Revised: July 2023

NORTHERN SEA OTTER (*Enhydra lutris kenyoni*): Southwest Alaska Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sea otters (*Enhydra lutris*) occur in nearshore coastal waters of the North Pacific Rim from the northern end of Japan to California. The northern sea otter sub-species (*E. lutris kenyoni*) extends from Alaska's Aleutian Islands through British Columbia (Canada) and Washington. Sea otters primarily inhabit nearshore habitats within the 40 meters (m) (~ 130 feet [ft]) depth contour where they forage for benthic invertebrates in shallow subtidal and intertidal zones (Riedman and Estes 1990), though they can forage and will occur at depths over 100 m (~ 328 ft) (Bodkin et al. 2004). Sea otters are not migratory and generally do not disperse over long distances, although movements of tens of kilometers (km) (tens of miles [mi]) are common (Garshelis and Garshelis 1984). Annual home range sizes of adult sea otters are relatively small, with male territories ranging from 4 to 11 square kilometers (km^2) (~ 1.5 to 4.2 square miles [mi^2]) and adult female home ranges from a few to 24 km^2 (~ 9.3 mi^2) (Garshelis and Garshelis 1984, Ralls et al. 1988, Jameson 1989). Sea otter distribution and density can vary at small spatial scales seasonally and across years as sea otters seek refuge from storms (Stewart et al. 2015) and populations recover across their historical range (Larson et al. 2014).

Gorbics and Bodkin (2001) applied the phylogeographic approach (Dizon et al. 1992) and used the best available data at the time to identify three sea otter stocks in Alaska: Southeast, Southcentral, and Southwest. The ranges of these stocks are defined as follows: (1) Southeast Alaska stock extends from Dixon Entrance to Cape Yakataga; (2) Southcentral Alaska stock extends from Cape Yakataga to Cook Inlet including Prince William Sound, the Kenai Peninsula coast, Eastern Cook Inlet and Kachemak Bay; and (3) Southwest Alaska stock includes Western Cook Inlet, the Alaska Peninsula and Bristol Bay coasts, and the Aleutian, Barren, Kodiak, and Pribilof Islands (Figure 1). This stock assessment report is focused on the Southwest stock of sea otters in Alaska (hereafter, Southwest stock). The U.S. Fish and Wildlife Service (Service) recognizes that the inclusion of genetic variation among sea otter populations is important to define stock delineations. Recent genetic analyses support existing stock structure designations that genetic differentiation among northern sea otters is clinal across their range (Flannery et al. 2021, Larson et al. 2021). The Service also acknowledges that range-wide reductions and extirpations during the commercial fur trade of the 18th and 19th centuries occurred not simply because of excessive harvest, but because the harvest was not allocated proportionally to the abundance and distribution of sea otters (Bodkin and Ballachey 2010). This process of serial depletion was facilitated by the relatively sedentary nature of sea otters. To reduce the risk of overexploitation, sea otters must be managed on a spatial scale compatible with their well-known behavioral and reproductive biology (Bodkin and Monson 2002), incorporating traits such as home range and movements.

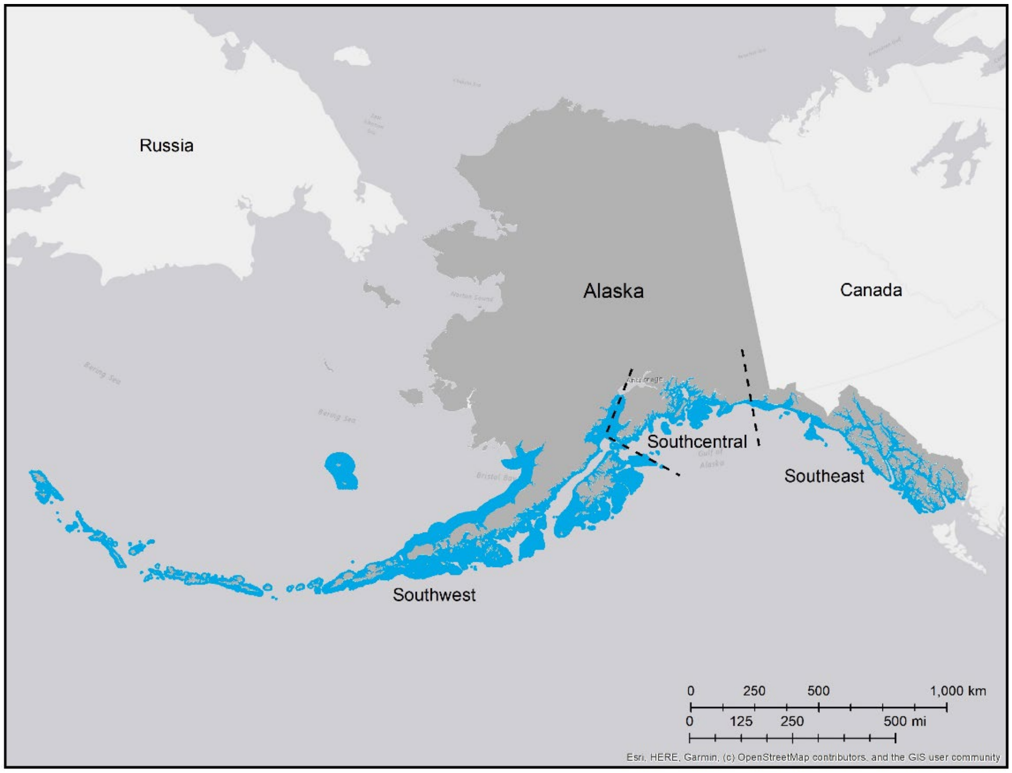

Figure 1. Northern sea otter distribution in Alaska (blue) delineated as ocean waters within the 100 m (328 ft) depth contour, within the median ice extent for the month of March from 2001–2020 and restricted to the 24 nautical mile Contiguous Zone maritime boundary. The boundaries among the three stocks are indicated with a dashed line.

POPULATION SIZE

Historically, sea otters occurred across the North Pacific Rim, ranging from Hokkaido, Japan, through the Kuril Islands, the Kamchatka Peninsula, the Commander Islands, the Aleutian Islands, Alaska Peninsula and southern coasts of Alaska, and south through British Columbia, Canada, into Washington, Oregon, California and Baja California, Mexico (Kenyon 1969). However, commercial exploitation of sea otters extirpated them from much of their range, with probably fewer than 2,000 animals remaining in an estimated thirteen remnant colonies (Kenyon 1969) when they were afforded protection by the International Fur Seal Treaty in 1911. Population recovery began following legal protection. As part of efforts to re-establish sea otters in portions of their historical range to offset costs of nuclear testing in Alaska and reinvigorate fur harvest, otters from Amchitka Island and Prince William Sound were translocated to other areas in the 1960s and 1970s, including to southeast Alaska, Washington, and Oregon (Jameson et al. 1982). Through both natural population growth and human-assisted translocations, sea otters have since repatriated much of their historical range in Alaska.

