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

STOCK DEFINITION AND GEOGRAPHIC RANGE

The California sea lion *Zalophus californianus* includes three subspecies: *Z. c. wollebaeki* (on the Galapagos Islands), *Z. c. japonicus* (in Japan, but now thought to be extinct), and *Z. c. californianus* (found from southern Mexico to southwestern Canada; herein referred to as the California sea lion). The breeding areas of the California sea lion are on islands located in southern California, western Baja California, and the Gulf of California (Figure 1). These three geographic regions are used to separate this subspecies into three stocks: (1) the United States stock begins at the U.S./Mexico border and extends northward into Canada; (2) the Western Baja California stock extends from the U.S./Mexico border to the southern tip of the Baja California Peninsula; and (3) the Gulf of California stock which includes the Gulf of California from the southern tip of the Baja California peninsula and across to the mainland and extends to southern Mexico (Lowry et al. 1992). Some movement has been documented between these geographic stocks, but rookeries in the United States are widely separated from the major rookeries of western Baja California, Mexico. Males from western Baja California rookeries may spend most of the year in the United States. Genetic differences have been found between the U.S. stock and the Gulf of California stock (Maldonado et al. 1995). There are no international agreements for joint management of California sea lions between the U.S., Mexico, and Canada.

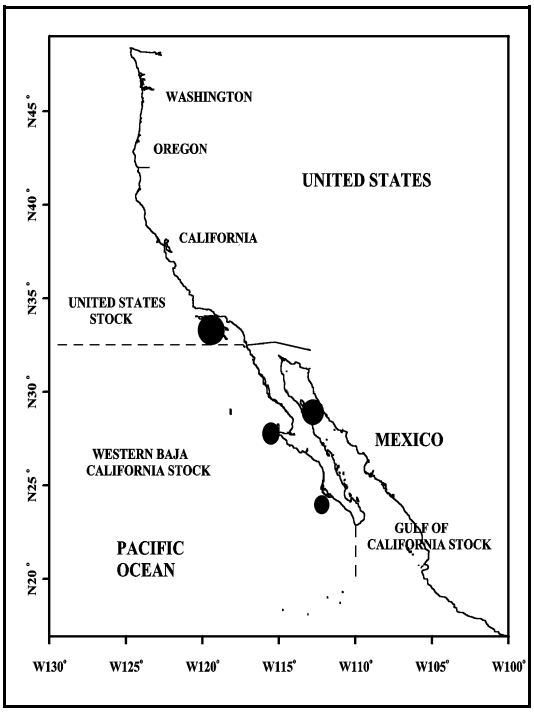

Figure 1. Geographic range of California sea lions showing stock boundaries and locations of major rookeries.

POPULATION SIZE

The entire population cannot be counted because all age and sex classes are never ashore at the same time. In lieu of counting all sea lions, pups are counted during the breeding season (because this is the only age class that is ashore in its entirety), and the number of births is estimated from the pup count. The size of the population is then estimated from the number of births and the proportion of pups in the population.

Censuses are conducted in July after all pups have been born. To estimate the number of pups born, the pup count in 1999 (42,388) was adjusted for an estimated 15% pre-census mortality (Boveng 1988; Lowry et al. 1992), giving an estimated 48,746 live births in the population. The fraction of newborn pups in the population (22.8% to 23.9%) was estimated from a life table derived for the northern fur seal (*Callorhinus ursinus*) (Boveng 1988, Lowry et al. 1992) which was modified to account for the growth rate of this California sea lion population (5.0% to 6.2% yr^{-1}, respectively, see below). Multiplying the number of pups born by the inverse of these fractions (4.39 to 4.19) results in population estimates ranging from 214,000 to 204,000 (respectively).

Minimum Population Estimate

The minimum population size was determined from counts of all age and sex classes that were ashore at all the major rookeries and haulout sites during the 1999 breeding season. The minimum population size of the U.S. stock is 109,854 (NMFS unpubl. data). It includes all California sea lions counted during the July 1999 census at the four rookeries in southern California and at the haulout sites located between Point Conception and the Oregon/California border. *An additional unknown number of California sea lions are at sea or hauled out at locations that were not censused.*

