PINNIPED ASSESSMENT IN THE POINT REYES/FARALLON ISLANDS NATIONAL MARINE SANCTUARY, 1982 - 83.

Sarah G. Allen and Harriet R. Huber

Point Reyes Bird Observatory
4990 Shoreline Highway
Stinson Beach, CA 94970

ABSTRACT

From March 1982 to February 1983 we censused three species of pinnipeds [harbor seal, California sea lion, and northern (Steller) sea lion] found on the coast of the Point Reyes/Farallon Islands National Marine Sanctuary. We censused harbor seals semi-monthly and simultaneously at all traditional haul out sites. Seals were present throughout the year with most seals recorded in the breeding season; the maximum count for the season was 2502 with 566 pups. An enormous influx of animals occurred primarily at coastal locations during the breeding season and appeared to be from areas outside of the Sanctuary. The diurnal haul out pattern varied depending upon time of day, tide level, and physical features of the hauling ground. Disturbance also modified the seals' diurnal pattern and was considered a factor in reproductive success. Preliminary recommendations for management are presented.

California and northern sea lions were censused weekly during the breeding season (May-August) and semi-monthly during the rest of the year at Sea Lion Overlook, Point Reyes. We divided animals into five age-classes and compared coastal counts to counts on the Farallon Islands. Peak numbers were 338 at the

Headlands in April and 3725 at the Farallones in January for California sea lions; for northern sea lions high counts were 19 at the Headlands in July and 192 at the Farallones also in July. No pups were observed at Point Reyes. Censuses were analyzed to clarify seasonal, diurnal and tidal fluctuations. Sea lions were censused in Tomales Bay during the herring run, December to March.

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INTRODUCTION

The presence of harbor seals, Phoca vitulina richardsi , within the coastal zone of the Point Reyes/Farallon Islands National Marine Sanctuary has been documented sporadically since Scammon (1968) first visited Point Reyes in the 1850's. Bonnot (1928) recorded numbers of seals for the California Division of Fish and Game but made only cursory observations in Point Reyes. More recently, Carlisle and Alpin (1966, 1971), Frey (1970), Mate (1977) and the Bureau of Land Management (BLM) (1981; Dohl 1982) conducted aerial surveys of pinnipeds in California. The focus of Mate's survey was on sea lions, and accordingly, the figures for harbor seals were low for the entire region. He distinguished only three seal haul out areas: Drakes Bay, Tomales Bay, and Tomales Point. BLM conducted aerial surveys of marine mammals in central and northern California in 1980 and 1981, and their survey was the first attempt to determine seasonal variability. Their estimates from latitude 37°30' to 38°30' for harbor seals in 1981 were 1333 in January, 1262 in May, 2559 in June, and 658 in September. Incidental information on pinnipeds was presented by Chan (1979) in reports on Areas of Special Biological Significance (ASBS) in the Point Reyes region, and detailed information on the population at Bolinas Lagoon was provided by Allen (1980). This survey, however, is the first comprehensive assessment of numbers and seasonal use patterns of harbor seals for the entire coastal zone of the Sanctuary. Management plans can be designed from this baseline information in conjunction with that to be collected in the second survey year.

STUDY AREA AND METHODS

The coastal zone of the Point Reyes/Farallon Islands National Marine Sanctuary extends from Bodega Bay (38° 30'N) south to and including Bolinas Bay (37°30'N). Coastal embayments such as Tomales Bay, Drakes Estero, and Bolinas Lagoon, also under the jurisdiction of the Marine Sanctuary, were included. The Point Reyes National Seashore (PRNS), the Golden Gate National Recreation Area (GGNRA), and the Marin County Department of Parks and Recreation share jurisdiction with the Sanctuary over segments of this coastline. In addition to the protection afforded by these agencies, Bird Rock, Point Reyes Headland, and Double Point were designated by the California Department of Fish and Game (CDFG) and the State Water Resources Control Board as Areas of Special Biological Significance (ASBS) because of their unique biological attributes.

Because of its agricultural character, much of this coastline has remained largely undeveloped even prior to its inclusion in the 1960's and 70's in PRNS and GGNRA. This character and the inaccessibility of much of the area have afforded protection from human disruption to the seals' terrestrial resting periods. Consequently, seal habitat usage probably has not changed significantly over the past century.

The topographical diversity of this coastal zone provides a broad range of substrates upon which harbor seals haul out in large groups. These include tidal mud flats, offshore tidal ledges, and sandy beaches. We censused harbor seals from the ground semi-monthly at recognized haul out sites within the coastal zone of the Sanctuary from March 1982 to March 1983. "Haul out site" is defined as a terrestrial location where seals

aggregate on a daily basis. These sites were Hog Island, sand bars in Tomales Bay near Toms Point, Bird Rock and adjacent beaches, Point Reyes Headland, Drakes Estero, Limantour Estero and Limantour Spit, Double Point, Duxbury Reef, and Bolinas Lagoon (Figure 1). In addition, we counted seals monthly at Bodega Rock. Censuses at Limantour Estero, though initially included in this project, were discontinued because seals were absent during low tides and were noted only incidentally during medium tides. The change in seal presence at Limantour Estero can be attributed to the high rate of siltation precipitated by severe storms in 1982 which rendered the area inaccessible.

Seals were censused on weekdays in order to minimize the chance of human disturbance. Censuses occurred simultaneously during low tides except on the few occasions when weather conditions prevented human access to remote sites. Low tide is usually the time when maximum numbers of seals haul out in the San Francisco Bay region (Allen 1980, Fancher 1979, Risebrough 1978).

We categorized harbor seals into three age classes: adults, subadults, and pups. Pups, born April through June, were considered subadults at the end of July because their size and coloration were then indistinguishable from first year immatures (i.e., immatures began to molt, and pup pelage became faded). Harbor seals reach maturity between three and five years, so division of this age group was based solely on size in comparison to adult animals which are about 160 cm long. We excluded information on immature seals for Tomales Bay, Limantour Spit, and Duxbury Reef; age-classes were difficult to separate consistently in these areas because of distance from the observer and glare from the afternoon sun.

Individual animals, those with distinct coloration or scars, were identified whenever possible to determine seal movement between locations. We consistently observed individuals with distinct scars only at Double Point where the observer was on a cliff overlooking the seals 70 m away. "Red" seals, those with a deep russet hue to the pelage, however, were easily counted at all locations. Unfortunately, when seals molted from July through September, the red also disappeared and did not reappear in the population until November (for a description of red seals, see Risebrough 1978).

For analysis of seasonal trends, the year was divided into three seasons: breeding (March through June); summer (July through October); and winter (November through February). We examined seasonal means for the region and for each site. To test whether the seasonal haul out pattern was different at coastal versus estuarine locations, we compared the total number of seals for each habitat during breeding and non-breeding seasons, using a Chi-square test.

Data collected at Bird Rock, Tomales Bay, Drakes Estero, and Bolinas Lagoon by National Park Service (NPS) personnel in 1981 were examined as a reference to that gathered in this study.

Hourly counts during 13 full-day censuses at Drakes Estero were conducted to ascertain diurnal and tidal differences in haul out patterns between Double Point, a coastal habitat, and from Bolinas Lagoon, an estuarine one, where data have been collected previously (Allen unpubl. data, Allen et al. ms.). When examining the daily haul out patterns at Drakes Estero, hourly means were compared combining all seasons. To determine the tidal effect on the hauling pattern at Drakes Estero and at

Double Point, we compared the mean number of seals on land at hourly intervals from one hour prior to four hours after low tide on those days when disturbance did not have a major effect on the seals.

Data collected by Allen (unpubl. data) from January 1976 to March 1982 were included in the analysis of seasonal and diurnal haul out patterns at Double Point. During this seven-year period, seals were censused on 247 days with over 410 hours of observation. Seasonal coverage of the area was regular for all years but 1979 and 1980. The majority of the censuses took place during the breeding season: 1976 (16 d), 1977 (44 d), 1978 (19 d), 1979 (9 d), 1980 (5 d), 1981 (13 d), and 1982 (32 d). Sufficient data for analysis of daily haul out patterns were available only for the breeding season since early morning censuses were rarely conducted during the months of November through February. Most censuses were confined to the hours 0700-1630 because the remoteness of the area required 3 h hiking time round trip, and most were conducted during low to medium tides when access by foot along the beach was possible. We estimated the increase in harbor seal usage at Double Point from 1976 to 1982 by dividing the seasonal means of 1982 by those of 1976, 1977, and 1978.

Harbor seals are well known for their avoidance of humans when hauled out on land, and thus, during censuses we monitored any disruption to their haul out pattern. Disturbance was defined as any activity, human or non-human, that caused at least two seals to stampede into the water. Sources for disturbance were classified as hiker, fisherman (including abalone diver and clam digger), boat (power, non-power), aircraft (plane, helicopter), dog, marine salvagers, natural, and unknown. Marine salvagers were a separate category because of a unique incident when a sailboat

washed ashore in the midst of the haul out area at Double Point.

During April and May, 17 additional censuses (three per week) were made to determine whether pup mortality was higher at a disturbed haul out site (Drakes Estero) than at an undisturbed one (Double Point). The expected relative levels of disturbance were reversed because of the wrecked sailboat at Double Point. The presence of the boat attracted much attention from the news media, the U. S. Coast Guard (which conducted rescue operations), and curiosity seekers. The boat remained on the beach from 11 to 21 April when marine salvagers and PRNS personnel removed it.

During these additional censuses, we collected information on the number of dead pups and on mother-pup separations. We estimated the mortality rate of pups before weaning based on the proportion of the number of dead to the number of live pups. Mother-pup separations were inferred from the presence of lone pups. Harbor seal females characteristically remain in close proximity to their offspring until pups are weaned from three to six weeks after birth. An unattended pup with an estimated age of from 1 to 10 d was considered a lone pup. Lone pups often vocalized and traveled through the herd attempting to nurse from seals of all age-classes. Thus they were easily recognized. We also identified pups which retained the lanugo pelage, normally shed in utero for this subspecies, because we suspected that disturbance might affect premature parturition. Since the reaction of females to disturbance also would have some bearing on pup survival, we compared the number of mother-pup pairs retreating to the water or remaining on land after disturbance versus the reaction of other seals, using a Chi-square test.

We examined human/seal fishery interactions in Tomales Bay by boat from

December through March when herring, Clupea harengus pallasii, spawn (Spratt 1981). Seals were counted on haul out sites and in the water where herring were spawning on nine separate days.

RESULTS

Seasonal and Spatial Use Patterns

Regional

Harbor seals were present year round at all sites censused within the Marine Sanctuary; however, the number of animals predictably fluctuated seasonally (Tables 1 & 2, Figure 2). A comparison of the seasonal means showed that more seals used haul out sites in the breeding ($\bar{x}$ = 1839.4) and the summer ($\bar{x}$ = 1191.5) seasons than during winter ($\bar{x}$ = 692.4). Maximum counts for the region occurred during the pupping season [May (2339) and June (2502)] with Tomales Point, Drakes Estero, and Double Point contributing most of the total number of pups (Tables 1 & 3).

Pups were first sighted during the first week of April and the seasonal peak was in May (566 and 564) with pups representing 24% of the total count (2339) (Figure 2). These two pup counts were remarkably similar, though made two weeks apart. Pups were easily distinguished in the field because their bright pelage contrasted with pre-molt immatures and adults, and because herds were loosely spaced out during this season.

A seasonal trend was not apparent, though, in the number of immature seals for either the breeding or the summer seasons; the presence of subadults at haul out sites averaged from 196.3 (SE = 24.8, range = 141-296, n = 7) to 203.7 (SE = 23.1, range = 128-282, n = 6). During the winter season their representation declined slightly to 155.7 (SE = 21.1, range = 83-257, n = 7). Monthly maximum counts of immatures were suggestive of trends only since not all locations were included in the analysis; nevertheless, they were surprisingly similar with 283 in March,

296 in April, 282 in August, 200 in September, 256 in October, and 257 in February. The numbers were slightly lower for May (177) and June (152) and for December (174) and January (149).

The representation of "red" seals at haul out sites varied considerably and did not prove a good indicator of seal movement between locations. Nonetheless, their presence at certain haul out sites suggested that seals were resident for prolonged periods. For example, at Bolinas Lagoon, one red seal was sighted during most censuses throughout the year except in May and during the molt. Similar examples were noted at Double Point where known individual animals have been followed since 1976. On three occasions in May and June 1982, a flipper-tagged and dye-marked harbor seal was sighted at Point Reyes Headland. The animal had been picked up in San Mateo and rehabilitated at the California Marine Mammal Center. It was subsequently released in January 1982 at the site of retrieval, 80 km south of Point Reyes Headland (M. Weber, pers. comm.). Sighting of the seal was the first confirmation that seals may travel from areas south of San Francisco Bay to Point Reyes.

A comparison of coastal (Tomales Point, Point Reyes Headland, Double Point, and Duxbury Reef) and estuarine (Tomales Bay, Drakes Bay, and Bolinas Lagoon) locations mirrored the seasonal pattern for the region. The degree of change in numbers, though, was significantly greater for coastal areas than for estuaries ($\chi^2 = 85.01$, $p<0.001$), indicating that more seals were migrating to coastal areas than to estuaries during the breeding season. The mean number of seals counted at coastal areas during the breeding season was 929.9 and was 721.3 for estuarine sites, but during the non-breeding season the means were nearly equal (Table 4, Figure 3).

The seasonal pattern of each haul out site reflected this coastal/estuarine model in most cases, as described below.

Bodega Bay

Bodega Rock is an offshore sea stack situated at the mouth of Bodega Bay. Seals hauled out only on tidal reefs on the east and southeast portions of the island. Our maximum count was 48 seals in February. Only three pups were seen in May (Table 1).

Tomales Bay

Harbor seals hauled out in Tomales Bay on the southeast side of Hog Island and on tidal mud flats extending from Toms Point to Sand Point. Both areas were used throughout the year, but most seals were counted on the tidal mud flats. The seasonal pattern for this area, though similar to the estuarine model, was more difficult to interpret due to frequent disturbances. Seals were disturbed during 16 of the 26 censuses. Nevertheless, seasonal means showed that numbers remained relatively stable during the breeding and summer seasons, and declined in winter months (Tables 1 & 2). A maximum of 58 pups was counted in May. Censuses conducted in 1981 showed a spring peak and a winter decline; however, numbers were also substantially reduced during summer months (Table 5).

