



Figure 4.21. Map for blue whale: sightings and survey effort data from the CDAS central California data set (1980-2003).

**ABOUT THIS MAP**

Figure 4.21 shows the individual sightings of blue whales (*Balaenoptera musculus*) at sea, along with at-sea survey effort from the CDAS data set (1980-

2003). Due to insufficient sightings in the CDAS data set (88 sightings of 133 individuals) for the study area, density maps were not generated for the

blue whale. At-sea sightings for cetaceans are from several studies (see “Data and Analyses” section of this chapter). For context, the combined survey effort is also shown, summarized in 10'x10' cells.

### DATA SOURCES AND METHODS

At-sea sightings and effort for the blue whale are based on the CDAS central California data set (2003), developed using software called Marine Mammal and Seabird Computer Data Analysis System (CDAS), by the R.G. Ford Consulting Co. This data set contains data from eight survey programs (five aerial surveys, three ship surveys) conducted between 1980 and 2003; the data extends from Pt. Arena to Pt. Sal in the study area. See the Data and Analyses section of this chapter for information on the at-sea survey data sets and mapping methods used.

### RESULTS AND DISCUSSION

The blue whale is listed as a Federally endangered under the Endangered Species Act. One population of blue whale of the Eastern North Pacific Stock (there may be as many as five populations - Carretta *et al.*, 2001; Reeves *et al.*, 1998) is present in waters off California generally from June through November; this population migrates south to waters off Mexico and as far south as the Costa Rica Dome. Arrival and departure times in the study area are highly variable both seasonally and interannually (Benson *et al.*, 2002; Calambokidis *et al.*, 1998). Based on best estimates of the average of ship line-transect and mark-recapture estimates, the population is estimated to be 1,744 (CV=0.28) (Carretta *et al.*, 2006).

Due to insufficient sightings in the CDAS data set for the study area, seasonal maps of blue whale density were not generated. Movement patterns, distribution, and occurrence of blue whales off California are related to their annual migration between foraging areas predominately off central California (but some north to British Columbia and south to Baja Mexico and the Costa Rican Dome), and the following breeding areas: 1) off the west coast of Baja California (September-December); 2) the Gulf of California (January-April); and 3) the Costa Rica Dome (Mate *et al.*, 1999). Although blue whales are often present in parts of all three central California National Marine Sanctuary waters, mostly from June through November, their occurrence and distribution during this feeding period is highly variable. Ninety-eight percent the sightings in the CDAS data set were in the Upwelling and Oceanic seasons, and most were in the Oceanic season.

In general, the absence of sightings of this species in the CDAS data set may reflect the distribution of

spatial and temporal survey effort rather than absence from the survey area; the maps shown do not reflect the total distribution of the species in the study area.

See an additional map for this species in Figure 4.31, from NOAA's Southwest Fisheries Science Center stock assessment surveys (July-December, 1991, 1993, 1996 and 2001). This map provides additional information on the range of the species off the coasts of California, Oregon and Washington.

Blue whales aggregate and feed in areas where seasonally abundant and dense euphausiids (krill) occur at discrete depths in the water column (Benson *et al.*, 2002). Krill concentrate in the deep scattering layer along canyon and shelf-break edges, and in the daytime, move to the surface in swarms (Schoenherr, 1991; Croll *et al.*, 1998; Forney and Barlow, 1998). Blue whales are widely distributed from the shelf to the deep ocean, but in the study area, these whales were mostly in shelf-break and slope habitats. Blue whales occur in and beyond all three national marine sanctuaries in the study area. Though not directly shown in the data on this map, blue whales do occur in the Cordell Bank National Marine Sanctuary and off Bodega Bay (Calambokidis *et al.*, 1990b; Calambokidis *et al.*, 1998), as well as in waters around the Farallon Islands (Keiper, pers.comm.). However, occurrence is highly variable.

There is considerable interchange and interregional movements between blue whales that occur off southern California (from the Santa Barbara Channel and Southern California Bight) to areas in the Monterey Bay, Gulf of the Farallones, Bodega Bay, and northern California (Calambokidis *et al.*, 1998). In a study of the Monterey Bay area (Benson *et al.*, 2002), occurrence of blue whales in Monterey Bay was related to seasonal upwelling patterns that affect seasonally abundant, dense (and ephemeral) patches of euphausiids that occur during summer and fall (Benson *et al.*, 2002).

Human-related sources of mortality for blue whales include ship strikes (0.2 per year for 1998-2002) (Carretta *et al.*, 2006); this appears to be less than the calculated Potential Biological Removal (PBR) for this stock. No blue whale mortality or serious injury has been associated with the California gillnet fisheries, so total fishery mortality is near zero.

The increasing levels of anthropogenic noise in the world's oceans has become a habitat concern for this species (Carretta *et al.*, 2006).