Revised 12/30/2016

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).

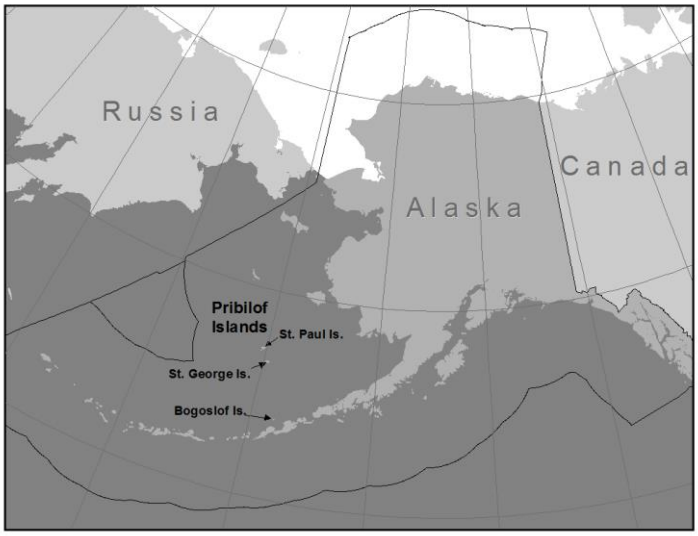

Figure 1. Approximate distribution of northern fur seals in the eastern North Pacific (dark shaded area).

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, fur 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 distribution and population response factors of the Dizon et al. (1992) phylogeographic approach: 1) Distribution: continuous during non-breeding season and discontinuous during the breeding season, high natal site fidelity (DeLong 1982, Baker et al. 1995); 2) Population response: substantial differences in population dynamics between the 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 (2014), on St. Paul and St. George

Islands (mean of 2010, 2012, and 2014), and on Bogoslof Island (2011), is 626,734 (4.47 × 140,209) northern fur seals.

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 prior 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)
2014	91,737 (769)	5,250 (293)	18,937 (308)	"	138,829 (0.009)

*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 626,734 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 530,474.

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 1998-2014, pup production declined 4.25% per year (SE = 0.48%; P < 0.01) on St. Paul Island and 1.42% per year (SE = 0.54%; P = 0.04) on St. George Island. The estimated pup production in 2014 was below the 1917 level on both St. Paul and St. George Islands (MML, unpubl. data). Northern fur seal pup production at Bogoslof Island has grown at an exponential rate since the 1990s (Towell and Ream 2012). 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 2014 estimates from the Pribilofs shows a small and insignificant decline 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.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

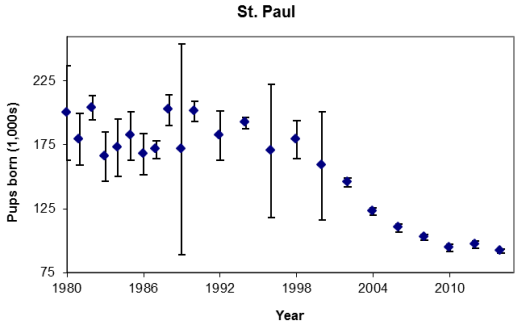

Figure 2. Estimated number of northern fur seal pups born on St. Paul Island, 1980-2014.

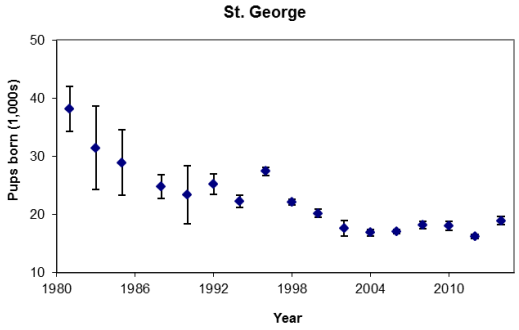

Figure 3. Estimated number of northern fur seal pups born on St. George Island, 1980-2014.

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-MML (retired), 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 = 11,405 (530,474 × 0.043 × 0.5) animals.

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.

During 2010-2014, 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 and serious injury by fisheries observers: Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Table 2; Breiwick 2013; MML,

unpubl. data). The estimated mean annual mortality and serious injury rate in these fisheries in 2010-2014 is 1.1 northern fur seals.

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 Eastern Pacific northern fur seals due to U.S. commercial fisheries in 2010-2014 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, 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	2010	obs data	99	0 (+1)[a]	0 (+1)[b]	0.2 (+0.2)[c] (CV = 0.04)
	2011		100	0	0	
	2012		99	0	0	
	2013		99	0	0	
	2014		99	1	1	
Bering Sea/Aleutian Is. pollock trawl	2010	obs data	86	2	2.0	0.4 (CV = 0.07)
	2011		98	0	0	
	2012		98	0	0	
	2013		97	0	0	
	2014		98	0	0	
Bering Sea/Aleutian Is. Pacific cod longline	2010	obs data	64	1	1.4	0.3 (CV = 0.52)
	2011		57	0	0	
	2012		51	0	0	
	2013		67	0	0	
	2014		64	0	0	
Minimum total estimated annual mortality						1.1 (CV = 0.17)

[a]Total mortality and serious injury observed in 2010: 0 fur seals in sampled hauls + 1 fur seal in an unsampled haul.
[b]Total estimate of mortality and serious injury in 2010: 0 fur seals (extrapolated estimate from 0 fur seals observed in sampled hauls) + 1 fur seal (1 fur seal observed in an unsampled haul).
[c]Mean annual mortality and serious injury for fishery: 0.2 fur seals (mean of extrapolated estimates from sampled hauls) + 0.2 fur seals (mean of number observed in unsampled hauls).

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 per year on the rookeries were entangled in pieces of trawl netting and an average of 0.1 fur seals per year were 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. Since 2011, there has been an increased effort to include entanglement reports in the NMFS Alaska Region stranding database. A summary of entanglements in fishing gear that were reported in 2010-2014 is provided in Table 3 (Helker et al. 2016).

Three northern fur seals entangled in commercial Bering Sea/Aleutian Islands halibut longline gear and nine northern fur seals entangled in commercial Bering Sea/Aleutian Islands trawl gear were reported to the NMFS Alaska Region stranding network in 2010-2014, resulting in minimum mean annual mortality and serious injury rates of 0.6 and 1.8 fur seals, respectively, in these fisheries (Table 3; Helker et al. 2016).

An additional seven northern fur seals were initially considered to be seriously injured due to entanglement in commercial Bering Sea/Aleutian Islands trawl gear (2 in 2011, 2 in 2012, and 1 in 2014) and unidentified net (1 each in 2011 and 2012); however, since these animals were disentangled and released with non-serious injuries (Helker et al. 2016), they were not included in the mean annual mortality and serious injury rate for 2010-2014.

The total mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2010-2014 is 3.5 northern fur seals (1.1 from observer data + 2.4 from stranding data).

The minimum mean annual mortality and serious injury rate due to entanglement in fishing line (0.2), pot gear (0.2), gillnet (0.2), and unidentified fishing net (0.8) in Alaska waters in 2010-2014 is 1.4 northern fur seals (Table 3; Helker et al. 2016). 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. More thorough reporting of events has occurred since 2011, and 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 most likely affects 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. During 2010-2014, three northern fur seal entanglements in trawl gear occurred off the U.S. west coast in December through May (Carretta et al. 2016), resulting in an average annual mortality and serious injury rate of 0.6 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. 2016); therefore, it was not included in the mean annual mortality and serious injury rate for 2010-2014.