Tomales Point

Seals hauled out on a diversity of substrates at Tomales Point. North and South Rocks are examples of rocky intertidal substrates. Rope Beach and South Beach are sandy pocket beaches, and Bird Rock is comprised of

both rocky and sandy features. The largest concentration of animals hauled out on Bird Rock, North Rocks, and South Beach throughout the year. The geographic diversity of this point as well as its juxtaposition to Tomales Bay may explain the significance of the area to seals; it was a major site used by seals during the breeding season with counts ranging from 151 to 563 including 135 pups (Tables 1 & 2). The number of seals declined in summer to an average of 242.1, and dramatically so in winter months. A similar trend was observed during censuses in 1981, but the largest count (647) was made in early July rather than in June (Table 5).

Point Reyes Headland

Point Reyes Headland is another coastal location characterized by offshore rocks and pocket beaches. The largest gathering of seals occurred around the promontory at Split Rock Cove with some seals scattered along offshore rocks at Sea Lion Cove. This was a minor haul out area compared to nearby Tomales Point and Drakes Estero; however, the seasonal pattern resembled the coastal model with a peak during the breeding season ($\bar{x}$ = 104.5) including 19 pups, and a sharp reduction in summer ($\bar{x}$ = 71.7) and again in winter ($\bar{x}$ = 49.1) (Tables 1 & 2). Point Reyes Headland was not censused in 1981. This is the only location within the Sanctuary where other pinniped species haul out on the mainland. Harbor seals did not intermingle with sea lions at Sea Lion Overlook but preferred offshore rocks. Harbor seals did share pocket beaches with a few northern elephant seals at Split Rock Cove.

Drakes Estero

Drakes Estero is an example of an estuarine environment where seals hauled out on tidal mud flats exposed at low, medium, and medium high tides. Numerous sand bars extending far up into the estero were used, but the preferred site was a bar near the estero mouth. Seals were also noted hauled out in large numbers at the tip of Limantour Spit but only during the breeding season (14 of 30 censuses). Surprisingly, seals were absent from Limantour Spit during summer and winter months.

Drakes Estero was a major haul out area year round for harbor seals in the Sanctuary. Maximum numbers during the breeding season ranged from 116 to 726 including 150 pups (Tables 1 & 2). In contrast to coastal populations, the summer decline was more gradual, and numbers during winter were still much higher than those at Double Point and Tomales Point, the other two major rookeries. The same trend was seen in 1981, but the extremes were more pronounced (Table 5).

Double Point

Double Point is a coastal habitat named for its concave, steep, cliff-backed beach enclosed by two jagged promontories, and encompasses a variety of substrates preferred by seals to haul out on. The seals frequented a number of sites within the Double Point area: South Point (a rocky outcrop with tidal reefs); tide pools (exposed at low to medium low tides); south Bolsa Beach (a sandy pocket beach); north Bolsa Beach (an extension of the south beach but separated by the outfall from Pelican Lake); Stormy Stack (an offshore sea stack); and offshore rocks in the bay just south of South Point.

The degree to which each subsite was frequented varied seasonally.

Seals were found at all subsites during the breeding season, though south Bolsa Beach was the area of highest concentration. The tide pools and north Bolsa Beach were used only during this season and almost exclusively by mother-pup pairs. During summer, south Bolsa Beach, South Point, and Stormy Stack were the preferred haul out sites, but seals also were noted on offshore rocks south of South Point. During winter months, the level of use was nearly equal at South Point and south Bolsa Beach.

Studies at Double Point since 1976 (Allen, unpubl. data) reveal a distinct seasonal variability in the number of seals which parallels the seasonal change in subsite preference. Maximum counts for each year consistently occurred during the breeding season from April to the onset of July. Greatly reduced numbers were observed during winter months from October through January. The months August/September and February/March were transition periods when numbers were declining or increasing, respectively (Table 6, Figures 4 & 5). The seasonal means in 1982 were 517.5 for breeding, 246.5 for summer, and 142.9 for winter (Table 2). Pups represented 31% (263/851) of all seals counted in May 1982 at Double Point and 47% (263/566) of all pups censused in the Sanctuary (Tables 1 & 3).

Each year, pups were initially sighted in late March or early April and the maximum pup count consistently occurred in the first two weeks of May. The May peak coincided with the annual peak for all age-classes combined, but surprisingly more adult seals hauled out in July ($\bar{x}$ = 308.4) than in May ($\bar{x}$ = 265.5) (Table 6, Figure 5), which coincides with the mating season and the onset of molt. Females come into estrus after pups are weaned, and mating is purported to extend into August (Bigg 1969). Seals at Double Point molted from July to September.

The mean number of immature seals present at Double Point was largest in February, March, and July and declined during August and the winter months. During the breeding season the numbers declined only slightly, but the proportion of subadults to all seals counted then was much lower than in summer or winter (Table 5).

Based on monthly maximum counts since 1976, the number of seals appeared to increase gradually during the breeding season except in 1979 and 1980. The slight decline during those two years was probably attributable to the small sample size and to frequent disturbances that seals experienced during those censuses; seals were disturbed on five of nine days and three of five days, respectively.

A comparison of the mean number of seals counted during the 1976 breeding season ($\bar{x}$ = 195.2, with 85 pups) with that of 1982 ($\bar{x}$ = 517.5, with 236 pups) revealed almost a three-fold increase in the presence of all seals (2.7) and of pups (3.1) over the seven-year period (Table 7). In 1977 there was a two-fold increase for all seals (1.7) but less so for pups (1.5). The average for 1978 was similar to that of 1977. The maximum number of pups counted each year was 85 (1976), 175 (1977), 177 (1978), 142 (1979), 159 (1980), 229 (1981), and 263 (1982). The annual increase was also complemented by changes in spatial haul out patterns. For example, more seals hauled out at north Bolsa Beach in 1982 (205) than in 1977 (8) or in 1976 (2).

The average numbers of seals hauled out in summer in 1976, 1977, and 1978, however, were similar to those in 1982 (Table 7). The winter seasonal means for 1976 and 1977 also were not substantially different from those of 1982.

Duxbury Reef

Duxbury Reef is a coastal intertidal reef jutting out from Bolinas Point. Though a seasonal pattern was exhibited, numbers varied greatly within each season, and maximum counts were made in September (164) and January (148) rather than during the pupping season (Tables 1 & 2). This wide variation was in part due to disturbance. Seals were disturbed on six of the 28 census days. Duxbury Reef was probably not a pupping ground because the number of pups counted was minimal (5), and pups were noted in June, a weaning period at all other sites within the Sanctuary.

Bolinas Lagoon

Bolinas Lagoon, like Drakes Estero, is an estuarine habitat where seals hauled out on tidal mud flats bordering two islands, Kent Island (KI) and Pickleweed Island (PWI). In a previous study (Allen et al. 1980), KI was the preferred haul out site for all seasons. In 1982, however, PWI was used almost exclusively during winter months; seals were counted at KI on only one of eight winter censuses. Seasonal variation in 1982 followed the pattern of prior years, and in contrast to all other locations within the Sanctuary, the annual peak occurred in summer rather than during the breeding season (Tables 1 & 2). As at all other locations, numbers declined in winter. Bolinas Lagoon was not a major pupping ground, with only 17 pups counted in 1982.

The average numbers of seals censused at Bolinas Lagoon in 1978-79 during the breeding and summer seasons were 38.3 (SE = 2.8, range = 8-101, n = 46) and 59.4 (SE = 5.4, range = 5-105, n = 29), respectively (Allen,

unpubl. data). The maximum number of pups counted in 1979 was 12. When one compares breeding and summer means for 1978 and 1982, the increase in usage over this five-year period is nearly two-fold for the breeding season (1.9) but not very different for the summer season (1.4). The increase in the presence of pups was insubstantial.

Daily Usage

Harbor seals were sighted year round at all locations monitored. On only four occasions were seals not hauled out (three at Duxbury and one at Tomales Bay), though they were seen in the vicinity. On each of these occasions, seals were disturbed prior to our census and failed to rehaul during the census interval.

Seals at Drakes Estero hauled out more frequently at 1300 h ($\bar{x}$ = 324.0, SD = 171.2, n = 13) than in the morning at 0800 h ($\bar{x}$ = 127.3, SD = 165.6, n = 11) or in the late afternoon at 1700 h ($\bar{x}$ = 143.5, SD = 158.0, n = 13) (Figure 6). Only when sand bars were reduced in size at medium to medium-high tides were seals diverted from this pattern, and even when areas were awash, seals would congregate above submerged bars. The mean number of seals hauled out at -1 hour prior to low tide ($\bar{x}$ = 414.0) was not much different from that at +3 hour after low tide ($\bar{x}$ = 457.8), but at +4 hour the numbers began to decline ($\bar{x}$ = 393.8) (Table 8). Disturbances occurred on six of the 13 all-day censuses, but disturbances were short in duration, and seals quickly rehauled.

At Double Point we had sufficient data on the hourly presence of seals only for the breeding season from 0700 to 1600 h. The pattern revealed

there was quite different from that at Drakes Estero, with more seals present on land in the late afternoon at 1600 h ($\bar{x}$ = 683.4) than at 1300 h ($\bar{x}$ = 475.8) (Table 9). Tide, too, seemed to influence the seals' hauling out pattern. When combining all subsites, the mean number of seals hauled out at +3 hour ($\bar{x}$ = 465.7) was higher than at -1 hour prior to low tide ($\bar{x}$ = 374.8): at +4 hour the numbers were higher still ($\bar{x}$ = 567.1) (Table 8). Conversely at the subsite South Point, where rising tides had a more direct effect on haul out space, more seals were hauled out at low tide ($\bar{x}$ = 37.4) than at +3 hour ($\bar{x}$ = 27.6) or at +4 hour ($\bar{x}$ = 21.0) after low tide. As the tide rose, seals shifted from offshore rocks, tide pools, and tidal ledges at South Point to south Bolsa Beach which provided ample space at medium to medium-high tides.

Disturbance

Seals at all haul out sites within the study area experienced some degree of disturbance from human or non-human sources. The activities of fishermen (all categories) caused the greatest disturbance to seals, representing 32% of the 79 disturbances observed (Table 10). Seals on sand bars in Tomales Bay received the highest level of disturbance (46%), the major source being the activities of people digging for clams. More than 100 people on a single day were ferried by boat from Lawson's Landing on the eastern shore of Tomales Bay to these sand bars to dig for clams. Clam diggers also frightened seals at Drakes Estero, as did people canoeing and hiking.

Sources for disturbance at Double Point were almost entirely related to

the presence of the wrecked boat. The majority of these disturbances were from Coast Guard helicopters (6), and personnel involved in the salvage operation (4). Though a dog was observed flushing seals only once, dogs commonly accompanied clam diggers at Tomales Bay and fishermen at Duxbury Reef when seals were disturbed.

Natural sources for disturbance included large birds such as Turkey Vultures, Cathartes aura, and Brown Pelicans, Pelecanus occidentalis, alighting near seals at Drakes Estero; a black-tailed deer, Odocoileus hemionus, swimming by the Point Reyes Headland herd; and a sudden land slide in the vicinity of the Double Point herd. Thirteen percent of the disturbances were of unknown origin.

During April and May when additional censuses were made, seals were disturbed on six days at Drakes Estero and on nine days at Double Point. At Drakes Estero, these disturbance days occurred throughout the season; disturbances usually resulted from a single event and were short in duration. In contrast, seven disturbance days at Double Point took place during an eight-day period in April. Multiple disturbances occurred on a single day, and marine salvagers remained on the beach for three entire days and one night. The salvagers were 350 m from the south Bolsa Beach herd and 250 m from the north Bolsa Beach herd. Seals were constantly aware of their activities, though salvagers made every attempt to minimize their impact. During eight days prior to the salvage operation, U. S. Coast Guard, U. S. Army, and news media helicopters flew daily over Double Point below 300'. At least twice, helicopters landed on south Bolsa Beach.

The degree to which these disturbances caused mother-pup separations, disrupted nursing periods, and ultimately contributed to pup mortality, could

be inferred from the incidental information that was collected during observations.

Of the 150 pups counted at Drakes Estero, none were found dead and only one lone and one lanugo pup were noted in April. The lone pup was just born when the herd of seals, including the mother, was flushed into the water by a canoer. The pair was permanently reunited 1 h 45 min after separation.

In contrast, 34 dead pups were counted at Double Point (14 in April, 19 in May and 1 in June), representing 13% of all pups (263) counted in 1982. Two of the dead pups displayed lanugo pelage. The majority of dead pups (20) was seen from 29 April to 14 May which coincided with the peak of the pupping season. When the wrecked sailboat was present, seven dead pups were counted. Most pups likely died from starvation, since many were small and very thin.

Most lone pups were counted on 21 April (11), 23 April (11), 29 April (10), 30 April (12) and 2 May (10). Only two lone pups were seen reunited with females. Pups with lanugo pelage were primarily seen in April (32) with only seven seen in May. Our estimate for pups born with lanugo in 1982 was 15%.

On 21 April when salvagers were most active, the number of seals on land was never stable except at South Point, the area most distant from the operation. Seals stampeded en masse six separate times during the 3.5 h observation period, and individual animals, particularly females with pups, were continually retreating to the water. The highest number of seals resting on land on this day was 248, including 31 mother-pup pairs. On 22 April, the day after the salvagers had left, a total of 605 seals,

including 133 mother-pup pairs, were hauled out. The percentage increase in mother-pup pairs hauled out was nearly quadruple. Females with pups were significantly more reactive to disturbances than were other seals. When combining data from eight separate instances, 74 females with pups retreated to the water and 47 pairs remained on shore, whereas only 135 adults/immatures entered the water and 321 remained on shore ($X^2 = 39.85$, $p<0.001$).

