Revised 12/30/2020

STELLER SEA LION (*Eumetopias jubatus*): Western U.S. Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Steller sea lions range along the North Pacific Rim from northern Japan to California (Loughlin et al. 1984) (Fig. 1). Outside of the breeding season (late May to July), large numbers of individuals, especially juveniles and males, disperse widely, probably to access seasonally important prey resources (Jemison et al. 2018). This results in marked seasonal patterns of abundance in some parts of the range and potential for intermixing of animals that were born in different regions (Sease and York 2003; Baker et al. 2005; Jemison et al. 2013, 2018; Hastings et al. 2019). During the breeding season, sea lions, especially adult females, typically return to their natal rookery or a nearby breeding rookery to breed and pup (Raum-Suryan et al. 2002, Hastings et al. 2017).

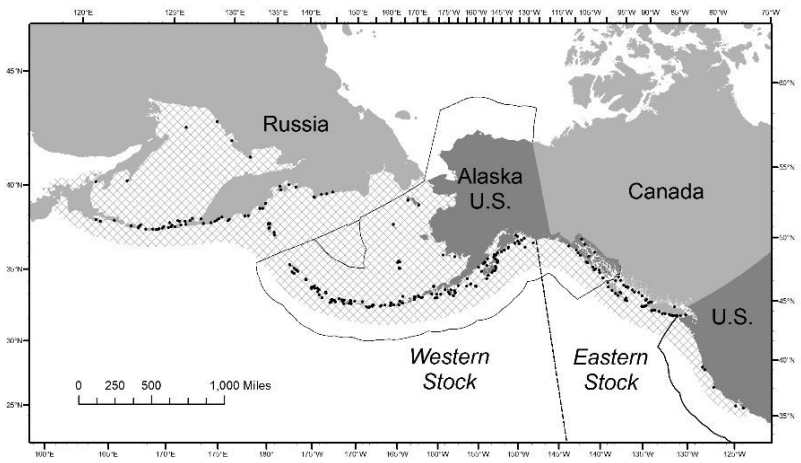

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005, Olesiuk 2008). A black dashed line (144°W) indicates the stock boundary (Loughlin 1997) and a black line delineates the U.S. Exclusive Economic Zone.

Loughlin (1997) considered the following information when classifying stock structure based on the phylogeographic approach of Dizon et al. (1992): 1) Distributional data: geographic distribution continuous, yet a high degree of natal site fidelity and low (<10%) exchange rate of breeding animals among rookeries; 2) Population response data: substantial differences in population dynamics (York et al. 1996); 3) Phenotypic data: differences in pup mass (Merrick et al. 1995, Loughlin 1997); and 4) Genotypic data: substantial differences in mitochondrial DNA (Bickham et al. 1996). Based on this information, two distinct population segments (DPSs) of Steller sea lions were recognized in the U.S.: the Eastern DPS, which includes animals born east of Cape Suckling, Alaska (144°W), and the Western DPS, which includes animals born at and west of Cape Suckling (Loughlin 1997; Fig. 1). However, there is regular movement of Steller sea lions, especially juveniles and males outside the breeding season, between the Western DPS (males and females equally) and the Eastern DPS (almost exclusively males) across the DPS boundary (Jemison et al. 2013, 2018; Hastings et al. 2019). In this report, the Western DPS is equivalent to the Western stock and the Eastern DPS is equivalent to the Eastern stock.

Mixing of mostly breeding females occurred between Prince William Sound and northern Southeast Alaska, beginning in the 1990s (Gelatt et al. 2007; Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Rehberg et al. 2018). In 1998 a single Steller sea lion pup was observed on Graves Rock just north of Cross Sound in Southeast Alaska, and within 15 years (2013) pup counts increased to 551 (DeMaster 2014). Movements of animals marked as pups in both stocks corroborate the extensive genetic research findings for a strong separation between the two currently recognized stocks (Jemison et al. 2013, 2018). Mitochondrial and microsatellite analysis of pup tissue samples collected at Graves Rock in 2002 revealed that approximately 70% of the pups had mtDNA haplotypes that were consistent with those found in the Western stock (Gelatt et al. 2007). Similarly, a rookery to the south on the White Sisters Islands, where pups were first noted in 1990, was also sampled in 2002 and approximately 45% of those pups had Western stock haplotypes (O'Corry-Crowe et al. 2014). Hastings et al. (2019) estimated that a minimum of 38% and 13% of animals in the North Outer Coast-Glacier Bay and Lynn Canal-Frederick Sound regions in northern Southeast Alaska, respectively, carry genetic information unique to the Western stock. Collectively, this information demonstrates that these two most recently established rookeries in northern Southeast Alaska were partially to predominately established by Western stock females (Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Rehberg et al. 2018; Hastings et al. 2019).

O'Corry-Crowe et al. (2014) concluded that the results of their study of the genetic characteristics of pups born on these new rookeries "demonstrates that resource limitation may trigger an exodus of breeding animals from declining populations, with substantial impacts on distribution and patterns of genetic variation." Jemison et al. (2018) also found that movement of Prince William Sound females east to these rookeries was negatively correlated with density: the population's declines prior to the early 2000s likely spurred these animals to move east in search of better foraging opportunities. This movement also revealed that this event is rare because colonists dispersed across an evolutionary boundary, suggesting that the causative factors behind recent declines are unusual or of larger magnitude than normally occur (O'Corry-Crowe et al. 2014). Thus, although recent colonization events in the northern part of the Eastern stock indicate movement of Western sea lions (especially adult females) into this area, the mixed part of the range remains geographically distinct (Jemison et al. 2013, 2018), and the discreteness between the Eastern and Western stocks remains. Movement of Western stock sea lions south of these rookeries and Eastern stock sea lions moving to the west is less common (Jemison et al. 2013, O'Corry-Crowe et al 2014).

Hybridization among subspecies and species along a contact zone such as a stock boundary is not unexpected as the ability to interbreed is an ancestral condition, whereas reproductive isolation would be considered a recently derived condition. As stated by NMFS and the U.S. Fish and Wildlife Service (USFWS) in a 1996 response to a previous comment regarding stock discreteness policy (61 FR 47222), "The Services do not consider it appropriate to require absolute reproductive isolation as a prerequisite to recognizing a distinct population segment" or stock. The fundamental concept overlying this distinctiveness is the collection of morphological, ecological, behavioral, and genetic evidence for stock differences initially described by Bickham et al. (1996) and Loughlin (1997) and supported by Baker et al. (2005), Harlin-Cognato et al. (2006), Hoffman et al. (2006, 2009), O'Corry-Crowe et al. (2006), and Phillips et al. (2009, 2011).

