Revised: July 2023

PACIFIC WALRUS (*Odobenus rosmarus divergens*): Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The family Odobenidae is represented by a single modern species, *Odobenus rosmarus* of which two sub-species are generally recognized: the Atlantic walrus (*O. r. rosmarus*), which ranges from the central Canadian Arctic eastward to the Kara Sea (Reeves 1978), and the Pacific walrus (*O. r. divergens*) which ranges across the Bering and Chukchi Seas (Fay 1982, Lowry 2016). The Pacific walrus is the only sub-species occurring in United States (U.S.) waters and considered in this account. Genetic studies suggest that Pacific walruses are represented by a single panmictic population (Scribner et al. 1997, Sonsthagen et al. 2012, Beatty et al. 2020).

Pacific walruses inhabit the shallow continental shelf waters of the Bering and Chukchi seas, occasionally moving into the East Siberian Sea and the Beaufort Sea (Fig. 1). Walruses forage primarily on benthic invertebrates and rest between feeding bouts either on sea ice or land.

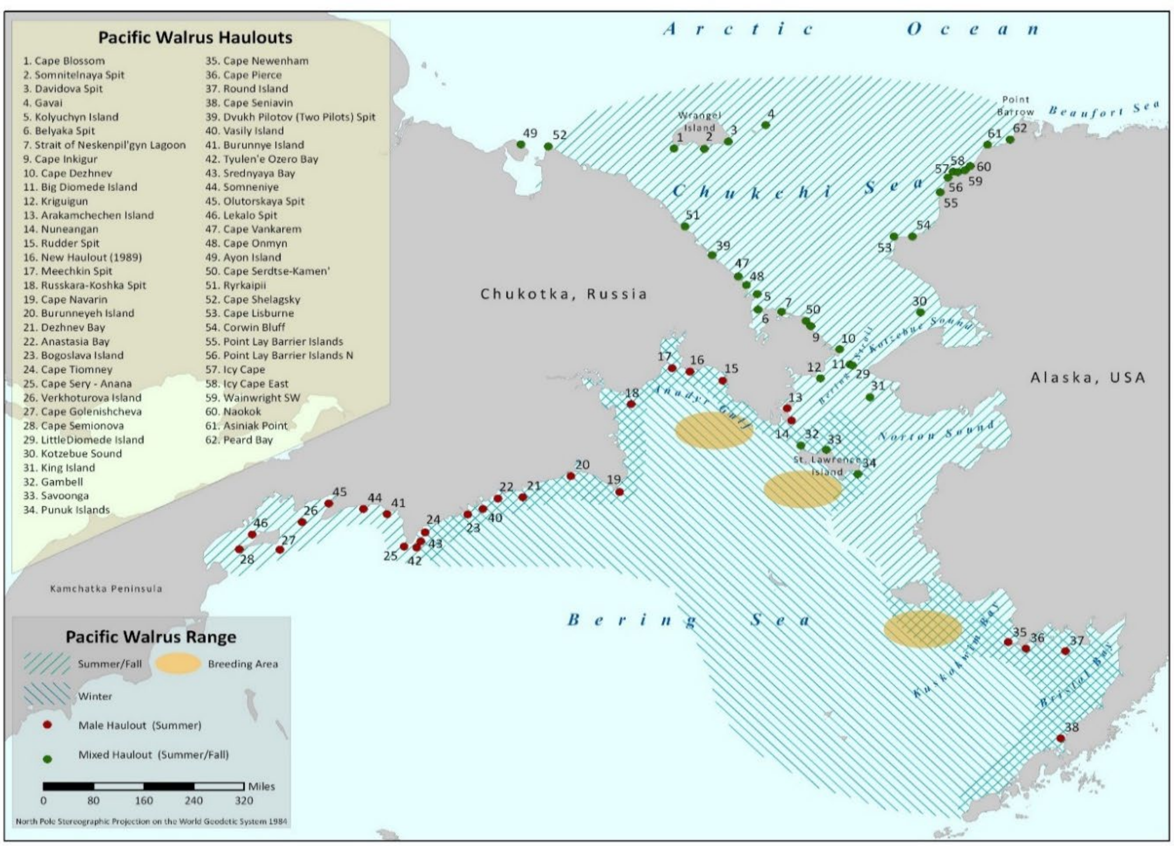

Figure 1. Seasonal distribution, breeding areas, and coastal haulouts of Pacific walruses in the Bering and Chukchi seas.

