# CHAPTER 6 BIOGEOGRAPHY OF MARINE MAMMALS

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The waters around Point Conception and the northern Channel Islands are influenced by cool and warm water masses and strong nearshore upwelling which makes this area highly productive. Because of this productive environment, this region contains a rich fauna of marine mammals. The area around Point Conception is a significant biogeographic mixing zone for many species of marine mammals (Chapter 1.3).

## 6.1 Cetacean Single Species Analysis

This chapter presents a description of the distribution patterns of nine cetacean species off central and southern California, as well as an analysis of how these distribution patterns relate to the proposed CINMS boundary concepts. The nine cetacean species chosen by CINMS staff for individual analysis represent those species which are common in the region of interest and include:

Blue whale (*Balaenoptera musculus*)
Bottlenose dolphin (*Tursiops truncatus*)
Short-beaked common dolphin (*Delphinus delphis*)
Long-beaked common dolphin (*Delphinus capensis*)
Gray whale (*Eschrichtius robustus*)
Humpback whale (*Megaptera novaeangliae*)
Killer whale (*Orcinus orca*)
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
Risso's dolphin (*Grampus griseus*)

In addition to these requested species, five additional cetaceans are briefly discussed at the end of this chapter. Spatial patterns for these species, though not selected for detailed analysis, are described within the sanctuary and the six proposed boundary concepts and include:

Dall's porpoise (*Phocoenoides dalli*)
Fin whale (*Balaenoptera physalus*)
Harbor porpoise (*Phocoena phocoena*)
Minke whale (*Balaenoptera acutorostrata*)
Northern right-whale dolphin (*Lissodelphis borealis*)

Spatial patterns of many cetaceans are not static. Cyclic movements exist on many time scales from seasonal migrations to distributional shifts related to interannual scale climate events, such as the El Niño/La Niña Southern Oscillation (ENSO). An analysis of seasonal distribution patterns is beyond the scope of this project, and in some cases, is not feasible given the available data. The analysis presented here describes general patterns, in many cases averaged over different seasons and years. Where seasonal movements are known, they are mentioned in the text. More detailed information about seasonal distribution patterns of cetaceans in California waters can be found in Forney and Barlow (1998). In addition to seasonal movements there are also trends in the abundance and spatial patterns of some cetaceans. Where known, these trends are also mentioned in the text.

Because of the patchy distribution of many marine organisms in time and space, the general patterns described here may not be a good predictor of abundance at a specific location and time. This is particularly true for species such as blue and humpback whales which track aggregations of seasonal prey (e.g., krill or small schooling fish), but is also likely to be the case for many other cetaceans that aggregate. For such species, the average abundances estimated in this report will most often be higher than the actual abundance at a particular time, but during high use periods, abundance may greatly surpass the average.

### Data and Methods

Several types of geo-referenced survey data for cetaceans were used in this report, including: shipboard surveys from the NMFS Southwest Fisheries Science Center (SWFSC), shipboard and aerial surveys compiled for the Minerals Management Service (MMS) in the Computer Database Analysis System (CDAS), and an aerial survey of bottlenose dolphin (SWFSC). These surveys are summarized in Table 6.1.1 and discussed below. Only the SWFSC ship survey and the aerial bottlenose dolphin survey were used to develop densities or encounter rates

**Table 6.1.1** Summary of marine mammal field surveys examined in this chapter.

| Survey | Dates | Platform | Months | Marine Mammal Sightings | Marine Mammal Individuals |
|---|---|---|---|---|---|
| Southwest Fisheries Science Center Ship Surveys | 1991, 1993, 1996, 2001 | ship | July-December | 2963 | 87402 |
| Southwest Fisheries Science Center Aerial Southern California Bight Surveys | 1992-1993 1998-2003 | airplane | Year-round | 37 (Gray whale) | - |
| Southwest Fisheries Science Center Coastal Bottlenose Dolphin Surveys | 1990-2000 | airplane | February-December (most effort in summer) | 311 | 3190 |
| Minerals Management Service Aerial Surveys-CDAS | 1980-1983 | airplane (high altitude) | Year-round | 221 | 777988 |
| Minerals Management Service Aerial Surveys-CDAS | 1980-1983 | airplane (low altitude) | Year-round | 4089 | 40528 |
| California Dept. of Fish and Game, Office of Spill Prevention and Response-CDAS | 1994-1997 | airplane (low altitude) | Year-round | 351 | 1027 |
| Southern California Bight High Aerial Survey-CDAS | 1975-1978 | airplane (high altitude) | Year-round | 695 | 68557 |
| Southern California Bight Low Aerial Survey-CDAS | 1975-1978 | airplane (low altitude) | Year-round | 1319 | 15067 |
| Southern California Bight Ship Survey-CDAS | 1975-1978 | ship | Year-round | 3209 | 112136 |
| Minerals Management Service Survey-CDAS | 1995-1997 | airplane (low altitude) | Year-round | 898 | 3437 |

and abundance estimates for this report. This was only possible for certain species (listed below) for which there were sufficient numbers of sightings within the different boundary concepts. When properly corrected for survey effort, these sightings can be used to estimate density; however, without such corrections the sightings can only be plotted to confirm the presence of a given species at a given time and location. Such plots were developed for all of the requested species. Because of uneven distribution of effort, the absence of sightings does not necessarily indicate the absence of a species in a given area. Although only the requested species and five additional cetaceans commonly found in the Study Area were plotted, surveys generally recorded all marine mammals sighted. An analysis of the different boundary concepts was conducted for all species for which quantitative abundance estimates could be calculated. This analysis includes the Optimal Area Index (OAI), a metric for comparing boundary concepts that is discussed in greater detail in Chapter 1.4.

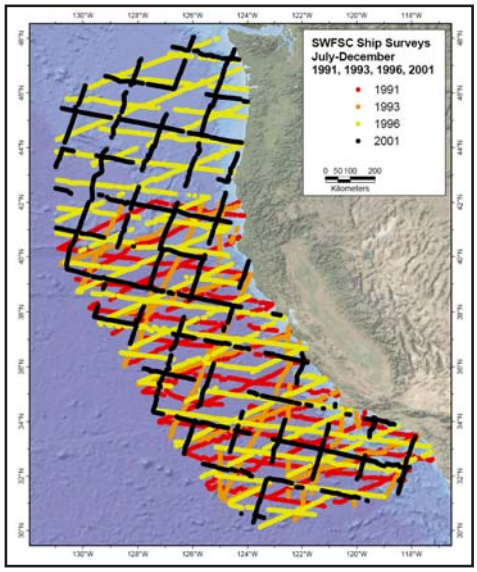


**Figure 6.1.1.** Survey tracks for the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001.

*SWFSC Shipboard Surveys*

Line-transect surveys of marine mammals were conducted by the SWFSC from late July through early November in 1991, 1993, and 1996, and from late July through early December in 2001. The surveys were conducted off California in all years and additionally off Washington and Oregon in 1996 and 2001. Survey tracks are shown

in Figures 6.1.1 and 6.1.2. Details of the survey methods are described fully by Barlow *et al*. (2001). Briefly, surveys were conducted aboard the *R/V David Starr Jordan* and the *R/V McArthur*. Three observers, two with 25x binoculars and one with the unaided eye, recorded marine mammal sightings, including species, group size, and perpendicular distance. Results of these surveys have been used by other researchers to estimate the abundance of cetaceans along the U.S. West Coast using line-transect methods (Barlow, 2003). Here, SWFSC shipboard survey data are used to calculate density estimates within the current CINMS boundary, No Action Concept (NAC), Study Area (McGinnis, 2000), and the six proposed boundary concepts for the following cetaceans:

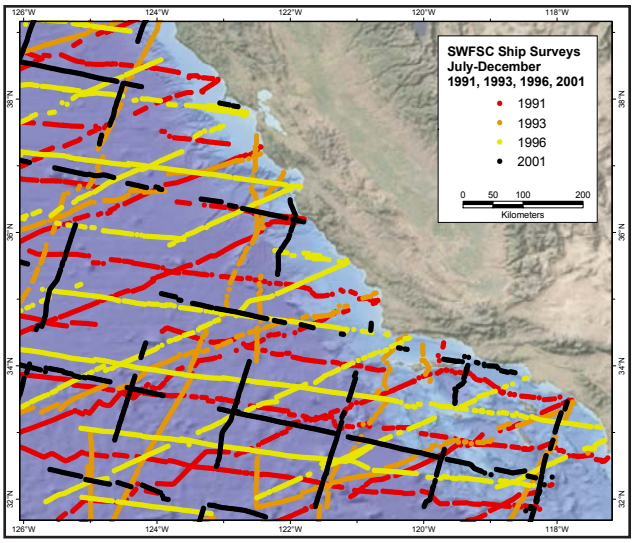


**Figure 6.1.2.** Survey tracks for the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 off central and southern California waters.

Blue whale (*Balaenoptera musculus*)
Short-beaked common dolphin (*Delphinus delphis*)
Long-beaked common dolphin (*Delphinus capensis*)
Unidentified common dolphin (*Delphinus* spp.)
Humpback whale (*Megaptera novaeangliae*)
Risso's dolphin (*Grampus griseus*)

Density and abundance of the above cetaceans were calculated using line-transect methods (Buckland *et al*., 1993), and ABUND4 (J. Barlow, pers.comm.), a Fortran program, was used to estimate abundance from this line-transect data using the equation:

$$N=A*n*S*f(0)/2*L*g(0)$$

where A equals the area of the region of interest, n equals the number of sightings, S is the mean group size, f(0) is the sighting probability density at zero perpendicular distance, L is the track length, and g(0) is the probability of seeing a group directly on the trackline. The parameters A, n, S, and L are intuitive and easily calculated from the data. The line transect parameters f(0) and g(0) require some explanation: The first parameter, f(0), is a component of the detection function which describes the decrease in sighting probability as the perpendicular distance from the transect line increases. The value of f(0) is the inverse of the Effective Strip Width (ESW), which determines the effective area searched, taking into account the detection function. The other major line-transect parameter, the detection probability on the transect line or g(0), is used to correct for animals that may have been missed on the transect line, either because they were diving and not available to be seen (availability bias) or because they were available to be seen but missed by the observer team (perception bias). Availability bias cannot be estimated empirically from the survey data and is generally determined from information on dive times and surface intervals of marine mammals. Availability bias during shipboard surveys is expected to be greatest for species that dive for prolonged periods, such as beaked whales and sperm whales, and low for most dolphins and other large whales. Perception bias, in contrast, is generally highest for small groups of inconspicuous cetaceans, and lowest for large whales and large, active dolphin schools. Values of g(0) used in this analysis were obtained from Barlow (2003) and include both sources of bias when possible.

Values of f(0) were determined empirically by fitting hazard rate detection functions to the sighting distances. Stratification and pooling of the data were used to obtain the simplest and best fitting models. Both group size and geographic strata were tested, and Akaike's Information Criterion (AIC) was used to select between competing models. To examine the value of geographic stratification, detection functions were fit to the entire pooled data sets (all four years) and a geographical subset of the data in Southern California (from 32.3° to 36°N and east of 122°W), which corresponds more closely to the region of the CINMS boundary concepts. AIC was compared between the pooled data and the sum of the two strata (southern California and all other west coast locations), and the geographic stratification that minimized AIC was selected. For all species except common dolphins and blue whale, the pooled data for the entire data set was selected.

The two common dolphin species and unidentified common dolphins were pooled for estimation of the detection function in order to increase the number of sightings and improve the precision of the f(0) estimate for this category. Estimates of f(0) were lower for the southern California subset than for the entire dataset. Lower f(0) indicates a greater effective strip width (ESW) and suggests that for some reason (*e.g.,* calmer conditions or behavioral differences) common dolphins were more visible within southern California than for the West Coast as a whole. Because of this difference, and a slight improvement in AIC (830.23 for the pooled data compared to 828.97 for the geographically stratified data), geographically specific f(0)'s were used for common dolphins.

Although Barlow (2003) used three group size strata (1-20, 20-60, and >60 individuals) when estimating f(0) coastwide for common dolphin, only two group size strata were used in this study because the f(0) values for groups of 20-60 and >60 were similar (0.464 and 0.451 respectively) in the southern California stratum, and pooling provided more robust sample sizes for variance estimation.

Density and abundance were estimated separately for the two common dolphin species and unidentified common dolphins, using the pooled estimates of f(0) and g(0). The unidentified common dolphin densities and abundances were then pro-rated to the two species according to the proportional abundances of the two species occurring in each concept. Unidentified common dolphins represented 3-10% of the estimated abundance of long-beak common dolphins and 4-7% of short-beak common dolphins within the boundary concepts. Confidence intervals for the combined (identified+unidentified) estimates of common dolphin abundance were approximated based on the coefficient of variation for each of the identified common dolphin abundance estimates. This was judged to be reasonable because the unidentified common dolphins represented only a small proportion of the combined abundance estimate and were expected to contribute little to the variance of the overall abundance estimate.

For blue whales, geographic stratification resulted in a lower f(0) and improved model fit, while group size stratification (1-2 and >2) did not.

Too few Risso's dolphin and humpback whale sightings were available for accurate f(0) estimation using only data from the southern California stratum; therefore coastwide values of f(0) were taken from Barlow (2003) for these species. A summary of input parameters for all species is provided in Table 6.1.2.

**Table 6.1.2.** Line transect parameters used to estimate the abundance of selected cetaceans within the six boundary concepts, the current CINMS boundary, and the Study Area. Numbers in bold are from Barlow, 2003.

| | Overall | 1-20 | >20 |
|---|---|---|---|
| Common dolphin | | | |
| f(0) | | 0.963 | 0.518 |
| CV f(0) | | 0.289 | 0.212 |
| g(0) | | **0.77** | **1** |
| CV g(0) | | **0.14** | **0** |
| Blue whale | | | |
| f(0) | 0.349 | | |
| CV f(0) | 0.13 | | |
| g(0) | **0.9** | | |
| CV g(0) | **0.07** | | |
| Humpback whale | | | |
| f(0) | **0.346** | | |
| CV f(0) | **0.15** | | |
| g(0) | **0.9** | | |
| CV g(0) | **0.07** | | |
| Risso's dolphin | | | |
| f(0) | | **0.73** | **0.459** |
| CV f(0) | | **0.16** | **0.2** |
| g(0) | | **0.74** | **1** |
| CV g(0) | | **0.39** | **0** |

Because density and abundance are estimated independently for the individual boundary concepts, it is possible that a larger concept that completely contains a smaller one could have a lower estimated abundance. This counterintuitive result can occur when few or no sightings are recorded in the portion of the larger concept that does not overlap the smaller concept. Such a contradiction reflects the uncertainty associated with abundance estimation at the scales in this study. Such examples underscore the importance of considering the confidence interval of each estimate, not just the point estimates, when comparing boundary concepts.

For the remaining requested cetaceans, too few sightings were recorded within the region to accurately estimate density. Sightings from the SWFSC shipboard surveys are shown for the above species and for:

Bottlenose dolphin (*Tursiops truncatus*): Offshore Stock
Gray whale (*Eschrichtius robustus*)
Killer whale (*Orcinus orca*)
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)

*SWFSC Aerial Surveys*

Additional sightings from SWFSC aerial surveys are displayed for the gray whale, because they are winter/spring migrants through California waters, and no sightings were made during the summer/fall shipboard surveys. Unlike the ship surveys, these aerial surveys were restricted to small areas within the Southern California Bight (Southern California Bight) (Figure 6.1.3) and were conducted year-round, approximately every 1-2 months. Surveys in the area surrounding San Nicolas Island were conducted in 1992-1993, and a second set of surveys around San Clemente Island were conducted in 1998-2003. Details of the survey methods are found in Carretta *et al*. (1995 and 2000). Because of the geographically focused nature of these surveys, the distribution of sightings viewed at a broader scale (i.e. the entire Southern California Bight or southern California) largely reflects the distribution of survey effort. Nevertheless, this survey provides useful recent information about the location of gray whale sightings within surveyed areas of the Southern California Bight. As with all geographically focused surveys, the absence of sightings does not necessarily indicate the absence of a species in a given area.

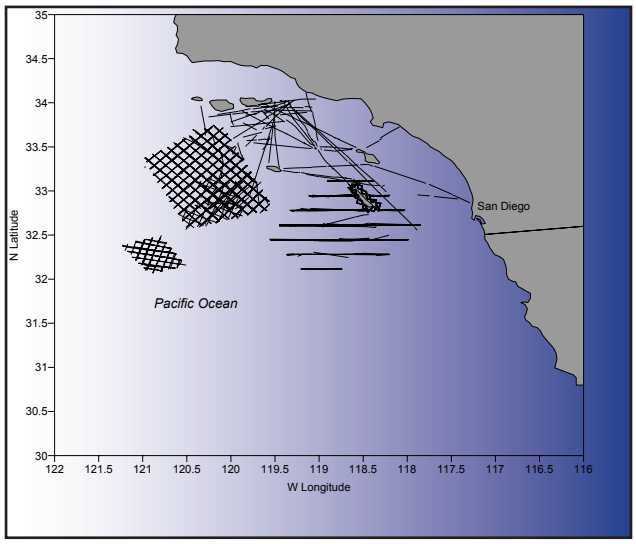


**Figure 6.1.3.** Survey tracks for the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 off southern California waters.

*Computer Database Analysis System (CDAS)*

Seven at-sea surveys from the period 1975-1997, compiled by R.G. Ford Consulting Co., in CDAS v2.1 (MMS, 2001) were used to display sightings and effort for the following cetaceans:

Blue whale (*Balaenoptera musculus*)
Bottlenose dolphin (*Tursiops truncatus*): Coastal and Offshore Stocks
Common dolphin (*Delphinus* spp.) (not identified to species)
Gray whale (*Eschrichtius robustus*)
Humpback whale (*Megaptera novaeangliae*)
Killer whale (*Orcinus orca*)
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
Risso's dolphin (*Grampus griseus*)

This list represents all of the requested cetacean species. Effort is represented by the total length of survey track in each five minute of latitude by five minute of longitude grid cell (Figures 6.1.4 and 6.1.5). Although effort for the bird surveys in the CDAS data set was represented by area swept, this conversion was not used for displaying cetacean survey effort because different effective strip widths apply for different cetaceans and different surveys. The CDAS data, though comprehensive and thorough, were recorded over a period of more than 20 years, during which time the distributions of some species are known to have varied considerably (Forney and Barlow, 1998). Additionally, the quality of geographical position data and effort information varied during the study period. Consequently, no quantitative analysis was conducted on the CDAS data for this report.