Table 3. Summary of mortality and serious injury of Eastern Pacific northern fur seals, by year and type, reported to the NMFS Alaska Region (Helker et al. 2016) and NMFS U.S. West Coast Region (Carretta et al. 2016) marine mammal stranding networks in 2010-2014. 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	2010	2011	2012	2013	2014	Mean annual mortality
Entangled in commercial Bering Sea/Aleutian Is. halibut longline gear	0	0	0	0	3	0.6
Entangled in commercial Bering Sea/Aleutian Is. trawl gear	0	2	1	0	6	1.8
Entangled in Bering Sea crab pot gear*	0	1	0	0	0	0.2
Entangled in Bering Sea/Aleutian Is. monofilament hook and line gear*	0	1	0	0	0	0.2
Entangled in gillnet*	0	0	0	0	1	0.2
Entangled in unidentified net*	0	0	3	0	1	0.8
Entangled in trawl gear*	0	1[a]	0	0	2[a]	0.6
Entangled in marine debris	0	10	4	1	11	5.2
Entrained in power plant intake	0	0	1[a]	0	0	0.2
Sum of 2011, 2012, and 2014 events[b]		15	9		24	16
Total in commercial fisheries						2.4
*Total in unknown (commercial, recreational, or subsistence) fisheries						2.0
Total in marine debris						5.2
Total due to other sources (power plant entrainment)						0.2

[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, 2012, and 2014 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 historical 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. 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 Island in 2011 (Lestenkof et al. 2011), one female was killed on St. George Island in 2012 (Lekanof 2013), three females were killed on St. Paul in 2013 (Lestenkof et al. 2014), and four females were killed on St. Paul (Melovidov et al. 2014) and one was killed on St. George (Kashevarof 2014b) in 2014. During the inaugural pup harvest on St. George Island in 2014, 54 pups were killed (M. Williams, NMFS, Alaska Regional Office, Anchorage, AK, pers. comm). During 2010-2014, an average of 426 northern fur seals were harvested each year in the subsistence harvest on the Pribilof Islands (Table 4).

Table 4. Summary of the Alaska Native subsistence harvest of northern fur seals on St. Paul and St. George Islands in 2010-2014.

Year	St. Paul	St. George	Total harvested
2010	357[a]	78[b]	435
2011	323[c]	120[d]	443
2012	383[e]	64[f]	447
2013	301[g]	80[h]	381
2014	266[i]	158[j, k]	424
Mean annual take (2010-2014)			426

[a]Zavadil et al. (2011); [b]Merculief (2010); [c]Lestenkof et al. (2011); [d]Merculief (2011); [e]Lestenkof et al. (2012); [f]Lekanof (2013); [g]Lestenkof et al. (2014); [h]Kashevarof (2014a); [i]Melovidov et al. (2014); [j]Kashevarof (2014b); [k]M. Williams, NMFS, Alaska Regional Office, Anchorage, AK, pers. comm.

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 marine debris in Alaska waters in 2010-2014 is 5.2 Eastern Pacific northern fur seals (Table 3; Helker et al. 2016). A northern fur seal mortality in 2012 due to entrainment in the cooling water system of a California power plant resulted in an additional mean annual mortality and serious injury rate of 0.2 Eastern Pacific northern fur seals in 2010-2014 (Table 3; Carretta et al. 2016).

An additional 14 northern fur seals that were initially considered seriously injured due to entanglement in marine debris (3 in 2011, 7 in 2012, and 4 in 2014) were disentangled and released with non-serious injuries (Helker et al. 2016); therefore, these animals were not included in the mean annual mortality and serious injury rate for 2010-2104.

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. In 2010-2014, no research-related mortality or serious injury was reported for the Eastern Pacific stock of northern fur seals (Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

Based on currently available data, the minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (3.5 fur seals) is less than 10% of the calculated PBR (10% of PBR = 1,140) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The total estimated annual level of human-caused mortality and serious injury (437 fur seals) does not exceed the PBR (11,405) 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, assumed to be 1.8 million animals) 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.

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 the 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 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 could potentially be affecting 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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Revised 12/30/2015

HARBOR SEAL (*Phoca vitulina richardii*)

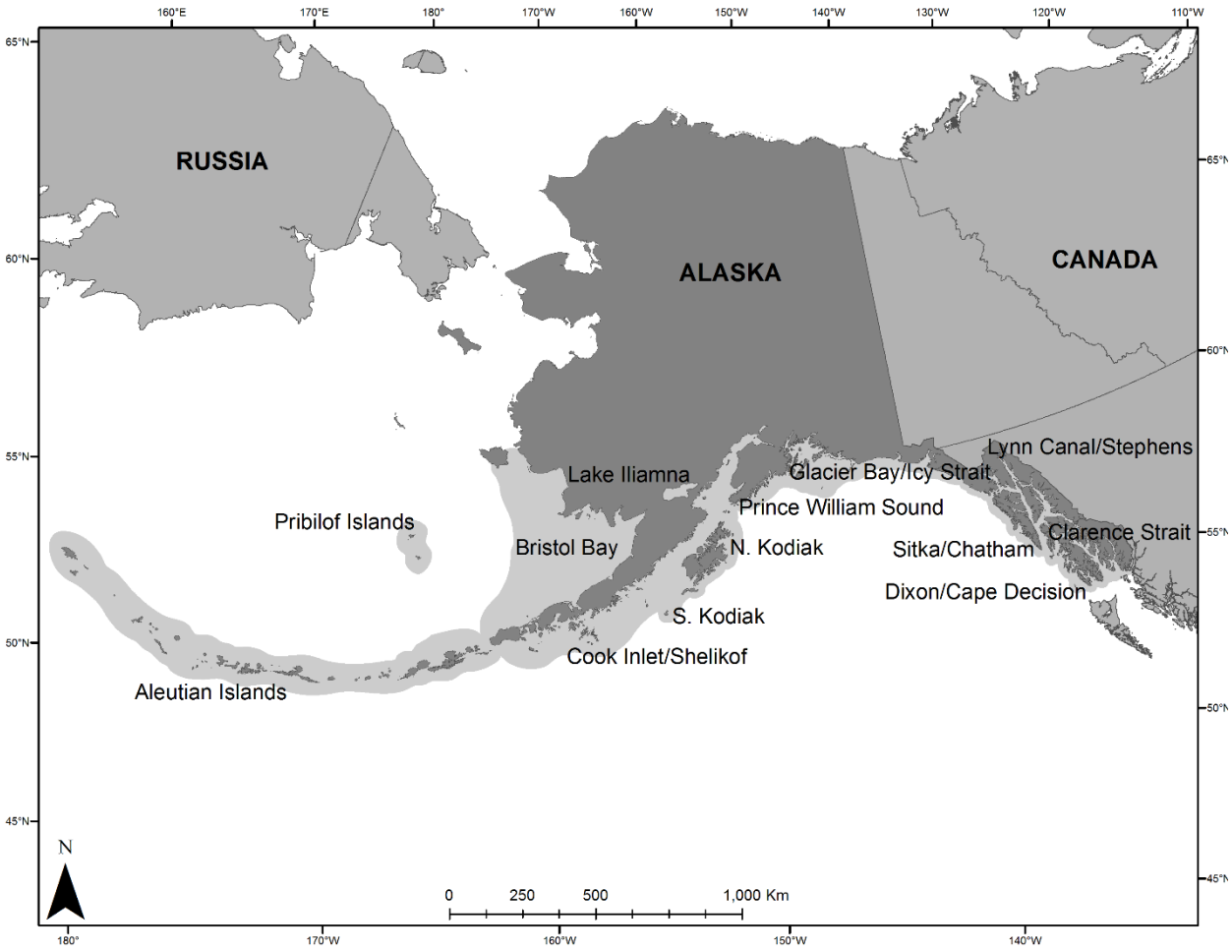

Figure 1. Approximate distribution of harbor seals in Alaska waters (shaded coastline area).

