

encounter them in this area of migrating whales. When the clicks were recorded in Wickaninnish Bay, the gray whales were feeding. Why Gigi emitted clicks when released is unknown. In this case, their function could have been orientation since it is unlikely that she was looking for food so soon after being placed in a new environment. The clicks discussed here are only slightly like those recorded by Asa-Dorian in 1955 (see Wenz, 1964). They are not similar to any other reported gray whale sounds.

Other recent evidence for mysticetes producing click-type sounds has been reported by Beamish and Mitchell (1971). Their recordings in the presence of blue whales included clicks with peak energy in a band from 21 to 31 kHz.

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MFR PAPER 1055

## Aerial Observations of Migrating Gray Whales, *Eschrichtius robustus*, off Southern California, 1969-72

J. S. LEATHERWOOD

#### ABSTRACT

*Migrating gray whales were observed from helicopter and fixed-wing aircraft from central California south to Cedros and Guadalupe Islands, Baja California, Mexico, with the primary sighting effort off southern California. Peak numbers were observed off southern California in January for the southward migration and in March for the northward migration. Individuals were observed with the same relative frequency 80-160 km offshore as they were within 80 km of shore. Cows with calves were seen from February through May, primarily inshore, and tended to be alone or with other cows with calves. Yearling whales were seen inshore from February through April and also tended to be solitary or with other yearlings. Average speed of movement for northward migrants was 2.8 km/hour.*

*Results of aerial surveys compare favorably with published summaries of the timing of migration based on shore and ship samples and support the value of aerial surveys as a tool in cetacean population studies.*

#### INTRODUCTION

Since shortly after its population began to recover from a second near-extirmination by man in the 1920's and 1930's (Gilmore, 1955), the California gray whale, *Eschrichtius robustus*, has been the subject of more public interest and more scientific research than perhaps any other species of large whale. Because of their

spectacular nature and proximity to shore along much of the route, the migrations of the species have been rather exhaustively described by Scammon (1874), Hubbs (1959), Gilmore (1960a and 1960b), Rice (1961), Pike (1962), Hubbs and Hubbs (1967), Adams (1968), and Rice and Wolman (1971). Observations from shore stations (primarily at Point Loma in

San Diego, and at Yankee Point near Monterey) supplemented with aerial observations and boat surveys, have fixed the timing and described most aspects of that migration in detail.

Even so, several interesting gaps still exist in our knowledge of the migrating animals. For instance, although Gilmore (1969) has discussed movement patterns of yearling whales on the southern migration, there are no reports on the movements of yearlings during the northern migration. Similarly, although Hubbs (1959) reported that "cows with calves seem to take a more offshore path," actual data on

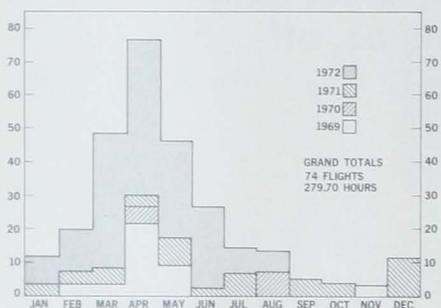


Figure 1.—Flight hours, 1969-72.

the movements of mothers with calves after they leave the breeding lagoons are so scant that Rice and Wolman (1971) simply report that "the route taken by females and calves during the spring migration is unknown." Finally, although average rates of movement for the population have been computed from dates of peak passage at two separate shore stations, there are actual numbers for rates of movement of individual animals to test those averages only for the southward migration (Wyrick, 1954; Cummings, Thompson, and Cook, 1968).

Since February of 1969, the author has been conducting routine aerial surveys of the cetaceans off southern California, primarily in the area from lat. 34°N south to Islas Todos Santos and offshore as far as 280 km. Additional flights have surveyed the

coast from Point Mugu north to Monterey Bay in March and the area from San Diego to Cedros and Guadalupe Islands in January and February.

