SOUTHERN SEA OTTER (*Enhydra lutris nereis*)

U.S. Fish and Wildlife Service, Ventura, California

STOCK DEFINITION AND GEOGRAPHIC RANGE

Southern sea otters are listed as threatened under the Endangered Species Act. They occupy nearshore waters along the mainland coastline of California from San Mateo County to Santa Barbara County (Figure 1). A small colony of southern sea otters also exists at San Nicolas Island, Ventura County, as a result of translocation efforts initiated in 1987. The San Nicolas Island colony is considered to be an "experimental" population (52 FR 29754; August 11, 1987). Historically, southern sea otters ranged from Punta Abreojos, Baja California, Mexico to Oregon (Valentine *et al.* 2008), or possibly as far north as Prince William Sound, Alaska (reviewed in Riedman and Estes 1990). During the 1700s and 1800s, the killing of sea otters for their pelts extirpated the subspecies throughout most of its range. A small population of southern sea otters survived near Bixby Creek in Monterey County, California, numbering an estimated 50 animals in 1914 (Bryant 1915). Since receiving protection under the International Fur Seal Treaty in 1911, southern sea otters have gradually expanded northward and southward along the central California coast. The estimated carrying capacity of California is approximately 16,000 animals (Laidre *et al.* 2001).

Figure 1. Current range of the southern sea otter (2010 census). Source: U.S. Geological Survey, http://www.werc.usgs.gov/Project.aspx?ProjectID=91.

Mating and pupping of southern sea otters takes place year round, but a birth peak extending over several months occurs in the spring, and a secondary birth peak occurs in the fall (Siniff and Ralls 1991; Riedman *et al.* 1994). Male sea otters typically aggregate at the northern and southern limits of the range in winter and early spring, when some males that have maintained breeding territories in the predominantly female center of the range abandon their territories and join other males at its ends (Jameson 1989; Ralls *et al.* 1996).

All sea otters of the subspecies *Enhydra lutris nereis* are considered to belong to a single stock because of their recent descent from a single remnant population. Southern sea otters are geographically isolated from the other two recognized subspecies of sea otters, *E. l. lutris* and *E. l. kenyoni*, and have been shown to be distinct from these subspecies in studies of cranial morphology (Wilson *et al.* 1991) and variation at the molecular level (Sanchez 1992; Cronin *et al.* 1996; Larson *et al.* 2002).

POPULATION SIZE

Data on population size have been gathered for more than 50 years. In 1982, a standardized survey technique was adopted to ensure that subsequent counts were comparable (Estes and Jameson 1988). This survey method involves shore-based censuses of approximately 60% of the range, with the remainder surveyed from the air. These surveys are now conducted once each year (in spring). At San Nicolas Island, counts are conducted from shore on a quarterly basis. The highest of the four counts is used as the official count for the year.

The 2011 spring census was not completed due to weather conditions that prevented completion of the aerial portion of the survey. Therefore, the latest available 3-year running average is 2,711 individuals (U.S. Geological Survey, http://www.werc.usgs.gov/Project.aspx?ProjectID=91). This number is based on the raw counts for the years 2008, 2009, and 2010 (2,760, 2,654, and 2,719, respectively) and excludes the experimental population at San Nicolas Island. The San Nicolas Island colony numbers 51 animals (based on the high count for 2010), 46 independent sea otters and 5 dependent pups (U.S. Geological Survey unpub. data).

Minimum Population Estimate

The minimum population estimate for the southern sea otter stock is taken as the lesser of the latest count or the latest 3-year running average for the mainland population, plus the count for that year at San Nicolas Island. In 2010, the mainland count was 2,719. The 3-year running average was slightly lower, 2,711. Therefore, the minimum population estimate is 2,711 plus 51, or 2,762 animals.