Current Population Trend

Records of pup counts from 1975 to 1999 (Figure 2) were compiled from the literature, NMFS reports, unpublished NMFS data, and Lowry 1999 (the literature up to 1992 is listed in Lowry et al. 1992). Pup counts from 1975 through 1999 were examined for four rookeries in southern California and for haulouts in central and northern California. Log-linear interpolation between adjacent counts was used to estimate counts for rookeries when they were

not censused in a given year: (1) 1980 at Santa Barbara Is.; (2) 1978-1980 at San Clemente Is.; (3) 1978, 1979, 1988, and 1989 at San Nicolas Is. The mean was used when more than one count was available for a given rookery. Also, an index was used for San Miguel Island because some years lacked data for certain areas. Three major declines in the number of pups counted occurred during El Niño events in 1983, 1992-93, and 1998 (Figure 2). A regression of the natural logarithm of the pup counts against year indicates that the counts of pups increased at an annual rate of 5.0% between 1975 and 1999. The counts of pups between the 1976, 1983, and 1992 El Niño events increased at 8.8% annually (from 1976 to 1982) and at 10.2% annually (from 1983 to 1991). Since 1983, the counts of pups has increased at 6.2% annually.

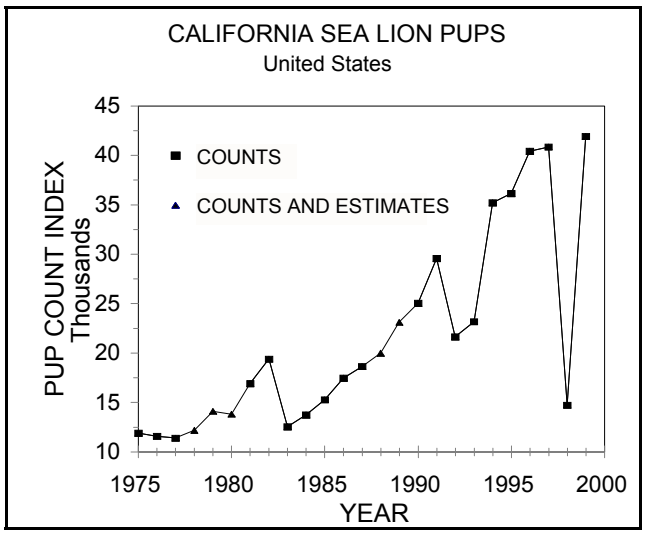

Figure 2. U.S pup count index for California sea lions (1975-99).

The 1975-99 time series of pup counts shows the effect of three El Niño events on the sea lion population. Pup production decreased by 35 percent in 1983, 27 percent in1992, and 64 percent in 1998. After the 1992-93 and 1997-98 El Niños, pup production rebounded by 52 percent and 185 percent, respectively, but there was no rebound after the 1983-84 El Niño (Figure 2). Unlike the 1992-93 and 1997-98 El Niños, the 1983-84 El Niño affected adult female survivorship (DeLong et al 1991) which prevented the rebound in pup production after the event was over because there were fewer adult females available in the population to produce a pup (it took five years for pup production to return to the 1982 level). Other characteristics of El Niños are higher pup and juvenile mortality rates (DeLong et al 1991, NMFS unpubl. data) which affect future recruitment into the adult population for the affected cohorts. The long term effects of the 1992-93 event, which resulted in fewer females being recruited into the adult population, is manifested in lower net productivity rates for 1997 and 1999 (relative to 1997; Figure 2) because fewer females reached reproductive age (females reach reproductive age at 3 to 5 years). Therefore, the effects of the 1992-93 and 1997-98 El Niños will result in lower net productivity rates for several years due to a drop in adult female recruitment. The drop in net production shows the long-term effect of El Niños and does not signal that the population has reached carrying capacity. The severity, timing, length, and frequency of future El Niños will govern the growth rate of the sea lion population in the future.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The rate of net production is greater than the observed growth rate because human related mortalities take a fraction of the net production. Net productivity was, therefore, calculated for 1980-1999 as the realized rate of population growth (increase in pup counts from year *I* to year *I*+1, divided by pup count in year *I*) plus human related mortalities (fishery and non-fishery mortalities in year *I* divided by population size in year *I*). For California sea lions, the total mortalities estimated from NMFS, California Dept. of Fish and Game, Columbia River Area observer programs, and reports from stranding programs and from salmon net pen fisheries were 1,967, 1,967, 1,967, 4,344, 2,476, 2,364, 4,417, 2,847, 3,753, 2,315, 2,753, 1,901, 3,520, 2,039, 946, 827, 1,107, 1,502, 1,435, 1,348 for 1980 to 1998, respectively (Miller et al. 1983; Hanan et al. 1988; Hanan and Diamond 1989; Brown and Jeffries 1993; Barlow et al. 1994, Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, NMFS unpubl. data). Fishery mortality for 1999 (1,261) was estimated as the mean of 1996-1998.

