Pinnipeds of the California Islands: Abundance and Distribution

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INTRODUCTION

The purpose of this paper is to update George Bartholomew's (1967) article published in the last symposium proceedings on the biology of the California Islands. We will expand on his article by treating the California Islands in a most general sense; by California Islands we mean those islands in western Baja California, Mexico, the Channel Islands in the Southern California Bight, and Año Nuevo and the Farallons in northern California.

It is no small problem to deal with six species of pinnipeds on eighteen islands or island groups. We will have to be brief, severely limit our aspirations, and beg the reader to take some statements on faith. We will dispense with background history, biomedical physiology, esoteric behavior, and cute anecdotes and just plunge into number, distribution, movements, and population trends because we think that understanding the role of pinnipeds in the ecology of the California Islands starts here. We will emphasize changes in various characteristics of pinniped populations which have occurred during the last 13 years—changes in number and distribution and changes in reproductive rate and mortality. Most of the data we present were obtained simply by counting.

It will be helpful to consider three things regarding the animal subjects before presenting data. (1) Pinnipeds are long-lived (15 to 25 years is a reasonable estimate of longevity). This means that some of the animals counted in 1977 were counted by Bartholomew in the early 1960s. The time dimension involved in the study of pinnipeds is quite different from that of most other species on the California Islands. Obviously one cannot talk about the evolution of populations of pinnipeds during the last 13 years. (2) Most pinniped populations were severely depleted during the last century. Thus, we are looking at them during a period of recovery. (3) Many systematic studies of the pinniped populations in Baja California and California have been conducted since Bartholomew's 1967 paper was published.

To justify this last point, and for whatever historical value there may be, we mention five recent and ongoing research efforts: (1) Le Boeuf and numerous collaborators from the University of California at Santa Cruz have studied pinniped populations from Baja California to northern California from 1967 to the present, making approximately one expedition per year to the Baja California islands, to San Miguel Island and San Nicolas Island in southern California, and year-round daily observations on Año Nuevo Island in northern California. (2) Intensive, systematic studies supported by the Bureau of Land Management began in the Southern California Bight in 1974 and were conducted during the period 1974 to 1978 (Le Boeuf, Bonnell, Pierson, Dettman, and Farrens 1976). The census methods used in these studies were more thorough and systematic than those of previous studies in the area. Pinnipeds were counted on all islands in the Southern California Bight eight times per year. Eight aerial and eight ship transects were made over water each year. In addition, detailed observations during the breeding season were made on San Miguel Island and Santa Barbara Island. (3) A long-term study of the northern fur seal population on San Miguel Island by the National Marine Fisheries Service began in 1969 and is still going on. The principal researchers involved in the project have been Robert DeLong and G.A. Antonelis. (4) During 1974 and 1975, Bruce

FIGURE 1. *A photograph of the northern fur seal colony at Adam's Cove, San Miguel Island, taken on 21 July 1968. The adult male is in the center; on the left are some of the females, and on the right are newborn pups. California sea lion males and females are in the background.*

Mate, supported by the Marine Mammal Commission, conducted several aerial censuses of pinnipeds from Vancouver Island south along the coast of Washington, Oregon, California, and Baja California to Cabo San Lucas, and then along several points of the coast in the Sea of Cortez. (5) David Ainley, Harriet Huber, and collaborators from the Point Reyes Bird Observatory have conducted detailed censuses of pinnipeds on the Farallon Islands year-round from 1969 to the present.

In addition, numerous individuals have studied colonies of particular species. For example, Daniel Odell studied northern elephant seals and California sea lions on San Nicolas Island during the early 1970s; Roger Gentry, Finn Sandegren, and Robert Gisiner studied breeding behavior of Steller sea lions on Año Nuevo Island; and Charles Woodhouse and Paul Paulbitski observed harbor seals in southern California and northern California, respectively.

ACCOUNTS OF SPECIES

Northern Fur Seals

Bartholomew (1967) stated that northern fur seals were regular visitors to offshore waters in the Southern California Bight. He noted that the only time these animals were seen on islands or on the mainland was when they were sick, and this was an infrequent occurrence.

Since that time, the northern fur seal has started breeding on San Miguel Island in southern California and has shown signs of being there to stay. In July of 1968, a small colony of approximately 100 fur seals was discovered at Adam's Cove on San Miguel Island (Peterson, Le Boeuf, and DeLong 1968). Photographs taken earlier revealed that the colony had been established before this date, certainly by 1964, and probably as early as 1961. In 1968, the colony on Adam's Cove contained one male, 60 females, and 40 newborn pups (Fig. 1). Tags on several of the females indicated that they had been born on the Pribilof and Komandorski Islands in the Bering Sea. The colony has grown rapidly since that time. Figure 2 shows that the number of pups born annually has increased exponentially. In 1972, another colony was discovered on Castle Rock, only a short distance north of San Miguel Island. It, too, has grown exponentially; 521 pups were born there in 1976. Thus, in 1976, the National Marine Fisheries

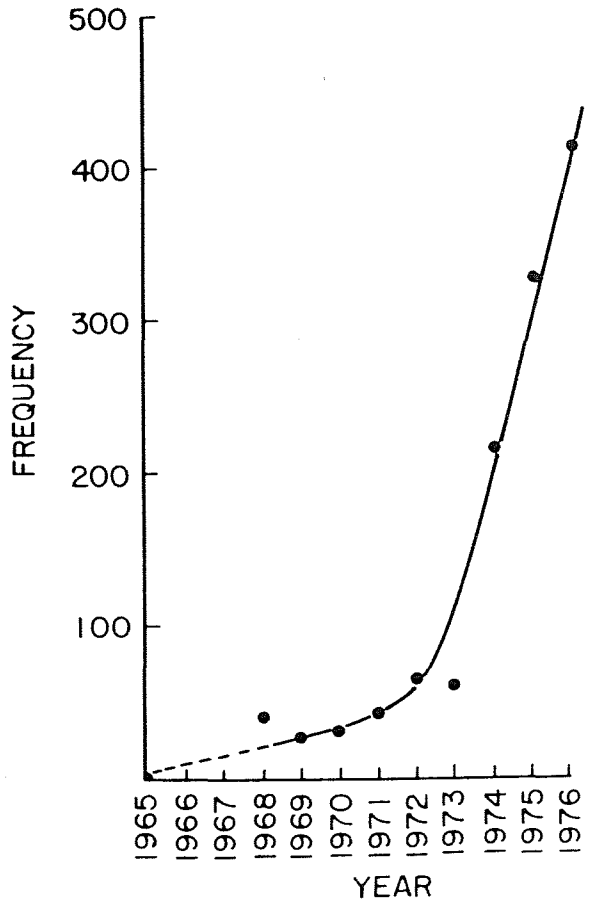

FIGURE 2. *Annual northern fur seal pup production at Point Bennett, San Miguel Island, during the period 1968 to 1976. The dotted line represents a hypothetical extrapolation of the curve to the mid-1960s, when breeding appears to have begun. The curve is plotted from data in Fiscus, DeLong, and Antonelis (1976).*

