SPOTTED SEAL (*Phoca largha*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Spotted seals are distributed along the continental shelf of the Bering, Chukchi, and Beaufort seas, and the Sea of Okhotsk south to the western Sea of Japan and northern Yellow Sea (Fig. 1). Eight main areas of spotted seal breeding have been reported (Shaughnessy and Fay 1977). On the basis of small samples and preliminary analyses of genetic composition, potential geographic barriers, and significance of breeding groups, Boveng et al. (2009) grouped those breeding areas into three Distinct Population Segments (DPSs): the Bering DPS, which includes breeding areas in the Bering Sea and portions of the East Siberian, Chukchi, and Beaufort seas that may be occupied outside the breeding period; the Okhotsk DPS; and the Southern DPS, which includes spotted seals breeding in the Yellow Sea and Peter the Great Bay in the Sea of Japan. For the purposes of this stock assessment, we define the Alaska stock of spotted seals to be that portion of the Bering DPS in U.S. waters.

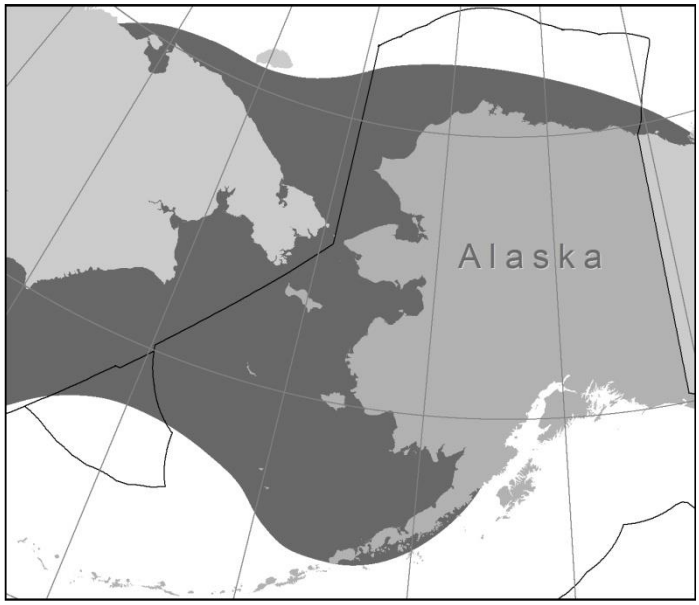

Figure 1. Approximate distribution of spotted seals in the Bering DPS (dark shaded area). The Alaska stock is defined as the portion of the Bering DPS within U.S. waters.

The distribution of spotted seals is seasonally related to specific life-history events that can be broadly divided into two periods: late-fall through spring, when whelping, nursing, breeding, and molting occur in association with the presence of sea ice on which the seals haul out, and summer through fall when seasonal sea ice has melted and most spotted seals use land for hauling out (Boveng et al. 2009). Satellite-tagging studies showed that seals tagged in the northeastern Chukchi Sea moved south in October and passed through the Bering Strait in November. Seals overwintered in the Bering Sea along the ice edge and made east-west movements along the edge (Lowry et al. 1998). During spring they tend to prefer small floes (i.e., <20 m in diameter), and inhabit mainly the southern margin of the ice in areas where water depth does not exceed 200 m, and move to coastal habitats after molting and the retreat of the sea ice (Fay 1974, Shaughnessy and Fay 1977, Lowry et al. 2000, Simpkins et al. 2003). In summer and fall, spotted seals use coastal haul-out sites regularly (Frost et al. 1993, Lowry et al. 1998) and may be found as far north as 69-72°N in the Chukchi and Beaufort seas (Porsild 1945, Shaughnessy and Fay 1977). To the south, along the west coast of Alaska, spotted seals are known to occur around the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands. Spotted seals are closely related to, and often mistaken for, Pacific harbor seals (*Phoca vitulina richardii*). The two species are often seen together and are partially sympatric, as their ranges overlap in the southern part of the Bering Sea (Quakenbush 1988). Yet, spotted seals breed earlier and are less social during the breeding season, and only spotted seals are strongly associated with pack ice (Shaughnessy and Fay 1977). These and other ecological, behavioral, genetic, and morphological differences support their recognition as two separate species (Quakenbush 1988, O'Corry-Crowe and Westlake 1997, Berta and Churchill 2012).

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous; 2) Population response data: unknown; 3) Phenotypic data: unknown; 4) Genotypic data: unknown. Based on this limited information, and the absence of any significant fishery interactions, there is currently no strong evidence to suggest splitting Alaska spotted seals into more than one stock. Therefore, only one Alaska stock is recognized in U.S. waters.

