Revised 12/30/2020

SPOTTED SEAL (*Phoca largha*): Bering 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. The Bering stock of spotted seals is defined as the Bering DPS. This stock assessment considers only the portion of the stock found within U.S. waters bounded by the U.S. Exclusive Economic Zone (EEZ; Fig. 1), because the relevant stock assessment data on abundance and human-caused mortality and serious injury are generally not available for the broader range of the stock or even for waters adjacent to the U.S. EEZ.

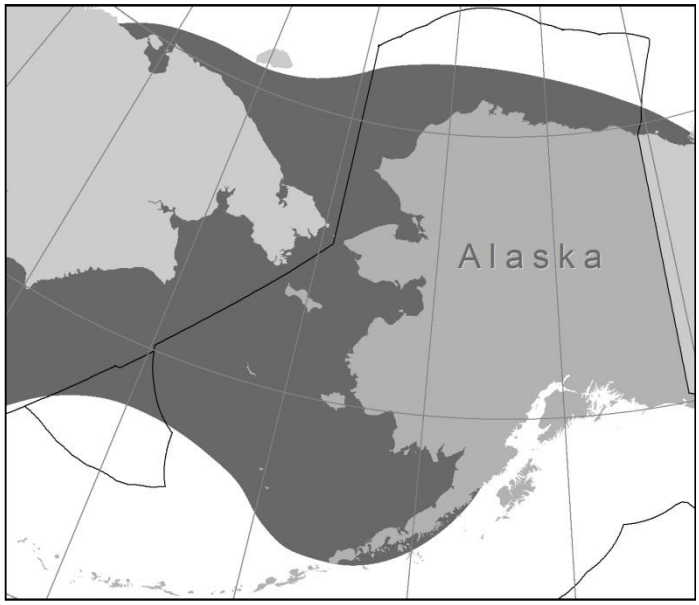

Figure 1. Approximate distribution of spotted seals in the Bering stock (dark shaded area), which is defined as the Bering DPS. This stock assessment considers only the portion of the stock occurring within U.S. waters (i.e., the U.S. Exclusive Economic Zone delineated by a black line).

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, Citta et al. 2018). 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).

POPULATION SIZE

In the spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire ice-covered portions of the Bering Sea (Moreland et al. 2013). Conn et al. (2014), using a sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of 461,625 spotted seals (95% CI: 388,732-560,348) in those waters. Although this is a preliminary abundance estimate it is also the best available and it is a reasonable estimate for the entire portion of the Bering spotted seal stock in U.S. waters because relatively few spotted seals are expected north of the Bering Strait during the surveys.

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 (NMFS 2016): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$, which approximates the 20th percentile of a distribution that is assumed to be log-normal. However, the abundance estimate based on Conn et al. (2014) was calculated using a Bayesian hierarchical framework, so we used the 20th percentile of the posterior distribution of abundance estimates as a more direct estimator of N_{MIN} than Equation 1 to provide an N_{MIN} of 423,237 spotted seals in the U.S. Bering Sea in the spring.

Current Population Trend

Reliable data on trends in population abundance for the Bering stock of spotted seals or the portion of the stock within U.S. waters are not available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Bering stock of spotted seals or for any portion of the stock within U.S. waters. Until additional data become available, the default pinniped maximum theoretical net productivity rate of 12% will be used for this stock (NMFS 2016).

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 1.0, a value that may be used for stocks that are not known to be decreasing and are taken primarily by aboriginal subsistence hunters, provided there have not been recent increases in the levels of takes (NMFS 2016). Using the N_{MIN} based on Conn et al. (2014) for spotted seals in the U.S. portion of the stock, the PBR is 25,394 seals (423,237 $\times$ 0.06 $\times$ 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused mortality and serious injury for the portion of the Bering spotted seal stock in U.S. waters between 2014 and 2018 is 5,254 seals: 1 in U.S. commercial fisheries, 0.4 incidental to Marine Mammal Protection Act (MMPA)-authorized research, and 5,253 in the Alaska Native subsistence harvest (average statewide harvest, including struck and lost animals, in 2015, based on a recently published analysis (Nelson et al. 2019) that is higher and likely more accurate than previous estimates but also revealed stable or decreasing trends in harvest numbers; see below). 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 without genetic analysis), 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

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental

takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed December 2020).

Between 2014 and 2018, incidental mortality and serious injury of spotted seals in U.S. waters occurred in one of the federally-managed U.S. commercial fisheries in Alaska monitored for incidental mortality and serious injury by fisheries observers: the Bering Sea/Aleutian Islands flatfish trawl fishery (Table 1; Breiwick 2013; MML, unpubl. data). This resulted in a minimum estimated mean annual mortality and serious injury rate of one spotted seal incidental to U.S. commercial fisheries between 2014 and 2018, based exclusively on observer data.