Current Population Trend

As recommended in the Final Revised Recovery Plan for the Southern Sea Otter (U.S. Fish and Wildlife Service 2003), 3-year running averages are used to characterize population trends to dampen the effects of anomalous counts in any given year. Based on 3-year running averages of the annual spring counts, population performance has been mixed over the past 5 years, increasing between 2006 and 2008 and then decreasing between 2008 and 2010. The overall 5-year trend has been slightly negative, with an average rate of decline of about 0.3

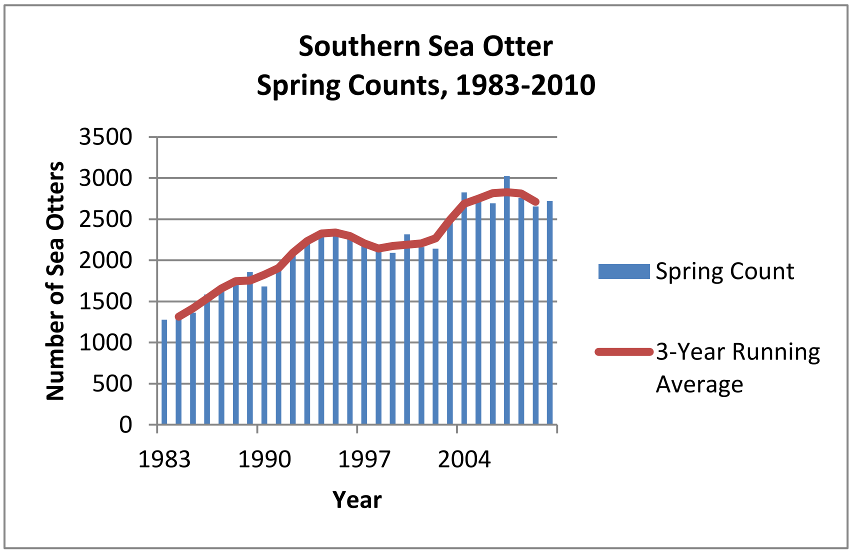

Figure 2. Southern sea otter counts 1983-2010 (mainland population). Data source: U.S. Geological Survey, http://www.werc.usgs.gov/Project.aspx?ProjectID=91.

percent per annum. The most recent census indicates a decline rate of 3.6 percent (Figure 2). Growth of the colony at San Nicolas Island has slowed from the approximately 9 percent average annual growth evident from the early 1990s to the mid-2000s to an average annual growth of approximately 2.5 percent for the period 2006-2010.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

We use the 5-year population trend to characterize current net productivity rates. As stated above, the average growth rate for this period is approximately -0.3 percent annually for the mainland population and approximately 2.5 percent annually for the San Nicolas Island population. The maximum growth rate (R_{max}) for southern sea otters along the mainland coastline appears to be six percent per year. Recovering or translocated populations at Attu Island, southeast Alaska, British Columbia, and Washington state have all exhibited growth rates of up to 17 or 20 percent annually (Estes 1990, Jameson and Jeffries 1999, Jameson and Jeffries 2005), but the mainland southern sea otter population has grown much more slowly. From the early 1900s to the mid-1970s, it increased at about 5 percent annually (Estes 1990). From 1983 to 1995, annual growth averaged about 6 percent. The population declined during the late 1990s, resumed growth in the early 2000s, and ceased growth again beginning in 2008. Growth rates at San Nicolas Island averaged approximately nine percent annually from the early 1990s to the mid-2000s, but these higher rates have never been seen in the mainland population as a whole.

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of three elements: the minimum population estimate (N_{min}); half the maximum net productivity rate (0.5 R_{max}); and a recovery factor (F_r). This can be written as: PBR = (N_{min}) (½ of R_{max})(F_r).

For the southern sea otter stock, N_{min} = 2,762, R_{max} = 6 percent, and F_r = 0.1. A recovery factor of 0.1 is used for the southern sea otter stock because the population is currently decreasing, N_{min} is below 5,000, and the species is vulnerable to a natural or human-caused catastrophe, such as an oil spill, due to its restricted geographic distribution in nearshore waters (Taylor *et al.* 2002). Therefore, the PBR for the southern sea otter stock is 8 animals. It should be noted that because sea otters are expressly excluded from the provisions in the MMPA concerning incidental take from commercial fisheries (see section 118(4)), PBR does not apply to the governance of incidental take of southern sea otters in commercial fisheries.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Sea otters are susceptible to entanglement and drowning in gill nets. The set gill net fishery in California is estimated to have killed from 48 to 166 (average of 103) southern sea otters per year from 1973 to 1983 (Herrick and Hanan 1988) and 80 sea otters annually from June 1982 to June 1984 (Wendell *et al.* 1986). A 1991 closure restricted gill and trammel nets to waters deeper than 30 fathoms (55 meters) throughout most of the southern sea otter's range (California Senate Bill No. 2563). In 1990, NMFS started an observer program using at-sea observers, which provided data on incidental mortality rates relative to the distribution of fishing effort. The observer program was active through 1994, discontinued from 1995 to 1998, and reinstated in the Monterey Bay area in 1999 and 2000 because of concern over increased harbor porpoise mortality. Based on a detailed analysis of fishing effort, sea otter distributions by depth, and regional entanglement patterns during observed years, NMFS estimated southern sea otter mortality in the halibut set gill net fishery to have been 64 in 1990, zero from 1991 to 1994, 3 to 13 in 1995, 2 to 29 in 1996, 6 to 47 in 1997, 6 to 36 in 1998, 5 in 1999, and zero in 2000 (Cameron and Forney 2000; Carretta 2001; Forney *et al.* 2001). The increase in estimated mortality from 1995 to 1998 was attributed to a shift in set gill net fishing effort into areas where sea otters are found in waters deeper than 30 fathoms (55 meters).