Between 1980 and 1999 the net productivity rate averaged 16.1% (Figure 3). A regression (thin line) shows a slight increase in net production rates, but the regression is strongly influenced by the El Niño years (1983, 1992, and 1998) and the high net production rate during El Niño recovery years (1994 and 1999). When El Niño years (1983, 1992, and 1998) and El Niño recovery years (1994 and 1999) are removed, the regression line shows a slight decrease (thick line) and net production averages 13.2%. Maximum net productivity rates cannot be estimated from available data.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (109,854) times one half the default maximum net growth rate for pinnipeds (½ of 12%) times a recovery factor of 1.0 (for a stock of unknown status that is growing, Wade and Angliss 1997); resulting in a PBR of 6,591 sea lions per year.

ANNUAL HUMAN-CAUSED MORTALITY

Fisheries Information

California sea lions are killed incidentally in set and drift gillnet fisheries (Hanan et al. 1993; Barlow et al. 1994; Julian 1997; Julian and Beeson, 1998, Cameron and Forney 1999; Table 1). Detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California the set and drift gillnet fisheries are included in Table 1 for the five most recent years of monitoring, 1994-98 (Julian and Beeson 1998; Julian 1997; Cameron and Forney 1999). A controlled experiment during 1996-97 demonstrated that the use of acoustic warning devices (pingers) reduced sea lion entanglement rates considerably within the drift gillnet fishery (Barlow and Cameron 1999). However, entanglement rates increased again during the 1997 El Niño and continued during 1998. The reasons for the increase in entanglement rates are unknown. However, it has been suggested that sea lions may have foraged further offshore in response to limited food supplies near rookeries, which would provide opportunity for increased interactions with the drift gillnet fishery (Barlow and Cameron 1999). Because of interannual variability in entanglement rates, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 1 are based only on 1997-98 data. This results in an average estimate of 158 (CV = 0.23) California sea lions taken annually.

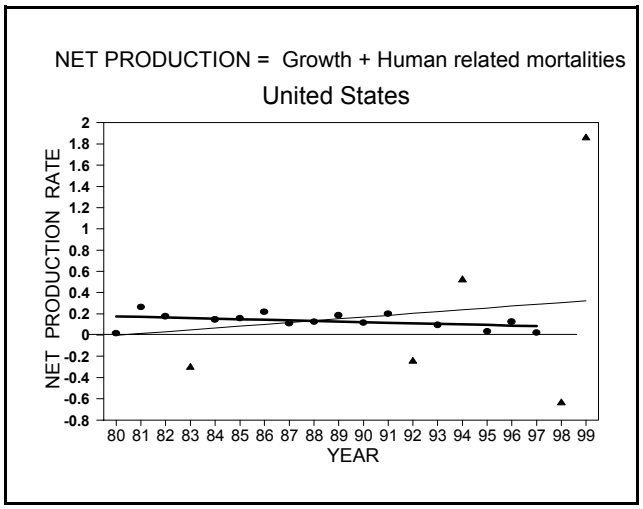

Figure 3. Net productivity rates and regression lines estimated from pup counts with corrections for incidental human related mortalities. Thick line excludes El Niño years and El Niño recovery years (i.e., triangles); thin line includes all years.

Logbook and observer data, and fisher reports, indicate that mortality of California sea lions occurs, or has occurred in the past, also in the following fisheries: (1) California, Oregon, and Washington salmon troll fisheries; (2) Oregon and Washington non-salmon troll fisheries; (3) California herring purse seine fishery; (4) California anchovy, mackerel, and tuna purse seine fishery; (5) California squid purse seine fishery, (6) Washington, Oregon, California and British Columbia, Canada salmon net pen fishery, (7) Washington, Oregon, California groundfish trawl fishery, and (8) Washington, Oregon and California commercial passenger fishing vessel fishery (NMFS 1995, M. Perez pers. comm, and P. Olesiuk pers. comm.). The OR Columbia River gillnet fishery has been reduced to such levels that California sea lion mortality, if any, is negligible (J. Scordino, per. comm.). The California Marine Mammal Stranding Network database maintained by the National Marine Fisheries Service, Southwest Region contains records of human-related fishery mortalities of stranded California sea lions. These records show that at least 17 additional mortalities and 17 injuries occurred in 1998 as a result of fishing net entanglement and 24 additional mortalities and 31 injuries from hook and line fisheries.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the U.S. stock. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet has increased from two vessels in 1986 to 31 vessels in 1993. (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2,700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and

Beeson 1998), but species-specific information is not available for the Mexican fisheries. There are currently efforts underway to convert the Mexican swordfish driftnet fishery to a longline fishery (D. Holts, pers. comm.).

