Revised 5/10/2024

STELLER SEA LION (*Eumetopias jubatus*): Western Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

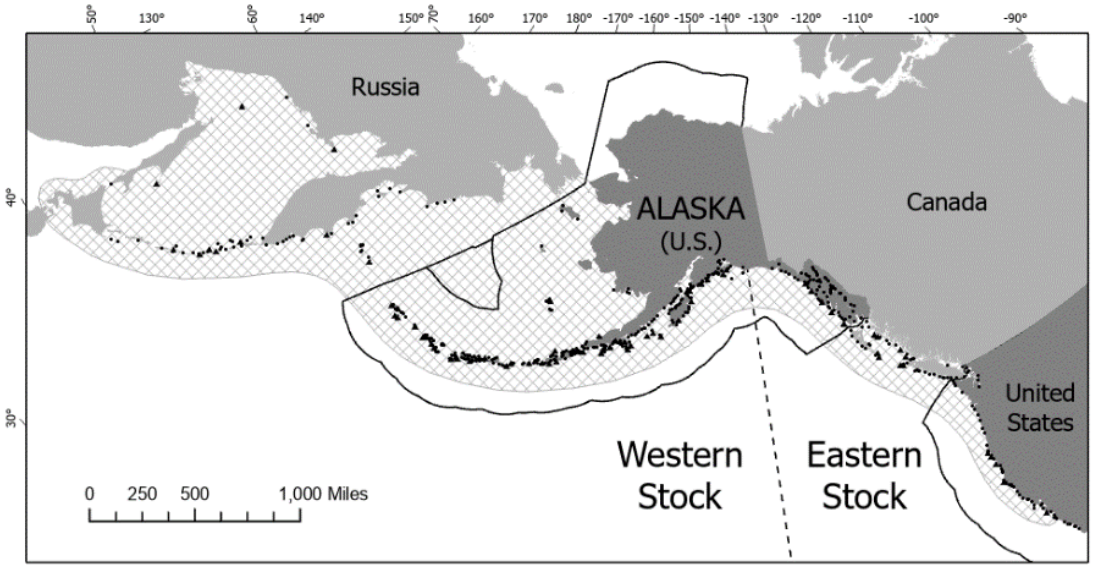

Figure 1. Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts and rookeries (points: Burkanov and Loughlin 2005, Olesiuk 2018). A black dashed line (144°W) indicates the stock boundary (Loughlin 1997) and a black line delineates the U.S. Exclusive Economic Zone.

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. 2020). The Western stock is transboundary, extending west from Cape Suckling in the Gulf of Alaska into Asia. During the breeding season, Steller 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).

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 stocks of Steller sea lions were recognized: the Eastern stock, which includes animals born east of Cape Suckling, Alaska (144°W), and the Western stock, which includes animals born at and west of Cape Suckling (Loughlin 1997; Fig. 1). These stocks are equivalent to the eastern and western distinct population segments (DPSs) identified under the Endangered Species Act (62 FR 24345, 62 FR 30772).

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 separation of the Western and Eastern stocks by noting that ancient population subdivision likely led to the sequestering of most mitochondrial DNA (mtDNA) haplotypes as stock or subspecies-specific (Phillips et al. 2011).

Observations of marked sea lions indicate there is regular movement of Steller sea lions across the stock boundary, especially by juveniles and males outside the breeding season (Jemison et al. 2013, 2018; Hastings et al. 2020). During the breeding season, an equal number of male and female Western stock Steller sea lions have been observed in the Eastern stock area, while Eastern stock sea lions observed moving west have been almost exclusively males (Jemison et al. 2013, 2018; Hastings et al. 2020). 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. (2020) 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 predominantly established by Western stock females (Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Rehberg et al. 2018; Hastings et al. 2020).

While movements of animals marked as pups in both stocks support these genetic results (Jemison et al. 2013, 2018; Hastings et al. 2020), overall the observations of marked Steller sea lion movements corroborate the extensive genetic research findings for a strong separation between the two currently recognized stocks. 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 area indicate movement of Western stock 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. 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. The level of differentiation indicates long-term reproductive isolation resulting from four glacial refugia events 60,000 to 180,000 years before present (Harlin-Cognato et al. 2006). 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), Phillips et al. (2009, 2011), and Hastings et al. (2020). As stated by NMFS and the U.S. Fish and Wildlife Service (USFWS) in a 1996 response to a previous comment regarding their joint DPS policy (61 FR 4722), "The Services do not consider it appropriate to require absolute reproductive isolation as a prerequisite to recognizing a distinct population segment" or stock.

In Asia, Steller sea lions seasonally inhabit coastal waters of Japan during the non-breeding season and breeding rookeries are only located in Russia (Burkanov and Loughlin 2005). Analyses of genetic data differ in their interpretation of an Asian stock separate from the Western stock of Steller sea lions. Based on analysis of mitochondrial DNA, Baker et al. (2005) found evidence of a genetic split in Russia between Kamchatka and the Commander Islands, with the latter being included as part of the Western stock with Alaska sea lions. However, Hoffman et al. (2006) did not support a stock split based on their analysis of nuclear microsatellite markers indicating high rates of male gene flow. Further, 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." In the 2008 Steller sea lion Recovery Plan (NMFS 2008), sea lions that breed in Asia are considered part of the Western stock.

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 Western stock in Russia and Alaska. The geographic range in Alaska is composed of six regions (eastern, central, and western Gulf of Alaska and eastern, central, and western Aleutian Islands); the boundaries of which were identified based on metapopulation analysis of survey count data collected from 1976 to 1994 (York et al. 1996).

An updated agTrend model (R package; Johnson and Fritz 2014, Gaos et al. 2021) was used to estimate counts and trends by augmenting missing counts. The updated agTrend model uses the penalized spline model to reduce variance for years where missing data is interpolated (Gaos et al. 2021). This model improves upon the previous method, which used a random walk time series model (Johnson and Fritz 2014), providing more precise estimates. Non-pup counts do not account for animals at sea and therefore cannot be used as an abundance estimate. Pup counts are considered a census (i.e., total pup production) however, these counts do not account for pups that are born, or die, after the surveys.