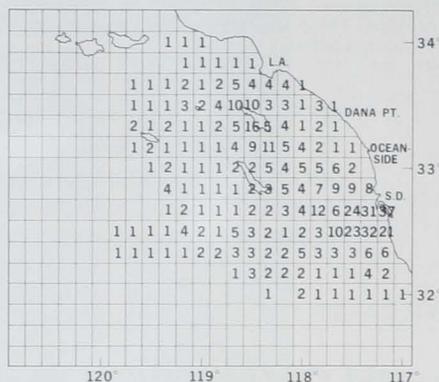


Figure 2.—Survey effort by 10-minute blocks, southern migration, 1 October to 15 February. Each number represents total number of times that area was surveyed during this time period.

## METHODS

Flights were made in Navy H-3 helicopters and S-2 reconnaissance aircraft, and in twin-engine rental aircraft. Survey altitudes ranged from 150 to 300 meters depending on weather conditions. Detailed observations were made from as low as 15 meters. Although gray whales were not the exclusive target of the survey, for every gray whale sighting the number and estimated size of individuals, their location, swimming direction and speed, and details of behavior were recorded.

Through 1 July 1972 we made 74 flights totaling 279.7 hours of observation time (Figure 1). Sampling effort was accelerated during March, April, May, and June 1972 in support of the radio track of the gray whale Gigi (Evans, 1972, and this publication) and of a common dolphin, *Delphinus delphis*, subsequently tagged and radio-tracked from aircraft (Evans and Leatherwood, 1972). In general, surveys were more extensive during the period of the northern migration (approximately mid-February through May).

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To facilitate data analysis, the study area was divided into 10-minute blocks, and tallies were maintained of the number of times each zone was surveyed for cetaceans whether or not animals were sighted. Zones were not recorded as surveyed if cloud cover, fog, or surface water conditions prevented adequate observation in the area.

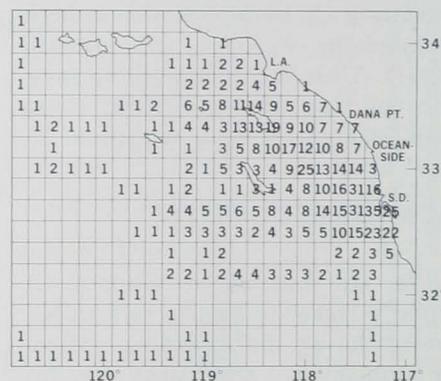


Figure 3.—Survey effort by 10-minute blocks, northern migration, 16 February to 1 June. Each number represents total number of times that area was surveyed during this period.

Figures 2 and 3 summarize the total number of times each zone was surveyed during the periods of the southern migration (1 October to 15 February) and northern migration (16 February to 1 June) of gray whales. Effort was concentrated off San Diego during both periods because all three airfields used are located there. The substantial increase of effort in the southern San Pedro Channel from the southern to the northern migration is the result of the aerial radio-tracking mentioned above.

During the three migratory seasons, gray whale groups were sighted 91 times in the study area. Of these, 23 groups included mothers with calves, 19 included yearling whales, and 8 sightings represented observations of the same animals on successive days.

## RESULTS

### Migration Peaks and Offshore Movements

The picture of migration peaks obtained from the aerial surveys agrees with the summaries of Hubbs (1959) and Gilmore (1960). The earliest animals were seen in the third week of December and the latest during late May. The largest numbers of animals were seen during the first and second weeks of January and the second and fourth weeks of March. Because the amount of aerial survey effort varied from month to month, indices of apparent abundance were computed for data in blocks of a month by dividing both the number of aerial observations and the number of individuals seen by the amount of survey effort during that time period. These indices (Figure 4) also clearly indicate the periods of greatest abundance off San Diego as January and March.