The Southwest stock inhabits a region extending more than 2,500 km distance (1,553 mi). The best available information indicates that the Southwest stock in the Aleutian archipelago declined by up to 90 percent in the 1990s (Doroff et al. 2003). Due to that decline, the Southwest stock was listed as a threatened distinct population segment (DPS) under the Endangered Species Act (ESA) in 2005 (70 FR 46366). Predation by killer whales was suspected to be the primary cause of decline (U.S. Fish and Wildlife Service 2013). As part of the ESA listing decision, the Service designated 15,164 km^2 (5,855 mi^2) of nearshore waters as Southwest stock critical habitat, which occurs in nearshore marine waters ranging from the mean high tide line seaward for a distance of 100 m or to a water depth of 20 m (65.6 ft) (74 FR 51988). Further, as part of the ESA recovery plan for this DPS-listed stock, the Service delineated five management units (MU): Western Aleutians; Eastern Aleutians; South Alaska Peninsula; Bristol Bay; and Kodiak, Kamishak, and Alaska Peninsula (Figure 2).

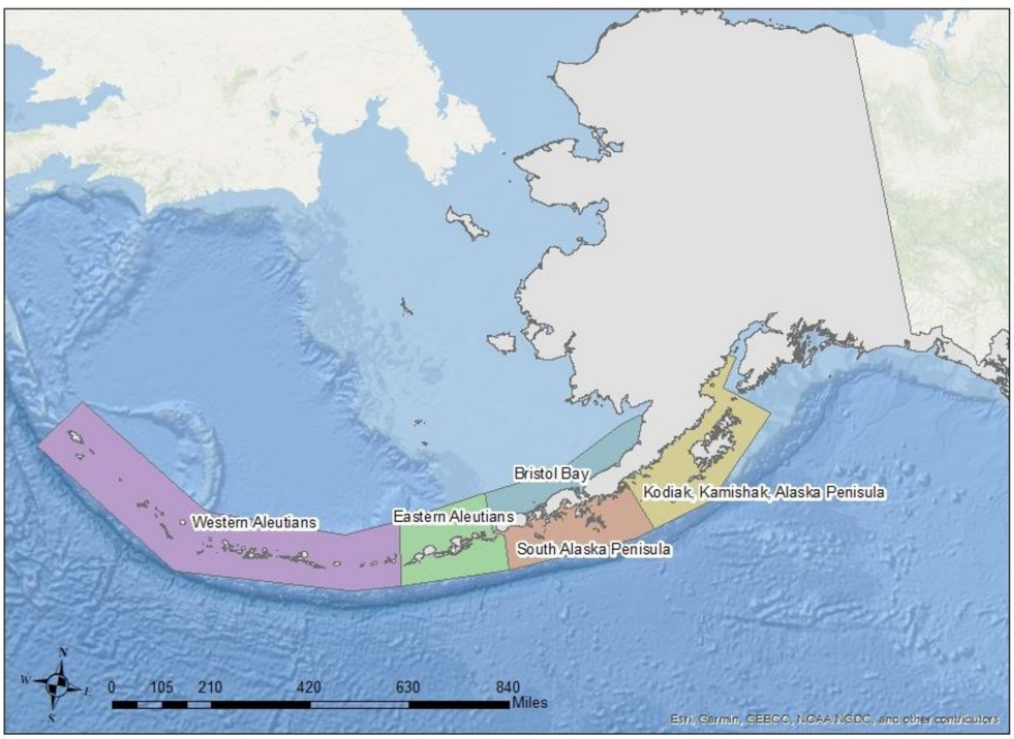

Figure 2. Boundaries of the five management units of the Southwest stock of northern sea otters.

Given the large spatial extent of the five MUs comprising the Southwest stock, it has not been feasible to survey all MUs in a single year. Additionally, different survey methodologies have been used across MUs through time, but all methods in the past eight years have accounted for imperfect detectability and/or availability and are therefore, individually, considered unbiased individual estimates of sea otter abundance in each of the MUs. However, making comparisons across MUs and discerning trends through time remains difficult. Therefore, we provide both the current population estimates for each MU and the total population estimate summed across MUs in this SAR. The current sea otter population estimate for each of the MUs are: Kodiak, Kamishak, and Alaska Peninsula MU: 30,658 sea otters (CV = 0.18); Bristol Bay MU: 9,733 sea otters (CV = 1.07), South Alaska Peninsula

MU: 546 sea otters (CV = 0.33); Eastern Aleutians MU: 8,593 sea otters (CV = 0.07); Western Aleutians MU: 2,405 sea otters (CV = 0.16). The combined population estimate for the Southwest stock is 51,935 sea otters (Table 1).

Table 1. Population estimates for the Southwest Alaska stock of northern sea otters.

Management Unit	Year	Population Estimate	CV	N_{MIN}	Reference
Kodiak, Kamishak, Alaska Peninsula	2014-2018	30,658	0.18	26,378	Cobb 2018, Esslinger 2020, Garlich-Miller et al. 2018, USFWS. 2020
Bristol Bay	2016	9,733	1.07	4,665	Beatty et al. 2021
South Alaska Peninsula	2016	546	0.33	417	Beatty et al. 2021
Eastern Aleutians	2017	8,593	0.07	8,102	Wilson et al. 2021
Western Aleutians	2021	2,405	0.16	2,104	Tinker et al. 2023
Southwest Stock Total		**51,935**	*	**41,666**	

* A global CV is unavailable for the Southwest stock due to the different survey methods and analytical approaches used for population assessments in each of the five Management Units.

MINIMUM POPULATION SIZE

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— (A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and (B) provides reasonable assurance that the stock size is equal to or greater than the estimate." (MMPA § 3(27)).

The N_{MIN} for the Southwest stock was calculated using equation 1 from the Potential Biological Removal Guidelines (NOAA 2016): $N_{MIN} = N/\exp(0.842 \times [\ln(1+[CV(N)]2)]^{½})$. The N_{MIN} for each of the five MUs are listed in Table 1. The total estimated N_{MIN} for the five MUs comprising the Southwest stock is 41,666 sea otters, which consists of 26,378 sea otters in Kodiak, Kamishak, and Alaska Peninsula MU, 4,665 sea otters in Bristol Bay MU, 417 sea otters in South Alaska Peninsula MU, 8,102 sea otters in Eastern Aleutians MU, and 2,104 sea otters in Western Aleutians MU (Table 1).