STOCK DEFINITION AND GEOGRAPHIC RANGE

Harbor seals inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and Southeast Alaska, west through the Gulf of Alaska and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice and feed in marine, estuarine, and occasionally fresh waters. Harbor seals generally are non-migratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944; Fisher 1952; Bigg 1969, 1981; Hastings et al. 2004). The results of past and recent satellite-tagging studies in Southeast Alaska, Prince William Sound, Kodiak Island, and Cook Inlet are also consistent with the conclusion that harbor seals are non-migratory (Swain et al. 1996, Lowry et al. 2001, Small et al. 2003, Boveng et al. 2012). However, some long-distance movements of tagged animals in Alaska have been recorded (Pitcher and McAllister 1981, Lowry et al. 2001, Small et al. 2003, Womble 2012, Womble and Gende 2013). Strong fidelity of individuals for haul-out sites during the breeding season has been documented in several populations (Härkönen and Harding 2001), including some harbor seal stocks in Alaska such as South Kodiak Island, Prince William Sound, Glacier Bay/Icy Strait, and Cook Inlet (Pitcher and McAllister 1981, Small et al. 2005, Boveng et al. 2012, Womble 2012, Womble and Gende 2013).

Local or regional trends in harbor seal numbers have been monitored at various time intervals since the 1970s, revealing diverse spatial patterns in apparent population trends. Where declines have been observed, they seem

generally to have been strongest in the late 1970s or early 1980s to the 1990s. For example, counts of harbor seals declined by about 80% at Tugidak Island in the 1970s and 1980s (Pitcher 1990), and numbers at Nanvak Bay in northern Bristol Bay also declined at about the same time (Jemison et al. 2006). In Prince William Sound, harbor seal numbers declined by about 63% overall between 1984 and 1997, including a 40% decline prior to the *Exxon Valdez* oil spill that occurred in 1989 (Frost et al. 1999, Ver Hoef and Frost 2003). Harbor seal counts in Glacier Bay National Park, where the majority of seals haul out on floating ice calved from glaciers, declined by roughly 60% between 1992 and 2001 and continued to decline through 2008 (Mathews and Pendleton 2006, Womble et al. 2010). At Aialik Bay, a site in Kenai Fjords National Park where harbor seals also haul out on ice calved from a glacier, harbor seal numbers declined by 93% from 1979 to 2009 (Hoover-Miller et al. 2011). In the Aleutian Islands, counts declined by 67% between the early 1980s and 1999, with declines of about 86% in the western Aleutians (Small et al. 2008). Although there is evidence for recent stabilization or even partial recovery of harbor seal numbers in some areas of long-term harbor seal decline, such as Tugidak Island and Nanvak Bay (Jemison et al. 2006), most have not made substantial recoveries toward historical abundances. But these areas of declines in harbor seals contrast strongly with other large regions of Alaska where harbor seal numbers have remained stable or increased over the same period: trend monitoring regions around Ketchikan and the Kodiak area increased significantly in the 1980s and 1990s and were stable in around Sitka and Bristol Bay (Small et al. 2003). Differences in trend across the various regions of Alaska suggest some level of independent population dynamics (O'Corry-Crowe et al. 2003, O'Corry-Crowe 2012).

Westlake and O'Corry-Crowe's (2002) analysis of genetic information from 881 samples across 181 sites revealed population subdivisions on a scale of 600-820 km. These results suggest that genetic differences within Alaska, and most likely over their entire North Pacific range, increase with increasing geographic distance. New information revealed substantial genetic differences indicating that female dispersal occurs at region specific spatial scales of 150-540 km. This research identified 12 demographically independent clusters within the range of Alaskan harbor seals; however, significant geographic areas within the Alaskan harbor seal range remain unsampled (O'Corry-Crowe et al. 2003).

In 2010, NMFS and their co-management partners, the Alaska Native Harbor Seal Commission, identified 12 separate stocks of harbor seals based largely on genetic structure; this represents a significant increase in the number of harbor seal stocks from the three stocks (Bering Sea, Gulf of Alaska, Southeast Alaska) previously recognized. Given the genetic samples were not obtained continuously throughout the range, a total evidence approach was used to consider additional factors such as population trends, observed harbor seal movements, and traditional Alaska Native use areas in the final designation of stock boundaries. The 12 stocks of harbor seals currently identified in Alaska are 1) the Aleutian Islands stock – occurring along the entire Aleutian chain from Attu Island to Ugamak Island; 2) the Pribilof Islands stock – occurring on Saint Paul and Saint George Islands, as well as on Otter and Walrus Islands; 3) the Bristol Bay stock – ranging from Nunivak Island south to the west coast of Unimak Island and extending inland to Kvichak Bay and Lake Iliamna; 4) the North Kodiak stock – ranging from approximately Middle Cape on the west coast of Kodiak Island northeast to West Amatuli Island and south to Marmot and Spruce Islands; 5) the South Kodiak stock – ranging from Middle Cape on the west coast of Kodiak Island southwest to Chirikof Island and east along the south coast of Kodiak Island to Spruce Island, including the Trinity Islands, Tugidak Island, Sitkinak Island, Sundstrom Island, Aiaktalik Island, Geese Islands, Two Headed Island, Sitkalidak Island, Ugak Island, and Long Island; 6) the Prince William Sound stock – ranging from Elizabeth Island off the southwest tip of the Kenai Peninsula to Cape Fairweather, including Prince William Sound, the Copper River Delta, Icy Bay, and Yakutat Bay; 7) the Cook Inlet/Shelikof Strait stock – ranging from the southwest tip of Unimak Island east along the southern coast of the Alaska Peninsula to Elizabeth Island off the southwest tip of the Kenai Peninsula, including Cook Inlet, Knik Arm, and Turnagain Arm; 8) the Glacier Bay/Icy Strait stock – ranging from Cape Fairweather southeast to Column Point, extending inland to Glacier Bay, Icy Strait, and from Hanus Reef south to Tenakee Inlet; 9) the Lynn Canal/Stephens Passage stock – ranging north along the east and north coast of Admiralty Island from the north end of Kupreanof Island through Lynn Canal, including Taku Inlet, Tracy Arm, and Endicott Arm; 10) the Sitka/Chatham Strait stock – ranging from Cape Bingham south to Cape Ommaney, extending inland to Table Bay on the west side of Kuiu Island and north through Chatham Strait to Cube Point off the west coast of Admiralty Island, and as far east as Cape Bendel on the northeast tip of Kupreanof Island; 11) the Dixon/Cape Decision stock – ranging from Cape Decision on the southeast side of Kuiu Island north to Point Barrie on Kupreanof Island and extending south from Port Protection to Cape Chacon along the west coast of Prince of Wales Island and west to Cape Muzon on Dall Island, including Coronation Island, Forrester Island, and all the islands off the west coast of Prince of Wales Island; and 12) the Clarence Strait stock – ranging along the east coast of Prince of Wales Island from Cape Chacon north through Clarence Strait to Point Baker and along the east coast of Mitkof and Kupreanof Islands north to Bay Point, including Ernest Sound, Behm Canal, and Pearse Canal (Fig. 1). Individual stock distributions can be seen in Figures 2a-l.