Fishery/Seal Interactions

The presence of harbor seals hauled out in Tomales Bay when the herring were spawning fluctuated widely from 0 to 271 (Table 1); however, the numbers were no greater then than during other months (see section on Tomales Bay). Seals were more difficult to census when in the water because they did not travel in compact groups, and instead surfaced randomly and usually alone. Our rough estimates for seals noted in the vicinity of boats involved in commercial herring operations and for seals feeding near spawning fish ranged from four to 50 on nine separate census days. At this time a small group of seals was seen hauled out far up the bay near Papermill Creek, an area hitherto unused.

DISCUSSION

Point Reyes accommodates a significant harbor seal breeding population. Our maximum figure recorded in late June was 2502 and was substantially higher than that collected during most recent surveys (Mate 1977, BLM 1980), but similar to that observed in early July 1981 by Dohl (1982). Dohl, however, reported much lower numbers in May 1981 compared to NPS simultaneous censuses in 1981 and to this survey, particularly for specific locations such as Double Point where only 243 seals including 30 pups were noted. Preliminary data collected in the most recent CDFG aerial survey in 1982 were similar to that presented here (D. Miller, Department of Fish and Game, Menlo Park, CA, pers. comm.).

For some locations within the study area, the CDFG aerial survey figures proved more accurate than ground surveys because of distance from shore and angle of view. Our information on harbor seals at Bodega Rock, for example, was unreliable because seals primarily hauled out on the back side of the island, out of view. Miller recorded 115 seals in May of 1982. The most seen there by us was 48.

All aerial survey estimates failed to equal the number of seals recorded in ground surveys at Double Point and Drakes Estero during the breeding season. Our figures indicated that Double Point was the largest harbor seal pupping ground in the state. Combined with seals recorded at Drakes Estero, Tomales Point, and Tomales Bay, the Point Reyes population of harbor seals represented a significant proportion (14%) of the state population which Miller estimated to be 19,000 in 1982 (Miller, pers. comm.). Miller's estimates for the number of pups in Marin County,

however, were unduly low (224) compared to our counts (566 and 564) because the CDFG survey was in April rather than May.

These figures are not absolute, though, and indicate only trends because we do not know what percentage of the total population is hauled out in a given area even under optimal conditions. Sullivan (1979) estimated that harbor seals spent 50% of daylight hours in the water, and Pitcher's data revealed that radio-tagged seals hauled out 50% of the days during June. Consequently, the harbor seal population in Point Reyes may be substantially higher than our estimates.

Though little information was available for determining whether the reproductive population has been increasing in the Point Reyes area, data collected at Double Point and from Bolinas Lagoon suggest that on a local level there has been an expansion in usage during the breeding season. There is no indication, however, that the size of the resident population at Double Point has changed, because summer and winter means were similar. The increase is explainable, therefore, by the emigration of animals to the area. Because the population of subadults remained relatively stable year round, breeding animals likely represent a major part of the influx. Each year, distinctively marked and scarred adult animals arrived at Double Point, and if present in previous years, would easily have been identified. A rapid increase in the number of harbor seals has also occurred on S. E. Farallon Island during the past decade, also attributable to emigration because only two pups have been observed there in any given season since 1971 (PRBO, unpubl. data).

The seasonal fluctuation in numbers throughout the area was expected. Unexpected, however, was the degree of seasonal change in coastal versus

estuarine aggregations. Coastal populations appeared to receive a significant influx of transient animals in the breeding season, whereas estuarine populations experienced a lesser influx. There was no evidence that estuarine animals shifted to coastal areas to breed, nor that coastal animals moved into estuaries such as Tomales Bay to feed on herring since the number of seals counted there in winter was no greater than during breeding and summer seasons.

Studies by Everitt and Jefferies (1979) in Washington State showed that seasonal movement occurred between Grays Harbor/Willapa Bay and the Columbia River with the former the preferred breeding ground and the latter a wintering area. Movement from bays to coastal locations was not indicated in their study. The same pattern could exist for the Point Reyes region with exchange occurring between Tomales Bay, Drakes Bay, and Bolinas Lagoon. Certainly the post-pupping increase of animals at Bolinas lasting until late October suggests that seals were migrating there for reasons other than pupping. However, the degree of decline in numbers at both Tomales and Drakes Bays during the winter months did not equal the elevation at Bolinas. More likely, seals were traveling to areas outside the Sanctuary. A comparison of aerial surveys conducted by BLM (1980) in May and January denoted a northward movement of seals from this region to Sonoma and Mendocino Counties in winter. In January, seals were using more locations and forming smaller groups; in May, seal haul out sites were reduced 10% and population size increased 25%. The number of haul out sites in Point Reyes did not increase during winter months, further suggesting that seals were migrating to other areas.

Pitcher's (1979) study of radio-tagged harbor seals in Alaska revealed

substantial variation in distances that individuals moved. Some seals moved long distances (194 km) to one or two other locations from the site of capture, and some were year round residents. Year round site fidelity of known seals over a seven-year period has also been documented at Double Point, as has seasonal emigration of known females, demonstrating that seals here may also display breeding site fidelity (Allen, unpubl. data). Information gathered from radio-tagging revealed too that seals spent more time hauled out in June (50%) and less in September (41%) (Pitcher 1979). Winter numbers likely are reduced at Point Reyes both by dispersal and by alterations in daily hauling patterns.

From our analysis, time of day, tide, and substrate type were the determining factors in the diurnal haul out pattern of seals. The influence of each factor, alone and in combination, differed tremendously as is indicated by the variety of patterns documented in other studies (Ainley et al. 1977, Allen et al. 1980, Boulva and McLaren 1979, Calambokidis et al. 1978, Fancher 1979, Pitcher 1979, and Sullivan 1979).

Sullivan (1979) determined that seals hauling out on rocky intertidal areas in northern California were influenced only by tides and did not follow a diurnal pattern. Conversely, on Sable Island along the eastern seaboard of Canada, seals hauled out on sandy beaches independently of tides and daylight hours, but were not present at night (Boulva and McLaren 1979). Calambokidis (1978) found that seals preferred various sites depending upon access at different tide levels.

At Drakes Estero, an estuarine site, more seals were hauled out at mid-day, and tide became a limiting factor primarily when sand bars were inundated. A similar pattern was demonstrated at Bolinas Lagoon in spring

and summer but not in winter (Allen et al. ms.). During the breeding season at Double Point, the number of seals increased progressively throughout the day so that even at medium tides more seals were present. At South Point, a rocky intertidal subsite, seals decreased in number after low tide because of limited hauling out space, and would then shift to the beach. In Point Reyes, therefore, seals seem to haul out within an optimum range from mid-day to late afternoon at low to medium tides. The physical features of each location, though, must be assessed when evalutating daily trends in seal behavior.

Disturbance to seals must also enter into the analysis when distinguishing daily haul out patterns. At heavily disturbed areas such as Strawberry Spit in San Francisco Bay, seals have adapted by hauling out at night (Paulbitski 1975). In this study, seals do not appear to experience levels of disturbance which would preclude their daytime presence. Though seals were often flushed from sand bars in Tomales Bay and Drakes Estero, these were primarily incidental occurrences, subject to seasonal human activites. Alternate haul out sites in the vicinity allowed for some flexibility in seal haul out opportunities, and were believed important to seal adaptability in Bolinas Lagoon (Allen et al. 1980). Certain locations in the Sanctuary, however, lack suitable alternate sites, and consequently, are more vulnerable to disturbances. This is the case primarily for coastal locations where haul out space is limited, as was evidenced at Double Point in 1982 where seals were unable to accommodate to prolonged disturbances. Adequate alternate sites were unavailable, and instead, seals spent more time in the water.

Disturbance was also an important consideration in reproductive

success. The deleterious effects of human-related disturbance on pup survival have been addressed in studies by others (Boulva and McLaren 1979, Kenyon 1972, Johnson 1977). Though no areas in this survey suffered undue pup mortality, deaths were higher at Double Point in 1982 than in 1977 when the percentage was estimated to be 7.4% (Allen 1980). In the 1977 breeding season, seals were flushed into the water on 13 separate days, but in contrast to 1982, disturbances were short in duration. Our 1982 estimate is probably low because carcasses removed by wave scouring and those pups predated upon by sharks would be missed. The 1982 mortality rate was similar to that recorded by Boulva (1979). His research, though, involved manipulation of pups which caused separations and ultimately death in some cases, and therefore, his figures are not representative of an undisturbed population.

Pup mortality at Double Point was probably exacerbated by greater levels of disturbance occurring early in the season. Interruption of nursing periods would tend to weaken young pups, and pup separations/desertions were likely related to disturbance since females with pups were highly reactive to disturbances. Johnson (1977) reported that the major cause of pup deaths at Tugidak Island, Alaska, was starvation due to disturbance induced seperations/desertions of young pups. Some premature births could have been precipitated by disturbance since the percentage of pups with lanugo in 1982 was double that in 1977 (6.3%) (Allen unpubl. data).

The absence of dead pups at Drakes Estero was probabluy due to a combination of strong tidal flushing near the mouth of the estero and haul out sites being completely awash during high tides so that carcass

deposition would be in areas other than the haul out site.

Fishery/seal interaction in Tomales Bay during the herring season was minimal in this study since the numbers of seals censused near fishing vessels were few. Miller (1981) also found little interaction between harbor seals and herring operations in Tomales Bay in 1980, and in fact, fishermen followed the activities of pinnipeds in order to locate concentrations of herring.

Though not included in the scope of this study, pinnipeds did interact with commercial gill net fishing operations from late May to mid-July. Gill nets were constructed of 4" monofilament line and extended up to 2 mi in length. We gathered information from various agencies and organizations involved in collecting beach-cast marine mammals in order to determine whether these fishing operations were incidentally killing marine mammals. The number of dead animals (40) that washed ashore in the area was much higher than expected, with 18 harbor porpoises, 19 harbor seals, and three sea lions. All but three of the 19 harbor seal specimens were of weaner or yearling size (4'). Size may be an important consideration since smaller marine mammals are believed to be susceptible to entanglement and drowning in nets, whereas large animals are able to break away. A few of these specimens were actually entangled in netting when they washed ashore. The incidental take of harbor seals in Alaska, Washington, and Oregon is associated primarily with gill net fishery interactions in which seals are either entangled in nets or shot by fishermen (NMFS 1980).

SUMMARY

Preliminary recommendations are presented here based on results from the first year survey. From these we can modify censusing techniques for the second survey year. Our initial results indicate that diurnal and tidal effects on the hauling out behavior of seals vary within an optimum range from mid-day to late afternoon at low to medium tides. The physical attributes of each location seem to determine when is best to census within this optimum range. Thus more attention will be given to the interplay of these factors when conducting simultaneous censuses.

The breeding population represents a sizable proportion of the state population, and a tremendous number of seals appear to migrate to the Sanctuary to breed from unknown areas. Radio-tagging and tracking of seals could provide valuable information on where these transient breeding animals disperse in summer and winter months. Only with this information can one determine whether resource plans in areas outside of the Sanctuary are in conflict with Sanctuary management plans.

The qualities that attract seals to Point Reyes to breed in large aggregations at Double Point, Drakes Estero and Tomales Point are numerous including suitable habitat and food availability. Likely another important reason is lack of human intrusion since none of these areas have been developed nor are they readily accessible. Consequently, reasons for preserving and protecting existing haul out locations are enhanced. First, however, we must identify present levels of disturbance. From the second survey year we will collect specific data on whether disturbance is severely impacting seals. At the completion of the second survey year, we

will be able to forward recommendations on long term monitoring techniques and on management considerations.

INTRODUCTION

In the past, information on the status of California (Zalophus californianus) and northern (Steller) sea lions (Eumetopias jubata) at Point Reyes has been sketchy. Mention of the historical presence of sea lions in the area is made by Scammon (1874). California Fish and Game censused breeding sea lions along the California coast between 1930 and 1970 (Bonnot, 1937; Bonnot et al., 1938; Bureau of Marine Fisheries, 1947; Bonnot and Ripley, 1948; Ripley et al. 1962; Carlisle and Alpin, 1966, 1971; Frey and Alpin, 1970); but it was not until 1974-75 (Mate, 1977) that aerial surveys to look at seasonal fluctuations in the sea lion population began. Aerial surveys of northern and central California continued in 1980 and 1981 (BLM 1981; Dohl 1982). These and other censuses (Chan, 1979) are summarized in Table 11.

The first year (March 1982 - February 1983) of the sea lion assessment program was set up to initiate close scrutiny of seasonal, diurnal and tidal fluctuations in numbers and age classes of sea lions in the coastal zone of the Point Reyes/Farallon Islands National Marine Sanctuary. We also wanted to determine whether Point Reyes is a breeding rookery or just a haul out area, to establish what interchange occurs between the Point Reyes and the Farallon Island sea lion populations, and to determine how the herring (Clupea harengus) run in Tomales Bay affects sea lion numbers along the coast.

METHODS

We censused California and northern sea lions at the Point Reyes Headlands (Figure 1) twice a month throughout the year (March 1982 - February 1983). During the breeding season we censused once a week checking for evidence of pupping. One census each month lasted from 0700 to 1800 h to assess sea lion haul out patterns, discover when maximum numbers haul out and determine how seasonal, diurnal and tidal changes affect each species. Some censuses were incomplete because weather (fog, high winds or heat waves) impeded the count. California sea lions were censused once a month at Bodega Rock. During the herring run (December to March) there were nine censuses of Zalophus in Tomales Bay by boat.

All counts of the Point Reyes Headlands were made from Sea Lion Overlook with a 25X spotting scope. In August a hidden cove containing up to 100 animals was found south of the main haul out; from then on it was censused regularly from the antenna north of Sea Lion Overlook. Descriptions of animals with distinctive scars or marks were recorded whenever seen. Weather and tidal conditions were also noted.

Whenever possible, both sea lion species were separated into five age-classes: adult male, subadult male, female-size, immature, and pup. These censuses were compared with weekly sea lion censuses on the Farallones during the same time period. Because of the difficulty in separating age classes when counting thousands of animals, California sea lions on the Farallones were divided into four age classes: male, female-size, immature, and pup.

