

# Sightings and Movements of Blue Whales off Central California 1986–88 from Photo-Identification of Individuals

J. Calambokidis<sup>1</sup>, G.H. Steiger<sup>1</sup>, J.C. Cabbage<sup>1</sup>, K.C. Balcomb<sup>2</sup>,  
C. Ewald<sup>3</sup>, S. Kruse<sup>4</sup>, R. Wells<sup>4</sup> and R. Sears<sup>5</sup>

## ABSTRACT

We summarize research into the relative abundance and movements of blue whales off central California using data from aerial surveys and photo-identification of individuals from vessels. The Gulf of the Farallones region (including north to Bodega Bay) was the primary study area; 1,457hrs of vessel surveys and 88hrs of aerial surveys were carried out from July to November 1986–88. Blue whales were seen on 776 occasions (1,315 animals, including duplicates). The relative abundance of blue whales in the Gulf of the Farallones increased over the three years. A total of 179 individual blue whales were photographically identified in the area from 1986 to 1988. Most individuals were identified in 1988 (101) and 1987 (75). Twenty-two (15%) of the identified whales were seen in more than one year and five (3%) were seen in all three years.

Blue whales were also individually identified in other regions of California (principally near Monterey Bay and Point Arena) using photographs taken on an opportunistic basis by the authors and collaborating researchers. In 1987 and 1988, five and three individuals, respectively were seen in both Monterey Bay and the Gulf of the Farallones; all but one travelled from Monterey Bay in August to the Gulf of the Farallones in late August and September. A large number of blue whales were seen north of the Gulf of the Farallones near Point Arena in middle to late October 1988 and 8 of the 17 animals identified were seen in the Gulf of the Farallones in September or October. Some of the blue whales identified in this study were also seen off Baja California, Mexico: nine animals seen in the Gulf of the Farallones were seen off the west coast of Baja or the Sea of Cortez, Mexico, including three identified in March and April of 1988 off Baja and seen in August or September 1988 in the Gulf of the Farallones or Monterey Bay.

## INTRODUCTION

The blue whale (*Balaenoptera musculus*) is an endangered species as a result of depletion from commercial whaling. The North Pacific population is reported to be 1,600 (National Marine Fisheries Service, 1987; Gambell, 1976), however, this estimate is based on a small number of sightings during whale scouting trips in the early 1970s (Wada, 1973; Omura and Ohsumi, 1974). Commercial whaling for blue and other whales continued off California through the early 1960s from shore-based whaling stations including two in San Pablo Bay (Rice, 1963). Little research has been conducted on North Pacific blue whales since the end of commercial whaling. Blue whale occurrence in the 19th and early 20th centuries off central California was noted by Scammon (1874) and Starks (1922). Sightings of blue whales along the central California coast have been reported since the late 1970s (Huber, Boekelheide, McElroy, Henderson, Strong and Ainley, 1982; Dohl, Guess, Duman and Helm, 1983; Webber and Cooper, 1983; Dohl, 1984; Szczepaniak and Webber, 1985; Smith, Dustan, Au, Baker and Dunlap, 1986; Rondeau, 1987; and Schoenherr, 1988).

Photo-identification of individuals has been possible for a number of large cetacean species and has recently been reported for blue whales (Sears, 1987; Sears, Wenzel and Williamson, 1987; Calambokidis, Kruse, Cabbage, Wells, Balcomb; Steiger, 1987 and Sears, Williamson and Wenzel, 1990). In this paper we use photo-identification data to provide information on the movements and site

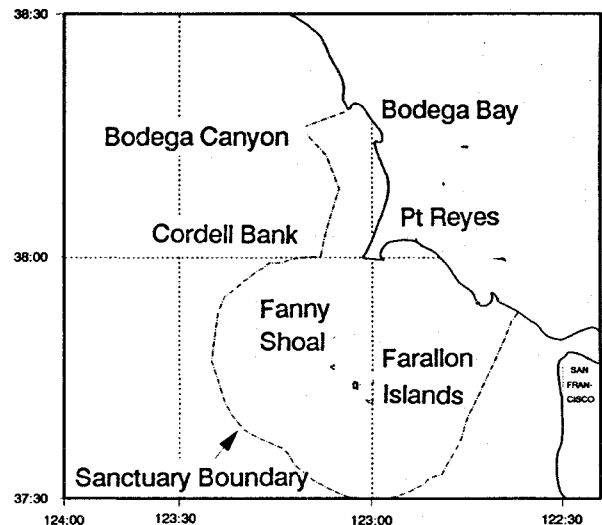


Fig. 1. Gulf of the Farallones region showing the boundary of the National Marine Sanctuary.

fidelity of whales in our study area (Fig. 1). Other findings from our blue whale research in the Gulf of the Farallones, including distribution, behavior, and length measurements, are reported elsewhere (Calambokidis, Steiger, Cabbage and Balcomb, 1989).