*SWFSC Bottlenose Dolphin Aerial Survey*

Aerial surveys of California coastal bottlenose dolphins were conducted by SWFSC in May 1990; April, June, August, October, and December 1991; February, April, and July 1992; May-August 1993; July 1994; May 1999; and June 2000. The surveys covered the mainland coast from Point Montara to the U.S.-Mexico border and the Channel Islands. Coastal bottlenose dolphins are associated with nearshore habitat spending 99% of their time within about 500m of shore (Hanson and Defran, 1993). Aerial surveys were conducted at an altitude of 213 m within 300 to 500 m of shore by three observers: inshore (facing shoreward), offshore (facing seaward), and belly (facing down). Further details of the survey methods are reported by Carretta *et al*., (1998).

Encounter rates for bottlenose dolphin were calculated for 20 km shoreline segments by dividing the total number of sightings by the total length of survey track. Portions of survey track in which the sea state was rougher than Beaufort 4 were eliminated as were those portions for which the glare on the inshore observer window (from

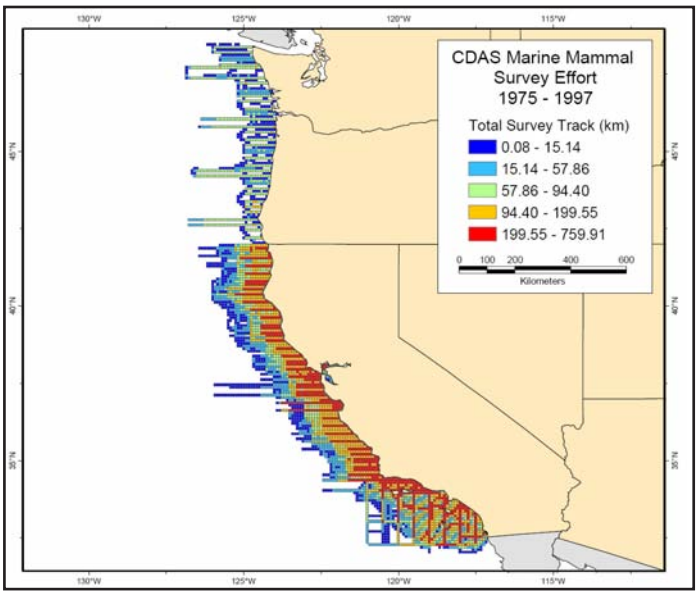


**Figure 6.1.4.** Survey effort (km of survey track) for the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

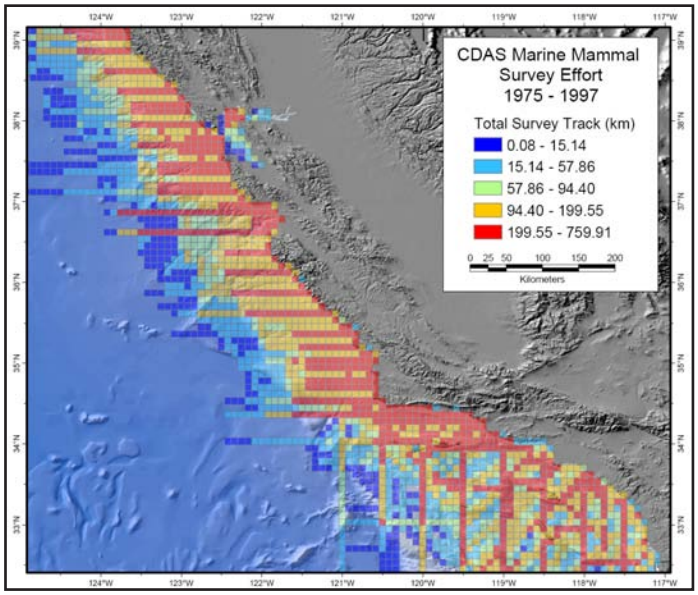


**Figure 6.1.5.** Survey effort (km of survey track) for the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1 off central and southern California waters.

which the majority of sightings were made) and the belly window obscured more than 75% of the viewing area. The shoreline segments adjacent to restricted air space near Point Mugu, Camp Pendleton, and Los Angeles International Airport were treated in the same manner as other segments; however, encounter rates in these areas may not accurately reflect bottlenose dolphin abundance because the survey aircraft was frequently required to change course or altitude for safety reasons. Shoreline segments with less than 5 km of effort were eliminated from the analysis. Although all of the Channel Islands were surveyed at least once, only two on-effort bottlenose dolphin sightings were recorded off Santa Catalina Island. Encounter rates were therefore estimated only for the mainland, and no OAI analysis was conducted for this species. Minimum abundance estimates were calculated for each of the concepts that include parts of the mainland coast. These estimates were calculated by multiplying the average encounter rate within each concept by the total length of mainland coast. Because this method does not account for individuals that were present but not sighted (Carretta *et al.,* 1998), it represents a minimum estimate. Because sightability was not considered, it was not possible to calculate the uncertainty associated with the abundance estimates.

## Broad-scale Patterns and Analysis of Boundary Concepts

**Blue whale** (*Balaenoptera musculus*)

Although stock structure of blue whales in the North Pacific has been hypothesized to include one (Donovan, 1991) to five (Reeves *et al*., 1998) sub-stocks, the most recent U.S. stock assessments for this species (Carretta *et al*., 2002) includes an *Eastern North Pacific* stock in addition to the *Hawaiian* stock. The *Eastern North Pacific* stock, which feeds in California waters during the summer and fall and migrates to waters off Mexico and Central America during the winter (Calambokidis *et al*., 1990), is believed to be separate from the Gulf of Alaska population (Rice, 1992). The most recent abundance estimate for this stock, based on a weighted average of the estimates from the 1991-1996 SWFSC ship surveys (Barlow, 1997) and a 1993 mark-recapture survey (Calambokidis and Steiger, 1994) was 1,940 individuals (Carretta *et al*., 2002). Blue whale is a federally listed endangered species.

Sightings of blue whales from the SWFSC ship surveys and the CDAS surveys (Figure 6.1.6) occurred throughout the shelf, slope, and offshore waters of southern California. A notable cluster of sightings was found to the west of San Miguel Island in shelf waters. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that blue whales do exist in a given area; the absence of sightings for this widely ranging species may reflect insufficient survey effort rather than real absence from the area.

Estimates of the summer and fall abundance of blue whales within the NAC, the six boundary concepts, and the Study Area were derived from the 1991-2001 SWFSC ship surveys described above and are summarized in Table 6.1.3. Because of the relatively small number of on-effort sightings (4-14) and the uncertainty in the

line transect input parameters, confidence intervals for the abundance estimates are wide and overlap substantially among different concepts. The wide intervals show that abundance cannot be estimated precisely, and the overlap indicates that the differences in estimated abundance among concepts are not likely to be statistically significant. Nevertheless, large differences in estimated blue whale density and abundance exist among the concepts. Blue whale sightings were numerous within the NAC and exhibited higher estimated density than any of the concepts or the Study Area. Sharp increases in estimated blue whale abundance relative to that of the NAC are apparent in Concepts 1, 1a, and 2. The OAI shows that, although none of the concepts provide higher density than the NAC, Concepts 1 and 1a provide the greatest relative increase in blue whale abundance for the smallest relative increase in area. It is important to remember, however, that blue whales aggregate in areas where their prey (krill) are concentrated. Any boundary concept might, therefore, contain a larger number of blue whales during times when krill densities are high.

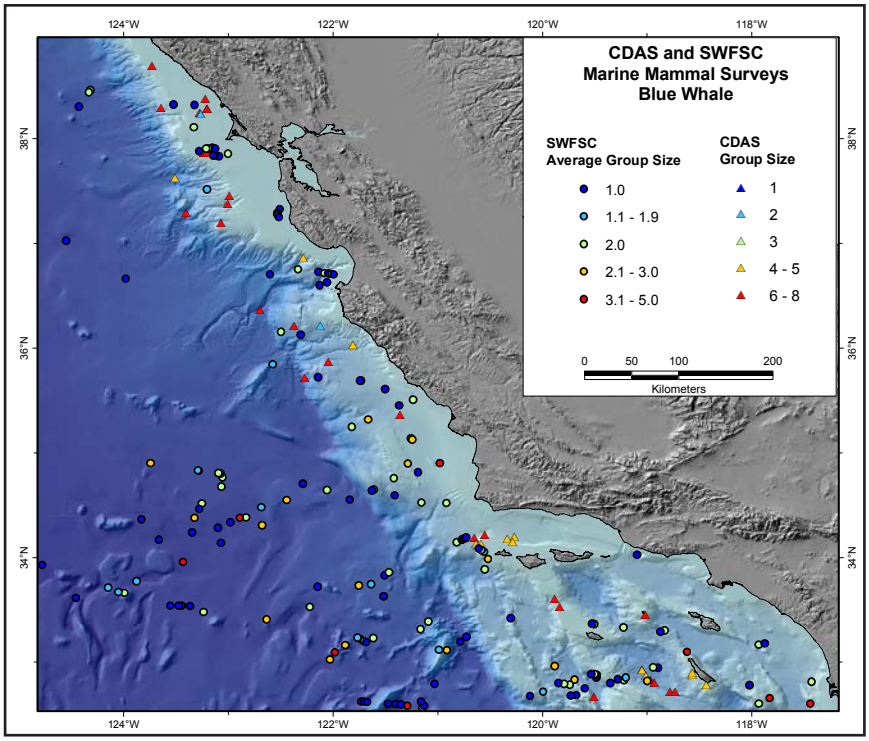


**Figure 6.1.6.** Blue whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

**Table 6.1.3.** Blue whale. Sightings, estimated density and abundance, coefficient of variation (CV), and upper and lower 95% confidence limits for the abundance estimate, and the Optimal Area Index (OAI) for the six boundary concepts, the No Action Concept (NAC), and the Study Area (SA). Abundance and density values in bold reflect increases from the NAC and shaded OAI values represent maximum observed benefit.

| Concept | Area (km$^2$) | Sightings | Estimated Density | Estimated Abundance | CV | Lower 95% CI | Upper 95% CI | Δ Area (%) | Δ Density (%) | Δ Abundance (%) | Density OAI (relative) | Abundance OAI (absolute) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NAC | 3745 | 4 | 0.00807 | 30 | 0.93 | 6 | 141 | - | - | - | - | - |
| 5 | 4536 | 4 | 0.00712 | **32** | 0.78 | 8 | 124 | 21.12 | -11.77 | 6.67 | -0.557 | 0.316 |
| 4 | 7981 | 4 | 0.004 | **32** | 0.73 | 9 | 115 | 113.11 | -50.43 | 6.67 | -0.446 | 0.059 |
| 3 | 9044 | 4 | 0.00358 | **32** | 0.72 | 9 | 114 | 141.50 | -55.64 | 6.67 | -0.393 | 0.047 |
| 2 | 13736 | **7** | 0.006 | **82** | 1.34 | 11 | 598 | 266.78 | -25.65 | 173.33 | -0.096 | 0.65 |
| 1a | 22591 | **14** | 0.00587 | **133** | 0.4 | 63 | 283 | 503.23 | .27.26 | 343.33 | -0.054 | 0.68 |
| 1 | 22613 | **14** | 0.00587 | **133** | 0.4 | 63 | 283 | 503.82 | -27.26 | 343.33 | -0.054 | 0.681 |
| *SA* | *17093* | **8** | *0.0053* | *91* | *0.44* | *40* | *208* | *356.42* | *-33.95* | *203.33* | *-0.095* | *0.57* |

**Bottlenose dolphin** (*Tursiops truncatus*)

Two populations of bottlenose dolphin are found in California waters: 1) an offshore population found at distances greater than 1 km from the mainland shore in the Southern California Bight and extending to the offshore limits (300 nmi) of the SWFSC ship surveys throughout much of California waters; and 2) a coastal population that is found primarily within 500 m of the mainland shore from San Francisco south into Baja California, Mexico (Carretta *et al*., 2002). The abundance of the offshore population in U.S. west coast waters during the 1991-1996 SWFSC ship surveys was estimated at 956 individuals (Barlow, 1997). The most recent average estimate for the

coastal population, based on 1999-2000 tandem aerial surveys by the SWFSC (a subset of the data was used to map encounter rates in this report), is 206 individuals (Carretta *et al*., 2002). A multi-year average estimate of the number of individuals in the Study Area was presented by Carretta *et al*. (2002), because some individuals in this population spend part of the time off Mexico and farther north along the central California coast. Although the abundance of the coastal population in California overall appears to be stable (Dudzick, 1999), there is movement along the coast, some of which appears to be related to seasonal and interannual changes in water temperature (Hansen and Defran, 1990; Wells *et al*., 1990). Bottlenose dolphins are not federally listed as a threatened or endangered species.

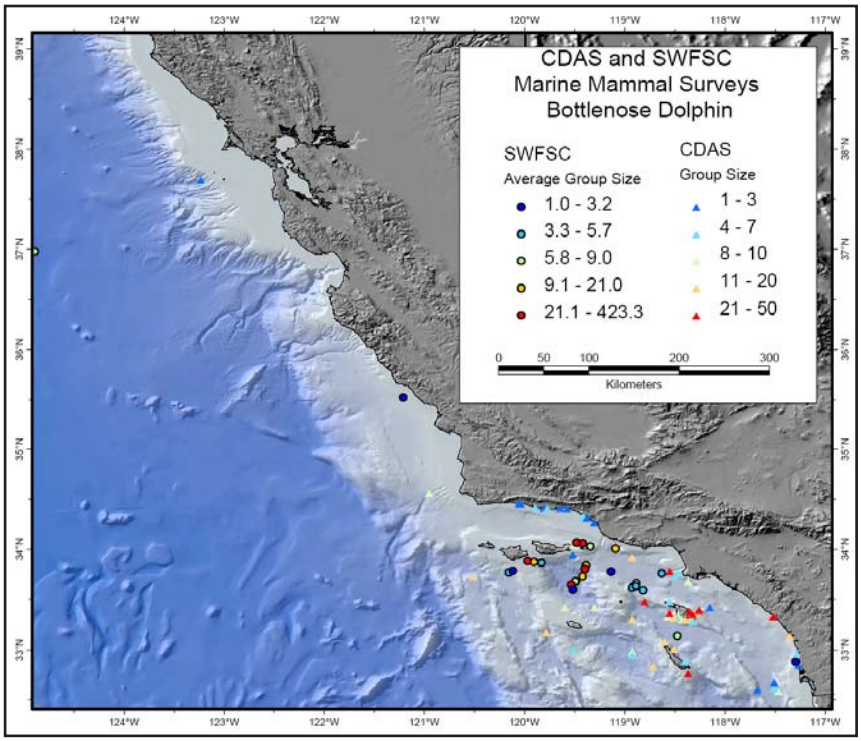


**Figure 6.1.7.** Bottlenose dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

Sightings of bottlenose dolphin from the SWFSC ship surveys and the CDAS surveys (Figure 6.1.7) occur mostly in shelf and nearshore waters of the Southern California Bight. Both populations, coastal and offshore, are apparent in the sightings. A string of sightings likely to be from the coastal population occurs along the coast from west of Santa Barbara to Ventura and another between Dana Point and San Diego. Sightings that can be attributed to the offshore population occur throughout the Southern California Bight with a cluster of sightings from the SWFSC surveys found in the Santa Cruz Basin. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that bottlenose dolphin do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. No abundance estimates were calculated for the offshore stock of bottlenose dolphin.

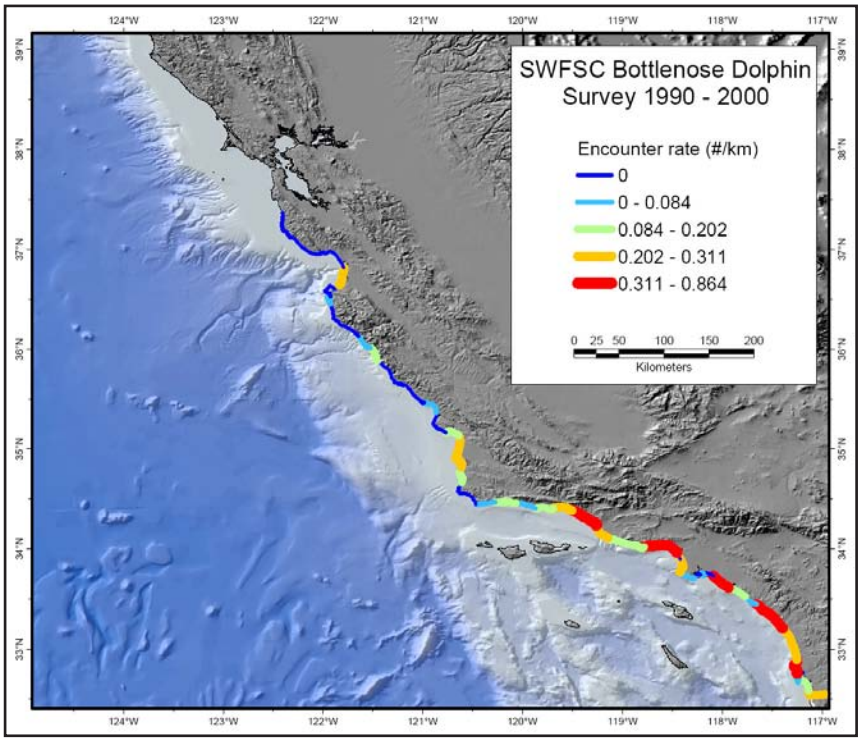


**Figure 6.1.8.** Bottlenose dolphin (coastal population). Encounter rates (#/km) based on Southwest Fisheries Science Center (SWFSC) aerial surveys, 1990-2000.