Mortality and serious injury of harbor seals incidental to U.S. commercial fisheries occurred between 2014 and 2018 and, because it is virtually impossible to distinguish between harbor seals and spotted seals without genetic analysis, 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 Bering spotted seals in U.S. waters due to U.S. commercial fisheries between 2014 and 2018 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 3 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality (CV)	Mean estimated annual mortality
Bering Sea/Aleutian Is. flatfish trawl	2014	obs data	100	0	0	1 (CV = 0.02)
	2015		100	2	2 (0.03)	
	2016		99	1	1 (0.05)	
	2017		100	2	2 (0.03)	
	2018		100	0	0	
Minimum total estimated annual mortality						1 (CV = 0.02)

Alaska Native Subsistence/Harvest Information

NMFS signed an agreement with the Ice Seal Committee (ISC; 2006) to co-manage Alaska ice seal populations. This co-management agreement promotes full and equal participation by Alaska Natives in decisions affecting the subsistence management of ice seals (to the maximum extent allowed by law) as a tool for conserving ice seal populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

Spotted seals are an important resource for Alaska Native subsistence hunters. Approximately 64 coastal communities in Alaska, from Bristol Bay to the Beaufort Sea, harvest ice seals (ISC 2019). The ISC, as co-managers with NMFS, recognizes the importance of harvest information and has collected it since 2008. Annual household survey results compiled in a statewide harvest report include historical ice seal harvest information from 1960 to 2017 (Quakenbush et al. 2009, ISC 2019). To estimate the recent subsistence harvest of ice seals, Nelson et al. (2019) used ice seal harvest survey data collected from 1992 to 2014 for 41 of 55 communities that regularly hunt ice seals, as well as the per capita removal estimates (based on the 2015 human population) from the surveyed communities, to estimate the average regional and statewide subsistence harvest (Table 2). The best statewide estimate of the average number of spotted seals harvested in 2015, including struck and lost animals, is 5,253 seals (Nelson et al. 2019). The authors also found stable or decreasing trends in the annual numbers of ice seals harvested (Nelson et al. 2019).

Table 2. Average regional and statewide subsistence harvest (including struck and lost animals) of Bering spotted seals in 2015 (Nelson et al. 2019). See Figure 1 in Nelson et al. (2019) for a list of the communities in each region.

Region	Average harvest (including struck and lost animals)
North Slope Borough	89
Maniilaq	507
Kawerak	3,175
Association of Village Council Presidents	1,205
Bristol Bay Native Association	277
Statewide total	5,253

Other Mortality

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 2014 and 2018, there were two reports of mortality incidental to research on the Bering stock of spotted seals (one each in 2014 and 2016), resulting in a mean annual mortality and serious injury rate of 0.4 spotted seals from this stock (Table 3; Young et al. 2020).

In 2011, NMFS and the U.S. Fish and Wildlife Service declared an Unusual Mortality Event (UME) for pinnipeds in the Bering and Chukchi seas, due to the unusual number of sick or dead seals and walruses discovered with skin lesions, bald patches, and other symptoms. The UME occurred from 1 May 2011 to 31 December 2016 and primarily affected ice seals, including ringed seals, bearded seals, ribbon seals, and spotted seals. The investigation concluded that the skin and hair symptoms were signs of a molt abnormality; however, no infectious disease agent or environmental cause for the UME symptoms and mortality was identified (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). Patchy baldness and delayed molt, however, continue to be observed in limited numbers (<20 per year) of harvested and beachcast ringed seals, bearded seals, ribbon seals, and spotted seals in Alaska.

Since 1 June 2018, elevated numbers of ice seal strandings have occurred in the Bering and Chukchi seas in Alaska and NMFS declared a UME for bearded seals, ringed seals, and spotted seals from 1 June 2018 to present in the Bering and Chukchi seas (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). As of 31 July 2020, 298 ice seal strandings of all age classes have been reported, including 88 bearded seals, 72 ringed seals, 49 spotted seals, and 89 unidentified seals. A subset of seals has been sampled for genetics and harmful algal bloom exposure and a few have had histopathology samples collected.

Table 3. Summary of mortality and serious injury of Bering spotted seals in U.S. waters, by year and type, reported to the NMFS Office of Protected Resources between 2014 and 2018 (Young et al. 2020).

Cause of injury	2014	2015	2016	2017	2018	Mean annual mortality
Incidental to MMPA-authorized research	1	0	1	0	0	0.4
Total incidental to MMPA-authorized research						0.4

STATUS OF STOCK

The Bering spotted seal stock is 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 (Boveng et al. 2009) and concluded that listing the Bering DPS of spotted seals, which corresponds to the Bering stock of spotted seals, was not warranted at that time (73 FR 51615, 20 October 2009). The Bering stock of spotted seals is not considered a strategic stock. The best estimate of the mean annual level of human-caused mortality and serious injury in the portion of the stock in U.S. waters is 5,254 spotted seals, which is less than the PBR (25,394 seals). The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (one seal) is less than 10% of the PBR (10% of PBR = 2,539) and, therefore, can

be considered insignificant and approaching a zero mortality and serious injury rate. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Bering stock of spotted seals. The 2012 Bering Sea abundance estimate by Conn et al. (2014) was calculated using only a sub-sample of the survey data and may be biased. Further, the sample size available for genetics analysis was small so there could be additional stock structure within the Bering stock. Nearshore commercial fisheries are not observed, and fishery-related mortality and serious injury in these fisheries could occur undetected. 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 is long-term habitat loss and modification resulting from climate change (Boveng et al. 2009). 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. Climate models consistently project substantial reductions in both the extent and timing of sea ice within the range of spotted seals in Alaska waters; however, the sea ice in the Bering Sea is expected to continue forming annually in winter for the foreseeable future. Spotted seals are associated with sea ice during the periods of reproduction and molting. The presence of sea ice is considered a requirement for whelping and nursing young, providing a platform out of the water to facilitate these life-history events. Similarly, the molt is believed to be promoted by elevated skin temperatures that, in polar regions, can only be achieved when seals haul out of the water. 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.

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. As described in Boveng et al. (2009), changes in spotted seal prey, anticipated in response to ocean warming and loss of sea ice, have the potential for negative impacts, but the possibilities are complex. Ecosystem responses may have very long lags as they propagate through trophic webs. Because of spotted seals' apparent dietary flexibility, this threat should be of less immediate concern than the direct effects of sea-ice degradation.

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

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