ABOUT THIS MAP

Figure 4.3 displays the current distribution and density of southern sea otters (*Enhydra lutris nereis*) along the California coast, based on the running -year average (2005-2007) of annual range-wide counts. Data are summarized for 17 contiguous coastal habitat sections, representing sea otter habitat (defined as the area of sea floor stretching from the low tide line to the 40 m isobath) divided at boundaries between different benthic substrate types (sandy, rocky or mixed). The current range of the sea otter in California extends from Half Moon Bay in the north to Santa Barbara in the south.

DATA SOURCES AND METHODS

Data were collected by wildlife biologists from the U.S. Department of the Interior (currently the U.S. Geological Survey, Biological Resources Division, Western Ecological Research Center), the California Department of Fish and Game (CDFG), University of California Santa Cruz, the Monterey Bay Aquarium, and trained volunteers during range-wide censuses, 2005-2007. Each census is conducted over a two week period, with the entire range surveyed using one of two methodologies: shore-based counts are made by pairs of experienced observers using binoculars and telescopes, and account for most of the range (~70% of the population), while those areas that are difficult to access or view from shore are counted by plane. Aerial counts are made by 3 experienced observers from a Partenavia PN68 Observer provided by the Department of Air Services, CDFG, flown at an altitude of 200' (60 m) above sea level and at a typical air speed of 90 kts. In the case of both shore-based and aerial-based counts, all sea otter sightings are recorded and entered into a GIS database: a single observation consists of a geo-location, number of animals, behavior, and presence/absence of a kelp canopy, as well as ambient weather and viewing conditions. Although otters cannot be reliably identified as male or female during the census, they are classified as either "independents" (i.e. > six months of age) or "dependent pups" (<6 months of age). Supplementary information suggest that regions without dependent pups present are predominantly male areas, although some juvenile and sub-adult females also utilize these areas.

Range-wide censuses are conducted twice annually, in late spring (May) and early autumn (October), but the late spring counts are considered to be the more reliable of the two data sets and are thus used as the primary indicator of change in population distribution and abundance. Because these data represent minimum population counts, with no associated correction factor or variance estimate, they include significant (but unquantifiable) observation error, probably caused mostly by year-to-year variance in survey conditions. Accordingly, in order to reduce potential influences from the vagaries of any single census, data are presented as 3-year running averages. The data set is provided by the USGS–Western Ecological Research Center, Santa Cruz Field Station: contact Brian Hatfield, Tim Tinker or Mike Kenner (831-459-2357) for more information.

RESULTS AND DISCUSSION

The southern sea otter (*Enhydra lutris nereis*) is one of three subspecies: southern (*E. l. nereis*), northern (*E. l. kenyoni*), and Russian (*E. l. lutris*) and is listed as "threatened" under the Federal Endangered Species Act, "depleted" under the Marine Mammal Protection Act (MMPA), and "fully protected" under California Fish and Game Code. The southern sea otter inhabits the nearshore waters of the central California coast; at present the range extends from about Half Moon Bay in the north to Santa Barbara in the south. A small, satellite population of approximately 20-40 animals also occurs at San Nicolas Island, the result of a translocation effort in the late 1980's (Rathbun *et al.,* 2000). Although sea otters are occasionally sighted outside of this range (as far North as Pt. Reyes Headlands and Bodega Bay, and as far south as Ventura and the Channel Islands), these sightings generally represent the transient movements of individual animals, almost always males, and are not considered part of the permanent range (defined as habitat occupied by three or more sea otters for at least three consecutive years). Range expansion continues to occur both to the north and south, with more rapid range expansion occurring to the south (Tinker *et al.,* 2006a). Since the mid 1990s, when otters moved south of Point Conception, the distribution at the southern end of the range has been particularly variable from year to year (Harris, pers. comm.).

Sea otters generally inhabit rocky shorelines with kelp beds, but also utilize open water habitats, sandy/soft bottom areas, and tidal estuaries. When resting, otters tend to aggregate in "rafts" in kelp beds, but may occasionally haul out on exposed