Encounter rates of coastal bottlenose dolphin derived from the 1990-2000 SWFSC aerial surveys designed specifically for this population (Figure 6.1.8) vary along the central and southern California coast, with the highest encounter rates observed to the south of Santa Barbara. Notable hotspots (encounter rates in the highest quintile or 0.311-0.864 individuals/km) for this species occur from Carpinteria to Ventura, Point Dume to Santa Monica, San Pedro Bay to Newport Beach, and near Oceanside to La Jolla. Many of these areas of high encounter rates contain long sandy beaches and/or river mouths.

Estimates for the mean encounter rates and abundance of the coastal stock of bottlenose dolphin within Concepts 1-3 and the Study Area were derived from the 1990-2000 SWFSC aerial coastal bottlenose dolphin surveys described

above and are summarized in Table 6.1.4. Mean encounter rates and estimated abundance were greatest in Concepts 1 and 1a and the Study Area. Substantial increases in both the mean encounter rate and the estimated abundance were observed for each increase in shoreline length. Abundance of coastal bottlenose dolphin in those concepts which do not include portions of mainland shore, is assumed to be zero since coastal bottlenose dolphin are not known to occur away from the mainland shore.

**Table 6.1.4.** Coastal bottlenose dolphin. Sightings, mean encounter rate, and estimated abundance for four boundary concepts and the Study Area (SA). No analysis was done for the NAC or Concepts 4-5 since encounter rates were calculated for the mainland coast.

| Concept | Area ($km^2$) | Mainland Shoreline (km) | Individuals Sighted | Mean Encounter Rate (#/km | Estimated Abundance |
|---|---|---|---|---|---|
| NAC | 3745 | 0 | - | - | - |
| 5 | 4536 | 0 | - | - | - |
| 4 | 7981 | 0 | - | - | - |
| 3 | 9044 | 20.32 | 5 | 0.04 | 1 |
| 2 | 13736 | 140.02 | 199 | 0.11 | 15 |
| 1a | 22591 | 277.64 | 1112 | 0.23 | 63 |
| 1 | 22613 | 277.64 | 1112 | 0.23 | 63 |
| *SA* | *17093* | *277.64* | *1112* | *0.23* | *63* |

**Long-beaked and short-beaked common dolphins** (*Delphinus* spp.)

Two distinct species of common dolphin, the long-beaked (*Delphinus capensis*) and the short-beaked (*Delphinus delphis*) common dolphin, have been recognized in the eastern North Pacific based on genetic and morphological differences (Heyning and Perrin, 1994; Rosel *et al*., 1994). Within California coastal waters, the distribution of the two species overlaps. Long-beaked common dolphins are found in nearshore (<50 nmi of the coast) waters from Baja California, Mexico to central California. Short-beaked common dolphins have a broader distribution along the west coast of North America, extending from approximately the California/Oregon border south into equatorial waters (Carretta *et al*., 2002). Short-beaked common dolphins may also be found farther from the coast, with many sightings in the SWFSC ship surveys occurring near the offshore limit (300 nmi) of the survey. Although common dolphins are frequently spotted during aerial surveys, the two species cannot be reliably distinguished from the air (Forney *et al*., 1995). The most recent abundance estimate for the California stock of long-beaked common dolphin based on data from the 1991-1996 SWFSC ship surveys (Barlow, 1997) is 32,239 individuals (Carretta *et al*., 2002). Estimated short-beaked common dolphin abundance throughout its U.S. West Coast range, based on the same data, is 373,573 individuals. Although these abundance estimates are for different geographic regions (stock assessments are for individual stocks which may have different geographic boundaries), analysis of the same data restricted to California shows that short-beaked common dolphin are the most abundant cetacean in California waters. The distributions of both species appear to vary seasonally and interannually with highest densities of long-beaks in California waters occurring during warm-water events (Heyning and Perrin, 1994). Neither species of common dolphin is considered a threatened or endangered species.

Sightings of common dolphins are divided into those that were not identified to species from the SWFSC ship surveys and the CDAS surveys (Figure 6.1.9) and those from the SWFSC ship surveys that could be identified as either long-beaked (Figure 6.1.10) or short-beaked (Figure 6.1.11). Common dolphins not identified to species were frequently sighted in the Southern California Bight in the CDAS surveys and were twice sighted in Monterey Bay. The SWFSC surveys include several sightings in shelf waters between Point Conception and Point Piedras Blancas as well as many

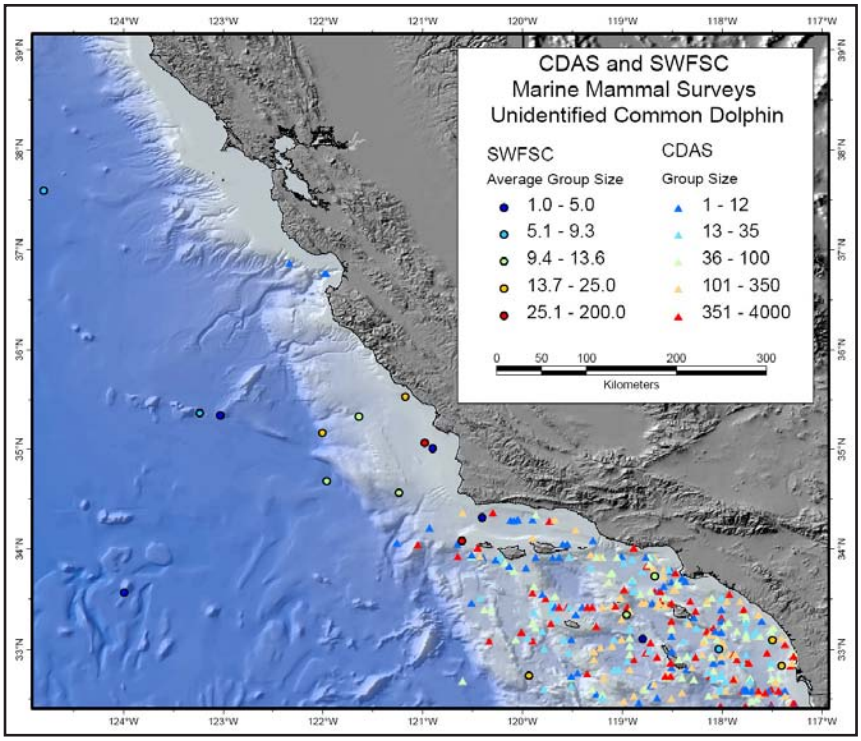


**Figure 6.1.9.** Common dolphin (*Delphinus* spp). Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

throughout the Southern California Bight. Sightings of long-beaked common dolphins occurred predominantly in inshore shelf waters from Point Piedras Blancas south to Newport Beach. There were several sightings in the Santa Barbara Channel and near Anacapa Island. Sightings of short-beaked common dolphins were much more numerous and occurred throughout central and southern California shelf and offshore waters, although offshore sightings predominate north of Monterey Bay. Because of the coarse distribution of survey effort, the pattern of sightings should be used only as confirmation that common dolphins do exist in a broad geographic area. The absence of sightings within smaller geographic areas may reflect the distribution of survey effort rather than real absence from the area.

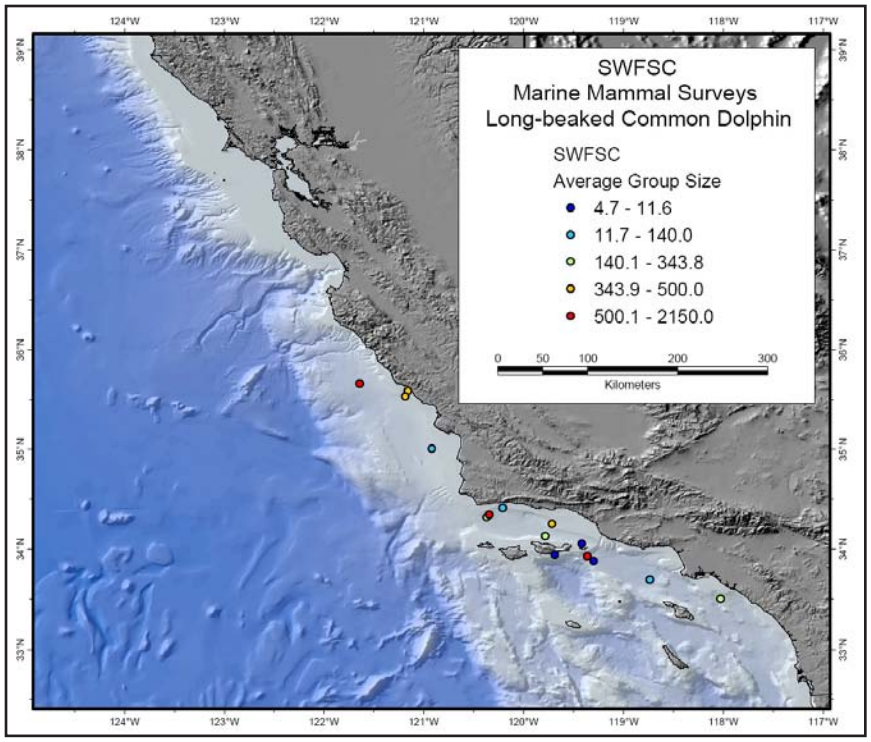


**Figure 6.1.10.** Long-beaked common dolphin. Sightings and average group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001.

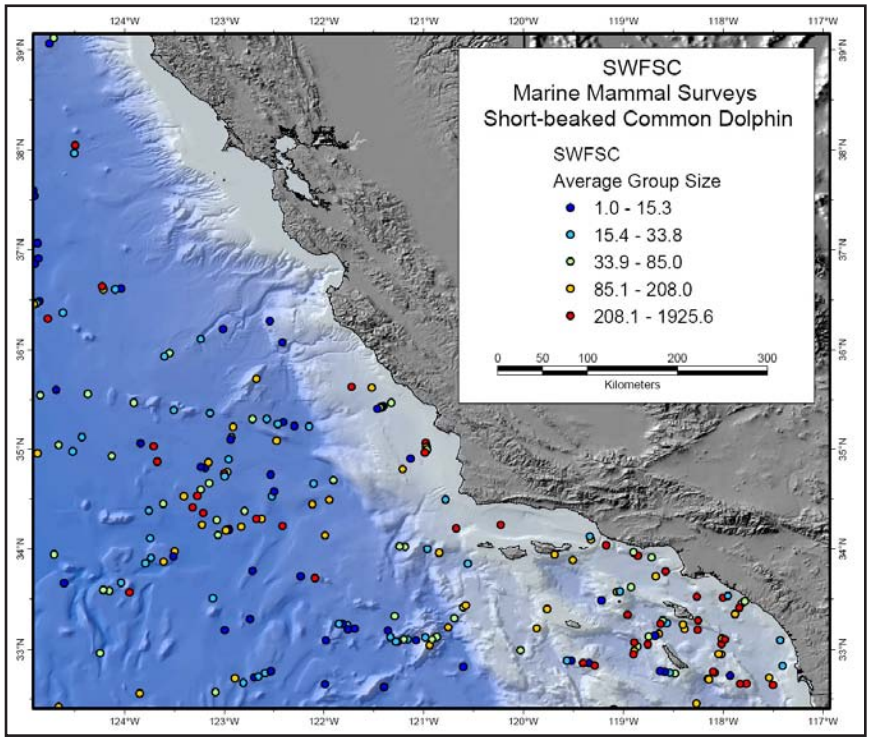


**Figure 6.1.11.** Short-beaked common dolphin. Sightings and average group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001.

Estimates of the summer and fall abundance of long-beaked and short-beaked common dolphins within the NAC, the six boundary concepts, and the Study Area, were derived from the 1991-2002 SWFSC ship surveys described above and are summarized in Tables 6.1.5 (long-beaks) and 6.1.6 (short-beaks). These results represent the combined estimates of species-specific abundance and, because many common dolphins could not be identified to species, an area-specific proportion of the estimated unidentified common dolphin abundance. Confidence intervals for the combined (identified + pro-rated unidentified) abundance estimates were approximated based on the coefficient of variation of the abundance estimates for identified sightings only. Because of the relatively small number of on-effort sightings (3-7 for long-beaks and 4-19 for short-beaks) and the uncertainty in the line transect input parameters, confidence intervals for the abundance estimates are wide and overlap substantially among different concepts. The overlapping confidence intervals indicate that the differences in estimated abundance among concepts are not statistically significant.

Estimated long-beaked common dolphin density is highest in Concept 2 and estimated abundance is highest in Concepts 1, 1a, and the Study Area. Notable increases in estimated abundance relative to that of the NAC are apparent with each increase in concept size with the exception of Concept 5, which shows a 7% increase relative to the NAC. The OAI shows that, of the proposed boundary concepts, Concept 2 provides the greatest relative increase in both density and abundance for the smallest relative increase in area.

**Table 6.1.5.** Long-beaked common dolphin. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate; and the Optimal Area Index (OAI) for the six boundary concepts, the No Action Concept (NAC), and the Study Area (SA). Abundance and density values in bold reflect increases from the NAC and shaded OAI values represent maximum observed benefit.

| Concept | Area (km$^2$) | Sightings (Long-beaked) | Sightings (*Delphinus* spp.) | Corrected Density | Corrected Abundance | CV | Lower 95% CI | Upper 95% CI | Δ Area (%) | Δ Density (%) | Δ Abundance (%) | Density OAI (relative) | AbundanceOAI (absolute) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NAC | 3745 | 3 | 0 | 1.41 | 5262 | - | - | - | - | - | - | - | - |
| 5 | 4536 | 3 | 0 | 1.24 | 5620 | - | - | - | 21.12 | -11.83 | 6.80 | -0.560 | 0.322 |
| 4 | 7981 | **4** | **2** | 0.75 | **5967** | 1.06 | 1089 | 32693 | 113.11 | -46.79 | 13.40 | -0.414 | 0.118 |
| 3 | 9044 | **4** | **2** | 0.67 | **6061** | 1.01 | 1172 | 31355 | 141.50 | -52.31 | 15.18 | -0.370 | 0.107 |
| 2 | 13736 | **6** | **2** | **1.72** | **23649** | 0.74 | 6476 | 86362 | 266.78 | 22.52 | 349.42 | 0.084 | 1.310 |
| 1a | 22591 | **7** | **3** | 1.16 | **26115** | 0.69 | 7686 | 88730 | 503.23 | -17.73 | 396.29 | -0.035 | 0.787 |
| 1 | 22613 | **7** | **3** | 1.16 | **26141** | 0.69 | 7694 | 88816 | 503.82 | -17.73 | 396.78 | -0.035 | 0.788 |
| *SA* | *17093* | *7* | *2* | *1.59* | *27138* | *0.66* | *8351* | *88191* | *356.42* | *12.98* | *415.73* | *0.036* | *1.166* |

**Table 6.1.6.** Short-beaked common dolphin. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate; and the Optimal Area Index (OAI) for the six boundary concepts, the No Action Concept (NAC), and the Study Area (SA). Abundance and density values in bold reflect increases from the NAC and shaded OAI values represent maximum observed benefit.

| Concept | Area (km$^2$) | Sightings (Short-beaked) | Sightings (*Delphinus* spp.) | Corrected Density | Corrected Abundance | CV | Lower 95% CI | Upper 95% CI | Δ Area (%) | Δ Density (%) | Δ Abundance (%) | Density OAI (relative) | AbundanceOAI (absolute) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NAC | 3745 | 4 | 0 | 0.62 | 2330 | - | - | - | - | - | - | - | - |
| 5 | 4536 | 4 | 0 | 0.55 | **2489** | - | - | - | 21.12 | -11.83 | 6.82 | -0.560 | 0.323 |
| 4 | 7981 | **8** | **2** | **1.17** | **9356** | 1 | 1830 | 47838 | 113.11 | 88.39 | 301.55 | 0.781 | 2.666 |
| 3 | 9044 | **8** | **2** | **1.05** | **9503** | 1 | 1859 | 48591 | 141.50 | 68.86 | 307.86 | 0.487 | 2.176 |
| 2 | 13736 | **9** | **2** | **0.78** | **10756** | 0.95 | 2234 | 51799 | 266.78 | 25.85 | 361.65 | 0.097 | 1.356 |
| 1a | 22591 | **19** | **3** | **0.92** | **20713** | 0.57 | 7324 | 58579 | 503.23 | 47.35 | 788.97 | 0.094 | 1.568 |
| 1 | 22613 | **19** | **3** | **0.92** | **20733** | 0.57 | 7331 | 58636 | 503.82 | 47.35 | 789.85 | 0.094 | 1.568 |
| *SA* | *17093* | *16* | *2* | *1.13* | *19321* | *0.6* | *6517* | *57286* | *356.42* | *81.66* | *729.25* | *0.229* | *2.046* |

Estimated short-beaked common dolphin density is highest in Concept 4 and estimated abundance is highest in Concepts 1, 1a, and the Study Area. Estimated abundance for this species seems to fall into three relatively distinct groupings: the NAC and Concept 5, with approximately 2,500 individuals; Concepts 2-4, with around 10,000 individuals; and Concepts 1, 1a, and the Study Area, with around 20,000 individuals. The OAI shows that Concept 4 provides the greatest relative increase in both density and abundance for the smallest relative increase in area.

Abundance estimates of the two common dolphin species present two apparent contradictions. While there are more sightings of short-beaked common dolphin, and this species is the most abundant cetacean in California waters, estimated abundance is higher for long-beaked common dolphin within several of the boundary concepts. The higher estimated abundance for long-beaked common dolphin is in part due to the larger average group size of this species (*e.g.*, in Concept 1, the average group size for long-beaked common dolphin was 480 individuals while the average group size for short-beaked common dolphin was 140 individuals). Although short-beaked common dolphins are more abundant throughout California, this partly reflects their broader distribution into offshore waters. Within certain areas, including some of the boundary concepts, long-beaked common dolphins are more abundant because they have a more nearshore distribution.

