Revised 12/30/2018

RIBBON SEAL (*Histriophoca fasciata*): Alaska Stock

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 during 2007-2010, 21 seals (29%) moved to the Bering Strait, Chukchi Sea, or Arctic Basin as the ice retreated northward, while the other tagged seals (51 seals) did not pass north of the Bering Strait (Boveng et al. 2013). Year-long passive acoustic sampling, 2008-2009, on the Chukchi Plateau also detected ribbon seal calls in October and November 2008 (Moore et al. 2012), similarly indicating presence of some ribbon seals north of the Bering Strait during 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).

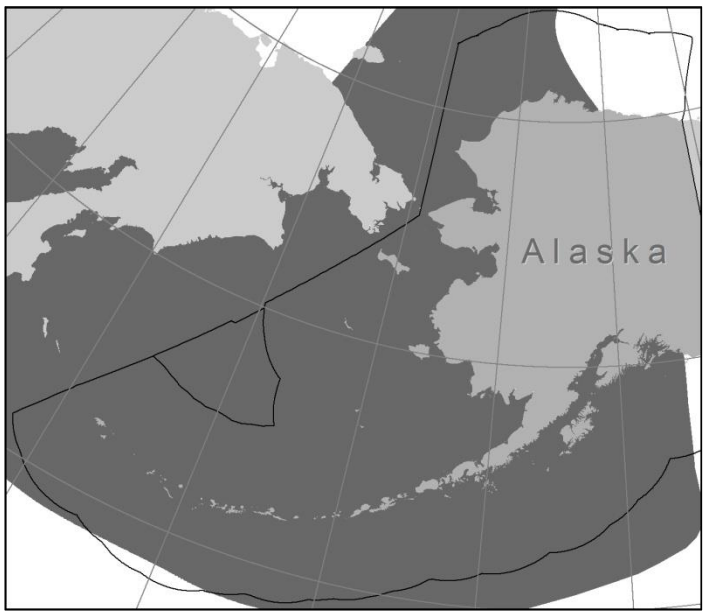

Figure 1. The Alaska stock of ribbon seals is defined as the portion of their distribution in U.S. waters. The dark shaded areas depict the combined summer and winter distribution. The U.S. Exclusive Economic Zone is delineated by the solid black line.

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; and 4) Genotypic data: unknown. Based on this limited information and the absence of significant fishery interactions, there is currently no strong evidence to support delineation of the distribution of ribbon seals into more than one stock (Boveng et al. 2013). Therefore, only the Alaska stock of ribbon seals is recognized in U.S. waters.

POPULATION SIZE

A reliable population estimate for the entire stock is not available, but research has developed survey methods and partial, but useful, abundance estimates. In spring 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys of the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). Conn et al. (2014), using a very limited sub-sample of the data collected from the U.S. portion of the Bering Sea in 2012, calculated an abundance estimate of approximately 184,697 ribbon seals (95% CI: 139,617-240,225) in those waters. Although this is a preliminary estimate, this abundance is a reasonable estimate for the entire U.S. population 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 (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 it is more accurate to use the 20th percentile of the posterior distribution of abundance estimates in place of the CV in Equation 1 to provide an N_{MIN} of 163,086 ribbon seals in this stock.

Current Population Trend

Reliable data on trends in population abundance for the Alaska stock of ribbon seals are unavailable. This stock is thought to occupy its entire historically-observed range (Boveng et al. 2013).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is unavailable for the Alaska stock of ribbon seals. Until additional data become available, the pinniped maximum theoretical net productivity rate 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 (N_{MIN}), 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, the value for stocks thought to be stable (Wade and Angliss 1997). Thus, the PBR for the Alaska stock of ribbon seals = 9,785 seals (163,086 × 0.06 × 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 in 2012-2016 is listed, by marine mammal stock, in Helker et al. (in press); 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 ribbon seals in 2012-2016 is 3.9 seals: 1.1 in U.S. commercial fisheries (from 2012-2016 data) and 2.8 in the Alaska Native subsistence harvest (from 2011-2015 data). This is a minimum estimate of the Alaska Native subsistence harvest because only a small proportion of the communities that harvest ice seals are surveyed each year. 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 (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.