Steller sea lions that breed in Asia are considered part of the Western stock in the 2008 Steller sea lion Recovery Plan (NMFS 2008). Steller sea lions seasonally inhabit coastal waters of Japan in the winter and breeding rookeries of Western stock animals outside of the U.S. are currently only located in Russia (Burkanov and Loughlin 2005). Analyses of genetic data differ in their interpretation of separation between Asian and Alaska sea lions. Based on analysis of mitochondrial DNA, Baker et al. (2005) found evidence of a genetic split between the Commander Islands (Russia) and Kamchatka that would include Commander Island sea lions within the Western U.S. stock and animals west of there in an Asian stock. However, Hoffman et al. (2006) did not support an Asian/Western stock split based on their analysis of nuclear microsatellite markers indicating high rates of male gene flow. Berta and Churchill (2012) concluded that a putative Asian stock is "not substantiated by microsatellite data since the Asian stock groups with the Western stock." All genetic analyses (Baker et al. 2005; Harlin-Cognato et al. 2006; Hoffman et al. 2006, 2009; O'Corry-Crowe et al. 2006) confirm a strong separation between Western and Eastern stocks, and O'Corry-Crowe et al. (2006) identified structure at the level of different oceanic regions within the Aleutian Islands. There may be sufficient morphological differentiation to support elevating the two recognized stocks to subspecies (Phillips et al. 2009), although a review by Berta and Churchill (2012) characterized the status of these subspecies assignments as "tentative" and requiring further attention before their status can be determined. Work by Phillips et al. (2011) addressed the effect of climate change, in the form of glacial events, on the evolution of Steller sea lions and reported that the effective population size at the time of the event determines the impact of change on the population. The results suggested that during historic glacial periods, dispersal events were correlated with historically low effective population sizes, whereas range fragmentation type events were correlated with larger effective population sizes. This work again reinforced the stock delineation concept by noting that ancient population subdivision likely led to the sequestering of most mtDNA haplotypes as stock or subspecies-specific (Phillips et al. 2011).

POPULATION SIZE

The Western stock of Steller sea lions decreased from 220,000 to 265,000 animals in the late 1970s to less than 50,000 in 2000 (Loughlin et al. 1984, Loughlin and York 2000, Burkanov and Loughlin 2005). Since 2003, the abundance of the Western stock has increased, but there has been considerable regional variation in trend (Sease and Gudmundson 2002; Burkanov and Loughlin 2005; Fritz et al. 2013, 2016). Abundance surveys to count Steller sea lions are conducted in late June through mid-July starting approximately 10 days after the mean pup birth dates in the survey area (4-14 June) after approximately 95% of all pups are born (Pitcher et al. 2001, Kuhn et al. 2017). Modeled counts and trends are reported for the total Western stock in Alaska and the six regions (eastern, central, and western Gulf of Alaska and eastern, central, and western Aleutian Islands) that compose this geographic range. The boundaries for the six regions were identified based on metapopulation analysis of survey count data collected from 1976 to 1994 (York et al. 1996).

NMFS uses raw counts collected during the period from 1978 through 2019 to model counts and annual rates of change of non-pups and pups for regional aggregations using agTrend (Johnson and Fritz 2014). Using this model produces two types of count estimates: predicted and realized counts. Predicted counts are used to estimate trends and account for both observation and process errors. Realized counts use the standardized variance of raw counts at each site throughout the time series to estimate survey counts we could expect to collect if we had completely surveyed all sites. Therefore, the more complete the survey, the more similar raw counts are to realized counts, which is evident by smaller confidence intervals. Modeled counts, like raw counts, do not account for animals at sea; however, pup counts are considered a census of live pups as they are generally not in the water during the survey period.

Demographic multipliers (e.g., pup production multiplied by 4.5) and corrections for proportions of each age-sex class that are hauled out during the day in the breeding season (when aerial surveys are conducted) have been proposed as methods to estimate total population size from pup and/or non-pup counts (Calkins and Pitcher 1982, Higgins et al. 1988, Milette and Trites 2003, Maniscalco et al. 2006). There are several factors which make using demographic multipliers problematic when applied to counts of Western Steller sea lions in Alaska, including the lack of vital (survival and reproductive) rate information for the western and central Aleutian Islands, the large variability in abundance trends across the range (see Current Population Trend section below and Pitcher et al. 2007), and the large uncertainties related to reproductive status and foraging conditions that affect proportions hauled out (see review in Holmes et al. 2007).

The most recent comprehensive aerial photographic and land-based surveys of Western Steller sea lions in Alaska were conducted during the 2018 (Aleutian Islands west of Shumagin Islands) and 2019 (Southeast Alaska and Gulf of Alaska east of Shumagin Islands) breeding seasons (Sweeney et al. 2018, 2019). The Western Steller sea lion pup and non-pup model-predicted counts in Alaska in 2019 were 12,581 (95% credible interval of 11,308-14,051) and 40,351 (35,886-44,884), respectively.

Methods used to survey Steller sea lions in Russia differ from those used in Alaska, with less use of aerial photography and more use of skiff surveys and cliff counts for non-pups and ground counts for pups (Burkanov 2018a). Since 2015, the use of drones has allowed more survey effort to collect aerial imagery, similar to survey methods used for the Alaska range (Burkanov 2018a). The most recent total count of live pups on rookeries in Russia is available from counts conducted in 2016 and 2017, which totaled 5,629 pups, about 11% more than the 5,073 pups counted in 2013 and 2015 (Burkanov 2018b). Rookery pup counts represent more than 95% of pup counts at all sites (including haulouts) but are underestimates of total pup production. Modeled counts and trends are reported for non-pups only (there are not robust data available to model pup counts) for the six regions (Commander Islands, east Kamchatka, Kuril Islands, northern part of Sea of Okhotsk, Sakhalin Island, and western Bering Sea) that compose the geographic range in Russia (Fig. 2). In 2017, the non-pup count was modeled to be 13,691 (95% credible interval of 12,225-15,133) in Russia (Burkanov 2017, Johnson 2018).

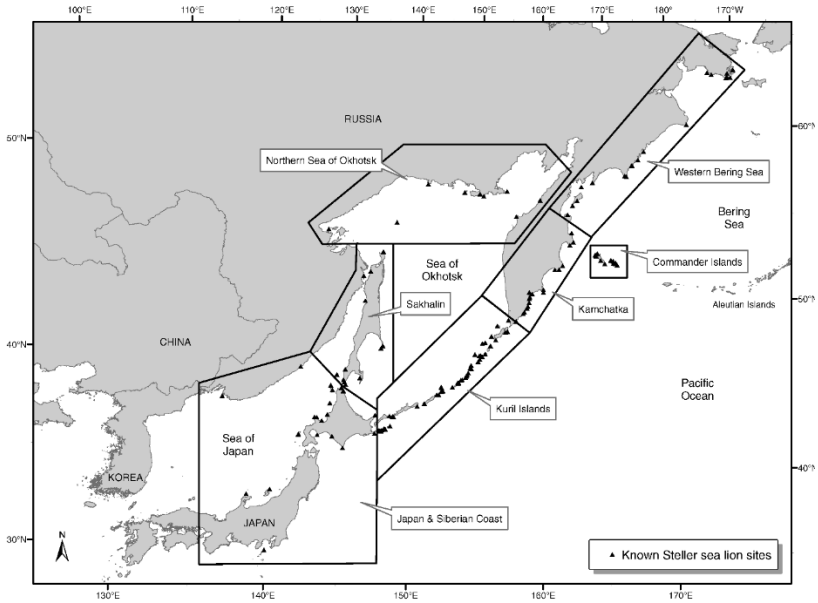

Figure 2. Steller sea lion survey regions along the Asian coast (Burkanov and Loughlin 2005).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) can be defined by the 20th percentile of a log-normal distribution based on a population abundance estimate for the stock (Wade 1994). Because current population size (N) and a pup multiplier to estimate N are not known we cannot produce an abundance estimate. With agTrend we can produce a sum of non-pup and pup modeled counts, which don't account for non-pups at sea, or animals that are born or die after the survey. Therefore, the summed count estimate is lower than an abundance estimate and we should not use the 20th percentile of this number. We use the best estimate of the total count of Western Steller sea lions in Alaska as the minimum population estimate (N_{MIN}). The agTrend model (Johnson and Fritz 2014) was used to estimate Western Steller sea lion pup and non-pup counts of 12,581 and 40,351, respectively, in Alaska in 2019 (Sweeney et al. 2019). These sum to 52,932, which will be used as the N_{MIN} for the U.S. portion of the Western stock of Steller sea lions (NMFS 2016).