**Gray whale (*Eschrichtius robustus*)**

Gray whales are currently found only in the North Pacific with two separate stocks recognized (Angliss and Lodge, 2002). The *Western North Pacific* stock is distributed throughout eastern Asia (Rice, 1981; Rice *et al*., 1984) while the *Eastern North Pacific* stock occurs from its summer feeding habitat in the northern Bering and Chukchi Seas (Rice and Wolman, 1971; Berzin, 1984; Nerini, 1984) to its winter calving habitat along the west coast of Baja California, Mexico (Rice *et al*,. 1984). The fall (southbound) migration begins in November-December (Rugh *et al*., 2001) and the spring (northbound) migration occurs from mid-February through May (Rice *et al*., 1981, 1984; Poole, 1984). The most recent estimate of the size of the *Eastern North Pacific* gray whale stock based on systematic counts of migrating (southbound) whales by shore-based observers at Granite Canyon, CA in 1997-98 is 26,635 individuals (Angliss and Lodge, 2002). There is evidence of a generally positive trend in gray whale abundance since 1992-1993. The gray whale was removed from the endangered species list in 1994.

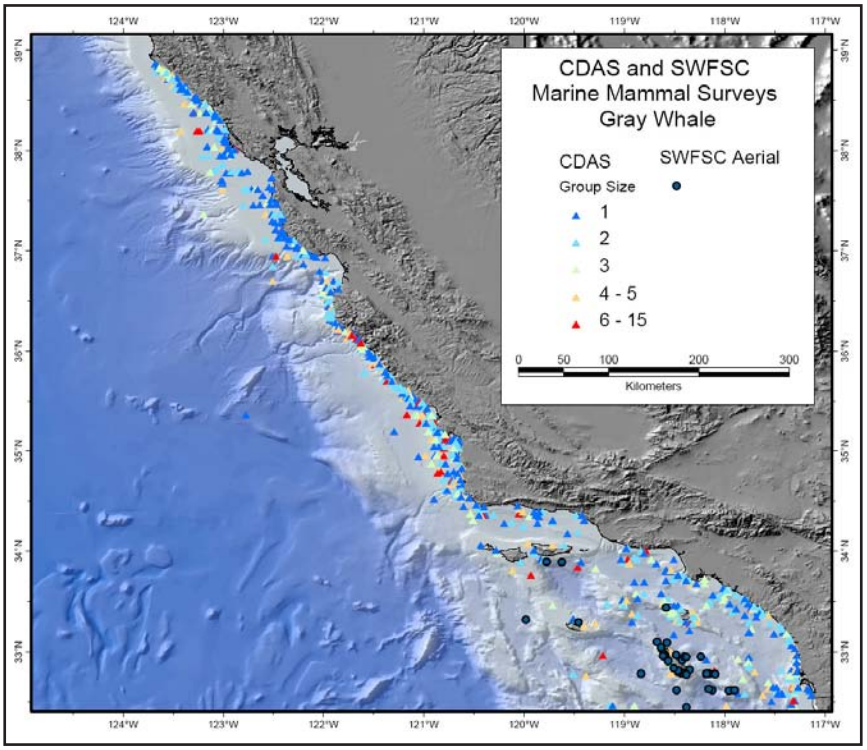


**Figure 6.1.12.** Gray whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) aerial surveys conducted near San Nicolas (1992-1993) and San Clemente (1998-2003) islands and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

Sightings of gray whales from the SWFSC aerial surveys and the CDAS surveys (Figure 6.1.12) reflect the broad nearshore distribution of this species during its migration through California waters. Gray whale sightings occur in nearshore waters throughout the Southern California Bight, including the Santa Barbara Channel, and near the Channel Islands. The cluster of sightings around San Clemente Island is probably more reflective of survey effort than a particular preference for this location, although San Clemente Island lies along one of the gray whales' migratory routes through the Southern California Bight. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that gray whales do exist in a broad area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. Quantitative comparison of the different boundary concepts was not possible due to the lack of sightings during the SWFSC ship surveys, which do not take place during the gray whale migration season.

**Humpback whale (*Megaptera novaeangliae*)**

Evidence from survey data and genetic analyses supports the division of humpback whales into three populations within U.S. Pacific waters (Carretta *et al*., 2002), one of which migrates from coastal Central America and Mexico to the west coast of the U.S. and into British Columbia during the summer and fall (Steiger *et al*., 1991; Calambokidis *et al*., 1993). This population, referred to as the *Eastern North Pacific* stock, passes through the Study Area during its summer and fall migration. The most recent abundance estimate for this stock based on a 1998-2000 mark-recapture survey (Calambokidis *et al*., 2001) was 856 individuals and a modest upward trend in abundance since 1990 is apparent (Carretta *et al*., 2002). Humpback whale is a federally listed endangered species.

Sightings of humpback whales from the SWFSC ship surveys and the CDAS surveys (Figure 6.1.13) occur most frequently in shelf waters to the north of Point Conception. Scattered sightings also occur in the Southern California Bight (including several in the Santa Barbara Channel) and in offshore waters. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that humpback whales do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area.

Estimates of the summer and fall abundance of humpback whales within the NAC, the six boundary concepts, and the Study Area were derived from the 1991-2001 SWFSC ship surveys described above and are summarized in Table 6.1.7. Because some of the sightings recorded as "Unidentified Large Whale" (including one that fell in Concepts 1 and 1a) were likely to be humpback whales (Carretta *et al*., 2002), abundance estimates in Concepts 1 and 1a may be negatively biased. Very small numbers of on-effort sightings (0-4) make the density and abundance estimates for this species extremely uncertain. This uncertainty is reflected in the wide and overlapping confidence intervals. The wide intervals show that abundance can not be estimated precisely, and the overlap indicates that the differences in estimated abundance among concepts are not likely to be statistically significant. No on-effort sightings were recorded within the NAC and only 1 on-effort sighting was recorded in Concepts 3-5, resulting in abundance estimates of approximately 10 individuals for these three concepts. Four on-effort sightings occurred in Concepts 1, 1a, 2, and the Study Area resulting in abundance estimates of approximately 50 individuals for these four areas. Because no on-effort sightings were recorded in the NAC, it was not possible to calculate the OAI for humpback whales. It is important to remember, however, that humpback whales aggregate in areas where their prey (krill and small schooling fish) are concentrated. Any boundary concept could, therefore, contain a larger number of humpback whales during times when prey densities are high.

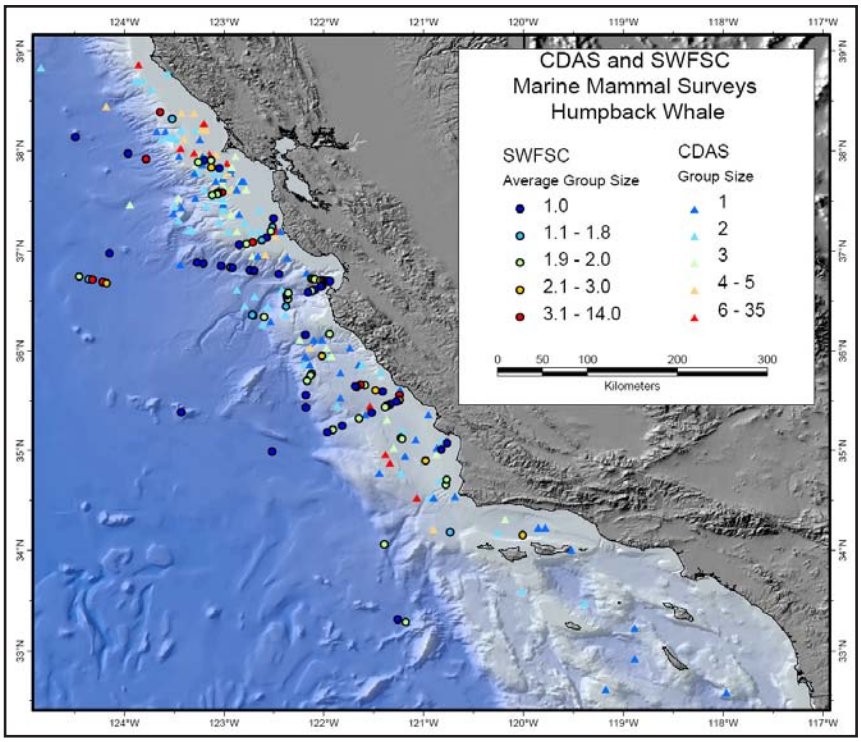


**Figure 6.1.13.** Humpback whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

**Table 6.1.7.** Humpback whale. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate for the six boundary concepts, the No Action Concept (NAC), and the Study Area (SA). SIghtings and density values in bold reflect increases from the NAC.

| Concept | Area ($km^2$) | Sightings | Estimated Density | Estimated Abundance | CV | Lower 95% CI | Upper 95% CI |
|---|---|---|---|---|---|---|---|
| NAC | 3745 | 0 | 0 | 0 | - | - | - |
| 5 | 4536 | 1 | **0.00234** | 11 | 1 | 2 | 56 |
| 4 | 7981 | 1 | **0.00131** | 10 | 1 | 2 | 51 |
| 3 | 9044 | 1 | **0.00118** | 11 | 1 | 2 | 56 |
| 2 | 13736 | **4** | **0.00375** | 52 | 2.33 | 4 | 754 |
| 1a | 22591 | **4** | **0.0023** | 51 | 0.91 | 11 | 234 |
| 1 | 22613 | **4** | **0.00226** | 51 | 0.91 | 11 | 234 |
| *SA* | *17093* | *4* | *0.0031* | *53* | *0.82* | *13* | *216* |

**Killer whale (*Orcinus orca*)**

Relatively little is known about the killer whales found in California waters compared to the well-studied populations of Alaska and the Pacific Northwest. Nevertheless, four separate types of killer whales have been identified and regularly sighted in California. These groups differ in their behavior, genetics, distribution, coloration and preferred prey (Ford and Fisher, 1982; Baird and Stacey, 1988; Baird *et al*., 1992; Hoelzel *et al*. 1998). Three of the four types found in California waters (the so-called 'resident', 'transient', and 'offshore' types) were first identified and characterized in the eastern North Pacific. The fourth (the "LA pod") has only been recorded off southern and central California and off Baja California, Mexico. The killer whale is not federally listed as threatened or endan-

gered; however, the Eastern North Pacific Southern Resident stock of killer whales, found primarily in the Pacific Northwest but occasionally seen off California, was listed as "depleted" under the Marine Mammal Protection Act in May 2003 and was designated as "endangered" by the State of Washington in April 2004. Furthermore, in November 2001, this stock of killer whale was listed as endangered by Canada's Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Resident-type killer whales have primarily been sighted from the Aleutian Islands south to Puget Sound, although there have been sightings of members of two resident pods as far south as Monterey Bay (N. Black, pers. comm.; Carretta *et al*., 2002). No sightings of this type have been recorded in southern California. The most recent estimate of the size of the resident killer whale population in southern British Columbia, Canada through central California based on direct counts of identified individuals is 82 individuals (Carretta *et al*., 2002).

Transient-type whales are unpredictable in their seasonal movements and travel throughout an extensive range with some individuals recorded in both central California and Southeast Alaska (Goley and Straley, 1994). Transients are the most frequently spotted type of killer whale off of central California (Black *et al*., 1997). They specialize on hunting marine mammals including seals and sea lions as well as large whales (such as gray whales) and their calves during seasonal whale migrations. The most recent estimate of the size of the Eastern North Pacific Transient stock of killer whales is a minimum of 346 individuals (Angliss and Lodge, 2002), of which 105 individuals have been identified in California (Black *et al*., 1997).

Offshore-type killer whales, first identified as a separate group off western Vancouver Island, Canada in the 1980's, are less well studied than residents and transients. The first offshore-type individuals in California were identified from photos taken in 1993 off of Point Conception, however, they may have been present in this area since the mid-1980s (Black *et al*., 1997). More recently, this type has been documented off Los Angeles and in Monterey Bay (Black *et al*., 1997). The offshore-type travels in larger groups, is more vocal than transient-types, and has not been observed feeding on marine mammals. The most recent estimate of the size of the offshore-type killer whale population in Washington, Oregon, and California based on the 1991-1996 SWFSC ship surveys is 285 individuals (Carretta *et al*., 2002). This is considered a conservative estimate.

The "LA Pod," named for the location where they were commonly observed during the 1980s, appears to be a distinct type that occurs primarily off Baja California, Mexico, but occasionally found off southern or central California. Members of this group were first photographed in 1982 and have been spotted from about San Francisco south to the Sea of Cortez, Mexico. They have never been observed feeding on marine mammals (Black *et al*., 1997).

Few sightings of killer whales were recorded in the SWFSC ship surveys and the CDAS surveys (Figure 6.1.14). Scattered sightings occur along the shelf and slope (with a few offshore sightings) north of Point Conception. Only two sightings exist in the Southern California Bight, one near Santa Barbara and one off San Diego. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that killer whales do exist in the broad area surveyed; the absence of sightings may reflect insufficient survey effort rather than real absence from the area.

Because so little distributional information or survey sightings exist for killer whales in the Study Area, it is difficult to evaluate the potential impacts of different boundary concepts. Concepts that have the potential to protect killer whales' prey species, including marine mammals such as gray whales and pinnipeds, as well as a variety of fish and cephalopod species, may provide indirect benefits to killer whales as well.

**Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)**

Pacific white-sided dolphins are found throughout the temperate waters of the North Pacific, with most sightings in California waters occurring over the shelf and slope. Two forms of this species occur off California: a northern form ranging from the Southern California Bight north to Alaska, and a southern form found from Baja California, Mexico north to approximately 36°N (Carretta *et al*., 2002). Although both forms are found in the Southern California Bight, genetic (Lux *et al*., 1997) and morphological (Walker *et al*., 1986; Chivers *et al*., 1993) differences indicate little mixing. They are treated as one stock for management purposes, because the two forms are indistinguishable in the field. Seasonal and interannual movements along the U.S. West Coast have been documented, with greater numbers of Pacific white-sided dolphins found in California waters during cool-water peri-

ods, such as the winter months (Green *et al*., 1992; Forney, 1994). Within California, the abundance of Pacific white-sided dolphins can vary seasonally by an order of magnitude, and they are considerably more common in the Southern California Bight during winter (Forney and Barlow, 1998). The most recent stock assessment (Carretta *et al*., 2002) estimates a population size of 25,825 individuals along the U.S. west coast, based on the 1991-1996 SWFSC ship surveys. Pacific white-sided dolphin is not listed as a threatened or endangered species.

Pacific white-sided dolphins were frequently sighted during the CDAS surveys and occasionally recorded during the SWFSC ship surveys (Figure 6.1.15). Many sightings occurred along the shelf and slope (with a few offshore sightings) throughout central and southern California. Sightings were also scattered throughout the Southern California Bight. Relatively few sightings of this species were recorded during the SWFSC ship surveys because of the previously mentioned seasonal changes in abundance. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that Pacific white-sided dolphins do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. Quantitative comparison of the different boundary concepts was not possible for Pacific white-sided dolphins due to the lack of adequate numbers of sightings in the summer/fall SWFSC ship surveys.

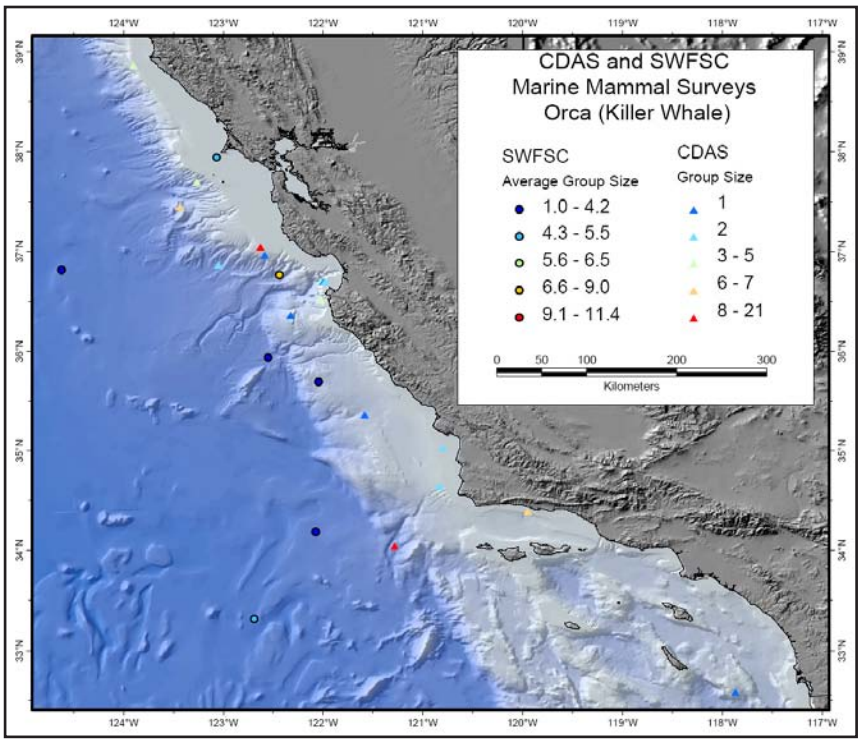


**Figure 6.1.14.** Killer whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

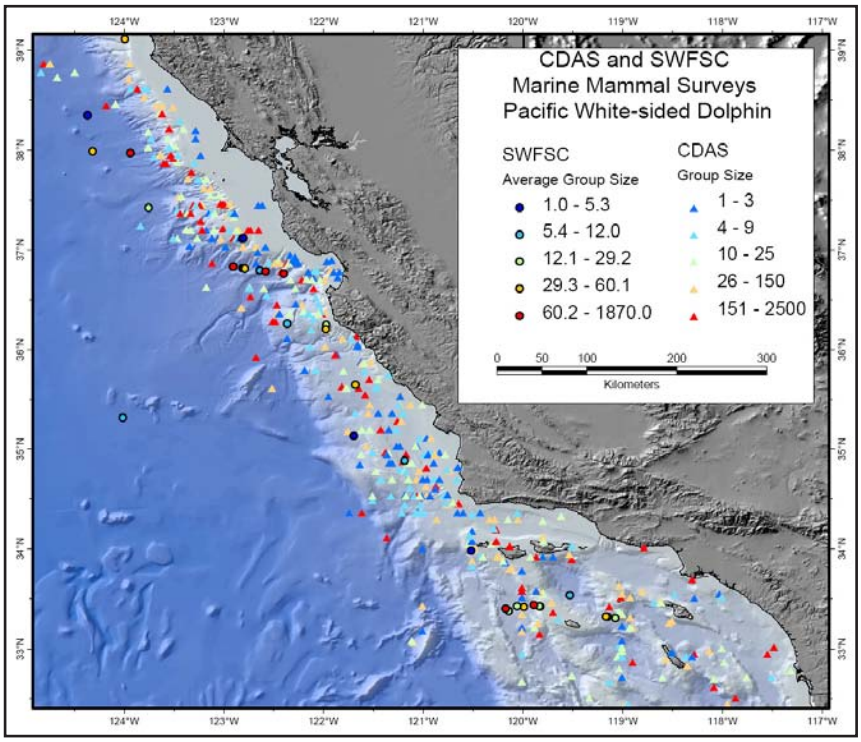


**Figure 6.1.15.** Pacific white-sided dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

**Risso's dolphin (*Grampus griseus*)**

Within U.S. Pacific waters, Risso's dolphin are divided into two stocks, a Hawaiian stock, and a California/Oregon/Washington stock. Green *et al*. (1992) suggest that Risso's dolphin in California move northward into Oregon and Washington in late spring and summer. The southern end of this stock's range appears to occur somewhere along the coast of Baja California, Mexico, with a large gap between this stock and Risso's dolphins found in equatorial waters. Although Risso's dolphin are generally found in slope and offshore waters in Washington, Oregon, and northern California, they are also found in large numbers in shelf waters off southern and central California (Carretta *et al*., 2002). The most recent abundance estimate for the California/Oregon/Washington stock, based on data from the 1991-1996 SWFSC ship surveys (Barlow, 1997), is 16,483 individuals (Carretta *et al*., 2002). The distribution of Risso's dolphin is highly variable, however, and seasonal and interannual shifts are common

(Forney and Barlow, 1998). Risso's dolphin is not considered a threatened or endangered species.