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, including the lack of more recent vital (survival and reproductive) rate information, the lack of vital 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 2021 (Southeast Alaska and Gulf of Alaska east of Shumagin Islands) and 2022 (Aleutian Islands west of Shumagin Islands) breeding seasons (Sweeney et al. 2022, 2023). The Western Steller sea lion pup and non-pup model-predicted count estimates in Alaska (U.S. range of the stock) in 2022 were 11,987 (95% credible interval of 11,291-12,703) and 37,333 (34,274-40,245), respectively.

Methods used to survey Steller sea lions in Russia differ from those used in Alaska, with more use of skiff surveys and cliff counts for non-pups and ground counts for pups (Burkanov 2020). Since 2016, the use of uncrewed aircraft systems (drones) has allowed more survey effort to collect aerial imagery, similar to survey methods used for the Alaska range (Burkanov 2020). Counts and trends for non-pups and pups were modeled using agTrend for the six regions in Russia (Commander Islands, East Kamchatka, Kuril Islands, northern part of Sea of Okhotsk, Sakhalin Island, and western Bering Sea) that compose the Steller sea lion geographic range along the entire Asian coast, because the species is absent in Japan during the breeding season (Fig. 2). In 2022, the non-pup modeled count estimate was 17,342 (95% credible interval of 13,944-21,354) and for pups 6,032 (95% credible interval of 5,555-6,541).

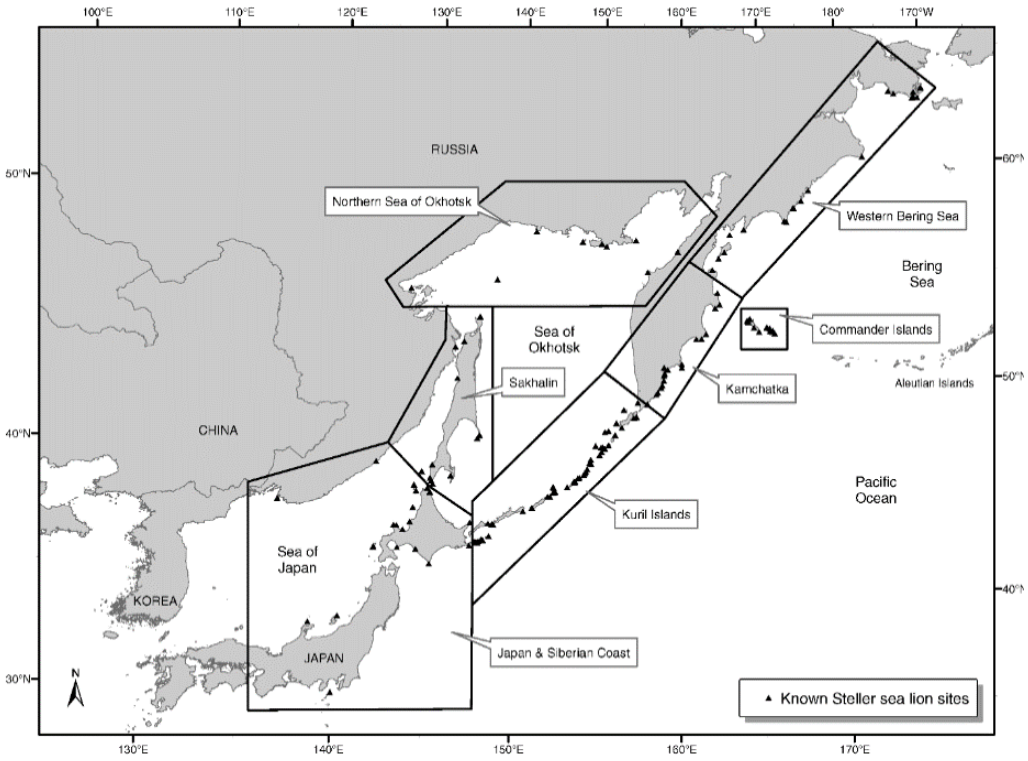

Figure 2. Steller sea lion survey regions along the Asian coast (Burkanov and Loughlin 2005).

Minimum Population Estimate

Steller sea lion non-pups from the Western stock occur in Southeast Alaska, east of the stock boundary line (O'Corry-Crowe et al. 2006; Jemison et al. 2013, 2018; O'Corry-Crowe et al. 2014; Hastings et al. 2020). Hastings et al. (2020) reported 7-8% of non-pups that occurred in Southeast Alaska in the summer were born in the Western stock area. They principally occurred in the north outer coast (identified as population mixing zone "F," Table 1; Fig. 3) and Glacier Bay (G), and at lower proportions in Lynn Canal (H), Frederick Sound (E), and the Central Outer Coast (D). Using the Hastings et al. (2020) proportions for Western stock non-pups in Southeast Alaska allows for apportionment of modeled counts to the corresponding stock by adjusting the N_{MIN} to help account for movement between stocks.

AgTrend modeled non-pup predicted counts by site were aggregated into the population mixing zones and the Western stock proportion was applied to calculate the number of Western stock non-pups in Southeast Alaska (Table 1; Hastings et al. 2020). This total number of Western stock non-pups in Southeast Alaska (517) was added to the estimated total number of Western stock pups and non-pups. As discussed above, the current population size (N) is unknown as there is no method for deriving abundance estimates from agTrend modeled counts and modeled counts are considered "minimum" estimates of population size. Pup counts are considered a census (i.e., total pup production) however, these counts do not account for pups that are born, or die, after the surveys.

While there are conflicting interpretations around the distinction of an Asian stock separate from the Western stock, NMFS' Steller sea lion Recovery Plan for the management and recovery of the Western stock includes all of Russia as a part of the Western stock. Therefore, we report the minimum population estimate for the entire Western stock of Steller sea lions in 2022 was 73,211 (summing: 17,342 non-pups and 6,032 pups in Russia, 37,333 non-pups and 11,987 pups in Alaska, and 517 Western stock non-pups in the Eastern stock area). The NMIN for the U.S. portion of the Western stock was 49,837 (summing: 37,333 non-pups, 11,987 pups, and 517 Western stock non-pups in the Eastern stock area).