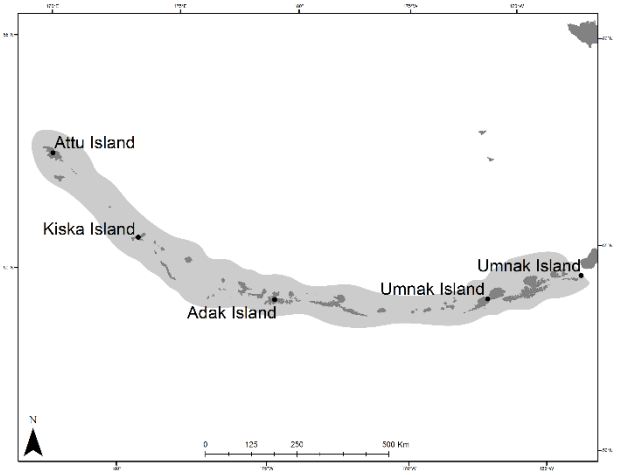

Figure 2a. Approximate distribution of Aleutian Islands harbor seal stock (shaded area).

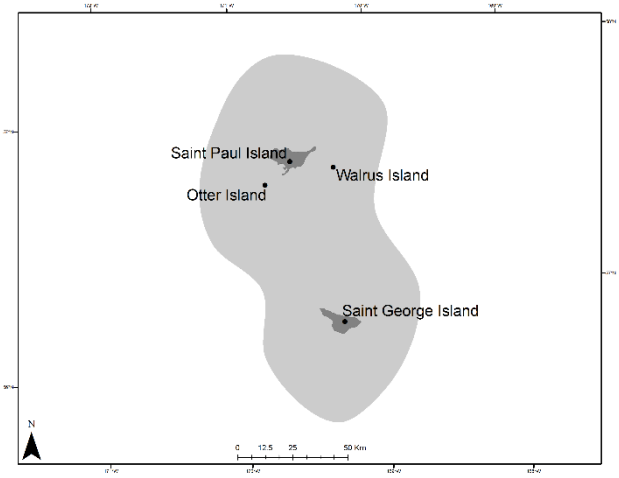

Figure 2b. Approximate distribution of Pribilof Islands harbor seal stock (shaded area).

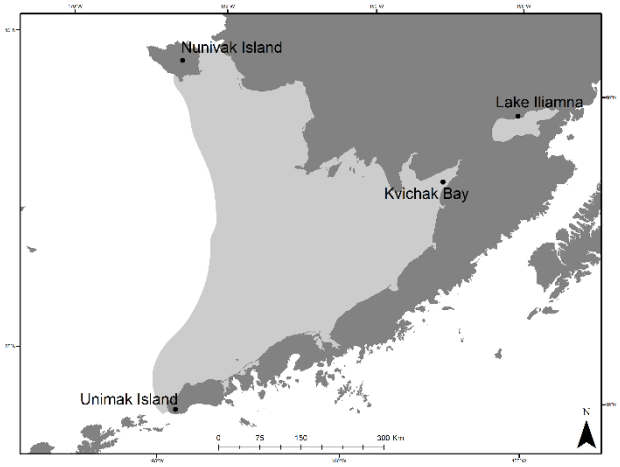

Figure 2c. Approximate distribution of Bristol Bay harbor seal stock (shaded area).

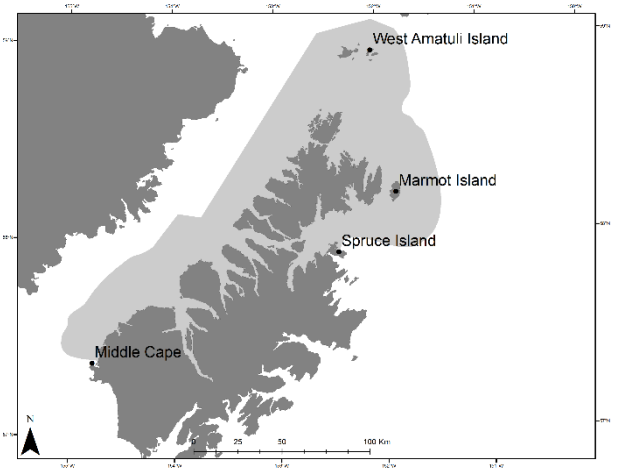

Figure 2d. Approximate distribution of North Kodiak harbor seal stock (shaded area).

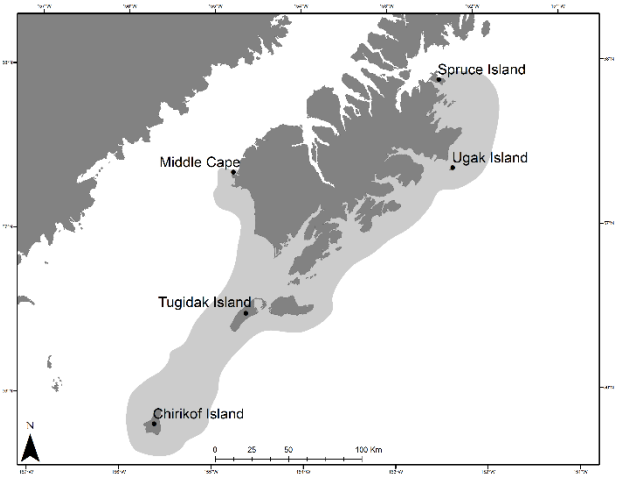

Figure 2e. Approximate distribution of South Kodiak harbor seal stock (shaded area).

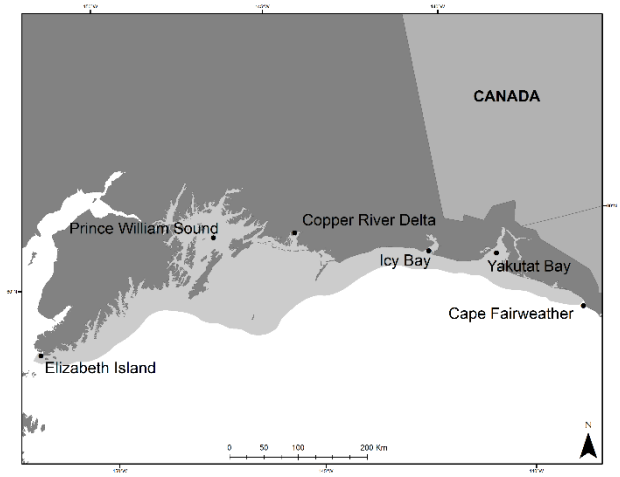

Figure 2f. Approximate distribution of Prince William Sound harbor seal stock (shaded area).

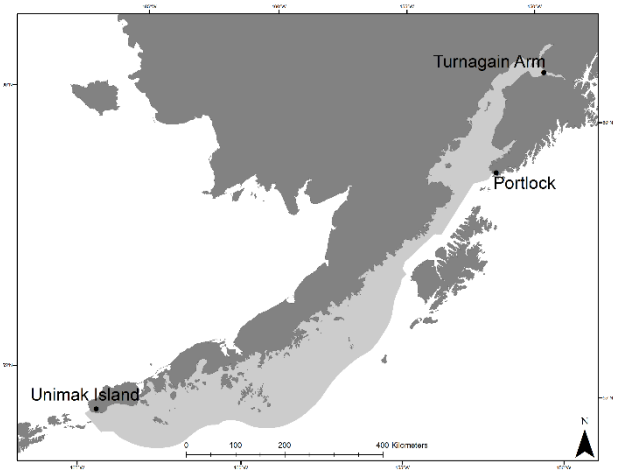

Figure 2g. Approximate distribution of Cook Inlet/Shelikof Strait harbor seal stock (shaded area).