Risso's dolphins were frequently sighted during the SWFSC ship surveys and the CDAS surveys (Figure 6.1.16). Many sightings occur along the shelf and slope (with a few offshore sightings) throughout central and southern California. Sightings are also scattered throughout the Southern California Bight with clusters of sightings at both the western and eastern ends of the Santa Barbara Channel, but relatively few in the Santa Barbara Channel itself. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that Risso's dolphins do exist in a given area. The absence of sightings may reflect insufficient survey effort rather real absence from the area.

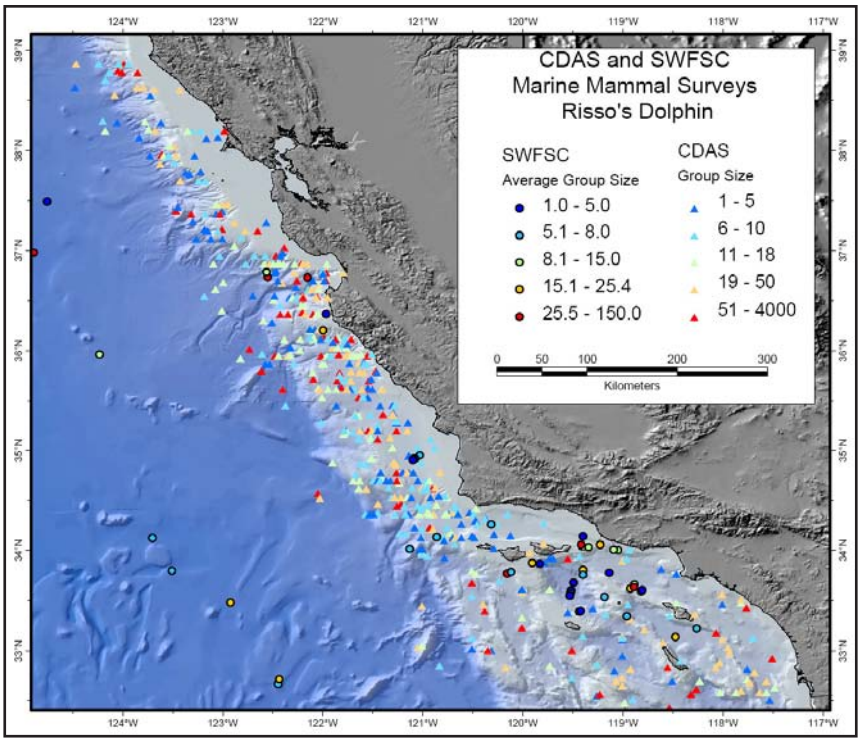


**Figure 6.1.16.** Risso's dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

Estimates of the summer and fall abundance of Risso's dolphin within the NAC, the five boundary concepts, and the Study Area were derived from the 1991-2001 SWFSC ship surveys described above and are summarized in Table 6.1.8. Because of the relatively small number of on-effort sightings (4-21) and the uncertainty in the line transect input parameters, confidence intervals for the abundance estimates are wide and overlap substantially among different concepts. The wide intervals show that abundance cannot be estimated precisely, and the overlap indicates that the differences in estimated abundance among concepts are not likely to be statistically significant. Estimated Risso's dolphin density is highest in Concept 3, and estimated abundance is highest in Concept 1 and the Study Area. Notable increases in estimated abundance relative to that of the NAC are apparent with each increase in concept size, with the exception of Concept 5, which shows only a 7% increase. Estimated abundance in Concept 4, for example, is more than twice as great as in the NAC, and the next largest boundary, Concept 3, has an estimated abundance approximately three times higher than the NAC. The OAI shows that, of the proposed boundary concepts, Concept 3 provides the greatest relative increase in both density and abundance for the smallest relative increase in area. Overall, the OAI is highest for the Study Area.

**Table 6.1.8.** Risso's dolphin. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate; and the Optimal Area Index (OAI) for the six boundary concepts, the No Action Concept (NAC), and the Study Area (SA). Abundance and density values in bold reflect increases from the NAC and shaded OAI values represent maximum observed benefit.

| Concept | Area (km$^2$) | Sightings | Estimated Density | Estimated Abundance | CV | Lower 95% CI | Upper 95% CI | Δ Area (%) | Δ Density (%) | Δ Abundance (%) | Density OAI (relative) | AbundanceOAI (absolute) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NAC | 3745 | 4 | 0.12831 | 481 | 0.54 | 178 | 1296 | - | - | - | - | - |
| 5 | 4536 | 4 | 0.11313 | **513** | 0.54 | 190 | 1383 | 21.12 | -11.83 | 6.65 | -0.56 | 0.315 |
| 4 | 7981 | **10** | **0.12535** | **1000** | 0.46 | 424 | 2360 | 113.11 | -2.31 | 107.90 | -0.02 | 0.954 |
| 3 | 9044 | **12** | **0.16215** | **1466** | 0.46 | 621 | 3460 | 141.50 | 26.37 | 207.78 | 0.186 | 1.447 |
| 2 | 13736 | **13** | **0.13464** | **1849** | 0.44 | 811 | 4217 | 266.78 | 4.93 | 284.41 | 0.018 | 1.066 |
| 1a | 22591 | **21** | **0.12975** | **2931** | 0.45 | 1263 | 6801 | 503.23 | 1.12 | 509.39 | 0.002 | 1.012 |
| 1 | 22613 | **21** | **0.12975** | **2934** | 0.45 | 1265 | 6808 | 503.82 | 1.12 | 509.98 | 0.002 | 1.012 |
| *SA* | *17093* | *21* | *0.1788* | *3056* | *0.42* | *1387* | *6734* | *356.42* | *39.33* | *535.34* | *0.11* | *1.502* |

### Additional Cetaceans

In addition to the requested species, several other species of cetaceans are known to occur within the region, including Dall's porpoise, fin whale, harbor porpoise, minke whale, and northern right-whale dolphins. Although no quantitative analysis was conducted for these species, it is important to recognize that they may be impacted by changes to the boundaries of the CINMS and further investigation into these species may be warranted. While a complete analysis of the biogeography of these additional species is beyond the scope of this project, distribution maps and a brief discussion for each of these species is included here. Several species of beaked whales have also been recorded in the Study Area; however, little is known about the distribution of these poorly studied cetaceans.

### Dall's porpoise (*Phocoenoides dalli*)

Dall's porpoise are found throughout the temperate shelf, slope, and offshore waters of the U.S. West Coast where they exhibit seasonal and interannual movements that appear to be related to changes in oceanographic conditions (Forney *et al*., 1995). They are most abundant off southern California in the winter. The California/Oregon/Washington stock size was estimated in the most recent stock assessment report (Carretta *et al*., 2002) at 116,016 individuals based on the 1991-1996 SWFSC ship surveys (Barlow 1997), with an estimated 1,500 additional individuals in Washington inland waters (Calambokidis *et al*., 1997). Dall's porpoise is not a federally listed endangered or threatened species.

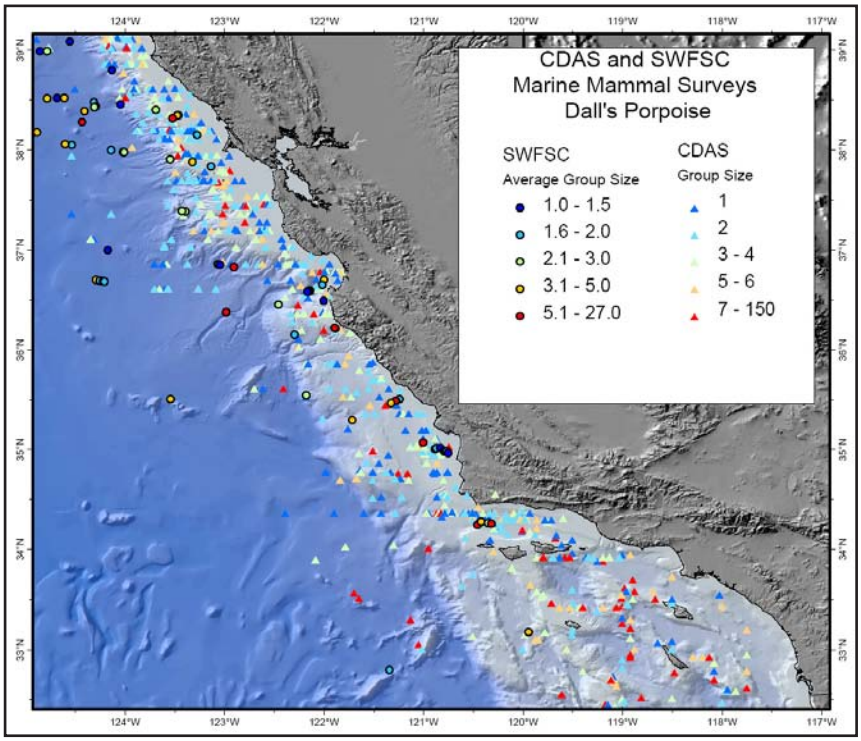


**Figure 6.1.17.** Dall's porpoise. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

Dall's porpoise were commonly sighted in shelf waters throughout central and southern California during the SWFSC ship surveys and the CDAS surveys (Figure 6.1.17). Many sightings were recorded in the Santa Barbara Channel, off Point Conception, and just south of Santa Cruz and Anacapa Islands. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that Dall's porpoise do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. Larger concepts are likely to encompass greater numbers of this widely distributed cetacean.

### Fin whale (*Balaenoptera physalus*)

Although three fin whale stocks are recognized in U.S. North Pacific waters, little is known about the population structure of this species. Year round aggregations of fin whales have been recorded in central and southern California with lower abundance in California waters during the winter and spring (Dohl *et al*., 1983; Forney *et al*., 1995). The California/Oregon/Washington stock size was estimated in the most recent stock assessment report (Carretta *et al*., 2002) at 1,851 individuals based on the 1993 and1996 SWFSC ship surveys (Barlow and Taylor, 2001); however, this is thought to be a slight underestimate because not all fin whales could be identified to species in the field. Fin whale is a federally listed endangered species.

Fin whales have been sighted in shelf, slope, and offshore waters throughout central and southern California during the SWFSC ship surveys and the CDAS surveys (Figure 6.1.18). Within the Southern California Bight only one sighting was recorded in the Santa Barbara Channel and scattered sightings occurred to the south of the CINMS. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that fin whale do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. Concepts 1, 1a, and 2 encompass a cluster of sightings on the shelf waters to the northwest of the CINMS,

with Concepts 1 and 1a encompassing several additional sightings in slope and offshore waters.

**Harbor porpoise (*Phocoena phocoena*)**
Along the west coast of the U.S., harbor porpoise are found in coastal waters from Alaska south to Point Conception. Harbor porpoise on the tend to form geographically and genetically distinct sub-populations with little mixing or movement among them (Chivers *et al*., 2002). A Morro Bay stock of harbor porpoise is one of four stocks identified in California waters by the most recent stock assessment report (Carretta *et al*., 2002). The Morro Bay stock ranges from about Point Sur to Point Conception, although the northern boundary which divides the Morro Bay stock from the Monterey Bay stock is uncertain because of a lack of genetic samples in this region. The most recent estimate of the size of the Morro Bay stock based on a 1997-1999 aerial survey is 932 individuals (Carretta *et al*., 2002). Harbor porpoise is not federally listed as threatened or endangered.

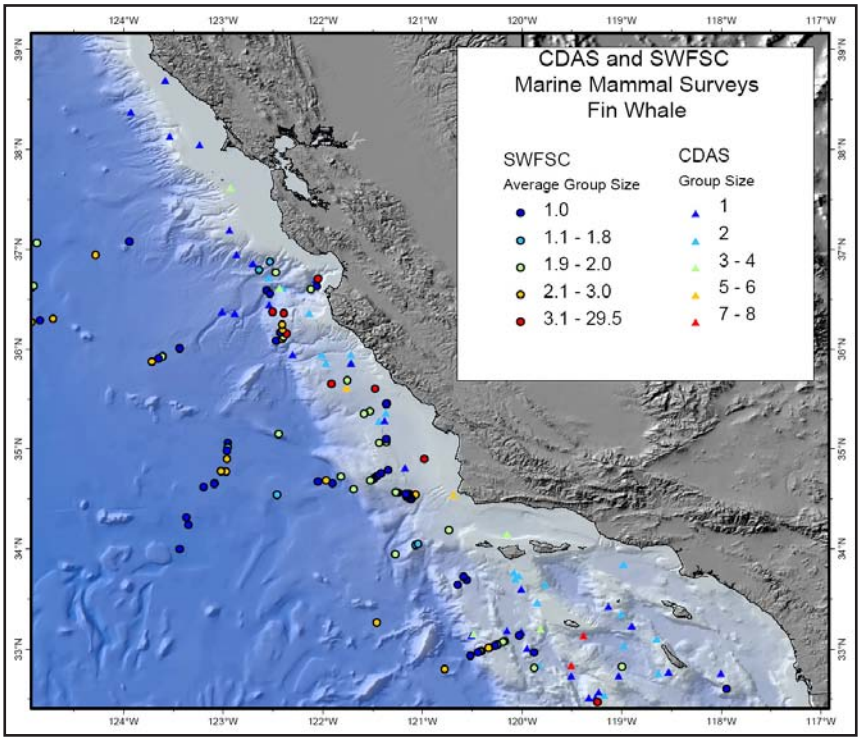


**Figure 6.1.18.** Fin whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

Harbor porpoise were commonly sighted in nearshore and shelf waters north of Point Conception during the SWFSC ship surveys and the CDAS surveys (Figure 6.1.19). Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that harbor porpoise do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. Concepts 1, 1a, and 2 (and a small portion of Concept 3) as well as the Study Area, extend north of Point Conception and may include an unknown number of individuals from the Morro Bay stock.

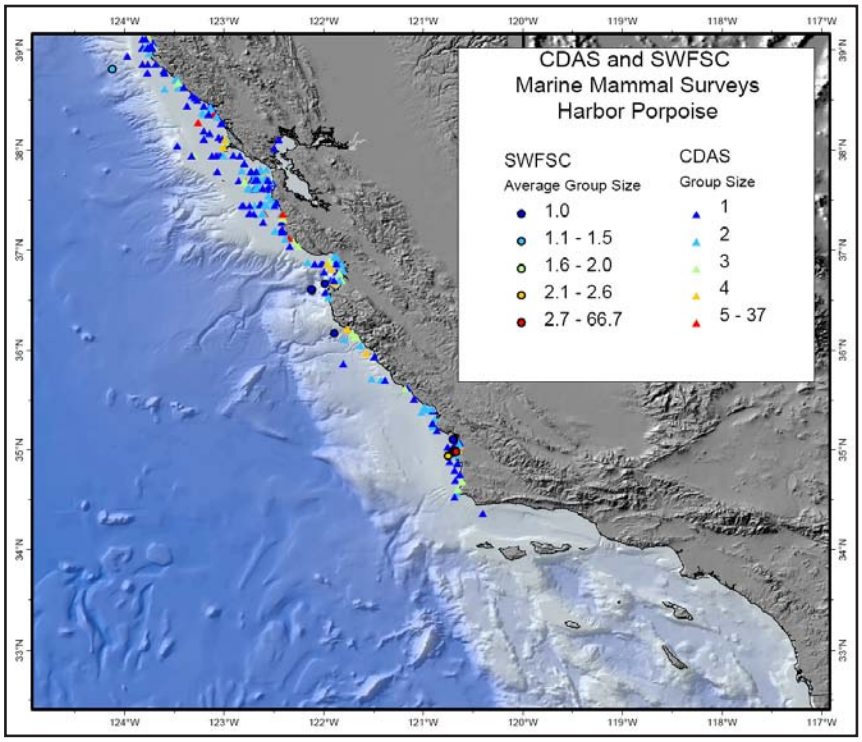


**Figure 6.1.19.** Harbor porpoise. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

**Minke whale (*Balaenoptera acutorostrata*)**
Two minke whale stocks are recognized in U.S. North Pacific waters, an Alaskan stock that is believed to be migratory, and a California/Oregon/Washington stock. In California, minke whales are present year-round (Dohl *et al*., 1983; Forney *et al*., 1995; Barlow, 1997) and some individuals are thought to establish home ranges (Dorsey *et al*., 1990). The California/Oregon/Washington stock size was estimated in the most recent stock assessment report (Carretta *et al*., 2002) at 631 individuals based on the 1991-1996 SWFSC ship surveys (Barlow 1997). Minke whale is not federally listed as threatened or endangered.