Current Population Trend

The first reported trend counts (sums of counts at consistently surveyed, large sites used to examine population trends) of Steller sea lions in Alaska were made in 1956-1960. Those counts indicated that there were at least 140,000 (no correction factor applied) sea lions in the Gulf of Alaska and Aleutian Islands (Merrick et al. 1987). Subsequent surveys indicated a major population decrease, first detected in the eastern Aleutian Islands in the mid-1970s (Braham et al. 1980). Counts from 1976 to 1979 totaled about 110,000 sea lions (no correction factor applied). The decline appears to have spread eastward to Kodiak Island during the late 1970s and early 1980s, and then westward to the central and western Aleutian Islands during the early and mid-1980s (Merrick et al. 1987, Byrd 1989). During the late 1980s, counts in Alaska overall declined at approximately 15% per year (NMFS 2008) which prompted the listing (in 1990) of the species as threatened range-wide under the Endangered Species Act (ESA). Continued declines in counts of Western Steller sea lions in Alaska in the 1990s (Sease et al. 2001) led NMFS to change the ESA listing status to endangered in 1997 (NMFS 2008). Surveys in Alaska in 2002, however, were the first to note an increase in counts, which suggested that the overall decline of Western Steller sea lions stopped in the early 2000s (Sease and Gudmundson 2002).

Johnson and Fritz's (2014) agTrend model estimated regional and overall trends in counts of pups and non-pups in Alaska using data collected at all sites with at least two non-zero counts, rather than relying solely on counts at "trend" sites (also see Fritz et al. 2013, 2016). Using agTrend, modeled count data from 1978 to 2019 were used to produce trends for the total Western DPS in Alaska, east of Samalga Pass, and the central, western, and eastern Gulf of Alaska regions.

Model results indicated that pup and non-pup counts of Western stock Steller sea lions in Alaska were at their lowest levels in 2002 and have increased at 1.63% y^{-1} and 1.82% y^{-1}, respectively, between 2002 and 2019 (Table 1; Fig. 3; Sweeney et al. 2019). However, there are strong regional differences across the range in Alaska, with positive trends in the Gulf of Alaska and the eastern Aleutian Islands region, including eastern Bering Sea (east of Samalga Pass, ~170°W), and generally negative trends to the west of Samalga Pass, in the central and western Aleutian Islands (Table 1; Figs. 4 and 5).

Table 1. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in counts of Western Steller sea lion pups and non-pups (adults and juveniles) in Alaska, by regional areas. The rates reported for the Western DPS in Alaska; east of Samalga Pass; and eastern, central, and western Gulf of Alaska were calculated for the period from 2002 to 2019 (Sweeney et al. 2019). The rates reported for west of Samalga Pass and eastern, central, and western Aleutian Islands were calculated for the period from 2002 (when the Western DPS as a whole began to rebound) to 2018 (Sweeney et al. 2018).

Region	Latitude Range	Pups				Non-pups		
		Trend	-95%	+95%		Trend	-95%	+95%
Western DPS in Alaska	144°W-172°E	1.63	1.12	2.16		1.82	1.29	2.38
East of Samalga Pass	144°-170°W	2.90	2.37	3.53		2.71	2.05	3.35
Eastern Gulf of Alaska	144°-150°W	2.68	1.08	4.36		3.32	1.42	5.24
Central Gulf of Alaska	150°-158°W	3.08	1.76	4.35		3.40	2.53	4.32
Western Gulf of Alaska	158°-163°W	3.37	2.25	4.52		2.77	1.47	4.01
Eastern Aleutian Islands	163°-170°W	2.54	1.67	3.46		1.76	0.50	3.07
West of Samalga Pass	170°W-172°E	-2.08	-3.13	-0.79		-1.22	-2.20	-0.25
Central Aleutian Islands	170°W-177°E	-1.60	-2.75	-0.21		-0.53	-1.64	0.50
Western Aleutian Islands	172°-177°E	-6.47	-7.42	-5.57		-6.47	-7.81	-5.21

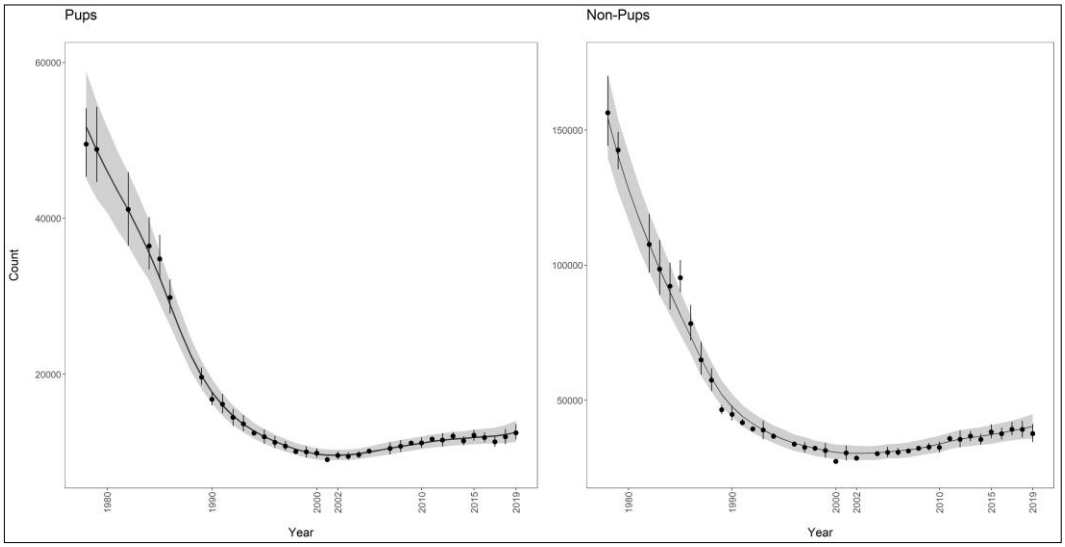

Figure 3. Realized and predicted counts of Western Steller sea lion pups (left) and non-pups (right) in Alaska, from 1978 to 2019. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval.