Table 1. Summary of available information on the mortality and serious injury of California sea lions in commercial fisheries that might take this species (Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, M. Perez per. comm, Appendix 1). Mean annual takes are based on 1994-98 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA driftnet fishery for sharks and swordfish	1994 1995 1996 1997 1998	observer	17.9% 15.6% 12.4% 23.0% 20.0%	5 4 4 36 23	28 (0.40) 26 (0.45) 36 (0.55) 201(0.34) 114 (0.23)	158 (0.23)[1]
CA set gillnet fishery for halibut and angel shark	1994 1995 1996 1997 1998	observer estimate extrapolated estimate	7.7% 0% 0% 0% 0%	109 - - - -	905 (0.15) 724 (0.08) [1] 999 (0.06) [1] 1,206 (0.06) [1] 1,228 (0.07) [1]	1,012 (0.04)[2]
WA, OR, CA domestic groundfish trawl fishery (At-sea processing Pacific whiting fishery only)	1994 1995 1996 1997 1998	observer	53.8% 56.2% 65.2% 65.7% 77.3%	1 0 0 0 1	2(0.68) 0 0 0 1(0.48)	1(0.48)
WA, OR salmon net pen fishery	1996 1997 1998	logbook		4 9 9	4 9 9	7(0.39)
Canada: BC salmon pen fishery	1994 1995 1996	reports			13 23 54	30(0.71)
Minimum total annual takes						1,208 (0.05)

[1] Only 1997-98 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

[2] The CA set gillnets were not observed after 1994; mortality was extrapolated from effort estimates and previous entanglement rates. Changes in the distribution of effort in this fishery add considerable uncertainty to these estimates.

Other Mortality

California sea lions that were injured by entanglement in gillnet and other man-made debris have been observed at rookeries and haulouts (Stewart and Yochem 1987, Oliver 1991). The proportion of those entangled ranged from 0.08% to 0.35% of those present on land, with the majority (52%) entangled with monofilament gillnet material. A marine mammal rehabilitation center found that 87% of 87 rescued California sea lions were entangled in 4 to 4.5 inch square-mesh monofilament gillnet (Howorth 1995). Of California sea lions entangled in gillnets, 0.8% in set gillnets and 5.4% in drift gillnets were observed to be released alive from the net by fishers during 1991-95 (Julian and Beeson 1998). Clearly, some are escaping from gillnets after being caught by them; however, the rate of escape from gillnets, as well as the mortality rate of these injured animals, is unknown.

Live strandings and dead beach-cast California sea lions have also been observed with gunshot wounds in California (Lowry and Folk 1987, Deiter 1991, Barocchi et al. 1993). A summary of records for 1998 from the California Marine Mammal Stranding Network (CMMSN) and the Oregon and Washington stranding databases shows the following non-fishery related mortality: boat collision (3 mortalities), entrainment in power plants (30 mortalities), and shootings (70 mortalities and 8 injuries). Stranding records are a gross under-estimate of injury and mortality.

However, CMMSN stranding records indicate a higher mortality rate as a result of shootings and hook and line entanglements during the1997-98 El Niño period (115 shootings, 26 hook and line entanglements) than during the 1995-96 non-El Niño period (61 shootings, 5 hook and line entanglements). There are currently no estimates of the total number of California sea lions being killed or injured by guns, boat collisions, entrainment in power plants, marine debris, or gaffs, but the minimum number in 1998 was 144.

Several Northwest Indian tribes have developed, or are in the process of developing, regulations for ceremonial and subsistence harvests of California sea lions and for the incidental take of marine mammals during tribal fisheries. The tribes have agreed to cooperate with NMFS in gathering and submitting data on takes of marine mammals.

Sea lion mortalities in 1998 along the central California coast have recently been linked to the algal-produced neurotoxin domoic acid (Scholin et al. 2000). Future mortalities may be expected to occur, owing to the periodic nature of such harmful algal blooms.

STATUS OF STOCK

Lowry et al. (1992) concluded that there was no evidence of a density dependent signal in counts of California sea lions between 1983 and 1990, and that it was not possible to determine the status of this stock relative to OSP. They are not listed as "endangered" or "threatened" under the Endangered Species Act or as "depleted" under the MMPA. They are not considered a "strategic" stock under the MMPA because total human-caused mortality (1208 fishery-related mortalities plus 144 from other sources) is less than the PBR (6,591). The total fishery mortality and serious injury rate for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. The population has been growing recently at 6.2% per year, and the fishery mortality is increasing.

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