## METHODS

The primary study region was the Gulf of the Farallones north to Bodega Bay (Fig. 1). Individual blue whales were photographed during vessel surveys conducted in 1986–88. Three vessel types were used: (1) *Noctilio*, a 44ft motor sailer; (2) *Shachi*, a 19ft Boston Whaler; and (3) 14 and 16ft *Achilles* inflatable boats. Vessel effort is summarized in Table 1. Blue whales were also photographed and recorded

<sup>1</sup> Cascadia Research, 218½ W. Fourth Ave., Olympia, WA 98501, USA.

<sup>2</sup> Center for Whale Research, 1359 Smugglers Cove Rd, Friday Harbour, WA, 98250, USA.

<sup>3</sup> Farallon Research Associates, 76 Gates St., San Francisco, CA 94110, USA.

<sup>4</sup> Long Marine Laboratory, University of California, Santa Cruz, CA 94064, USA.

<sup>5</sup> Mingan Island Cetacean Study, 285 Green St., St Lambert, QC, J4P 1T3, CANADA.

Table 1

Summary of effort and blue whale sightings in 1986-88 in the Gulf of the Farallones. S=no. of sightings; W=no. of whales; Id=no. of identifications; D=no. of different individuals

Year	Effort		Blue whale sightings			Blue whales identified		
	Days	Hours	S	W	W.hr <sup>-1</sup>	Id	D	Id.D <sup>-1</sup>
<i>Vessels</i>								
1986	71	513	96	196	0.38	82	35	2.3
1987	58	460	209	338	0.73	136	75	1.8
1988	76	484	234	409	0.85	166	101	1.6
Total	205	1,457	539	943	0.65	384	179	2.1
<i>Aerial surveys</i>								
1986	9 <sup>a</sup>	33.5 <sup>a</sup>	27	51	1.5			
1987	7	25.4	75	105	4.1			
1988	6	22.8	135	216	9.5			
Total	22	81.7	237	372	4.6			

<sup>a</sup>includes flights of more than 1hr including transit time

during commercial nature trips to the Farallon Islands which were usually made from June through November. There was additional effort in Monterey Bay and other areas from a number of vessels on a more opportunistic basis. Aerial surveys were flown in 1986-88 in the Gulf of the Farallones in a *Cessna 172* (Table 1). Aerial surveys were primarily used to locate animals for vessel-based photo-identification work.

Individuals were identified primarily by mottling and scarring patterns on the back (Sears *et al.*, 1987; Sears *et al.*, 1990); both the left and right sides of the body near the dorsal fin were photographed, as were the flukes if presented. We used motor-advance 35mm cameras with lenses from 180mm f2.8 to 300mm f4.5, and *Kodak Tri-X* or *Ilford HP-5* black and white film. Shutter speeds were 1/1000 of a second or faster, when lighting conditions permitted. Film was exposed at an ISO rating of 1000, and development times were adjusted accordingly using Edwal FG7 1:1 with 9% sodium sulfite. Selected prints were enlarged on *Kodak RC* paper to facilitate comparison.

Photographs of blue whales taken off the coast of California and Mexico by other researchers (Table 2) were compared with those taken in this study. Most of these photographs were color transparencies. They were copied with a duplicator onto black and white negative film, and then printed as described above. Also included in this comparison were the photographs taken in the Sea of Cortez and other areas by members of the Mingan Island Cetacean Study. Results of these comparisons will be reported in more detail elsewhere but are summarized briefly here.

## RESULTS

During vessel surveys in the Gulf of the Farallones in three study seasons (1986-88), over 500 sightings of 943 blue whales were recorded (Table 1). Concurrent aerial surveys recorded 237 sightings of 372 blue whales. A total of 179 different blue whales were photographically identified in the Gulf of the Farallones from 1986 to 1988 (Table 1).

Table 2

Names of researchers, naturalists and photographers, including those who worked on this study, who contributed photographs that have been incorporated into the blue whale catalog

### *Cascadia Research Collective and Center for Whale Research*

K. Balcomb; L. Barry; S. Bartok; P. Bloedel; D. Bockus; J. Calambokidis; D. Claridge; J. Cabbage; G. Steiger; N. Wadsworth

