

OCCURRENCE PATTERNS AND TRENDS OF CETACEANS RECORDED FROM SOUTHEAST FARALLON ISLAND, CALIFORNIA, 1973 TO 1994

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ABSTRACT—We summarize 22,682 observations of 15 species of cetaceans from Southeast Farallon Island off San Francisco, California, 1973 to 1994. Gray whales (*Eschrichtius robustus*) accounted for 63% of the observations. Most of these were of migrant individuals in the winter and spring, but up to 10 summer/fall residents were also recorded around the island each year. The other 14 species were recorded primarily from July to November. Observations of all cetaceans and of several different species increased significantly during the 22-yr period. These increases may be related to population recoveries due to protection of the large whale species, possible increases or changes in food resources in the Gulf of the Farallones region, possible observer biases, or likely, a combination of these factors. The occurrence of Pacific sardine (*Sardinops sagax*) in the region during the last three years of the study may have resulted in changes in the distributions of several species.

Southeast Farallon Island (SEFI; 37°42'N, 123°00'W), 48 km west of San Francisco, California, is located in a highly-productive, eastern boundary current system (Thompson 1981). The nutrient-rich waters around SEFI host large stocks of zooplankton, krill, and fish (Brinton 1962; Bolin & Abbott 1963; Parrish and others 1981), which in turn support large numbers of breeding seabirds and pinnipeds on the island (Ainley & Boekelheide 1990; Stewart and others 1994). Whales also have been recorded in the surrounding Gulf of the Farallones, both during migration and while foraging in the area (Pike 1962; Dohl and others 1983; Dohl 1984; Baker and others 1986; Huber and others 1986; Calambokidis and others 1989, 1990). Since 1986, humpback whales (*Megaptera novaeangliae*) and blue whales (*Balaenoptera musculus*) have been surveyed and photographed off California, including the SEFI region, during June through November each year (Calambokidis and others 1990, 1993). Otherwise, little has been published on the year-round occurrence patterns, long-term trends, or biological roles of these and other cetaceans in the Gulf of the Farallones marine ecosystem.

Biologists from the Point Reyes Bird Observatory (PRBO) have been stationed on SEFI continuously since 1968, participating in daily censusing of bird occurrence on the island (Pyle and Henderson 1990). Since 1973, all cetaceans observed from the island also have been recorded on a daily basis. In this paper we summarize occurrence patterns of 15 species of cetaceans in the Gulf of the Farallones, based on our 22-yr survey from SEFI. Seasonal and inter-annual variation of the more abundant species are assessed, along with long-term population trends in the Gulf of the Farallones.

METHODS

Each day from 1973 through 1994, the species and estimated totals of all cetaceans observed from SEFI were recorded by PRBO biologists. All observations included the use of 10× binoculars and 25× telescopes to assist in identification and number counted. Only positive identifications at the species level were recorded, and daily totals were conservatively estimated when large numbers were present or the number observed was debated. Although there were no standardized cetacean observation procedures, seasonally constant numbers (from 3 to 8) of trained personnel on the island consistently scanned sur-

rounding waters during daily censuses of birds and other biological events, and a fairly standardized observer effort can be assumed for most of the period (see DeSante and Ainley 1980 and Ainley et. al. 1985 for further details corroborating a constant effort by SEFI personnel). An exception to this standard protocol occurred during the winter of 1986–1987, when numbers of migrating gray whales were not consistently recorded. Also, from 1987 to 1994, a monitoring program for white sharks (*Carcharodon carcharias*; Klimley et. al. 1992; Pyle and others 1996), during autumn may have resulted in increased observations of certain cetacean species (see Results). For this project, observers scanned surrounding waters for white shark activity, during all daylight hours, visibility permitting, from the lighthouse at an elevation 103 m atop the island. Before 1987, personnel visited the lighthouse less frequently to scan for cetacean activity; effort was not quantified during this period. The area covered for cetaceans ranged to 30 km on very clear days, but on average included the area within 15 km of the island. It is probable that observation skills varied slightly over the 22-yr period due to changes in personnel or possible increases in observer awareness of cetaceans. Such changes cannot be quantified, although we believe that they have had only a minor impact on our data. We use caution, however, in interpreting our data, particularly those of long-term trends. No standardized attempt was made to distinguish individual cetaceans. Thus, statistical analyses for this paper were based on the number of cetaceans observed per day (hereafter "observations"), irrespective of whether the same individuals may have been present on different days. A few individuals of certain species were recognized from day to day or year to year from behavior and unique marks or scars (see Katona & Whitehead 1981); thus, certain residency patterns, particularly of individual gray whales, could be inferred from repeat observations.

Linear trends were estimated from regression analyses on annual observation totals. To reduce skewness and to approximate a normal distribution, yearly totals ($N+0.5$) were log-transformed before regressions were performed. Non-linear trends were estimated by examining effects of quadratic year terms (year^2); a significant positive effect of these terms indicates an accelerating trend, whereas a significant negative effect indicates a decelerating trend. Means + SD are reported in the text. Statistics were performed using the STATA statistical program (Computing Resource Center 1992).