CURRENT POPULATION TREND

Overall, the population trend across the five MUs is highly variable. One MU, the South Alaska Peninsula, is in decline. Another MU, Western Aleutians, declined and is low but stable. Two MUs, Eastern Aleutians and Bristol Bay, are increasing in recent years. The MU Kodiak, Kamishak, and Alaska Peninsula is stable or slightly increasing. Overall, available data suggests that the Southwest stock trend is generally stable to increasing.

Kodiak, Kamishak, and Alaska Peninsula MU

As noted above, sea otter population survey methods have been variable across the five MUs in the Southwest stock, which has constrained subsequent statistical modeling and inferences on population trends across the MUs. The intensive search unit (ISU) method (Bodkin and Udevitz 1999) has been used consistently in some MUs, particularly in the Kodiak, Kamishak, and Alaska Peninsula MU, where surveys were conducted spring/summer in Kodiak (July/August 1994, 2001, 2004, 2014), in Katmai National Park (NP) (May-August 2008, 2012, 2015, 2018), and in Western Cook Inlet (May/June 2002, 2017) (Figure 3). It is hypothesized that the Katmai NP population reached carrying capacity in 2012, fluctuating around an equilibrium population size, given that energy intake rates (a metric of the population status relative to carrying capacity) had declined to a lower and stable level. This is similar to other populations in Alaska perceived to be at an equilibrium population size (Coletti et al. 2016). Similar abundance estimates in 2015 and 2018 also suggest the sea otter population is stabilizing in this area (Figure 3). In Kodiak, surveys depict a decline between the 1994 to 2001 surveys and an increase between the 2004 and 2014 surveys (Figure 3). The ISU surveys in Western Cook Inlet indicate sea otter population increased from 2002 to 2017, with a high proportion of the sea otters observed in Kamishak (Garlich-Miller et al. 2018).

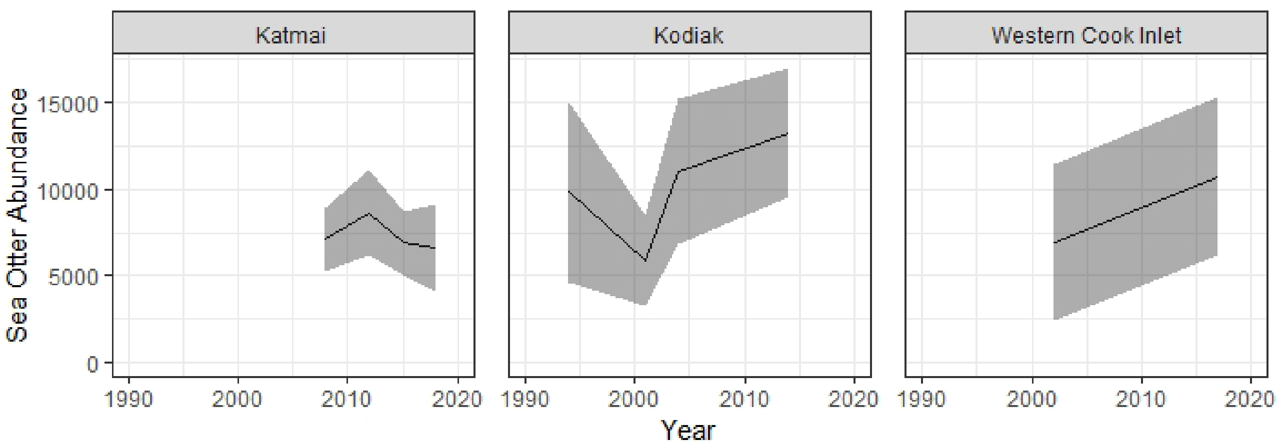

Figure 3. Sea otter population estimates (with 95 percent CI) and population trend lines in three focal study areas in the Kodiak, Kamishak, and Alaska Peninsula MU. All surveys presented were conducted using the Bodkin-Udevitz ISU aerial survey methodology.

Western Aleutians MU

Sea otter count data in the Western Aleutians MU has primarily relied on skiff surveys in the summer (July/August), which had historically (until 2021) not taken into account perceptibility or availability, but the counts were assumed to have a consistent relationship to true sea otter abundance in space and time (Pollock et al. 2002). Therefore, skiff counts have been considered a useful metric for tracking sea otter population trends through time in the Western Aleutians. In spring (April) 1992 and 2000, however, aerial sea otter surveys were conducted across a set of islands in the Aleutian chain with a twin engine aircraft (Doroff et al. 2003). Aerial survey data indicated a decline of 70 percent in sea otter densities from 1992-2000 for the islands of Adak, Agattu, Amchitka, Attu, Kagalaska, Kiska, Little Kiska, Little Tanaga, Ogliuga/Skagul, Rat (now Hawadax), and the Semichi Islands (Doroff et al. 2003). Skiff-based surveys in the early 1990s (1991-1993) and in 2000 indicated a similar rate of decline at 81 percent. Sea otter abundance has remained extremely low, but stable since the decline (Figure 4).

