

### ABOUT THESE MAPS

These maps provide a second comparison of the density and spatial patterns of two marine bird species, Fork-tailed Storm-Petrel (maps a and b) and Black-legged Kittiwake (maps c and d), during an intense El Niño (~1997-1998) and an adjacent La Niña (1999-2000). See Methods below for explanation of time periods used. This comparison provides an example of how two marine birds that prefer cooler waters may respond to short-term excursions from the usual marine climate. See also Figure 3.46, which has the same time periods of data as this comparison, but with two species that occur in relatively warmer waters than the species described here.

Densities are based on combined data of several studies; see the Data and Analyses section of this chapter. 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-term 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 El Niño, the period of the Oceanic Season 1997 through the Upwelling Season 1998 was used; for La Niña, the Oceanic Season 1998

through the Upwelling Season 2000 was used. See Table 3.4 for information on how ocean seasons were classified in terms of warm, cool or neutral.

### RESULTS AND DISCUSSION

Fork-tailed Storm-Petrels and Black-legged Kittiwakes are more northern species and prefer cooler waters. In response to the water temperature change from relatively warm to cool in 1998 to 1999, these two species apparently preferred the cooler, central California waters of the 1999-2000 La Niña over the waters of the El Niño event in 1997-1998 (compare maps a and b for Fork-tailed Storm-Petrel and maps c and d for Black-legged Kittiwake). During the cooler conditions, both species were more numerous off central California.