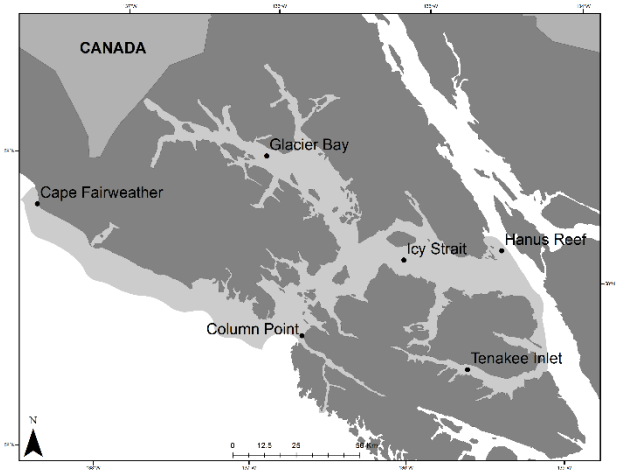

Figure 2h. Approximate distribution of Glacier Bay/Icy Strait harbor seal stock (shaded area).

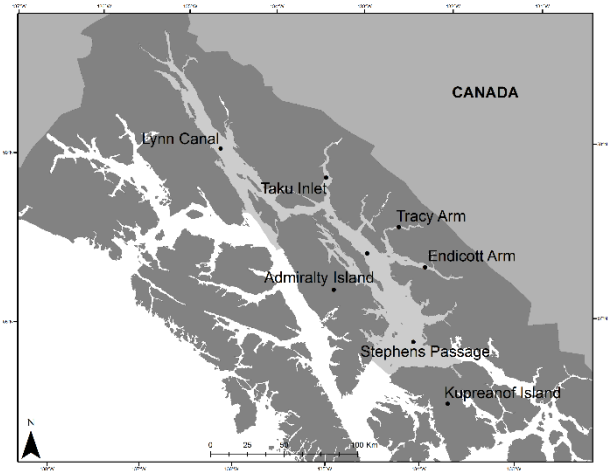

Figure 2i. Approximate distribution of Lynn Canal/Stephens Passage harbor seal stock (shaded area).

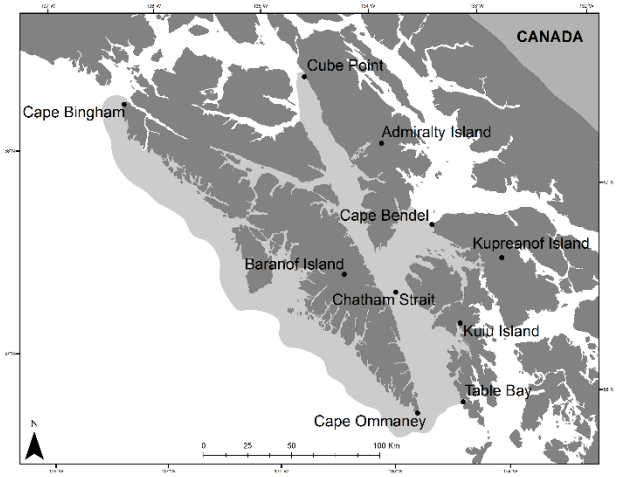

Figure 2j. Approximate distribution of Sitka/Chatham Strait harbor seal stock (shaded area).

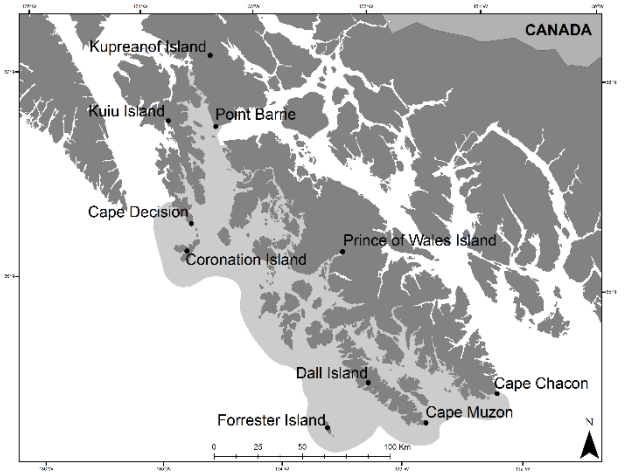

Figure 2k. Approximate distribution of Dixon/Cape Decision harbor seal stock (shaded area).

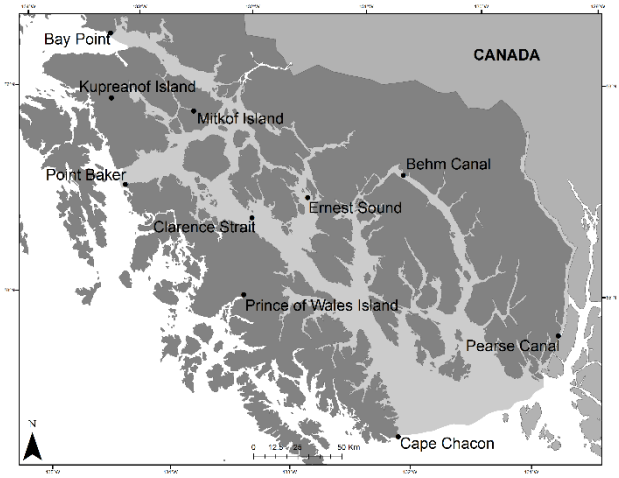

Figure 2l. Approximate distribution of Clarence Strait harbor seal stock (shaded area).

POPULATION SIZE

The Alaska Fisheries Science Center's National Marine Mammal Laboratory routinely conducts aerial surveys of harbor seals across their entire range in Alaska. Prior to 2008, Alaska was divided into five survey regions, with one region surveyed per year. In 2010, the survey sites were prioritized based on the newly defined harbor seal stock divisions, and annual aerial surveys attempt to sample the full geographic range of harbor seals in Alaska, with a focus on sites that make up a significant portion of each stock's population every year; sites with fewer seals are flown every 3 to 5 years. This site specific survey approach is designed to provide the counts necessary to estimate stock specific population abundance and trend for all 12 stocks annually. To derive an accurate estimate of population size from these surveys, a method was developed to address the influence of external conditions on the number of seals hauled out on shore, and counted, during the surveys. Many factors influence the propensity of seals to haul out, including tides, time of day, and date in the seals' annual life-history cycle. A statistical model defining the relationship between these factors and the number of seals hauled out was developed. Based on those models, the survey counts for each year were adjusted to the number of seals that would have been ashore during a hypothetical survey conducted under ideal conditions for hauling out (Boveng et al. 2003). In a separate analysis of radio-tagged seals, a similar statistical model was used to estimate the proportion of seals that were hauled out under those ideal conditions (Simpkins et al. 2003). The results from these two analyses were combined for each region to estimate the population size of each stock in Alaska.

Abundance Estimates and Minimum Population Estimates

The current statewide abundance estimate for Alaskan harbor seals is 205,090 (Boveng et al. in press a), based on aerial survey data collected during 1998-2011. See Table 1 for abundance estimates of the 12 stocks of harbor seals in Alaska. The minimum population estimate (N_{MIN}) for 11 of the 12 stocks of harbor seals in Alaska is calculated as the lower bound of the 80% credible interval obtained from the posterior distribution of abundance estimates. This approach is consistent with the definition of potential biological removal (PBR) in the current guidelines (Wade and Angliss 1997). The abundance estimate and N_{MIN} for the remaining stock, the Pribilof Islands stock, is simply the number counted in the most recent survey of this very small group.