### *Farallon Research Associates*

C. Ewald; P. Jones; B. Keener; I. Szczepaniak; M. Webber

### *Long Marine Laboratory*

D. Goley; S. Kruse; J. Ostman; R. Wells

### *Moss Landing Marine Laboratory*

N. Black; V. Dollarhide; T. Jefferson; T. Kieckhefer; C. Strong; C. Tanner; B. Tershy; B. Würsig

### *Other contributors*

B. Agler; C. Alvarez; A. Brady; R. Branson; H. Clarke; B. Elliot; M. Ezikial; L. Findley; P. Folkens; G. Friedrichsen; R.D. Harris; Hopkins-Lions; T. Johnson; J. Law; S. Leatherwood; M. Lippmeyer; F. Nicklin; D. Patten; R. Pittman; D. Robertson; H. Rondeau; D. Shearwater; R. Stallcup; J. Stern; R. Storro-Patterson; S. Swartz; M. Weinrich

## Abundance

Blue whale numbers increased in the study area during the three years of research. The three possible measures of abundance available from our data all showed an increase: (1) number and rate of blue whale sightings from aircraft; (2) number and rate of blue whale sightings from vessels; and (3) number of animals identified in each of the three years. Despite a small decrease in aerial survey coverage each year, the number of blue whales seen increased from 51 animals in 1986 to 216 in 1988. The effort-corrected sighting rate showed a 600% increase over the three-year period. Sightings from vessel surveys also increased, but not by as much. Because of the more consistent and broader coverage, we believe the increase revealed in the aerial survey data to be more representative of the entire study area. The number of individuals identified increased each year, from 35 in 1986 to 101 in 1988.

## Resightings

There were significant differences among years in the number of different days individual whales were seen within a year (Fig. 2, ANOVA,  $p < 0.001$ ). Individuals were seen on an average of 2.1 days ( $n=35$ ,  $SD=1.2$ ) in 1986 compared with 1.6 days ( $n=75$ ,  $SD=1.1$ ) in 1987 and 1.4 days ( $n=101$ ,  $SD=0.9$ ) in 1988. The frequency of resightings of individual blue whales was similar in 1987 and 1988 when over 70% of the blue whales identified were seen on only one day and about 10% of the whales were identified on 3 or more days. Resighting rates were higher in 1986, when only 45% of individuals were seen on only one day and more than 30% were seen on 3 or more days.

The differences in resighting patterns among the three years can also be seen in the rate at which new whales were initially identified (discovered) in each season (Fig. 3). The shallow slope for 1986 indicates that an increasing proportion of the whales identified through the year had been seen earlier in the season. This is consistent with a small stable number of blue whales residing in the study area in 1986. The steep slope (approaching 45 degrees) for 1988 indicates that only a small proportion of whales were reidentified during the season. As the effort was similar in all three years, this is consistent with the larger number of blue whales seen in the study area in each year.

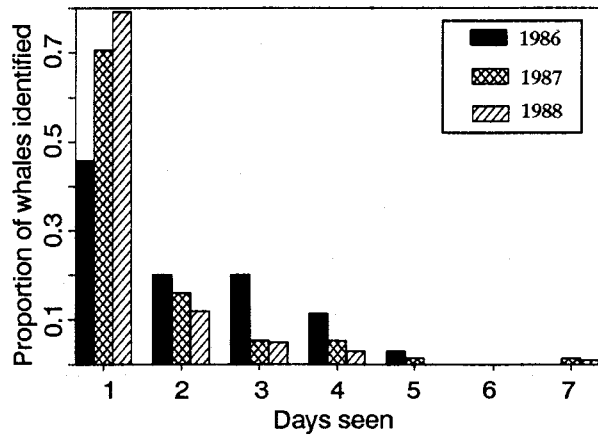


Fig. 2. Resighting frequencies of identified blue whales seen in the Gulf of the Farallones by year (1986-88).

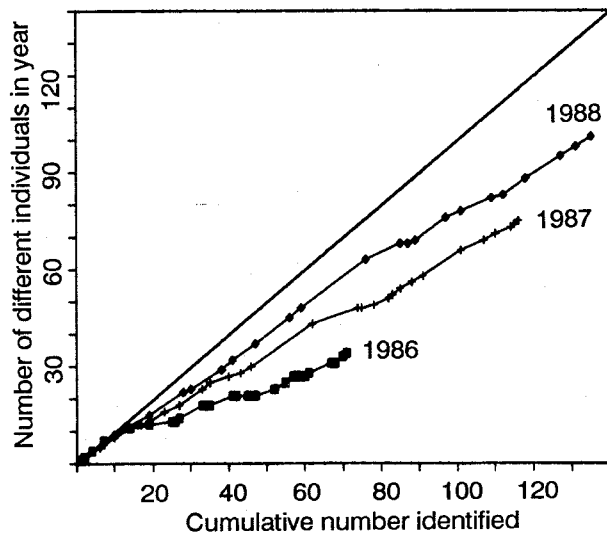


Fig. 3. Rate at which new whales were identified, or rate of discovery, in the Gulf of the Farallones region in 1986-88. The straight line shows the rate expected if all whales were seen on only one day (slope=1).