RESULTS

California Sea Lion

The seasonal variation in the number of California sea lions hauled out at Point Reyes Headlands and Bodega Rock is similar to the pattern at other non-breeding areas where peaks occur during the spring and fall (Fig. 7, Fig. 8) when animals are migrating to and from the southern breeding rookeries. At both Bodega Rock and the Headlands the population peaked in April and September with an additional peak at the Headlands in December - January. High counts were 450 at Bodega Rock on 23 Sept and 338 at the Headlands 7 April (Table 12). On the Farallones the peaks lasted longer: the spring peak went from late April through May and numbers in the fall peaked several times as a result of waves of migrating animals passing through the Farallon area (Fig. 9). Numbers remained generally high throughout the winter except for a strong dip in late December probably due to a severe winter storm. High count for the year was 3725 animals on 30 January.

The lowest numbers at both coastal and offshore sites were during June and July when the majority of the breeding population is at the southern breeding grounds.

In looking at the results of our all day censuses, we found no evidence of any seasonal difference in haul out patterns. A definite diurnal pattern occurred, however. In 83% (10/12) of the all day censuses, the most animals hauled out between 1000 and 1400 hours. Certain conditions

affected this basic pattern: a combination of high tides and big swells reduced the preferred area available for hauling out, and as a result animals either moved to higher ground or went into the water. Hot, calm days which caused animals to retreat into the water to cool off also affected counts. In general, maximum numbers were counted on high overcast days with light winds and a low to medium tide at mid-day.

The percentage of each age class present at the Headlands for each month of the year is shown in Figure 10. Adult males predominate in May, subadult males in June, August, and November through February. Female-size animals (the majority of which are 3-5 year old males) are the highest percentage of animals during March-April and September-October. Immatures (1-2 year olds) are most prevalent in July. No pups were seen during the breeding season.

Since Farallon Zalophus are divided into only 4 age classes, we lumped the Point Reyes subadult and adult males into one class to compare the two populations (Fig. 11, Fig. 12). We then compared the different age-classes of the Point Reyes and Farallon Islands Zalophus populations and found there is a significantly higher proportion of adult and subadult males on the Point Reyes Headlands than on the Farallones (t-test of means $t = 11.41$, $p < .01$).

An immature animal tagged at San Nicolas Island, off Santa Barbara, was seen at the Headlands in September.

During censuses in January up to 33 California sea lions were seen swimming in Tomales Bay, all concentrated in the vicinity of herring fishing boats. In one case a male sea lion was observed removing fish from the

herring nets.

Northern (Steller) Sea Lion

Unlike the California sea lions at Point Reyes whose numbers peak during migration, northern sea lions reach peak numbers during the breeding season from May to August (Fig. 13). This is similar to the pattern on the Farallones (Fig. 14). The high count at the Headlands was 19 animals on 27 August (Table 13) and 192 animals on 24 June at the Farallones.

Female and immature northerns were present year around at Sea Lion Overlook. We counted up to six adult males between May and August. Subadult males were present primarily from April to August with a few sightings in late winter. No pups were observed during the breeding season. Three animals with distinctive marks or scars were recognized at both Point Reyes and the Farallones: a female in January and two subadult males during the breeding season.

During 12 all-day watches the numbers of northern sea lions varied irregularly, depending on the initially chosen haul out sites. If they hauled out on low, off-shore rocks, numbers decreased as swells and tide rose to cover the rocks. If, however, the northerns were hauled out on high rocks, numbers remained high after 1000 h regardless of tide or swell. On calm, hot days animals went into the water as the air temperature increased.

In general, numbers were lowest before 1000 h, then increased and remained high throughout the rest of the day depending on temperature, swells, and haul out area.

Adult and subadult males were seen in the water more frequently than females and immatures. On three days in May a bull was seen feeding on unidentified fish near Double Point.

DISCUSSION

Both California and northern sea lions are at the edge of their breeding ranges in the Farallon/Point Reyes National Marine Sanctuary. California sea lions breed primarily south of Point Conception with major rookeries at the Channel Islands, California and the islands off Baja, Mexico; major breeding areas of northern sea lions are on the Aleutian and Pribilof Islands in Alaska (Scheffer, 1958). Both species have small breeding colonies on the Farallon Islands: 12 northern pups and 2 Zalophus pups were born in 1982. No cows of either species pupped on the mainland in 1982.

The population of California sea lions has increased throughout its range in the last 50 years; for the last several years the increase has been about 5% each year in California. In the past, only adult and subadult males migrated north, while the adult females and juveniles remained near the southern rookeries (Bartholomew, 1967). A change in migration pattern was first noted at the Farallones in 1978 when large numbers of immature sea lions hauled out in the fall. Since then the population at the Farallones has tripled. Ainley et al. (1981) propose that the increase in numbers and in the proportion of immatures at the Farallones is due primarily to the abundance of Pacific whiting Merluccius productus) near the islands. The availability of whiting to sea lions increased dramatically when the foreign whiting fishery, which was competing directly with sea lions, was eliminated by the imposition of the 200 mile fishing limit in 1977. Unfortunately we do not have comparative censuses for the mainland sea lion population.

In general, fluctuations in the number of California sea lions are similar at the Farallones and the Headlands (Figures 7, 9) but there is a sharp peak in numbers at the Headlands in December - January which does not occur at the Farallones. This may be a result of animals concentrating in the area to take advantage of seasonally abundant herring spawning in Tomales Bay.

The age-class distribution between the Farallones and the mainland is quite different. When looking at the age-classes at the Farallones (Figure 12), it is apparent that the adult and subadult males are essentially gone during June and July, begin to return in August, and migrate through in several waves during the fall. These waves decrease by winter as the males head further north and then increase again in April and May as the males return south to the breeding grounds (Mate, 1977). For immatures the pattern is different: numbers increase from August to December. The majority of these animals are young of the year dispersing from pupping areas in Baja and the Channel Islands. Numbers are low during winter and spring.

At Point Reyes the picture is a little more confusing. The adult males follow a similar pattern to the Farallones but immatures peak in number in July rather than in August as they do at the Farallones. This may indicate that dispersing juveniles haul out at the coastal site before moving to the Farallones. The number and percent of female-size animals (primarily 3-5 year old males) is lower throughout the year on the mainland. Conversely, there is a significantly higher number of adult and subadult males at the coast than off-shore ($p<.01$). Although statistically significant, this

difference may not have biological significance. For most of the year the Point Reyes population is less than a tenth the size of the Farallon population and the apparent difference in haul out patterns may merely be due to movements of animals the 18 miles between the two points. It is also possible that it is a real difference and that juveniles concentrate where food is more abundant and consequently easier to catch.

Tomales Bay and San Francisco Bay are the major spawning areas for herring in California. From December to March, herring migrate in large numbers to Tomales Bay where they lay eggs in the eel grass beds. After spawning they return to the open ocean (Spratt 1981). Censuses of sea lions in Tomales Bay during the 1982-83 spawning season were difficult because of severe winter storms. Maximum counts were 33 sea lions on 10 December. Only one sea lion was observed taking fish from a net, although all the sea lions concentrated at the mouth of the bay near the herring fishing fleet. Only California sea lions were observed. Twenty percent of these were adult males.

In central and southern California waters, the range of California and northern sea lions overlap. While California sea lions have increased, northern sea lions have suffered a concomitant decline in the last half century. Speculation on the causes of this shift include a warming trend in water temperature, a change in food resources, and diseases causing reproductive failure. The northern population at the Headlands is now small (maximum count 19) compared to previous years. Although Chan (1979) recorded observations of pups in June 1975, we did not see evidence of pupping during weekly censuses in May and June. It appears the Headlands

has changed from a pupping area to a haul out area.

We saw several animals on the Headlands which had previously been seen on the Farallones, a female and two subadult males, indicating that at least some of the Point Reyes population are transients from the Farallones.

The northern sea lion diurnal haul out pattern at Point Reyes is similar to that found at the Farallones (Ainley et al. 1977) and other breeding colonies (Gentry 1970, Edie 1977). Numbers are lowest in early morning, increase at mid-day, and then remain fairly constant. However, this pattern can be strongly affected by weather conditions: large swells, rain, and hot, calm days can cause animals to enter the water. During the breeding season, males frequently enter the water to patrol and defend their territories; this, too, can lower counts.

At Point Reyes the presence of different age and sex classes is similar to the Farallones and Ano Nuevo where females and immatures are present throughout the year, while adult and subadult males migrate into the area only during the breeding season.

Making sense of sea lion censuses in haul out areas is not easy: in all cases the count is only a minimum since at least some animals are always in the water and weather and tidal conditions can greatly affect numbers hauled out. From our studies on the Farallones we have discovered the year to year variation in sea lion counts can be extensive. At this point, both populations of sea lions found in the Point Reyes/Farallon Islands National Marine Sanctuary are in transition. The El Nino weather pattern which began in summer 1982 has most certainly affected the sea lion

populations since it has changed their environment so drastically. But exactly what these changes are and how they might affect the population in the long term we can only begin to guess at. Continued censuses to compare the interrelationship and differences of the Farallon and Point Reyes populations will improve our chances of understanding population fluctuations of the sea lion populations within the Sanctuary.

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Table 1. Harbor seal, Phoca vitulina richardsii, counts for all sites within the Point Reyes/Farallon Islands Marine Sanctuary. Census days during which disturbances occurred that affected numbers are noted with an asterisk (*); numbers following a slash (/) indicate pups.

	LOCATION												
Date	Bodega	Tomales Bay	Hog Is.	Bird Rock	Tomales Point	Point Reyes	Drakes Estero	Liman. Estero	Double Point	Duxbury Reef	Bolinas	Total Pups	Totals
1982													
3 March		246	39	104	47*	78*	193*	0	337	105	65		1214
7 March							116*	0					
19 March		275*	0	102	167	122	489*	0	356	102	63		1676
22 March	36												
7 April						12							
8 April									428/25*				
13 April		155/2*	48/1	104/7	121/1	70/1*	336/3	65	228/53*	81	46	68	1254
14 April									274/57*				
15 April						100	455/9	0	346/67*				
17 April									279/66*				
18 April							241/17	0	300/60				
20 April		242/22*	0	97/14	176/5	44/1	543/36*	0	465/136*	92	24	214	1683
21 April									391/110*				
22 April						70*	479/43	0	639/159				
23 April						70			694/168				
25 April							232/77	0					
27 April						32	338/47	12	375/158		0		
29 April	1*						447/101*	0	720/238		30		
30 April							533/95*	0	749/262*				
1 May						77/7	324/77	78/6					
2 May									722/225				
4 May		147/46	45/12	266/52	297/83	63/5	445/88	96	851/263	19*	77/17	566	2306
5 May									783/251				
6 May						12							
8 May						182/19	260/50	0					

11 May						70/18	591/127	0	454/166				
13 May						47/9	507/148*	54/10	609/228				
14 May									481/191	81	54/11		
15 May							447/111	75					
16 May						24							
17 May									565/186				
18 May	26/3	151/37	48/9	265/58	269/74	93/11	537/150	94/20	676/205	94	86/17	564	2339
19 May									685/204				
20 May						20	439/63	54/5					
22 May							348/95	0					
25 May							291/40*	0	270/78	32/1*	51/11		
27 May									433/90		62/12		
28 May							559/29*	0					
31 May									626/83*				
1 June		91/15	58/8	283/28	250/26	139/18	224/30	292	566/90	86/3	85/4	221	2074
2 June						113/17	162/21*	312/29	679/80				
3 June						131/17	271/33	145/20					
15 June	31	150	50	211/27	196/16	112/13	57/2	426	577/31	109/5	90/4	98	2009
28 June		185	0*	318/9	243/7	232/15	620/38	106	621/28	39	138	97	2502
12 July		54*	48	235/18	205/14*	149	310*	fog	469/29	0	126/9	41	1596
23 July		219/2	0*	276	178	fog	447/32	0	373/9	1	107	43	1601
27 July							545/48*	0					
29 July	32												
6 Aug		119	0	111	79	87/13	190/6	0	185*	15*	30	19	816
22 Aug							349*	0					
23 Aug		281*	0	136	58	fog	371	0	175	101	77*	0	1199
30 Aug					100								
31 Aug							175	0					
6 Sep		206*	Fog	62	81	51	402	0	141*	164	67*		1174
21 Sep		192	0*	36	101	13*	469*	0	288	141	98		1338
23 Sep	6												
30 Sep							413*	0					
2-4 Oct		168	0	55	116	65	146	0	270*	3	89		912
15-16 Oct		246	0	49 *	165	65	156	0	69	74	72*		896
26 Oct		105	20	100									
30 Oct	26												
31 Oct							365*	0					

Table 2. The average number of harbor seals hauled out by season during simultaneous censuses in the Point Reyes/Farallon Islands Marine Sanctuary in 1982 - 83; $\bar{x}$ is the mean number of seals, SE is the standard error, and n is the sample size. Tomales Bay includes Hog Island, Tomales Point includes Bird Rock, and Drakes Estero includes Limantour Spit.

	LOCATION							
	Tomales Bay	Tomales Point	Point Reyes	Drakes Estero	Double Point	Duxbury Reef	Bolinas Lagoon	All Sites
Breeding								
$\bar{x}$	213.0	376.2	104.5	436.7	517.5	82.6	73.8	1839.4
SE	13.3	50.8	16.8	25.3	30.6	9.5	9.6	150.1
n	10	10	10	30	33	10	10	10
range	149-285	151-563	44-232	116-726	228-851	19-109	30-126	
Summer								
$\bar{x}$	191.6	242.9	71.7	331.1	246.5	62.3	83.3	1191.5
SE	21.5	45.5	18.4	39.1	46.1	23.8	10.3	108.5
n	8	8	6	12	8	8	8	8
range	102-281	137-454	13-149	146-469	69-469	0-164	24-138	
Winter								
$\bar{x}$	92.3	158.3	49.1	257.4	142.9	49.5	56.4	692.4
SE	30.7	22.2	17.9	34.5	47.7	21.5	6.1	164.1
n	8	8	8	12	8	8	8	8
range	31-271	80-240	8-155	93-421	30-359	0-148	29-83	

Table 1 cont.