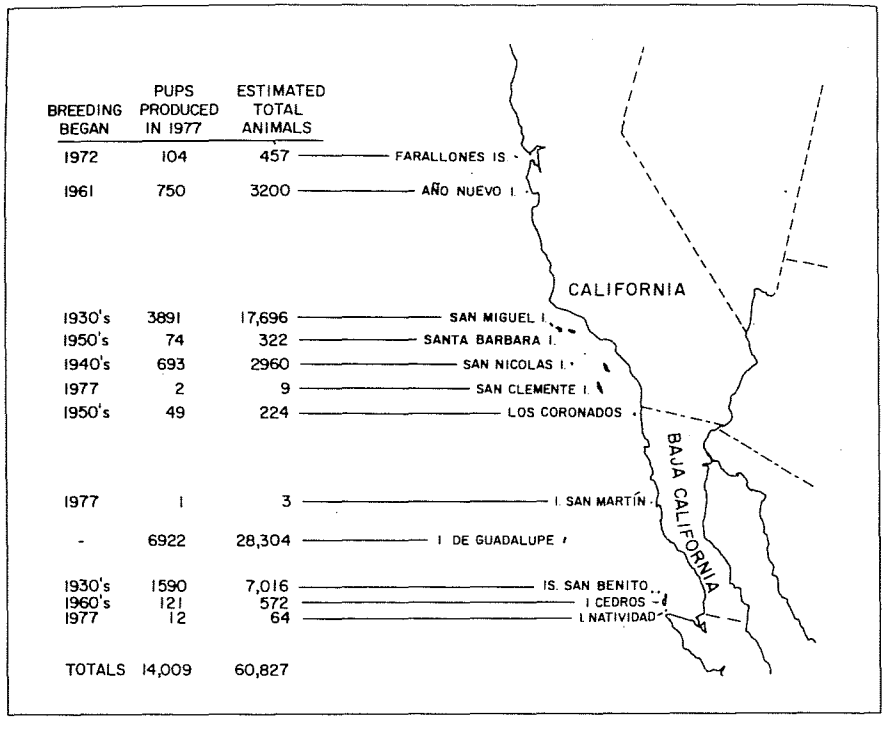

FIGURE 3. *A 1977 summary of northern elephant seal breeding locations, the approximate time that breeding began, pup production, and estimated total population size. Adapted from Le Boeuf (1977) with additional data from Le Boeuf and Mate (1978).*

Service reported that a total of 938 were born on San Miguel Island (Fiscus, DeLong, and Antonelis 1976). The breeding population is estimated to be between two and four thousand animals and rising fast. Recruits continue to come in from the Bering Sea.

Why are these animals here? It is well known that this species migrates from the Bering Sea to as far south as 30°N latitude on both sides of the Pacific during the period from fall to spring (*e.g.*, see Johnson 1975). Le Boeuf *et al.* (1976) noted winter migrants in large numbers beyond the edge of the continental shelf, especially west of San Miguel Island. In addition, many fur seals were seen within the Southern California Bight, especially along the Santa Rosa Ridge and over the San Nicolas Basin near Tanner Bank. Apparently some of these animals failed to make the long trek back to the Bering Sea and started breeding at the farthest point in their migration. The growth of the population in the last decade indicates that the colony is firmly established.

Northern Elephant Seals

The northern elephant seal population reached its nadir in the late 1800s; less than 50 individuals were then living and they were found on only one island, Isla de Guadalupe. By the mid-1960s, Bartholomew (1967) was able to say that northern elephant seals had recovered from near extinction. Approximately 15,000 animals were counted in 1957, and 17,500 in 1965.

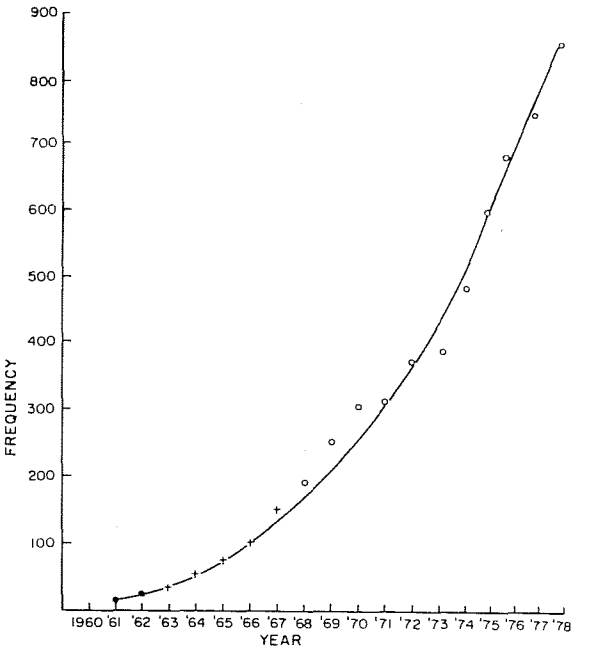

FIGURE 4. *Annual northern elephant seal pup production on Año Nuevo Island from 1961, when the first pup was born, to 1978. The data points for 1961 and 1962 (•) are from Radford* et al. *(1965), those for 1963 to 1967 (+) are from Poulter and Jennings (1966), and the remainder (○) are from Le Boeuf and Briggs (1977) and Le Boeuf (unpubl. data).*

The population was growing logarithmically. The species, all individual descendants from the remnant herd that survived in the latter part of the last century, was reoccupying its former range and was now breeding on Guadalupe, Islas San Benito, San Miguel Island, San Nicolas Island, Islas Los Coronados, and, most recently, Año Nuevo Island. He noted that this was one of the most dramatic demonstrations of population recovery known for any large mammal and he correctly predicted that it would continue.

The remarkable resurgence of the elephant seal has been well documented. Today there are approximately 60,000 elephant seals (Fig. 3). This represents more than a threefold increase in the population since 1965. These data are based on aerial and island censuses; each colony has been monitored very closely. For this species, we know approximately when breeding began at each colony, the number of pups produced, and the rate of growth. As of this writing, only Isla de Guadalupe, the mother colony, and Islas San Benito have populations which have stabilized. All other colonies are increasing in size and show indications of continuing to increase, space permitting (Le Boeuf 1977).

