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CALIFORNIA SEA LION (*Zalophus californianus*): U.S. Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

California sea lions breed on islands located in southern California, western Baja California, and the Gulf of California (Fig. 1). Mitochondrial DNA analysis identified five genetically distinct geographic populations: (1) Pacific Temperate, (2) Pacific Subtropical, (3) Southern Gulf of California, (4) Central Gulf of California and (5) Northern Gulf of California (Schramm *et al*. 2009). The Pacific Temperate population includes rookeries within U.S. waters and the Coronados Islands just south of U.S./Mexico border. Animals from the Pacific Temperate population range into Canadian and Baja California waters. Males from western Baja California rookeries may spend most of the year in the United States.

International agreements between the U.S., Mexico, and Canada for joint management of California sea lions do not exist, and sea lion numbers at the Coronado Islands is not monitored. Consequently, this report considers only the U.S. Stock, i.e. sea lions at rookeries north of the U.S./Mexico border. Pup production at the Coronado Islands is minimal (between 12 and 82 pups annually; Lowry and Maravilla-Chavez 2005) and does not represent a significant contribution to the overall size of the Pacific Temperate population.

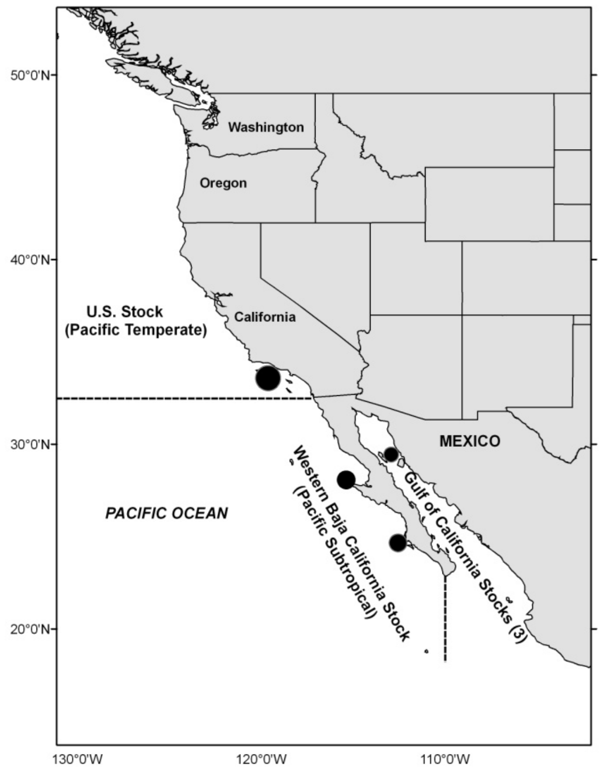

Figure 1. Geographic range of California sea lions showing stock boundaries and locations of major rookeries. The U.S. stock also ranges north into Canadian waters.

POPULATION SIZE

California sea lion population size was estimated from a 1975-2014 time series of pup counts (Lowry *et al*. 2017), combined with mark-recapture estimates of survival rates (DeLong *et al*. 2017, Laake *et al*. 2018). Population size in 2014 was estimated at 257,606 animals, which corresponded with a pup count of 47,691 animals along the U.S. west coast (Lowry *et al*. 2017, Laake *et al*. 2018).

Minimum Population Estimate

Minimum population size for 2014 is taken as the lower 95% confidence interval (CI) of the 2014 population size estimate, or 233,515 animals (Laake *et al.* 2018). The lower 95% CI is used as an estimate of N_{min} in this report because the lower 20^{th} percentile of the estimated population size is not calculated in Laake *et al*. 2018. The lower 95% CI is a more conservative estimate of minimum population size and is superior to previous approaches that simply used 2x the annual pup count, which were negatively-biased because not all age classes were represented.