1 Nov		144	0	42		86	22					
23 Nov				200		135						
29-1 Nov												
29 Nov												
8 Dec	21											
10 Dec		49	0	52		149	8					
11 Dec												
28 Dec		0*	0	69		72	12					
1983												
7 Jan		60										
10 Jan		76*	38	72		82	75*					
12 Jan												
19 Jan		45										
22 Jan												
24 Jan		150					60					
25 Jan		34*	0*	45		35	38					
9 Feb		0*	31	75		165	10					
22 Feb		230*	41	109		129	155					
24 Feb	48											
4 Mar												
9 Mar		146	54	123		123	92					
31 Mar	47											

able 3. The maximum number of harbor seal pups counted by month at each haul out site in the Point Reyes/Farallon Islands Marine Sanctuary in 1981 and 1982. Data for 1981 were provided courtesy of Gary Fellers, National Park Service.

		LOCATION						
		Tomales Bay	Tomales Point	Point Reyes	Drakes Estero	Double Point	Duxbury Reef	Bolinas Lagoon
981	April	0	0	*	0	5	0	1
	May	25	83		84	196	0	12
	June	0	106		4	54	0	3
982	April	22	19	1	101	262	0	0
	May	58	135	19	150	263	1	17
	June	23	54	18	60	90	5	4

Seals at Point Reyes Headland were not censused in 1981.

Table 4. The average number of harbor seals at coastal and estuarine locations during the breeding and non-breeding seasons; $\bar{x}$ is the mean number of seals, SE is the standard deviation, and n is the sample size.

	Coastal	Estuarine
Breeding		
$\bar{x}$	929.9	721.8
SE	85.6	41.0
n	10	10
Non-breeding		
$\bar{x}$	497.3	474.5
SE	62.5	48.4
n	16	16

Table 6. The average number of harbor seals hauled out at Double Point by month combining data from 1976 to 1982 for adults, subadults, and all age-classes. Only those censuses when immatures were distinguished were included in the analysis; $\bar{x}$ is the mean number, SD is the standard deviation, SE is the standard error, and n is the sample size.

	MONTH											
	J	F	M	A	M	J	J	A	S	O	N	D
n	10	12	23	38	29	21	17	12	10	9	8	9
ADULTS												
$\bar{x}$	87.0	191.8	185.9	207.1	265.5	261.1	308.4	91.4	80.2	60.0	25.4	48.4
SD	71.5	88.1	62.0	105.6	128.8	120.5	101.4	48.7	59.7	56.1	14.9	51.3
SE	22.6	25.4	12.9	17.1	23.9	26.3	24.6	14.1	18.9	17.7	5.3	17.1
SUBADULTS												
$\bar{x}$	13.6	38.7	40.0	24.1	24.6	30.1	36.9	14.0	25.8	19.0	5.1	13.4
SD	16.2	23.5	27.3	15.8	16.1	20.7	19.7	10.1	22.5	31.3	3.6	9.6
SE	5.1	6.8	5.7	2.6	3.0	4.5	4.8	2.9	7.1	10.4	1.3	3.2
ALL AGE CLASSES												
$\bar{x}$	108.3	237.3	231.7	319.8	465.7	349.8	383.9	138.3	133.3	98.0	41.5	79.2
SD	75.9	100.0	82.0	169.0	188.0	147.4	109.8	63.3	71.6	78.7	15.2	60.5
SE	24.0	28.9	17.1	27.4	34.9	32.2	26.6	18.3	22.6	26.2	5.4	20.2
PERCENTAGE OF SUBADULTS TO TOTAL POPULATION												
	12.6	16.3	17.3	7.5	5.3	8.6	9.6	10.1	19.4	19.4	12.3	16.9

Table 5. Simultaneous censuses of harbor seals in the Point Reyes National Seashore conducted in 1981 and 1982. Data courtesy of Gary Fellers of the National Park Service.

		LOCATION									
	Date	Tomales Bay	Hog Island	Bird Rock	Tomales Point	Drakes Estero	Limant. Spit	Double Point	Duxbury Reef	Bolinas Lagoon	Total
1981	May	47	225	181	72	295	0	522	-	56	1398
	Jun	50	50	213	181	199	344	577	-	76	1690
	Jul	95	12	419	228	695	0	-	-	85	1534
	Aug	37	35	0	53	326	178	168	0	84	881
	Sept	63	0	17	74	108	0	144	30	45	481
	Oct	6	10	32	12	148	0	31	25	62	326
	Nov	0	0	11	35	191	0	26	0	1	264
	Dec	0	0	56	40	257	0	9	-	25	387
1982	Jan	36	0	62	59	106	0	-	-	-	263
	Feb	149	0	103	149	-	-	317	104	71	893

Table 7. The seasonal average number of harbor seals at Double Point in 1976, 1977, 1978, and 1982; $\bar{x}$ is the mean, SE is standard error, and n is the sample size.

		Breeding	Summer	Winter
1976				
	$\bar{x}$	195.2	165.7	123.8
	SE	17.6	35.7	34.0
	n	14	13	9
	range	112-320	28-408	26-347
1977				
	$\bar{x}$	304.5	222.6	106.8
	SE	22.1	35.9	22.1
	n	30	21	10
	range	109-594	54-544	36-212
1978				
	$\bar{x}$	330.1	217.6	*
	SE	29.1	67.2	
	n	19	8	
	range	114-556	38-512	
1982				
	$\bar{x}$	517.5	246.5	142.9
	SE	30.6	46.1	47.7
	n	33	8	8
	range	228-851	69-469	30-359

* Insufficient sample size for comparison.

Table 8. The relationship between tide and the number of seals hauled out at Drakes Estero, Double Point, and subsite South Point from -1 hour prior to +4 hour after low tide; $\bar{x}$ is the mean number of seals, SE is the standard error, and n is the sample size.

	HOURS OF LOW TIDE					
	-1	0	+1	+2	+3	+4
Drakes Estero						
$\bar{x}$	414.0	412.3	406.7	417.3	457.8	393.8
SE	29.8	32.3	24.4	28.6	31.0	31.3
n	12	13	13	8	6	5
Double Point						
$\bar{x}$	374.8	435.9	427.8	451.2	465.7	567.1
SE	44.8	42.9	41.4	41.4	43.7	63.2
n	10	16	17	18	14	7
South Point						
$\bar{x}$	27.0	37.4	36.9	32.3	27.6	21.0
SE	6.6	6.6	6.6	6.7	6.6	11.6
n	7	12	14	13	11	6

Table 10. The incidence of disturbance to harbor seals at each haul out site within the Point Reyes/ Farallon Islands Marine Sanctuary in 1982-83.

	LOCATION										
	Tomales Bay	Hog Is	Bird Rock	Tomales Point	Point Reyes	Drakes Estero	Limantour Spit	Double Point	Duxbury Reef	Bolinas Lagoon	Totals
SOURCES											
Hiker	1			2	2	5			3		13
Fisherman	11					8		1	3	2	25
Boat		4	1	1		4		1		2	13
Aircraft						1		7			8
Marine Salvage								4			4
Dog										1	1
Natural					1	3		1			5
Unknown				1	2	3		3		1	10
TOTALS *	12	4	1	4	5	24	0	17	6	6	79
TOTAL DISTURBANCE DAYS	12	4	1	3	5	20	0	14	6	6	71
TOTAL CENSUS DAYS	26	26	26	26	37	54	54	48	29	32	358
% DAYS DISTURBED	46	15	4	12	14	37	0	29	21	19	20

* More than one disturbance occurred on census days at Drakes Estero, Tomales Point and Double Point.

Table 9. The relationship between time of day and the number of harbor seals hauled out at Double Point in the breeding season during low to medium tides: $\bar{x}$ is the mean number of seals, SD is the standard deviation and n is the sample size. Census days when disturbance occurred were excluded.

	TIME								
	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600
$\bar{x}$	261.6	200.3	285.7	260.8	329.5	391.3	475.8	453.0	483.7	683.4
SD	102.5	86.9	85.6	93.1	139.7	144.4	154.9	196.4	186.7	124.6
n	7	12	13	12	13	12	14	16	14	8

Table 11. Population of sea lions at Pt. Reyes, 1936 - 1981.

Year	Date	Northern sea lion	California sea lion	Total Number
1936	21 June - 1 July	45	9	54
1938	13 - 26 June	6	-	6
1946	June			111
1947	June	2		2
1958	June			936
1958	7 Dec		1800	1800
1959	7 Dec		105	105
1960	June			625
1961	June			795
1965	1 - 3 June			259
1967	12 Dec	78		78
1969	3 - 6 June			420
1970	9 - 11 June			197
1975	7 - 18 June	~150	~400	~550 *
	8 - 18 July	10		10 *
1975	4 - 17 Jan	~100	~1000	~1100 *
	14 - 27 Feb	~100	~1500	~1600 *
1981	17 Jan		513	513
	19 - 21 May		518	518
	30 June and 1, 8 July	0	0	0
	28 - 30 Sept		356	356

* Includes animals at Point Arena.

Data from Bonnot, 1937; Bonnot et al., 1938; Bureau of Marine Fisheries, 1947; Bonnot and Ripley, 1948; Ripley et al., 1962; Carlisle and Alpin, 1966; Frey and Alpin, 1970; Carlisle and Alpin, 1971; Chan, 1979; Dohl, 1982.

Table 12. High counts of California sea lions at Point Reyes Headlands, 1982 - 1983.

Date	Total	Adult male	Subadult male	Female size	Immature	Unknown
15 March	234	74	52	94	14	
31 March	244	77	63	92	12	
7 April	338	107	25	116	7	83
15 April	141	27	39	63	12	
27 April	151	52	42	47	10	
6 May	96	60	17	12	7	
16 May	169	65	50	40	14	
20 May	66	40	12	10	4	
30 May	106	56	38	10	1	
1 June	129	24	94	7	4	4
10 June	28	16	9	3		
24 June	64	8	15	20	16	5
1 July	105	2	8	26	69	
8 July	41	6	10	9	16	
23 July	49	28	14	3	4	
3 August	163	91	48	4	0	20
20 August	195	49	71	35	7	33
27 August	262	37	113	61		51
23 Sept	207	43	80	55	28	
29 Sept	118	16	4	69	29	
17 Oct	132	22	12	65	33	
28 Oct	111	18	4	39	41	
12 Nov	144	39	69	32	4	
22 Nov	37	2	24	9	2	
20 Dec	138	21	65	47	4	
28 Dec	270	12	224	31	3	
27 Jan	22	5	12	4	1	
11 Feb	46	8	20	16	2	
17 Feb	39	5	26	6	2	

Table 13. High counts of northern sea lions At Pt. Reyes Headlands, 1982 - 1983.

Date	Total	Adult male	Subadult male	Female size	Immature
15 March	0				
31 March	3		1	2	
7 April	2			1	1
15 April	8		1	6	1
27 April	8	1	2	3	2
6 May	11	3	4	2	2
16 May	12	3	5	3	1
20 May	14	6	4	2	2
30 May	11	4	5		2
1 June	14	3	3	6	2
10 June	11	3	3	4	1
24 June	14	2	4	5	3
1 July	10	3	1	2	4
8 July	11	1	0	4	6
23 July	14	1	5	4	4
3 Aug	14	2	3	7	3
20 Aug	12	1	3	4	4
27 Aug	19	1	6	10	2
23 Sept	7			6	1
29 Sept	4			3	1
17 Oct	6			5	1
28 Oct	5			4	1
12 Nov	7			7	
22 Nov	3			3	
20 Dec	8			4	4
28 Dec	6			4	2
27 Jan	1			1	
11 Feb	6		1	5	
17 Feb	4			3	1

FIGURE 1.

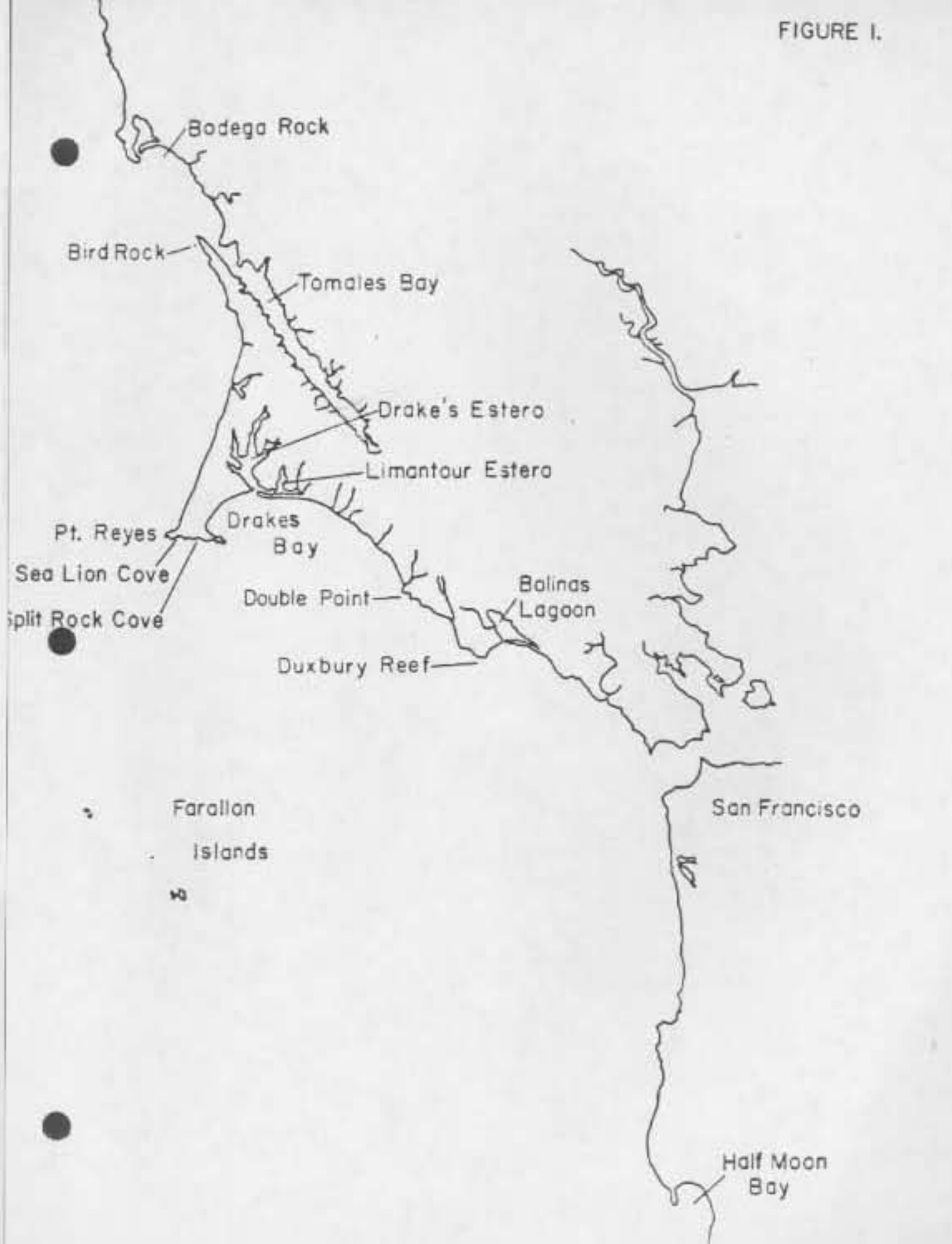


FIGURE 2.