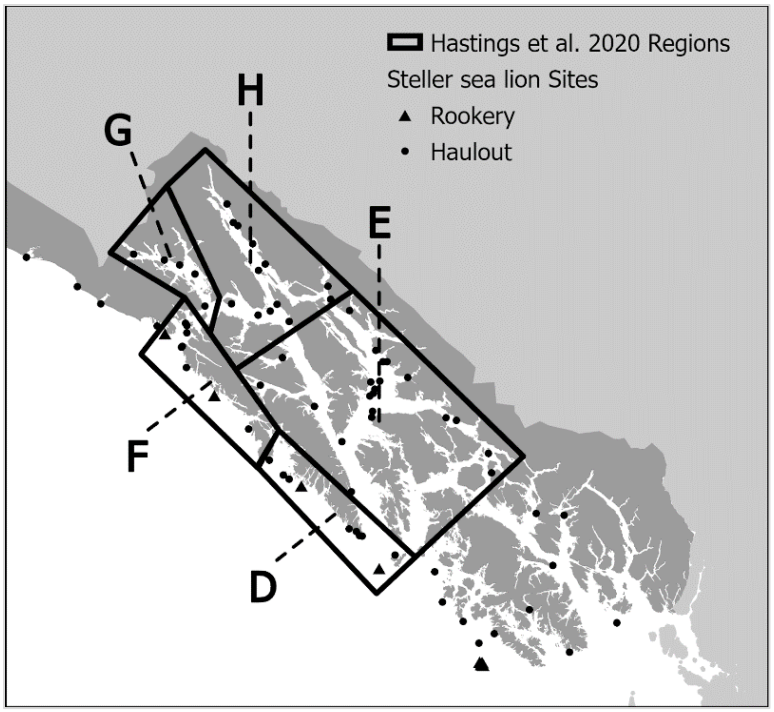

Figure 3. Hastings et al. (2020) mixing zones where non-pups born in the western stock area were reported to inhabit in different proportions, with most in the North Outer Coast (F) and Glacier Bay (G), and at lower proportions in Lynn Canal (H), Frederick Sound (E), and the Central Outer Coast (D) (Table 1).

Table 1. Steller sea lion non-pup apportionment to stock using the Hastings et al. (2020) proportions of Western stock non-pups in Southeast Alaska. Proportions were applied to agTrend modeled predicted counts to estimate the number of western- and eastern- born non-pups in the Hastings et al. (2020) population mixing zones.

Southeast Alaska Area	Population Mixing Zone	Western Stock Non-Pup Proportion	Modeled Non-Pup Count	Western Stock Non-Pup Count	Eastern Stock Non-Pup Count
Central Outer Coast	D	0.022	3,131	69	3,062
Frederick Sound	E	0.012	1,850	22	1,828
North Outer Coast	F	0.082	3,826	314	3,512
Glacier Bay	G	0.073	1,423	104	1,319
Lynn Canal	H	0.014	578	8	570
Remaining Southeast Alaska	I, B, C	-	6,298	-	6,298
TOTAL			17,106	517	16,589

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 of the Western stock to endangered in 1997 (NMFS 2008). Surveys in Alaska in 2002 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).

Using the updated agTrend model, we used count data from 1973 to 2022 for pups and 1978 to 2022 for non-pups to estimate trends for the Western stock in Alaska, east and west of Samalga Pass, and the six central, western, and eastern Gulf of Alaska and Aleutian Island regions (Table 2). Model results indicated that pup and non-pup counts of Western stock Steller sea lions in Alaska were at their lowest levels in 2002. Within the last 15-year period (2007 to 2022), pup and non-pup counts increased at 0.50% y^{-1} and 1.05% y^{-1}, respectively (Table 2; Fig. 4; Sweeney et al. 2023). There are regional differences in trend across the range in Alaska, with positive or plateaued trends in the Gulf of Alaska and the eastern Aleutian Islands region, including the eastern Bering Sea (east of Samalga Pass, ~170°W), and generally negative or plateaued trends to the west of Samalga Pass, in the central and western Aleutian Islands (Table 2; Figs. 5 and 6).

Table 2. 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 stock in Alaska; east and west of Samalga Pass; eastern, central, and western Gulf of Alaska; and eastern, central, and western Aleutian Islands were calculated for the period from 2007 to 2022 (Sweeney et al. 2022, 2023).

Region	Latitude Range	Pups			Non-pups		
		Trend	-95%	+95%	Trend	-95%	+95%
Western stock in Alaska	144°W-172°E	0.50	0.04	0.96	1.05	0.46	1.69
East of Samalga Pass	144°-170°W	1.35	0.84	1.91	1.52	0.82	2.20
Eastern Gulf of Alaska	144°-150°W	0.81	-0.53	2.13	-0.21	-2.25	1.81
Central Gulf of Alaska	150°-158°W	2.32	1.18	3.43	3.74	2.80	4.73
Western Gulf of Alaska	158°-163°W	1.36	0.46	2.28	1.22	0.08	2.45
Eastern Aleutian Islands	163°-170°W	0.73	-0.31	1.75	1.09	-0.27	2.46
West of Samalga Pass	170°W-172°E	-2.17	-2.94	-1.41	-0.70	-2.04	0.72
Central Aleutian Islands	170°W-177°E	-2.01	-2.85	-1.21	-0.20	-1.56	1.36
Western Aleutian Islands	172°-177°E	-4.10	-5.09	-3.07	-5.78	-8.02	-3.44