During the winter breeding season, walruses are found in areas of the Bering Sea where open leads, polynyas, or thin ice occur (Fay et al. 1984; Fig. 1). Although many adult male Pacific walruses remain in the Bering Sea during the ice-free season where they forage from coastal haulouts, most of the population (primarily females and juveniles) migrates north in summer and south in winter following seasonal patterns of sea ice advance and retreat (Fay 1982).

POPULATION SIZE

Between 1975 and 2006, the U.S. and Russia collaborated on a series of aerial surveys which yielded abundance estimates ranging from 129,000 to 254,890 animals (Table 1). Abundance estimates generated from these surveys were considered negatively biased due to the methods used (Gilbert 1999, Speckman et al. 2011). Between 2013 and 2017, the U.S. Fish and Wildlife Service (Service) carried out a series of research cruises in the Bering and Chukchi seas to collect skin biopsy samples from free-ranging walruses in support of a genetic mark-recapture study to estimate population abundance. Beatty et al. (2022) used a Bayesian multi-event mark-recapture model and age structure data from the 2013–2017 surveys to generate an abundance estimate of 257,193 (95 percent credible interval: 171,138–366,366) for the Pacific walrus population (Table 1; Fig. 2). We consider this estimate to be the best available information on population size, as no more recent survey data are available.

Table 1. Estimates of the size of the Pacific walrus population from aerial surveys, 1975-2006 and results of a genetic mark-recapture study for 2017.

Year	Population Size	95% confidence interval
1975[b]	199,783	112,000 – 330,000[a]
1980[c]	254,890	184,000 – 344,000[a]
1985[d]	242,882	125,000 – 427,000[a]
1990[e]	201,039	88,000 – 397,000[a]
2006[f]	129,000	55,000 – 507,000[f]
2017[g]	257,193	171,138 – 366,366[g]

Note: Large variances associated with population size estimates preclude inference of population trends.
[a]Taylor and Udevitz (2015); [b]Udevitz et al. (2001) and Estes and Gol'tsev (1984); [c]Udevitz et al. (2001), Johnson et al. (1982), and Fedoseev (1984); [d]Udevitz et al. (2001), Gilbert (1989[a,b]), and Fedoseev and Razlivalov (1986); [e]Gilbert et al. (1992)· [f]Speckman et al. (2011);[g]Beatty et al. (2022)

Minimum Population Estimate

The Marine Mammal Protection Act (MMPA) defines a minimum population estimate (N_{MIN}) as an estimate of the number of animals in a stock that: 1) Is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and 2) Provides reasonable assurance that the stock size is equal to or greater than the estimate (MMPA §3(27)). The N_{MIN} for a marine mammal stock is often calculated using Equation 1 from NMFS's potential biological removal guidelines: $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)^2])]^{½})$, which approximates the 20th percentile of a log-normal distribution (NMFS 2016). However, the most recent abundance estimate for Pacific walruses was generated using a Bayesian multi-event mark-recapture model, so the 20th quantile of the posterior distribution of the abundance estimate (214,008 animals) was used as the estimator of N_{MIN} (Beatty et al. 2022*;* Fig. 2).