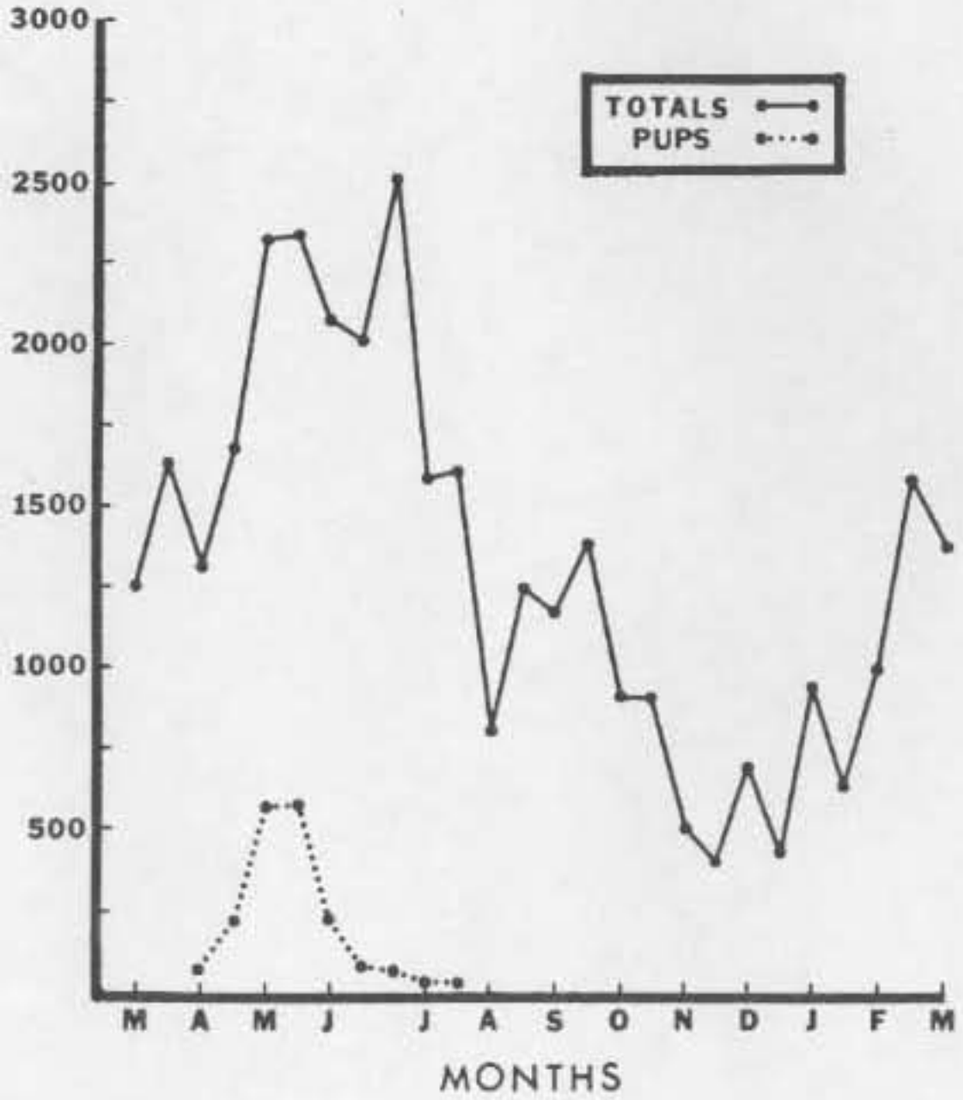


FIGURE 3.

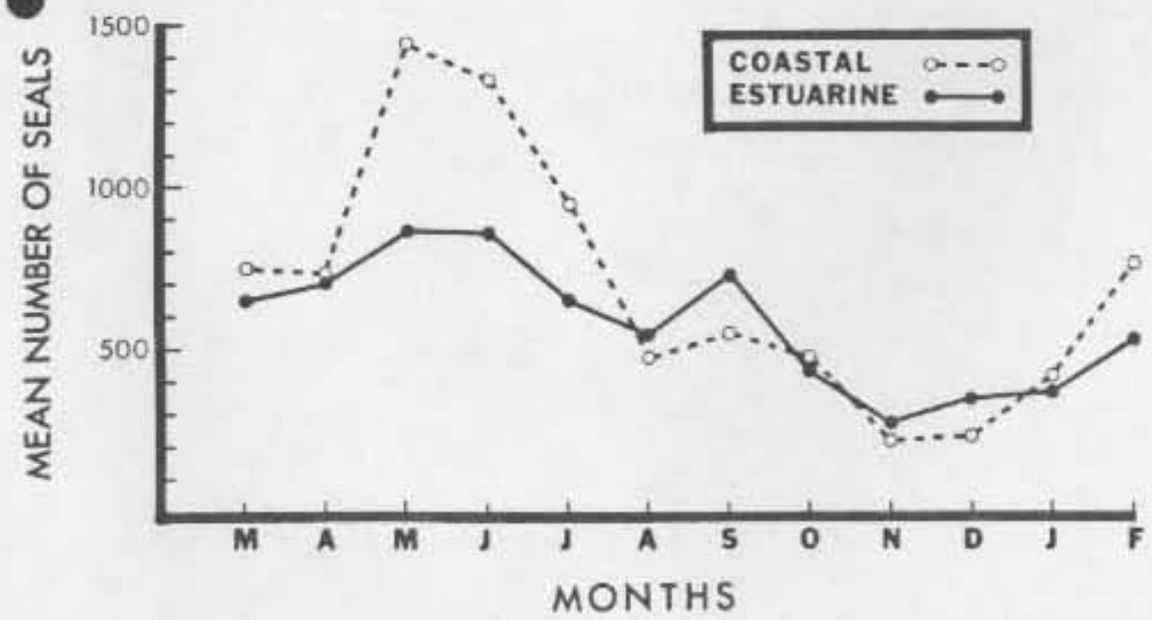


FIGURE 4.

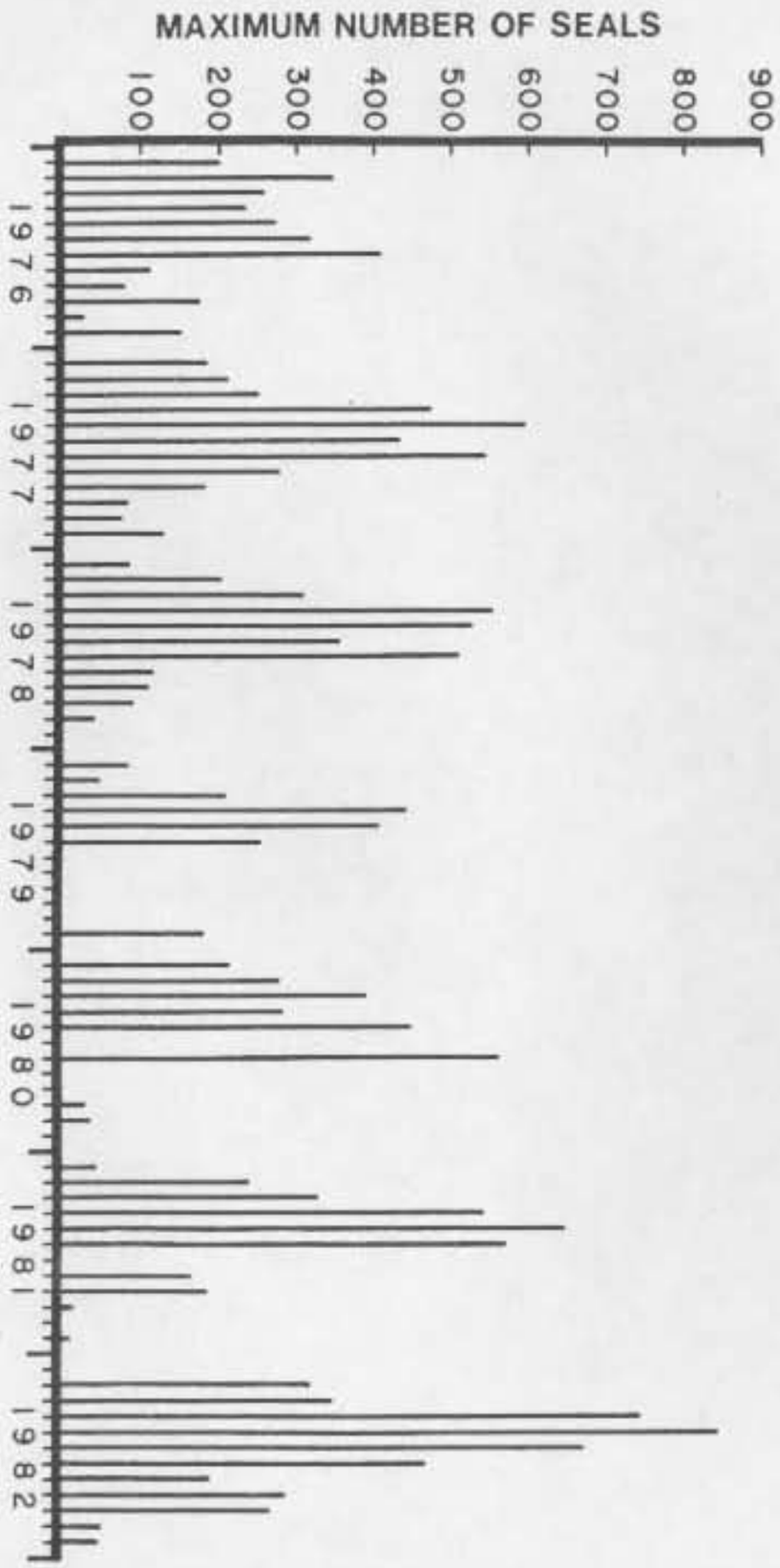


FIGURE 5.

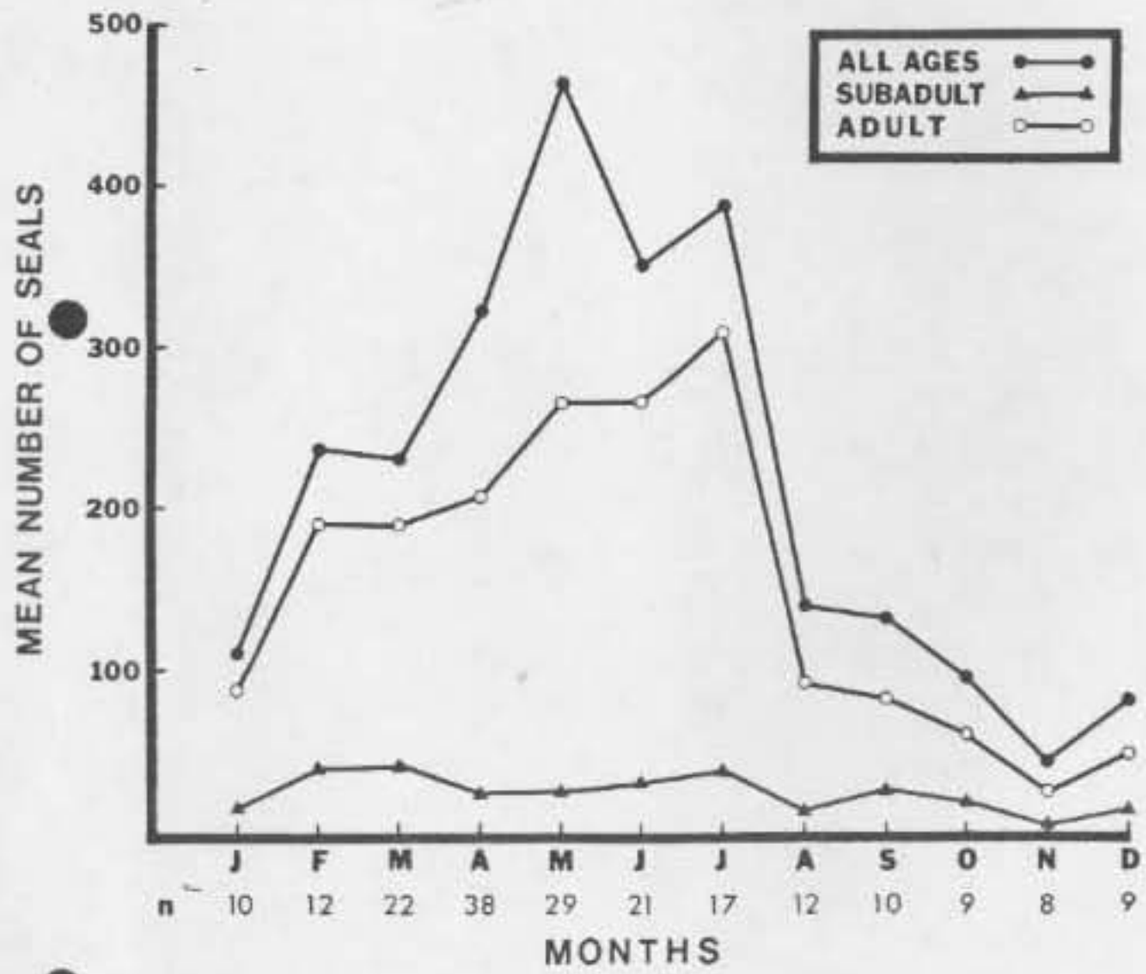


FIGURE 6.