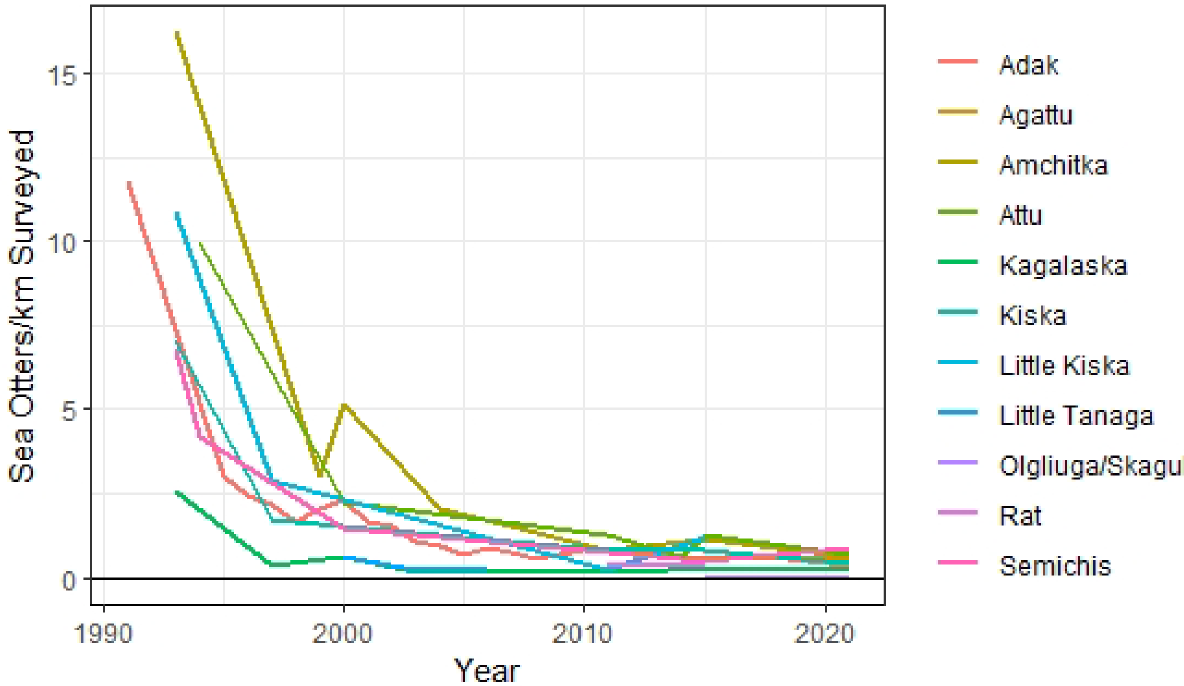

Figure 4. Sea otter population trends in the Western Aleutians MU based on standardized skiff-based sea otter counts while circumnavigating islands.

South Alaska Peninsula MU

Surveys in South Alaska Peninsula MU have been infrequent and used different methods for each survey. Fixed-wing aerial surveys were conducted in summer (June/July) 1986 and spring (April) 2001. Neither of these surveys directly accounted for imperfect detectability of sea otters. A spring (May) 2016 fixed wing aerial survey spanned a similar sized area as the 1986 and 2001 surveys, but used distance sampling methods (Buckland 2001), which accounts for detection probability. The results from the 2001 survey indicated sea otter abundance (1,005 sea otters) was more than 90 percent lower than in 1986 (14,042 sea otters) (Burn and Doroff 2005). The 2016 estimate was 546 sea otters (95 percent Bayesian Credible Interval: 322-879, CV = 0.33) (Beatty et al. 2021). Although evidence suggests the sea otter population in the South Alaska Peninsula MU has decreased substantially since 1986, it is difficult to accurately describe the extent of the decline due to differing methodologies (Figure 5).

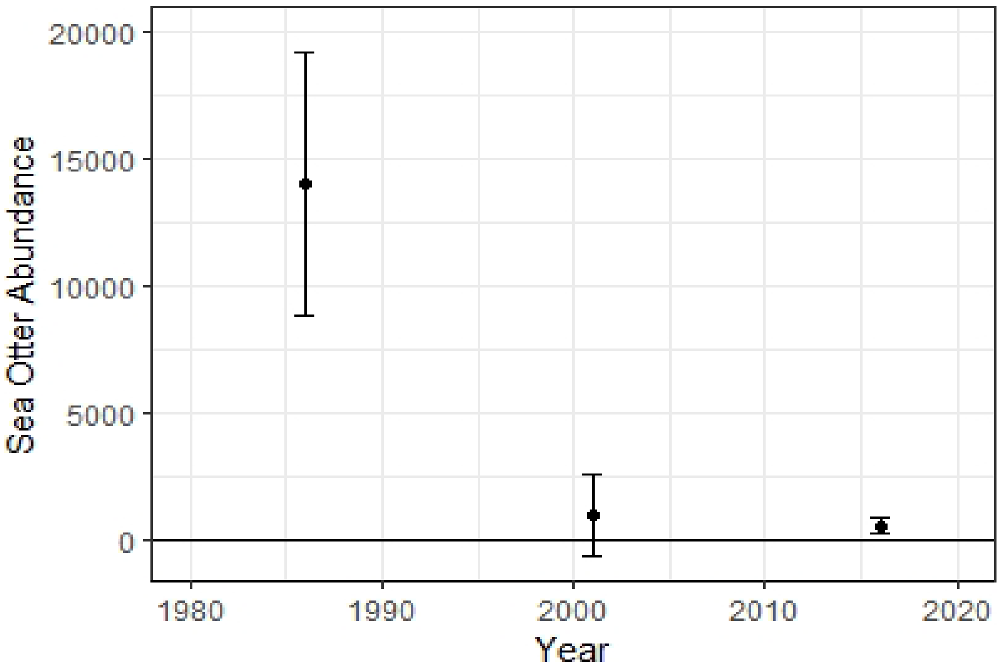

Figure 5. Sea otter population estimates in the South Alaska Peninsula MU in 1986, 2001, and 2017. Survey methods were different for each survey. As a result, accurately determining population trends is problematic and therefore no trend line was drawn.

Bristol Bay MU

Sparse historical data also exists for the Bristol Bay MU. Aerial fixed-wing surveys were conducted in spring/summer 1986 (June/July) and in 2000 (May). The 1986 survey resulted in an estimate of 6,474 sea otters (95 percent CI: 2,816–9,132). The results from the 2000 survey indicated abundance estimates of 4,728 sea otters (95 percent CI: 1,403–8,053). An aerial survey was conducted in spring (May) 2016 using distance sampling methods (Buckland 2001), which accounts for detection probability. This survey resulted in a population estimate of 9,733 sea otters (95 percent Bayesian Credible Interval: 6,412–17,819, CV = 1.07) for the Bristol Bay MU (Beatty et al. 2021). Evidence suggests the sea otter population potentially increased from 2000 to 2016. However, methodological differences among surveys make it difficult to determine the extent and magnitude of the increase between 2000 and 2016 (Figure 6).