Fishing with gill nets has since been further restricted throughout the range of the southern sea otter. An order prohibiting the use of gill and trammel nets year-round in ocean waters of 60 fathoms or less from Point Reyes, Marin County, to Point Arguello, Santa Barbara County was made permanent in September 2002. In the waters south of Point Arguello, the Marine Resources Protection Act of 1990 (California Constitution Article 10B) defined a Marine Resources Protection zone in which the use of gill and trammel nets is banned. This zone includes waters less than 70 fathoms (128 meters) or within one nautical mile (1.9 kilometers), whichever is less, around the Channel Islands, and waters generally within three nautical miles (5.6 kilometers) offshore of the mainland coast from Point Arguello to the Mexican border. Although sea otters occasionally dive to depths of 328 feet (100 meters), the vast majority (>99 percent) of dives are to depths of 131 feet (40 meters) or less.[1] Therefore, because of these restrictions and the current extent of the southern sea otter's range, southern sea otter mortalities resulting from entanglement in gill nets are believed to be currently at or near zero. An estimated 50 vessels participate in the CA halibut/white seabass and other species set gillnet (>3.5" mesh) fishery (75 FR 68468, November 8, 2010). Approximately 30 vessels participate in the CA yellowtail, barracuda, and white seabass drift gillnet fishery (mesh size ≥3.5" and <14") (75 FR 68468, November 8, 2010). Approximately 45 vessels participate in the CA thresher shark/swordfish drift gillnet fishery (≥14" mesh).

Three southern sea otter interactions with the California purse seine fishery for Northern anchovy and Pacific sardine have been documented. In 2005, a contract observer in the NOAA Fisheries California Coastal Pelagic Species observer program documented the incidental, non-lethal capture of two sea otters that were temporarily encircled in a purse seine net targeting Northern anchovy but escaped unharmed by jumping over the corkline. In 2006, a contract observer in the same program documented the incidental, non-lethal capture of a sea otter in a purse seine net targeting Pacific sardine. Again, the sea otter escaped the net at end of the haul without assistance.[2] Based on these observations and the levels of observer coverage in each year, 58 and 20 such interactions are estimated to have occurred in the CA sardine purse seine fishery in 2005 and 2006, respectively, but these estimates are accompanied by considerable uncertainty because of the low levels of observer coverage.[3] There are no data available to assess whether sea otter interactions with purse-seine gear are currently resulting in mortality or serious injury. The 2007 list of fisheries reorganized purse seine fisheries targeting anchovy and sardines into the "CA anchovy, mackerel, sardine purse seine" fishery. An estimated 65 vessels participate in the CA anchovy, mackerel, and sardine purse seine fishery (75 FR 68468, November 8, 2010).

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[1] Personal communication, M. Tim Tinker, 2008. Research Wildlife Biologist, USGS-Western Ecological Research Center, Santa Cruz Field Station, and Department of Ecology & Evolutionary Biology, University of California at Santa Cruz, 100 Shaffer Road, Santa Cruz, CA 95060.
[2] Personal communication, Lyle Enriquez, 2006. Southwest Regional Office, NOAA, U.S. National Marine Fisheries Service, 501 West Ocean Boulevard, Long Beach, CA 90802.
[3] Personal communication, Jim Carretta, 2008. Southwest Fisheries Science Center, NOAA, U.S. National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