Bartholomew (1967) said that breeding had just begun on Año Nuevo Island. A lot has happened in the interim. Figure 4 shows that pup production was still increasing exponentially in 1978. Over 800 pups were produced on this tiny island. Figure 5 shows that the increase was not specific to pup production, but occurred in the entire colony population during virtually all phases of the annual cycle. By 1978, breeding beaches were so crowded at the peak of the breeding season that many pregnant females had a difficult time landing (Fig. 6). Apparently as a result of crowding, some females started to breed on the Farallon Islands in 1972 (Le Boeuf, Ainley, and Lewis 1974) and on the Año Nuevo mainland in 1975 (Le Boeuf and Panken 1977). The rate of pup production at these two locations has been even higher than the rate of growth described for Año Nuevo Island. Indeed, the annual increase in pup production at several

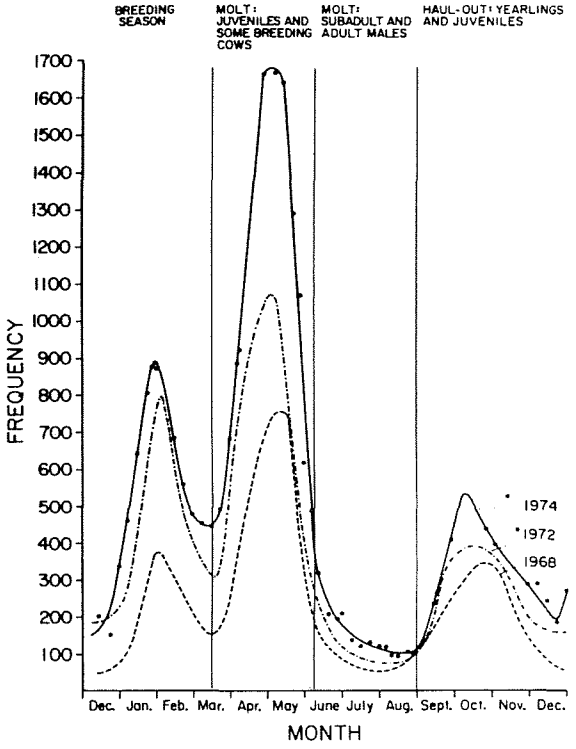

FIGURE 5. *Annual increase in total number of northern elephant seals throughout the annual cycle during the period 1968 to 1974. This annual rate of increment was still continuing in 1978.*

FIGURE 6. *An aerial photograph of the largest breeding aggregation of northern elephant seals on Año Nuevo Island taken on 21 January 1978, near the peak of the breeding season when crowding was greatest. Photograph by Frank McCrary, Jr.*

rookeries in recent years has ranged from approximately 12 to 400 per cent per year. The rate of growth of the total populations on San Miguel Island and San Nicolas Island, shown in Figures 7 and 8, is typical of expanding colonies. On both these islands the animals have not yet exhausted available breeding areas and further growth is expected.

The expansion of breeding areas on islands has proceeded from preferred sandy beaches to peripheral areas. The least preferred areas are cobblestone beaches. Figure 9 shows where elephant seals bred on San Miguel Island in 1976. In 1968, elephant seals bred only on the western tip of San Miguel, the area known as Point Bennett. In subsequent years, harems formed farther eastward each year so that, by 1978, the animals were breeding along virtually the entire southern portion of the island. At present, the animals show signs of starting to breed on the north side of the island, as well. A similar progression has taken place on San Nicolas Island.

We will note briefly some observations on island differences and colony formation which have been made during the last few years. The first concerns the sex and age composition of the breeding animals. This statistic is apparently determined by reproductive competition within each sex. The highest proportion of males at crowded rookeries, such as Isla de Guadalupe, are fully-grown adults. Young males going through puberty have a difficult time landing on breeding beaches and, consequently, many of them migrate to less crowded peripheral colonies, such as that on Año Nuevo Island during the 1960s (Le Boeuf 1974). Consequently, young pubescent males are under-represented at stable colonies like Isla de Guadalupe and are in the majority at peripheral colonies with space to accommodate immigrants. Similarly, the youngest females have a difficult time landing on crowded islands during the breeding season because they are smaller and subordinate to older females. The likelihood that the pups of young females that give birth on a crowded beach will survive is low because of the harassment from the older, larger, more aggressive females (Le Boeuf, Reiter, and Panken, unpubl. data). Consequently, it is the young females that colonize new places such as the Farallon Islands and the mainland across the channel from Año Nuevo Island (Le Boeuf and Panken 1977). Thus, one of the principal differences between an old established rookery and a new one is in the composition of breeding animals.

Island differences in male threat vocalizations, termed dialects, were noted by Le Boeuf and Peterson (1969). Le Boeuf and Petrinovich (1974) explained these differences as resulting from the manner in which the population expanded. To a certain extent, the dialects detected during the late 1960s reflected the direction and the time of dispersal from old established areas to new peripheral ones. Although inter-island differences were still apparent in the vocalizations of breeding-age males in 1978, the differences are decreasing annually as recruitment of individuals from large colonies to peripheral ones continues. If dispersion continues in this direction, the dialects will eventually disappear.

A complete lack of differences between individuals in different colonies was found in a study of genetic variability using blood proteins. Bonnell and Selander (1974) found no polymorphisms in 19 blood proteins at 24 different loci in a sample of 125 elephant seals from five different colonies. This was interpreted as indicating that elephant seals may lack genetic variation, relative to other marine and terrestrial mammals, and that this is, in large part, due to the bottleneck which the population underwent during the latter part of the last century.

Finally, a study of pup mortality by Le Boeuf and Briggs (1977) indicated that the pup mortality rate on Año Nuevo Island varied from 13 to 26 per cent per year during the period 1968 to 1976. This mortality rate was found to be higher than that estimated for San Miguel and San Nicolas Islands. The annual pup mortality rate for the Farallon Islands, on the other hand, has varied from 7 to 71 per cent of pups born during the period 1974 to 1977 (Ainley *et al.* 1978). Le Boeuf and Briggs (1977) concluded that weather was a very important variable which could

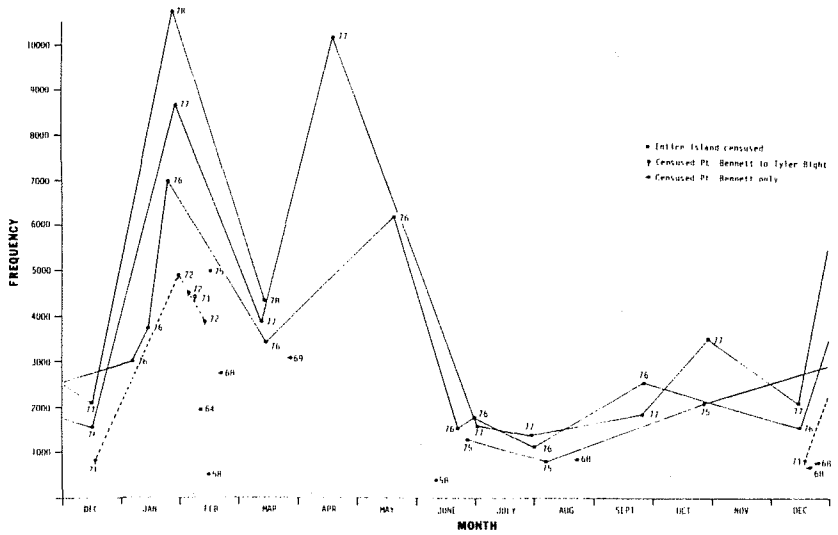

FIGURE 7. *Growth of the northern elephant seal population on San Miguel Island as reflected by censuses of total number of animals. Data points connected by straight lines for different years are from Le Boeuf* et al. *(1976). The remainder of the data points are from several investigators (see Le Boeuf* et al. *1976 for references).*