During 2012-2016, incidental mortality and serious injury of ribbon seals 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 estimated minimum mean annual mortality and serious injury rate incidental to U.S. commercial fisheries in 2012-2016 is 1.1 ribbon seals, based exclusively on observer data.

Table 1. Summary of incidental mortality and serious injury of Alaska ribbon seals due to U.S. commercial fisheries in 2012-2016 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	2012 2013 2014 2015 2016	obs data	99 99 99 99 99	1 0 1 0 0	1 0 1 0 0	0.4 (CV = 0.03)
Bering Sea/Aleutian Is. pollock trawl	2012 2013 2014 2015 2016	obs data	98 97 98 99 99	0 0 0 0 1	0 0 0 0 1.0	0.2 (CV = 0.1)
Bering Sea/Aleutian Is. Pacific cod trawl	2012 2013 2014 2015 2016	obs data	68 80 80 72 68	0 0 1 0 0	0 0 1.4 0 0	0.3 CV = 0.55
Bering Sea/Aleutian Is. rockfish trawl	2012 2013 2014 2015 2016	obs data	100 99 99 100 99	0 0 1 0 0	0 0 1 0 0	0.2 CV = 0.01
Minimum total estimated annual mortality						1.1 (CV = 0.14)

Alaska Native Subsistence/Harvest Information

Ribbon seals are an important resource for Alaska Native subsistence hunters. Approximately 64 Alaska coastal communities in Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals (Ice Seal Committee 2017). The Ice Seal Committee, 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 2015 (Quakenbush and Citta 2008, Ice Seal Committee 2017). Ribbon seal harvest information for 2011-2015 is available for 16 communities (see Table 2). However, a number of other communities harvest ice seals and were not surveyed in 2011-2015, including a few communities that have never been surveyed.

Household harvest surveys are designed to estimate the harvest within each surveyed community, but because of differences in ribbon seal availability, cultural hunting practices, and environmental conditions, it is not appropriate to extrapolate harvest numbers beyond that community. The number of communities surveyed and successive annual surveys in the same communities have also been limited. For example, during 2011-2015, 16 of 64 coastal communities were surveyed for ice seal harvests and, of the 16 communities, only 4 were surveyed for two or more consecutive years (Ice Seal Committee 2017). 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 2011-2015, the minimum annual ribbon seal harvest estimates totaled across surveyed communities ranged from 0 to 8 seals (Table 2). Based on the available harvest data from these 16 communities (Table 2), a minimum estimate of the average annual ribbon seal harvest in 2011-2015 is 2.8 seals. The Ice Seal Committee is working for a better understanding of ice seal harvest by conducting more consecutive surveys in more communities, and one of their goals is to report a statewide ice seal harvest estimate.

Table 2. Alaska ribbon seal minimum harvest estimates in 2011-2015 (Ice Seal Committee 2017). Empty cells represent the years in which the communities were not surveyed for harvest information.

Community	Ribbon seal minimum harvest estimates				
	2011	2012	2013	2014	2015
Nuiqsut				0	
Utqiaġvik (formerly Barrow)				0	
Point Lay		0			
Kivalina	0				
Noatak	1				
Buckland	0				
Deering	0				
Golovin		0			
Emmonak	0				
Scammon Bay	4	2			
Hooper Bay	0	4	0	0	0
Tununak	0	0			
Tuntutuliak			0		
Quinhagak	3	0	0	0	
Togiak	0				
Dillingham		0			
Minimum total	8	6	0	0	0

Other Mortality

In 2011, NMFS and the USFWS 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://alaskafisheries.noaa.gov/pr/ice-seals, accessed December 2018). Patchy baldness and delayed molt, however, continue to be observed in limited numbers (<20 per year) of harvested and beach-cast ringed seals, bearded seals, ribbon seals, and spotted seals in Alaska.