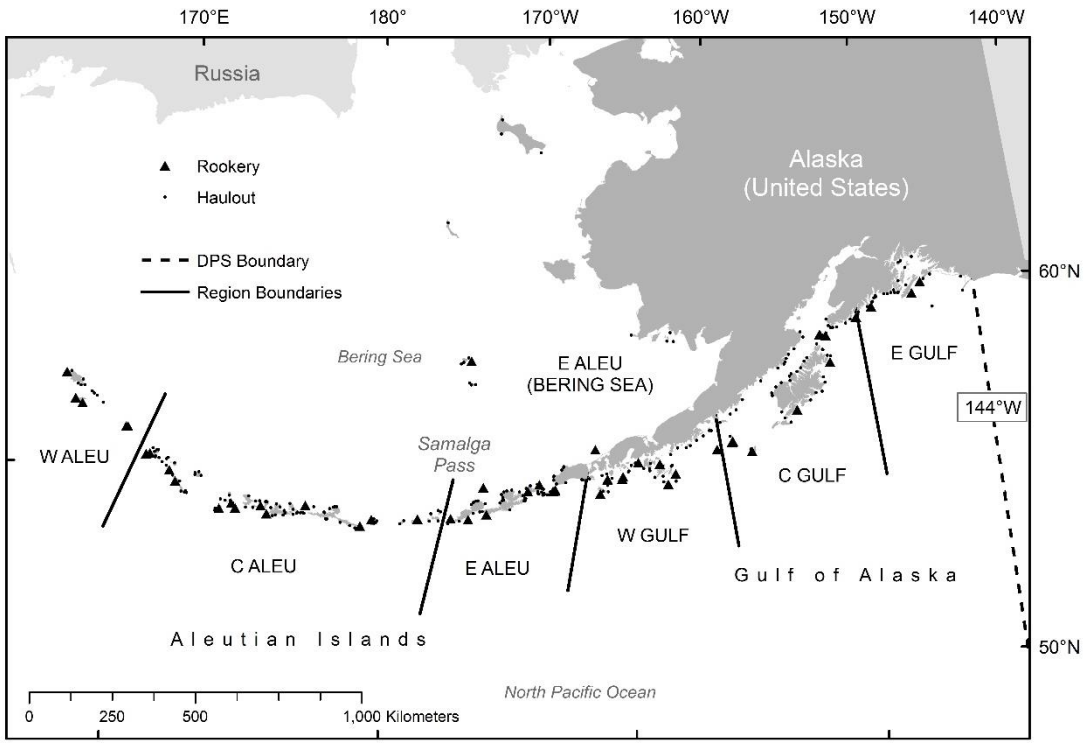

Figure 4. Regions of Alaska used for Western Steller sea lion population trend estimation. E GULF, C GULF, and W GULF are eastern, central, and western Gulf of Alaska regions, respectively. E ALEU, C ALEU, and W ALEU are eastern, central, and western Aleutian Islands regions, respectively (AFSC-MML-Alaska Ecosystems Program 2016).

In 2019, Western DPS survey effort was focused in the Gulf of Alaska (Sweeney et al. 2019). Between 2015 and 2017, pup counts declined in the eastern (-33%) and central (-18%) Gulf of Alaska, counter to the continuous increases observed in both regions since 2002 (Sweeney et al. 2017). These declines may have been due to changes in availability of prey associated with warm ocean temperatures that occurred in the northern Gulf of Alaska from 2014 to 2016 (Bond et al. 2015, Peterson et al. 2016, von Biela et al. 2019, Yang et al. 2019). There was also a movement of approximately 1,000 non-pups from the eastern to the central Gulf of Alaska regions, although the combined non-pup count in these two regions remained relatively stable between 2015 and 2017 (western Gulf of Alaska did not appear to change; Sweeney et al. 2017). In 2019, pup counts rebounded to 2015 levels; however, there was a decline in non-pup counts in the eastern, central, and western Gulf of Alaska regions (Sweeney et al. 2019).

No new data were collected for the Aleutian Islands in the 2019 survey, but the 2020 survey effort will be focused in this area. In 2018, survey effort was focused in the Aleutian Islands with some opportunistic surveys in the Gulf of Alaska (Sweeney et al. 2018). The area west of Samalga Pass was significantly declining, especially in the western Aleutian Islands region. The eastern Aleutian Islands region pups and non-pups have showed signs of recovery and have been increasing since the early 2000s.

Since part of the Western stock began to recover in the early 2000s, net movement between the Eastern and Western stocks appears to be small during the breeding season (Jemison et al. 2018). For example, there was an estimated net 75 sea lions that moved from east to west in 2016 (Jemison et al. 2013, Fritz et al. 2016). Very few females moved from Southeast Alaska to the Western stock, while approximately 500 were estimated to move from west to east (net increase in the east). Males moved in both directions, but with a net increase in the west. As a result, trends in counts estimated from breeding season surveys should be relatively insensitive, at a stock level, to inter-stock movements.

Burkanov and Loughlin (2005) estimated the Russian Steller sea lion population (pups and non-pups) declined approximately 52% from the 1970s to the 1990s. Johnson (2018) estimated the non-pup count in Russia

declined 1.3% y^{-1} between 2002 and 2017; however, just as in the U.S. portion of the Western stock, there were significant regional differences in population trend in Russia (Table 2; Fig. 6; Burkanov 2018a, Johnson 2018). The significant decline in non-pup counts appears to be primarily driven by the decline in the Kurils which, traditionally, represents the largest area in terms of non-pup counts (Burkanov 2018a, Johnson 2018). Moreover, it seems the statistically significant decline in the Kurils is the result of the 2015 survey, where there appeared to be a large reduction in comparison to previous years (Fig. 6; Johnson 2018). Pup production appeared to decline in most areas where breeding occurs in Russia (Kuril Islands, eastern Kamchatka, the Commander Islands, and parts of the Sea of Okhotsk-Iony rookery); only Tuleny Island (Sakhalin region) and part of the Sea of Okhotsk (Yamsky Islands rookery) had increasing pup counts between 2006 and 2017 (Burkanov 2018a, 2018b).

Table 2. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in non-pup counts for the Asian stock (Russia) of Steller sea lions and by region, from 2002 to 2017 (Johnson 2018). See Figure 2 for regions.

