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# California Sea Otter (*Enhydra lutris nereis*) Census Results, Spring 2018

Data Series 1097

U.S. Department of the Interior
U.S. Geological Survey

**Cover:** Photograph showing raft of southern sea otters (*Enhydra lutris nereis*) in Morro Bay, California. Photograph by Brian Hatfield, U.S. Geological Survey, March 8, 2018.

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U.S. Geological Survey, Reston, Virginia: 2018

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Suggested citation:
Hatfield, B.B., Yee, J.L., Kenner, M.C., Tomoleoni, J.A., and Tinker, M.T., 2018, California sea otter (*Enhydra lutris nereis*) census results, spring 2018: U.S. Geological Survey Data Series 1097, 10 p., https://doi.org/10.3133/ds1097.

ISSN 2327-638X (online)

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## Conversion Factors

International System of Units to U.S. customary units

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| meter (m) | 3.281 | foot (ft) |
| meter (m) | 1.094 | yard (yd) |
| kilometer (km) | 0.6214 | mile (mi) |

## Datum

Horizontal coordinate information is referenced to the World Geodetic System 1994.

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## Abstract

The 2018 census of southern sea otters (*Enhydra lutris nereis*) was conducted from late April to mid-May along the mainland coast of central California and in April at San Nicolas Island in southern California. The 3-year average of combined counts from the mainland range and San Nicolas Island was 3,128, a decrease of 58 sea otters from the previous year. The 5-year average trend in abundance, including both the mainland range and San Nicolas Island populations, remains positive at 1.3 percent per year. Continuing lack of growth in the range peripheries likely explains the cessation of range expansion.

## Introduction and Methods

A range-wide census is conducted collaboratively each spring by the U.S. Geological Survey, the California Department of Fish and Wildlife, the Monterey Bay Aquarium, and others, to monitor trends in abundance and distribution of the southern sea otter (*Enhydra lutris nereis*), and thus provide State and Federal resource agencies with the information requested for effective management. The standardized census has been conducted and completed annually since 1982, except for 2011, when weather conditions prevented survey completion. The survey entails a combination of aerial and shore-based counts, providing an uncorrected and exhaustive count of the entire range of the sea otter in coastal California. Shore-based counts are used in all areas accessible by ground-based observers, except in regions where otters are often located far offshore (such as shallow, sandy embayments) and, therefore, are more difficult to count reliably from the shore. In these areas, aerial surveys are flown along contiguous transects oriented parallel to the shore and covering all areas between the coastline and the 60-m depth contour. Details of survey methods, as well as data and metadata from this survey and surveys from previous years, are available in Hatfield and others (2018).

The spring 2018 mainland sea otter count began on April 26 and was completed by May 24. Overall viewing conditions this year were good, like those observed during the 2017 spring census (View Score = 2.4, where 0=poor, 1=fair, 2=good, 3=very good, and 4=excellent). The surface canopies of kelp (predominantly *Macrocystis pyrifera*) were (qualitatively) noted by observers to be greater than seasonal normal in most areas of the range, and much greater than those noted during the 2017 spring census. Sea otters along the mainland coast were surveyed from Pillar Point in San Mateo County in the north, to Rincon Point in the south at the Santa Barbara/Ventura County line (fig. 1). A separate, ground-based survey of the sea otter population at San Nicolas Island was completed earlier in the spring (April 13–15) under fair-good survey viewing conditions (View Score = 1.5). *Macrosystis* canopies at San Nicolas Island were estimated to be seasonally normal.


**Figure 1.** Distribution of sea otters (*Enhydra lutris nereis*) along the mainland coast of central California and at San Nicolas Island, 2018.

# California Sea Otter Census Results

## Range-Wide Summary

The Southern Sea Otter Recovery Plan (U.S. Fish and Wildlife Service, 2003) recommends using the 3-year running average of total counts as the official metric for monitoring trends, thereby reducing the influence of anomalously high or low counts from any particular year. The 3-year average of combined counts from the mainland range and San Nicolas Island therefore comprises the official index of relative abundance for southern sea otters, the current value of which is 3,128 (table 1).

## Range-Wide Trends

There is a considerable degree of uncertainty (random variation due to sampling and measurement error) in any 1 year's count, and thus longer-term trends are far more informative than year-to-year differences. We therefore report trends over the past 5 years as $\bar{\lambda}$ (the geometric mean of the annual rate of change λ) and as mean percent change. The annual λ values are computed by dividing the 3-year running average count by the equivalent value from the previous year, and thus λ = 1 indicates a constant population or 0-percent change. Mean percent change is calculated from the mean rate of change as $(\bar{\lambda} - 1) \times 100$ percent.