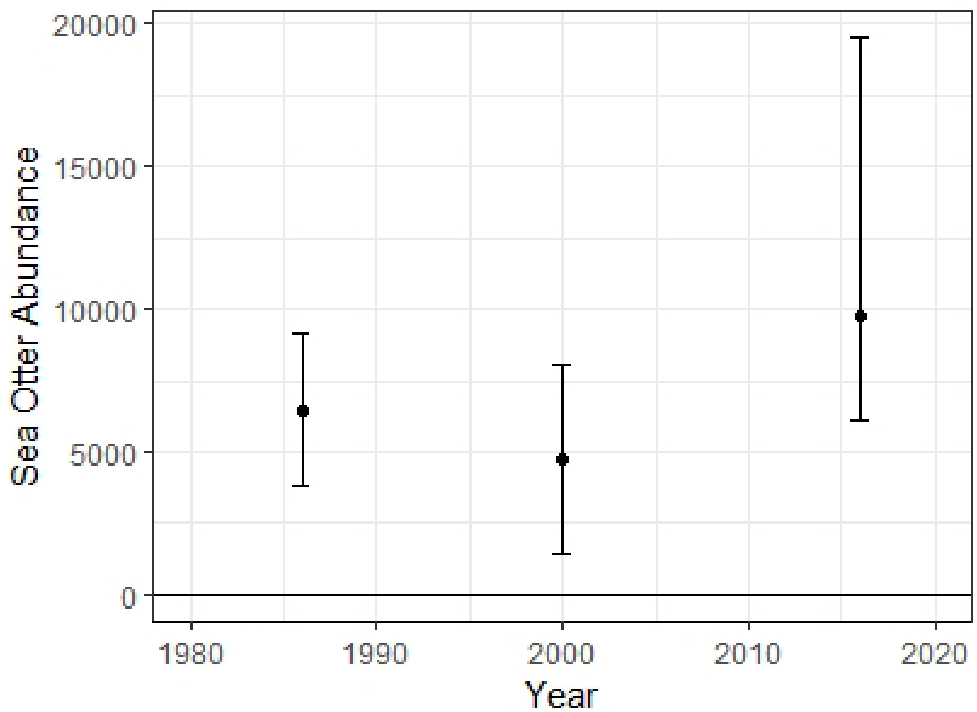

Figure 6. Sea otter population estimates in Bristol Bay MU in 1986, 2000, and 2016. Survey methods were different for each survey. As a result, accurately determining population trends is problematic and therefore no trend line was drawn.

Eastern Aleutians MU

Early surveys of islands now within the Eastern Aleutians MU conducted from 1957 to 1965 (Kenyon 1969) indicated two small sea otter populations totaling 41 otters occurred in the Fox and Krenitzen islands (Kenyon 1969). An aerial survey in spring (April) 1992 indicated sea otters had spread throughout the Fox and Krenitzen islands (Evans et al. 1997), with a population estimate across the area of 3,470 sea otters (95 percent CI: 2,876–4,064). An aerial survey in spring (April) 2000 indicated the sea otter population had declined to 2,291 sea otters (Doroff et al. 2003). A survey in spring/summer 2017 (May-July) utilizing aerial and skiff-based distance sampling methods estimated population abundance at 8,593 sea otters (95 percent Bayesian Credible Interval: 7,450–9,984, CV = 0.07) (Wilson et al. 2021). Although the 2017 abundance estimate appears to indicate a large increase compared to the previously published minimum population estimate (2,291) (Doroff et al. 2003), it is difficult to directly compare the results. Specifically, Doroff et al. (2003) did not account for the perceptibility, availability, or sampling effort in different study area strata, whereas the Wilson et al. (2021) study did. Although the magnitude and extent of population changes through time are difficult to ascertain, the Eastern Aleutians MU sea otter population appears to have increased from the population decline observed in 2000 (Doroff et al. 2003), and is possibly at a population level greater than in 1992 (Evans et al. 1997) (Figure 7).

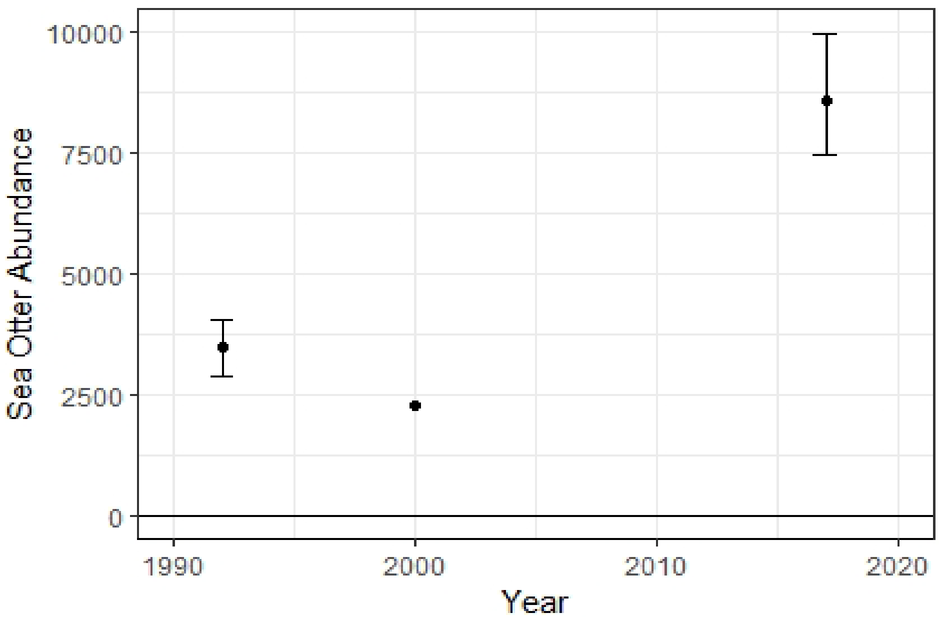

Figure 7. Sea otter population estimates in the Eastern Aleutians MU in 1992, 2000, and 2017. Survey methods were different for each survey. Although the sea otter population appears to be increasing, accurately describing the extent and magnitude of the trend is conflated by different methodologies and therefore no trend line was drawn.

MAXIMUM NET PRODUCTIVITY RATE

Eisaguirre et al. (2021) provides the most recent estimate of maximum theoretical net productivity rate (R_{MAX}) for northern sea otter at 0.29 (90 percent Bayesian Credible Interval: 0.28–0.31) based on an assessment of sea otter population dynamics in southeast Alaska. Given that R_{MAX} is the maximum intrinsic rate of growth achievable by northern sea otters, the value of 0.29 is also applied to calculations used for this Stock Assessment Report. Previously, R_{MAX} values ranging 0.20-0.24 were reported by Estes (1990) were generally accepted to be realistic for northern sea otter (Tinker et al. 2019). Estes (1990) assumed age of first reproduction of 3-4 years and female reproductive rates of 0.43-0.45 per year. However, more recent evidence suggests sea otters are physiologically capable of reproducing, and many do reproduce, at 2 years (von Biela et al. 2009) and female reproductive rates are probably as high as 0.54 (Riedman et al. 1994). Therefore, an R_{MAX} value of 0.29 was used for the Southwest stock.

POTENTIAL BIOLOGICAL REMOVAL

Under the MMPA, the potential biological removal (PBR) is defined 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." (MMPA § 3(20)). Potential biological removal is the product of the N_{MIN}, onehalf the maximum theoretical net productivity rate, and a recovery factor (F_R) ranging between 0.1 and 1.0. PBR = N_{MIN} x 0.5 R_{MAX} x F_R.

