[d]	435
2011	323[e]	120[f]	443
2012	383[g]	64[h]	447
2013	301[i]	80[j]	381
Mean annual take (2009-2013)			432

[a]Zavadil (2009); [b]Lekanof (2009); [c]Zavadil et al. (2011); [d]Merculief (2010); [e]Lestenkof et al. (2011); [f]Merculief (2011); [g]Lestenkof et al. (2012); [h]Lekanof (2013); [i]Lestenkof et al. (2014); [j]Kashevarof (2014).

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.

Since the Eastern Pacific and California stocks of northern fur seals overlap off the west coast of the continental U.S. during December through May, non-fishery mortality and serious injury reported off the coasts of Washington, Oregon, or California during that time will be assigned to both stocks. The mean annual mortality and serious injury rate due to entanglement in packing bands (0.4 in Alaska waters) and unknown marine debris or gear (3.2: 2.6 in Alaska waters + 0.6 in Oregon waters) is 3.6 Eastern Pacific northern fur seals in 2009-2013 (Table 3). An additional mean annual mortality and serious injury rate of 0.2 Eastern Pacific northern fur seals occurred in 2009-2013 due to entrainment in the cooling water system of a California power plant in 2012 (Carretta et al. 2015).

Mortality and serious injury 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 2008 and 2012, there was a single mortality resulting from research on the Eastern Pacific stock of northern fur seals in 2009, for an average annual mortality and serious injury rate of 0.2 northern fur seals (Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910). Mortality and serious injury of northern fur seals also occurred during a research groundfish bottom trawl survey in Alaska waters in 2009 (Helker et al. 2015) and a research trawl survey in California waters in 2009 (Carretta et al. 2015), resulting in an average annual mortality and serious injury rate of 0.4 northern fur seals in 2008-2012. The total combined mortality and serious injury of northern fur seals from marine mammal (0.2) and fisheries (0.4) research activities is 0.6 per year in 2008-2012.

STATUS OF STOCK

Based on currently available data, the minimum estimated U.S. commercial fishery-related mortality and serious injury for this stock (1.1) 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 (1.1 (commercial fisheries) + 1.8 (unknown fisheries) + 432 (Alaska Native harvest) + 0.6 (research activities) + 3.6 (marine debris/gear) + 0.2 (power plant entrainment) = 439) 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 and serious injury, there is no reason to believe that limiting mortality and serious injury 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 seals 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, 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 8 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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