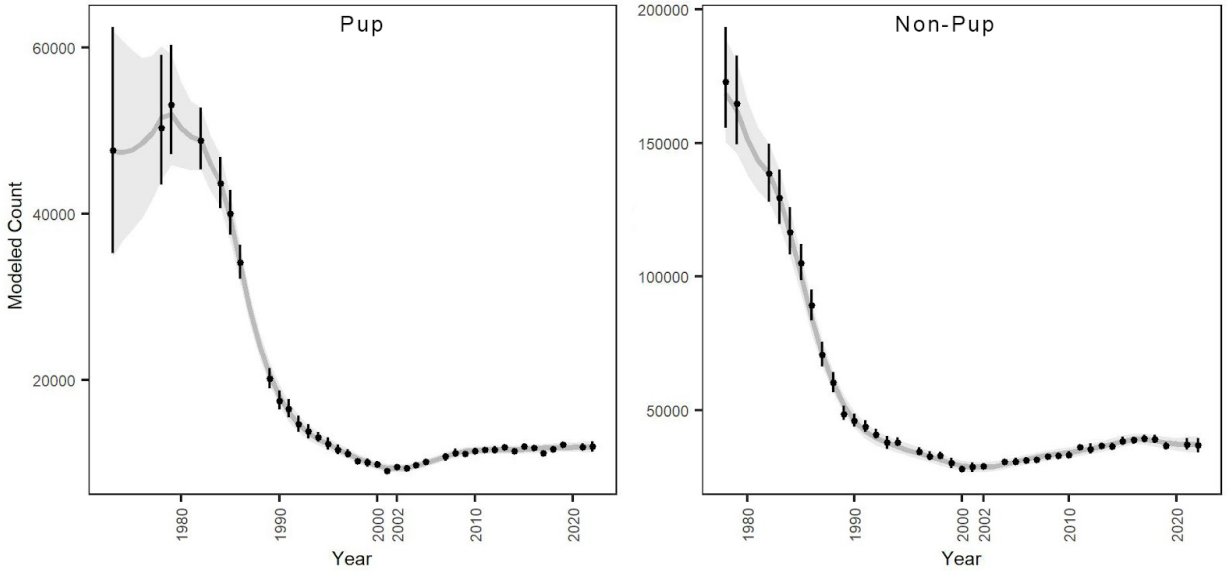

Figure 4. Realized and predicted counts of Western Steller sea lion pups (left) and non-pups (right) in Alaska, from 1973 for pups and 1978 for non-pups to 2022. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the dark gray line surrounded by the lighter gray 95% credible interval.

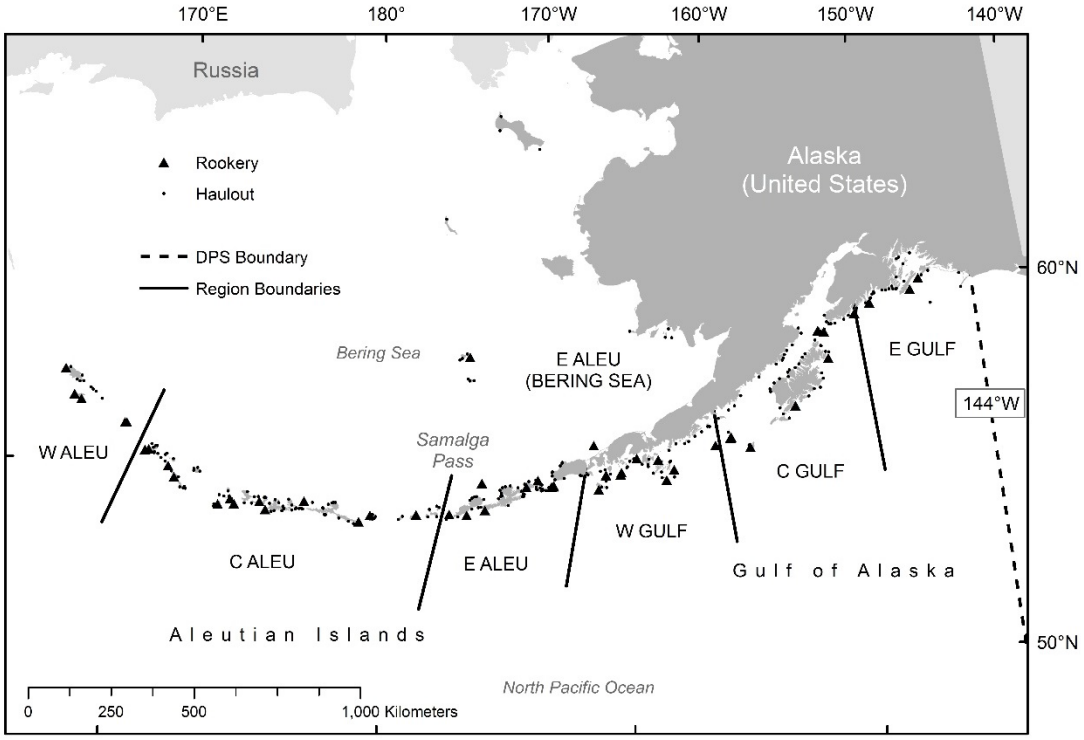

Figure 5. Regions of Alaska used for Western Steller sea lion population trend estimation. E GULF, C GULF, and W GULF are eastern, central, and western Gulf of Alaska regions, respectively. E ALEU, C ALEU, and W ALEU are eastern, central, and western Aleutian Islands regions, respectively (AFSC-MML-Alaska Ecosystems Program 2016).

In 2021, U.S. survey effort was focused in the Gulf of Alaska (Sweeney et al. 2022). 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, Suryan et al. 2021). 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). The eastern Gulf of Alaska region remained low in 2021, and the central Gulf of Alaska increased to 2010 levels. The western Gulf of Alaska showed the first signs of decline in 2021 after increasing since the early 2000s (Sweeney et al. 2022).

In 2022, survey effort was focused on the Aleutian Islands (Sweeney et al. 2023). From 2007 to 2022, pups declined west of Samalga Pass, especially in the western Aleutian Islands region, where non-pups have also continued to decline. The central Aleutian Island region plateaued; however, the eastern portion of this region, which was largely contributing to increases in counts in this region, has not been surveyed since 2016 or 2018. The eastern Aleutian Islands region, an area that had shown signs of recovery and was increasing since the early 2000s, has now plateaued for both pups and non-pups.

Describing population trends in Russia, 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. The most recent agTrend estimate between 2007 and 2022 for non-pups was 1.04% y^{-1} (Table 3). However, just as in the U.S. portion of the Western stock, there were significant regional differences in population trend throughout Russia (Table 3; Fig. 7; Burkanov 2020). The decline in non-pup counts continued in the Kurils which, traditionally, represents the largest area in terms of non-pup counts (Burkanov and Loughlin 2005). The growth was attributed to a significant increase in the Sakhalin region (Table 3; Fig. 7). Pup production continued to decline in three of five areas where breeding occurs in Russia (Kuril

Islands, the Commander Islands, and the northern part of the Sea of Okhotsk), while pup production continued to grow in the Sakhalin Region (Tuleny Island) and became equally important for the Asian population of Kurils.

Table 3. Trends (annual rates of change expressed as % y^{-1} with 95% credible interval) in non-pup counts for the Asian (Russia) portion of the Western stock of Steller sea lions and by region, from 2007 to 2022 (Johnson 2018, Gaos et al. 2021). See Figure 2 for regions.