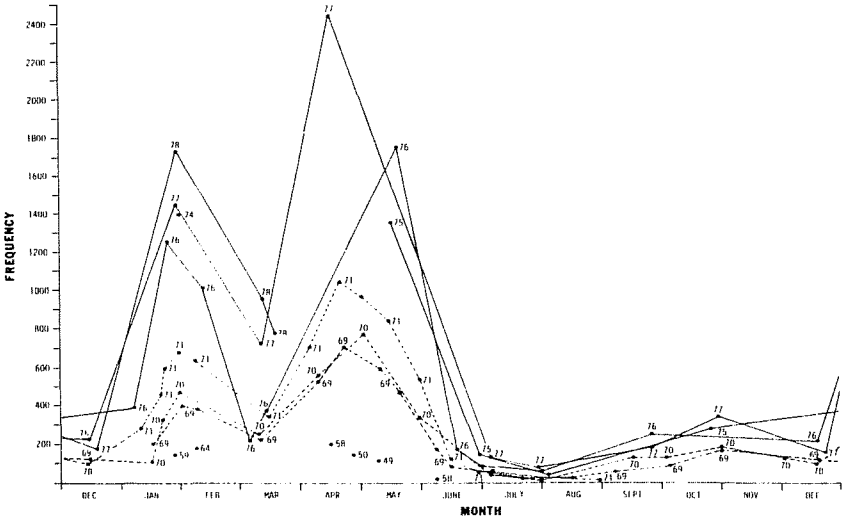

FIGURE 8. *Growth of the northern elephant seal population on San Nicolas Island as reflected by censuses of total number of animals. Data points connected by straight lines for different years are from Le Boeuf* et al. *(1976), those connected by a dotted line (the years 1969, 1970, and 1971) are from Odell (1972, 1974), and the remainder of the data points are from several investigators (see Le Boeuf* et al. *1976 for references).*

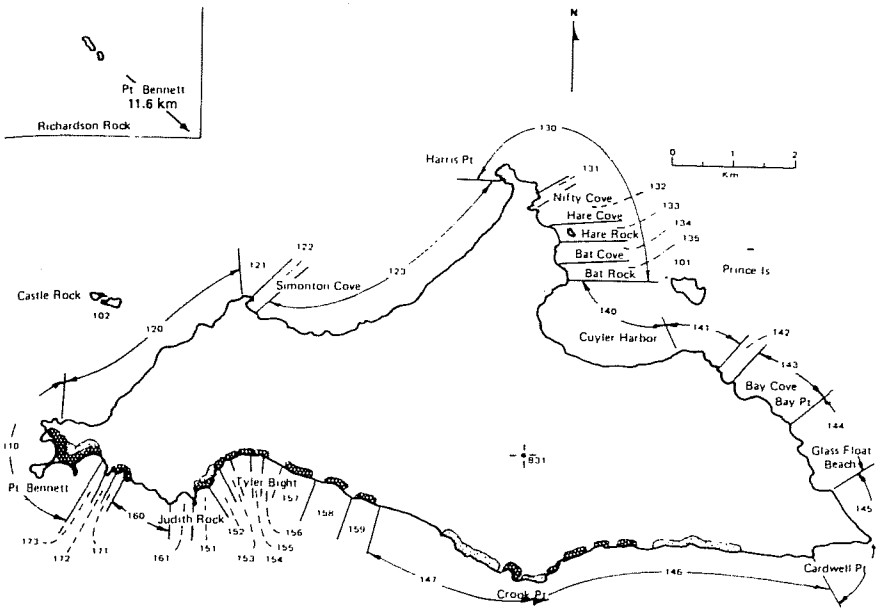

FIGURE 9. *A schematic map of San Miguel Island showing where northern elephant seals bred (crosshatched areas) and the principal resting areas (dotted areas) in 1976. The code numbers are for area identification. Adapted from Le Boeuf* et al. *(1976).*

interact with other factors to greatly augment mortality. This conclusion was borne out on Año Nuevo Island in 1978 when bad weather caused the pup mortality rate to exceed 40 per cent of pups born.

The present status of northern elephant seals can be summarized as follows: the population is increasing. Breeding space appears to limit population growth more readily than does food. Mainland breeding is an unusual event—a change in breeding habitat which could not have worked 200 years ago because of land predators, but a strategy which is working very well in the 1970s because grizzly bears, wolves, and mountain lions have been virtually eliminated. The extraordinary recovery of the northern elephant seal population continues, but the apparent lack of genetic variation indicated by blood protein studies is a matter of interest and concern (Le Boeuf 1977).

California Sea Lions

In this century, the California sea lion has been known to breed in the Southern California Bight, on islands along the west coast of California, and in the Gulf of California to the Tres Marías Islands. Bartholomew (1967) noted that the number of California sea lions breeding in the Southern California Bight increased exponentially during the first four decades that censuses were taken. The population in 1940 was estimated to be 2,000 animals. By 1964, Bartholomew estimated 17,000 animals and thought that the population was beginning to level off. He indicated that, with no disturbance, the population should remain between 15,000 and 20,000 animals. He further noted that males go north after the breeding season while females remain in the vicinity or move south. He called this species the most conspicuous and abundant pinniped in California and Mexico.

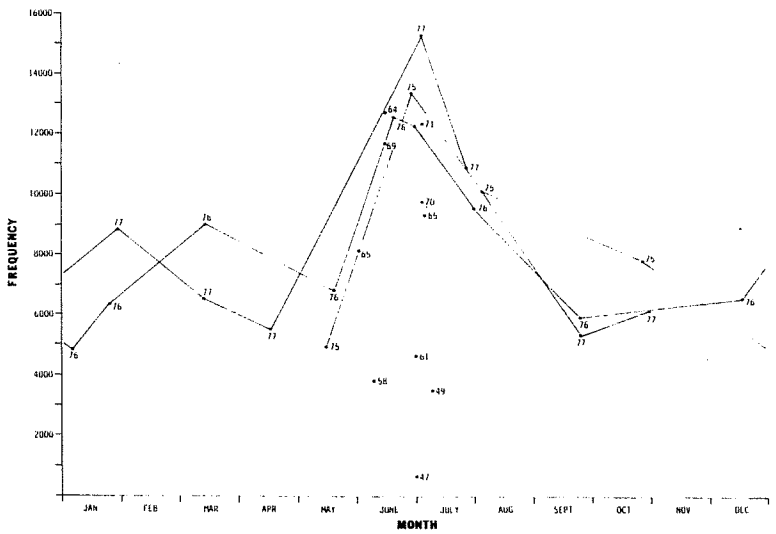

FIGURE 10. *Growth of the California sea lion population on San Nicolas Island as reflected by censuses of total number of animals. Data points connected by straight lines for different years are from Le Boeuf* et al. *(1976); references for other points can be found in Le Boeuf* et al. *(1976).*

