

Appendix C

**NOAA Fisheries 2007 Sea Lion
Stock Assessment Report**

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.

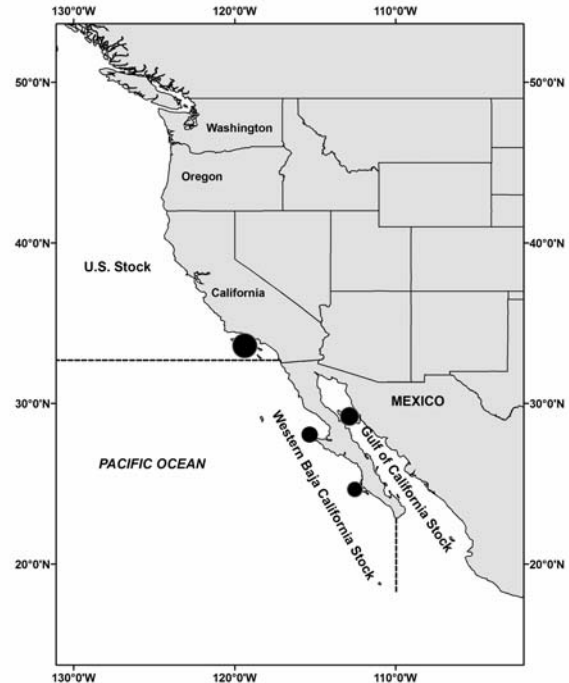


Figure 1. Geographic range of California sea lions showing stock boundaries and locations of major rookeries. The U.S. stock ranges north into Canadian waters.

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 2005 (48,277) was adjusted for an estimated 15% pre-census mortality (Boveng 1988; Lowry et al. 1992), giving an estimated 55,519 live births in the population. The fraction of newborn pups in the population (23.3%) 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 ($5.6\% \text{ yr}^{-1}$, see below). Multiplying the number of pups born by the inverse of this fraction (4.28) results in a population estimate of 238,000.

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 2005 breeding season. The minimum population size of the U.S. stock is 141,842 (NMFS unpubl. data). It includes all California sea lions counted during the July 2005 census at the Channel Islands in southern California and at 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 2005 (Figure 2) were compiled from the literature, NMFS reports, unpublished NMFS data, and Lowry 1999 (the literature up to 2000 is listed in Lowry and Maravilla 2005). Pup counts from 1975 through 2005 were examined for four rookeries in southern California and for haulouts in central and northern California. The number of pups at rookeries not counted were estimated using multiple regressions derived from counts of two neighboring rookeries using data from 1975-2000 (Lowry and Maravilla 2005) : (1) 1980 at Santa Barbara Is.; (2) 1978-1980 at San Clemente Is.; and (3) 1978 and 1979 at San Nicolas Is. The mean was used when more than one count was available for a given rookery. Four major declines in the number of pups counted occurred during El Niño events in 1983-1984, 1992-93, 1998, and 2003 (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 5.6% between 1975 and 2005 when pup counts for El Niño years (1983, 1984, 1992, 1993, 1998, and 2003) were removed from the 1975-2005 time series.

The 1975-2005 time series of pup counts shows the effect of four El Niño events on the sea lion population. Pup production decreased by 35 percent in 1983, 27 percent in 1992, 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 1983-1984 El Niño affected adult female survivorship (DeLong et al 1991) which prevented the rebound in pup production because there were fewer adult females available in the population to produce pups (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 2002 and 2003 decline can be attributed to (1) reduced number of reproductive adult females being incorporated into the population as a result of the 1992-93 and 1997-98 El Niños, (2) domoic acid poisoning (Scholin et al. 2000, Lefebvre et al. 2000), (3) lower survivorship of pups due to hookworm infestations (Lyons et al. 2001), and (4) the 2003 El Niño

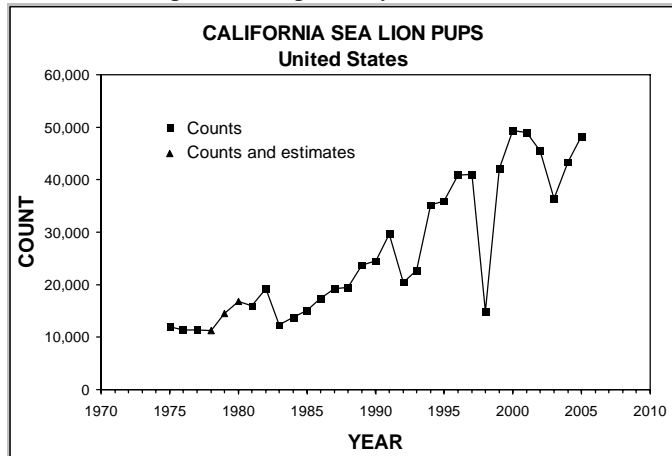


Figure 2. U.S. pup count index for California sea lions (1975-2005).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A generalized logistic growth model indicated that the maximum population growth rate (R_{max}) was 6.52 percent when pup counts from El Niño years (1983, 1984, 1992, 1993, 1998, and 2003) were removed (Figure 3).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (141,842) times one half the default maximum net growth rate for pinnipeds ($\frac{1}{2}$ 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 8,511 sea lions per year.