Some individual whales returned to the Gulf of the Farallones region in subsequent years. Twenty-two of 179 blue whales identified were seen in at least two of the three years (1986-88); five were identified across all three years. Resighting locations of two whales seen in all three years are shown in Fig. 4.

**Residency and site fidelity**

The sighting frequencies of individuals in 1987 and 1988 were higher for individuals that had been seen in a previous year. The average number of times an identified whale was seen in 1988 was significantly higher (t-test,  $p < 0.001$ ) for those whales seen in 1986 ( $n=11$ , mean=3.0, SD=2.9) compared to those not seen in 1986 ( $n=90$ , mean=1.5, SD=0.88). A similar difference (t-test,  $p < 0.001$ ) occurred for the 1988 sighting rates for whales that had been seen in 1987 ( $n=15$ , mean=2.7, SD=2.3) versus those not seen in 1987 ( $n=86$ , mean=1.5, SD=0.97). The sighting frequency of whales in 1987 followed a similar pattern (based on whether they had been seen in 1986) but the sightings rates were not significantly different (t-test,

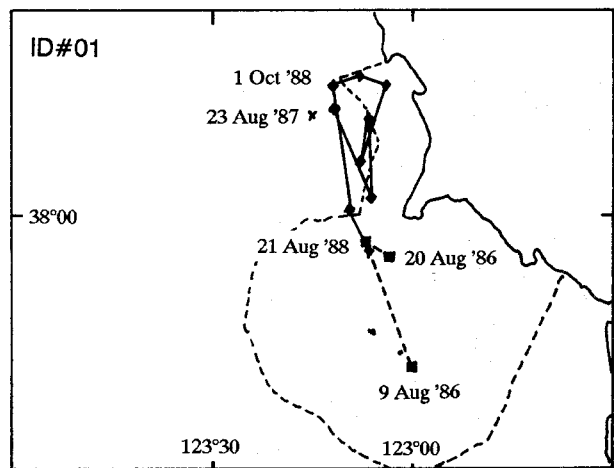
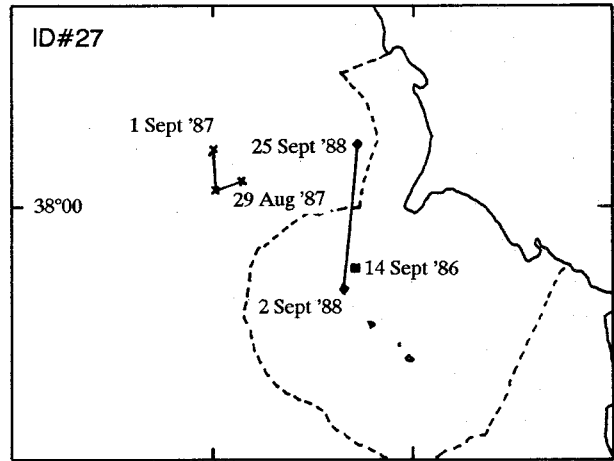


Fig. 4. Examples of seasonal and annual movements of individual blue whales in the Gulf of the Farallones region in 1986-88. Two individuals that were resighted in all three years (ID No.27 and No.01) are shown.

$p > 0.05$ ). In addition, of eight blue whales which had been individually identified in the Gulf of Farallones prior to our study, two (seen in 1984 and 1985) were identified there by us in both 1986 and 1987. These results suggest that a subgroup of blue whales regularly tends to return and stay longer in the Gulf of the Farallones. Consistent differences among individual whales in how easy they were to photograph, could also contribute to the observed patterns of resightings. This is unlikely, however, because we generally were able to photograph whales when we attempted to do so.

**Movements between areas**

Blue whales identified in the Gulf of the Farallones have also been seen off Monterey Bay (more than 60 n.miles to the south) and Point Arena (about 50 n.miles to the north) (Fig. 5). Eighteen identified whales were observed in both Monterey Bay and the Gulf of the Farallones and nine whales were sighted at both Point Arena and the Gulf of the Farallones. Many of the matches between Monterey Bay and the Gulf of the Farallones span a number of years; one animal identified in the Gulf in 1983 was seen in Monterey Bay in 1987 while an animal photographed by Gary Friedrichsen in Monterey Bay in 1975 was identified in the Gulf of the Farallones in 1986; an 11 year interval.

