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PINNIPED ASSESSMENT IN POINT REYES, CALIFORNIA, 1983 TO 1984

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NOTICE

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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Pinniped Assessment in Point Reyes, California, 1983 to 1984

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ABSTRACT

We surveyed three species of pinnipeds (harbor seals, California sea lions, and northern sea lions) for a second year in Point Reyes, California, from March 1983 through February 1984. Information gathered for both years (1982-83, 1983-84) are compared. Harbor seals, though present year round, were most abundant during the breeding season; the maximum count for the season was 2449 including 527 pups. The majority of breeding seals migrated to coastal locations rather than estuarine ones. At Double Point the breeding population has expanded three-fold since 1976; the annual rate of growth, though, has not been constant. During the non-breeding season, population numbers have remained stable. Sea lions also were seasonally abundant in Point Reyes. Northern sea lion numbers peaked during the breeding season; California sea lion numbers peaked during the southern spring migration and the northern fall migration when traveling to and from breeding grounds, and peaked again in December during the herring run in Tomales Bay. A significantly larger number of California sea lions, composed of mostly immatures, was present in 1983-84 than in 1982-83. The optimum time to census sea lions in Point Reyes was between 1100 and 1600 hr when low tides occurred mid day.

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PART A. HARBOR SEALS

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INTRODUCTION

Throughout historical times, harbor seals, Phoca vitulina, have resided at Point Reyes, California. Scammon (1874) was the first to record their presence (1850's), but only in recent years have researchers attempted to document the seasonal abundance of this species in the California coastal zone (Carlisle and Alpin 1966 and 1971, Dohl et al. 1982, Frey and Alpin 1970, Hanan 1985, Mate 1977, and Miller 1983). The results of these surveys, however, are insufficient for designing a reliable management plan for harbor seals specific to the Point Reyes area. With the more generalized state-wide emphasis of present information, we lack insight into the peculiarities of this local population. In addition, little information has been available on the reproductive rates of harbor seals in the region. Incidental information on pinnipeds in Point Reyes has been noted by Chan (1979) in reports on Areas of Special Biological Significance (ASBS) and by Allen et al. (1985).

Our two-year survey, 1982-1984 was designed to provide comprehensive information on abundance and seasonal use patterns of harbor seals in the coastal zone of the Point Reyes area. In the first survey year, we refined our census techniques by evaluating the tidal and diurnal differences in seal haul-out behavior as well as identifying haul-out sites and the

significance of each. Data from the second survey year validated findings on seasonal and spatial trends. We include in this report analyses of data collected since 1976 at Double Point, the largest breeding site in the region.

STUDY AREA AND METHODS

Study Area

The coastal zone of the Point Reyes/Farallon Islands National Marine Sanctuary extends from Bodega Bay (38° 30'N) south to Bolinas Bay (37° 30'N) (Figure 1). Included are embayments such as Tomales Bay, Drakes Estero, and Bolinas Lagoon. The Point Reyes National Seashore (PRNS), the Golden Gate National Recreation Area (GGNRA), and the Marin County Department of Parks and Recreation share boundaries with the Sanctuary over segments of this coastline. In addition to the protection afforded by Park and Sanctuary status, Bird Rock, Point Reyes Headland, and Double Point were designated as Areas of Special Biological Significance (ASBS) by the California Department of Fish and Game (CDFG) and the State Water Resources Control Board.

Much of this coastline remained largely undeveloped even before inclusion into PRNS and GGNRA during the 1960's and 1970's. An agricultural character and the inaccessibility of much of the area afforded protection from human disruption. Consequently, use of habitat by seals has probably has not changed significantly over the past few decades.

The topographical diversity of this coastal zone contributed to the broad range of substrates in seal habitat, including tidal mud flats, offshore tidal ledges, and sandy beaches. Coastal locations included Tomales Point, Point Reyes Headland, Double Point, and Duxbury Reef; estuarine locations included Tomales Bay, Drakes Estero, and Bolinas Lagoon (Figure 1).

Data Collection

We counted seals twice each month at all locations from March 1983 through February 1984. Censuses occurred simultaneously in the afternoon during low to medium-low tides except on a few occasions when weather conditions hindered human access to remote sites. Days when low to medium-low tides occurred mid-day to early afternoon were chosen to maximize counts (Ainley et al. 1977, Allen et al. 1985, Fancher 1979, Stewart 1984). In addition, an all day census at primary locations was conducted in June when seal numbers reach their annual maxima in the area (Allen and Huber 1983, Miller 1983). This all-day census was undertaken to confirm that there were no diurnal and tidal differences in haul out patterns between locations and to provide a maximum estimate of seals in the Point Reyes region.