Although scattered sightings of minke whales have been recorded in shelf, slope, and offshore waters off central California during the SWFSC ship surveys and the CDAS surveys (Figure 6.1.20), the bulk of sightings from the CDAS surveys occurred in the Southern California Bight, with a cluster of sightings around the northern Channel Islands. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that minke whales do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. The cluster of sightings around the northern Channel Islands is encompassed by all of the concepts including the NAC. Concepts that extend to the south and connect the northern Channel Islands to Santa Barbara Island appear likely to encompass more minke whales.

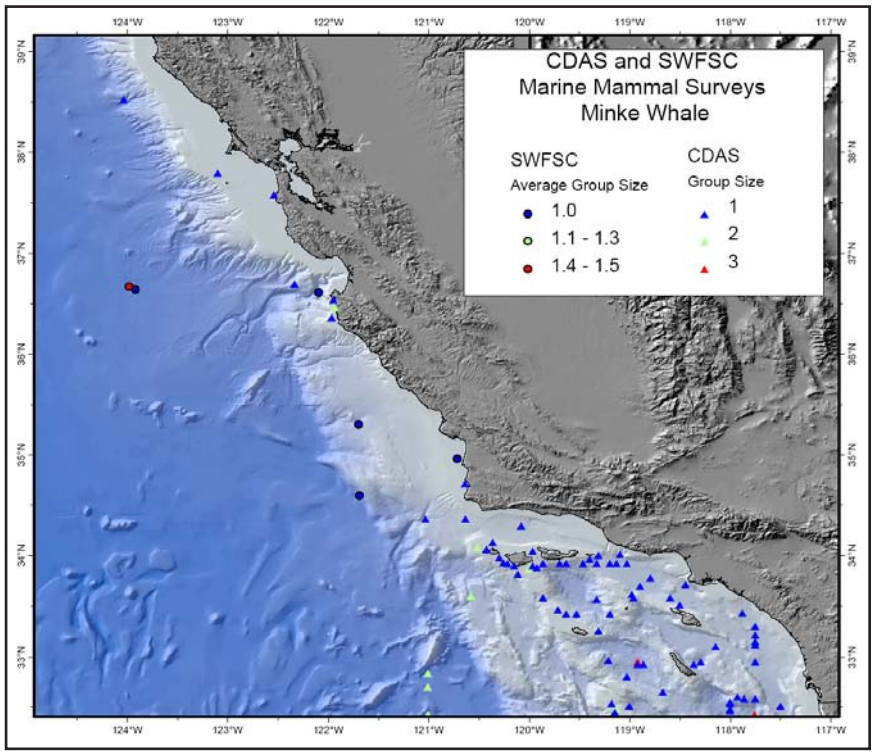


**Figure 6.1.20.** Minke whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

**Northern right-whale dolphin**
**(*Lissodelphis borealis*)**

Along the west coast of the U.S., northern right-whale dolphins are found primarily in temperate shelf and slope waters. Abundance of this species in California waters is greatest during cold-water months (Forney *et al*., 1995), and they are thought to range south to Baja California, Mexico during cold periods. Northern right-whale dolphins in U.S. west coast waters are considered a single California/Oregon/Washington stock due to insufficient genetic evidence of subpopulations (Dizon *et al*., 1994). The size of this stock was estimated in the most recent stock assessment report (Carretta *et al*., 2002) at 13,705 individuals based on the 1991-1996 SWFSC ship surveys (Barlow 1997). Northern right whale dolphin is not considered threatened or endangered.

Northern right-whale dolphins were frequently sighted in shelf and slope waters throughout central and southern California during the SWFSC ship surveys and the CDAS surveys (Figure 6.1.21). Although sightings are recorded throughout the Southern California Bight, relatively few were recorded in the Santa Barbara Channel. Because of the uneven distribution of survey effort, the pattern of sightings should be used only as confirmation that northern right-whale dolphins do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than real absence from the area. Concepts 1 and 1a, and, to a lesser extent Concept 2, encompass a cluster of sightings along the shelf and slope which are not encompassed by any of the smaller concepts.

**Summary**

• Marine mammal distributions within the region exhibit pronounced geographical heterogeneity with the consequence that the impact of extending the CINMS boundaries will vary depending on the specific areas added to the sanctuary. In general,

- Concepts that include the mainland will increase coastal bottlenose dolphin and both species of common dolphin sightings.

- Concepts that extend offshore will include a greater number of blue, fin, and humpback whales.

- Concepts that include waters between the northern Channel Islands and Santa Barbara Island added sightings for northern right-whale dolphins, offshore bottlenose dolphins, and Risso's dolphin.

- Concepts that extend north of Point Conception would add harbor porpoise and increase the abundance

of temperate cetacean species, such as Pacific white-sided dolphin and Dall's porpoise.

• Of those species for which abundance could be estimated (blue whale, bottlenose dolphin, long-beaked and short-beaked common dolphin, humpback whale, and Risso's dolphin), Concepts 1 and 1a provide the greatest estimated abundance within their boundaries, though density is often higher in the smaller concepts. This could be a sampling artifact, or indicate that the smaller areas contain a greater proportion of appropriate habitat for these species.

• Although their populations could not be estimated quantitatively, killer whales and gray whales are known to use the waters around and within the CINMS as feeding and migratory habitat, respectively.

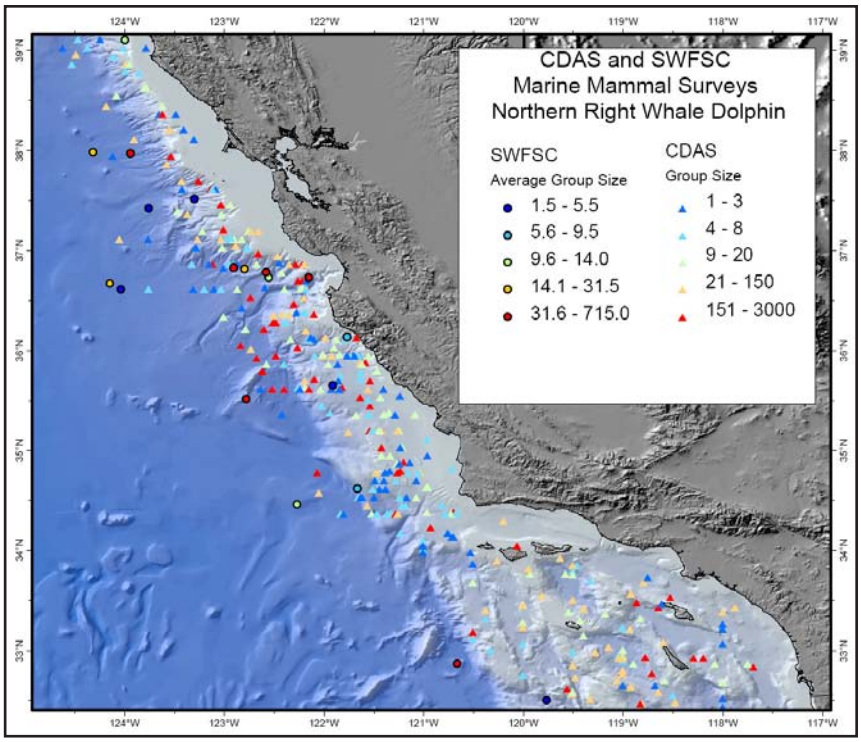


**Figure 6.1.21.** Northern right-whale dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1, 1975-1997.

• The abundance estimates presented here are intended as approximate guidelines only, because the surveys on which they are based were designed for other purposes and, therefore, do not provide data at the most appropriate temporal and spatial scales for an examination of boundary concepts. Furthermore, while the abundances presented here may be considered estimates of the average number of animals that may be found, in fact, it is likely that considerably larger aggregations may occur at times, particularly for feeding blue and humpback whales. This is true as well for dolphins that occur in groups of hundreds or thousands, or are known to exhibit large seasonal and interannual changes in distribution.

## 6.2 PINNIPEDS AND SOUTHERN SEA OTTER

(Portions of this section are reprinted with permission from McGinnis (2000)).

### Pinnipedia (seals, sea lions and fur seals)

Historically, six species of pinnipeds have occurred in the region of interest. These include four members of the family Otaridae and two representatives of the family Phocidae. In addition, a single sighting of one more phocid species has been reported in southern California. Two of the six species are listed as threatened under the Endangered Species Act (ESA).

Of the four otarid seals, the California sea lion (*Zalophus californianus c.*) is unquestionably the most abundant (Barlow *et al*., 1997). The Steller sea lion (*Eumetopias jubatus*) had two rookeries on San Miguel Island, but these rookeries have not been occupied since the 1982-1983 El Niño. The Steller sea lion is listed as threatened under the ESA. The northern fur seal (*Callorhinus ursinus*) has two rookeries on San Miguel Island. The Guadalupe fur seal (*Arctocephalus townsendi*) has been reported on San Nicolas and San Miguel Islands in very small numbers, usually from one to three individuals. A few strandings have occurred along the mainland coast (Hanni *et al*. 1997; Santa Barbara Marine Mammal Center, unpublished records). The Guadalupe fur seal is listed as threatened under the ESA.

Of the two species of phocid seals, the northern elephant seal (*Mirounga angustirostris*) is by far the most common, with rookeries at San Miguel, Santa Rosa, San Nicolas, and Santa Barbara Islands (Barlow *et al*., 1997). The Pacific harbor seal (*Phoca vitulina richardsi*) is common throughout the region, with numerous haulout and rookery sites throughout the Channel Islands and along the mainland coast (Barlow *et al*., 1997). The ribbon seal (*Histriophoca fasciata*), an Arctic species, is rare in California (Woodhouse, 2000).

**Carnivora**

The southern sea otter (*Enhydra lutris nereis*), a member of the mustelid family (which includes weasels), is the only marine representative of the order Carnivora. The southern sea otter is listed as threatened under the ESA. It has undergone drastic population changes, from an estimated pre-exploitation population of 16,000 individuals in California (Laidre *et al*., 2001), to near extinction in the early 1900s, to a current California population of around 2,300 individuals. The current population in the Channel Islands is considered an experimental population and investigations are currently underway to determine whether the translocation project at San Nicolas Island has been successful (USFWS, 2003).

**Data and Methods**

Surveys used in this chapter are summarized in Table 6.2.1. Counts of the four consistently sighted pinnipeds are presented for rookery and haulout sites in the Channel Islands and the Southern California mainland. At-sea distributions of pinnipeds and sea otter are difficult to estimate because they are not reliably sampled by the available at-sea visual surveys which mainly target either birds or cetaceans. At-sea distributions of pinnipeds have been estimated in previous biogeographic assessments, but at a scale (10 minutes of latitude by 10 minutes of longitude) that limits their usefulness for the current assessment of CINMS boundary concepts. The lack of at-sea distribution data means that conclusions in this section of the report reflect the distribution of haulout and rookery areas only. The waters nearest the high use rookery and haulout areas are clearly important, but pinnipeds also forage far from these sites. Sea otters are more closely associated with nearshore habitats, but are known to migrate considerable distances (Wendell *et al*., 1984).

**California sea lion (*Zalophus californianus californianus*)**

Sea lion data presented in this section are derived from aerial photo surveys conducted by the Southwest Fisheries Science Center (SWFSC) from 2001-2003. The surveys are conducted in July to coincide with the end of the pupping season and include all major rookeries and haulout sites. These survey results form the basis of SWFSC's stock assessment of California sea lion (Carretta *et al*., 2002). Counts at each location are total number of individuals (all sex and age categories) and total pups. Sightings should be considered minimum estimates of overall numbers since an unknown fraction of the population is at sea at any given time, and some pups may have already left the rookery. Data are georeferenced by beach codes which correspond to shoreline segments of varying length.

**Pacific harbor seal (*Phoca vitulina richardsi*)**

Harbor seal data presented in this section are comprised of a SWFSC aerial photo survey and an aerial photo and ground survey conducted by the California Department of Fish and Game (CDFG). Despite the fact that the two surveys occurred during the same time period, late May through mid-June 2002, counts for the Channel Islands differed by more than a factor of 2 between the two surveys, with 1,735 harbor seals counted at 61 sites

**Table 6.2.1.** Summary of pinniped and sea otter surveys used in this chapter.

| Survey | Dates | Platform | Months | Location | Total Unique Survey Sites | Total Individuals |
|---|---|---|---|---|---|---|
| NOAA, Southwest Fisheries Science Center, California Sea Lion Survey | 2001-2003 | Aerial Photo | July | Channel Islands (8 islands) | 127 | 230788 |
| NOAA, Southwest Fisheries Science Center, Harbor Seal Survey | 2002 | Aerial Photo | May-June | California Coast (south of Pt. Sal and Channel Islands | 160 | 5271 |
| California Dept. of Fish and Game, Harbor Seal Survey | 2002 | Aerial Photo/ Grount | May-July | Californa Coast and Channel Islands | NA | 18784 |
| NOAA, Southwest Fisheries Science Center, Northern Elephant Seal Survey | 1998, 2000-2001 | Aerial Photo | January-February | Channel Islands (5 islands) | 121 | 116548 |
| Sea Otter Survey (Multi-agency | 2001-2002 | Aerial Photo/ Ground | November and May | California Coast (Pt. Montara to Santa Barbara) | Fall-1150 Spring-1061 | Fall-2012 Spring-2139 |

in the CDFG survey and 3,878 counted at 144 sites in the SWFSC survey. Sweetnam and Read (2002) attribute the differences to the time of day and tidal state. Results from both surveys are presented to give an idea of intra-annual variability and population estimate uncertainty. Both surveys are georeferenced by a single latitude and longitude point for each site.

**Northern elephant seal (*Mirounga angustirostris*)**

Elephant seal survey data are extracted from an aerial photo survey (with the exception of San Clemente Island which was surveyed on the ground) of rookeries conducted by SWFSC in January and February 2001. Data are presented as the total number of individuals (all sex and age categories) and total number of pups (including live and dead pups). Stock assessments for elephant seals derive estimated population size by multiplying total pups counted at rookeries by the ratio of total individuals to pups because all age classes are not ashore at the same time (Carretta *et al*., 2002). Data are georeferenced by beach codes as for California sea lion (see above).

**Northern fur seal (*Callorhinus ursinus*)**

No georeferenced northern fur seal rookery data were available for this report. Two separate stocks of northern fur seal are recognized in U.S. waters: an Eastern Pacific stock and a San Miguel Island stock (Carretta *et al*., 2002). The San Miguel Island stock was established in the late 1950s or early 1960s (DeLong, 1982) and has generally increased since the first live pup counts in 1972. El Niño events are associated with both adult female and pup mortality and have had dramatic impacts on the population in 1982-1983 and 1997-1998. The most recent assessment of the San Miguel Island stock (2002 survey) estimates the population size at 7,784 individuals, and suggests continued rebuilding of the stock since the 1997-1998 El Niño event. Beginning in 1996, fur seals re-established a small breeding population on the South Farallon Islands, with fewer than 10 pups produced each year from 1997-2001 (Pyle *et al*. 2001).

**Southern sea otter (*Enhydra lutris nereis*)**

Sea otter data presented in this section are gathered from land-based surveys conducted by CDFG, USGS-Biological Resources Division, and the Monterey Bay Aquarium in November 2001 and May 2002. Sightings are georeferenced by 500 m shoreline segment, and were summarized by 20 km shoreline segment for clearer display.

**Broad-scale Patterns and Analysis of Boundary Concepts**

**California sea lion**

In order to account for interannual differences in survey effort (*i.e*., not all beach areas were surveyed in all years) and beach use, summary maps depict maximum recent usage calculated as the maximum number of individuals or pups counted at a beach area in the three most recent surveys. Although California sea lions do frequently haul out on man made objects such as barges and piers on the mainland, there are no known natural haulout areas or rookeries on the mainland (M. Lowry, pers. comm.).

Major haulout areas (top two quintiles, 620-12,760 individuals at maximum recent use) for California sea lions exist on East Anacapa, San Clemente, San Miguel, San Nicolas, and Santa Barbara Islands (Figure 6.2.1). Additional less populated haulout areas (less than 578 individuals at maximum recent use) exist on Santa Catalina and Santa Rosa Islands, and on Gull Island near Santa Cruz Island.

Major rookery areas (top two quintiles, 451-6,668 pups at maximum recent usage) exist on San Clemente, San Miguel, San Nicolas, and Santa Barbara Islands (Figure 6.2.2). Additional less-populated rookery areas (less than 373 pups at maximum recent usage) exist on East Anacapa and on Gull Island near Santa Cruz Island. No sea lion pups were counted on Santa Catalina or Santa Rosa Islands. There are no differences among the boundary concepts in terms of the number of sea lion haulout or rookery sites encompassed. However, this data cannot account for differences which may exist in the at-sea abundance of California sea lions within the different concepts.