There have been no reported rates of incidental mortality and serious injuries associated with commercial fisheries in the U.S. However, this is based on self-reporting and observer programs on vessels that may not overlap with sea otter habitat. Therefore, it is difficult to state the full effect of fisheries on the Southwest stock. Reported subsistence harvest rates have declined since 2018 (Figure 8), but it is unknown how much underreporting occurs. There is also uncertainty in the rate of human-caused mortality associated with oil spills, local boating activity, and increased development in the mariculture industry. Although population trends are detectible among a few of the MUs, due to the disparate nature of when and how these population estimates were conducted, it is difficult to directly compare the sea otter population within each MU over time.

Our estimate of N_{MIN} accounts for imprecision and uncertainty in the abundance estimates across MUs through time. Concerns over uncertainty or biases associated with the extent of human-caused mortality can be accounted for through a reduction in F_R from the default of 1 to a lower value (NOAA 2016). For stocks listed as threatened under the ESA, the default recommendation is to set F_R = 0.5 (NOAA 2016), which can serve as a safety factor to account for uncertainties and biases in mortality and knowledge of the factors associated with mortality (Wade 1998). A F_R value of 0.38, which represents a 25 percent reduction from the default value of 0.5, has been adopted for this stock to account for uncertainty and buffer against an underestimate of mortality. Thus, the calculated PBR value for the Southwest stock is 2,296 animals (41,666 × 0.5(0.29) × 0.38).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Our best estimate of the average rate of annual human-caused mortality and serious injury for the Southwest stock for the period 2017 through 2021 is 177 sea otters/year, which is below the calculated PBR of 2,296. Self-reported fisheries interactions averaged < 1 sea otter interaction per year. Data for subsistence harvest of sea otters in the Southwest stock are collected by a mandatory Marking, Tagging, and Reporting Program (MTRP) administered by the Service since 1988. Total annual subsistence harvest removals averaged 176 sea otters/year over this same 5-year period, which represents < 1 percent of N_{MIN}, but this is likely an underestimate. The MTRP indicates they have received some anecdotal reports of illegal and unreported harvest, but the extent to which it occurs across the stock is unknown. Rates of serious injury and strike and loss are also unknowns not quantified.

Additional factors likely to result in human-caused mortality or serious injury for this stock include oil and gas development and spills, boat strikes, and anthropogenic disturbance-related mortalities associated with fisheries or mariculture farms. Thus, the estimated annual human-caused mortality rate should be considered negatively biased to an unknown degree.

Fisheries Information

A complete list of fisheries and marine mammal interactions is published annually by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service. Numerous fisheries exist within the range of the Southwest stock. From 2017–2021, two fisheries were reported to incidentally kill or injure northern sea otters: the Kodiak salmon set gillnet (188 vessels and/or persons involved) and the Alaska Peninsula/Aleutian Islands salmon set gillnet (113 vessels and/or persons involved) (NOAA Fisheries 2022). The total number of animals affected is not available in these annual reports. Available information suggests that fisheries using other types of gear, including trawl, longline, and purse seine, are less likely to have interactions with northern sea otters due to the areas where such fisheries operate, the specific gear used, or both.

The Marine Mammal Authorization Program database includes self-reported incidences of mortality from fisheries operations. There have been no self-reported interactions with sea otters in Alaska over the past 5 years (2017–2021). The last self-reported incident was in June 2014 when a sea otter was reported as killed in a set gillnet for salmon near Kodiak. Another sea otter was reported killed in a set gillnet for salmon near Kodiak in July 2012. Credle et al. (1994) considered fisher self-reports to be a minimum estimate of sea otter mortality and serious injury as these data are most likely negatively biased.

NOAA Fisheries conducts a marine mammal observer program. Over the last 5 years (2017-2021), there have been no serious sea otter injuries or mortalities in the observed Alaska fisheries. One sea otter carcass was observed in 2020, but it was missing its head and appeared to have been dead for a while. The mortality was not attributed to the fishery and was not confirmed to be human caused. Sea otters are known to interact with pot fisheries in California, and it is possible that observer effort for pot fisheries in Alaska has been too low to detect sea otter bycatch (Hatfield et al. 2011).

In summary, in the last 5-year period (2017–2021) there have been no records of mortality or serious injury of sea otters by commercial fisheries within the range of the Southwest stock, no observer records of sea otter mortality, and no self-reports of sea otter mortality. It is difficult to determine whether these sources of information are comprehensive and to what extent sea otter injury and mortality goes unreported. Therefore, it is difficult to state the total combined effect of fisheries on the Southwest stock, including whether the total fishery mortality and serious injury rate is insignificant and approaching a zero mortality and serious injury rate.

Oil Spills

Activities associated with exploration, development, and transport of oil and gas resources can adversely impact sea otters and nearshore ecosystems in Alaska. Sea otters rely on air trapped in their fur for warmth. Contamination with oil drastically reduces the insulative value of the pelage, and consequently, sea otters are among the marine mammals most vulnerable to the direct effects of contact with oil. It is believed that sea otters can survive low levels of oil contamination (< 10 percent of body surface), but that greater levels(> 25 percent) will lead to death (Costa and Kooyman 1981, Siniff et al. 1982).

Within the range of the Southwest stock, the primary forms of oil and gas exposure are through vessel traffic and oil and gas development. A high level of vessel traffic passes through the Southwest stock, including vessels transporting oil and gas. According to the U.S. Coast Guard Response Center, mild oil spills do occur within sea otter habitat of the

Southwest stock. While the catastrophic release of oil has the potential to negatively affect many sea otters, there is currently no evidence that other effects (such as disturbance) associated with routine oil and gas development and transport have had a population-level impact on the Southwest stock. There have been no large oil spills impacting sea otters in the Southwest stock in the past five years (2017–2021).

The Bureau of Ocean Energy and Management (BOEM) manages oil and gas lease sales in Cook Inlet. The eastern portion of Cook Inlet includes the Southcentral sea otter stock and the western portion includes the Southwest stock. There are currently 14 active leases in Cook Inlet spanning 76,615 acres (BOEM 2022). Seven of these leases overlap Western Cook Inlet within the Kodiak, Kamishak, and Alaska Peninsula MU (BOEM 2022). There are currently no known oil and gas incidents associated with the Cook Inlet oil and gas leases that have led to sea otter mortalities or serious injuries.

Alaska Native Subsistence/Harvest Information

The MMPA exempts Alaska Natives from the prohibition on take of marine mammals, provided such taking is not wasteful and is done for subsistence use or for creating and selling authentic handicrafts or clothing. In addition, section 10(e) of the ESA allows for take of listed species for primarily subsistence purposes under certain circumstances. It is possible that some harvested sea otters are never reported, and the Service does not currently have a method in place to estimate the amount of unreported harvest that occurs. However, sea otter hides are required to have MTRP tags before they can be commercially tanned, which is thought to help ensure proper reporting. We rely on MTRP as an indication of minimum harvest levels in the Southwest stock.