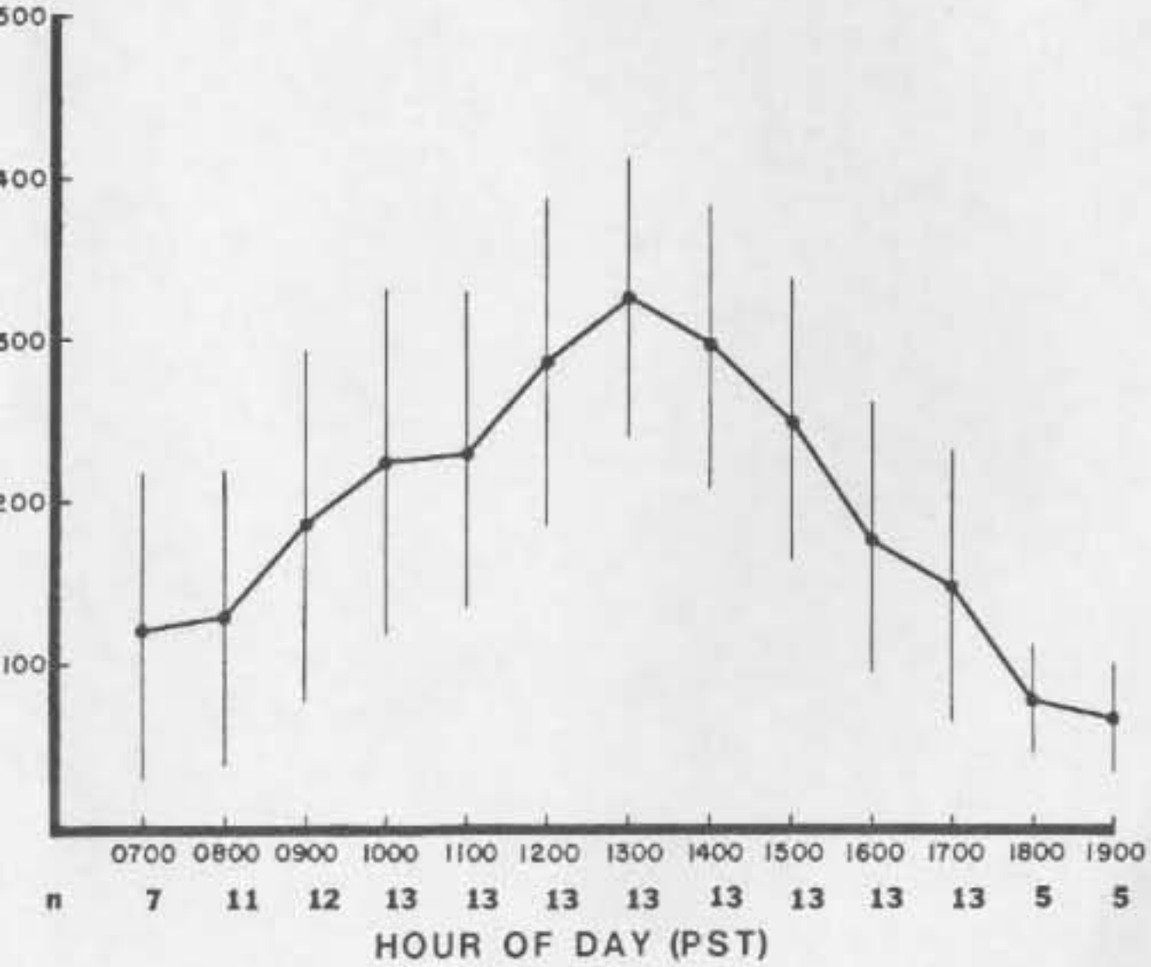
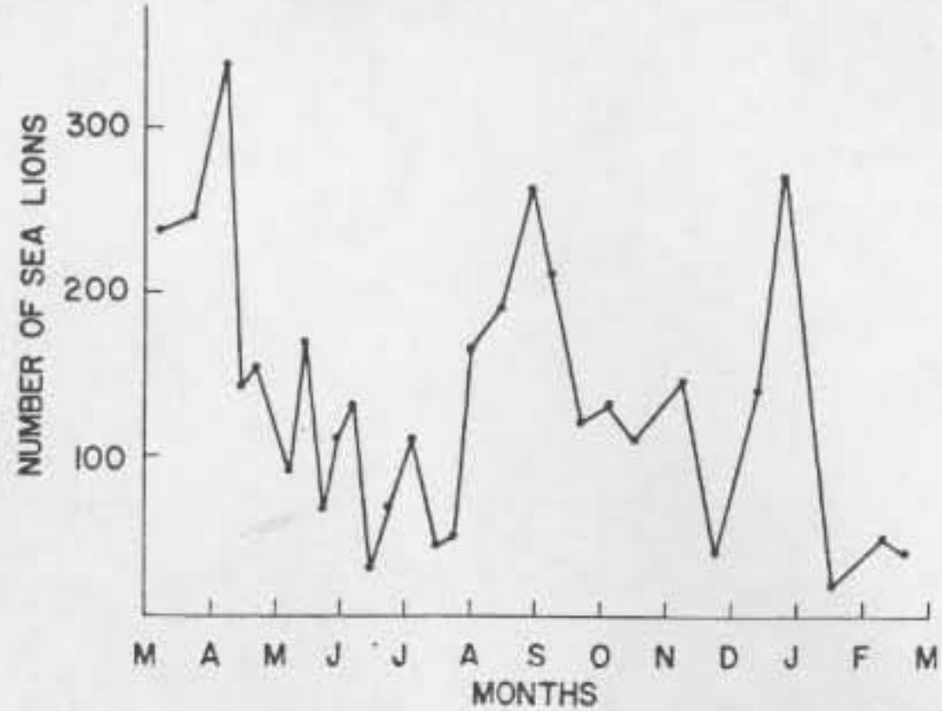
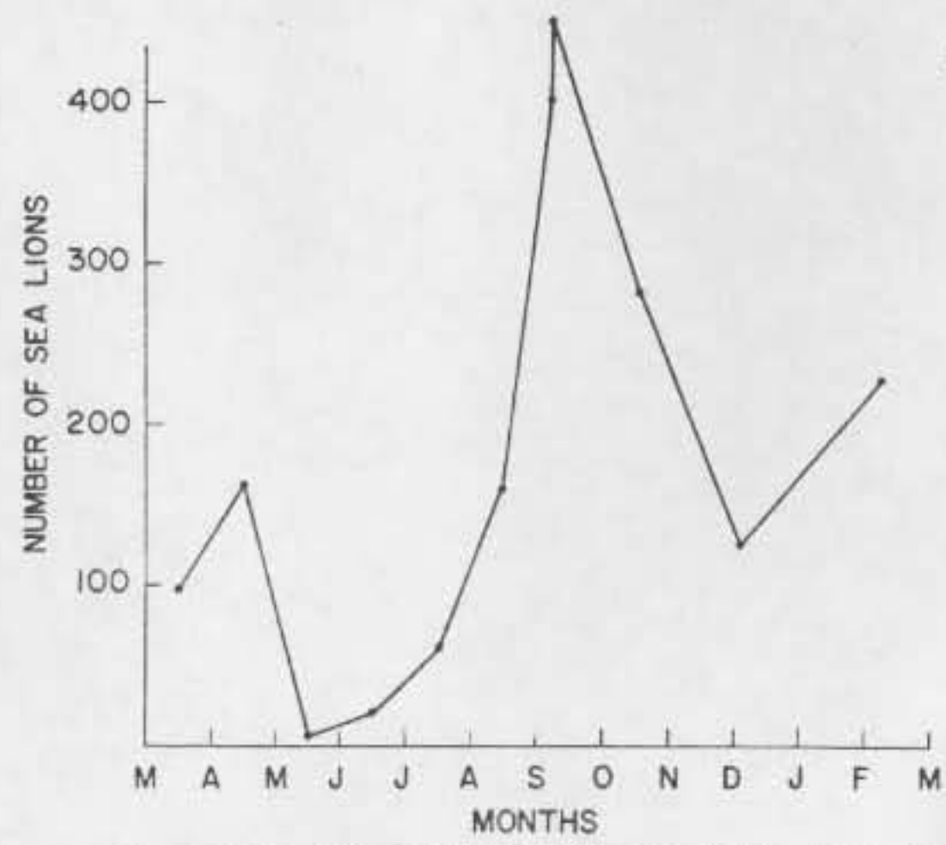


FIGURE 7.



CALIFORNIA SEA LIONS AT PT. REYES HEADLANDS, 1982-1983

FIGURE 8.



CALIFORNIA SEA LIONS AT BODEGA ROCK, 1982-1983

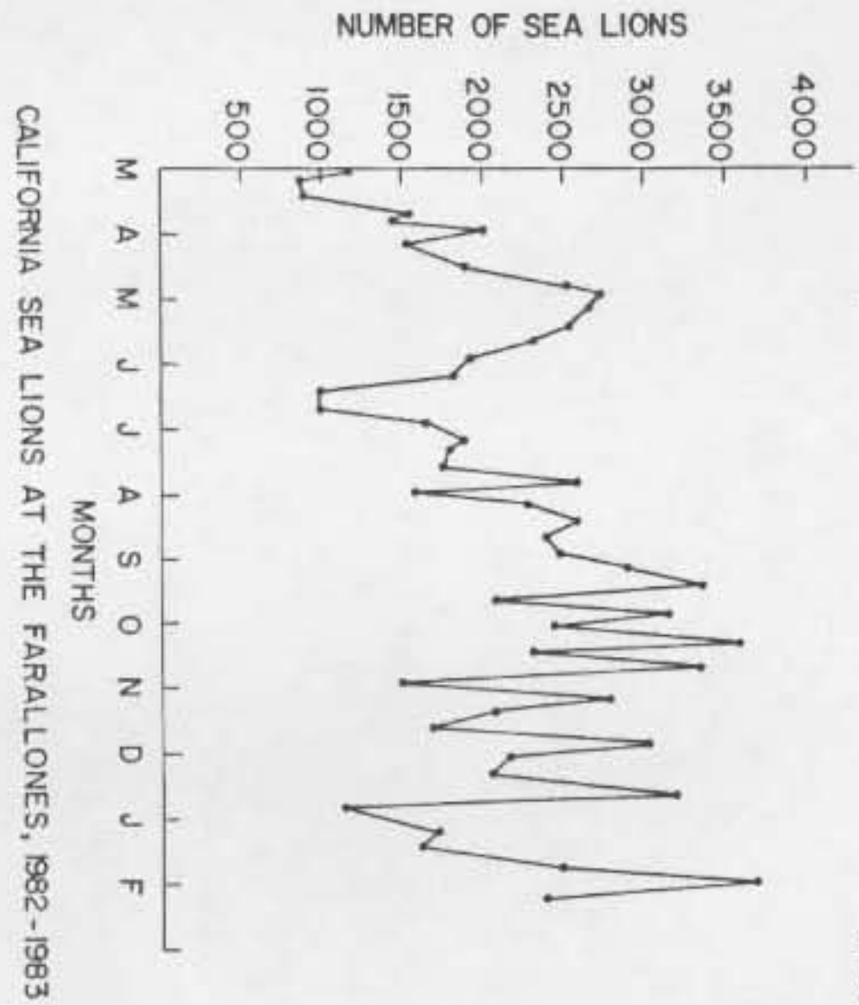
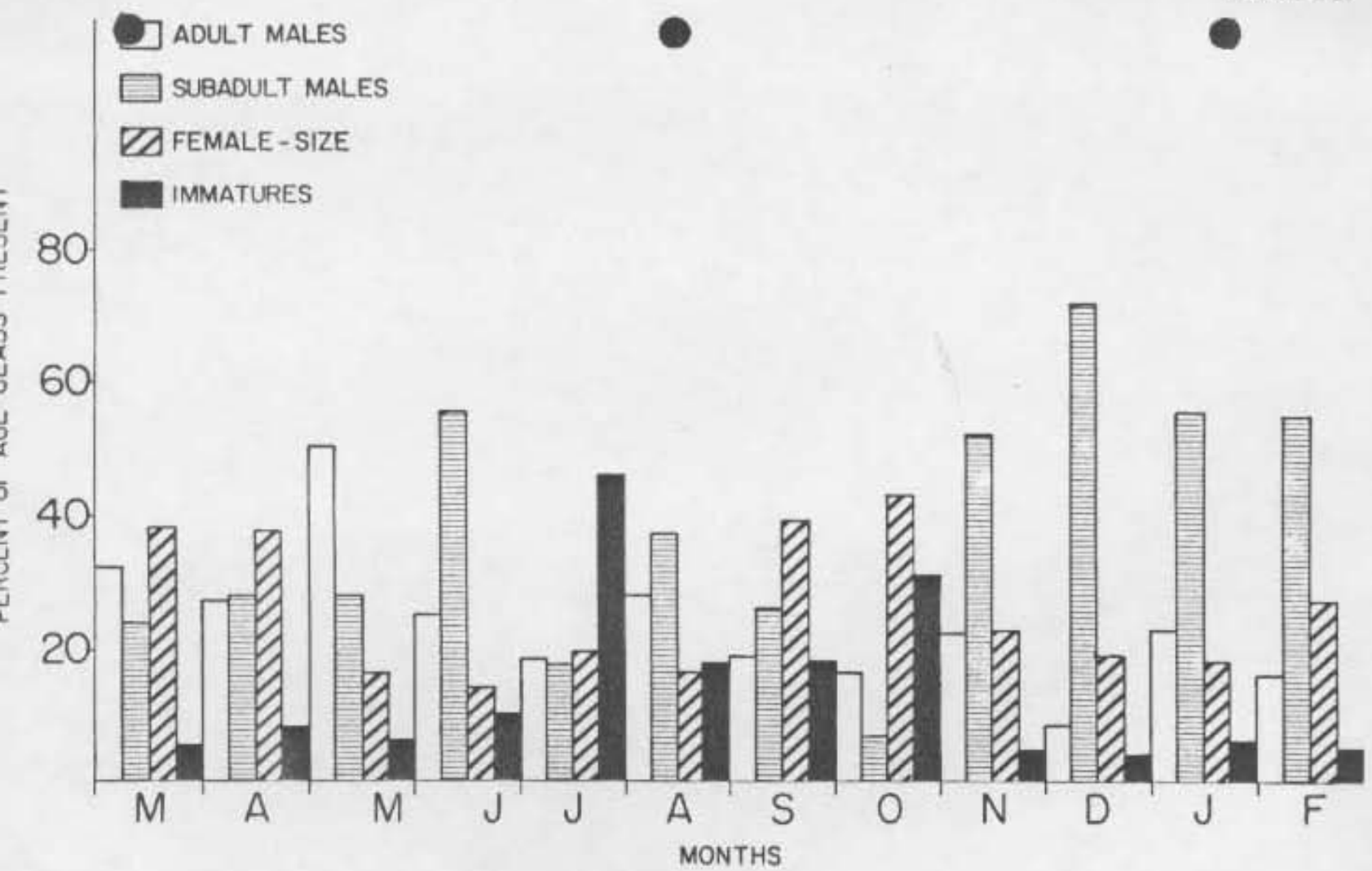
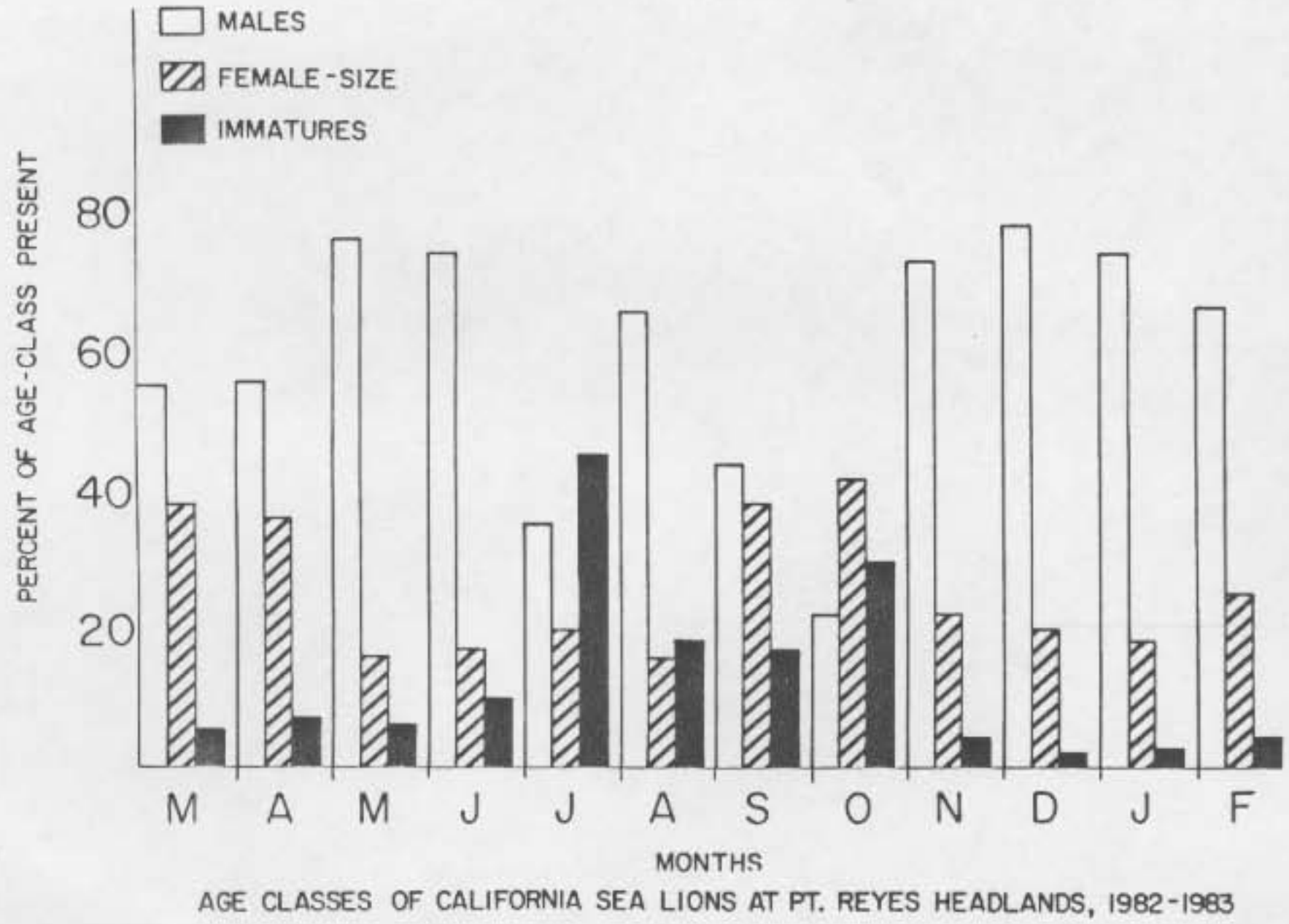