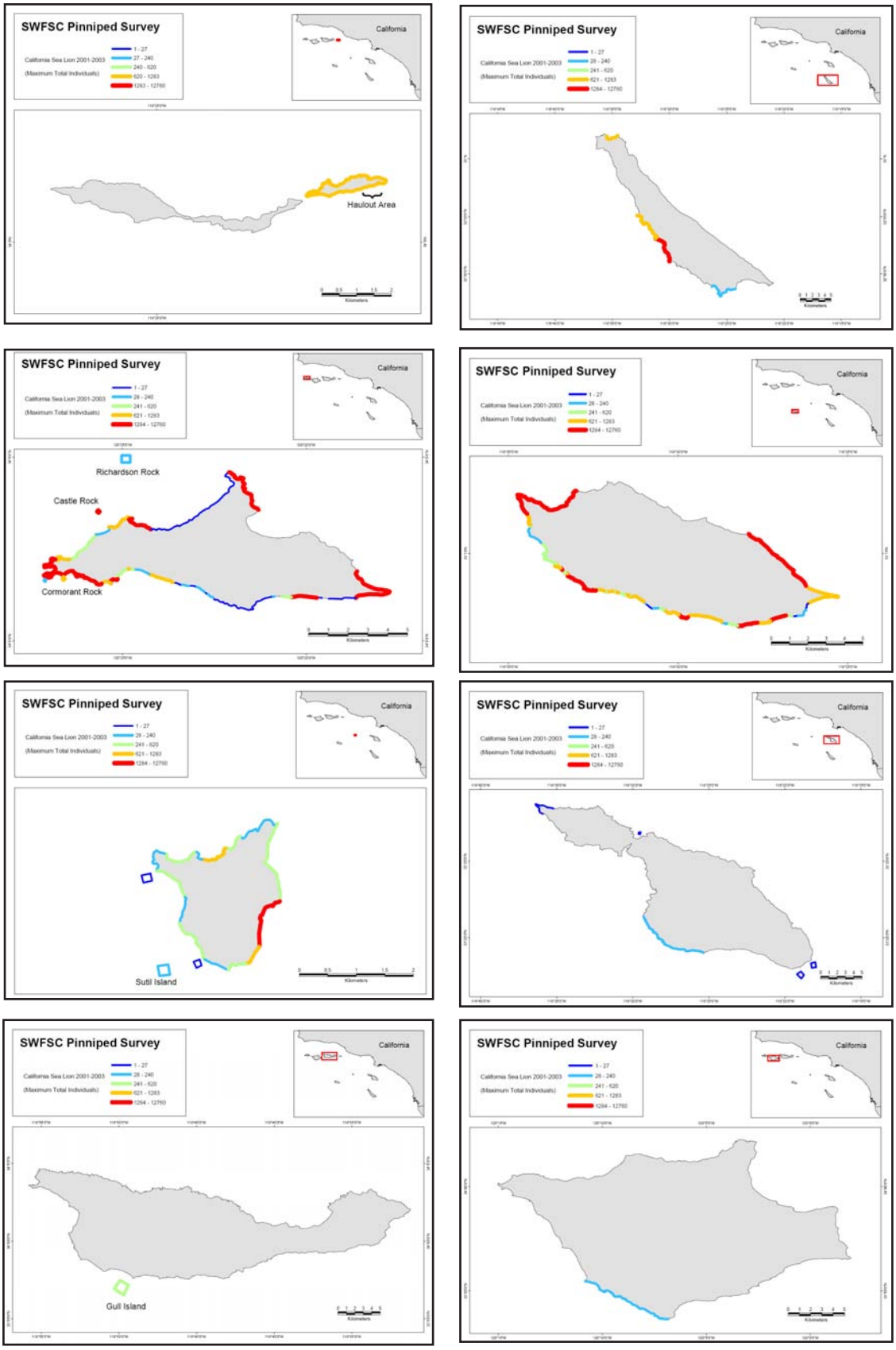


**Figure 6.2.1.** California sea lion. Maximum total individuals (greatest number of individuals of all sex and age classes counted for each beach area surveyed out of the three most recent SWFSC surveys 2001-2003) for (left to right) Anacapa, San Clemente, San Miguel, San Nicolas, Santa Barbara, Santa Catalina, Santa Cruz, and Santa Rosa Islands.

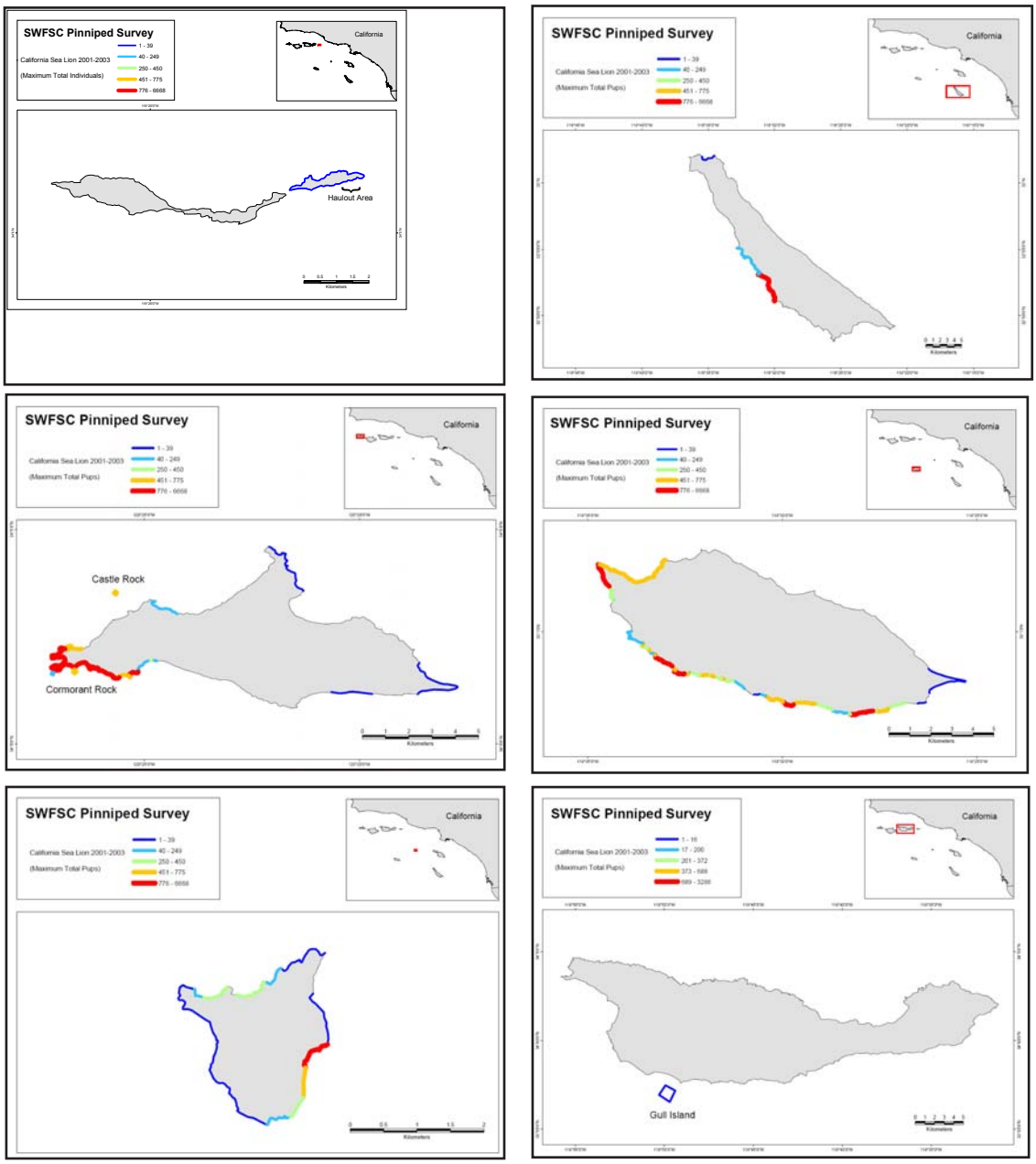


**Figure 6.2.2.** California sea lion. Maximum pups (greatest number of pups counted for each beach area surveyed out of the three most recent SWFSC surveys 2001-2003) for (left to right) Anacapa, San Clemente, San Miguel, San Nicolas, Santa Barbara, and Gull Islands.

## Pacific harbor seal

Counts of Pacific harbor seals at haulout areas are shown for the SWFSC survey (Figure 6.2.3) and the CDFG survey (Figure 6.2.4). Overlap in coverage between flights in the CDFG survey resulted in some haulout areas being surveyed more than once. Therefore separate symbols are used to depict the different flights.

Major haulout areas (more than 20 individuals) for harbor seal exist on all of the Channel Islands other than Santa Barbara Island, which includes only one (CDFG survey) or two (SWFSC survey) haulout areas, each with fewer than 10 individuals. Other major haulout areas exist along the mainland coast near the Channel Islands, including notable sites at Point Conception, Point Arguello and Point Sal.

Many of the most populated harbor seal haulout areas are located on the northern Channel Islands within the current boundaries of the CINMS. A total of 56%, according to the SWFSC survey, or 33%, according to the CDFG survey of the harbor seal population south of Pt. Sal surveyed in 2002 is within the current CINMS boundaries. While Concepts 4 and 5 may offer greater potential protection for harbor seals at sea, these options do not include any additional haulout areas that are not currently within the sanctuary. Concept 3 encompasses the

haulout area at Pt. Conception; Concept 2 further incorporates the haulout areas at Pts. Arguello, Purisima, and Sal, and one site just west of Santa Barbara; and Concept 1 includes all of these haulout areas, plus one additional site near Point Hueneme. The CDFG data shows an additional site located between Santa Barbara and Ventura that is included only in Concept 1. The OAI calculations (Table 6.2.2) convey that Concepts 2 (based on the SWFSC data) or 3 (based on CDFG data) offer the greatest relative increase in harbor seal abundance for the smallest relative increase in area.

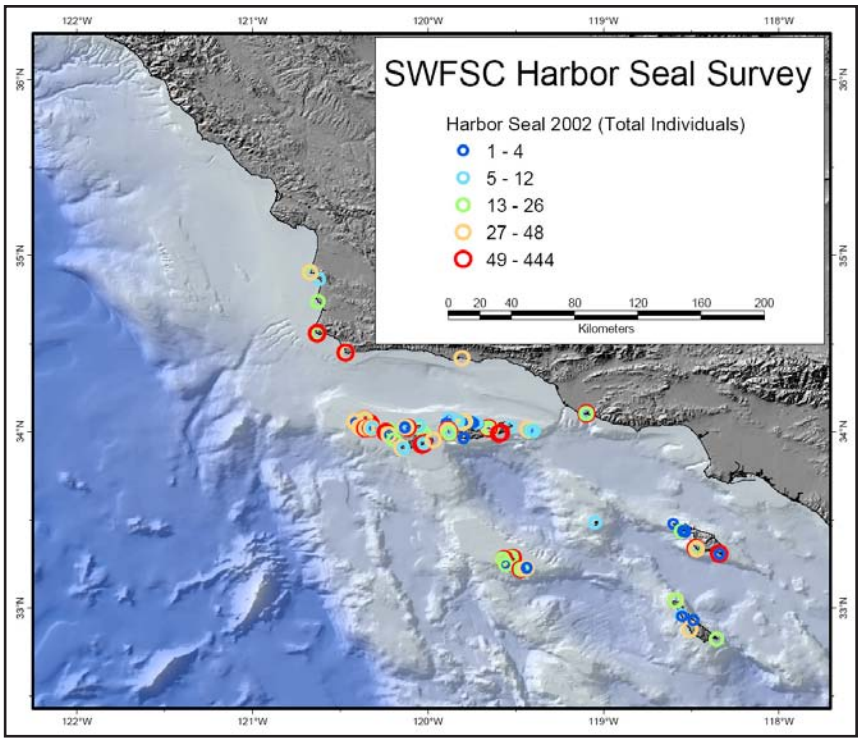


**Figure 6.2.3.** Pacific harbor seal. Total number of individuals counted (all sex and age classes) at each surveyed site for the 2002 SWFSC census.

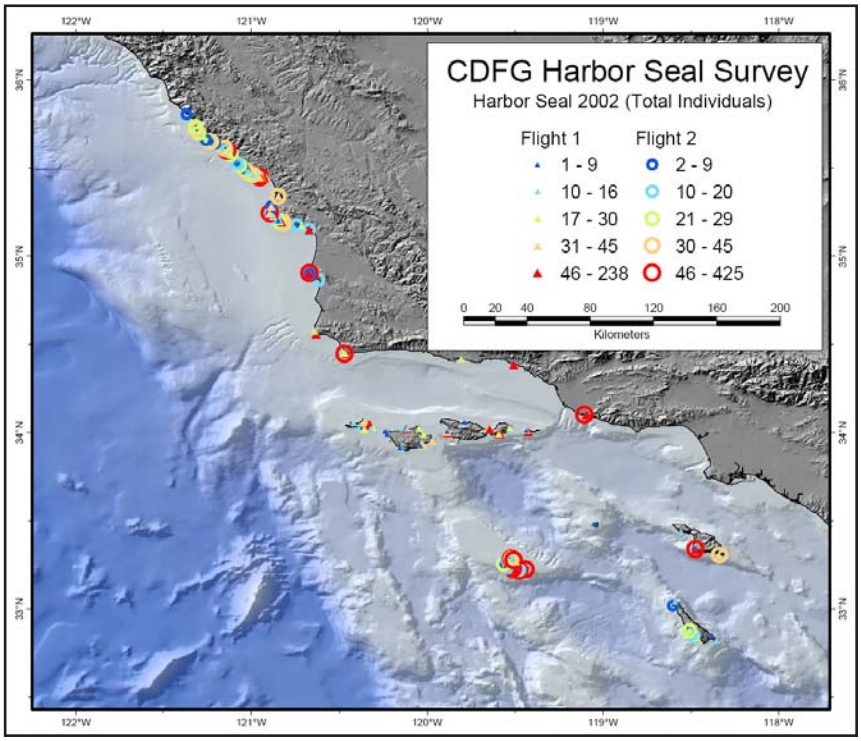


**Figure 6.2.4.** Pacific harbor seal. Total number of individuals counted (all sex and age classes) at each surveyed site for the 2002 CDFG census.

**Northern elephant seal**

Northern elephant seal summary maps are presented in the same manner as those described for California sea lion, in that they depict maximum recent usage calculated as the maximum number of individuals or pups counted at a beach area out of the three most recent surveys. The haulout and rookery areas for northern elephant seal represent all known consistently used locations in southern California (M. Lowry, pers.comm.). The results of these surveys conducted since the early to mid 1980s (depending on the island) show that San Miguel Island is consistently the largest elephant seal rookery in the Southern California Bight (Lowry, 2002).

Major haulout areas (top two quintiles: 211-5,223 individuals at maximum recent use) for Northern elephant seal exist on San Miguel, San Nicolas, and Santa Rosa Islands (Figure 6.2.5). Additional less populated haulout areas (less than 211 individuals at maximum recent use) exist on Santa Barbara and San Clemente Islands.

Major rookery areas (top two quintiles: 148-2794 pups at maximum recent use) exist on San Miguel, San Nicolas, and Santa Rosa Islands (Figure 6.2.6). Additional less-populated rookery areas (less than 148 pups at maximum recent use) exist on Santa Barbara and San Clemente Islands.

There are no differences among the boundary concepts in terms of the number of elephant seal haulout or rookery sites encompassed. However, this data cannot account for differences which may exist in the at-sea abundance of northern elephant seal within the different concepts.

**Table 6.2.2.** Pacific harbor seal. Total number of individuals, total area, and Optimal Area Index (OAI) for each boundary concept for SWFSC and CDFG 2002 surveys. Abundance values in bold reflect increases from the NAC and shaded OAI values represent maximum observed benefit.

| Concept | Area ($km^2$) | Total Individuals SWFSC | Total Individuals CDFG | Δ Individuals SWFSC (%) | Δ Individuals CDFG (%) | Δ Area (%) | OAI SWFSC | OAI CDFG |
|---|---|---|---|---|---|---|---|---|
| NAC | 3745 | 2943 | 1361 | - | - | - | - | |
| 5 | 4536 | 2943 | 1361 | 0 | 0 | 21.12 | 0 | 0 |
| 4 | 7981 | 2943 | 1361 | 0 | 0 | 113.11 | 0 | 0 |
| 3 | 9044 | **3431** | **1965** | 16.58 | 44.38 | 141.50 | 0.12 | 0.31 |
| 2 | 13736 | **3894** | **2263** | 32.31 | 66.27 | 266.78 | 0.12 | 0.25 |
| 1a | 22591 | **4181** | **2897** | 42.07 | 112.86 | 503.23 | 0.08 | 0.22 |
| 1 | 22613 | **4181** | **2897** | 42.07 | 112.86 | 503.82 | 0.08 | 0.22 |
| *SA* | *17093* | *4181* | *2897* | *42.07* | *112.86* | *356.42* | *0.12* | *0.32* |

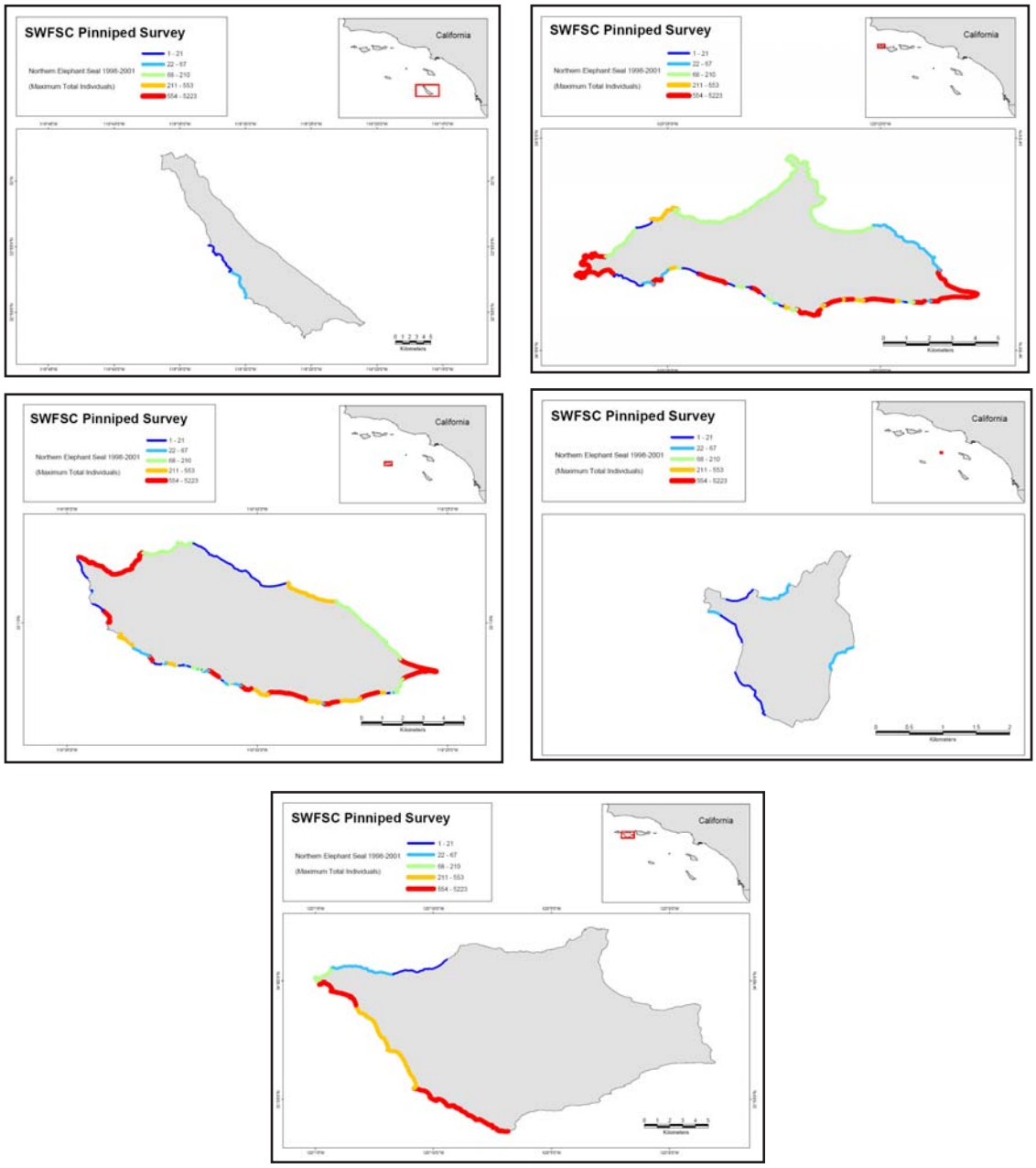


**Figure 6.2.5.** Northern elephant seal. Maximum total individuals (greatest number of individuals of all sex and age classes counted for each beach area surveyed out of the three most recent SWFSC surveys 2001-2003) for (left to right) San Clemente, San Miguel, San Nicolas, Santa Barbara, and Santa Rosa Islands.