STATUS OF STOCK

Ribbon seals are not designated as depleted under the Marine Mammal Protection Act or listed as threatened or endangered under the Endangered Species Act. The minimum population estimate of ribbon seals in U.S. waters is 163,086 seals, with a PBR of 9,785. Because the estimated annual level of U.S. commercial fishery-related mortality and serious injury (1.1) is less than 10% of PBR (10% of PBR = 979), it can be considered insignificant and approaching zero mortality and serious injury rate. A minimum estimate of the total annual level of human-caused mortality and serious injury is 3.9 ribbon seals. The Alaska stock of ribbon 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 ribbon seals. The abundance estimate by Conn et al. (2014) uses a very limited sub-sample of data from the U.S. portion of the Bering Sea and may be biased. Similarly, counts 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, ribbon seals are likely to be moderately sensitive to climate change.

HABITAT CONCERNS

The main concern about the conservation status of ribbon seals stems from the likelihood that a warming climate is reducing their preferred sea-ice habitats. Scientific projections are for continued and perhaps accelerated warming (Boveng et al. 2013). Ribbon seals, along with other seals that are dependent on sea ice for at least part of their life history (e.g., whelping and nursing young), will be vulnerable to reductions in sea ice. 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. Laidre et al. (2008) concluded that on a worldwide basis ribbon 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. Additional habitat concerns include the potential effects from increased shipping (particularly in the Bering Strait) and oil and gas exploration and development activities, such as disturbance from vessel traffic, seismic exploration noise, and the potential for oil spills.

CITATIONS

Boveng, P. L., J. L. Bengtson, M. F. Cameron, S. P. Dahle, E. A. Logerwell, J. M. London, J. E. Overland, J. T. Sterling, D. E. Stevenson, B. L. Taylor, and H. L. Ziel. 2013. Status review of the ribbon seal (*Histriophoca fasciata*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-255, 174 p.

Braham, H. W., J. J. Burns, G. A. Fedoseev, and B. D. Krogman. 1984. Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walruses in the Bering Sea, April 1976, p. 25-47. *In* F. H. Fay and G. A. Fedoseev (eds.), Soviet-American cooperative research on marine mammals. Vol. 1. Pinnipeds. U.S. Dep. Commer., NOAA Tech. Rep. NMFS-12.

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.

Burns, J. J. 1970. Remarks on the distribution and natural history of pagophilic pinnipeds in the Bering and Chukchi Seas. J. Mammal. 51:445-454.

Burns, J. J. 1981. Ribbon seal-*Phoca fasciata*, p. 89-109. *In* S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2. Seals. Academic Press, New York.

Burns, J. J., L. H. Shapiro, and F. H. Fay. 1981. Ice as marine mammal habitat in the Bering Sea, p. 781-797. *In* D. W. Hood and J. A. Calder (eds.), The Eastern Bering Sea Shelf: Oceanography and Resources. Vol. 2. U.S. Dep. Commer., NOAA, Office of Marine Pollution Assessment, Juneau, AK.

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.

Helker, V. T., M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, and J. Jannot. In press. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2012-2016. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX, XXX p.

Ice Seal Committee. 2017. The subsistence harvest of ice seals in Alaska – a compilation of existing information, 1960-2015. 78 p. Available online: http://www.north-slope.org/departments/wildlife-management/co-management-organizations/ice-seal-committee . Accessed December 2018.

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

Moore, S. E., K. M. Stafford, H. Melling, C. Berchok, Ø. Wiig, K. M. Kovacs, C. Lydersen, and J. Richter-Menge. 2012. Comparing marine mammal acoustic habitats in Atlantic and Pacific sectors of the High Arctic: year-long records from Fram Strait and the Chukchi Plateau. Polar Biol. 35:475-480. DOI: dx.doi.org/10.1007/s00300-011-1086-y .

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).

Quakenbush, L., and J. Citta. 2008. Biology of the ribbon seal in Alaska. Report to NMFS. Arctic Marine Mammal Program, Alaska Department of Fish and Game, Fairbanks, AK. 45 p.

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.