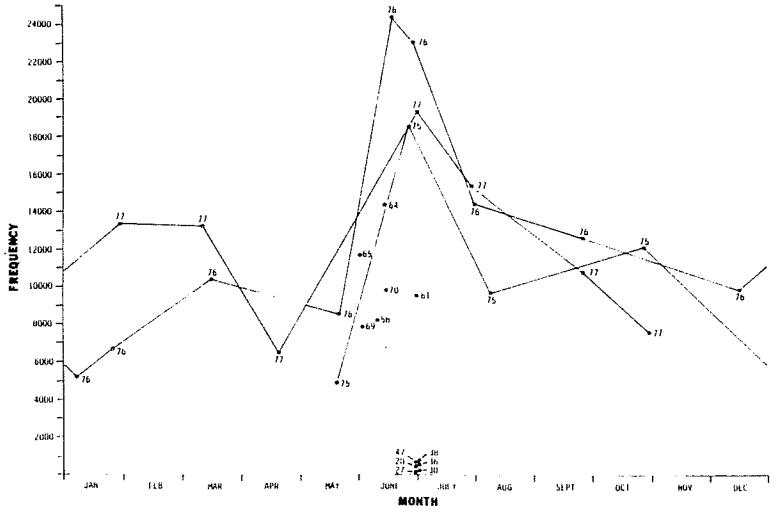

FIGURE 11. *Growth of the California sea lion population on San Miguel Island as reflected by censuses of total number of animals. Data points connected by straight lines for different years are from Le Boeuf* et al. *(1976); references for other points can be found in Le Boeuf* et al. *(1976).*

It has turned out that his estimate was low. In 1976, 48,000 California sea lions were counted on the Channel Islands (Le Boeuf *et al.* 1976), the area Bartholomew was referring to. This represents a 40 per cent increase in the population of this species since 1964 (Odell 1971). The population is still growing in the Channel Islands. The two largest rookeries are San Nicolas Island and San Miguel Island; 90 per cent of the California sea lions in southern California breed there. The growth of these two colonies during the last two decades is shown in Figures 10 and 11. Pup production in the Southern California Bight alone in 1976 was at least 13,500 pups, and may have been even greater (Le Boeuf *et al.* 1976). We think it is too soon to say whether the population is leveling off.

The California sea lion breeds on many islands in Baja California. The islands we monitored most closely were Los Coronados, San Martín, San Benito, Cedros, Natividad, and Guadalupe. Islas San Benito represent the largest rookery. Over 10,000 animals can be found there during the peak of the breeding season and approximately one-half that number at other times of the year. Colony size appears to be stable. Similarly, the small population on the distant oceanic island, Guadalupe, also appears to be stable. Colony size has varied from 230 to 750 animals during the last decade.

California sea lions do not breed regularly in northern California; one female was recorded giving birth on the Farallon Islands (Pierotti *et al.* 1977). Even so, thousands of animals haul out on Año Nuevo Island every year. The peak is in the fall during the male migration northward following the breeding season. The number of animals seen at this time of year has decreased considerably from a peak of 13,000 animals in 1961 (Orr and Poulter 1965) to a peak of about 2,000 animals in 1974 (Fig. 12). The peak number of animals was slightly less than 2,000 in 1977. On the other hand, the number of California sea lions sighted on the Farallon Islands has increased from approximately 400 in 1971 to almost 1,600 in 1977. The peak on the Farallon Islands occurs during the month of April (Ainley *et al.* 1978).

Mate (1977) estimates that the total California sea lion population in California and Baja California, including the Sea of Cortez, is approximately 75,000 animals. Le Boeuf *et al.* (1976) put this figure at 125,000 animals. We think that even the latter figure is probably a low estimate.

During the last 10 years, many premature pups have been aborted during the months between January and the beginning of the breeding season in early May (Odell 1970, Gilmartin *et al.* 1976). High pesticide levels, as well as viruses, have been implicated as possible causes (*e.g.*, Le Boeuf and Bonnell 1971, DeLong, Gilmartin, and Simpson 1973, Smith *et al.* 1974, Gilmartin *et al.* 1976). The trend in premature pupping continues, although a complete explanation for this phenomenon is still lacking.

Harbor Seals

Bartholomew (1967) observed that harbor seals were seen in the Southern California Bight throughout the year in groups of a few dozen to over 100 individuals. He remarked that nothing was known about their seasonal movements but they appeared to be more sedentary than other pinnipeds in the area. He estimated the population in southern California to be approximately 500 and he noted that there was no evidence of much change during the previous 20 years.

More recent data by Odell (1971) and Le Boeuf *et al.* (1976) show that the population in southern California has grown slowly. Odell reported a June 1964 census of 645 animals. In June 1975, Le Boeuf *et al.* (1976) counted 1,090 animals, and in June of 1977, 1,656 animals were counted. In these aerial surveys, harbor seals were seen on the following islands: San Miguel, Santa Rosa, Santa Cruz, Anacapa, San Nicolas, Santa Barbara, Santa Catalina, and San Clemente. It was further noted that the number on land varied seasonally, with the highest number of animals being seen in the late spring and early summer during the breeding season