The potential exists for sea otters to drown in traps set for crabs, lobsters, and finfish, but only limited documentation of mortalities is available. Hatfield and Estes (2000) summarize records of 18 sea otter mortalities in trap gear, 14 of which occurred in Alaska. With the exception of one sea otter, which was found in a crab trap, all of the reported Alaska mortalities involved Pacific cod traps and were either recorded by NMFS observers or reported to NMFS observers by fishers. Four sea otters are known to have died in trap gear in California: one in a lobster trap near Santa Cruz Island in 1987; a mother and pup in a trap with a 10-inch diameter opening (presumed to be an experimental trap) in Monterey Bay in 1987; and one in a rock crab trap 0.5 miles off Pt. Santa Cruz, California (Hatfield and Estes 2000). In 1995, the U.S. Geological Survey began opportunistic efforts to observe the finfish trap fishery in California. These efforts were supplemented with observations by the California Department of Fish and Game (CDFG) in 1997 and two hired observers in 1999. No sea otters were found in the 1,624 traps observed (Hatfield and Estes 2000). However, a very high level of observer coverage would be required to see any indication of trap mortality, even if mortality levels were high enough to substantially reduce the rate of population growth (Hatfield *et al.* 2011).

Controlled experiments conducted by the U.S. Geological Survey and the Monterey Bay Aquarium demonstrated that sea otters would enter a baited commercial finfish trap with inner trap funnel openings of 5.5 inches in diameter (Hatfield and Estes 2000). Hatfield *et al.* (2011) confirmed that some sea otters exposed to finfish, lobster, and mock Dungeness crab traps in a captive setting would succeed in entering them. Based on experiments with carcasses and live sea otters, they concluded that finfish traps with 5-inch-diameter circular openings would largely exclude diving sea otters; that circular openings of 5.5 to 6 inches in diameter and rectangular openings 4 inches high (typical of Dungeness crab pots) would allow the passage of sea otters up to about 2 years of age; and that the larger fyke openings of spiny lobster pots and finfish traps with openings larger than 5 inches would admit larger sea otters. Reducing the fyke-opening height of Dungeness crab traps by one inch (to 3 inches) would exclude nearly all diving sea otters while not significantly affecting the number or size of harvested crabs (Hatfield *et al.* 2011).

Since January 2002, CDFG has required 5-inch sea-otter-exclusion rings to be placed in live-fish traps used along the central coast from Pt. Montera in San Mateo County to Pt. Arguello in Santa Barbara County. No rings are required for live-fish traps used in the waters south of Point Conception, and no rings are currently required for lobster or crab traps regardless of their location in California waters.

Estimates of the number of vessels participating in pot and trap fisheries off California are given in parentheses: CA Dungeness crab pot (534); CA coonstripe shrimp, rock crab, tanner crab pot or trap (305); CA spiny lobster (225); and CA nearshore finfish live trap/hook-and-line (93) (75 FR 68468, November 8, 2010).

Available information on incidental mortality and serious injury of southern sea otters in commercial fisheries is very limited. Due to lack of observer coverage, a science-based estimate of the annual rate of mortality and serious injury cannot be determined. Fisheries believed to have the potential to kill or injure southern sea otters are listed in Table 1. It should be noted that, due to the nature of potential interactions (entrapment or entanglement followed by drowning), serious injury is unlikely to be detected prior to the death of the animal.

Table 1. Summary of available information on incidental mortality and serious injury of southern sea otters in commercial fisheries that might take southern sea otters.

Fishery Name	Year(s)	Number of Vessels	DataType	Percent Observer Coverage[1]	Observed Mortality/ Serious Injury	Estimated Mortality/ Serious Injury	Mean Annual Takes
CA halibut/white seabass and other species set gillnet (>3.5”)	2006 2007 2008 2009 2010	50	n/a obs. obs. n/a obs.	not obs. <1% 17.8% not obs. 12.5%	n/a 0 0 n/a 0	0	0
CA yellowtail, barracuda, and white seabass drift gillnet (≥3.5” and <14”)	2006 2007 2008 2009 2010	30	n/a	not obs.	n/a	n/a	n/a
CA thresher shark/swordfish drift gillnet fishery (≥14”)	2006 2007 2008 2009 2010	45	obs.	18.5% 16.4% 13.5% 13.3% 11.9%	0 0 0 0 0	0	0
CA anchovy, mackerel, and sardine purse seine	2006 2007 2008 2009 2010	65	obs.	~5% from 2006-2008 not obs.[2]	0	n/a	n/a
CA Dungeness crab pot	2006 2007 2008 2009 2010	534	n/a	not obs.	n/a	n/a	n/a
CA coonstripe shrimp, rock crab, tanner crab pot or trap	2006 2007 2008 2009 2010	305	n/a	not obs.[2]	n/a	n/a	n/a
CA spiny lobster	2006 2007 2008 2009 2010	225	n/a	not obs.[2]	n/a	n/a	n/a
CA nearshore finfish live trap/hook and line	2006 2007 2008 2009 2010	93	n/a	not obs.[2]	n/a	n/a	n/a
Unknown hook and line	2006 2007 2008 2009 2010	n/a	stranding data	-	0 2 0 0 0	≥2	≥0.4