Region	Trend	-95%	+95%
Asian portion of Western stock (Russia)	1.04	-0.73	3.24
Commander Islands (CI)	-0.30	-4.43	3.87
Kamchatka (KAM)	2.98	-3.02	9.49
Kuril (KUR)	-2.15	-4.16	0.26
Northern Sea of Okhotsk (NPSO)	1.01	-1.66	3.89
Sakhalin (SAK)	5.51	1.81	10.67
Western Bering Sea (WBS)	0.63	-12.26	14.43

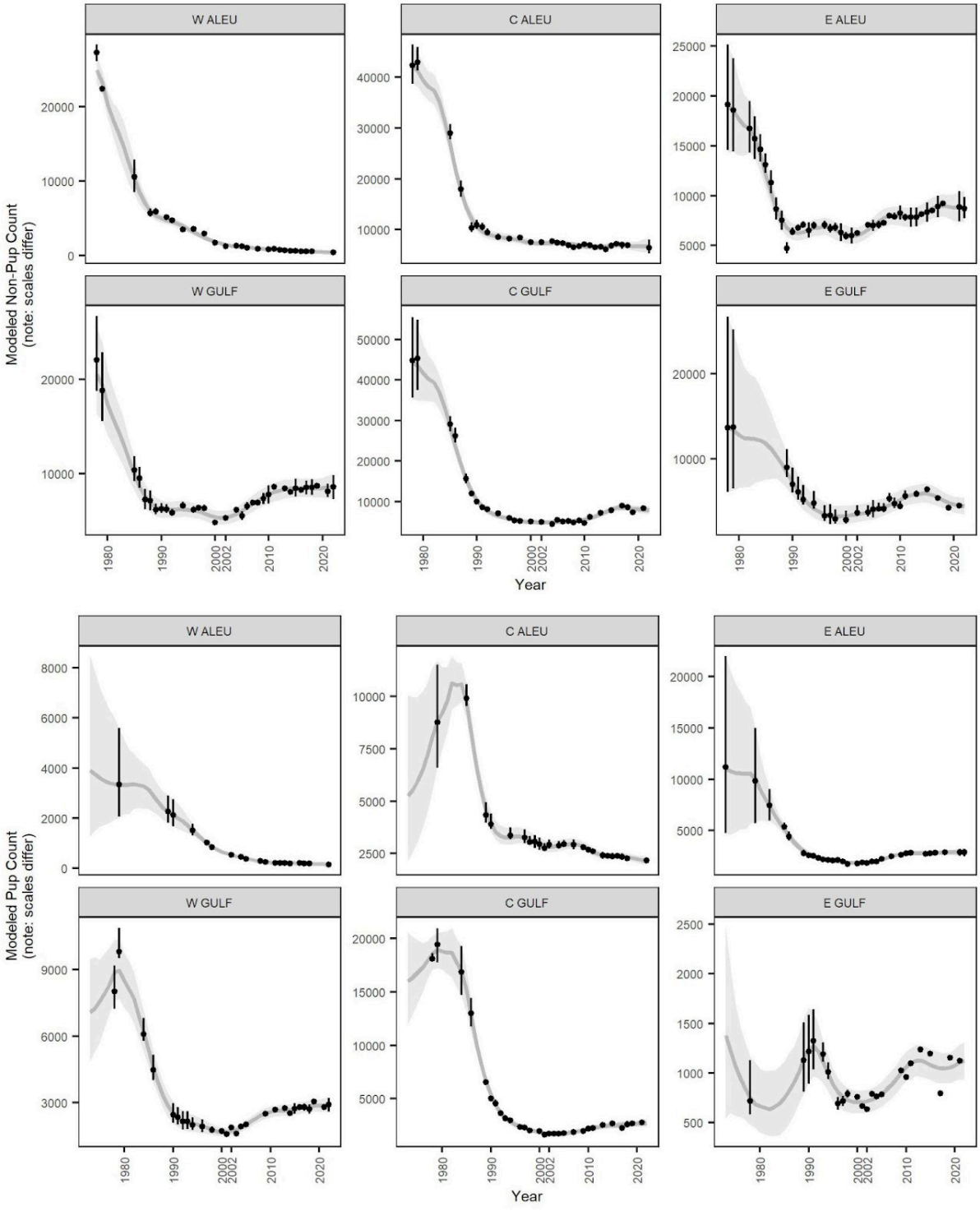

Figure 6. Realized and predicted counts of Steller sea lion pups (top) and non-pups (bottom) in the six regions that compose the Western stock in Alaska, 1973 for pups and 1978 for non-pups to 2022. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the dark gray line surrounded by the lighter gray 95% credible interval (Sweeney et al. 2023).