Current Population Trend

Population size trends from 1975 through 2014 are shown in Fig. 2. The time series of population estimates are derived from 3 primary data sources: 1) annual pup counts (Lowry *et al*. 2017); 2) annual survivorship estimates from mark-recapture data (DeLong *et al*. 2017); and 3) estimates of human-caused serious injuries, mortalities, and bycatch (Carretta and Enriquez 2012a, 2012b, Carretta *et al*. 2016, Carretta *et al*. 2018a, 2018b). These 3 data sources were combined to reconstruct the population size estimates shown in Fig. 2 (Laake *et al*. 2018). Age- and sex-specific survival rates of California sea lions were estimated by DeLong *et al*. (2017), and female survivorship exceeds that of males. Annual pup survival was 0.600 and 0.574 for females and males, respectively. Maximum annual survival rates corresponded to animals 5 years of age (0.952 and 0.931 for females and males, respectively). Survival of pups and yearlings declined with increasing sea surface temperatures (SST). For each 1 degree C increase in SST, the estimated odds of survival declined by 50% for pups and yearlings, while negative SST anomalies resulted in higher survival estimates (DeLong *et al*. 2017). Such declines in survival are related to warm oceanographic conditions (e.g. El Niño) that limit prey availability to pregnant and lactating females (DeLong *et al*. 2017).

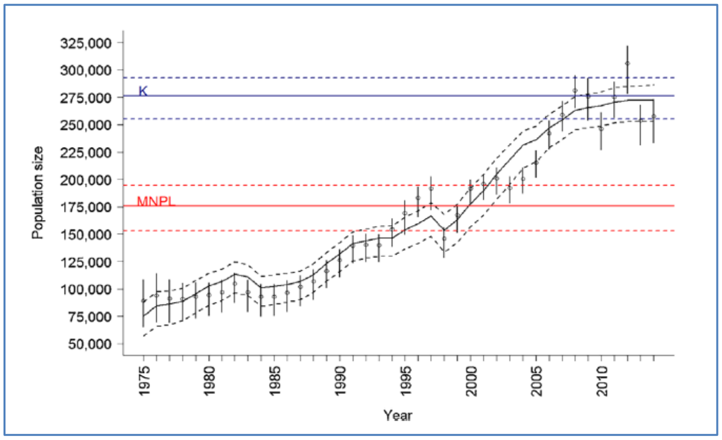

Figure 2. Fitted logistic growth curve (solid line) and 95% bootstrap intervals (dashed line) for reconstructed California sea lion annual population sizes in the United States, 1975–2014. Vertical lines indicate 95% confidence intervals for reconstructed annual population sizes. We also present estimated carrying capacity (K; solid blue line) with 95% confidence intervals (dashed blue line) and maximum net productivity level (MNPL; red solid line) with 95% confidence intervals (dashed red line). Figure from Laake *et al*. 2018.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Using a logistic growth model and reconstructed population size estimates from 1975-2014, Laake *et al*. (2018) estimated a net productivity rate of 7% per year. This estimate includes periods of sharp population declines associated with El Niño events and excludes undocumented levels of anthropogenic removals through bycatch and other sources (Carretta *et al*. 2016). The net productivity rate estimate of 7% per year is not considered a maximum net productivity rate, and Laake *et al*. (2018) note that the population is capable of faster growth rates. Therefore, we use the default maximum net productivity rate for pinnipeds of 12% per year (Wade and Angliss 1997). Laake *et al*. (2018) also estimated the population size at maximum net productivity level (MNPL) to be 183,481 animals.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (233,515) times one half the default maximum net growth rate for pinnipeds (½ of 12%) times a recovery factor of 1.0 (for a stock within OSP, Laake *et al*. 2018, Wade and Angliss 1997); or 14,011 sea lions per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Historical Depletion

Historic exploitation of California sea lions include harvest for food by native Californians in the Channel Islands 4,000-5,000 years ago (Stewart *et al*. 1993) and for oil and hides in the mid-1800s (Scammon 1874). Other exploitation of sea lions for pet food, target practice, bounty, trimmings, hides, reduction of fishery depredation, and sport are reviewed in Helling (1984), Cass (1985), Seagers *et al*. (1985), and Howorth (1993). There are few historical records to document the effects of such exploitation on sea lion abundance (Lowry *et al*. 1992).