During both legs of the migration many whales were sighted far offshore, (Figure 5) presumably taking what has been called the "inter-island leg" (Gilmore, 1969). For instance, within the 64 km wide band between lat.  $32^{\circ}15'N$  and  $32^{\circ}55'N$ , southern migrating gray whales were encountered during 4.7 percent of the flights in the first 80 km from shore, 5.0 percent of the flights in the second 80 km, and 1 percent of the flights over the next 48 km. Similarly on the northern migration, grays were sighted 6.4, 9.2, and 3.3 percent respectively of the times the three zones were surveyed. These findings support the contentions of Rice (1965) and Rice and Wolman (1971) that at least since 1965 a rather high percentage of the whales have passed offshore, out of sight of Point Loma.

Though most of the animals taking the offshore route apparently strike for the coast shortly after they pass by the southernmost of the Channel

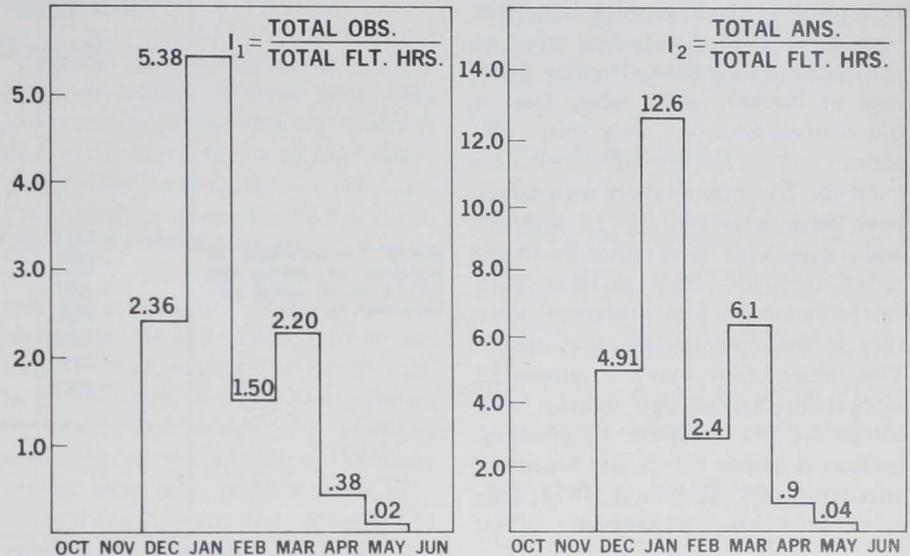


Figure 4.—Indices of apparent abundance ( $I_1$ ) of gray whales from aerial surveys, 1969-72.

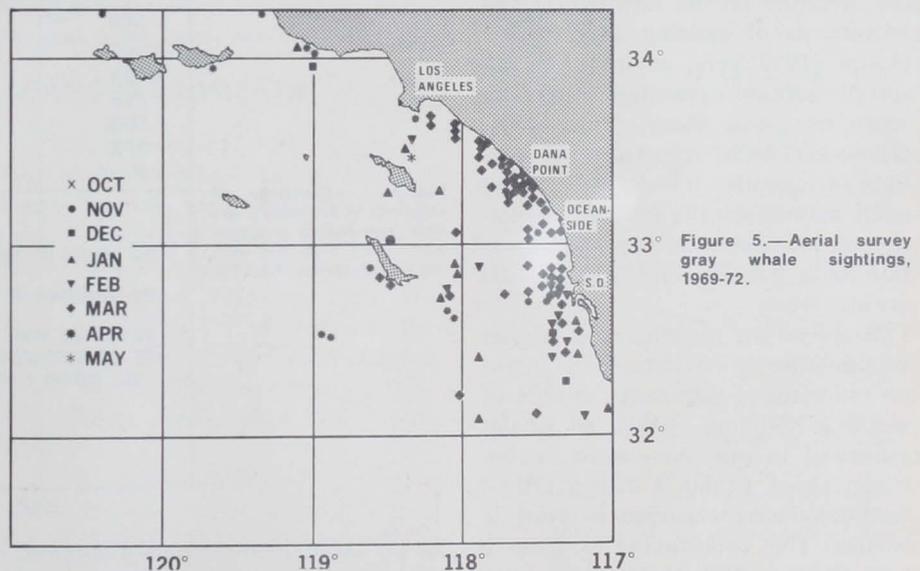


Figure 5.—Aerial survey gray whale sightings, 1969-72.