Table 1. Abundance and 5-year trend estimates, by stock, for harbor seals in Alaska, along with respective estimates of standard error. The probability of decrease represents the proportion of the posterior probability distribution for the 5-year trend that fell below a value of 0 seals per year.

Stock	Year of last survey	Abundance estimate	SE	5-year trend estimate	SE	Probability of decrease	N_{MIN}
Aleutian Islands	2011	6,431	882	75	220	0.36	5,772
Pribilof Islands	2010	232	n/a	n/a	n/a	n/a	232
Bristol Bay	2011	32,350	6,882	1,209	1,941	0.25	28,146
North Kodiak	2011	8,321	1,619	531	590	0.16	7,096
South Kodiak	2011	19,199	2,429	-461	761	0.72	17,479
Prince William Sound	2011	29,889	13,846	26	3,498	0.56	27,936
Cook Inlet/Shelikof Strait	2011	27,386	3,328	313	1,115	0.38	25,651
Glacier Bay/Icy Strait	2011	7,210	1,866	179	438	0.40	5,647
Lynn Canal/Stephens Passage	2011	9,478	1,467	-176	388	0.71	8,605
Sitka/Chatham Strait	2011	14,855	2,106	411	568	0.23	13,212
Dixon/Cape Decision	2011	18,105	1,614	216	360	0.29	16,727
Clarence Strait	2011	31,634	4,518	921	1,246	0.21	29,093

Current Population Trend

Aerial surveys of harbor seal haulout sites throughout Alaska have been conducted annually and provide information on trends in abundance. The most current estimates of trend (Table 1) were estimated as the means of the

slopes of 1,000 simple linear regressions over the most recent eight annual estimates in each of the 1,000 Markov Chain Monte Carlo (MCMC) samples from the posterior distributions for abundance. Thus, they are in units of seals per year, rather than the typical annual percent growth rate. There is no appropriate method for converting these estimates of trend to annual percent growth rate. As a reflection of uncertainty in trend estimates, the proportion of the posterior distribution for each stock's trend that lies below the value of 0 is used as an estimate of the probability that a stock is currently decreasing (Table 1). This allows a probabilistic determination of the qualitative trend status: a value greater than 0.5 means the evidence suggests that the stock is decreasing; less than 0.5 means the stock is increasing. Because there will typically be a 2-3 year lag between the most recent surveys and the Stock Assessment Report update, a 5-year interval was used for estimating trend. This ensures trend estimates are based on data no more than about 8 years old, which is considered to be the approximate threshold of reliability for Marine Mammal Protection Act (MMPA) stock assessment data. One caveat of this approach is that, due to the skewness inherent in the posterior distribution, it is possible for a stock to exhibit a positive trend while also having a probability of decrease greater than 0.5. The following summarizes historical and recent information on the population trend for each of the 12 stocks.

Aleutian Islands: A partial estimate of harbor seal abundance in the Aleutian Islands was determined from skiff surveys of 106 islands from 1977 to 1982 (8,601 seals). Small et al. (2008) compared counts from the same islands during a 1999 aerial survey (2,859 seals). Counts decreased at a majority of the islands. Islands with greater than 100 seals decreased by 70%. The overall estimates showed a 67% decline during the approximate 20-year period (Small et al. 2008). The current (2007-2011) estimate of the population trend in the Aleutian Islands is +75 seals per year, with a probability that the stock is decreasing of 0.36 (Table 1).

Pribilof Islands: Counts of harbor seals in the Pribilof Islands ranged from 250 to 1,224 in the 1970s. Counts in the 1980s and 1990s ranged between 119 and 232 harbor seals. Prior to July 2010, the most recent count was in 1995 when a total of 202 seals were counted. In July 2010, approximately 185 adults and 27 pups were observed on Otter Island plus approximately 20 on all the other islands combined for a total of 232 harbor seals. Maximum seal counts (all ages) are nearly identical to the 1995 counts (212 vs. 202), but 2010 pup numbers were slightly less (27 vs. 42). The current population trend in the Pribilof Islands is unknown.

Bristol Bay: At Nanvak Bay, the largest haulout in northern Bristol Bay, harbor seals declined in abundance from 1975 to 1990 and increased from 1990 to 2000 (Jemison et al. 2006). Land-based harbor seal counts at Nanvak Bay from 1990 to 2000 increased at 9.2% per year during the pupping period and 2.1% per year during the molting period (Jemison et al. 2006). The Iliamna Lake harbor seal population of about 400 seals, that forms a small portion of the Bristol Bay stock, likely increased through the 1990s and is now stable at around 400 animals (Boveng et al. in press b). The current (2007-2011) estimate of the population trend in the Bristol Bay stock is +1,209 seals per year, with a probability that the stock is decreasing of 0.25 (Table 1).

North Kodiak: The current (2007-2011) estimate of the North Kodiak population trend is +531 seals per year, with a probability that the stock is decreasing of 0.16 (Table 1).

South Kodiak: A significant portion of the harbor seal population within the South Kodiak stock is located at and around Tugidak Island off the southwest coast of Kodiak Island. Sharp declines in the number of seals present on Tugidak were observed between 1976 and 1998. The highest rate of decline was 21% per year between 1976 and 1979 (Pitcher 1990). While the number of seals on Tugidak has stabilized and shown some evidence of increase since the decline, the population in 2000 remained reduced by 80% compared to the levels in the 1970s (Jemison et al. 2006). The current (2007-2011) estimate of the South Kodiak population trend is -461 seals per year, with a probability that the stock is decreasing of 0.72 (Table 1).

Prince William Sound: The Prince William Sound stock includes harbor seals both within and adjacent to Prince William Sound proper. Within Prince William Sound proper, harbor seals declined in abundance by 63% between 1984 and 1997 (Frost et al. 1999). In Aialik Bay, adjacent to Prince William Sound proper, there has been a decline in pup production by 4.6% annually from 40 down to 32 pups born from 1994 to 2009 (Hoover-Miller et al. 2011). The current (2007–2011) estimate of the Prince William Sound population trend over a 5-year period is +26 seals per year, with a probability that the stock is decreasing of 0.56 (Table 1). As noted earlier, this is an example where the skewed nature of the posterior distribution of the abundance estimate has resulted in a higher than 0.5 probability of decrease while subsequently showing an increasing trend.

Cook Inlet/Shelikof Strait: A multi-year study of seasonal movements and abundance of harbor seals in Cook Inlet was conducted between 2004 and 2007. This study involved multiple aerial surveys throughout the year, and the data indicated a stable population of harbor seals during the August molting period (Boveng et al. 2011). Aerial surveys along the Alaska Peninsula present greater logistical challenges and have therefore been conducted less frequently. The current (2007-2011) estimate of the Cook Inlet/Shelikof Strait population trend is +313 seals per year, with a probability that the stock is decreasing of 0.38 (Table 1).