POPULATION SIZE

In spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire Bering Sea (defined as south of 65°45'N) and Sea of Okhotsk (Moreland et al. 2013). Conn et al. (2014), using a very limited sub-sample of the data collected only from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of approximately 461,625 spotted seals (95% CI: 388,732-560,348) in those waters. Although the entire Alaska stock of spotted seals is believed to be in the Bering Sea in the spring (Boveng et al. 2009), the proportion of the Alaska stock that occupies U.S. (vs. Russian) waters at that time is not known. As the Conn et al. (2014) estimate is only for the U.S. Bering Sea it is possible that it is a biased estimate of the Alaska stock, but the direction of any bias cannot be determined at this time.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for a stock is usually calculated using Equation 1 from the potential biological removal (PBR) guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. The 2012 Bering Sea abundance estimate by Conn et al. (2014), however, was calculated using a Bayesian hierarchical framework and so we used the 20th percentile of the posterior distribution of abundance estimates in place of the CV in Equation 1 to provide an N_{MIN} of 423,237 spotted seals in the U.S. portion of the Bering Sea in the spring.

Current Population Trend

Reliable data on trends in population abundance for the Alaska stock of spotted seals are unavailable.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is unavailable for the Alaska stock of spotted seals. Hence, until additional data become available, the pinniped maximum theoretical net productivity rate (R_{MAX}) of 12% will be used for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for pinniped stocks with unknown population status (Wade and Angliss 1997). Using the N_{MIN} calculated from Conn et al. (2014), the PBR for the Alaska stock of spotted seals is 12,697 seals (423,237 × 0.06 × 0.5).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Detailed information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals in 2011-2015 is listed, by marine mammal stock, in Helker et al. (2017); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The total estimated annual level of human-caused mortality and serious injury for Alaska spotted seals in 2011-2015 is 329 seals: 0.9 in U.S. commercial fisheries and 0.2 due to mortality incidental to Marine Mammal Protection Act (MMPA)-authorized research (from 2011-2015 data) and 328 in the Alaska Native subsistence harvest (from 2010-2014 data). However, the total mortality and serious injury due to commercial fisheries is unknown because some of the reported harbor seal takes in U.S. commercial fisheries may actually have been spotted seals (since it is virtually impossible to distinguish between these two species) and there have been no observer programs in nearshore Bristol Bay fisheries that are known to interact with spotted seals. Additional potential threats most likely to result in direct human-caused mortality or serious injury of this stock include the increased potential for oil spills due to an increase in vessel traffic in Alaska waters (with changes in sea-ice coverage).

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.

In 2011-2015, incidental mortality and serious injury of spotted seals occurred in 2 of the 22 federally-regulated U.S. commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Table 1; Breiwick 2013; MML, unpubl. data). The estimated minimum mean annual mortality and serious

injury rate incidental to U.S. commercial fisheries in 2011-2015 is 0.9 spotted seals, based exclusively on observer data.

Mortality and serious injury of harbor seals incidental to commercial fisheries occurred in 2011-2015 and, because it is virtually impossible to distinguish between these two species, some of the reported harbor seal takes may actually have been spotted seals. Further, there have been no observer programs on nearshore Bristol Bay fisheries that are known to interact with spotted seals, making the total mortality and serious injury due to fisheries unknown.

Table 1. Summary of incidental mortality and serious injury of Alaska spotted seals due to U.S. commercial fisheries in 2011-2015 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	2011 2012 2013 2014 2015	obs data	99 99 99 99 99	0 2 0 0 1	0 2 0 0 1	0.6 (CV = 0.03)
Bering Sea/Aleutian Is. Pacific cod longline	2011 2012 2013 2014 2015	obs data	57 51 66 64 62	1 0 0 0 0	1.6 0 0 0 0	0.3 (CV = 0.61)
Minimum total estimated annual mortality						0.9 (CV = 0.21)

Alaska Native Subsistence/Harvest Information

Spotted seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee 2016). The Ice Seal Committee, as co-managers with NMFS, recognizes the importance of harvest information and has collected it since 2008, when funding and personnel have allowed. Annual household survey results compiled in a statewide harvest report include historical ice seal harvest information back to 1960 (Quakenbush et al. 2009). This report is used to determine where and how often harvest information has been collected and where to focus in the future (Ice Seal Committee 2016). Information for 2010-2014 is available for 12 communities (Point Lay, Kivalina, Noatak, Buckland, Deering, Emmonak, Scammon Bay, Hooper Bay, Tununak, Quinhagak, Togiak, and Twin Hills) (Table 2), but more than 50 other communities harvest spotted seals and have not been surveyed in this time period or have never been surveyed. Harvest surveys are designed to estimate harvest within the surveyed community, but because of differences in seal availability, cultural hunting practices, and environmental conditions, extrapolating harvest numbers beyond that community is not appropriate. For example, during 2010-2014, only 12 of 64 coastal communities were surveyed for spotted seals and, of those communities, only 5 were surveyed for two or more consecutive years (Ice Seal Committee 2016). Thus, annual community-level harvest estimates totaled across communities provide a partial (i.e., minimum) estimate of annual statewide harvest. The geographic distribution of communities with annual harvest estimates also varies among years, so total annual estimates across communities may be geographically or otherwise biased. During 2010-2014, the minimum annual spotted seal harvest estimates totaled across surveyed communities ranged from 83 (in 2 communities) to 518 spotted seals (in 10 communities) (Table 2). Based on the harvest data from these 12 communities (Table 2), a minimum estimate of the average annual harvest of spotted seals in 2010-2014 is 328 seals. The Ice Seal Committee is working toward a better understanding of ice seal harvest by conducting more consecutive surveys in more communities with a goal to report a statewide ice seal harvest estimate.

