## ABOUT THESE MAPS

These maps provide a comparison of the density and spatial patterns for two marine bird species, California Brown Pelican and Black-vented Shearwater, during an intense El Niño warm-water event (1997-98) and an adjacent and intense La Niña cool-water event (1999-2000); the distributions for these two species is centered in warmer-water areas, south of the study area. This comparison provides an example of how two marine bird species that prefer warmer waters may respond to short-term anomalies from the usual marine climate. Also see also Figure 3.47, which has the same time periods of data as this comparison, but with two species that generally occur in relatively cooler waters than the species described here. See Methods below for time periods used.

Densities are based on combined data of several studies (see "Data Sources and Methods" below). The color and mapping intervals were customized to show the most structure and highlight significant areas. Cells that were surveyed but in which no birds were observed have a density of zero; areas not surveyed are shown in white. Blue lines indicate the National Marine Sanctuary boundaries of Cordell Bank, Gulf of the Farallones, and Monterey Bay; bathymetric contours for the 200 m and 2,000 m isobaths are also shown in light blue.

## DATA SOURCES AND METHODS

The at-sea data set is referred to as the CDAS central California data set (1980-2001) and was developed using software called Marine Mammal and Seabird Computer Data Analysis System (CDAS), by the R.G. Ford Consulting Co. The data set extends from Pt. Arena to Pt. Sal in the study area, and the surveys used were conducted between 1980 and 2001. See the Data and Analyses section of this chapter for more information on the at-sea survey data sets and methods.

Estimating Density for the Two Temperature Periods. Two criteria were used to select the cool and warm periods within the CDAS data set: 1) intensity (looking for an intense warm or cool); and 2) adjacent time periods (so long-terms changes in populations were not involved in the species occurrence patterns). Densities for each of the two species were mapped for the following time periods: for the El Niño condition, the period of the Oceanic Season 1997 through the Upwelling Season 1998 was used; for the La Niña condition, the Oceanic Season 1998 through the Upwelling Season 2000 was used. For a description of how these warm and cool periods were chosen, see Table 3.4 and the "Response to Variation in Marine Climate" in the introduction of this chapter.

## RESULTS AND DISCUSSION

Species such as California Brown Pelican, Black-vented Shearwater and Black Storm-Petrel are zoogeographically centered to the south of central California, where waters are normally warmer and food availability is relatively low. These species move north into central California waters when warmer ocean temperatures expand northward. Many of these individuals have foregone breeding owing to depleted food availability, which is often more extreme in areas to the south, where these species breed.

Shown here are comparisons of spatial patterns in density for California Brown Pelican and Black-vented Shearwater during the short-term, warm-water period. In both cases, densities were higher in central California during the El Niño. And although not reflected in this data, during warm-water conditions the range of California Brown Pelican expands as far north as the Columbia River and sometimes farther; Black-vented Shearwaters, however, do not go much farther north than central California waters.

The response of these species to short-term, cold-water conditions (e.g, La Niña) is less dramatic, but a difference was evident in the Black-vented Shearwater maps; this species density and overall occurrence was lower during cool-water conditions.