Region	**Trend**	**-95%**	**+95%**
Asian stock (Russia)	-1.3	-2.6	-0.1
Commander Islands	-0.6	-2.6	1.2
Kamchatka	-0.8	-3.0	1.5
Kuril	-4.1	-5.4	-2.8
Northern Sea of Okhotsk	0.9	-2.0	4.0
Sakhalin	0.9	-2.3	5.4
Western Bering Sea	-1.1	-16.1	10.2

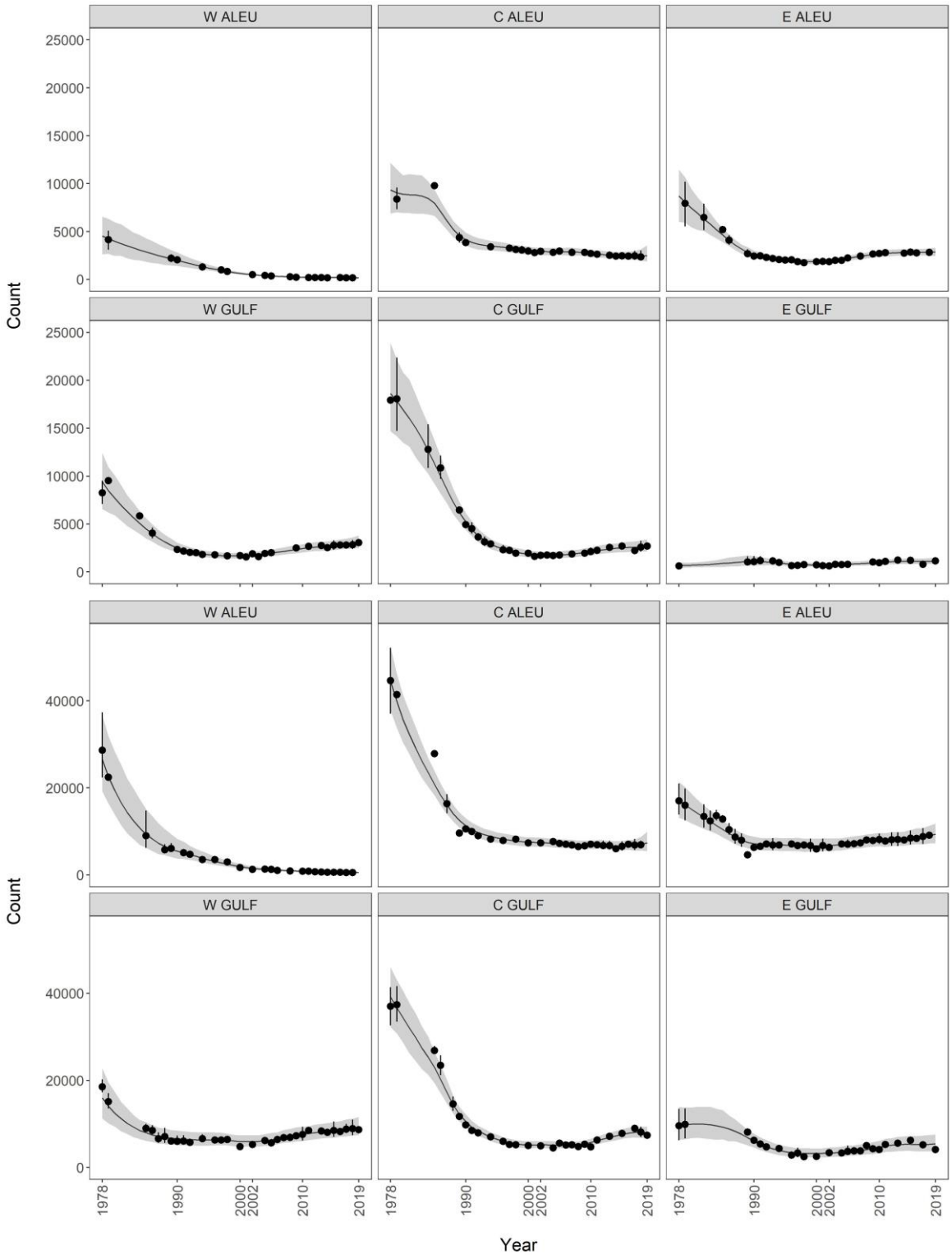

Figure 5. Realized and predicted counts of Steller sea lion pups (top) and non-pups (bottom) in the six regions that compose the Western stock in Alaska, 1978 to 2019. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval (Sweeney et al. 2018, 2019).

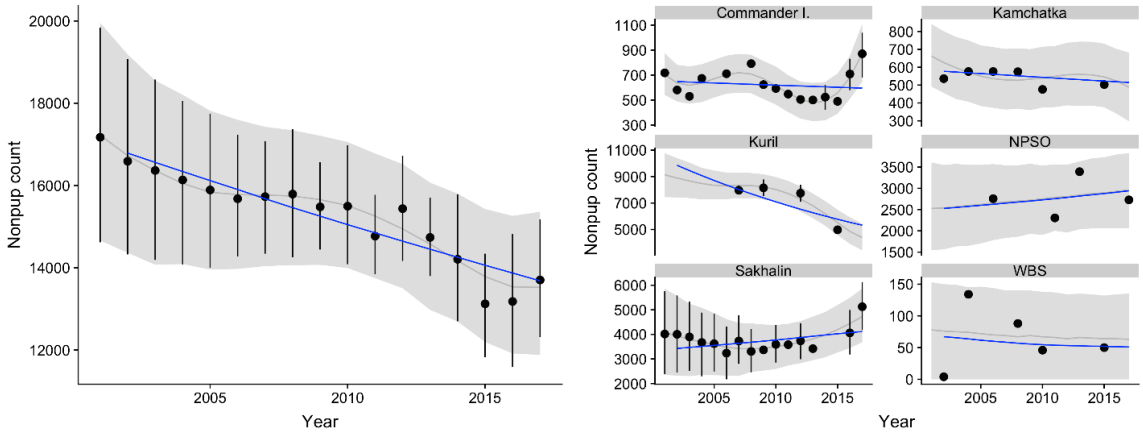

Figure 6. Realized and predicted counts of Russian Steller sea lion non-pups in Russia (left) and by region (right; Fig. 2), 2002 to 2017. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval. The blue line represents the trend based on constant average growth for the entire Asian stock as a whole.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the maximum net productivity rate (R_{MAX}) for Steller sea lions. 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

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 0.1, the default value for stocks listed as endangered under the ESA (NMFS 2016). Thus, for the U.S. portion of the Western stock of Steller sea lions, PBR is 318 sea lions (52,932 × 0.06 × 0.1).

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 Western U.S. Steller sea lions between 2014 and 2018 is 254 sea lions: 37 in U.S. commercial fisheries, 0.8 in unknown (commercial, recreational, or subsistence) fisheries, 3.6 in marine debris, 3.6 due to other causes (illegal shooting, mortality incidental to Marine Mammal Protection Act (MMPA)-authorized research), and 209 in the Alaska Native subsistence harvest. No observers have been assigned to several fisheries that are known to interact with this stock and estimates of entanglement in fishing gear and marine debris based solely on stranding reports in areas west of 144°W longitude may underestimate the entanglement of Western stock animals that travel to parts of Southeast Alaska. Due to a lack of available resources, NMFS is not operating the Alaska Marine Mammal Observer Program (AMMOP) focused on marine mammal interactions that occur in fisheries managed by the State of Alaska. The most recent data on Steller sea lion interactions with state-managed fisheries in Alaska are from the Southeast Alaska salmon drift gillnet fishery in 2012 and 2013 (Manly 2015), a fishery in which the majority of the Steller sea lions taken are likely to be from the Eastern stock, although sea lions carrying Western genetic material could be as high as 38% (Hastings et al. 2019). Counts of annual illegal gunshot mortality in the Copper River Delta should be considered minimums as they are based solely on aerial carcass surveys from 2015 to 2018, no data are available for 2014, a cause of death for all carcasses found was not determined, and it is not likely that all carcasses are detected. Disturbance of Steller sea lion haulouts and rookeries can potentially cause disruption of reproduction, stampeding, or increased exposure to predation by marine predators (NMFS 2008; see also NMFS 1990, 1997). Effects of

disturbance are highly variable and difficult to predict. Data are not available to estimate potential impacts from non-monitored activities, including disturbance near rookeries without 3-nmi no-entry buffer zones. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include subsistence harvest, incidental take, illegal shooting, disturbance at rookeries that could cause stampedes, and entanglement in fishing gear and marine debris.