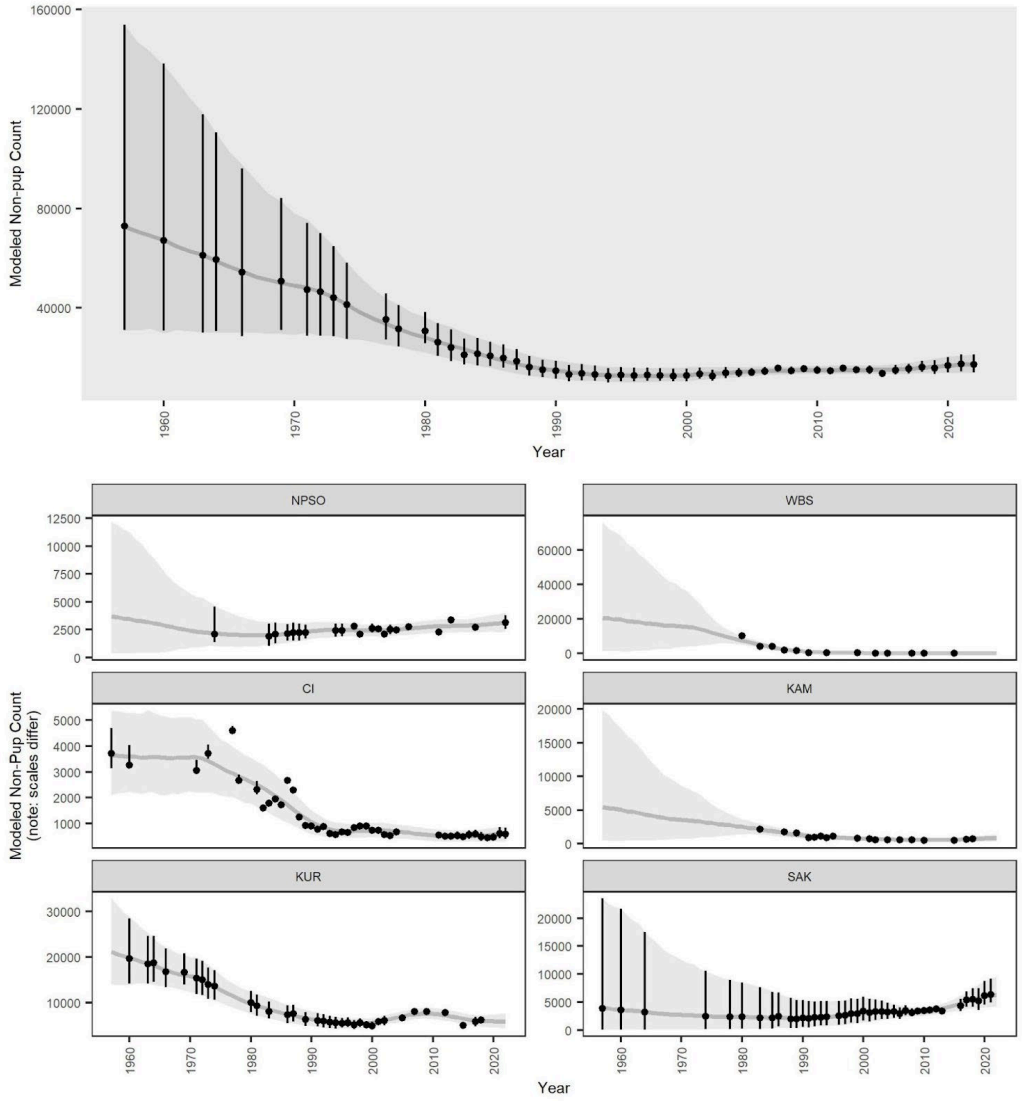

Figure 7. Realized and predicted counts of Russian Steller sea lion non-pups (above) and by region (below), 1957-2022. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the dark gray line surrounded by the lighter gray 95% credible interval. See Table 3 and Figure 2 for regions.

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 2023).

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 2023). Thus, for the Western stock of Steller sea lions (including Russia), PBR is 439 sea lions (73,211 × 0.06 × 0.1). The PBR for the U.S. portion of the Western stock of Steller sea lions is 299 sea lions (49,837 × 0.06 × 0.1).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury (SI), and non-serious injury (NSI) reported for NMFS-managed Alaska marine mammals between 2017 and 2021 is listed, by marine mammal stock, in Freed et al.

(2023); however, only the mortality and serious injury (M/SI) data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused M/SI for the U.S. portion of the Western Steller sea lion stock between 2017 and 2021 is 267 sea lions: 39 in U.S. commercial fisheries, 0.004 in Alaska subsistence fisheries, 0.2 in Alaska salmon hatcheries, 1.9 in unknown (commercial, recreational, or Alaska subsistence) fisheries, 6.6 in marine debris, 0.8 due to illegal shooting, and 218 in the Alaska Native subsistence harvest. The number of human-caused M/SI of Western Steller sea lions in the Asian portion of the range is unknown.

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. 2020). 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 2017 to 2019, no data are available for 2020-2021, 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 M/SI 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

Commercial fisheries

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 May 2024).

Based on historical reports and their geographic range, Steller sea lion M/SI could occur in several fishing gear types, including trawl, gillnet, longline, and hook and line 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 M/SI in non-trawl fisheries. Therefore, the potential for fisheries-caused M/SI may be greater than is reflected in existing observer data.

Between 2017 and 2021, M/SI of Western Steller sea lions was observed or recorded via electronic monitoring in 8 of the federally-managed commercial fisheries in Alaska that are monitored for incidental M/SI 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 flatfish trawl, Gulf of Alaska pollock trawl, and Gulf of Alaska sablefish longline fisheries, resulting in a mean annual M/SI rate of 24 sea lions (Table 4; 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 4). No incidental M/SI was observed during 1990 for this fishery (Wynne et al. 1991), resulting in a mean annual M/SI rate of 15 sea lions for 1990 and 1991. It is not known whether this incidental M/SI rate is representative of the current rate in this fishery; between 2017 and 2021, only one Steller sea lion mortality, reported to the NMFS Alaska Region marine mammal stranding network, was attributed to the Prince William Sound salmon drift gillnet fishery (Freed et al. 2023).

The minimum estimated mean annual M/SI rate in U.S. commercial fisheries between 2017 and 2021 is 39 Steller sea lions from this stock (Table 4). All U.S. commercial fishery-related reports of M/SI of this stock came from U.S. commercial fishery observer or electronic monitoring data. No observers have been assigned to several fisheries that are known to interact with this stock, thus, the estimated M/SI is likely an underestimate of the actual level.

Commercial fishery-related serious injuries averted (i.e., human intervention or self-release lessened the severity of the initial serious injury, leaving the animal with only non-serious or no injuries) and non-serious injuries are not included in the total estimate of annual human-caused M/SI that is compared to PBR, but are used to develop the List of Fisheries under Section 118 of the Marine Mammal Protection Act and inform management (e.g., take reduction planning and negligible impact determinations). No serious injuries of Western Steller sea lions were averted

in U.S. commercial fishery interactions between 2017 and 2021. Additionally, there were no U.S. commercial fisheries with only non-serious injuries of western Steller sea lions between 2017 and 2021.

Table 4. Summary of incidental M/SI of Western stock Steller sea lions in U.S. waters due to U.S. commercial fisheries between 2017 and 2021 (or the most recent data available) and calculation of the mean annual M/SI rate (Wynne et al. 1991, 1992; Breiwick 2013; MML, unpubl. data). The "Observed mortality" column does not include M/SI in unsampled hauls unless there were no observed M/SI in sampled hauls in that fishery that year. 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. Mean annual estimates are rounded but the total estimate is based on unrounded estimates.