Table 2. Alaska spotted seal minimum harvest estimates in 2010-2014 (Ice Seal Committee 2016).

Community	Estimated spotted seal harvest				
	2010	2011	2012	2013	2014
Point Lay			8		
Kivalina		21			
Noatak		25			
Buckland		84			
Deering		3			
Emmonak		28			
Scammon Bay		56	53		
Hooper Bay	71	57	46	61	27
Tununak	96	100	51		
Quinhagak	179	78	128	195	56
Togiak[1]	132	66			
Twin Hills[1]	18				
Minimum total	496	518	286	256	83

[1]Spotted seals or harbor seals.

Other Mortality

Beginning in mid-July 2011, elevated numbers of sick or dead pinnipeds, primarily ringed seals, with skin lesions were discovered in the Arctic and Bering Strait regions. By December 2011, there were more than 100 cases of affected pinnipeds, including spotted seals, ringed seals, bearded seals, and walruses in northern and western Alaska. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, NMFS and the USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on 20 December 2011 (https://alaskafisheries.noaa.gov/pr/ice-seals, accessed December 2017). Since 2014, few new cases similar to those observed in 2011 have been seen, but the UME investigation remains open for spotted seals based on continuing reports of ice seals with patchy hair loss (alopecia). Some of these seals may be survivors of the 2011 mortality event. No specific cause for the disease has been identified.

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 2014, there was one report of a mortality incidental to research on the Alaska stock of spotted seals, resulting in a mean annual mortality and serious injury rate of 0.2 spotted seals from this stock in 2011-2015 (Table 3) (Helker et al. 2017).

Table 3. Summary of mortality and serious injury of Alaska spotted seals, by year and type, reported to NMFS in 2011-2015 (Helker et al. 2017).

Cause of injury	2011	2012	2013	2014	2015	Mean annual mortality
MMPA authorized research-related	0	0	0	1	0	0.2
Total						0.2

STATUS OF STOCK

Spotted seals in Alaska are not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act (ESA). NMFS completed a comprehensive status review of the spotted seal under the ESA in 2009 and concluded that listing the Bering DPS of spotted seals was not warranted at that time (73 FR 51615, 20 October 2009). Based on available data, the minimum estimated U.S. commercial fishery-related mortality and serious injury rate for this stock (0.9) is less than 10% of the calculated PBR (10% of

PBR = 1,270) and, therefore, can be considered to be insignificant and approaching a zero mortality and serious injury rate. The PBR of the Alaska stock (i.e., portion of the Bering DPS that occurs in U.S. waters) is 12,697 spotted seals. The total estimated annual level of human-caused mortality and serious injury is 329 spotted seals. The Alaska stock of spotted seals is not considered a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Alaska stock of spotted seals. Though the entire Alaska stock is believed to be in the Bering Sea in the spring, the proportion that occupies U.S. (vs. Russian) waters at that time is not known. As such, it is possible that using the Conn et al (2014) abundance estimates to describe the entire Alaska stock may be biased. Further, the sample size available for genetics analysis was small so there could be additional stock structure within the Alaska stock. Nearshore commercial fisheries are not observed, and fishery-related mortality and serious injury in these fisheries could occur undetected. Similarly, the estimates of harvest by Alaska Natives are taken from surveys of only a fraction of the communities known to harvest marine mammals and so are considered minimum estimates. Based on the best available information, spotted seals are likely to be moderately sensitive to climate change.

HABITAT CONCERNS

The main concern about the conservation status of spotted seals stems from the likelihood that their preferred sea-ice habitats are being modified by the warming climate. Scientific projections are for continued and perhaps accelerated warming (Boveng et al. 2009). Despite the recent dramatic reductions in Arctic Ocean ice extent during summer, the sea ice in the Bering Sea is expected to continue forming annually in winter for the foreseeable future. There will likely be more frequent years in which ice coverage is reduced, resulting in a decline in the long-term average ice extent, but Bering Sea spotted seals will likely continue to encounter sufficient ice to support adequate vital rates. Even if sea ice were to vanish completely from the Bering Sea, there may be prospects for spotted seals to adjust their breeding grounds to follow the northward shift of the annual ice front into the Chukchi Sea. Laidre et al. (2008) concluded that on a worldwide basis spotted seals were likely to be moderately sensitive to climate change, based on an analysis of various life history features that could be affected by climate.