[1] Vessel numbers are from the final List of Fisheries for 2011 (75 FR 68468, November 8, 2010).

[2] Personal communication, Jim Carretta, 2010, 2011. Southwest Fisheries Science Center, NOAA, U.S. National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

[3] This fishery is classified as a Category III fishery (75 FR 68468, November 8, 2010). Category III fisheries are not required to accommodate observers aboard vessels due to the remote likelihood of mortality and serious injury of marine mammals.

Note: n/a indicates that data are not available or are insufficient to estimate mortality/serious injury.

Other Mortality

A study of 3,105 beach-cast carcasses salvaged from 1968 through 1999 identified several patterns in the strandings that occurred during periods of population decline: increased percentages of (1) prime-age (3 to 10 years) animals, (2) deaths caused by white shark bites, (3) carcasses recovered in spring and summer, and (4) animals for which the cause of death was unknown (Estes *et al.* 2003). Analysis of beach-cast carcasses recovered from October 1997 to May 2001 showed that 13 percent of the mortalities resulted directly or indirectly from infection by acanthocephalans of the genus *Profilicollis* (Mayer *et al.* 2003). Common causes of death identified for fresh beach-cast carcasses necropsied from 1998 to 2001 included protozoal encephalitis, acanthocephalan-related disease, shark attack, and cardiac disease (Kreuder *et al.* 2003, Kreuder *et al.* 2005). Encephalitis caused by *Toxoplasma gondii* was associated with shark attack and heart disease, and these causes of death were more common in prime-age animals than in juveniles (Kreuder *et al.* 2003). Diseases (due to parasites, bacteria, fungi, or unspecified causes) were identified as the primary cause of death in 63.8 percent of the sea otter carcasses examined (Kreuder *et al.* 2003).

An unusually high number of stranded southern sea otters was recovered in 2003, prompting declaration of an Unusual Mortality Event for the period from 23 May to 1 October 2003. In 2003, the relative number of strandings exceeded 10 percent of the spring count. No one cause appears to have been responsible for the increase in mortality, although intoxication by domoic acid produced by blooms of the alga *Pseudonitzchia australis* appears to have been an important contributor (Jessup *et al.* 2004). Relative mortality has remained nearly as high in subsequent years. The relative number of strandings from 2006 through 2010 averaged 9.7 percent of the spring count (Figure 3). This average includes the record high relative number of strandings, which reached 11.2 percent of the spring count in 2010.

Shootings and boat strikes are relatively low but persistent sources of anthropogenic mortality. Other rare sources of anthropogenic mortality include debris entanglement and complications associated with research activities. During the period from 2006 through 2010, 2 sea otters were shot, 11 were suspected to have been struck by boats, 1 was entangled in debris, and 3 died as a result of complications related to research activities (U.S. Geological Survey and CDFG unpub. data). Total observed mortality (i.e., from 2006-2010) due to direct anthropogenic causes, excluding fisheries, is 17, yielding an estimated mortality of ≥17 and a mean annual mortality of ≥3.4.