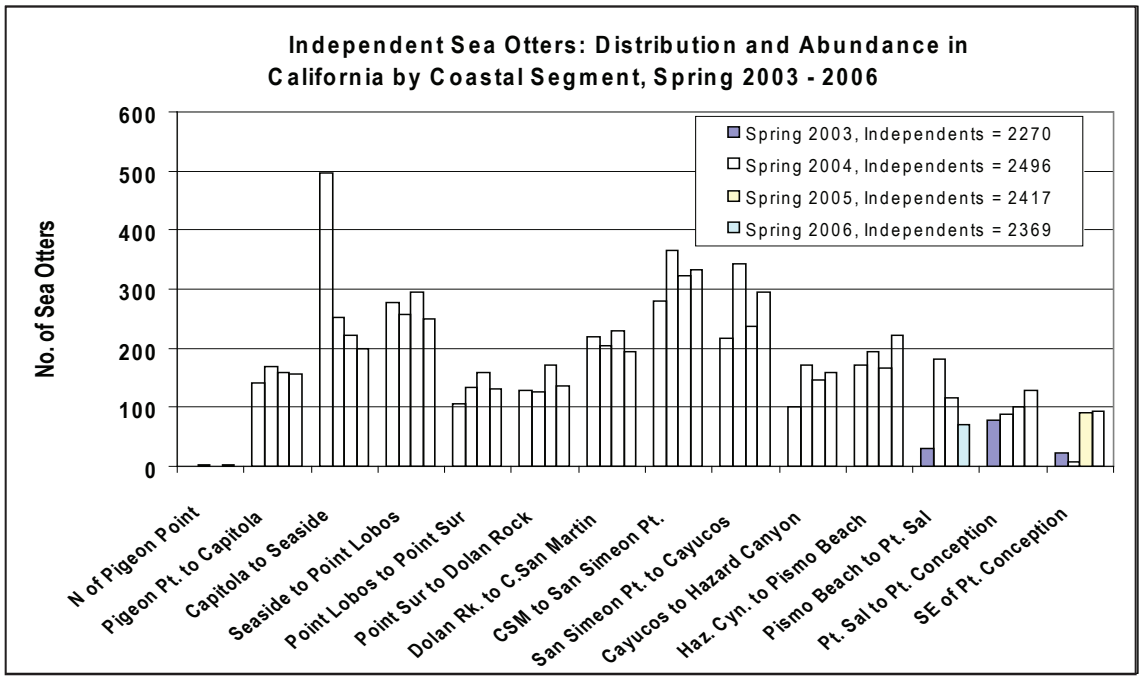

Figure 4.4. Independent southern sea otters: distribution and abundance in California by coastal segment, spring 2003-2006. http://www.werc.usgs.gov/otters/ca-surveyspr2006.htm

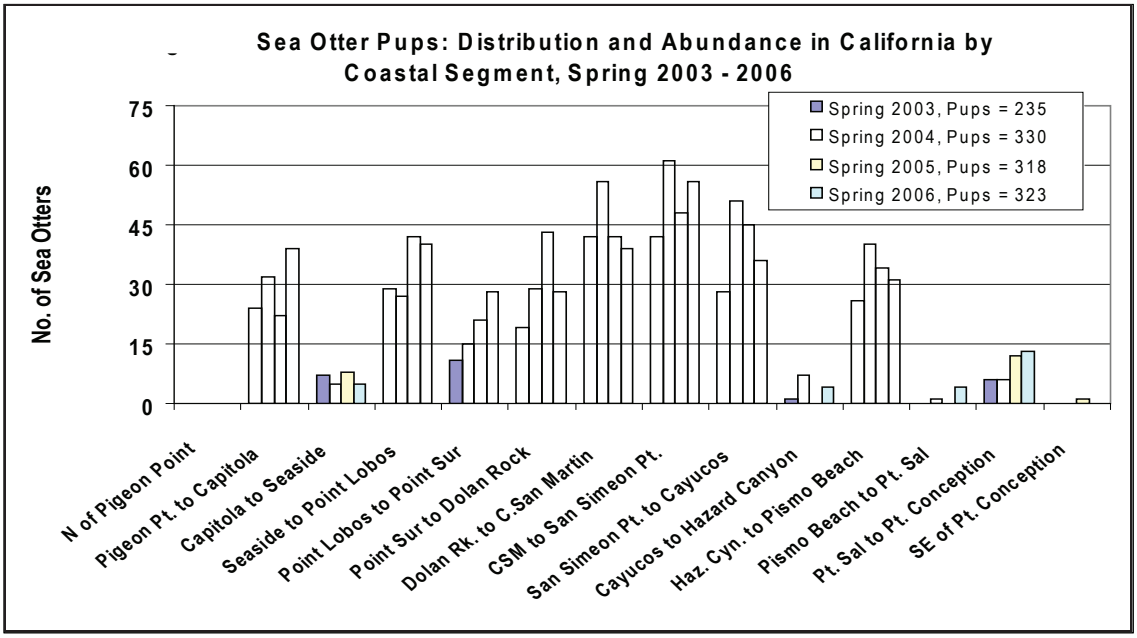

Figure 4.5. Southern sea otter pups: distribution and abundance of in California by coastal segment, spring 2003-2006. http://www.werc.usgs.gov/otters/ca-surveyspr2006.htm