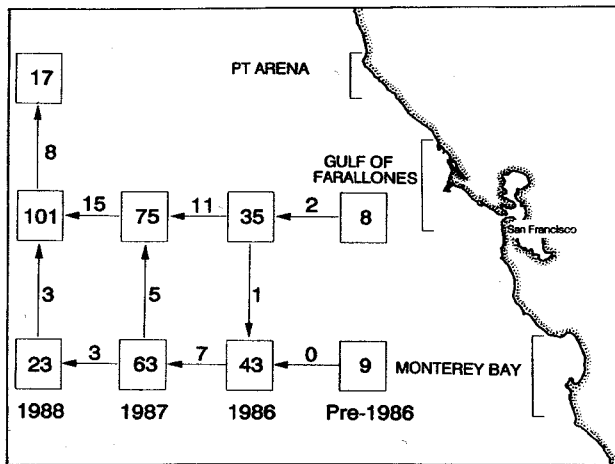


Fig. 5. Number of blue whales identified off central California by region and year (shown by the number in the boxes) and the number of matches among regions in the same year and between consecutive years for the same region are shown with arrows. The direction of the arrow indicates time (e.g. in 1988, blue whales were first identified in the Gulf of the Farallones and later off Point Arena). A second whale seen in 1986, first in the Gulf and then in Monterey Bay is not shown here but was part of the catalog of the Mingan Island Cetacean Study.

The movement of blue whales between the Gulf of the Farallones and Monterey Bay appeared to vary by year. However, little quantitative information on rates of interchange between these regions can be concluded from these results due to the sporadic effort in Monterey Bay.

In 1986, two blue whales were identified in August and September in the Gulf of the Farallones and then in mid-October in Monterey Bay. In 1987 and 1988, 5 and 2 blue whales, respectively, were identified in Monterey Bay in August and then seen in late August or early September in the Gulf of the Farallones. One individual in 1987 and one in 1988 followed a reverse course. Three animals moved between these regions in less than 15 days.

On 11 and 28 October 1988, 17 individuals were identified near Point Arena. Eight of these had been seen earlier in the year in the Gulf of the Farallones. The matching of almost half of the Point Arena whales with ones from the Gulf of the Farallones suggests a fairly cohesive movement of whales north from the study area. Two blue whales were identified in three regions (Gulf of the Farallones, Monterey Bay and Point Arena) in 1988.

Despite the movement of blue whales between Monterey Bay and Gulf of the Farallones there was a greater tendency for animals to return to the same area rather than go to other areas in consecutive years. Observed inter-year resightings for the same region (e.g. Gulf of Farallones whales identified in 1986 and returning in 1987 or 1988) were higher than expected and inter-year resightings between regions lower than expected if redistribution was random (chi-square,  $p < 0.001$ ). Pooled values for each site and region were used because no significant heterogeneity was found in the values for each region and year (heterogeneity chi-square,  $p > 0.05$ ; Zar, 1984).

Blue whales identified in the Gulf of the Farallones and Monterey Bay have been seen in the Sea of Cortez, Mexico and along the west coast of Baja California, Mexico in early spring. Nine of the whales identified in the Gulf of the Farallones matched whales photographed in Mexico by

people contributing photographs to the primary author or by members of the Mingan Island Cetacean Study. Five whales seen in Monterey Bay also matched whales photographed in Mexico.

Some of the resightings between Mexico and California are in the same year and demonstrate the migratory movement of at least a portion of the blue whale population. One whale seen on 17 March 1988 in the Sea of Cortez was identified in the Gulf of the Farallones on 2 September. A second whale seen in late March and early April outside Magdalena Bay along the west coast of Baja California was resighted in late September and October in the Gulf of the Farallones. A third whale seen in early April 1988 along the west coast of Baja California was identified in Monterey Bay on 12 August.

## DISCUSSION

The increase in blue whale numbers seen in the Gulf of the Farallones from 1986 to 1988 reported here appears to be the continuation of an increase that began in the late 1970s or early 1980s. Sightings of blue whales in the vicinity of Southeast Farallon Island were uncommon in the 1970s. From 1970 to 1980 only one sighting of a blue whale was reported by biologists working on the Farallon Islands (Ainley, Huber, Henderson and Lewis, 1977; Ainley, Huber, Henderson, Lewis and Morrell, 1977; Ainley, Huber, Morrell and LeValley, 1978; Huber, Ainley, Morrell, LeValley and Strong, 1979; Huber, Ainley, Morrell, Boekelheide and Henderson, 1980; Huber, Ainley, Boekelheide, Henderson and Bainbridge, 1981). More frequent sightings of blue whales began in 1981 (Huber *et al.*, 1982; Huber, McElroy, Boekelheide and Henderson, 1983; Huber, Beckham, Nisbet, Rovetta and Nusbaum, 1985; Huber, Fry, Rovetta, Johnston and Nusbaum, 1986) and between 20 June and 30 October 1982, 10 sightings of 22 whales were made. Sightings of blue whales offshore from the Gulf of the Farallones in 1979 were reported by Smith *et al.* (1986). Monthly aerial surveys of the central and northern coast of California from 1980 to 1983 also suggested an increase in blue whale numbers in the Gulf of the Farallones region during this period (Dohl *et al.*, 1983; Dohl, 1984). No sightings were made in 1980, three were made in 1981 and eight in both 1982 and 1983 (Dohl, 1984, and estimated from figures in Dohl *et al.*, 1983).