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).

Based on historical reports and their geographic range, Steller sea lion mortality and serious injury could occur in several fishing gear types, including trawl, gillnet, longline, and troll fisheries. However, observer data are limited. Of these fisheries, only trawl fisheries are regularly observed and gillnet fisheries have had limited observations in select areas over short time frames and with modest observer coverage. Consequently, there are little to no data on Steller sea lion mortality and serious injury in non-trawl fisheries. Therefore, the potential for fisheries-caused mortality and serious injury may be greater than is reflected in existing observer data.

Between 2014 and 2018, mortality and serious injury of Western Steller sea lions was observed in 10 of the federally-managed commercial fisheries in Alaska that are monitored for incidental mortality and serious injury by fisheries observers: Bering Sea/Aleutian Islands Atka mackerel trawl, Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands Pacific cod trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod longline, Gulf of Alaska Pacific cod trawl, Gulf of Alaska Pacific cod longline, Gulf of Alaska flatfish trawl, Gulf of Alaska rockfish trawl, and Gulf of Alaska pollock trawl fisheries, resulting in a mean annual mortality and serious injury rate of 22 sea lions (Table 3; Breiwick 2013; MML, unpubl. data).

AMMOP observers monitored the Alaska State-managed Prince William Sound salmon drift gillnet fishery in 1990 and 1991, recording two incidental mortalities in 1991, extrapolated to 29 (95% CI: 1-108) for the entire fishery (Wynne et al. 1992; Table 3). No incidental mortality or serious injury was observed during 1990 for this fishery (Wynne et al. 1991), resulting in a mean annual mortality rate of 15 sea lions for 1990 and 1991. It is not known whether this incidental mortality and serious injury rate is representative of the current rate in this fishery.

Between 2014 and 2018, Steller sea lion mortality resulting from entanglements in commercial longline gear (1 in 2015) and commercial salmon seine net (1 in 2018) was reported to the NMFS Alaska Region marine mammal stranding network (Young et al. 2020), resulting in a mean annual mortality and serious injury rate of 0.4 sea lions in commercial gear (Table 4). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and is a minimum because not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined.

The minimum estimated mean annual mortality and serious injury rate in U.S. commercial fisheries between 2014 and 2018 is 37 Steller sea lions from this stock (37 from observer data + 0.4 from stranding data) (Tables 3 and 4). No observers have been assigned to several fisheries that are known to interact with this stock, thus, the estimated mortality and serious injury is likely an underestimate of the actual level.

Table 3. Summary of incidental mortality and serious injury of Western U.S. Steller sea lions due to U.S. commercial fisheries between 2014 and 2018 (or the most recent data available) and calculation of the mean annual mortality and serious injury rate (Wynne et al. 1991, 1992; Breiwick 2013; MML, unpubl. data). N/A indicates that data are not available. 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. Atka mackerel trawl	2014 2015 2016 2017 2018	obs data	100 100 98 100 100	0 0 0 1 5	0 0 0 1 (0.06) 5.1 (0.08)	1.2 (CV = 0.07)
Bering Sea/Aleutian Is. flatfish trawl	2014 2015 2016 2017 2018	obs data	100 100 99 100 100	5 6 9 13 8	5.0 (0.02) 6.0 (0.02) 9.0 (0.02) 13 (0.01) 8.0 (0.02)	8.2 (CV = 0.01)
Bering Sea/Aleutian Is. Pacific cod trawl	2014 2015 2016 2017 2018	obs data	80 72 68 68 73	0 0 0 1 1	0 0 0 1 (0) 1 (0)	0.4 (CV = 0)
Bering Sea/Aleutian Is. pollock trawl	2014 2015 2016 2017 2018	obs data	98 99 99 99 99	2 1 13 6 6	2.0 (0.1) 1 (0.07) 13 (0.03) 6.1 (0.05) 6.1 (0.04)	5.7 (CV = 0.02)
Bering Sea/Aleutian Is. pollock trawl	2017	obs data	99	1[a]	N/A	0.2 (CV = N/A)
Bering Sea/Aleutian Is. Pacific cod longline	2014 2015 2016 2017 2018	obs data	64 62 57 58 55	1 3 0 1 0	1.7 (0.63) 4.9 (0.36) 0 1.6 (0.6) 0	1.6 (CV = 0.28)
Gulf of Alaska Pacific cod longline	2014 2015 2016 2017 2018	obs data	31 36 30 40 29	0 1 0 0 0	0 1.3 (0.5) 0 0 0	0.3 (CV = 0.5)
Gulf of Alaska Pacific cod trawl	2014 2015 2016 2017 2018	obs data	12 13 13 11 25	0 0 1 0 0	0 0 10 (0.9) 0 0	2.0 (CV = 0.9)
Gulf of Alaska flatfish trawl	2014 2015 2016 2017 2018	obs data	47 54 39 56 34	0 0 (+1)[b] 0 0 0	0 0 (+1)[c] 0 0 0	0 (+0.2)[d] (CV = N/A)

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality (CV)	Mean estimated annual mortality
Gulf of Alaska rockfish trawl	2014 2015 2016 2017 2018	obs data	96 93 98 98 95	0 0 (+1)[b] 0 0 0	0 0 (+1)[c] 0 0 0	0 (+0.2)[d] (CV = N/A)
Gulf of Alaska pollock trawl	2014 2015 2016 2017 2018	obs data	14 23 27 19 21	0 0 (+5)[e] 1 0 0	0 0 (+5)[f] 4.8 (0.89) 0 0	1.0 (+1)[g] (CV = 0.89)
Prince William Sound salmon drift gillnet	1990 1991	obs data	4 5	0 2	0 29	15 (CV = 1.0)
Minimum total estimated annual mortality						37 (CV = 0.43)

[a]This animal was discovered during a vessel offload. Because it could not be associated with a haul number, it was not included in the bycatch estimate for the fishery.
[b]Total mortality and serious injury observed in 2015: 0 sea lions in sampled hauls + 1 sea lion in an unsampled haul.
[c]Total estimate of mortality and serious injury in 2015: 0 sea lions (extrapolated estimate from 0 sea lions observed in sampled hauls) + 1 sea lion (1 sea lion observed in an unsampled haul).
[d]Mean annual mortality and serious injury for fishery: 0 sea lions (mean of extrapolated estimates from sampled hauls) + 0.2 sea lions (mean of number observed in unsampled hauls).
[e]Total mortality and serious injury observed in 2015: 0 sea lions in sampled hauls + 5 sea lions in unsampled hauls.
[f]Total estimate of mortality and serious injury in 2015: 0 sea lions (extrapolated estimate from 0 sea lions observed in sampled hauls) + 5 sea lions (5 sea lions observed in unsampled hauls).
[g]Mean annual mortality and serious injury for fishery: 1.0 sea lion (mean of extrapolated estimates from sampled hauls) + 1 sea lion (mean of number observed in unsampled hauls).