The mean reported annual subsistence harvest during the past five complete calendar years (2017 to 2021) was 176 animals/year across the Southwest stock (Figure 8), which represents < 1 percent of N_{MIN}. Annual sea otter harvest increased between 2015 and 2018 to a high of 379 sea otters, reflecting escalated hunting effort to increase the availability of sea otter hides to be sold. Subsistence harvest reporting should be considered a minimum estimate as it does not account for underreporting of harvest or correct for struck and lost animals (i.e., attempted to be harvested, but not recovered and tagged). Those factors are known to exist, but since they are not currently monitored in any substantive way, the subsistence harvest data is not corrected to account for them.

Age and sex composition of harvest can influence sea otter population demographics, but is not a concern at the current harvest level (Bodkin and Ballachey 2010). Reported age composition during this period was 88 percent adults, 9 percent subadults, 2 percent pups and <1 percent unknown age. Sex composition during the past 5 years was 71 percent males, 27 percent females, and 2 percent of unknown sex. Most of the harvest in the Southwest stock over the past 5 years (96 percent), and throughout the 1989–2021-time frame that harvest data has been recorded by MTRP, has occurred in the Kodiak, Kamishak, and Alaska Peninsula MU, which has the highest concentration of people and highest abundance of sea otters in the Southwest stock.

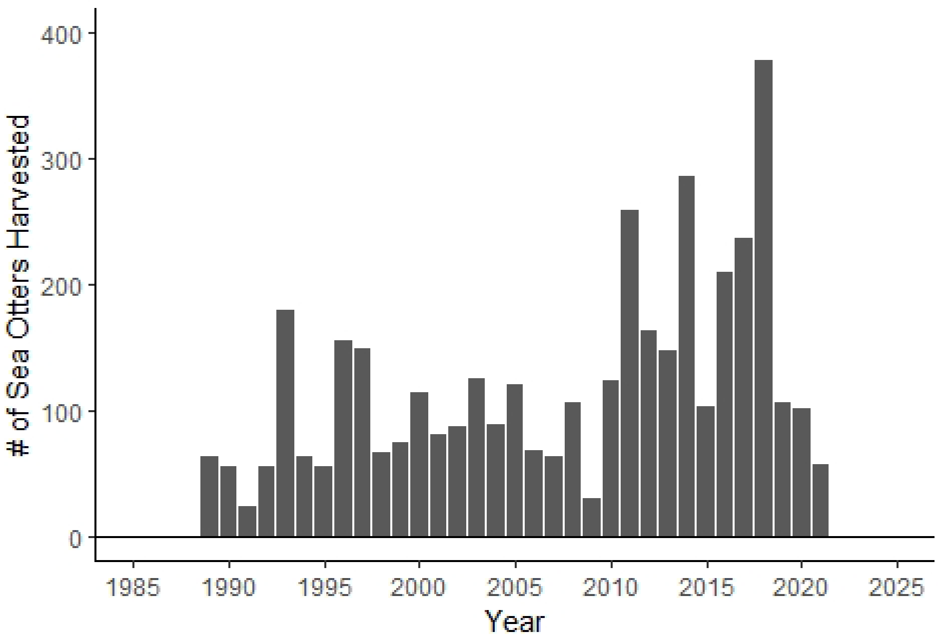

Figure 8. Reported subsistence harvest of northern sea otters from the Southwest Alaska stock, 1989 to 2021.

Illegal Take

The extent to which sea otters are illegally killed as a result of conflict with fisheries-related activities is unknown. The Service's Law Enforcement office maintains records of the number of prosecutions for unlawful take, possession, transport, or sale of sea otters or sea otter hides. From 2017-2021 there were three illegal instances of take of sea otters in the Southwest stock, but the origin of the incident, the nature of the takes, or the number of sea otters taken in these incidents is unknown. The Service does not currently have a method for quantifying illegal take of northern sea otters.

Research and Public Display

Over the past 5 years, no sea otters from the Southwest stock were captured, rehabilitated, or placed for public display.

Boat Strike

The Service maintains a baseline stranding program to determine cause of death, disease incidence, and status of general health parameters. However, the stranding program receives few carcasses from the Southwest stock, which has few human population centers compared to the Southcentral and Southeast stocks. Despite the spatial imbalance of stranding reporting, boat strike is considered a recurring potential cause of mortality and serious injury across all three stocks (Burek Huntington et al. 2021), so it is useful to summarize what is known about boat strikes in Southcentral to assess the potential risk to the Southwest stock. In Kachemak Bay, boat strikes have been the most commonly encountered human-inflicted injury (Burek Huntington et al. 2021). Necropsies of boat-struck sea otters have revealed that although trauma was the ultimate cause of death, disease or biotoxin exposure likely incapacitated the animal and made it more vulnerable to boat strike (Lefebvre et al. 2016, Burek Huntington et al. 2021). Due to the limited spatial extent of the stranding program outside of Kachemak Bay in the Southcentral stock, the total injury/mortality related to boat strikes is unknown for the Southwest stock.

Mariculture

Mariculture is defined as the farming of aquatic plants, such as kelps and other macro-algae, fish, and shellfish in salt water (Monson and Degange 1988). Aquatic farms specializing in cultivating macro-algae and various shellfish species have been increasing in Alaska since 1988 when the Aquatic Farm Act (Alaska Statutes 16.40.100-199) was passed by the Alaska Legislature (Alaska Mariculture Task Force 2018). It is currently unknown how mariculture activities affect the Southwest stock and how these effects will change under various scenarios of industry growth. The Service has developed a Mariculture Working Group to better understand mariculture activities and to take a proactive role in helping reduce any potential negative sea otter-farm interactions. A recent review of self-reporting to the State of Alaska revealed conflicts between sea otters and mariculture operations in Kachemak Bay and described measures taken by operators (e.g., maintaining a human physical presence to discourage and mitigate sea otter impacts), which may have disturbed some Southcentral sea otters (Rehberg and Goodglick 2023). Future monitoring of reporting and outreach to mariculture operators about legal and sustainable pathways to resolving sea otter conflicts, in collaboration with state agencies tasked with oversight will be essential to reducing conflict with sea otters.

