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RIBBON SEAL (*Histriophoca fasciata*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Ribbon seals inhabit the North Pacific Ocean and adjacent parts of the Arctic Ocean. In Alaska waters, ribbon seals range from the North Pacific Ocean and Bering Sea into the Chukchi and western Beaufort seas (Fig. 1). Ribbon seals are very rarely seen on shorefast ice or land. From late March to early May, ribbon seals inhabit the Bering Sea ice front (Burns 1970, 1981; Braham et al. 1984). They are most abundant in the northern part of the ice front in the central and western parts of the Bering Sea (Burns 1970, Burns et al. 1981). As the ice recedes in May to mid-July, the seals move farther north in the Bering Sea, where they haul out on the receding ice edge and remnant ice (Burns 1970, 1981; Burns et al. 1981). As the ice melts, seals become more concentrated, with at least part of the Bering Sea population moving to the Bering Strait and the southern part of the Chukchi Sea. Ten ribbon seals satellite tagged in the spring of 2005 near the eastern coast of Kamchatka spent the summer and fall throughout the Bering Sea (Boveng et al. 2013). However, of 72 ribbon seals satellite tagged in the central Bering Sea from 2007 to 2010, 21 seals (29%) moved to the Bering Strait, Chukchi Sea, or Arctic Basin as the ice retreated northward, while the other 51 tagged seals did not pass north of the Bering Strait (Boveng et al. 2013). Passive acoustic sampling detected ribbon seal calls in August to early/mid-November in the Chukchi Sea and on the Chukchi Plateau (Moore et al. 2012, Hannay et al. 2013, Jones et al. 2014, Frouin-Mouy et al. 2019), as well as in the western Beaufort Sea in September to early November (Frouin-Mouy et al. 2019), similarly indicating presence of some ribbon seals north of the Bering Strait during summer and fall. The 72 seals tagged in the central Bering Sea and the 10 seals tagged near Kamchatka dispersed widely, occupying coastal areas as well as the middle of the Bering Sea, both on and off the continental shelf (Boveng et al. 2013).

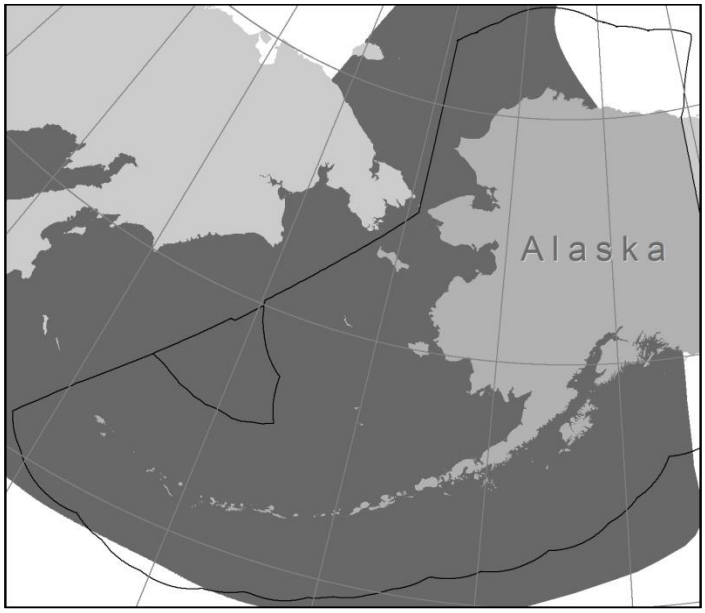

Figure 1. The ribbon seal stock is defined as the *Histriophoca fasciata* species (dark shaded areas depict the combined summer and winter distribution). This stock assessment considers only the portion of the stock occurring in U.S. waters (i.e., the U.S. Exclusive Economic Zone delineated by a black line).

This stock is defined as the *Histriophoca fasciata* species; however, 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.

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 and Sea of Okhotsk (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 184,697 ribbon seals (95% CI: 139,617-240,225) 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 stock in U.S. waters because relatively few ribbon seals are expected north of the Bering Strait during the surveys. When the final analyses for the Bering Sea and Sea of Okhotsk are complete, they will provide the first range-wide estimates of ribbon seal abundance.