The 3-year running average count of the mainland population is 3,035, a decrease of 2.2 percent from the previous-year value (table 1). This decrease in the 3-year average is associated with a reduction in the 5-year trend for the mainland to 1.04 percent per year ($\bar{\lambda}$ = 1.01, slightly less than the 2017 $\bar{\lambda}$ value of 1.02). The large number of pups observed in 2018 resulted in a relatively high pup-to-independent ratio of 22.5 (table 1). The 3-year running average total count of the San Nicolas Island population increased to 93 (table 1), which continues a positive trend of about 10.5 percent per year ($\bar{\lambda}$ = 1.10; fig. 2). The overall 5-year trend for southern sea otters (including both mainland and San Nicolas Island populations) is 1.26 percent per year ($\bar{\lambda}$ = 1.01).

## Regional Trends

Regional trends in abundance within the mainland range can vary considerably. The 5-year trend for the center segment of the range, between Seaside and Cayucos (fig. 1), remains positive at 2.9 percent per year ($\bar{\lambda}$ = 1.03), although with high year-to-year variance in raw counts that is probably influenced by counting conditions and relative abundance of kelp. Counts tend to be higher in years with greater kelp canopy due to the tendency of otters to aggregate in kelp beds, thus increasing their probability of being counted during the survey (Drummer and others, 1990). One factor possibly contributing to the positive trend in the central range is the recent increase in availability of sea urchins and mussels (sea otter prey), a phenomenon that likely has several causes including the ecological absence of the predatory sunflower star, *Pycnopodia helianthoides*, from a sea star wasting disease (Burt and others, 2018). This surge in prey availability might explain the larger number of sea otters in this part of the range over the last several years compared to the long-term average. It was hypothesized last year (Tinker and Hatfield, 2017) that the effects of this prey subsidy might have been ending, and although the 2018 survey results are not entirely consistent with this hypothesis, the slowing trend (fig. 3) suggests a limit to the potential growth in this area.

The pattern is different to the north of the central region, with a 5-year trend of -7.6 percent per year ($\bar{\lambda}$ = 0.92). The 5-year trend in the southern region was positive this year (1.8 percent per year with $\bar{\lambda}$ = 1.02, compared to -3.4 percent per year with $\bar{\lambda}$ = 0.97 last year); however, most of this change probably was due to more animals observed in areas with surface kelp canopies (fig. 3). The trends in the northern and southern regions are consistent with elevated observations of shark bite mortality in recent years in these peripheral areas of lower population density (fig. 4). The specific areas where the population trends are most negative (from Pigeon Point to north Monterey Bay, and most areas south of Cayucos; fig. 5) coincide with the areas known for highest shark bite mortality. These areas tend to have little or no kelp canopy and thus represent high-risk areas for sea otters, as the presence of kelp is believed to provide some degree of refuge from shark bite (Tinker and others, 2015; Nicholson and others, 2018).

Although the 2018 range-wide 5-year trend remains slightly positive, population growth was not observed in the areas to the north and in many areas to the south of the central region (areas from which future range expansion would occur; fig. 5; Tinker and others, 2008; Lafferty and Tinker, 2014).

**Table 1.** Summary of spring survey counts of sea otters (*Enhydra lutris nereis*) in California, and 3-year averages, 1990–2018.

[–, no data]