Other Mortality Sources

Predation

Sea otter predation occurs in all three stocks from killer whales, wolves, bears, and eagles on pups. Where sea otters have recolonized and frequently haul out, they become susceptible to terrestrial predators such as bears and wolves (Monson 2021, Roffler et al. 2021); however, terrestrial predators are unlikely to have stock-wide population impacts (Monson 2021). Eagle predation primarily occurs on pups less than 1 month old, and experienced sea otter mothers will alter behavior to minimize eagle predation risk to pups (Esslinger et al. 2014). While the population-level impacts from predators are generally difficult to discern, predation from killer whales was a driver of population dynamics for the Southwest stock (USFWS 2020). The drastic decline in the Southwest stock that led to their listing as threatened under the ESA in 2005 was attributed to a high level of predation by transient (mammal-eating) killer whales (*Orcinus orca*) (Estes et al. 1998, Williams et al. 2004, U.S. Fish and Wildlife Service 2013, Tinker et al. 2021).

Sea otter abundance in the Western Aleutians MU has remained very low and stable since the decline in the 1990s (Tinker et al. 2021). A recent meta-analysis evaluated a suite of ecological, environmental, and anthropogenic variables that could have led to the observed Southwest stock population decline (Tinker et al. 2021). This research indicated reproductive rates were stable during the decline and mortality was high, yet few carcasses were observed on shore during the decline (Tinker et al. 2021). Sea otter energetic intake rate, prey biomass density, and body length and condition all increased after the population decline and were inversely related to sea otter population density beyond the area of decline, indicating food limitation was not the reason for the decline (Tinker et al. 2021). There was no evidence that pathogens, biotoxins, contaminants, or abnormal gene transcription patterns contributed substantially to the observed decline in an area examined from the Alaska Peninsula out to the Aleutian archipelago, including the Western Aleutians MU, Eastern Aleutians MU, South Alaska Peninsula MU, and a portion of the Bristol Bay MU. Overall, the authors indicated their results supported predation as the most probable cause for the sea otter population decline (Tinker et al. 2021). Due to the logistical challenges of recording incidences of killer whale predation on sea otters, it is difficult to determine the current severity of predation and how it will affect sea otter population growth in the future.

Biotoxins

Biotoxins are compounds produced by algae (dinoflagellates and diatoms) that can reach high levels under certain conditions known as harmful algal blooms (HAB). HABs occur most often in warm water conditions, but biotoxins can occur in the environment at high levels at any time, particularly in bivalve mollusks, which are a common prey item to sea otters. When biotoxins associated with HABs are consumed, they can cause significant illness and mortality in sea otters and other marine mammal species. Biotoxins, including neurotoxins domoic acid and saxitoxin, are an emerging concern in Alaska as sea surface temperatures increase (Burek et al. 2008).

While sea otters are at risk for exposure and uptake of biotoxins as detected around the State of Alaska (Lefebvre et al. 2016), it is unknown how the concentrations reported in sea otters to date relate to concentrations known to cause clinical signs of toxicity or mortality in other animals. Therefore, the population-level health effects to sea otters are not well understood and while the population shows an increasing trend, it is unknown how the frequency and severity of HABs influence sea otter demographics.

Pathogens

Pathogens (bacteria, fungi, viruses, parasites) can exert population-level effects through increased rates of mortality and reducing fertility or fecundity. Individual health and susceptibility to disease is a complex interaction of several factors such as immune status, body condition, and environmental conditions (Burek et al. 2008). Climate change is also increasing the prevalence of existing pathogens and introducing new pathogens to arctic and sub-arctic animal populations (Harvell et al. 1999, Dudley et al. 2015). However, due to the lack of information on sea otter health statewide in Alaska and the uncertainty in how a changing climate will influence distribution of pathogens and sea otter vulnerability to them, it is difficult to predict the impact pathogens will have at the stock level in the future.

STATUS OF STOCK

On August 9, 2005, the Southwest stock was listed as a threatened DPS under the ESA, and it is therefore classified as a strategic stock and considered as depleted under the MMPA. There is insufficient information to determine if incidental mortality and serious injury related to commercial fisheries is zero or approaching zero, as the information that exists is based on self-reporting. However, the best available information indicates that fishery-related mortality and serious injury is likely low. Current sea otter harvest levels are within a sustainable range.

The reported annual human-caused removals average 176 sea otters/year. The total known human-caused removals are below the calculated PBR level of 2,296 sea otters/year.

HABITAT AND PREY CONCERNS

Sea Surface Temperature and Ocean Acidification

Sea surface temperatures (SST) have been increasing around the world for several decades, including in the northeast Pacific Ocean and the southeast Bering Sea (IPCC 2013). Although there is no evidence linking sea otter mortality to increased SSTs, there are potential indirect effects of increasing SSTs on sea otter prey. As stated above, warmer waters promote harmful algae blooms that contain the biotoxins saxitoxin and domoic acid, which can concentrate in sea otter prey. Warmer waters also promote the spread and abundance of pathogens that may infect sea otters. In addition, increasing SST may alter the distribution and abundance of temperate and subarctic invertebrate prey as ocean water temperatures enter and exit each species' thermal tolerance (Kordas et al. 2011).

The ocean is also experiencing ocean acidification, whereby atmospheric carbon dioxide is absorbed by the ocean, which reduces seawater pH and the concentration of carbonate ions (Feely et al. 2004). The pH of ocean surface waters has decreased by about 0.1 units since the beginning of the industrial revolution (Caldeira and Wickett 2003, Orr et al. 2005). Changes in pH may affect reproduction, larval development, growth, behavior, and survival of calcifying marine organisms, such as sea urchins (e.g., *Strongylocentrotus droebachiensis*), abalone and other marine snails (e.g., *Haliotis kamtschatkana*), crabs (e.g., *Telmessus* spp.), mussels (*Mytilus spp.*), and clams (e.g., *Saxidomus spp.*) (Kroeker et al. 2013). The long-term impacts of ocean acidification on the distribution and availability of calcifying marine organisms, which comprise a large portion of the sea otter diet, are uncertain.

Habitat Fragmentation

Recent assessments of sea otter population viability in the Western Aleutians MU have revealed a pattern of inter-island and intra-island fragmentation (Tinker et al. 2023). Killer whale predation led to sea otter declines across islands resulting in a pattern of inter-island fragmentation. Declining sea otter populations on each island were likely able to persist within predation refuges particularly at larger islands with more complex habitat. Restriction of sea otters to these predation refuges has led to intra-island fragmentation, whereby sea otters in larger islands consist of several discrete clusters separated by seemingly inhospitable stretches of coastline habitat. The combination of inter-island and intra-island fragmentation may increase the risks of demographic stochasticity, and depending on the degree of disconnect among discrete clusters, there may be limited potential for rescue effect if some clusters become extirpated. It is not known whether habitat fragmentation is an issue to sea otter populations in the other four MUs.

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