FIGURE 9.

FIGURE 10.

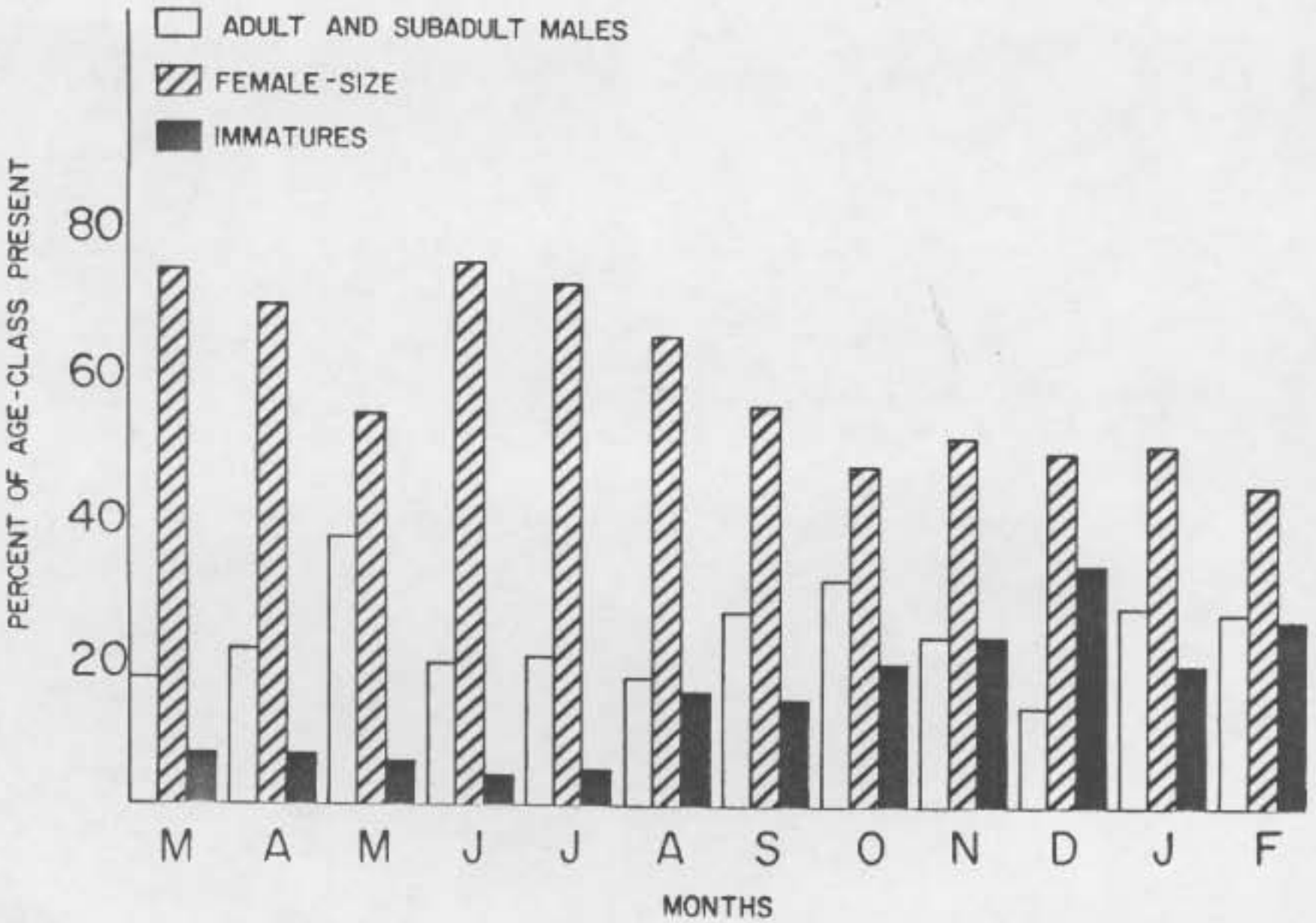


AGE CLASSES OF CALIFORNIA SEA LIONS AT PT. REYES HEADLANDS, 1982-1983



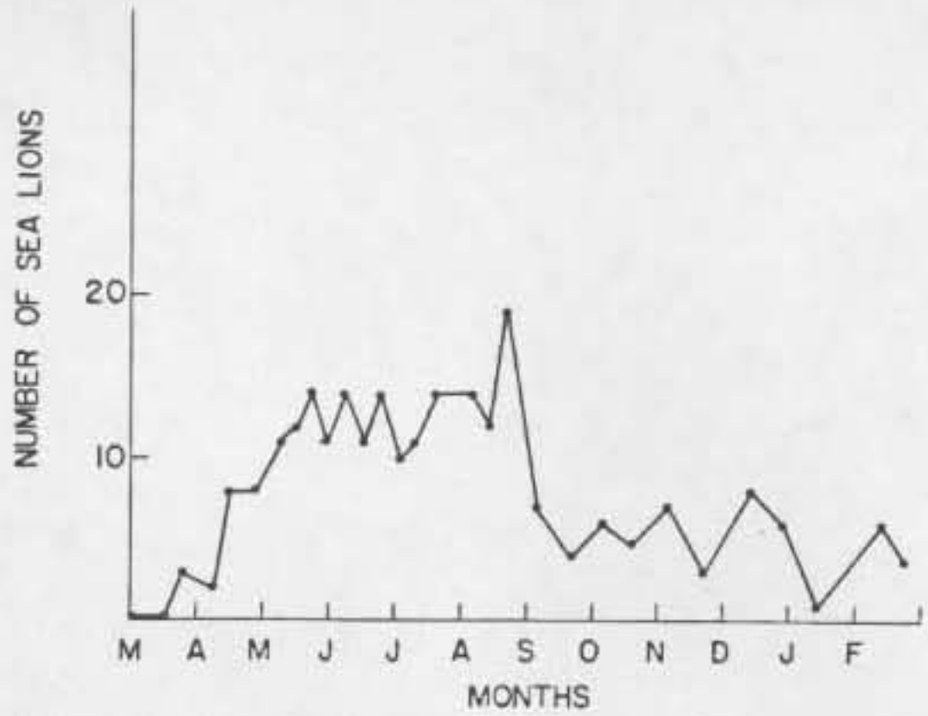
AGE CLASSES OF CALIFORNIA SEA LIONS AT PT. REYES HEADLANDS, 1982-1983

FIGURE 12.



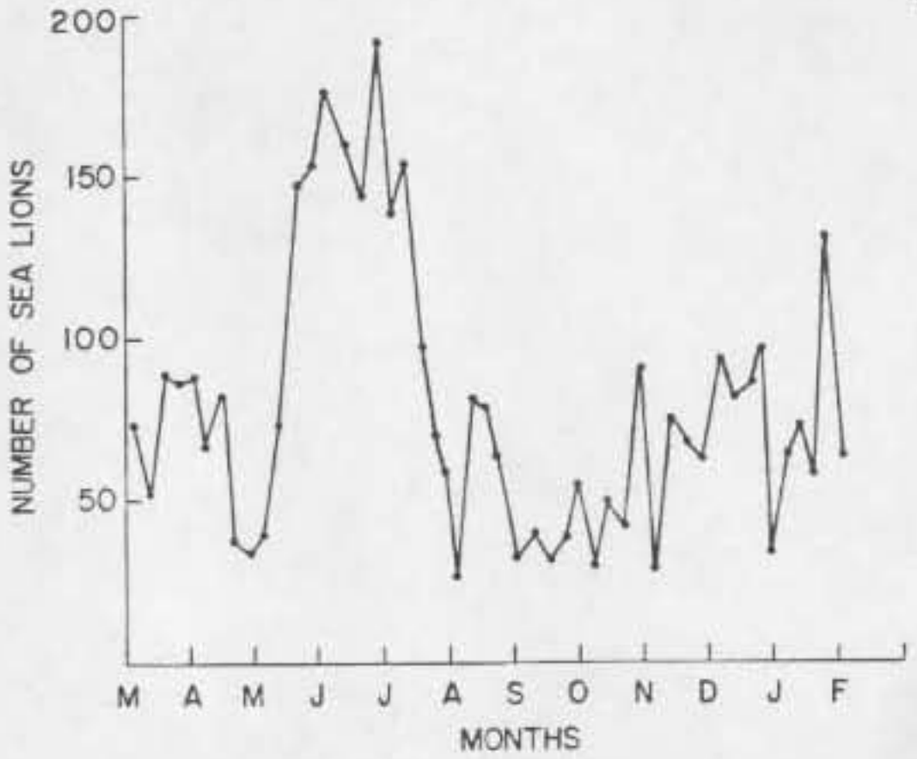
AGE CLASSES OF CALIFORNIA SEA LIONS AT THE FARALLONES, 1982-1983

FIGURE 13.



NORTHERN (STELLER) SEA LIONS AT PT. REYES HEADLANDS, 1982-1983

FIGURE 14.



NORTHERN (STELLER) SEA LIONS AT THE FARALLONES, 1982-1983

From Allen et al. ms.