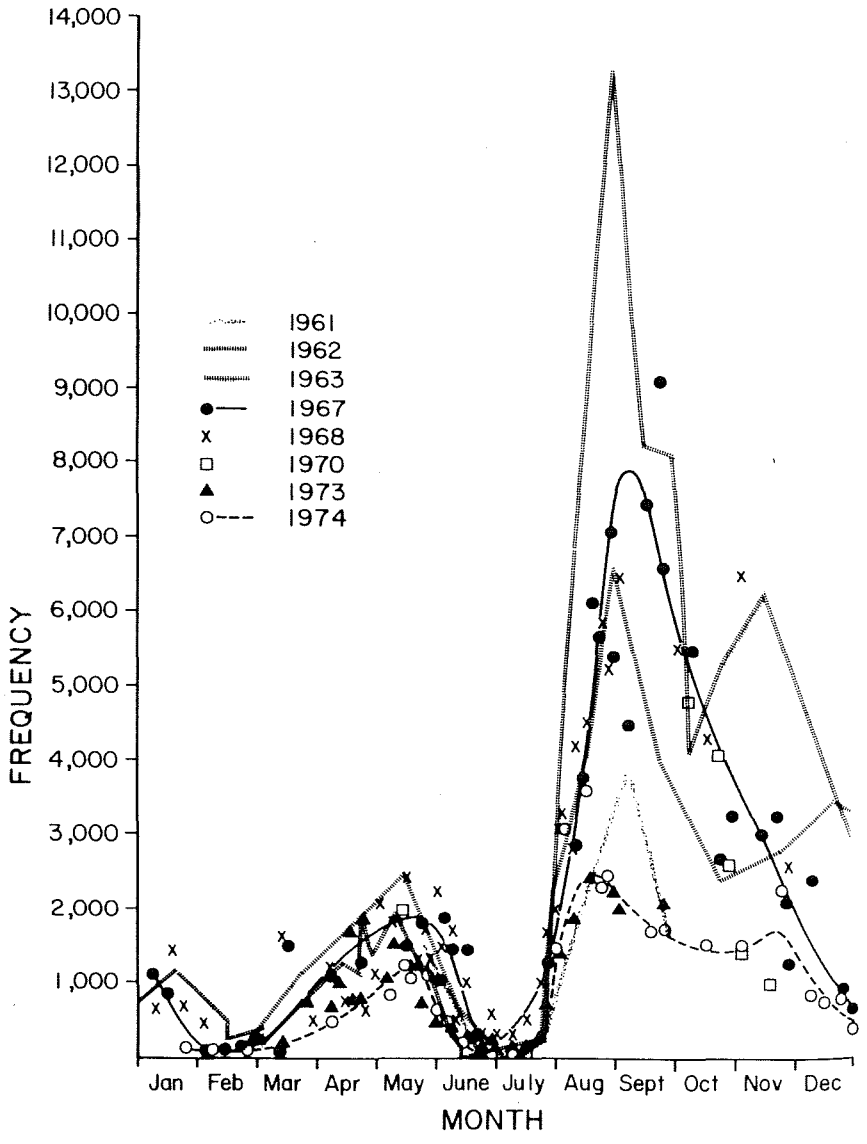

FIGURE 12. *Censuses of California sea lions on Año Nuevo Island, 1961 to 1974. Data from 1961 to 1963 are from Orr and Poulter (1965).*

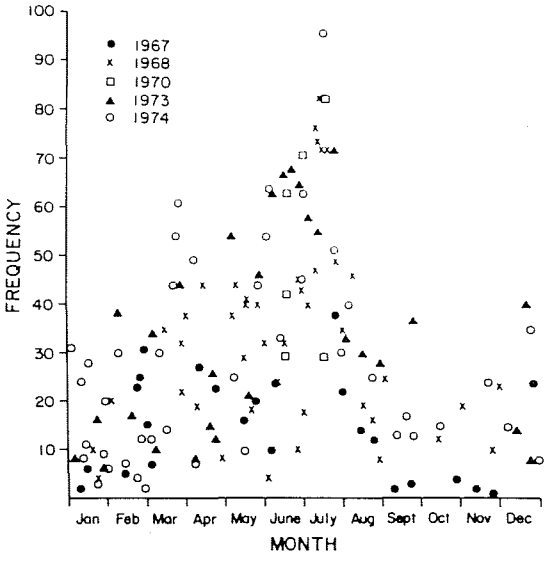

FIGURE 13. *Censuses of harbor seals on Año Nuevo Island from 1967 to 1974. The number of seals counted varied so much with tidal conditions and time of day that it is difficult to compare censuses from year to year. Note that the highest censuses each year were taken in late July.*

(these counts include pups). The average count at other times of the year was approximately 400 individuals. Herds were observed repeatedly in the same areas. The largest numbers were consistently seen on San Miguel Island (*e.g.*, 600 animals in June 1975) and Santa Rosa Island (*e.g.*, 336 in June 1975, 900 in April 1977). Harbor seals were rarely seen at sea; the few sightings were in the Santa Barbara Channel area.

Bartholomew (1967) had no censuses from Baja California. Mate (1977) made aerial censuses in this region during 1974 and 1975, and Le Boeuf and collaborators made periodic censuses in the area from 1968 to 1978. Mate counted 400 harbor seals from the southern California border to the southern tip of Baja California. He found no harbor seals south of Isla Cedros. Our studies reveal that most harbor seals along the west coast of Baja California occur on two islands: Los Coronados and San Martín. On the former, the census counts in the last decade vary from 36 to 136 animals. Pups were seen as early as 11 March in 1974. The highest counts always occurred on the middle island. Isla San Martín may be the southernmost rookery along the west coast of Baja California. Large numbers of harbor seals haul out there in a shallow lagoon on the east side of the island. Three censuses from that area are available: 60 animals with two pups were counted on 21 April 1970, 223 animals with 15 pups were counted on 28 May 1971, and 236 animals with nine pups (three dead) were counted on 19 February 1977. Apparently, breeding in Baja California occurs during February, March, and April. This is somewhat early compared with more northerly places where harbor seals breed.

In northern California, harbor seals breed on Año Nuevo Island, the Farallon Islands, in San Francisco Bay, and at several other locations along the mainland shore. On Año Nuevo Island, as elsewhere, there is great fluctuation in colony number with tide and time of day. The greatest number is seen during the late afternoon and at low tide. Here, these animals breed from April to late May and the greatest number of them is always in July. The peak number in July has steadily increased since the early 1960s (Fig. 13). Eighty-six were counted in 1963 (Orr and Poulter 1965). Le Boeuf and collaborators counted 85 in 1968, 95 in 1970, 162 in 1976, and 183 on 12 July 1977. Evidently the population is increasing slowly.