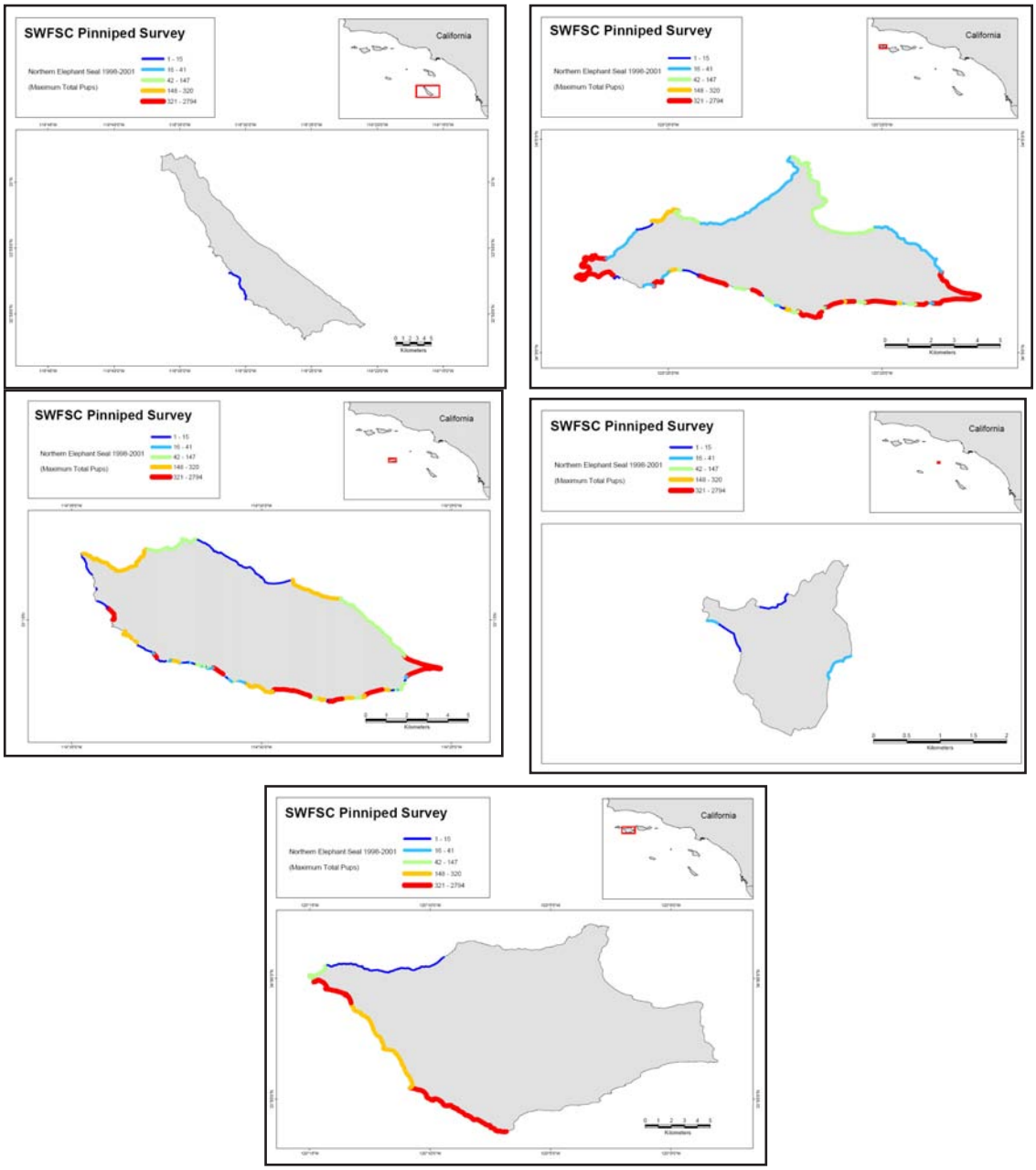


**Figure 6.2.6.** Northern elephant seal. Maximum pups (greatest number of pups counted for each beach area surveyed out of the three most recent SWFSC surveys 2001-2003) for (from left to right) San Clemente, San Miguel, San Nicolas, Santa Barbara, and Santa Rosa Islands.

### Southern sea otter

Southern sea otter summary maps (Figure 6.2.7) show fall 2001 and spring 2002 distributions of sea otters along the California mainland. Georeferenced survey data within the Channel Islands were not available; however, the U.S. Fish and Wildlife Service does survey the San Nicolas Island experimental population approximately every two months (Carretta *et al*., 2002). The most recent recovery plan (USFWS, 2003) for this species estimates a population size of 27 individuals for the San Nicolas Island colony and states that more than 70 births have been recorded at this colony between 1987 and 2002. Sea otters have also been sighted irregularly near Point Bennett on San Miguel Island, with 14 individuals from this area captured and relocated between 1990 and 1993. More recently, 4 individuals were recorded in this area in a 1999 aerial survey, and no sightings were recorded during a September 2001 ground survey (USFWS, 2003). Historical expansion of the Southern sea otter's range (Figure 6.2.8) suggests that the mainland coast near the CINMS may provide increasingly important habitat for sea otter as the population grows; however, a three-year moving average (Figure 6.2.9) of the census results suggests that the population is not currently growing (USFWS, 2003).

Substantial differences exist among the six boundary concepts in terms of their potential impacts on sea otters. The current boundaries and Concepts 4 and 5 include only the small population at San Miguel Island. Reli-

able estimates of the size of this population are not available. For comparisons of boundary concepts, the higher 1999 aerial survey estimate of 4 individuals was used. To evaluate the sensitivity of the boundary concept analysis to this estimate, a high estimate of 25 individuals for the San Miguel Island population was also tested. While the absolute values of the OAI depend on the estimated population size within the current boundaries, the relative value of the OAI among concepts is not affected, therefore results (Table 6.2.3.) are shown only for calculations based on the estimate of 4 individuals within current boundaries.

Concepts 1, 1a, 2, and 3 all include portions of the mainland coast. To the extent that sea otter protection is a goal of the CINMS, Concepts 1, 1a, and 2 offer the greatest benefit. All of these options incorporate portions of the coast between Point Conception and Point Sal, which is in the primary range of the Southern sea otter. At this point in time, Concepts 1 and 1a appear to encompass little additional sea otter habitat than that encompassed by Concept 2. If the Southern sea otter's range continues to expand, however, the additional section of mainland coast to the south of Santa Barbara that is included in Concepts 1 and 1a may become important habitat. Although the coast south of Point Conception was designated as an otter management zone in 1986 (USFWS, 2003), and otters found in this zone were originally translocated out of the zone, this practice has been discontinued. Based on the most recent available surveys of sea otters, Concept 2 provides the greatest benefit in terms of sea otters encompassed by the boundaries for the smallest relative change in area. The OAI results support this conclusion for both the spring and fall survey data.

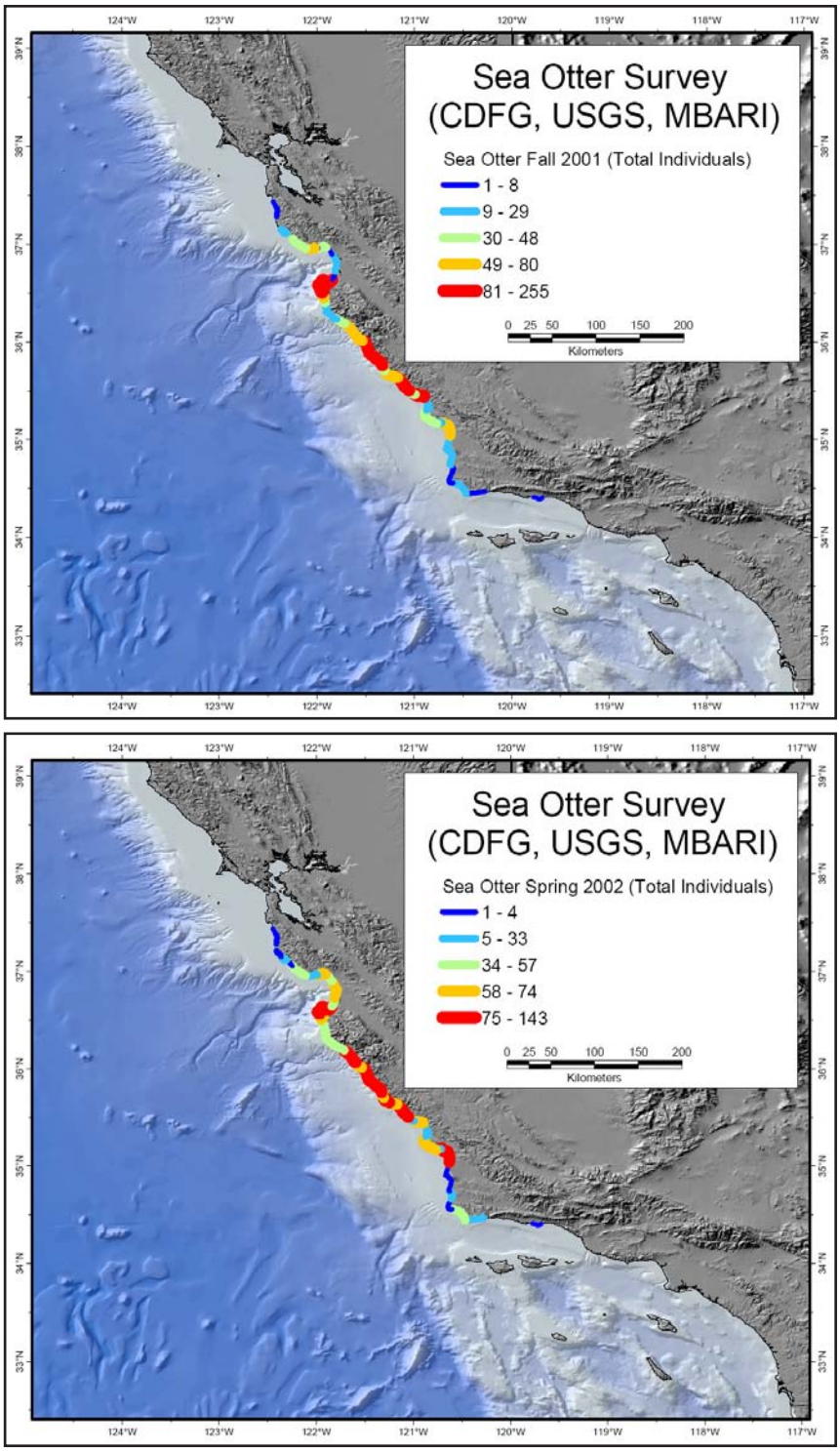


**Figure 6.2.7.** Southern sea otter. Counts summarized by 20 km shoreline segment for Fall 2001 (top) and Spring 2002 (bottom) surveys conducted by CDFG, USGS-Biological Resources Division, and the Monterey Bay Aquarium.

**Summary**

• The current boundaries of the CINMS encompass important haulout and rookery areas for California sea lion, harbor seal, northern elephant seal, and northern fur seal.

• San Miguel Island is used by all of these pinnipeds and has some of the most heavily used haulout and rookery areas in southern California for California sea lion, northern elephant seal, and northern fur seal.

• Although reliable estimates of at-sea distributions of pinnipeds at a scale useful for evaluating boundary concepts are not available, much of the waters surrounding the CINMS is likely to be important transit and foraging habitat for pinnipeds.

• Of the six boundary concepts being considered, Concepts 2 and 3 provide relatively large increases in harbor seal abundance within their boundaries relative to area.

• Expansion of the CINMS to include sections of mainland coast (Concepts 1, 1a, 2, and 3) would substantially increase the amount of occupied sea otter habitat within sanctuary boundaries. Of the six boundary concepts being considered, Concept 2 provides the greatest relative increase in sea otter abundance per area added.

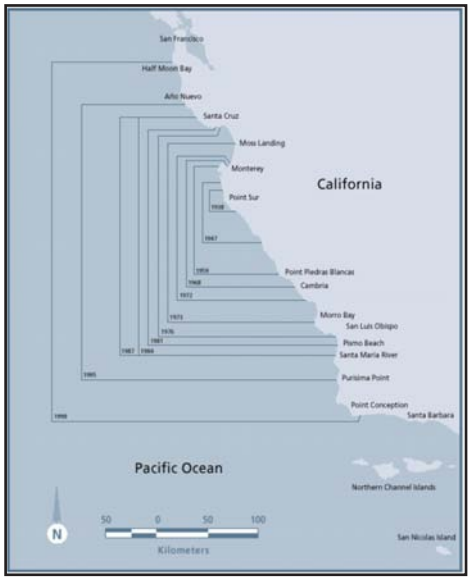


**Figure 6.2.8.** Southern sea otter. Expansion of sea otter range in California from 1938 to 1998. Reprinted with permission from The Otter Project Inc.

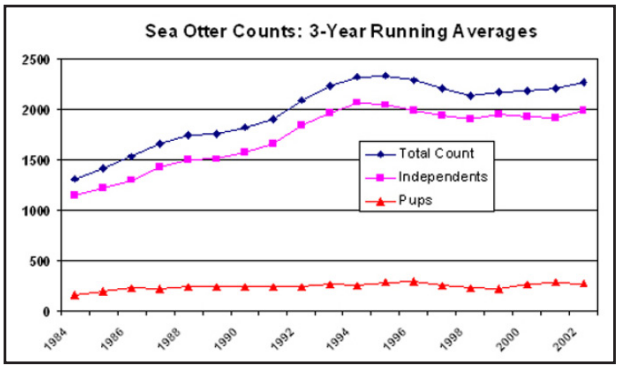


**Figure 6.2.9.** Southern sea otter. Three-year moving average of spring sea otter survey counts since 1984. Reprinted with permission from the USGS Western Ecological Research Center.

**Table 6.2.3.** Southern sea otter. Total number of individuals, mainland encounter rates, total area, and OAI for each boundary concept for Fall 2001 and Spring 2002 survey. Numbers in bold indicate an increase from the NAC and shaded OAI values represent maximum observed benefit.

| Concept | Area ($km^2$) | Individuals (spring) | Spring Encounter Rate (#/km) | Individuals (fall) | Fall Encounter Rate (#/km) | Δ Area (%) | Δ Individuals (spring) | Δ Individuals (fall) | OAI Spring (absolute) | OAI Fall (absolute) |
|---|---|---|---|---|---|---|---|---|---|---|
| NAC | 3745 | 4 | NA | 4 | NA | - | - | - | - | - |
| 5 | 4536 | 4 | NA | 4 | NA | 21.12 | 0 | 0 | 0 | 0 |
| 4 | 7981 | 4 | NA | 4 | NA | 113.11 | 0 | 0 | 0 | 0 |
| 3 | 9044 | **11** | **1.6** | **6** | 0.4 | 141.50 | 175 | 50 | 1.24 | 0.35 |
| 2 | 13736 | **89** | **0.62** | **41** | 0.46 | 266.78 | 2125 | 925 | 7.97 | 3.47 |
| 1a | 22591 | **92** | **0.55** | **58** | 0.425 | 503.23 | 2200 | 1350 | 4.37 | 2.68 |
| 1 | 22613 | **92** | **0.55** | **58** | 0.425 | 503.82 | 2200 | 1350 | 4.37 | 2.68 |
| *SA* | *17093* | *92* | *0.55* | *58* | *0.425* | *356.42* | *2200* | *1350* | *6.17* | *3.79* |

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