| Year | Mainland range | | | | | | | San Nicolas Island | | | | Range-wide |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Independents (raw count) | Pups (raw count) | Total (raw count) | Pups per 100 independents | Independents (3-year average) | Pups (3-year average) | Total (3-year average) | Independents (raw count) | Pups (raw count) | Total (raw count) | Total (3-year average) | Index of relative abundance |
| 1990 | 1,466 | 214 | 1,680 | 14.6 | 1,514 | 240 | 1,754 | 14 | 3 | 17 | – | – |
| 1991 | 1,700 | 241 | 1,941 | 14.2 | 1,579 | 247 | 1,826 | 14 | 2 | 16 | – | – |
| 1992 | 1,810 | 291 | 2,101 | 16.1 | 1,659 | 249 | 1,907 | 10 | 2 | 12 | 15 | – |
| 1993 | 2,022 | 217 | 2,239 | 10.7 | 1,844 | 250 | 2,094 | 7 | 4 | 11 | 13 | – |
| 1994 | 2,076 | 283 | 2,359 | 13.6 | 1,969 | 264 | 2,233 | 10 | 4 | 14 | 12 | – |
| 1995 | 2,095 | 282 | 2,377 | 13.5 | 2,064 | 261 | 2,325 | 9 | 4 | 13 | 13 | – |
| 1996 | 1,963 | 315 | 2,278 | 16.0 | 2,045 | 293 | 2,338 | 12 | 4 | 16 | 14 | – |
| 1997 | 1,919 | 310 | 2,229 | 16.2 | 1,992 | 302 | 2,295 | 16 | 0 | 16 | 15 | – |
| 1998 | 1,955 | 159 | 2,114 | 8.1 | 1,946 | 261 | 2,207 | 12 | 2 | 14 | 15 | – |
| 1999 | 1,858 | 232 | 2,090 | 12.5 | 1,911 | 234 | 2,144 | 18 | 3 | 21 | 17 | – |
| 2000 | 2,053 | 264 | 2,317 | 12.9 | 1,955 | 218 | 2,174 | 21 | 2 | 23 | 19 | – |
| 2001 | 1,863 | 298 | 2,161 | 16.0 | 1,925 | 265 | 2,189 | 21 | 5 | 26 | 23 | – |
| 2002 | 1,846 | 293 | 2,139 | 15.9 | 1,921 | 285 | 2,206 | 22 | 5 | 27 | 25 | – |
| 2003 | 2,270 | 235 | 2,505 | 10.4 | 1,993 | 275 | 2,268 | 33 | 5 | 38 | 30 | – |
| 2004 | 2,495 | 330 | 2,825 | 13.2 | 2,204 | 286 | 2,490 | 27 | 4 | 31 | 32 | – |
| 2005 | 2,417 | 318 | 2,735 | 13.2 | 2,394 | 294 | 2,688 | 22 | 3 | 25 | 31 | – |
| 2006 | 2,369 | 323 | 2,692 | 13.6 | 2,427 | 324 | 2,751 | 36 | 5 | 41 | 32 | – |
| 2007 | 2,637 | 389 | 3,026 | 14.8 | 2,474 | 343 | 2,818 | 26 | 4 | 30 | 32 | – |
| 2008 | 2,434 | 326 | 2,760 | 13.4 | 2,480 | 346 | 2,826 | 22 | 3 | 25 | 32 | – |
| 2009 | 2,263 | 391 | 2,654 | 17.3 | 2,445 | 369 | 2,813 | 27 | 6 | 33 | 29 | – |
| 2010 | 2,452 | 267 | 2,719 | 10.9 | 2,383 | 328 | 2,711 | 38 | 7 | 45 | 34 | – |
| 2011 | – | – | – | – | – | – | – | 44 | 6 | 50 | 43 | – |
| 2012 | 2,486 | 379 | 2,865 | 15.2 | 2,469 | 323 | 2,792 | 48 | 10 | 58 | 51 | – |
| 2013 | 2,444 | 455 | 2,899 | 18.6 | 2,465 | 417 | 2,882 | 54 | 8 | 62 | 57 | 2,939 |
| 2014 | 2,410 | 469 | 2,879 | 19.5 | 2,447 | 434 | 2,881 | 59 | 9 | 68 | 63 | 2,944 |
| 2015 | 2,688 | 505 | 3,193 | 18.8 | 2,514 | 476 | 2,990 | 54 | 7 | 61 | 64 | 3,054 |
| 2016 | 3,078 | 433 | 3,511 | 14.1 | 2,725 | 469 | 3,194 | 92 | 12 | 104 | 78 | 3,272 |
| 2017 | 2,211 | 396 | 2,607 | 17.9 | 2,659 | 445 | 3,104 | 72 | 9 | 81 | 82 | 3,186 |
| 2018 | 2,438 | 548 | 2,986 | 22.5 | 2,576 | 459 | 3,035 | 81 | 14 | 95 | 93 | 3,128 |
| **5-year (2014-2018) geometric mean annual growth rate (% change):** | | | | | **Mainland: 1.04** | | | **San Nicolas: 10.49** | | **Combined: 1.26** | | |