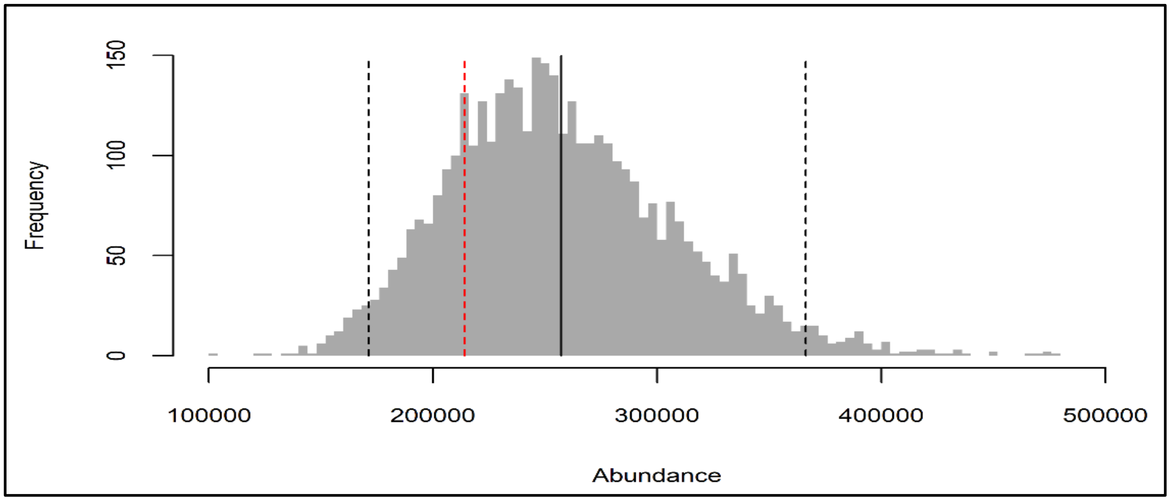

Figure. 2. Posterior distribution for Pacific walrus total abundance. Posterior mean (black line), 95 percent credible interval (dotted black lines), and minimum abundance estimate (red dotted line) are also shown (from Beatty et al. 2022).

Current Population Trend

Based on large, sustained harvests in the 18th and 19th centuries, Fay (1982) speculated that the pre-exploitation population was represented by a minimum of 200,000 animals. Large-scale commercial harvests are thought to have reduced the population to less than 100,000 animals by the mid-1950s (Fay et al. 1997). The population appears to have rapidly increased in size during the 1960s and 1970s in response to harvest regulations that limited the harvesting of females (Fay et al. 1989, Fay et al. 1997, Garlich-Miller et al. 2006). By the 1980s, walrus researchers were concerned that the population had exceeded its natural carrying capacity and warned that a combination of density-dependent mechanisms and rising harvest rates in both the U.S. and Russia (Fig. 3) could lead to a population decline (Fay et al. 1989, Fay et al. 1997). Taylor et al. (2018) used Bayesian models to assess walrus population dynamics using available information regarding historic estimates of abundance, population demographics, and harvest removals. Selected models indicated that the Pacific walrus population underwent a sharp decline in the 1980s which began to moderate in the 1990s as harvest rates declined and reproductive and calf survival rates began to increase in a density-dependent manner. Selected models were, however, equivocal regarding whether population growth rates were positive or negative for the period 1999–2015 (Taylor et al. 2018).

Although the most recent (2017) point estimate of abundance (257,192) is substantially larger than the 2006 aerial survey-based estimate (129,000), the two estimates are statistically indistinguishable due to overlapping credibility intervals (Table 1) and known negative biases associated with the 2006 aerial survey effort (Table 2, Beatty et al. 2022, Speckman et al. 2011). Thus, the current population trend for this stock is unknown. An integrated population model that incorporates recently available data sets regarding abundance, age-structure, and harvest removals could help to improve our understanding of past, present, and likely future population trends (Beatty et al. 2022).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Published estimates of net productivity rates for walrus populations range from 3 percent to 13 percent per year (Chapskii 1936, DeMaster 1984, Sease and Chapman 1988, Fay et al. 1997). Chivers (1999) developed an individual age-based model of the Pacific walrus population using published estimates of survival and reproduction which yielded a theoretical maximum population growth rate (R_{MAX}) of 8 percent but cautioned that age-specific survival rates for Pacific walruses were poorly known. In the absence of stock-specific derived values, a default R_{MAX} value of 12 percent is recommended for pinniped stocks (NMFS 2016). Whereas most pinnipeds can produce an offspring annually, walruses have a lower reproductive rate due to their biennial reproductive cycle (Fay 1982, Garlich-Miller et al. 2006). An R_{MAX} value of 6 percent (one half the default pinniped value) has been adopted for the Pacific walrus stock pending the publication of stock-specific values. The Service is in the process of developing a walrus population model incorporating the best available estimates of population size, age-structure, growth rate, carrying capacity and harvest demographics from which stock specific estimates of R_{MAX} can be derived.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) of a marine mammal stock is defined under the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (OSP). The PBR is the product of the following factors: (A) the minimum population estimate N_{MIN}, (B) one-half the maximum net productivity rate (0.5 R_{MAX}), and (C) a recovery factor (F_R) ranging between 0.1 and 1.0 (MMPA §3(20)).