rocky reefs, offshore rocks, and other areas protected from disturbance (Tinker, pers. comm.). Sea otters prey upon a wide variety of benthic marine invertebrates, including crabs, urchins, clams, mussels, abalone, marine snails, marine worms, sea stars, sand dollars, squid and octopus, although individual animals tend to specialize on a sub-set of the population diet (Estes *et al.,* 2003b; Tinker *et al.,* 2006a; Tinker *et al.,* 2007). Although sea otters occasionally make dives of up to 100 m, the vast majority of feeding dives (~99%) occur in waters less than 40 m in depth (Tinker *et al.,* 2006a): accordingly, sea otter habitat is typically defined out to the 40 m isobath (Laidre *et al.,* 2000). Dive

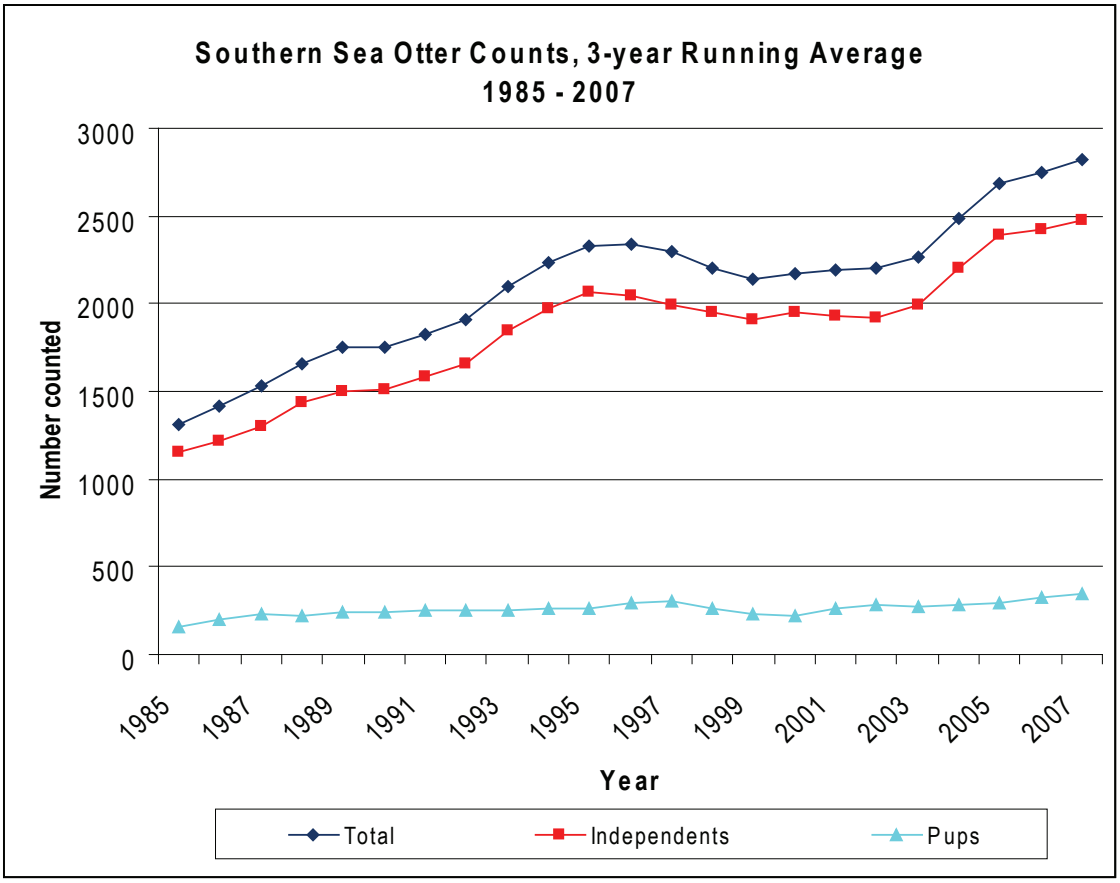

Figure 4.6. Number of southern sea otters counted during spring surveys, plotted as 3-year running averages from 1985-2007. Reprinted with permission from the USGS Western Ecological Research Center. http://www.werc.usgs.gov/otters/ca-survey3yr.html

depth and dive pattern vary by sex (males tend to make dives >25 m more frequently than females), geographic location and diet specialization (see Tinker *et al.,* 2006a; Tinker *et al.,* 2007).