Islands, some do pass offshore toward Guadalupe Island. Gilmore (1955) reported Hubbs' sighting of three mothers with calves outside Guadalupe in February of 1950. In February 1972, I located two gray whales on the outside of Guadalupe near the southwest tip. A third animal, too close to the cliffs to permit close examination, was also believed to be a gray. The two verified sightings were both adult animals 11 or more meters in length.

### Cow-Calf Groups

As was noted earlier, the routes taken by females with calves during the spring migration have been unknown.

Twenty-three northward migrating groups containing mothers with calves were observed during the aerial surveys (Figure 6). The earliest was sighted 18 February, the latest on 18 May. Although the majority of those sightings were well inshore, this may

be a result of the heavy sighting effort inshore in 1972 during the times of the northern migration. The few sightings of mothers with calves late in the season, however, were more offshore.

Of the 23 times mothers with calves have been observed, in 18 mothers and calves have been either by themselves or with other mothers with calves. In only four instances were they in the company of other adults. This observation may be supported in part by the fact that females with calves are not receptive to breeding because a female calves and breeds in alternate years (Scammon, 1874; Gilmore, 1961; Rice and Wolman, 1971).

### Yearlings

There is still little information in the literature on the distribution and movements of yearling gray whales. Hubbs (1972 pers. comm.) has observed solitary yearlings migrating south very near shore off La Jolla. Gilmore (1960b) reported that yearlings frequently travel with larger adult animals on the southern migration, presumably learning the migration route, but that solitary individuals are also seen.

Based on the growth curve of gray whales (Rice and Wolman, 1971) and on estimates of size range at time of weaning (Gilmore, 1961), all whales estimated in our surveys to be between about 6 and 9 meters (20-30 feet) long were classified as yearling whales. The opportunity to observe Gigi (8.26 m [27 ft] long) from the air for nearly an hour in early March 1972 verified the accuracy of my previous size estimates and increased confidence in the reliability of the classification in subsequent sightings.

The room for error in this estimate notwithstanding, yearling-sized whales were observed with higher frequency than expected (Figure 7). A total of 21 yearlings or groups of yearlings was observed in the study area. Of those, 16 were observed after the release of Gigi (Evans, 1972) all during

Figure 6.—Locations of sightings of mother-calf groups during aerial surveys, 1969-72.

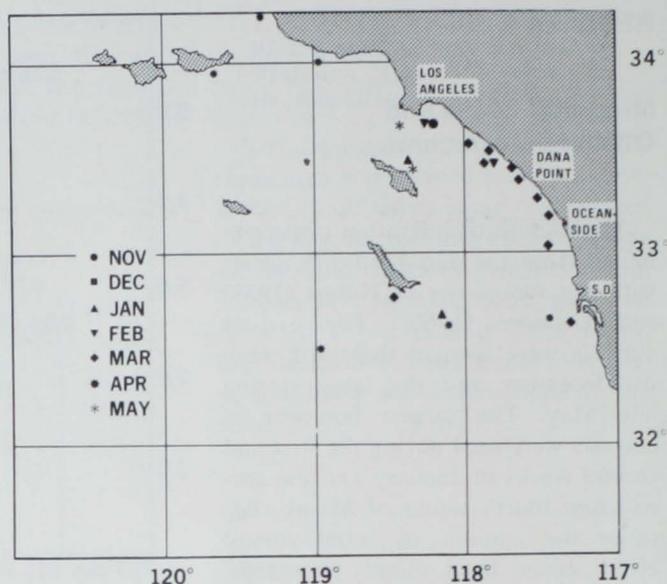
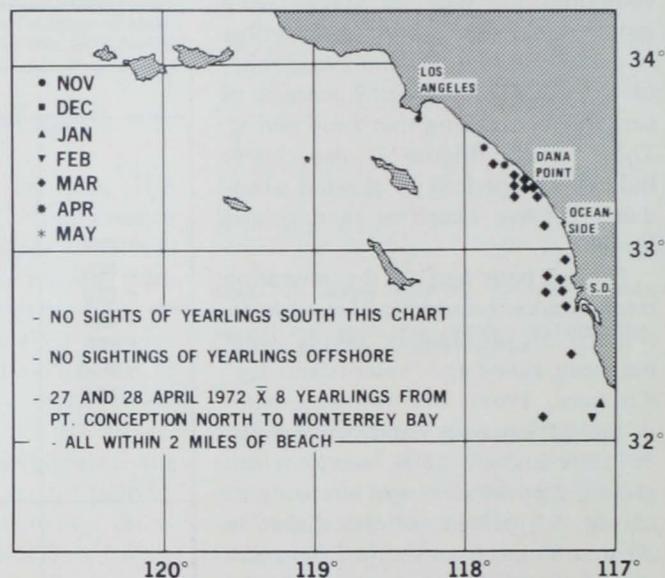