Fisheries Information

California sea lions are killed in a variety of trawl, purse seine, and gillnet fisheries along the U.S. west coast (Barlow *et al*. 1994, Carretta and Barlow 2011, Carretta *et al*. 2018a, 2018b, Julian and Beeson 1998, Jannot *et al*. 2011, Stewart and Yochem 1987). Sources with recent observations or estimates of bycatch mortality are summarized in Table 1. In addition to bycatch estimates from fishery observer programs, data on fishery-related sea lion deaths and serious injuries comes largely from stranding data (Carretta *et al*. 2018b). Stranding data represent a minimum number of animals killed or injured, as many entanglements are unreported or undetected.

California sea lions are also killed and injured by hooks from recreational and commercial fisheries. Sea lion deaths due to hook-and-line fisheries can result from complications involving hook ingestion, perforation of body cavities leading to infections, or the inability of the animal to feed. Many animals die post-stranding during rehabilitation or are euthanized as a result of their injuries. Between 2012 and 2016, there were 146 California sea lion deaths / serious injuries attributed to hook and line fisheries, or an annual average of 29 animals (Carretta *et al*. 2018b).

Table 1. Summary of available information on the mortality and serious injury of California sea lions in commercial fisheries that might take this species (Carretta *et al.* 2012a, 2012b, 2014a, 2018a, 2018b;). Mean annual takes are based on 2012-2016 data unless noted otherwise. Bycatch estimates for 2 additional years, 2010 and 2011, have been included for the CA halibut and white seabass set gillnet fishery because this fishery has not been observed recently or lacks estimates of bycatch.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish large mesh drift gillnet fishery	2012 2013 2014 2015 2016 2012-2016	observer	19% 37% 24% 20% 18% 23%	6 3 3 0 0 12	16.1 (0.58) 11.6 (0.35) 10.9 (0.59) 6.2 (0.92) 17 (0.67) 62.3 (0.24)	12.5 (0.24)
CA halibut and white seabass set gillnet fishery	2010 2011 2012 2013 2014 2015 2016	observer	12.5% 8.0% 5.5% n/a 0% 0% 0%	25 6 18 0 n/a n/a n/a	199 (0.30) 74 (0.39) 326 (0.33) 0 (n/a) n/a n/a n/a	150 (0.28)
CA small-mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna	2010 2011 2012	observer	0.7% 3.3% 4.6%	0 0 0	0 (n/a) 0 (n/a) 0 (n/a)	0 (n/a)
CA anchovy, mackerel, sardine, and tuna purse- seine fishery	2004-2008	observer	~5%	2	n/a	≥2 (n/a)
WA, OR, CA domestic groundfish trawl fishery (includes at-sea hake and other limited-entry groundfish sectors)	2012-2016	observer	98% to 100% of tows in at-sea hake fishery Generally less than 30% of landings observed in other groundfish sectors	95	n/a	≥ 19 (n/a)
Unknown entangling net fishery	2012-2016	stranding	n/a	55	n/a	≥ 11 (n/a)
Unidentified fishery interactions	2012-2016	stranding	n/a	11	n/a	≥ 2.2
Minimum total annual takes						≥ 197 (0.23)

Other Mortality

California sea lions strand with evidence of human-caused mortality and serious injury from a variety of non-commercial fishery sources, including shootings, hook and line fisheries, power plant entrainment, marine debris entanglement, oil exposure, vessel strikes, and dog attacks (Carretta *et al*. 2018b). Between 2012 and 2016, there were 485 mortality and serious injuries documented from these sources, or an annual average of 97 sea lions (Carretta *et al*. 2018b). The most common sources of mortality and serious injury were shootings (n=155), hook and line fisheries (n=146), entanglements in marine debris (n=65), and oil exposure (n=58), which accounted for 87% of all cases. These values represent a minimum accounting of impacts, because an unknown number of dead or injured animals are unreported or undetected.