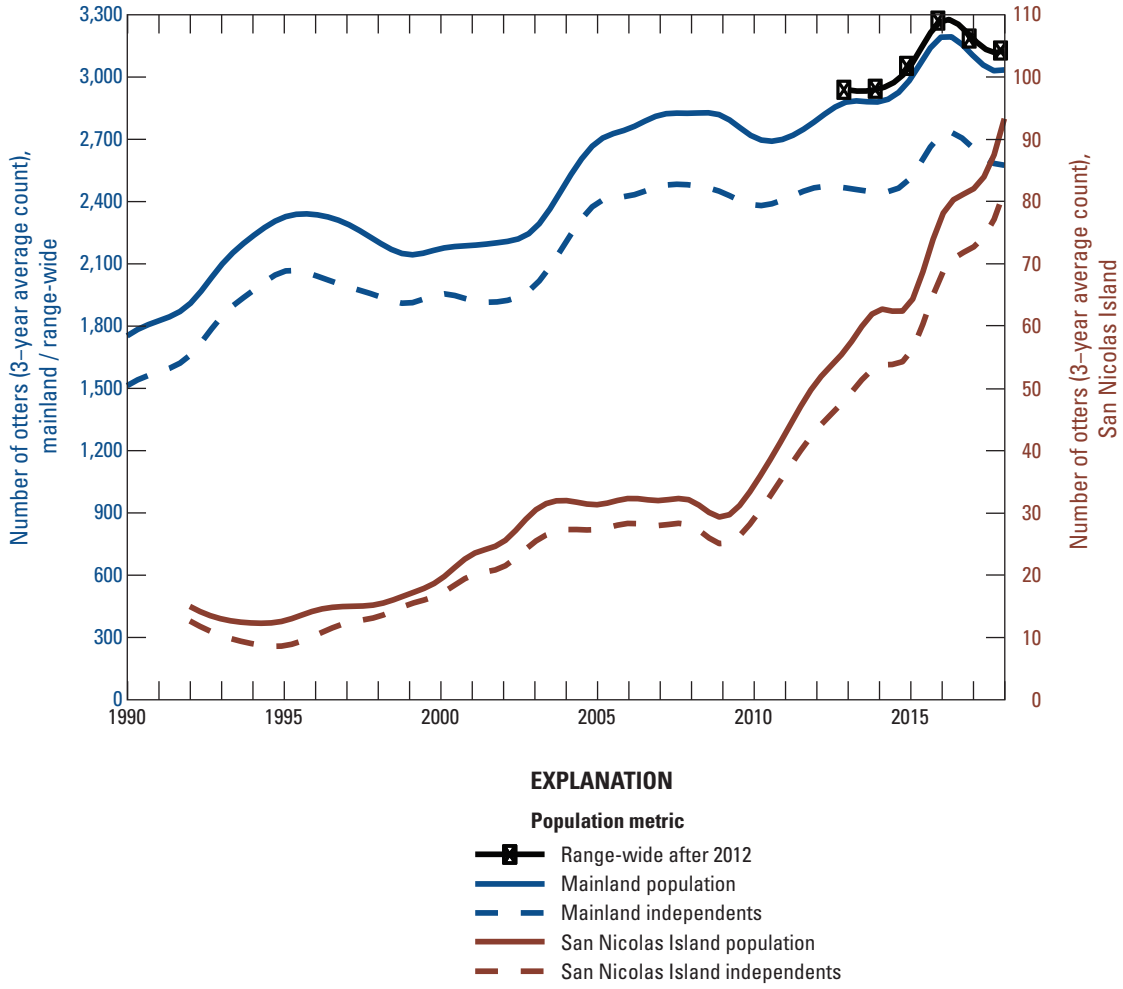


**Figure 2.** Trends in abundance of sea otters (*Enhydra lutris nereis*) in California, based on 3-year running averages of raw counts. Data are shown for all otters (solid lines) and independents (non-pups; dashed lines) for the mainland range (left axis), San Nicolas Island (right axis), and for the entire range after 2012, when counts were combined to create the official index of relative abundance.