RESULTS AND DISCUSSION

From 1973 through 1994, 22,682 observations of 15 species of cetaceans were recorded from SEFI (Table 1). Observations of all cetaceans

TABLE 1. Cetaceans recorded from Southeast Farallon Island, California, 1973–1994. Mean group sizes are for species that occurred in cohesive groups.

Species	Total	Daily group size			SD	Dates observed
		Range	Mean			
Gray whale, <i>Eschrichtius robustus</i>	14,192	1–75	—			See text
Blue whale, <i>Balaenoptera musculus</i>	894	1–41	—			See text
Fin whale, <i>B. physalus</i>	12	1–2	—			Apr–Oct, 1974–1994
Sei whale, <i>B. borealis</i>	2	1	—			Jun 1974, Oct 1989
Minke whale, <i>B. acutorostrata</i>	116	1–4	—			See text
Humpback whale, <i>Megaptera novaeangliae</i>	2504	1–75	—			See text
Sperm whale, <i>Physeter macrocephalus</i>	8	1–5	—			Jun 1974, Aug 1988, Nov 1992
Baird's beaked whale, <i>Berardius bairdii</i>	15	15	—			Sep 1994
Orca, <i>Orcinus orca</i>	97	1–9	3.5	2.8		Feb–Nov, 1973–1992
Pacific white-sided dolphin, <i>Lagenorhynchus obliquidens</i>	702	2–150	70	54		Feb, Sep–Nov, 1985–1993
Common dolphin, <i>Delphinus delphis/capensis</i>	3294	2–530	235	211		Aug–Nov, 1973; 1985–1994
Risso's dolphin, <i>Grampus griseus</i>	440	15–125	49	39		Mar–May, Sep–Nov, 1986–1993
Northern right whale dolphin, <i>Lissodelphis borealis</i>	20	10	—			May 1986, Sep 1993
Harbor porpoise, <i>Phocoena phocoena</i>	68	1–35	9.7	12.1		Mar–Nov, 1982–1992
Dall's porpoise, <i>Phocoenoides dalli</i>	326	1–25	7.8	5.2		See text
Total	22,682					

excluding 1986 to 1987), although the negative correlation of this analysis indicates that the increase may have been decelerating (see Fig. 2). These trends reflect the well-documented increase in the gray whale population since the International Convention for the Regulation of Whaling imposed complete protection in 1947 (Reilly 1992; Buckland and others 1993). Our rate of increase was slightly greater than that of $3.29\% \pm 0.44\%$ (1968 to 1988) calculated by Buckland and others (1993) for gray whales migrating past Monterey County, about 270 km southwest of SEFI. Dohl (1979) provided evidence for an increase in offshore migration routes during the 1970s in the California Bight; it is possible that, if such a shift also occurred in central California, it may have contributed to the increase in numbers observed from SEFI.

The number of gray whales observed during the summer residency period varied both inter-annually and during the course of the summer period. We defined "resident" whales as those observed around the island for at least 2 wks during the residency period. The annual mean number of residents observed during the study period was $3.1 (\pm 2.3)$, ranging from none in 1986 to 10 in 1991 (Fig. 2). Most residents departed the island in June and July (Fig. 1) but some remained throughout the fall, until the onset of the southbound migration. Most residents appeared to be smaller animals, yearlings and subadults, although a very old and scarred animal remained around the island for June and July of 1988. One small resident with a unique scar near its blowhole remained throughout both the 1993 and 1994 residency periods. There was no significant trend in numbers of residents observed during the 22-yr period (Fig. 2; $t = 1.04$, $p = 0.310$). Dohl (1979) and Sumich (1984) discuss gray whales south of their normal summering range.

Blue Whale

We recorded 894 observations of blue whales (Table 1), although none were observed until 1978. Blue whales have been sighted from SEFI in all months except February to April, with most seen from August to November (Fig. 3). The mean date of occurrence for this period was 19 September ± 15.6 days. Peak counts were 41 on 3 October 1986 and 34 on 11 September 1994. Most blue whales near SEFI are likely part of the over-summering North Pacific

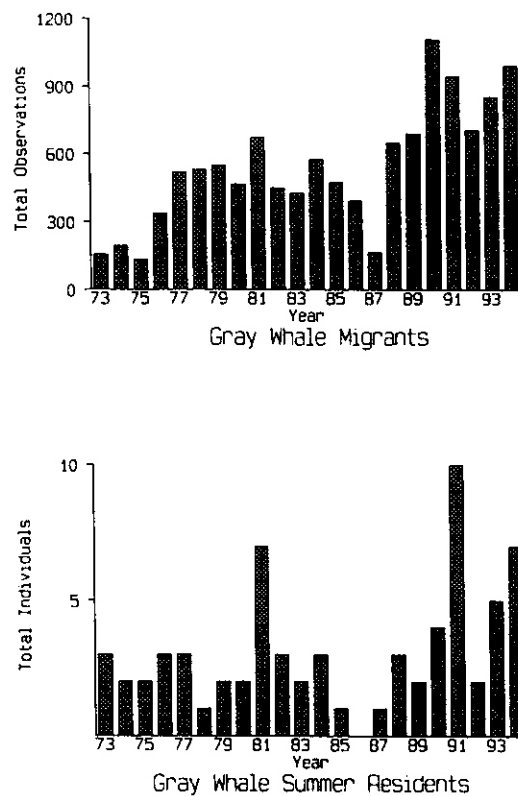


FIGURE 2. Inter-annual distribution and trends of migrant and summer resident gray whales observed from Southeast Farallon Island, California, 1973 through 1994.

population that visits central California from the tip of Baja California (Calambokidis and others 1990; Barlow 1994).