The F_R value for this stock has been adjusted to account for uncertainties associated with human-caused mortality rates and current and future population trends. Although rates of incidental mortality and serious injuries associated with commercial fisheries in the U.S. are well documented and approaching a zero-mortality rate, there is little information available to evaluate fishery mortality rates in Russia. Reported subsistence harvest rates in both the U.S. and Russia have declined substantially over the past 30 years; however, under-reporting of harvest is a known concern, and there is uncertainty associated with correction factors used to estimate total annual subsistence removal levels. Human activities contribute to disturbance related mortality rates at coastal haulouts but are difficult to distinguish from non-human events. Although the most recent 2017 point estimate of abundance is substantially higher than the previous (2006) estimate, large overlapping credibility intervals preclude firm conclusions regarding population trend. Lastly, human caused global greenhouse gas emissions are leading to ecosystem changes, such as the reduction in available summer sea ice habitat, that influence trends in Pacific walrus abundance and disturbance related mortality at coastal haulouts. Using an F_R lower than 1.0 accounts for known biases and uncertainties associated with the human-caused mortality rates and future population trends. Given relevant known biases and uncertainties, a conservative F_R value of 0.5 has been adopted for this stock. A default F_R value of 0.5 is recommended for species listed under the U.S. Endangered Species Act (ESA) (NMFS 2016). The Service has been petitioned to list walruses under the ESA due to observed and projected losses of sea-ice habitats. The Service is in the process of preparing a Species Status Assessment to evaluate current and future threats to the population. We have adopted the default

F_R value for ESA listed species (0.5) until the analysis is complete. Thus, the calculated PBR value for the Pacific walrus stock is 3,210 animals (214,008 × 0.5(0.06) × 0.5).

ANNUAL HUMAN CAUSED MORTALITY AND SERIOUS INJURY

Our best estimate of the average rate of annual human-caused mortality and serious injury for the Pacific walrus stock for the period 2016 through 2020 is 4,211 walruses/year. Reported fishery interactions averaged < 1 walrus per year, a rate considered insignificant and approaching a zero mortality and serious injury rate (Table 2). Total annual subsistence harvest removals averaged 4,210 walruses/year over this same five-year period (Table 3).

Additional factors likely to result in human-caused mortality or serious injury for this stock include disturbance-related mortalities at coastal haulout sites. Both anthropogenic and non-anthropogenic disturbances occur at coastal haulout sites, and monitoring data linking haulout mortalities directly to human-caused disturbances does not exist at present.

Fisheries Information

Thirteen fisheries operate within the range of the Pacific walrus in Alaskan waters (NOAA 2022). Incidental mortality during 2016-2020 (the most recent 5-year period for which data are available) was observed in only one fishery: The Bering Sea/Aleutian Island flatfish trawl fishery. The Bering Sea/Aleutian Island flatfish trawl fishery is a Category II Commercial Fishery with an estimated 32 vessels participating (NOAA 2022). Observer coverage for this fishery averaged 99.5 percent during 2016-2020. The mean number of observed mortalities was < 1 walrus per year, with a range from zero to 2 (Table 2). No incidental injuries were observed during this time period.

Few data exist regarding interactions between walruses and fisheries operating in Russian territorial waters in recent years. In August 2021, the Service received a report and video from Russian colleagues of an adult male walrus that was captured alive in pollock trawl gear near Bukhta Natalii (western Bering Sea). The animal was reported to have been unharmed and was immediately released. Given the limited availability of data regarding fisheries interactions with walruses in Russia, the total estimate of fishery related mortality should be considered negatively biased to an unknown degree.

Table 2. Summary of incidental mortality of Pacific walruses in the Bering Sea/Aleutian Islands flatfish trawl fishery from 2016-2020 and estimated mean annual mortality (NMFS Alaska Fisheries Science Center *unpubl. data*). Estimates were made following methods in Breiwick (2013).