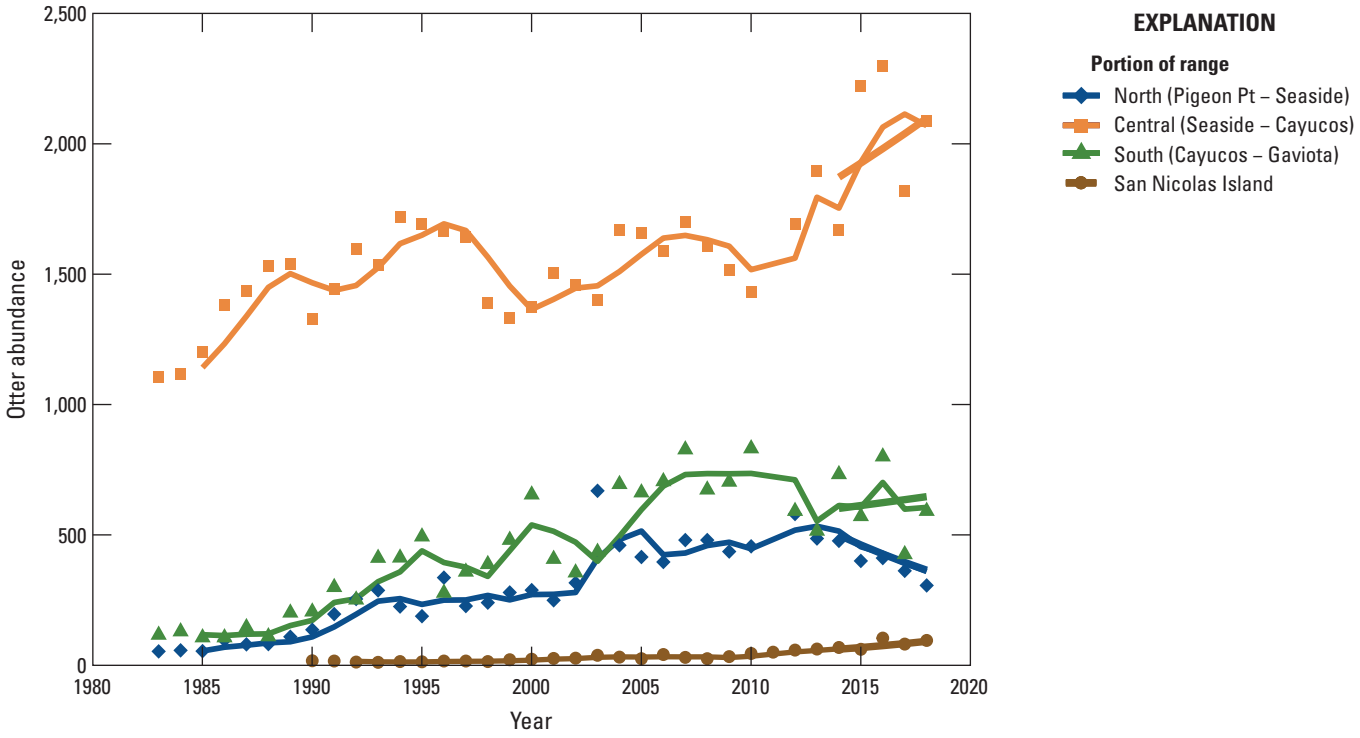


**Figure 3.** Regional trends in abundance of sea otters (*Enhydra lutris nereis*) along the mainland coast, central California, and at San Nicolas Island, southern California. Raw counts and 3-year running averages (solid lines across entire length of each time series) are plotted for the north, central, and southern regions of the mainland coast and for San Nicolas Island. The most recent 5-year average trend (calculated as the geometric mean annual rate of change) is shown as a solid line at the end of each time series.