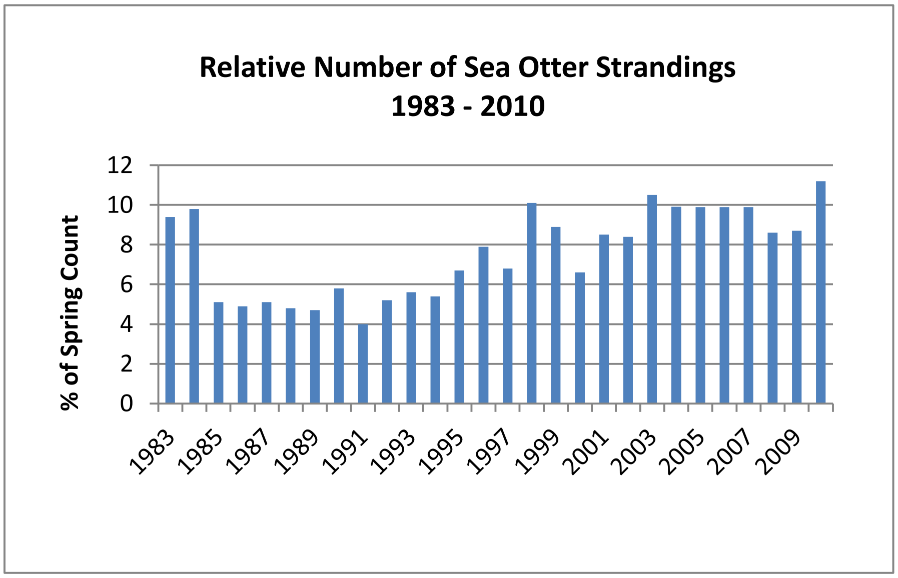

Figure 3. Strandings of southern sea otters relative to the spring count, 1983-2010. Data source: U.S. Geological Survey unpub. data.

It should be noted that mean annual mortalities reported here and in Table 1 are minimum estimates. Documentation of these sources of mortality comes primarily from necropsies of beach-cast carcasses. Because it is unknown to what extent the levels of human-caused mortality documented in beach-cast carcasses are representative of the relative contributions of known causes or of human-caused mortality as a whole, we are unable to give upper bounds for these estimates. Disease has been identified as the primary cause of death in more than half of the beach-cast carcasses necropsied (Kreuder *et al.* 2003), but the anthropogenic contribution to disease levels in sea otters is currently unknown. Therefore, animals that died of disease are not included in the number of mortalities reported here.

STATUS OF STOCK

The southern sea otter is designated a fully protected mammal under California State law (California Fish and Game Code §4700) and was listed as a threatened species in 1977 (42 FR 2965) pursuant to the federal Endangered Species Act, as amended (16 U.S.C. 1531 et seq.). As a consequence of its threatened status, the southern sea otter is considered by default to be a "strategic stock" and "depleted" under the MMPA.

The status of the southern sea otter in relation to its optimum sustainable population (OSP) level has not been formally determined, but population counts are well below the estimated lower bound of the OSP level for southern sea otters, about 8,400 animals (U.S. Fish and Wildlife Service 2003), which is roughly 50 percent of the estimated carrying capacity of California (Laidre *et al.* 2001). Because of the lack of observer data for several fisheries that may interact with sea otters, it is not possible to make a science-based determination of whether the total fishery mortality and serious injury for sea otters is insignificant and approaching a zero mortality and serious injury rate.

Habitat Issues

Sea otters are particularly vulnerable to oil contamination (Kooyman and Costa 1979; Siniff *et al.* 1982), and oil spill risk from large vessels that transit the California coast remains a primary threat to the southern sea otter. Studies of contaminants have documented accumulations of dichlorodiphenyltrichloro-ethane (DDT), dichlorodiphenyl-dichloroethylene (DDE) (Bacon 1994; Bacon *et al.* 1999), and polychlorinated biphenyls (PCBs) in stranded sea otters (Nakata *et al.* 1998), as well as the presence of butyltin residues, which are known to be immunosuppressant (Kannan *et al*. 1998). Kannan *et al.* (2006, 2007) found a significant association between infectious diseases and elevated concentrations of perfluorinated contaminants and polychlorinated biphenyls (PCBs) in the livers of sea otters, suggesting that chemical contaminants may play a role in driving patterns of sea otter mortality. Food limitation and nutritional deficiencies may also contribute to sea otter mortality, either directly or as a consequence of dietary specialization, by increasing levels of exposure to protozoal pathogens (Bentall 2005, Tinker *et al.* 2006, Tinker *et al.* 2008, Johnson *et al.* 2009). Harmful algal blooms are an apparently increasing source of mortality. The ocean discharge of freshwater microcystins (persistent biotoxins produced by cyanobacteria of the genus *Microcystis*) has been linked to the deaths of 21 sea otters, with the earliest known case occurring in 1999 and the greatest number of cases occurring in 2007 (Miller *et al.* 2010).

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