Year	Observer coverage (%)	Observed mortality	Estimated Mortality	95% confidence interval
2016	98.7	0	0	
2017	99.8	2	2.01	1.99 – 2.03
2018	99.7	1	1	1.0 – 1.0
2019	99.5	0	0	
2020	100	0	0	

5 year mean (SE)	99.5 (0.2)	0.6 (0.4)	0.6 (0.4)	

Alaska Native Subsistence/Harvest Information

Subsistence walrus hunting is an important component of the economy and culture of many Native communities along the Bering and Chukchi Sea coasts of Alaska (U.S.) and Chukotka (Russia). Total (U.S. and Russian) annual harvest removals for the period 1960 through 2020 are presented in Fig. 3. Total harvest removals for the 1960s and 1970s averaged 5,331 and 5,747 walruses per year for each decade respectively. The 1980s saw a substantial increase in harvest with a total removal estimate averaging 10,970 walruses per year (Fig. 3). The increased harvest rates in the 1980s were thought to reflect several factors, including removals associated with a ship-based (commercial) harvests in Russia and increased availability of walruses to subsistence hunters coinciding with the Pacific walrus population peaking and reaching carrying capacity (Fay et al. 1989, Fay et al. 1997). The increased harvest levels of the 1980s was accompanied by an increase in the proportion of harvested females, which likely had a depleting effect on the population (Fay et al. 1997). The 1990s saw lower total removal levels than the previous decade, with an average of 6,325 walrus per year. Harvest removals have continued to decline over the past two decades with average harvest removal rates of 5,669 for the 2000s and 4,327 walruses/year for the 2010s, respectively (Fig. 3).

Walrus harvests in the U.S. and Russia are known to be under-reported (Garlich-Miller and Burn 2009). We derived a harvest correction factor for reported U.S. walrus harvests based on data from observer-based programs at the primary walrus-hunting villages in Alaska gathered between 1993-1997 (Garlich-Miller and Burn 1999). A mean correction factor and associated variance from this dataset (1.36, SE: 0.13) were applied to reported walrus harvest data for the years 2016-2020 (Table 3) in the absence of similarly reliable correction factors for that timeframe. Reported walrus harvest data from Russia has also been corrected for under-reporting using a fixed correction factor of 1.25 based upon a recent estimate reported by Kryukova (2019). Total harvest removal estimates have also been adjusted to account for struck and lost animals at a rate of 42 percent based on Fay et al. (1994).

The average annual removal estimate for the most recent 5-year period for which data is available (2016-2020) is 4,210 (95 percent credible interval: 4,021-4,398) walruses/year (Table 3). The U.S. harvest monitoring data indicates that the sex ratio of the 2016–2020 subsistence walrus harvest in Alaska was approximately 2.24 males:female. Demographic data for Russian harvests is not available for the years 2016–2020 (Kryukova 2019), but has historically averaged approximately 2.8 males:female (Kochnev 2009).

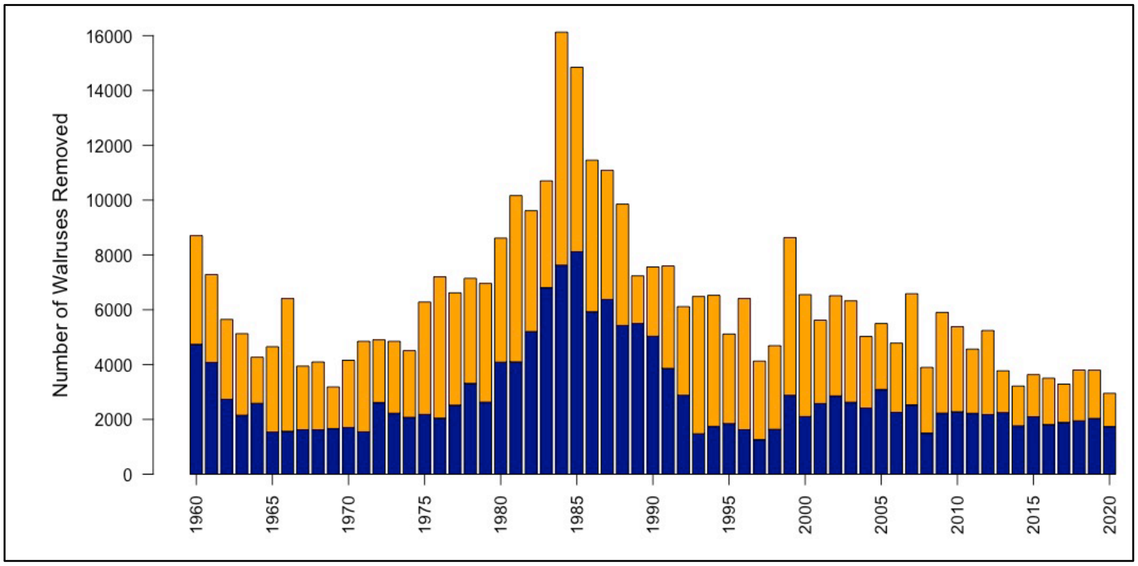

Figure 3. Total Annual Harvest Removal of Pacific Walrus in the US (Blue) and Russia (Orange), 1960–2020.