ANNUAL HUMAN-CAUSED MORTALITY

Historical Depletion

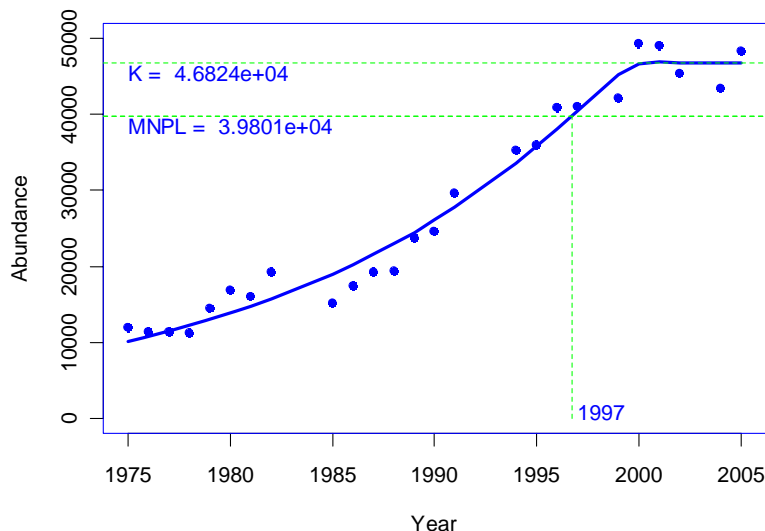
Historic exploitation of California sea lions include harvest for food by native Californians in the Channel Islands 4,000-5,000 years ago (Stewart et al. 1993) and for oil and hides in the mid-1800s (Scammon 1874). More recent exploitation of sea lions for pet food, target practice, bounty, trimmings,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

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; Carretta et al. 2005a; 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, 2000-2004 (Carretta and Chivers 2004, Carretta et al. 2005a, 2005b). 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 2003). 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. 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. Mortality estimates from the drift gillnet fishery are based on 2000-2004 observer data (~20% observer coverage). In past years, the largest source of sea lion mortality has been in the California halibut and angel shark set gillnet fishery, which currently operates south of Point Arguello, California and has not been observed throughout its range since 1994. Limited observer coverage occurred in Monterey Bay in 2000 and 2001, but represented less than 5% of the total fishing effort. Given the lack of recent observer data, it is not possible to estimate sea lion mortality for this fishery. Evidence from fisher self-reports (Table 1) indicates that mortality of sea lions still occurs in this fishery, but it is not possible to extrapolate these self reports to overall mortality because these self reports have been shown to be grossly underreported. Logbook and observer data, and fisher reports, indicate that mortality of California sea lions occurs, or has occurred in the past 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, (8) Washington, Oregon and California commercial passenger fishing vessel fishery (NMFS 1995, M. Perez pers. comm, and P. Olesiuk pers. comm.) (9) the California small mesh drift gillnet fishery, and (10) the California purse seine fishery for anchovy, mackerel, and tuna. 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.). Stranding data from California, Oregon, and Washington during 2000-2004 shows that an additional 66 sea lions died from unknown entangling net fisheries (Table 1). Animals are typically found on the beach or sometimes at sea with portions of gillnet wrapped around the carcass. This represents a minimum number of animals killed, as many entanglements are likely unreported or undetected.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California,

Figure 3. Generalized logistic growth of California sea lion pup counts obtained during 1975-2005 (excluding El Niño years) indicating when Maximum Net Productivity Level (MNPL) was reached and that the population has reached carrying capacity (K).



Mexico and may take animals from the same population. 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 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 2700, 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. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).

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 2001; 2002, Carretta et al. 2005a, 2005b, Perez 2003, Perez 2003; Appendix 1). Mean annual takes are based on 2000-2004 data unless noted otherwise. In past years, the set gillnet fishery for halibut and angel shark has been responsible for the majority of fishery-related mortalities. However, this fishery has not been observed recently and thus, current estimates of mortality are unknown. Because current mortality estimates are lacking for this fishery, overall mean annual takes reported in Table 1 are negatively biased by an unknown amount.