Under authorization of MMPA Section 120, individually identifiable California sea lions have been euthanized or relocated since 2008 in response to their predation on endangered salmon and steelhead stocks in the Columbia River. Relocated animals are transferred to aquaria and/or zoos. Between 2012 and 2016, 122 California sea lions were removed from this stock (115 lethal removals and 7 relocations to aquaria and/or zoos). The average annual mortality due to direct removals for the 2012-2016 period is 24.4 animals per year (Carretta *et al*. 2018b). Relocations to aquaria/zoos are treated equivalent to mortality because animals are effectively removed from the environment.

Mortality and serious injury may occasionally occur incidental to marine mammal research activities authorized under NMFS protected species permits issued to government, academic, and other research organizations, including research trawls and animal studies that require handling and tagging of individuals. From 2012-2016, nine mortalities were reported during research activities, resulting in a mean annual mortality and serious injury rate of 1.8 sea lions (Carretta *et al*., 2018b).

NOAA declared an unusual mortality event (UME) for California sea lions during 2013-2017. High mortality of pup and juvenile age classes were documented during this time and NOAA identified changes in the availability of sea lion prey species, particularly sardines, as a contributing factor. Changes in prey abundance and distribution have been linked to warm-water anomalies in the California Current that have impacted a wide range of marine taxa (Cavole *et al*. 2016).

Habitat Concerns

The algal neurotoxin domoic acid has been linked to mortality of California sea lions since 1998 (Scholin *et al*. 2000, Brodie *et al*. 2006, Ramsdell and Zabka 2008). Future mortality is expected to occur, due to the repeated occurrence of such harmful algal blooms.

Exposure to anthropogenic sound may impact individual sea lions. Experimental exposure of captive California sea lions to simulated mid-frequency sonar (Houser *et al*. 2013) and acoustic pingers (Bowles and Anderson 2012) resulted in a wide variety of behavioral responses, including increases in respiration, refusal to participate in food reward tasks, evasive hauling out, and prolonged submergence.

Expanding pinniped populations have resulted in increased human-caused serious injury and mortality, due to shootings, entrainment in power plants, interactions with hook and line fisheries, separation of mothers and pups due to human disturbance, dog bites, and vessel and vehicle strikes (Carretta *et al*. 2018b).

Increasing sea-surface temperatures in the California Current negatively impact prey species availability and reduce survival rates of California sea lions (DeLong *et al*. 2017, Laake *et al*. 2018, Lowry *et al*. 1991, Melin *et al*. 2008, 2010). Increasing ocean temperatures may continue to limit the population size of the California sea lion stock within the California Current (Cavole *et al*. 2016, DeLong *et al*. 2017, Laake *et al*. 2018).

STATUS OF STOCK

California sea lions in the U.S. are not listed as "endangered" or "threatened" under the Endangered Species Act or as "depleted" under the MMPA. The stock is estimated to be approximately 40% above its maximum net productivity level (MNPL = 183,481 animals), and it is therefore considered within the range of its optimum sustainable population (OSP) size (Laake *et al*. 2018). The carrying capacity of the population was estimated at 275,298 animals in 2014 (Laake *et al*. 2018). Mean annual commercial fishery mortality is 197 animals per year (Table 1). Other sources of human-caused mortality (shootings, direct removals, recreational hook, research-related and line fisheries, entrainment in power plant intakes) average 97 animals per year. Human-caused mortality and serious injury of this stock is ≥ 321 animals annually, which does not include undetected and unreported cases. California sea lions are not considered "strategic" under the MMPA because human-caused mortality is less than the PBR (14,011). The fishery mortality and serious injury rate (197 animals/year) for this stock is less than 10% of the calculated PBR and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate.

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