Reports to the NMFS Alaska Region marine mammal stranding network of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data (Table 4; Young et al. 2020). From 2014 to 2018, there were three reports of Steller sea lion interactions with salmon hook and line gear, in which an animal in poor body condition had a flasher lure hanging from its mouth and was believed to have ingested the hook, and one report of an animal that was entangled in unidentified hook and line gear, resulting in a mean annual mortality and serious injury rate of 0.8 sea lions in these unknown (commercial, recreational, or subsistence) fisheries (Table 4). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and is a minimum because not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined. Additionally, since Steller sea lions from parts of the Western stock are known to regularly occur in parts of Southeast Alaska (Jemison et al. 2013, 2018; NMFS 2013), and higher rates of entanglement of Steller sea lions have been observed in this area (e.g., Raum-Suryan et al. 2009), estimates based solely on stranding reports in areas west of 144°W longitude may underestimate the total entanglement of Western stock sea lions in fishery-related gear and marine debris.

Table 4. Summary of Western U.S. Steller sea lion mortality and serious injury, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and Alaska Department of Fish and Game between 2014 and 2018 (Young et al. 2020). N/A indicates that data are not available.

Cause of injury	2014	2015	2016	2017	2018	Mean annual mortality
Entangled in commercial Kodiak salmon seine net	0	0	0	0	1	0.2
Entangled in commercial longline gear	0	1	0	0	0	0.2
Hooked by salmon hook and line gear*	1	0	0	1	1	0.6
Entangled in unknown hook and line gear*	1	0	0	0	0	0.2
Entangled in marine debris	3	6	1	3	5	3.6
Illegally shot	N/A	8	1	0	0	3[a]
Incidental to MMPA-authorized research	0	1	2	0	0	0.6
Total in commercial fisheries						0.4
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.8
Total in marine debris						3.6
Total due to other causes (illegally shot, incidental to MMPA-authorized research)						3.6

[a]Dedicated effort to survey the Copper River Delta for stranded marine mammals began in 2015 in response to a high number of reported strandings, some of which were later determined to be human-caused (illegally shot). Dedicated surveys were also conducted in 2016, 2017, and 2018. Because similar data are not available for 2014 and survey effort was limited in 2018, the data were averaged over 3 years of survey effort (2015-2017) for a more informed estimate of mean annual mortality.

The minimum mean annual mortality and serious injury rate for all fisheries between 2014 and 2018, based on observer data and stranding data for U.S. commercial fisheries (37 sea lions) and on stranding data for unknown (commercial, recreational, or subsistence) fisheries (0.8 sea lions), is 38 Western Steller sea lions.

Alaska Native Subsistence/Harvest Information

NMFS signed agreements with the Tribal Government of St. Paul Island (2000) and the Traditional Council of St. George Island (2001) to co-manage Steller sea lions and northern fur seals. NMFS also signed an agreement with the Aleut Marine Mammal Commission (2006) for the conservation and management of all marine mammal subsistence species, with particular focus on Steller sea lions and harbor seals. These co-management agreements promote full and equal participation by Alaska Natives in decisions affecting the subsistence management of Steller sea lions (to the maximum extent allowed by law) as a tool for conserving Steller sea lion populations in Alaska (https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/co-management-marine-mammals-alaska, accessed December 2020).

Information on the subsistence harvest of Steller sea lions comes via three sources: the Alaska Department of Fish and Game (ADF&G), the Ecosystem Conservation Office of the Aleut Community of St. Paul Island, and the Kayumixtax Eco-Office of the Aleut Community of St. George Island. The ADF&G conducted systematic interviews with hunters and users of marine mammals in approximately 2,100 households in about 60 coastal communities within the geographic range of the Steller sea lion in Alaska (Wolfe et al. 2005, 2006, 2008, 2009a, 2009b). The interviews were conducted once per year in the winter (January to March) and covered hunter activities for the previous calendar year. As of 2009, annual statewide data on community subsistence harvests are no longer being consistently collected. Data are being collected periodically in subareas. Data were collected on the Alaska Native harvest of Western U.S. Steller sea lions for 7 communities on Kodiak Island in 2011 and for 15 communities in Southcentral Alaska in 2014. The Alaska Native Harbor Seal Commission (ANHSC) and ADF&G estimated a total of 20 adult sea lions were harvested on Kodiak Island in 2011, with a 95% confidence range between 15 and 28 animals (Wolfe et al. 2012), and 7.9 sea lions (CI = 6-15.3) were harvested in Southcentral Alaska in 2014, with adults comprising 84% of the harvest (ANHSC 2015). These estimates do not represent a comprehensive statewide estimate; therefore, the best available statewide subsistence harvest estimates for a 5-year period are those from 2004 to 2008. Thus, the most recent 5 years of data available from the ADF&G (2004-2008) will be used for calculating an annual mortality and serious injury estimate for all areas except St. Paul, St. George, and Atka Islands (Wolfe et al. 2005, 2006, 2008, 2009a, 2009b; NMFS, unpubl. data) (Table 5). Harvest data are

collected in near real-time on St. Paul Island (e.g., Melovidov 2013) and St. George Island (e.g., Kashevarof 2015) and recorded within 36 hours of the harvest. The most recent 5 years of data from St. Paul (Melovidov 2013, 2014, 2015, 2016; NMFS, unpubl. data) and St. George (Kashevarof 2015; NMFS, unpubl. data) are for 2014 to 2018 (Table 5).

The mean annual subsistence harvest from this stock for all areas except St. Paul, St. George, and Atka Island between 2004 and 2008 (172) combined with the mean annual harvest for St. Paul (30), St. George (1.4), and Atka (6) Islands between 2014 and 2018 is 209 Western Steller sea lions (Table 5).

Table 5. Summary of the subsistence harvest data for Western U.S. Steller sea lions. As of 2009, data on community subsistence harvests are no longer being consistently collected. Therefore, the most recent 5 years of data (2004 to 2008) will be used for calculating an annual mortality and serious injury estimate for all areas except St. Paul, St. George, and Atka Islands. Data from St. Paul, St. George, and Atka Islands are still being collected and the most recent 5 years of data available (2014 to 2018) will be used. N/A indicates that data are not available.

	All areas except St. Paul Island			St. Paul Island	St. George Island	Atka Island
Year	Number harvested	Number struck and lost	Total	Number harvested + Number struck and lost	Number harvested + Number struck and lost	Number harvested + Number struck and lost
2004	136.8	49.1	185.9[a]			
2005	153.2	27.6	180.8[b]			
2006	114.3	33.1	147.4[c]			
2007	165.7	45.2	210.9[d]			
2008	114.7	21.6	136.3[e]			
2014	N/A	N/A	N/A	35[h]	1[g]	N/A
2015	N/A	N/A	N/A	24[i]	3[g]	N/A
2016	N/A	N/A	N/A	31[j]	2[j]	N/A
2017	N/A	N/A	N/A	30[j]	0[j]	N/A
2018	N/A	N/A	N/A	28[j]	1[j]	6
Mean annual harvest	137	35	172	30	1.4	6

[a]Wolfe et al. (2005); [b]Wolfe et al. (2006); [c]Wolfe et al. (2008); [d]Wolfe et al. (2009a); [e]Wolfe et al. (2009b); [h]Melovidov (2015); [i]Melovidov (2016); [j]NMFS, unpubl. data.