The reason for the increase in blue whale occurrence in the Gulf of the Farallones is not clear but may reflect an increase in the total blue whale population and/or a shift in distribution to more coastal waters. Blue whale populations would be expected to increase because they have not been hunted in the North Pacific since 1966 but, other than the observations in central California, there have been no reports of increases in blue whale sightings in other areas of the North Pacific. Sightings of blue whales from Japanese whale scouting expeditions showed no increase from 1965 to 1978 (Wada, 1979; 1980). In the 1980s, no blue whales were seen in surveys of the Gulf of Alaska or Aleutian Islands (Rice and Wolman, 1982; Brueggeman, Green, Grotefendt and Chapman, 1987; Brueggeman, Green, Tressler and Chapman, 1988) where they were formerly hunted (Reeves, Leatherwood, Karl and Yohe, 1985; Brueggeman, Newby and Grotefendt, 1985).

Blue whales in the North Pacific often occur far offshore (Wade and Friedrichsen, 1979; Wada, 1980), but Dohl *et al.* (1983) reported a decrease in the depth of water in which blue whales were seen from 1980 to 1982. Smith *et al.* (1986) reported sightings of blue whales in 1979 offshore from the Farallon Islands at a time when blue whales were not being seen in the vicinity of the islands. These sightings (Dohl *et al.*, 1983; Smith *et al.*, 1986) were farther offshore than we have observed in recent years.

Blue whale sightings and the matches from photo-identification indicate that the blue whales seen in the Gulf of the Farallones and Monterey Bay share a common migratory route. The timing of the sightings allows some generalizations to be made about the movements of at least a subset of the population. Blue whales enter the Sea of Cortez from February to April and occur along the west coast of Baja California from March to at least June. They begin to appear in Monterey Bay and the Gulf of the Farallones area in June and July. The resighting data from Monterey Bay to Point Arena indicate that blue whales range widely from August to November, with yearly variation in the areas and times of occurrence of concentrations.

The stock identity of the California-Mexico blue whales in relation to areas to the north and south is not resolved. Previous information on the migrations and movements of blue whales along the coast of Mexico and California has been limited (Mizroch, Rice and Breiwick, 1984). Wade and Friedrichsen (1979) suggested that blue whales seen off Central America in December to February later migrated north to Mexico and California. Rice (1974) suspected that blue whales occurring along the Baja coast in early spring had migrated from California in the fall and were then proceeding north to British Columbia and the Gulf of Alaska. Obtaining identification photographs from these areas will be required to test these hypotheses.

#### ACKNOWLEDGEMENTS

This research was funded by the Gulf of the Farallones National Marine Sanctuary, National Oceanic and Atmospheric Administration. Nancy Stone and Miles Croom of the Sanctuary and Gary Fellers of the National Park Service provided advice and support for the study. Other researchers provided blue whale photographs for comparison with our catalogue (Table 2) and we greatly appreciate their help. Prentice Bloedel played an important role in the success of the study and provided the main research vessel (*Noctilio*). Dan Bockus, Diane Claridge, Stephanie Bartok, Prentice Bloedel, Heidi Rodingier, Nicola Wadsworth, Lisa Barry, Luke Bloedel, Jeanette Smith, Greg Falxa, Gary Falxa, Lea Mitchell, Stuart Goldman, Tom Ford, Gary Davis and J. Conover all assisted in data collection in the field. Tom Kieckhefer and Chris Tanner shared information from their work in the Gulf of the Farallones. Farallon Research Associates, under a subcontract, provided information on sightings and photographs taken from Oceanic Society nature trips. N. Haenel and Kelly Balcomb assisted with film developing; Joe Buchanan, Donald Smith, Suzanne Kort, Jennifer Horn, Elizabeth McManus, Jeff McGowan and Payton Carling helped in photographic printing and matching and data entry. Elizabeth McManus also assisted in literature search, data compilation and editing. The Bodega Marine Laboratory, including Paul Siri, Kitty Brown and Deke Nelson, provided housing and organized

and conducted a vessel survey using the *Avant Garde*; Ronn Storro-Patterson provided the *Delphinus. Achilles Inflatable Craft* provided the inflatable boats used in 1987 and 1988. Joseph Buchanan, John Francis, Jeff Laake, David Rugh and Dale Rice reviewed the manuscript. We thank these people and organizations.