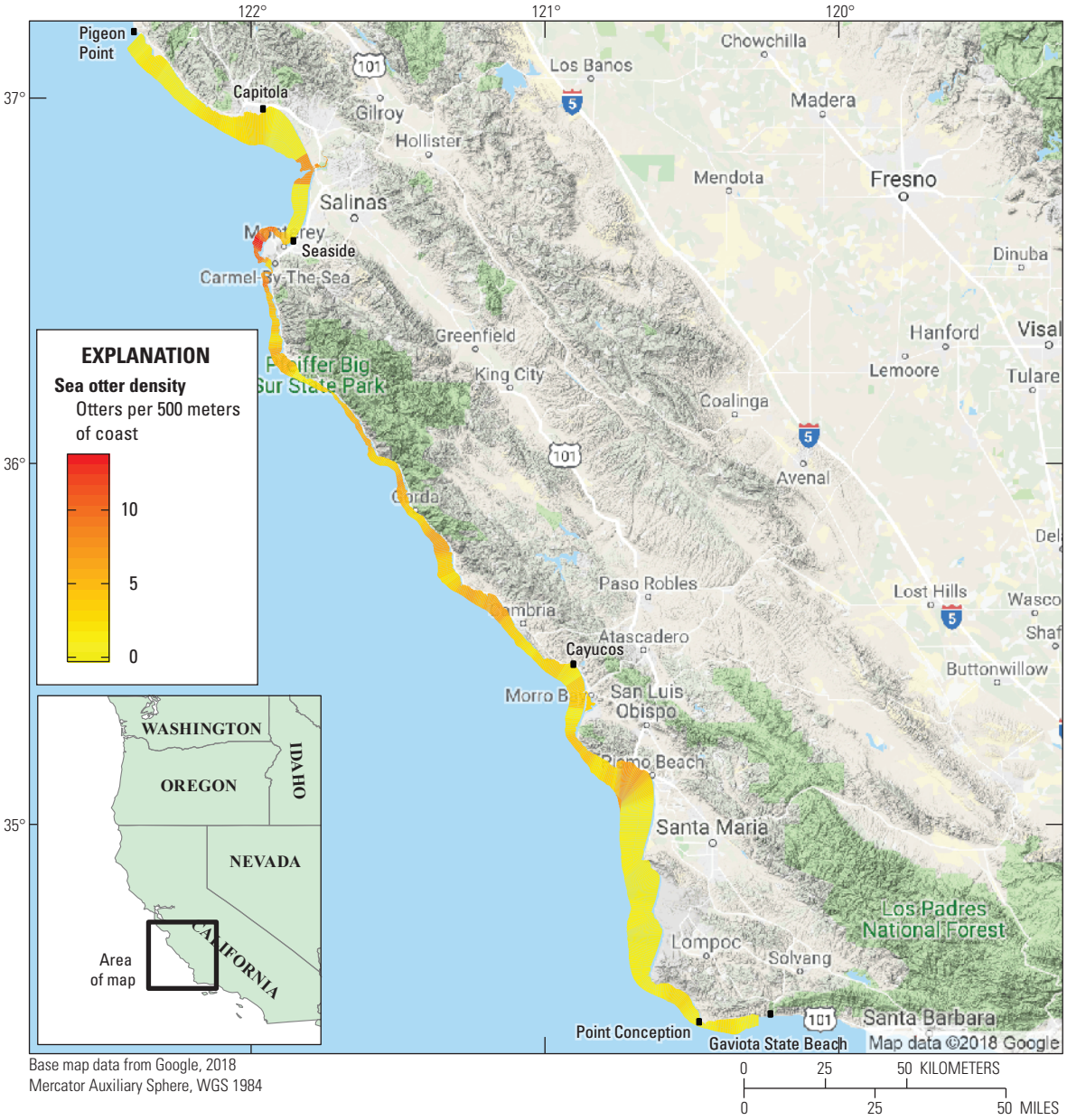


**Figure 4.** Variation in local population density (number of sea otters per 500 meters of coast) of sea otters (*Enhydra lutris nereis*) along the mainland coast, central California. Data for San Nicolas Island are not shown because spatially explicit analyses are not currently conducted for San Nicolas.