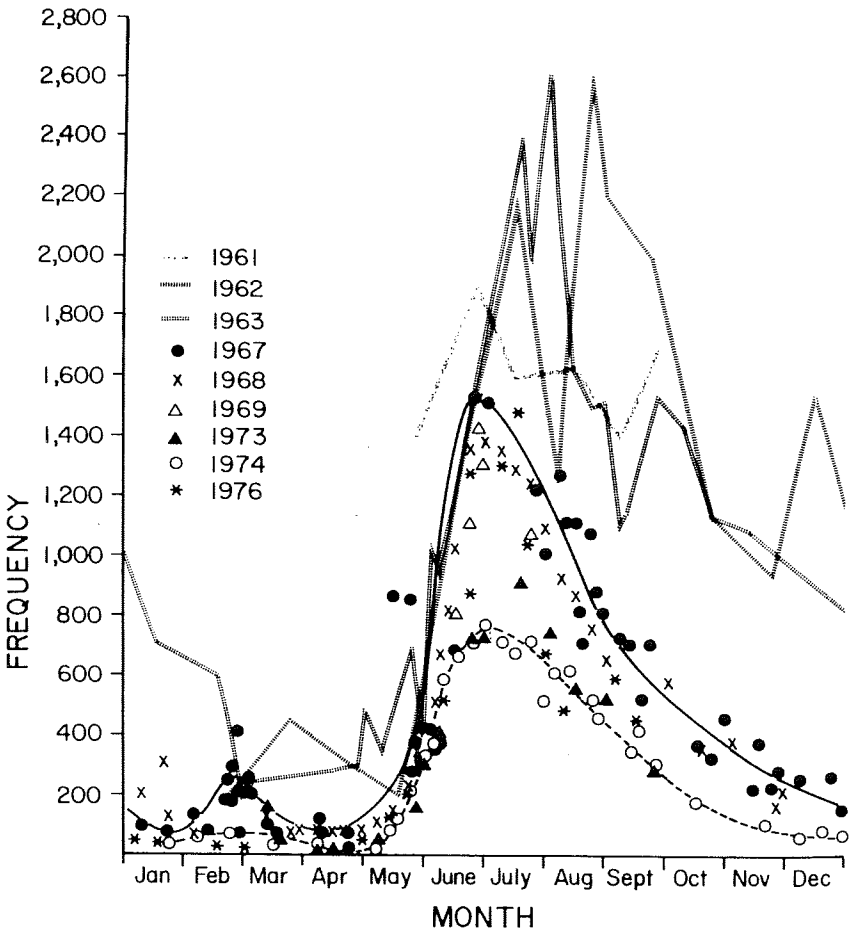

FIGURE 14. *Censuses of Steller sea lions on Año Nuevo Island, 1961 to 1974. Data from 1961 to 1963 are from Orr and Poulter (1965).*

Harbor seals were first seen on the Farallon Islands during the fall of 1971 (Ainley *et al.* 1977). Breeding occurred in 1974. In July of 1977, 26 harbor seals were counted, a 13 per cent increase over 1976 (Ainley *et al.* 1978). These animals are now present there year-round.

Combining the figure of Mate (1977) and those from the Bureau of Land Management studies (Le Boeuf *et al.* 1976), we estimate that the harbor seal population from Año Nuevo Island south to Isla San Martín is at least 2,500 animals. The greatest number ever seen together is approximately 250 animals. We suspect that groups of 100 or more may move *en masse* from one island to the next, or from the island to the mainland (*e.g.*, from Año Nuevo to the mainland, from Los Coronados to an area near Tijuana, from San Martín to an area near San Quintín). We conclude that there are more harbor seals today than there were in the mid-1960s. Harbor seals have been increasing in numbers slowly and consistently throughout their range.

Steller Sea Lions

The Steller sea lion was the most abundant pinniped in southern California during the late 1920s. During the 1930s, 2,000 animals were reported to breed on San Miguel Island alone. However, the number breeding there has been declining ever since. In 1958, Bartholomew (1967) noted that less than 100 animals bred in the Channel Islands, and then only on the western tip of San Miguel Island. In contrast, Bartholomew stated that the population on Año Nuevo Island had been stable for a long time and that approximately 1,000 adults were recorded annually during the breeding season. He mentioned that there was a seasonal separation of sexes similar to that of California sea lions during the nonbreeding season.

During the last 13 years, the Steller sea lion has been seen in the Southern California Bight only on San Miguel Island and in steadily decreasing numbers. Odell (1971) reported 61 adults and seven pups on San Miguel Island in June 1964 and said that they bred there in 1969 and 1970. DeLong (1975) reported that approximately 10 pups were born on San Miguel Island each year since 1969. The highest counts determined by the Bureau of Land Management studies from aerial censuses were four adult males, 12 females, and three pups on 7 August 1975 (Le Boeuf *et al.* 1976). Steller sea lions have been observed only on Point Bennett, Richardson Rock, and Castle Rock near San Miguel Island. These animals are rarely seen at sea in southern California. Clearly, the decline in southern California continues and there are evidently less than 50 individuals there during the breeding season.

The population of Steller sea lions is four to six times lower than it was 40 years ago on the Farallon Islands. The population peaks in April when migrants haul out briefly. The breeding population is apparently stable at approximately 130 animals. The pregnancy rate is low, approximately 24 per cent; only about 27 pups are born each year. Most of the pups born before the first week in June are stillborn or die shortly after birth. The mortality rate is high, approximately 41 per cent, and is due primarily to premature births. The trend has been very consistent during the last four years (Ainley *et al.* 1978).

On Año Nuevo Island, the population has fluctuated slightly during the last two decades (Fig. 14). Peak population in 1977 was similar to that in 1974. Pup production has varied from 300 to 600 per year.

We conclude that the population is continuing to decrease in the southern portion of the range and is relatively stable in northern California. Bartholomew (1967) suggests several reasons for the declining numbers in southern California.

Guadalupe Fur Seals

A few years ago, it was not clear whether the Guadalupe fur seal had ever occurred in the Southern California Bight. Bartholomew (1967) knew that the species had occurred on Isla de Guadalupe, Islas San Benito, and on the Farallon Islands before exploitation began. He estimated the 1965 population to be between 400 and 600 animals on Isla de Guadalupe, the only place where these animals bred at the time. He noted that occasional males were seen on San Nicolas Island and on Islas San Benito.

A recent paper by Walker (in press) presents evidence that the Guadalupe fur seal did reside in the Channel Islands before exploitation began. He found that Guadalupe fur seal bones were the most frequent remains in archaeological sites on the west end of San Miguel Island, being more common than those of any other Pacific pinniped or those of the sea otter.

Today, the Guadalupe fur seal still breeds only on Isla de Guadalupe. Winter counts have increased from 350 on 17 February 1969 to 470 on 13 February 1977. The highest summer census was taken in 1977 by Luis Fleischer and Mark Pierson (unpubl. data). They counted 1,073 animals; 400 of them were pups. We estimate, therefore, that the present population of Guadalupe fur seals numbers approximately 2,000 individuals. Fleischer and Pierson con-

FIGURE 15. *An adult female and adult male Guadalupe fur seal photographed against the background of volcanic rock and caves which they inhabit.*

cluded that boat censuses underestimate by at least 50 per cent the number of individuals present. Pup counts from boats may underestimate the true figure by as much as 90 per cent.

It is now evident that Guadalupe fur seals are expanding their range southward on the east side of Isla de Guadalupe. However, they still inhabit only rocky areas where there are numerous caves (Fig. 15). Studies on population dynamics and social and reproductive behavior continue.

In the last few years, DeLong and others have seen occasional male Guadalupe fur seals on San Miguel Island (pers. comm.). One male held a territory against California sea lions in 1973 and 1974 (DeLong 1975).

SUMMARY

The following points characterize the present status of each of the pinnipeds inhabiting the California Islands.

(1) Northern fur seals started breeding on San Miguel Island in southern California during the 1960s. They show signs of being there to stay. The population numbered at least 2,000 animals in 1976.

(2) The fantastic recovery of the northern elephant seal continues. Dramatic increases in their numbers continue throughout the range and several new colonies are being formed. In 1977, there were approximately 60,000 elephant seals.

(3) There are now twice as many California sea lions on the California Islands as there were 13 years ago. There were 80,000 to 125,000 animals in Californian and Mexican waters in 1976.

(4) There are at least three times as many harbor seals on the California Islands as pinniped researchers thought there were in 1965. Approximately 2,000 harbor seals were counted in 1976.