A second major concern, driven primarily by the production of carbon dioxide (CO_2) emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem. Ocean acidification, a result of increased CO_2 in the atmosphere, may affect spotted seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms. The nature and timing of such impacts are extremely uncertain. Because of spotted seals' apparent dietary flexibility, this threat should be of less immediate concern than the direct effects of sea-ice degradation (Boveng et al. 2009).

Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait), such as disturbance from vessel traffic or the potential for oil spills.

CITATIONS

Berta, A., and M. Churchill. 2012. Pinniped taxonomy: review of currently recognized species and subspecies, and evidence used for their description. Mammal Rev. 42(3):207-234.

Boveng, P. L., J. L. Bengtson, T. W. Buckley, M. F. Cameron, S. P. Dahle, B. P. Kelly, B. A. Megrey, J. E. Overland, and N. J. Williamson. 2009. Status review of the spotted seal (*Phoca largha*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-200, 153 p.

Breiwick, J. M. 2013. North Pacific marine mammal bycatch estimation methodology and results, 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-260, 40 p.

Conn, P. B., J. M. Ver Hoef, B. T. McClintock, E. E. Moreland, J. M. London, M. F. Cameron, S. P. Dahle, and P. L. Boveng. 2014. Estimating multispecies abundance using automated detection systems: ice-associated seals in the Bering Sea. Methods Ecol. Evol. 5:1280-1293. DOI: dx.doi.org/10.1111/2041-210X.12127 .

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

Fay, F. H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea, p. 383-399. *In* D. W. Hood and E. J. Kelley (eds.), Oceanography of the Bering Sea. University of Alaska Fairbanks, Institute of Marine Science, Occasional Publication 2.

Frost, K. J., L. F. Lowry, and G. Carroll. 1993. Beluga whale and spotted seal use of a coastal lagoon system in the northeastern Chukchi Sea. Arctic 46:8-16.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. 2017. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2011-2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-354, 112 p.

Ice Seal Committee. 2016. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2014. 76 p.

Laidre, K. L., I. Stirling, L. Lowry, Ø. Wiig, M. P. Heide-Jørgensen, and S. Ferguson. 2008. Quantifying the sensitivity of arctic marine mammals to climate-induced habitat change. Ecol. Appl. 18(2):S97-S125.

Lowry, L. F., K. J. Frost, R. Davis, D. P. DeMaster, and R. S. Suydam. 1998. Movements and behavior of satellite-tagged spotted seals (*Phoca largha*) in the Bering and Chukchi Seas. Polar Biol. 19:221-230.

Lowry, L. F., V. N. Burkanov, K. J. Frost, M. A. Simpkins, A. Springer, D. P. DeMaster, and R. Suydam. 2000. Habitat use and habitat selection by spotted seals (*Phoca largha*) in the Bering Sea. Can. J. Zool. 78:1959-1971.

Moreland, E., M. Cameron, and P. Boveng. 2013. Bering Okhotsk Seal Surveys (BOSS), joint U.S.-Russian aerial surveys for ice-associated seals, 2012-13. Alaska Fisheries Science Center Quarterly Report (July-August-September 2013):1-6.

O'Corry-Crowe, G. M., and R. L. Westlake. 1997. Molecular investigations of spotted seals (*Phoca larhga*) and harbor seals (*P. vitulina*), and their relationships in areas of sympatry, p. 291-304. *In* A. E. Dizon, S. J. Chivers, and W. F. Perrin (eds.), Molecular Genetics of Marine Mammals. The Society for Marine Mammalogy, Spec. Publ. 3.

Porsild, A. E. 1945. Mammals of the Mackenzie Delta. Can. Field-Nat. 59:4-22.

Quakenbush, L. T. 1988. Spotted seal, *Phoca largha*, p. 107-124. *In* J. W. Lentfer (ed.), Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, DC.

Quakenbush, L., J. Citta, and J. Crawford. 2009. Biology of the spotted seal (*Phoca largha*) in Alaska from 1962 to 2008. Report to NMFS. Arctic Marine Mammal Program, Alaska Department of Fish and Game, Fairbanks, AK. 66 p.

Shaughnessy, P. D., and F. H. Fay. 1977. A review of the taxonomy and nomenclature of North Pacific harbour seals. J. Zool. (Lond.) 182:385-419.

Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. L. Bengtson. 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. Polar Biol. 26:577-586.

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