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 163,086 ribbon seals in the U.S. Bering Sea in the spring.

Current Population Trend

Reliable data on trends in population abundance for the ribbon seal stock or for 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 ribbon seal stock 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 ribbon seals in the U.S. portion of the stock, the PBR is 9,785 seals ($163{,}086 \times 0.06 \times 1.0$).

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 ribbon seal stock in U.S. waters between 2014 and 2018 is 163 seals: 0.9 in U.S. commercial fisheries and 162 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). 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 ribbon seals in U.S. waters occurred in four 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, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod trawl, and Bering Sea/Aleutian Islands rockfish trawl fisheries (Table 1; Breiwick 2013; MML, unpubl. data). The minimum estimated mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2014 and 2018 is 0.9 ribbon seals, based exclusively on observer data.

Table 1. Summary of incidental mortality and serious injury of ribbon 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 2015 2016 2017 2018	obs data	100 100 99 100 100	1 0 0 0 0	1 (0.04) 0 0 0 0	0.2 (CV = 0.04)
Bering Sea/Aleutian Is. pollock trawl	2014 2015 2016 2017 2018	obs data	98 99 99 99 99	0 0 1 0 0	0 0 1.0 (0.13) 0 0	0.2 (CV = 0.13)
Bering Sea/Aleutian Is. Pacific cod trawl	2014 2015 2016 2017 2018	obs data	80 72 68 68 73	1 0 0 0 0	1.3 (0.49) 0 0 0 0	0.3 (CV = 0.49)
Bering Sea/Aleutian Is. rockfish trawl	2014 2015 2016 2017 2018	obs data	100 100 100 100 100	1 0 0 0 0	1 (0) 0 0 0 0	0.2 (CV = 0)
Minimum total estimated annual mortality						0.9 (CV = 0.15)

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).

Ribbon 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 and Citta 2008, 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 ribbon seals harvested in 2015, including struck and lost animals, is 162 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 ribbon 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	0
Maniilaq	9
Kawerak	130
Association of Village Council Presidents	23
Bristol Bay Native Association	0
Statewide total	162

Other Mortality

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. Although the UME was not declared for ribbon seals, some of the unidentified carcasses could have been ribbon seals that were too decomposed to be identified. A subset of seals has been sampled for genetics and harmful algal bloom exposure and a few have had histopathology samples collected.

STATUS OF STOCK

Ribbon seals are not designated as depleted under the Marine Mammal Protection Act (MMPA) or listed as threatened or endangered under the Endangered Species Act (ESA). NMFS completed a comprehensive status review of ribbon seals under the ESA in 2013 (Boveng et al. 2013) and concluded that listing ribbon seals was not warranted at that time (78 FR 41371, 10 July 2013). The ribbon seal stock 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 163 ribbon seals, which is less than the PBR (9,785 seals). The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (0.9 seals) is less than 10% of the PBR (10% of PBR = 979) 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 ribbon seal stock. The N_{MIN} used here, based on a 2012 Bering Sea density estimate from Conn et al. (2014) was calculated using only a sub-sample of the survey data and may be biased. Based on the best available information, ribbon seals are likely to be moderately sensitive to environmental change.

HABITAT CONCERNS

The main concern about the conservation status of ribbon seals is long-term habitat loss and modification resulting from environmental change (Boveng et al. 2013). Laidre et al. (2008) concluded that on a worldwide basis ribbon seals were likely to be moderately sensitive to environmental 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 ribbon seals in Alaska waters; however, the sea ice in the Bering Sea is expected to continue forming annually in winter for the foreseeable future. Ribbon seals are closely associated with sea ice, particularly 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; however, ribbon seals will likely continue to encounter sufficient ice to support adequate vital rates.

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 ribbon 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. (2013), changes in ribbon 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 ribbon seals' apparent dietary flexibility, this threat may be of less immediate concern than the threats from 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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