(5) Steller sea lions continue to decline in southern California, although their numbers have been relatively stable in northern California. There were less than 50 Steller sea lions in the Southern California Bight in 1976 (all on San Miguel Island), and approximately 1,600 breeding individuals in northern California in that same year.

(6) Guadalupe fur seals continue their slow recovery from near extinction. The highest count during a breeding season was in 1977 when 1,073 individuals were seen. The entire world population probably numbers less than 2,000 individuals.

Finally, we would like to note that the perspective one gains from summarizing species by species obscures the rhythm and seasonality of island use by pinnipeds. There is a dovetailing of the activities of different species on land throughout the year, and also variation in patterns of island use within each species with respect to sex and age. For example, northern elephant seal adults breed on San Miguel Island in winter while juveniles are at sea. In spring, juveniles and adult females molt on this island while adult males are at sea. When northern elephant seals breed there are few California sea lions on land—the opposite is true in summer. Again, one will find pinnipeds at Adam's Cove, San Miguel Island, for example, at all times of the year, but the number representing each species, and the sex and age composition within each species, will vary predictably with time of year.

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REFERENCES

AINLEY, D. G., H. R. HUBER, R. P. HENDERSON, and T. J. LEWIS. 1977. Studies of marine mammals at the Farallon Islands, California, 1970-1975. Final report to U.S. Marine Mammal Commission, Washington, D.C. (Contract MM4AC002).

AINLEY, D. G., H. R. HUBER, S. MORRELL, and R. H. LE VALLEY. 1978. Studies at the Farallon Islands, 1977. Final report to U.S. Marine Mammal Commission, Washington, D.C. (Contract MM6AC027).

BARTHOLOMEW, G. A. 1967. Seal and sea lion populations of the California Islands. Pp. 227-244 *in* R. N. Philbrick, ed., Proceedings of the symposium on the biology of the California Islands. Santa Barbara Botanic Garden, Santa Barbara, Calif.

BONNELL, M. L., and R. K. SELANDER. 1974. Elephant seals: genetic variation and near extinction. Science 184:908-909.

DELONG, R. L. 1975. San Miguel Island management plan. U.S. Marine Mammal Commission, Washington, D.C.

DELONG, R. L., W. G. GILMARTIN, and J. G. SIMPSON. 1973. Premature births in California sea lions: association with high organochlorine pollutant levels. Science 181:1168-1170.

FISCUS, C. H., R. L. DELONG, and G. A. ANTONELIS. 1976. Population growth and behavior, San Miguel Island. Pp. 40-51 *in* Fur seal investigations, 1976. U.S. Dept. Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Marine Mammal Division, Seattle, Wash.

GILMARTIN, W. G., R. L. DELONG, A. W. SMITH, J. C. SWEENEY, B. W. DE LAPPE, R. W. RISEBROUGH, L. A. GRINER, M. D. DAILEY, and D. B. PEAKALL. 1976. Premature pupping in the California sea lion. J. Wildl. Diseases 12:104-115.

JOHNSON, A. 1975. The status of northern fur seal populations. Rapp. P-v. Réun. Cons. Int. Explor. Mer. 169:263-266.

LE BOEUF, B. J. 1974. Male-male competition and reproductive success in elephant seals. Amer. Zool. 14:163-176.

———. 1977. Back from extation? Pacific Discovery 30:1-9.

LE BOEUF, B. J., D. G. AINLEY, and T. J. LEWIS. 1974. Elephant seals on the Farallones: population structure of an incipient breeding colony. J. Mammal. 55:370-385.

LE BOEUF, B. J., and M. L. BONNELL. 1971. DDT in California sea lions. Nature 234:108-110.

LE BOEUF, B. J., M. L. BONNELL, M. O. PIERSON, D. H. DETTMAN, and G. D. FARRENS. 1976. Numbers, distribution and movements of pinnipeds in the Southern California Bight. Final report, 1975-1976, to the Bureau of Land Management, U.S. Dept. Interior, Washington, D.C. (Contract 08550-CT5-28).

LE BOEUF, B. J., and K. T. BRIGGS. 1977. The cost of living in a seal harem. Mammalia 41:167-195.

LE BOEUF, B. J., and B. R. MATE. 1978. Elephant seals colonize additional Mexican and Californian islands. J. Mammal. 59:621-622.

LE BOEUF, B. J., and K. PANKEN. 1977. Elephant seals breeding on the mainland in California. Proc. California Acad. Sci. 41:267-280.

LE BOEUF, B. J., and R. S. PETERSON. 1969. Dialects in elephant seals. Science 166:1654-1656.

LE BOEUF, B. J., and L. F. PETRINOVICH. 1974. Dialects of northern elephant seals, *Mirounga angustirostris:* origin and reliability. Anim. Behav. 22:656-663.

MATE, B. R. 1977. Aerial censusing of pinnipeds in the eastern Pacific for assessment of population numbers, migratory distributions, rookery stability, breeding effort, and recruitment. Final report to U.S. Marine Mammal Commission, Washington, D.C. (Contract MM5AC001).

ODELL, D. K. 1970. Premature pupping in the California sea lion. *In* Proceedings of the seventh annual biosonar and diving mammal conference. Stanford Research Institute, Menlo Park, Calif.

———. 1971. Censuses of pinnipeds breeding on the California Channel Islands. J. Mammal. 52:187-190.

———. 1972. Studies on the biology of the California sea lion and the northern elephant seal on San Nicolas Island, California. Ph.D. thesis, University of California, Los Angeles, Calif.

———. 1974. Seasonal occurrence of the northern elephant seal, *Mirounga angustirostris,* on San Nicolas Island, California. J. Mammal. 55:81-95.

ORR, R. T., and T. C. POULTER. 1965. The pinniped population of Año Nuevo Island, California. Proc. California Acad. Sci. 32:377-404.

PETERSON, R. S., B. J. LE BOEUF, and R. L. DELONG. 1968. Fur seals from the Bering Sea breeding in California. Nature 219:899-901.

PIEROTTI, R. J., D. G. AINLEY, T. J. LEWIS, and M. C. COULTER. 1977. Birth of a California sea lion on Southwest Farallon Island. California Fish and Game 63:64-65.

POULTER, T. C., and R. JENNINGS. 1966. Annual report to the Division of Beaches and Parks, State of California. Stanford Research Institute, Menlo Park, Calif.

RADFORD, K. W., R. T. ORR, and C. L. HUBBS. 1965. Reestablishment of the northern elephant seal *(Mirounga angustirostris)* off central California. Proc. California Acad. Sci. 31:602-612.

SMITH, A. W., C. M. PRATO, W. G. GILMARTIN, R. J. BROWN, and M. C. KEYES. 1974. A preliminary report on potentially pathogenic microbiological agents recently isolated from pinnipeds. J. Wildl. Diseases 10:54-59.

WALKER, P. Archaeological evidence concerning the prehistoric occurrence of sea mammals at Point Bennett, San Miguel Island. California Fish and Game (in press).