Fishery name	Years	Data type	Percent observer coverage	Observed M/SI	Estimated M/SI (CV)	Mean estimated annual M/SI
Bering Sea/Aleutian Is. Atka mackerel trawl	2017 2018 2019 2020 2021	obs data	100 100 100 100 99	1 5 0 0 1	1 (0.06) 5.1 (0.08) 0 0 1 (0.04)	1.4 (CV = 0.06)
Bering Sea/Aleutian Is. flatfish trawl	2017 2018 2019 2020 2021	obs data	100 100 100 100 99	13 8 12 14 17	13 (0.01) 8.0 (0.02) 12.1 (0.02) 14.1 (0.02) 17.2 (0.03)	13 (CV = 0.01)
Bering Sea/Aleutian Is. Pacific cod trawl	2017 2018 2019 2020 2021	obs data	68 73 67 71 58	1 1 0 0 0	1 (0) 1 (0) 0 0 0	0.40 (CV = 0)
Bering Sea/Aleutian Is. pollock trawl	2017 2018 2019 2020 2021	obs data	99 99 98 91 77	6 7 4 10 5	6.1 (0.05) 7.1 (0.05) 4 (0.02) 11.2 (0.13) 6.5 (0.22)	7.0 (CV = 0.06)
Bering Sea/Aleutian Is. Pacific cod longline	2017 2018 2019 2020 2021	obs data	58 55 52 52 55	1 0 0 0 0	1.6 (0.61) 0 0 0 0	0.32 (CV = 0.61)
Gulf of Alaska flatfish trawl	2017 2018 2019 2020 2021	obs data	56 35 39 38 82	0 0 2[a] 0 0	0 0 2 0 0	0.40 (CV = N/A)
Gulf of Alaska pollock trawl	2017 2018 2019 2020 2021	obs data	19 21 23 10 13	0 0 0 1[b] 0	0 0 0 1 0	0.20 (CV = N/A)
Gulf of Alaska sablefish longline	2017 2018 2019 2020 2021	obs data	10 9 12 7 11	0 0 2 0 0	0 0 9.4 (0.79) 0 0	1.9 (CV = 0.79)

Fishery name	Years	Data type	Percent observer coverage	Observed M/SI	Estimated M/SI (CV)	Mean estimated annual M/SI
Prince William Sound salmon drift gillnet	1990 1991	obs data	4 5	0 2	0 29.0	15 (CV = 1.0)
Minimum total estimated annual mortality						39 (CV = 0.37)

[a] Two animals were killed in unsampled hauls and represent a minimum estimate of M/SI in this fishery in this year.
[b] One mortality was detected via electronic monitoring while the fishery was operating on an exempted fishing permit. This mortality represents a minimum estimate of M/SI in this fishery in this year.

Non-commercial and unknown fisheries

Reports to the NMFS Alaska Region marine mammal stranding network and the Alaska Department of Fish and Game (ADF&G) of Steller sea lions entangled in fishing gear or with injuries caused by interactions with gear are another source of M/SI data (Table 5; Freed et al. 2023). 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). From 2017 to 2021, one mortality was reported in an Alaska subsistence halibut longline fishery, resulting in a mean annual M/SI rate of 0.004 western Steller sea lions in Alaska subsistence fisheries. Other fishery-related M/SI included a mean of 0.2 sea lions in salmon hatchery nets and 1.9. in unknown (commercial, recreational, or Alaska subsistence) fishing gear (Table 5). These M/SI estimates result from actual counts 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.

An additional two Steller sea lions in the Eastern and Western stock mixing area of Southeast Alaska that were initially considered seriously injured due to hooking by unknown salmon hook and line gear (one in 2017 and one in 2018) were disentangled or dehooked and released, or presumed to have self released, with non-serious injuries (Freed et al. 2023). None of these serious injuries averted were included in the estimate of the average annual M/SI rate for 2017 to 2021.

Table 5. Summary of Western stock Steller sea lion M/SI in U.S. waters, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and Alaska Department of Fish and Game between 2017 and 2021 (Freed et al. 2023). In areas of Southeast Alaska where the western (wSSL) and eastern (eSSL) populations mix, the mean annual M/SI of both stocks (wSSL + eSSL) was multiplied by the mixing zone-specific proportion of western non-pups (Table 1; Hastings et al. 2020) to produce estimates for the Western stock (wSSL only).

Cause of injury				2017	2018	2019	2020	2021	Mean annual M/SI	
									wSSL + eSSL	wSSL only
Southeast Alaska – Mixing Zone D										
Hooked by Alaska subsistence halibut longline gear				0	0	0	0	1	0.2	0.004
Hooked by salmon hook and line gear*				4	0	1	1	3	1.8	0.040
Hooked by unknown hook and line gear*				0	1	0	0	0	0.2	0.004
Entangled in Southeast Alaska salmon hatchery pen				0	0	0	1	0	0.2	0.004
Entangled in unknown fishery gear*				0	0	1	0	0	0.2	0.004
Entangled in marine debris				3	3	2	0	0	1.6	0.035
Illegally shot				0	0	1	0	0	0.2	0.004

Southeast Alaska – Mixing Zone E										
Hooked by halibut hook and line gear*				0	1	0	0	0	0.2	0.002
Hooked by salmon hook and line gear*				4	0	1	0	0	1.0	0.012
Entangled in marine debris				3	2	1	0	0	1.2	0.014
Southeast Alaska – Mixing Zone F										
Hooked or entangled by salmon hook and line gear*				8	8	4	0	6	5.2	0.426
Hooked by unknown hook and line gear*				2	1	2	0	0	1.0	0.082
Entangled in unknown fishery gear*				0	0	0	1	0	0.2	0.016
Entangled in marine debris				2	8	1	0	3	2.8	0.230
Dependent pup of animal seriously injured by marine debris				0	1	0	0	0	0.2	0.016
Southeast Alaska – Mixing Zone G										
Hooked by salmon hook and line gear*				1	1	2	0	0	0.8	0.058
Entangled in marine debris				3	3	0	0	0	1.2	0.088
Southeast Alaska – Mixing Zone H										
Hooked by salmon hook and line gear*				3	0	1	1	1	1.2	0.017
Entangled in marine debris				3	2	1	0	1	1.4	0.020
All Other Areas in Western Stock Range										
Entangled in Kodiak salmon hatchery seine net				0	1	0	0	0	-	0.2
Hooked by salmon hook and line gear*				1	1	1	0	0	-	0.6
Hooked by unknown hook and line gear*				0	0	0	0	2	-	0.4
Entangled in unknown trawl gear				0	0	0	1	0	-	0.2
Entangled in marine debris				3	5	2	8	13	-	6.2
Illegally shot				0	0	3	1	0	-	0.8
Total in commercial fisheries										0
Total in Alaska subsistence fisheries										0.004
Total in salmon hatchery nets										0.2
*Total in unknown (commercial, recreational, or Alaska subsistence) fisheries										1.9
Total in marine debris (including dependent pup(s) of animal(s) seriously injured or killed by marine debris)										6.6
Total due to illegal shooting)										0.8

