ABOUT THESE MAPS

Maps a, b and c show the at-sea density (birds/km^2) of Double-crested Cormorant (*Phalacrocorax auritus*) in three ocean seasons – Upwelling, Oceanic, and Davidson Current, displayed in cells of 5' latitude by 5' longitude. Densities are based on the combined data sets of several studies; see the Data and Analyses section of this chapter. The color and mapping intervals were selected to show the most structure and highlight significant areas, while allowing comparisons among marine bird species. Cells that were surveyed but in which no Double-crested Cormorants were observed have a density of zero. Areas not surveyed appear white; no information was available. Blue lines indicate the boundaries of the National Marine Sanctuaries in the study area: Cordell Bank, Gulf of the Farallones and Monterey Bay. Bathymetric contours for the 200 m and 2,000 m isobaths are shown in light blue.

In order to provide an integrated look at the patterns of a species' spatial and temporal occurrence and abundance in the study area, map d shows seasonal high-use areas, displayed in cells of 10' latitude by 10' longitude, and also breeding colonies (when available). The seasonal high use map provides a further synthesis of densities presented in maps a, b and c, and portrays the relative importance of various areas to the species. Areas with consistently high use are highlighted. See the Data and Analyses section of this chapter for further explanation of high-use areas.

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.

Data on colony sizes were recently updated and obtained from Capitolo *et al.,* (2004a and b, 2006). Previous data came from Carter *et al.,* (1992). Aerial photographic surveys of most colonies were conducted in late May to early June by the U.S. Fish and Wildlife Service in cooperation with Humboldt State University and California Department of Fish and Game. Counts from photographs were made in most, but not all years for a given colony. Colonies that cannot be surveyed from the air, such as the bridges in San Francisco Bay, are counted from boats. To estimate breeding population sizes, nest counts were multiplied by two to account for both members of each nesting pair.

RESULTS AND DISCUSSION

The Double-crested Cormorant on the North American West Coast (outside of Mexico) is not usually a "marine" species; perhaps because, unlike the East Coast, the marine niche is occupied by other, more numerous cormorant species (inshore/coastal - the Pelagic Cormorant, and farther offshore, the Brandt's Cormorant). Along most of the East Coast (not including Central America), only the Double-crested Cormorant is present, except in the very far north (e.g., Newfoundland), where the Great Cormorant (*P. carbo*) occurs too. Along the central California coast, Double-crested Cormorants occupy and feed mainly in estuaries. However, a population does nest during the Upwelling Season at the South Farallon Islands, and thus accounts for much of the offshore occurrence of this species (commuting individuals) especially in the Gulf of the Farallones. A few Farallon individuals feed adjacent to the coast, but most commute to Tomales and San Francisco bays.

At-sea surveys in CDAS tallied 140 sightings of 352 individuals in marine waters of the study area; making this an uncommon species at sea. The species is more common in San Francisco Bay, where colonies occur on bridges, power transmission towers, and other man-made structures, such as structures on Alcatraz. A multiple regression model of nine independent variables explained 9.7% of the variation in density, with season being the most important variable; see Table 3.8. Like the other cormorant species, the Double-crested Cormorant was most abundant during the Upwelling Season and decreased dramatically from marine waters during the Oceanic Season. It was virtually absent from marine waters during the Davidson Current Season, being found then only in San Francisco Bay (distribution not shown) and at inland water habitats. This pattern was due to their departure from the Farallones abruptly after the breeding season. Then, most individuals remain inside San Francisco, Tomales or other coastal bays, or frequent adjacent reservoirs.

Several large breeding colonies occur in San Francisco Bay, South Farallon Islands, and Morro Bay; ssee also Appendix 1A. Most colonies are associated with estuaries. At breeding colonies, this species has increased substantially in the last 25 years as it recovers from historical declines (Carter *et al.,* 1992, 1995; Capitolo *et al.,* 2004).

Double-crested Cormorants feed principally on schooling fish that they catch by diving to mid-depths in shallow water. See Tables 3.5 and 3.11 for related summary information.