Sea otter abundance varies considerably across the range, with higher densities mostly occurring in the center part of the range (Monterey peninsula - Estero Bay), where sea otters have been present for the longest (Figure 4.4). Sea otter densities tend to be most stable from year-to-year in rocky, kelp-dominated areas that are primarily occupied by females, dependent pups and territorial males. In contrast, sandy and soft-bottom habitats (in particular Monterey Bay, Estero Bay, and Pismo Beach – Pt. Sal) tend to be occupied by males and sub-adult animals of both sexes (but rarely by adult females and pups; see Figure 4.5), and these areas are more variable in abundance from year to year (Figure 4.4). This variation is apparently driven in part by the long-distance movements and seasonal redistribution of males (Tinker *et al.,* 2006b). The variability of counts at the south end of the range is also related to seasonal movements: many males migrate to the range peripheries during the winter and early spring, apparently to take advantage of more abundant prey resources, but then return to the range center during the period when most breeding occurs (June - November) in search of estrous females (Bonnell *et al.,* 1983; Jameson, 1989; Tinker *et al.,* 2006a, b).

Because the sea otter survey data consist of uncorrected counts, they do not represent population abundance estimates, but rather are used to assess trends. From 1983 until 2007 the spring population count increased from 1,277 animals to 3,026 animals (http://www.werc.usgs.gov/otters/ca-surveydata.html). However, the pattern of change was highly inconsistent, with periods of growth, stability and decline. The 3-year running average, the index used by management agencies to reduce the influence of variable survey conditions and assess long-term population trends,

indicates that after a period of decline (1995-2000), the population has now resumed recovery, with an average growth rate of approximately 5% per year over the 2001-2007 period (see Figure 4.6). It is important to note that most of this increase has occurred at the south end of the range (south of Estero Bay), with a more sluggish rate of growth in the north and center of the range where densities are highest, suggesting that sea otters may be approaching local carrying capacity in some areas (Tinker *et al.,* 2006b).

Estes *et al.,* (2003a) reported that elevated mortality appeared to be the main reason for both sluggish growth and periods of decline in southern sea otters. A period of decline from 1976 to 1984 was likely due to incidental mortality in set-net fisheries (Estes *et al.,* 2003a). An analysis by Tinker *et al.,* (2006b) indicated that increased mortality of sub-adult and prime-age females, particularly in the northern and center part of the range, was responsible for the period of decline from 1995-2000. Based on analysis of beach-cast carcasses, it appears that the two causes of death most important for limiting population growth are white shark attacks and infectious disease (Gerber *et al.,* 2004), with the prevalence of disease appearing to be unusually high (Thomas and Cole, 1996; Estes *et al.,* 2003a; Kreuder *et al.,* 2003; Hanni *et al.,* 2003). One such disease is toxoplasmosis, caused by the protozoan *Toxoplasma gondii*, a parasite that is shed in the feces of both wild and domestic cats (Miller *et al.,* 2002). Other sources of disease in sea otters include *Sarcocystus neurona* (another protozoan parasite), acanthocephalan worms (*Profilicollis* spp.) (Mayer *et al.,* 2003), bacterial and viral infections, domoic acid toxicity and cardiac lesions (Krueder *et al.,* 2005). Food limitation and nutritional deficiencies may also play a role in driving patterns of disease mortality (Tinker, pers. comm.), as well as the degree of exposure to chemical contaminants such as PCBs (Kannan *et al.,* 2006).

Due to its small population size and coastal distribution, the southern sea otter population is especially vulnerable to human disturbance, competition with fisheries, point-source and non-point source pollution (including both chemical contaminants and “pathogen pollution”), and the threat of a major oil spill. Other sources of human related causes of mortality include illegal shooting, boat strikes, capture and relocation efforts. In April 2003, the U.S. Fish and Wildlife Service released its recovery plan for the southern sea otter. The recovery plan identifies two main threats to the southern sea otter: (1) habitat degradation, which includes oil spills and the impacts from other environmental contaminants; and (2) human impacts, which includes shooting, entanglement in fishing gear, and harassment. As a result of their susceptibility to disease and contaminants, and their status as keystone predators in kelp forest ecosystems (Estes *et al.,* 2004), southern sea otters represent an ideal sentinel of marine ecosystem health in coastal California (Jessup *et al.,* 2004; Conrad *et al.,* 2005).