Glacier Bay/Icy Strait: The Glacier Bay/Icy Strait stock showed a negative population trend estimate for harbor seals from 1992 to 2008 in June and August for glacial (-7.7%/yr; -8.2%/yr) and terrestrial sites (-12.4%/yr, August only) (Womble et al. 2010). Trend estimates by Mathews and Pendleton (2006) were similarly negative for both glacial and terrestrial sites. Long-term monitoring of harbor seals on glacial ice has occurred in Glacier Bay since the 1970s (Mathews and Pendleton 2006) and has shown this area to support one of the largest breeding aggregations in Alaska (Steveler 1979, Calambokidis et al. 1987). After a dramatic retreat of Muir Glacier (more than 7 km), in the East Arm of Glacier Bay, between 1973 and 1986 and the subsequent grounding and cessation of calving in 1993, floating glacial ice was greatly reduced as a haul-out substrate for harbor seals and ultimately resulted in the abandonment of upper Muir Inlet by harbor seals (Calambokidis et al. 1987, Hall et al. 1995, Mathews 1995). Prior to 1993, seal counts were up to 1,347 in the East Arm of Glacier Bay; 2008 counts were fewer than 200 (Streveler 1979, Molnia 2007). The current (2007–2011) estimate of the Glacier Bay/Icy Strait population trend is +179 seals per year, with a probability that the stock is decreasing of 0.40 (Table 1).

Lynn Canal/Stephens Passage: The current (2007-2011) estimate of the Lynn Canal/Stephens Passage population trend is -176 seals per year, with a probability that the stock is decreasing of 0.71 (Table 1).

Sitka/Chatham Strait: The current (2007-2011) estimate of the Sitka/Chatham Strait population trend is +411 seals per year, with a probability that the stock is decreasing of 0.23 (Table 1).

Dixon/Cape Decision: The current (2007-2011) estimate of the Dixon/Cape Decision population trend is +216 seals per year, with a probability that the stock is decreasing of 0.29 (Table 1).

Clarence Strait: The current (2007-2011) estimate of the Clarence Strait population trend is +921 seals per year, with a probability that the stock is decreasing of 0.21 (Table 1).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reliable rates of maximum net productivity have not been estimated directly from the 12 stocks of harbor seals identified in Alaska. Based on monitoring in Washington State from 1978 to 1999, Jeffries et al. (2003) estimated R_{MAX} to be 12.6% and 18.5% for harbor seals of the inland and coastal stocks, respectively. Harbor seals have been protected in British Columbia since 1970, and the monitored portion of that population responded with an annual rate of increase of approximately 12.5% through the late 1980s (Olesiuk et al. 1990), though a more recent evaluation suggested that 11.5% may be a more appropriate figure (DFO 2010). These empirical estimates of R_{MAX} indicate that the continued use of the pinniped maximum theoretical net productivity rate of 12% is appropriate for the Alaska stocks (Wade and Angliss 1997).

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: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. Marine mammal stocks such as the harbor seal stocks in Alaska that are taken by subsistence hunting may be given F_R values up to 1.0, provided they are "known to be increasing" or "not known to be decreasing" and "there have not been recent increases in the levels of takes" (Wade and Angliss 1997). For harbor seals in Alaska, these guidelines were followed by assigning all harbor seal stocks an initial, default recovery factor of 0.5. The default value was adjusted up to 0.7 if the estimated probability of decrease was greater than 0.7. The value was adjusted down to 0.3 if the estimated probability of decrease was less than 0.3. This provides a simple, balanced approach for providing a recovery factor consistent with current guidelines while incorporating results from novel statistical methods. Table 2 summarizes the PBR levels for each stock of harbor seals in Alaska based on N_{MIN} estimates, R_{MAX} = 12%, and F_R values.

Table 2. PBR calculations by stock for harbor seals in Alaska. The N_{MIN} values are determined from the 20th percentile of the posterior distribution for stock-level abundance estimates, except for the Pribilof Islands. A default value of 0.5 was used as the recovery factor. Based on evaluation of the trend estimates and probability of decrease, the recovery factor for some stocks was increased to 0.7. For other stocks, the recovery factor was decreased to 0.3.

Stock	N_{MIN}	R_{MAX}	Recovery Factor (F_R) (default value = 0.5)	PBR
Aleutian Islands	5,772	0.12	0.5	173
Pribilof Islands	232	0.12	0.5	7
Bristol Bay	28,146	0.12	0.7	1,182
North Kodiak	7,096	0.12	0.7	298
South Kodiak	17,479	0.12	0.3	314
Prince William Sound	27,936	0.12	0.5	838
Cook Inlet/Shelikof Strait	25,651	0.12	0.5	770
Glacier Bay/Icy Strait	5,647	0.12	0.5	169
Lynn Canal/Stephens Passage	8,605	0.12	0.3	155
Sitka/Chatham Strait	13,212	0.12	0.7	555
Dixon/Cape Decision	16,727	0.12	0.7	703
Clarence Strait	29,093	0.12	0.7	1,222

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

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

Previous stock assessments for harbor seals indicated three observed commercial fisheries operated within the range of the Bering Sea stocks of harbor seals, three within the range of stocks in Southeast Alaska, and five within the range of harbor seal stocks in the Gulf of Alaska. As of 2003, changes in how fisheries are defined in the MMPA List of Fisheries have resulted in separating these fisheries into 14 fisheries in the Bering Sea, 9 fisheries in Southeast Alaska, and 22 fisheries in the Gulf of Alaska based on both gear type and target species (69 FR 70094, 2 December 2004). This change does not represent a change in fishing effort but provides managers with better information on the component of each fishery that is responsible for the incidental mortality or serious injury of marine mammal stocks in Alaska.

Observer programs have documented mortality and serious injury of harbor seals in the Bering Sea/Aleutian Islands (BSAI) flatfish trawl fishery (1 in 2011 and 2 in 2012), Gulf of Alaska (GOA) Pacific cod trawl fishery (1 in 2010), and GOA flatfish trawl fishery (1 in 2011 and 2 in 2013) in 2009-2013 (Breiwick 2013; NMML, unpubl. data) (Table 3).

Although a reliable estimate of the overall mortality and serious injury rate incidental to commercial fisheries is currently unavailable because of the absence of observer placements in salmon gillnet fisheries known to interact with several of these stocks, for the purposes of stock assessment, mean annual mortality and serious injury rates are assigned to the following harbor seal stocks based on the location of takes in observed fisheries in 2009-2013 (Table

3): Bristol Bay stock: 0.6 from the BSAI flatfish trawl fishery; South Kodiak stock: 0.6 from the GOA Pacific cod trawl fishery + 1.3 from the GOA flatfish trawl fishery; Cook Inlet/Shelikof Strait stock: 0.4 from the GOA flatfish trawl fishery mortality in 2011 (this seal could have been from either the South Kodiak or Cook Inlet/Shelikof Strait stock, so the mortality is assigned to both stocks).

Table 3. Summary of incidental mortality and serious injury of harbor seals in Alaska due to U.S. commercial fisheries in 2009-2013 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; NMML, unpubl. data).

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	0 0 1 2 0	0 0 1 2 0	0.6 (CV = 0.02)
Gulf of Alaska Pacific cod trawl	2009 2010 2011 2012 2013	obs data	29 31 41 25 11	0 1 0 0 0	0 2.8 0 0 0	0.6 (CV = 0.81)
Gulf of Alaska flatfish trawl	2009 2010 2011 2012 2013	obs data	21 26 31 42 46	0 0 1 0 2[a]	0 0 1.9 0 4.7	1.3 (CV = 0.69)[b]
Minimum total estimated annual mortality						2.5 (CV = 0.41)

[a]Two pinnipeds incidentally caught in 2013 were recently genetically identified as harbor seals.
[b]The CV for this fishery does not accommodate the 2013 data.

Observer programs in Alaska State-managed salmon set gillnet and salmon drift gillnet fisheries have documented harbor seal mortality and serious injury (Table 4). The Prince William Sound salmon drift gillnet fishery is known to interact with harbor seals, although the most recent observer data available for this fishery are from 1990 and 1991. The minimum estimated average annual mortality and serious injury rate (24 seals) in this fishery will be applied to the Prince William Sound stock of harbor seals.