#### REFERENCES

- Ainley, D.G., Huber, H.R., Henderson, R.P. and Lewis, T.J. 1977. Studies of marine mammals at the Farallon Islands, California, 1970-1975. Rep. to the US Mar. Mamm. Comm., Natl Tech. Info. Serv., PB-274 046, Springfield, Va. 42pp.
- Ainley, D.G., Huber, H.R., Henderson, R.P., Lewis, T.J. and Morrell, S.H. 1977. Studies of marine mammals at the Farallon Islands, California, 1975-1976. Rep. to the US Mar. Mamm. Comm., Natl Tech. Info. Serv., PB-266 249, Springfield, Va.
- Ainley, D.G., Huber, H.R., Morrell, S.H. and LeValley, R.R. 1978. Studies of marine mammals at the Farallon Islands, California, 1976-1977. Rep. to the US Mar. Mamm. Comm., Natl Tech. Info. Serv., PB-286 603, Springfield, Va.
- Brueggeman, J.J., Green, G.A., Grotefendt, R.A. and Chapman, D.G. 1987. Aerial surveys of endangered cetaceans and other marine mammals in the northwestern Gulf of Alaska and southeastern Bering Sea. Report to the Minerals Management Service, Alaska OCS Office, and NOAA Office of Oceanography and Marine Assessment, Alaska Office (unpublished).
- Brueggeman, J.J., Green, G.A., Tressler, R.W. and Chapman, D.G. 1988. Shipboard surveys of endangered cetaceans in the northwestern Gulf of Alaska. Report to the Minerals Management Service, Alaska OCS Office, and NOAA Office of Oceanography and Marine Assessment, Alaska Office (unpublished).
- Brueggeman, J.J., Newby, T.C. and Grotefendt, R.A. 1985. Seasonal abundance, distribution, and population characteristics of blue whales reported in the 1917 to 1939 catch records of two Alaska whaling stations. *Rep. int. Whal. Commn* 35:405-11.
- Calambokidis, J., Kruse, S., Cabbage, J.C., Wells, R., Balcomb, K.C. and Steiger, G.H. 1987. Blue whale occurrence and photo-identification along the central California coast. Presented to the Seventh Conference on the Biology of Marine Mammals, Miami, Florida, December 1987 (unpublished).
- Calambokidis, J., Steiger, G.H., Cabbage, J.C. and Balcomb, K.C. 1989. Biology of blue whales in the Gulf of the Farallones and adjacent areas of California. Final Report to the Gulf the the Farallones National Marine Sanctuary, NOAA, San Francisco, California (unpublished). 56pp.
- Dohl, T.P. 1984. Harbor porpoise and other cetaceans of the Farallon Basin. *Southwest Fish. Cent. Adm. Rep. LJ-84-16C*, Natl Mar. Fish. Serv., La Jolla, Calif.
- Dohl, T.P., Guess, R.C., Duman, M.L. and Helm, R.C. 1983. Cetaceans of central and northern California, 1980-1983: Status, abundance, and distribution. OCS Study MMS 84-0045, Minerals Management Service, US Dept. Int., Wash. DC (unpublished).
- Gambell, R. 1976. World whale stocks. *Mamm. Rev.* 6:41-53.
- Huber, H.R., Ainley, D.G., Boekelheide, R.J., Henderson, R.P. and Bainbridge, B. 1981. Studies of marine mammals at the Farallon Islands, California, 1979-1980. Natl Tech. Info. Serv., PB81-167082, Springfield, Va.
- Huber, H.R., Ainley, D.G., Morrell, S.H., Boekelheide, R.J. and Henderson, R.P. 1980. Studies of marine mammals at the Farallon Islands, California, 1978-1979. Rep. to the US Mar. Mamm. Comm., Natl Tech. Info. Serv., PB80-178197, Springfield, Va.
- Huber, H.R., Ainley, D.G., Morrell, S., LeValley, R.R. and Strong, C.S. 1979. Studies of marine mammals at the Farallon Islands, California, 1977-1978. Rep. to the US Mar. Mamm. Comm., Natl Tech. Info. Serv. PB80-111602, Springfield, Va.
- Huber, H.R., Beckham, C., Nisbet, J., Rovetta, A. and Nusbaum, J. 1985. Studies of marine mammals at the Farallon Islands, California, 1982-1983. *Southwest Fish. Cent. Adm. Rep. LJ-85-01C*, Natl Mar. Fish. Serv., La Jolla, Calif.
- Huber, H.R., Boekelheide, R.J., McElroy, T., Henderson, R.P., Strong, C. and Ainley, D.G. 1982. Studies of marine mammals at the Farallon Islands, California, 1980-1981. Rep. to the Natl Mar. Fish. Serv., Contract No.81-ABC-00129 (unpublished).
- Huber, H.R., Fry, L., Rovetta, A., Johnston, S. and Nusbaum, J. 1986. Studies of marine mammals at the Farallon Islands, California, 1983-1985. *Southwest Fish. Cent. Adm. Rep. LJ-86-17C*, Natl Mar. Fish. Serv., La Jolla, Calif.