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	2000	observer	22.9%	13	50 (0.43)	38 (0.18)
	2001		20.4%	2	10 (0.67)	
	2002		22.1%	18	81 (0.25)	
	2003		20.2%	4	20 (0.50)	
	2004		20.6%	6	29 (0.44)	
CA angel shark/halibut and other species large mesh (>3.5 in) set gillnet fishery	2001	No fishery-wide observer program since 1994	0%	n/a	n/a	n/a
	2002		0%	n/a	n/a	
	2003		0%	n/a	n/a	
	2004		0%	n/a	n/a	
	2005		0%	n/a	n/a	
	2000-2004	MMAP self reports	-	57	n/a	≥11.4
CA small-mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna	2003 ¹	observer	11% ¹	2	18 (0.71)	13.5 (0.57)
	2004 ¹		11% ¹	1	9 (0.94)	
CA anchovy, mackerel, and tuna purse seine fishery	2004 ²	observer	n/a	1	≥ 1 (n/a)	≥ 1 (n/a)
WA, OR, CA domestic groundfish trawl fishery (At-sea processing Pacific whiting fishery only)	2000	observer	80.6%	0	0	1.2 (0)
	2001		96.2%	0	0	
	2002		100%	1	1	
	2003		100%	2	2	
	2004		100%	2	2	
WA, OR, CA domestic groundfish trawl fishery (bottom trawl)	2000	observer	n/a	n/a	n/a	≥11
	2001		n/a	8	n/a	
	2002		n/a	6	n/a	
	2003		n/a	24	n/a	
	2004		n/a	6	n/a	
WA, OR salmon net pen fishery	2000	n/a	n/a	n/a	n/a	n/a
	2001		n/a	n/a	n/a	
	2002		n/a	n/a	n/a	
	2003		n/a	n/a	n/a	
	2004		n/a	n/a	n/a	
Canada: BC salmon pen fishery	2000	MMAP	n/a	225	225	≥70
	2001		n/a	88	88	
	2002		n/a	19	19	
	2003		n/a	14	14	
	2004		n/a	6	6	

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
Unknown entangling net fishery	2000-2004	stranding	n/a	66	n/a	13 (n/a)
Minimum total annual takes						≥159 (n/a)

¹ A pilot observer program existed for two years in the small mesh drift gillnet fishery, where observer coverage ranged between 11-17%, based on logbook effort data and 22 observed sets in 2003 and 2004, respectively.

Other Mortality

California sea lions 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 hauled out, with the majority (52%) entangled in monofilament gillnet. Data from a marine mammal rehabilitation center showed that 87% of 87 rescued California sea lions were entangled in 4-4.5 inch square-mesh monofilament gillnet (Howorth 1994). 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 1991-1995 (Julian and Beeson 1998). Clearly, some are escaping from gillnets; 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 are regularly observed with gunshot wounds in California (Lowry and Folk 1987, Deiter 1991, Barocchi et al. 1993, Goldstein et al. 1999, NMFS unpublished stranding data). A summary of records for 2000-2004 from the California Marine Mammal Stranding Network (CMMSN) and the Oregon and Washington stranding databases shows the following non-fishery related mortalities: boat collisions (17 mortalities), entrapment in power plants (106 mortalities), shootings (237 mortalities), marine debris (three mortalities), and unknown sources (seven mortalities). Stranding records are a gross under-estimate of injury and mortality because many animals and carcasses are never recorded. There are currently no estimates of the total number of California sea lions being killed or injured by guns, boat collisions, entrapment in power plants, marine debris, or gaffs, but the minimum number from 2000-2004 was 370. The average annual non-fishery related mortality of sea lions from 2000-2004 is a minimum of the 370 mortalities listed above, divided by 5 years = 74 sea lions annually.

Several Pacific Northwest treaty Indian tribes have promulgated tribal regulations allowing tribal members to exercise treaty rights for subsistence harvest of sea lions. Current estimates of annual take are zero to two animals per year.

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, due to the periodic nature of such harmful algal blooms.

STATUS OF STOCK

A generalized logistic growth model of pup counts obtained during 1975-2005 (excluding El Niño years) indicated that the population reached its Maximum Net Productivity Level (MNPL) of 39,800 pups in 1997 and has reached carrying capacity (K) at 46,800 pups per year ($z = 19.09$, $R_{max} = 0.0652$, $n_0 = 10,100$, $SE = 1,055$) (Figure 3). This determination should be taken with caution until more years of data have been collected to verify whether the flattening of the generalized logistic curve persists in future years. 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. Even though current total human-caused mortality is unknown (due a lack of observer coverage in the California set gillnet fishery that historically has been the largest source of human-caused mortalities), California sea lions are not considered a "strategic" stock under the MMPA because (based on historical takes in the set gillnet fishery and current levels of fishing effort) total human-caused mortality is still likely to be less than the PBR (8,511). The total fishery mortality and serious injury rate for this stock likely remains above 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate.

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