Table 4. Summary of incidental mortality and serious injury of harbor seals in Alaska due to U.S. commercial salmon drift and set gillnet fisheries in 1990 and 1991 and calculation of the mean annual mortality and serious injury rate based on the most recent observer program data available.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean estimated annual mortality
Prince William Sound salmon drift gillnet	1990 1991	obs data	4 5	2 1	36 12	24 (CV = 0.50)
Minimum total estimated annual mortality						24 (CV = 0.50)

Reports to the NMFS Alaska Region stranding database of harbor seals entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data (Helker et al. 2015). During 2009-2013, harbor seal mortality and serious injury occurred due to interactions with unknown fisheries (1 Clarence Strait harbor seal was observed with a hook and weight in its mouth in 2010 and 1 Cook Inlet/Shelikof Strait harbor seal entangled in an unknown set net in 2011) and recreational fishing gear (1 Prince William Sound harbor seal was caught in hook and line gear and cut loose with trailing gear in 2009), resulting in mean annual mortality and serious injury rates of 0.2 harbor seals from each of these stocks due to fishery-related strandings.

Alaska Native Subsistence/Harvest Information

The Alaska Native subsistence harvest of harbor seals has been estimated by the Alaska Native Harbor Seal Commission (ANHSC) and the Alaska Department of Fish and Game (ADF&G). Information from the ADF&G indicates the average harvest levels for the 12 stocks of harbor seals identified in Alaska from 2004 to 2008, including struck and lost, as follows (see Table 5; average annual harvest column). In 2011 and 2012, data on community subsistence harvests were collected for Kodiak Island, Prince William Sound, and Southeast Alaska (see Table 5; annual harvest 2011-2012 column). The remaining stocks have no updated community subsistence data, therefore, the most recent 5-years of data (2004-2008) will be retained and used for estimating average annual mortality and serious injury for these stocks.

Table 5. Summary of the subsistence harvest data for all 12 harbor seal stocks in Alaska, 2004-2008 and 2011-2012. Data are from Wolfe et al. (2005, 2006, 2008, 2009a, 2009b, 2012, 2013).

Stock	Minimum annual harvest 2004-2008	Maximum annual harvest 2004-2008	Average annual harvest 2004-2008	Annual harvest 2011 or 2012
Aleutian Islands	50	146	90	N/A
Pribilof Islands	0	0	0	N/A
Bristol Bay	82	188	141	N/A
North Kodiak	66	260	131	37
South Kodiak	46	126	78	126
Prince William Sound	325	600	439	255
Cook Inlet/Shelikof Strait	177	288	233	N/A
Glacier Bay/Icy Strait	22	108	52	104
Lynn Canal/Stephens Passage	17	60	30	50
Sitka/Chatham Strait	97	314	222	77
Dixon/Cape Decision	100	203	157	69
Clarence Strait	71	208	164	40

Other Mortality

Reports to the NMFS Alaska Region stranding database of harbor seals entangled in marine debris or with injuries caused by other types of human interaction are another source of mortality and serious injury data (Helker et al. 2015). During 2009-2013, one harbor seal (observed towing a buoy in 2011) was determined to be seriously injured due to entanglement in marine debris and one harbor seal mortality due to a ship strike occurred in 2009, 2010, and 2012. The estimated average annual serious injury and mortality rates based on these stranding data are 0.6 Clarence Strait harbor seals (0.2 due to entanglement in marine debris/gear + 0.4 due to ship strikes in 2009 and 2012) and 0.2 Lynn Canal/Stephens Passage harbor seals (due to a ship strike in 2010) for 2009 to 2013. An additional average annual mortality and serious injury rate of 0.2 will be applied to the Prince William Sound stock for a harbor seal entanglement, observed (with a remotely operated vehicle) in the salmon seine net of a sunken fishing vessel in Prince William Sound in 2011, that was reported to the NMFS Alaska Region (Helker 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 2003 and 2007, there was no mortality or serious injury resulting from research on any stock of harbor seals in Alaska (Division of Permits and Conservation, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910).

STATUS OF STOCK

No harbor seal stocks in Alaska are designated as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act, and human-caused mortality does not exceed PBR for any of the stocks; therefore, none of the stocks are strategic. At present, average annual mortality and serious injury levels incidental to U.S. commercial fisheries that are less than 10% of PBR can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. The status of all 12 stocks of harbor seals identified in Alaska relative to their Optimum Sustainable Population is unknown.

Aleutian Islands: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 17 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 (commercial fisheries) + 90 (harvest) + 0 (other fisheries + other mortality) = 90) is not known to exceed the PBR (173). The Aleutian Islands stock of harbor seals is not classified as a strategic stock.

Pribilof Islands: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 0.7 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 0 + 0 = 0) is not known to exceed the PBR (7). The Pribilof Islands stock of harbor seals is not classified as a strategic stock.

Bristol Bay: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 118 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.6 + 141 + 0 = 142) is not known to exceed the PBR (1,182). The Bristol Bay stock of harbor seals is not classified as a strategic stock.

North Kodiak: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 30 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 37 + 0 = 37) is not known to exceed the PBR (298). The North Kodiak stock of harbor seals is not classified as a strategic stock.

South Kodiak: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 32 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (1.9 + 126 + 0 = 128) is not known to exceed the PBR (315). The South Kodiak stock of harbor seals is not classified as a strategic stock.

Prince William Sound: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 84 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and

serious injury (24 + 255 + 0.4 = 279) is not known to exceed the PBR (838). The Prince William Sound stock of harbor seals is not classified as a strategic stock.

Cook Inlet/Shelikof Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 77 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0.4 + 233 + 0.2 = 234) is not known to exceed the PBR (770). The Bristol Bay stock of harbor seals is not classified as a strategic stock.

Glacier Bay/Icy Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 17 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 104 + 0 = 104) is not known to exceed the PBR (169). The Glacier Bay/Icy Strait stock of harbor seals is not classified as a strategic stock.

Lynn Canal/Stephens Passage: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 16 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 50 + 0.2 = 50) is not known to exceed the PBR (155). The Lynn Canal/Stephens Passage stock of harbor seals is not classified as a strategic stock.

Sitka/Chatham Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 56 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 77 + 0 = 77) is not known to exceed the PBR (555). The Sitka/Chatham Strait stock of harbor seals is not classified as a strategic stock.

Dixon/Cape Decision: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 70 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 69 + 0 = 69) is not known to exceed the PBR (703). The Dixon/Cape Decision stock of harbor seals is not classified as a strategic stock.

Clarence Strait: At present, U.S. commercial fishery-related annual mortality and serious injury levels less than 122 animals (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. A reliable estimate of the annual rate of mortality and serious injury incidental to commercial fisheries is unavailable. Therefore, it is unknown whether the mortality and serious injury rate due to commercial fishing is insignificant. Based on the best scientific information available, the estimated level of human-caused mortality and serious injury (0 + 40 + 0.8 = 41) is not known to exceed the PBR (1,222). The Clarence Strait stock of harbor seals is not classified as a strategic stock.

HABITAT CONCERNS

Glacial fjords in Alaska are critical for harbor seal whelping, nursing, and molting. Several of these areas have experienced a ten-fold increase in tour ship visitation since the 1980s. This increase in the presence of tour vessels has resulted in additional levels of disturbance to pups and adults (Jansen et al. 2015). The level of serious injury or mortality resulting from increased disturbance is not known.

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