- Huber, H.R., McElroy, T., Boekelheide, R.J. and Henderson, P. 1983. Studies of marine mammals at the Farallon Islands, California, 1981-1982. Southwest Fish. Cent. Adm. Rep. LJ-83-09C, Natl Mar. Fish. Serv., La Jolla, Calif.
- Mizroch, S.A., Rice, D.W. and Breiwick, J.M. 1984. The blue whale, *Balaenoptera musculus*. *Mar. Fish. Rev.* 46:15-19.
- National Marine Fisheries Service. 1987. Marine Mammal Protection Act of 1972. Annual Report 1986/87. Natl Oceanic and Atm. Adm., US Dept. Comm., Wash., DC.
- Omura, H. and Ohsumi, S. 1974. Research on whale biology of Japan with special reference to the North Pacific stocks. pp.196-208. In: W.E. Schevill (ed.) *The Whale Problem. A Status Report*. Harvard University Press, Cambridge, Mass. 419pp.
- Reeves, R.R., Leatherwood, S., Karl, S.A. and Yohe, E.R. 1985. Whaling results at Akutan (1912-39) and Port Hobron (1926-1937), Alaska. *Rep. int. Whal. Commn* 35:441-57.
- Rice, D.W. 1963. Progress report on biological studies of the larger Cetacea in the waters off California. *Norsk Hvalfangstid.* 7:181-7.
- Rice, D.W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-95. In: W.E. Schevill, (ed.) *The Whale Problem, A Status Report*. Harvard University Press, Cambridge, Mass. 419pp.
- Rice, D.W. and Wolman, A.A. 1982. Whale census in the Gulf of Alaska, June to August 1980. *Rep. int. Whal. Commn* 32:491-7.
- Rondeau, J.H. 1987. The Farallon Islands 1542-1986, an ecosystem review. Unpublished report, P.O. Box 620458, Woodside, California. 239pp.
- Scammon, C.M. 1874. *The Marine Mammals of the Northwestern Coast of North America*. G.P. Putnam's Sons, New York.
- Schoenherr, J.R. 1988. Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. Unpublished masters thesis presented to Moss Landing Marine Laboratories, San Jose State Univ., San Jose, Calif. 43pp.
- Sears, R. 1987. The photographic identification of individual blue whales (*Balaenoptera musculus*) in the Sea of Cortez. *Cetus* 7:14-7.
- Sears, R., Wenzel, F.W. and Williamson, J.M. 1987. The blue whale: A catalogue of individuals from the western North Atlantic (Gulf of St. Lawrence). Mingan Island Cetacean Study, St. Lambert, Quebec (unpublished). 27pp.
- Sears, R., Williamson, J.M. and Wenzel, F.W. 1990. Photographic identification of the blue whale (*Balaenoptera musculus*) in the Gulf of St. Lawrence, Canada. Paper SC/A88/ID23 (published in this volume).
- Smith, R.C., Dustan, P., Au, D., Baker, K.S. and Dunlap, E.A. 1986. Distribution of cetaceans and sea-surface chlorophyll concentrations in the California Current. *Mar. Biol.* 91:385-402.
- Starks, E.C. 1922. A history of California shore whaling. *Fish. Bull.* 6:1-38.
- Szczepaniak, I.D. and Webber, M.A. 1985. Summer and autumn sightings of marine mammals in the Gulf of the Farallones, California 1983-1984. Rep. to Oceanic Society Expeditions, San Francisco, Calif. (unpublished).
- Wada, S. 1973. The ninth memorandum on the stock assessment of whales in the North Pacific. *Rep. int. Whal. Commn* 23:164-9.
- Wada, S. 1979. Indices of abundance of large sized whales in the North Pacific in the 1977 whaling season. *Rep. int. Whal. Commn* 29:253-63.
- Wada, S. 1980. Japanese whaling and whale sighting in the North Pacific 1978 whaling season. *Rep. int. Whal. Commn* 30:415-24.
- Wade, L.S. and Friedrichsen, G.L. 1979. Recent sightings of the blue whale, *Balaenoptera musculus*, in the northeastern tropical Pacific. *Fish. Bull., US* 76:915-9.
- Webber, M.A. and Cooper, S.M. 1983. Autumn sightings of marine mammals and birds near Cordell Bank, California 1981-82. Cordell Bank Expeditions, Walnut Creek, Calif. (unpublished). 44pp.
- Zar, J.H. 1984. *Biostatistical Analysis*. Prentice-Hall, Inc., Englewood Cliffs, N.J. 718pp.