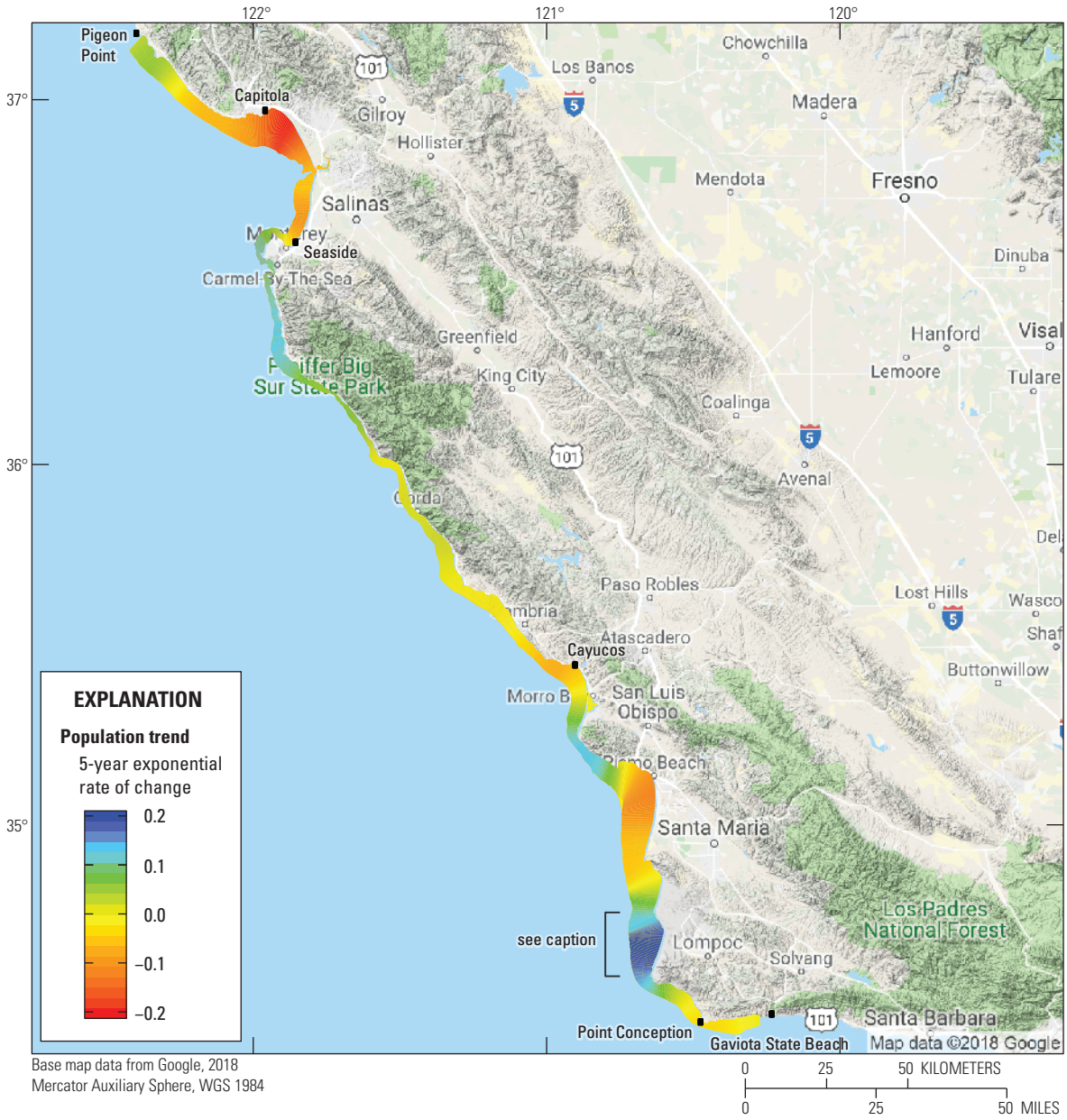


**Figure 5.** Local trends in abundance of sea otters (*Enhydra lutris nereis*) along the mainland coast, central California. Trends represent mean exponential rates of change, log(λ), estimated by fitting a log-linear model to the most recent 5-year time series at each point on the coast, and then spatially smoothing the calculated trend using a 10-kilometer moving window average. Note: the high trend estimates (log(λ) greater than 0.1) along the coast west of Lompoc correspond to an area with very low otter density (less than 6 otters counted on average over the past 5 years), and thus should be interpreted with caution as they reflect a small absolute increase in abundance.

## Geographic Distribution

The mainland subpopulation of the southern sea otter is descended from a small, remnant population in Big Sur that survived the North Pacific fur trade. Because of this historical pattern of depletion and recovery, the population has been slowly expanding to the north and south along the California coast from the source location in Big Sur. The rate of range expansion to the north and south has varied over time, and traditionally the rate of spatial spread has been faster to the south (Lubina and Levin, 1988) than to the north. Because of the one-dimensional nature of the California coast, the location of the northern and southern range boundaries can be described using the "ATOS" line (the "As The Otter Swims" line). The ATOS line is a linear axis described as a series of points spaced regularly at 500-m intervals along the 10-m depth contour. A value of 0 is arbitrarily assigned to the ATOS point at the southern tip of the Golden Gate Bridge, and then ATOS values increase as one moves south along the coast, with ATOS 1,111 corresponding to Point Conception. To standardize descriptions of the sea otter distribution in California, the officially recognized mainland range boundaries are defined as the ATOS points along the coast farthest from the range center at which at least 5 otters are counted within a 10-km stretch of coastline for at least 2 consecutive surveys.