Table 3. Annual harvest removal estimates for Pacific walruses, 2016-2020.

Year	United States harvests [a]	Russian harvests[b]	Total harvest removals including struck and lost animals[c] (SE)	95% confidence interval
2016	1,192	1,275	4,254 (225)	3,813 – 4,695
2017	984	1,330	3,989 (193)	3,611 – 4,387
2018	1,304	1,373	4,615 (243)	4,138 – 5,092
2019	1,239	1,434	4,607 (234)	4,149 – 5,066
2020	855	1,223	3,583 (172)	3,245 – 3,920
5-year mean	1,115	1,327	4,210 (96)	4,021 – 4,398

[a] US harvest information collected by the U.S. Fish and Wildlife Service, Marking Tagging and Reporting Program. Reported harvests have been adjusted by a mean correction factor of 1.36 (SE: 0.13) to account for unreported animals (Garlich-Miller and Burn 1999).
[b] Russian harvest information provided by ChukotTINRO and the Russian Agricultural Department. Reported harvest have been adjusted by a fixed correction factor of 1.25 to account for unreported animals (Kryukova 2019). [c] Total harvest removals include estimates of struck and lost animals (42 percent; Fay et al. 1994)

Other Mortality

Although there are no verified reports of human-caused mortality or serious injuries from sources other than fisheries interactions and subsistence harvests between 2016 and 2020, it should be noted that there are no systematic monitoring programs in either the U.S. or Russia that record or determine the cause of death of stranded walruses. Mortalities and serious injuries occasionally occur incidental to other MMPA authorized activities (including scientific research, construction, resource exploration and development); however, no walrus injuries or mortalities have been reported for other MMPA authorized activities since 2011.

Disturbance-related mortalities at coastal haulout sites are an emerging conservation and management concern. Identified sources of disturbances at coastal walrus haulout sites include both human activities (aircraft overflights, transiting marine vessels, hunting activities, loose pets, and wildlife viewing) and non-human activities such as predators and scavengers drawn to the haulouts (Robards and Garlich-Miller 2013). Large-scale disturbance events are occasionally reported. Fay and Kelly (1980) examined several hundred Pacific walrus carcasses on St. Lawrence Island and the Punuk Islands in the fall of 1978. The principal cause of death was attributed to trampling associated with disturbance-related stampedes, but the source of the disturbances could not be identified (Fay and Kelly 1980). Large mortality events have also been reported at coastal haulouts in Russia. In the fall of 2007, walrus researchers and hunters from Russian coastal villages reported large numbers (>2,600) of walrus carcasses at several coastal walrus haulout sites along the Chukchi Sea coast. Most animals appeared to have died from trampling associated with haulout disturbances (Kochnev 2013). Although disturbance events are often difficult to link directly to human activities, managers recognize that coastal haulout use will likely increase in the future, and they are concerned about the potential for increasing levels of human activities near coastal haulouts to contribute to increased mortality rates, particularly among calves (Robards and Garlich-Miller 2013, Udevitz et al. 2013).

STATUS OF STOCK

The Pacific walrus population is not designated as depleted under the MMPA or listed as threatened or endangered under the ESA. The Optimum Sustainable Population (OSP) range for this stock is unknown. Fluctuations in density-dependent vital rates over the past several decades (Fay et al. 1989, Garlich-Miller et al. 2006) suggest that the carrying capacity of the ecosystem (the upper bound of OSP) has likely shifted over time. The population appears to have approached or exceeded its carrying capacity in the 1980s (Fay et al. 1989). Population models indicate a decline in abundance may have occurred through the 1980s and 1990s, which lessened over time as harvest rates declined and reproductive and calf survival rates rose in a density-dependent manner (Taylor et al. 2018). MacCraken et al. (2017) used a Bayesian Belief Network model to evaluate current and future abundance stressors (including seasonal sea ice cover, benthic productivity, and human-caused mortalities, injuries, and disturbances) acting on the Pacific walrus population under various future climate-change scenarios. They found current levels of harvest and other abundance stressors were low to moderately low, consistent with a population at or near its OSP range. Abundance stressors were, however, projected to increase in the future in response to observed and projected climate-mediated habitat changes in the Bering and Chukchi seas (MacCraken et al. 2017).