In summary, the minimum mean annual M/SI rate for all fisheries in the U.S. between 2017 and 2021, is 41 Western Steller sea lions based on observer data and stranding data for: U.S. commercial fisheries (39 sea lions), Alaska subsistence fisheries (0.004 sea lions), salmon hatchery nets (0.2 sea lions), and unknown (commercial, recreational, or Alaska subsistence) fisheries (1.9 sea lions).

Alaska Native Subsistence/Harvest Information

NMFS has 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 has 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 May 2024).

Information on the subsistence harvest of Steller sea lions comes via four sources: the Alaska Department of Fish and Game (ADF&G), the Ecosystem Conservation Office of the Aleut Community of St. Paul Island, the Kayumixtax Eco-Office of the Traditional Council of St. George Island, and the Aleut Marine Mammal Commission. 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 stock Steller sea lions for seven 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 7.8 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. In addition, different surveys have produced different harvest estimates; for example, the ANHSC survey produced an estimate of 0 Steller sea lions harvest in the community of Tatitlek for 2014 (ANHSC 2015), while the ADF&G comprehensive survey that year produced an estimate of 10.3 for that community that year (Fall and Zimpelman 2016). 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 M/SI estimate for all areas except St. Paul, St. George, Atka, and Akutan Islands (Wolfe et al. 2005, 2006, 2008, 2009a, 2009b) (Table 6). Current harvest data are being collected on St. Paul (Tribal Government of St. Paul Island, unpubl. data), St. George (Traditional Council of St. George Island, unpubl. data), and Atka and Akutan Islands (Aleut Marine Mammal Commission, unpubl. data) (Table 6). Since the cessation of ADF&G monitoring, there is an incomplete understanding of harvest levels statewide.

The mean annual subsistence harvest from this stock for all areas except St. Paul, St. George, Atka, and Akutan Islands between 2004 and 2008 (172) combined with the mean annual harvest for St. Paul (31), St. George (0.6), Atka (10), and Akutan (4) Islands between 2017 and 2021 is 218 western Steller sea lions (Table 6).

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 M/SI data. These M/SI 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 2017 and 2021, reports to the stranding network resulted in mean annual M/SI rates of 0.8 Western Steller sea lions illegally shot (most of which were observed during surveys of the Copper River Delta), 6.6 entangled in marine debris, and 0.016 dependent pups of an animal seriously injured by marine debris (Table 5; Freed et al. 2023).

An additional six Steller sea lions in the Eastern and Western stock mixing area of Southeast Alaska that were initially considered seriously injured in marine debris (four in 2017, one in 2018, and one in 2019) were disentangled or dehooked and released, or presumed to have self released, with non-serious injuries (Freed et al. 2023). None of these serious injuries averted were included in the estimate of the average annual M/SI rate for 2017 to 2021.

Table 6. Summary of the Alaska Native subsistence harvest data for Western stock 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 M/SI estimate for all areas except St. Paul, St. George, Atka, and Akutan Islands. Data from St. Paul, St. George, Atka, and Akutan Islands are still being collected and the most data available will be used. Mean annual harvest is calculated across only the years where data are available. N/A indicates that data are not available. No data are available for struck and lost animals at Akutan Island in 2020 and 2021.

	All areas except St. Paul, St. George, Atka, and Akutan Islands			St. Paul Island	St. George Island	Atka Island	Akutan 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	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]				
2017	N/A	N/A	N/A	30[f]	0[g]	N/A	N/A
2018	N/A	N/A	N/A	28[f]	1[g]	6[h]	N/A
2019	N/A	N/A	N/A	33[f]	1[g]	6[h]	N/A
2020	N/A	N/A	N/A	33[f]	0[g]	20[h]	3[h]
2021	N/A	N/A	N/A	N/A	1[g]	7[h]	5[h]
Mean annual harvest	137	35	172	31	0.6	10	4

[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); [f] Tribal Government of St. Paul Island, unpubl. data; [g] Traditional Council of St. George Island, unpubl. data; [h] Aleut Marine Mammal Commission, unpubl. data.

STATUS OF STOCK

The minimum estimated mean annual U.S. commercial fishery-related M/SI rate (39 sea lions) is more than 10% of the PBR for the U.S. portion of the range (10% of PBR = 30) and, therefore, cannot be considered insignificant and approaching a zero M/SI rate. Based on available data, the minimum estimated mean annual level of human-caused M/SI (267 sea lions) in the U.S. is below both the U.S. PBR level (299) and the range-wide PBR level (439) for this stock. The Western 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 M/SI. Population trends and status of this stock relative to its Optimum Sustainable Population are unknown.

There are key uncertainties in the assessment of the Western stock of Steller sea lions. Some genetic studies support the separation of Steller sea lions in western Alaska from those in Russia. Information on human-caused M/SI is currently only available for the U.S. portion of the stock's range. 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 operating within the stock's range that are not observed; thus, there is likely to be unreported fishery-related M/SI of Steller sea lions. Estimates of human-caused M/SI from stranding data are underestimated 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.

OTHER FACTORS THAT MAY BE CAUSING A DECLINE OR IMPEDING RECOVERY

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 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, 2020), 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 eastern Aleutian Islands region where Steller sea lion numbers are increasing, 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 Steller 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, Suryan et al. 2021), including survival of adult female Steller sea lions in Southeast Alaska, Prince William Sound, and Chiswell Island (Hastings et al. 2023). 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 NMFS' Steller sea lion surveys that this could continue to impact the Western stock of Steller sea lions in the U.S. It is also possible that changes in foraging ability could affect Steller sea lion movements between and within the stocks (Jemison et al. 2018).

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