Other Mortality

Reports to the NMFS Alaska Region marine mammal stranding network of Steller sea lions entangled in marine debris or with injuries caused by other types of human interaction are another source of mortality and serious injury data. These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and are minimums because not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined. Between 2014 and 2018, reports to the stranding network resulted in mean annual mortality and serious injury rates of three Steller sea lions illegally shot in the Copper River Delta (3-year average) and 3.6 observed entangled in marine debris (Table 4; Young et al. 2020). Additional reports of Steller sea lion mortality due to gunshot wounds are not included in the estimate of the mean annual mortality and serious injury rate for 2014 to 2018 because it could not be confirmed that the animals were illegally shot rather than struck and lost in the Alaska Native subsistence harvest.

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 three reports (one in 2015 and two in 2016) of mortality incidental to research on the Western U.S. stock of Steller sea lions (Table 4; Young et al. 2020), resulting in a mean annual mortality and serious injury rate of 0.6 sea lions from this stock.

STATUS OF STOCK

The minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate (37 sea lions) is more than 10% of the PBR (10% of PBR = 32) and, therefore, cannot be considered insignificant and approaching a zero mortality and serious injury rate. Based on available data, the minimum estimated mean annual level of human-caused mortality and serious injury (254 sea lions) is below the PBR level (318) for this stock. The Western U.S. stock of Steller sea lions is currently listed as endangered under the ESA and, therefore, designated as depleted under the MMPA. As a result, the stock is classified as a strategic stock. The population previously declined for unknown reasons that are not explained by the documented level of direct human-caused mortality and serious injury.

There are key uncertainties in the assessment of the Western U.S. stock of Steller sea lions. Some genetic studies support the separation of Steller sea lions in western Alaska from those in Russia; population numbers in this assessment are only from the U.S. to be consistent with the geographic range of information on mortality and serious injury. We provide data for the Russian population for context for the entire Western DPS. There is some overlap in range between animals in the Western and Eastern stocks in northern Southeast Alaska. The population abundance is based on counts of visible animals; the calculated N_{MIN} and PBR levels are conservative because there are no data available to correct for animals not visible during the visual surveys. There are multiple nearshore commercial fisheries that are not observed; thus, there is likely to be unreported fishery-related mortality and serious injury of Steller sea lions. Estimates of human-caused mortality and serious injury from stranding data are underestimates because not all animals strand nor are all stranded animals found, reported, or have the cause of death determined. Several factors may have been important drivers of the decline of the stock. However, there is uncertainty about threats currently impeding their recovery, particularly in the Aleutian Islands.

HABITAT CONCERNS

Many factors have been suggested as causes of the steep decline in abundance of Western Steller sea lions observed in the 1980s, including competitive effects of fishing, environmental change, disease, contaminants, killer whale predation, incidental take, and illegal and legal shooting (Atkinson et al. 2008, NMFS 2008). A number of management actions have been implemented since 1990 to promote the recovery of the Western U.S. stock of Steller sea lions, including 3-nmi no-entry zones around rookeries, prohibition of shooting at or near sea lions, and regulation of fisheries for sea lion prey species (e.g., walleye pollock, Pacific cod, and Atka mackerel; see reviews by Fritz et al. 1995, McBeath 2004, Atkinson et al. 2008, NMFS 2008). Additionally, potentially deleterious events, such as harmful algal blooms (Lefebvre et al. 2016) and disease transmission across the Arctic (VanWormer et al. 2019) that have been associated with warming waters, could lead to potentially negative population-level impacts on Steller sea lions. Metal and contaminant exposure remains a focus of ongoing investigation. Total mercury concentrations measured in hair samples collected from pups in the western-central Aleutian Islands are the highest measured for this species and at levels that in other species cause neurological and reproductive effects (Rea et al. 2013), and organochlorine burdens were detected in tissue samples from across the range but were highest in pups sampled from the Aleutian Islands (Beckmen et al. 2016, Keogh et al. 2020).

The area of greatest (continued) decline in the U.S. remains in the western Aleutian Islands (west of Samalga Pass). Pacific cod and Atka mackerel are two of the primary prey species of Steller sea lions in the central and western Aleutian Islands (Sinclair et al. 2013, Tollit et al. 2017). In the increasing eastern Aleutian Islands region, Rand et al. (2019) reported dense and consistent aggregations of Atka mackerel. However, in the western Aleutian Islands region, this important prey species was more spread out over a larger area during the non-breeding (i.e., "winter") season (Fritz et al. 2019, Rand et al. 2019). Prey availability over winter is thought to be a key factor in energy budgets of sea lions, especially for pregnant females and especially those supporting a pup and/or juvenile (NMFS 2010, Boyd 2000, Malavaer 2002, Winship et al. 2002, Williams 2005). This could result in increases in energy expenditures by Steller sea lions associated with finding and capturing prey, as evident by increased frequency and duration of foraging trips observed in juvenile Steller sea lions in this region (Lander et al. 2010). Prey species (e.g., Atka mackerel, Pacific cod, and walleye pollock) are likely to have lower overall abundance, less predictable spatial distributions, and altered demographics in fished versus unfished habitats (Hsieh et al. 2006, Barbeaux et al. 2013, Fritz et al. 2019). In 2011, the Pacific cod and Atka mackerel fisheries were closed and then re-opened in 2014. In the western Aleutian Islands region, modeled realized counts exhibited stability from 2014 to 2016 (and potentially an increase in pup counts), followed by continued declines since 2016 (Sweeney et al. 2016, 2017, 2018). Fritz et al. (2019) suggested that if nutrition is a driver of the decline, then it appears that other factors (than diet diversity, species mix, and energy density) may be acting. The literature does not prove (or disprove) a correlation between fisheries, sea lion population trends, and prey availability in the Aleutian Islands, and this hypothesis is an important area of investigation for Steller sea lions, especially in the Aleutian Islands.

The Pacific marine heatwave that occurred from 2014 to 2016, and subsequent warm waters in the north Pacific, especially the Gulf of Alaska, has been linked to large declines in productivity and impacts on groundfish populations (von Biela et al. 2019, Yang et al. 2019). In fact, the concomitant decline in pup productivity in the eastern and central Gulf of Alaska regions observed from 2015 and 2017 may be related to the reduction of available prey in the area (Sweeney et al. 2017). In 2019, pup production in these regions rebounded to 2015 levels; however, there was a decline in non-pups that spanned all the Gulf of Alaska regions (Sweeney et al. 2019). These declines are concerning given that prior to 2017, these regions were showing relatively consistent and steady increases in counts (Sweeney et al. 2019). As Alaska waters, especially the Gulf of Alaska, continue to warm, it seems evident from NOAA Fisheries sea lion surveys that this could continue to impact the Western stock in the U.S. It is also possible that changes in foraging ability could affect sea lion movements between and within the stocks (Jemison et al. 2018).

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