As in 2017, the northernmost sea otters detected in the 2018 mainland survey were near Point Año Nuevo. At the southern end of the mainland range, 35 sea otters were counted southeast of Point Conception, 27 fewer than counted in 2017. Only one sea otter was counted this year southeast of Gaviota State Beach (compared to five last spring), with this animal being observed near Santa Barbara Point. Both the northern and southern limits of the official sea otter range along the mainland coast remained unchanged from 2017 (fig. 6): the northern boundary is about 2.5 km southeast of Pigeon Point (ATOS 162), and the southern boundary is about 7 km west of Gaviota State Beach (ATOS 1153; fig. 1).

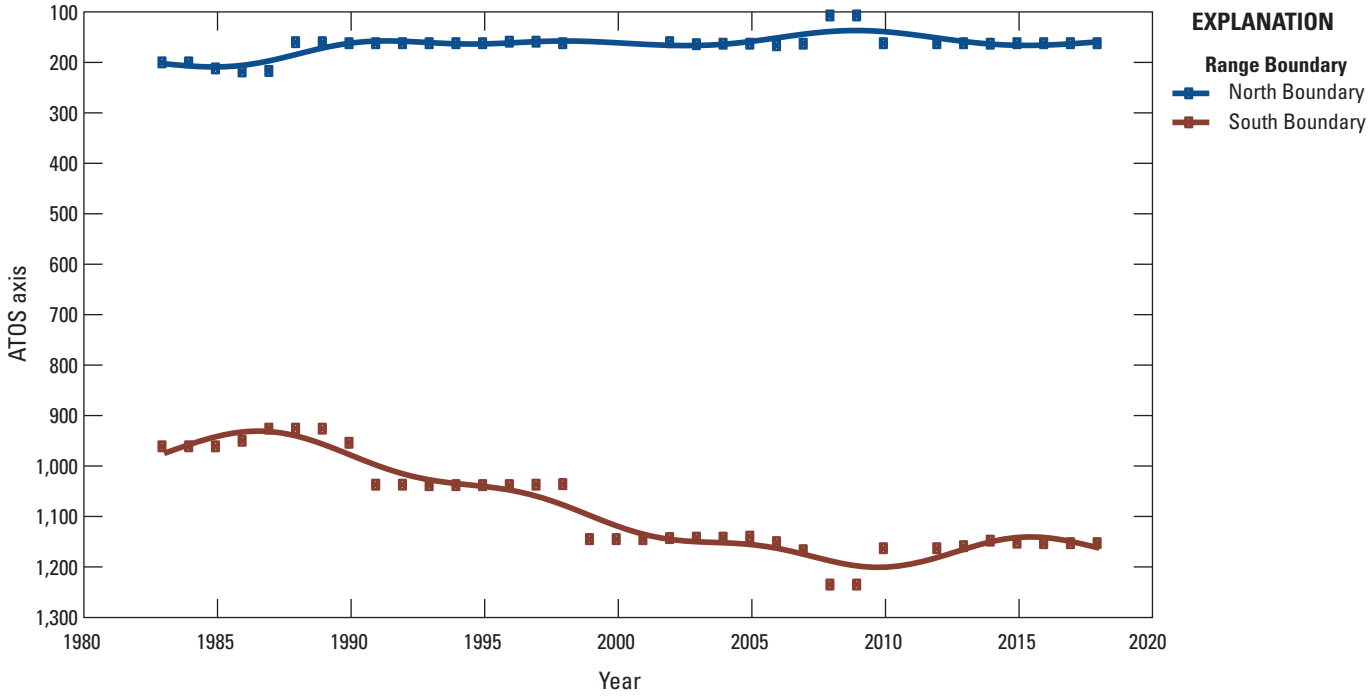


**Figure 6.** Variation over time in the location of the northern and southern range boundaries (defined on the "As The Otter Swims" [ATOS] scale) of sea otters (*Enhydra lutris nereis*) along the mainland coast, central California, 1983–2018. Increasing intervals between ATOS values represent the rate of range expansion.

## Acknowledgments

The annual census is conducted in partnership with personnel of the California Department of Fish and Wildlife, Monterey Bay Aquarium, the U.S. Fish and Wildlife Service and others. The staff of the Bureau of Ocean Energy Management and many experienced and dedicated volunteers also provided invaluable assistance. The Navair Ranges Sustainability Office of the U.S. Navy is acknowledged for access to and logistical support for the sea otter surveys at San Nicolas Island.

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Publishing support provided by the U.S. Geological Survey
Science Publishing Network, Tacoma, Publishing Service Center

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ISSN 2327-638X (online)
https://doi.org/10.3133/ds1097