Figure 7.—Locations of sightings of probable yearling gray whales (estimated size, 20 to 30 feet) during aerial surveys, 1969-72.



the period of the northward migration. No yearlings were seen south of the Coronado Islands, but a total of 16 was encountered on a 2-day survey flight north to Monterey Bay in April. All were within 5 km of the beach.

No yearlings were observed in the offshore areas where other whales were seen. Further, like cows and calves, yearlings tended to be either by themselves or with other yearlings. In only 4 of the 21 cases were yearlings accompanying adult animals. This absence of yearlings with adults may be a result of the forced rejection

by the mother at the late summer weaning in the north.

### Rates of Movement

Estimates of rates of movement for southward migrating whales have ranged from 7.7 km/hour calculated over the entire migration route (Pike, 1962) to 10.2 km/hour calculated over a small segment of the route (Cummings et al., 1968). Rice and Wolman (1971) used the times of peak passage at two separate shore stations to calculate the average distance trav-

eled in 24 hours as 185 km. Pike (1962) used the same calculations to determine that northward migrants traveled from 56-80 km/day at about 1/3-1/2 the rate of southern migrants.

During this study, natural markings on three whales observed on successive days permitted the calculation of speeds of movement along two areas of the coastline. Rates of movement of all 3 are comparable to Pike's calculations.

Two 12-13 meter individuals, one distinctly marked with white brush markings on the tail stock and flukes, were seen 11, 12, and 13 April 1972. During the 49.5 hours between the first and third sightings, they moved approximately 129 km from the Coronado Islands to near San Clemente, Calif., an average speed of only 2.6 km/hour.

A 12-meter individual with a nearly all white tail fluke and a wide white band across the tail stock was seen with four other animals off Point La Jolla on 27 March 1972. The same animal was observed again on the 28th just northwest of Newport Beach and on the 29th 13 km southwest of Point Vicente. Net movement in 44 hours was 128 km or 2.9 km/hour.

Finally, an unusually dark yearling observed just south of Point San Luis 27 April 1972 had moved 64 km to the north when it was resighted 23 hours later northwest of Point Estero. It had moved at an average rate of 2.8 km/hour.

## SUMMARY

Results of periodic aerial surveys are comparable to those from ship and land-based surveys in defining the timing of migration of gray whale populations past southern California. Peak densities were observed in January for the southward and in March for the northward migration. Over half the population observed passed more than 64 km offshore from San Diego. Cows with calves were seen from February through May primarily inshore and tended to be alone or with other cows with calves. Yearling whales were seen inshore from February through April and tended to be solitary or with other yearlings. Finally, average speeds observed for three individuals over small segments of the northward migration route were comparable to estimates based on peak movements past shore stations.

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