While mortality and serious injury rates in Russian fisheries are unknown, there is little spatial overlap between commercial fisheries and walruses due to walruses' close association with sea ice habitats. The potential for significant levels of fisheries interactions appears to be low at present but may increase in the future as sea ice habitats decline (MacCraken et al. 2017). The best available information indicates the annual rate of mortality and serious injury associated with commercial fisheries likely represents less than 1 percent of the calculated PBR. The

Service considers this to be insignificant and approaching a zero mortality and serious injury rate.

Subsistence harvest rates are declining and appear to be within a sustainable range (MacCraken et al. 2017). The Service is in the process of developing a projection model based on the best available estimates of population size, growth rate, and carrying capacity to help inform harvest management decisions under an array of potential climate change and anthropogenic disturbance scenarios. Section 119(a) of the MMPA provides for the development of co-management agreements with Alaska Natives for the subsistence use of marine mammals, and tribally-based hunting ordinances in the two primary walrus hunting communities in Alaska (Gambell and Savoonga on Saint Lawrence Island) provide a potential mechanism for self-regulation of harvest in the future.

Our best estimate of annual human-caused mortality and serious injury for the Pacific walrus stock (4,211 walruses/year) is greater than the calculated PBR level of 3,210 animals. Therefore, the Pacific walrus stock is classified as strategic. It should be noted that the Service has adopted a conservative F_R value of 0.5 in our PBR calculation in consideration of some level of uncertainty associated with available estimates of human caused mortality. The Service is tentatively planning (subject to the availability of funds) to conduct a walrus harvest monitoring project in key walrus hunting communities to refine future harvest estimates. A default F_R value of 0.5 is also recommended for species listed under the ESA (NMFS 2016). The Service has been petitioned to list walruses under the ESA in consideration of observed and projected losses of sea-ice habitats and is in the process of preparing a Species Status Assessment to evaluate current and future threats to the population. We have adopted the default F_R value for ESA listed species (0.5) until the analysis is complete.

HABITAT CONCERNS

Global greenhouse gas emissions are contributing to a warming climate. Climate-mediated sea ice loss is changing the spatial and temporal distribution of walruses across the Bering and Chukchi seas and their habitat use patterns (MacCraken et al. 2017). Projections of future ice conditions generated from global circulation models suggest that by mid to late century, the location of favorable ice conditions for walruses in winter and spring will likely shift further to the north (Douglas 2010). Observed and projected sea ice loss during the summer feeding season is more pronounced, and walruses are expected to become increasingly dependent on coastal haulouts along the Chukchi Sea coast (Garlich-Miller et al. 2011, Jay et al. 2011). This shift in habitat use patterns is expected to increase rates of mortality from disturbance events along the coast, increase the energetic costs associated with foraging trips, and potentially lead to a reduction in the prey base within range of coastal haulouts (Garlich-Miller et al. 2011, Jay et al. 2017). Walruses may exhibit seasonal reductions in body mass that could translate into reductions in reproductive and survival rates (Udevitz et al. 2017). Other abundance stressors including ocean acidification, oil and gas exploration, commercial shipping, and disease could also increase in response to a warming climate (Garlich-Miller et al. 2011). Together these factors are expected to result in a population decline over time, although the timeframe and magnitude of the projected decline is unknown (MacCracken et al. 2017).

The efficacy of management efforts to protect walruses at coastal haulouts will likely be an important factor influencing future population outcomes (MacCracken et al. 2017). The

Service and partners have an active outreach program to raise awareness about the potential impacts of disturbance-related mortalities at coastal haulouts. Targeted outreach efforts include distribution of disturbance mitigation guidelines to coastal communities and commercial fishermen, pilots, mariners, and tour operators living and working near coastal walrus haulouts in Alaska. In 2018, the Eskimo Walrus Commission passed a resolution requesting subsistence walrus hunters not to target walruses resting at coastal haulouts to mitigate incidental injuries and mortality. The Native village of Point Lay has also taken on a strong and effective stewardship role in protecting walruses resting at the largest walrus haulout in Alaska, which is situated near their community.

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