Since 1978, there has been a significant linear increase in sightings of blue whales from the island (Fig. 4; $t = 3.88$, $p = 0.001$; $t = 6.30$, $p < 0.001$ for 1973 to 1994); there was no curvilinear effect (quadratic year term, $t = -0.47$, $p = 0.646$ for 1978 to 1994). Substantial inter-annual variation occurred in numbers recorded (Fig. 4), which likely reflected differences in the distribution of food resources in the area (Calambokidis and others 1989). These data complement the observed increase of this species in the Gulf of the Farallones during the 1980s, attributed to possible increases in the population since protection in 1966 and a shift in the distribution of this species toward the California coast (Calambokidis and others 1990, 1993),

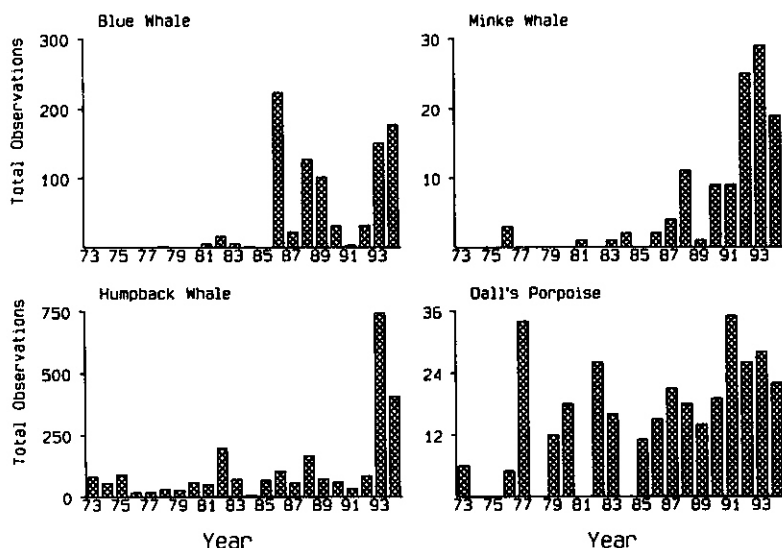


FIGURE 3. Seasonal distribution of four species of cetaceans observed from Southeast Farallon Island, California.

concurrent with a shift away from the Gulf of Alaska (Barlow 1994).

Minke Whale

Most observations of minke whales (*Balaenoptera acutorostrata*; Table 1) occurred from July through November (Fig. 3), with a mean fall date of 6 October \pm 20.8 days. Observations of

this species showed an accelerated increase during the 22-yr period (Fig. 4; linear trend, $t = 6.68, p < 0.001$; curvilinear trend, $t = 2.73, p = 0.013$). A high proportion of observations (92.2%) occurred after 1986, suggesting that the shark monitoring program affected our survey of this species. It is probable that the minke whale's brief and shallow surfacing be-

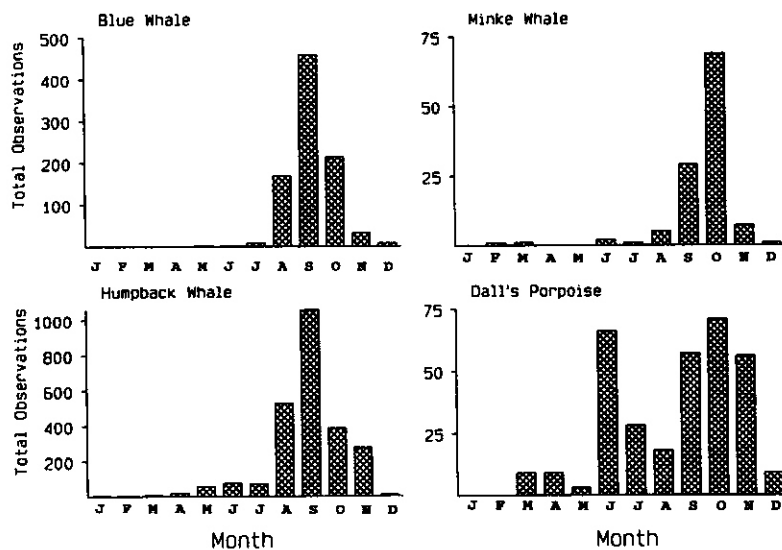


FIGURE 4. Inter-annual distribution and trends of four species of cetaceans observed from Southeast Farallon Island, California, 1973 through 1994.