Whenever possible we classified seals in three categories based on size and color: adults, subadults, and pups. Seals in the eastern Pacific are purported to reach sexual maturity between three and six years of age (Bigg 1969). At locations other than Double Point, Drakes Estero, Point Reyes Headland, and Tomales Point, distance from observer and the oblique angle

of view made it difficult to distinguish subadults. Pups were easily identified at all locations during the breeding season because of their bright coloration and diminutive size.

We counted seals on four to five consecutive days at Double Point during the breeding season (March through June) and molting period (June through August) in 1983 and 1984 in order to determine daily variability in the haul out pattern.

Data Analysis

For analysis of seasonal trends, we divided the year 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 and used a t-test to compare the average abundance for spring, summer and winter of 1982 with that of 1983. Age class representation for subadults and pups was expressed as a percentage of the total herd. Maximum counts of pups for the region were based on simultaneous censuses in the event that females with pups might travel between locations. To test whether the seasonal haul-out pattern was different at coastal compared to estuarine locations during breeding and non-breeding seasons (summer and winter seasons combined) in 1982 and 1983, we made two 2 x 2 contingency tables. We used a log-linear model to analyze the tables and then we used Freeman-Tukey deviates to see which cells did not fit the model (Fienberg 1981).

Examination of trends in abundance at Double Point included data collected by Allen (unpublished data) from January 1976 to June 1984.

During that period seals were censused on 325 days with over 625 hours of observation. Seasonal coverage was similar for all years except 1979 and 1980. Most censuses were confined to the hours 0700-1630 because the remoteness of the area required three hours of hiking, round trip. We estimated the increase in the number of seals at Double Point from 1976 to 1984 by dividing the seasonal mean of 1984 by that of 1976. The change in abundance for each year was determined from the formula $\lambda = \frac{\bar{N}_{t+1}}{\bar{N}_t}$, where N is the mean population size and t is the year (Caughley 1977).

We examined the representation of sex and age classes at Double Point in spring 1984 to identify more accurately which animals accounted for this annual peak. The period was divided into early (March to mid-April), middle (mid-April to mid-May), and late (mid-May to June). Seals were categorized as male, female, female with pup, subadult, and pup. We then calculated the percent representation of each category by dividing the number identified for each category by the total number of animals classified. Since male and female adult seals are almost identical in size, we were not able to sex all adult animals and did not attempt to sex subadults.

The daily variability in the number of seals hauled out at Double Point during the breeding season was compared with that of the molt period (late June through July) and the end of molt (August) using the coefficient of variation $CV = \frac{SD}{\bar{x}}$ (Snedecor and Cochran 1967). Only counts from 1200-1400 hr and from 1-3 hr after low tide were used in the analysis. For comparison, we calculated an analogous CV from data gathered at Bolinas

Lagoon by Allen (unpubl. data).

We were able to identify a number of individual females at Double Point by scars and unusual spot patterns. For eight years we noted the recurrence of many of these animals during successive breeding seasons (Allen, unpubl. data). To verify the accuracy of our ability to identify individuals, we compared the presence of known females during consecutive three-day periods during the 1977, 1983 and 1984 breeding seasons, excluding days when excessive disturbance occurred. We calculated the probability of sighting, P, by the formula:

$$P = \frac{N_{1 \text{ and } 3}}{N_{1-3}},$$

where $N_{1 \text{ and } 3}$ is the number of females seen only on days one and three, and N_{1-3} is the number seen on all three days. The average for all three-day periods was used as the probability of sighting (P). Our estimated average probability of sighting was 0.9 (n = 3, range 0.8-1.0). The sample size of known individuals was small (7, 5, 6), but these animals were easily distinguished within a herd composed of 400-700 animals. Since our probability of sighting was within an acceptable range, we felt confident in calculating the pupping frequency of known females and the probability of pupping.

The pupping frequency (pf) of females was figured from the conditional probabilities for successive samples of females in three-year sets using the formula:

$$pf = \frac{\text{No. of same females in denominator seen w/pup in yr}_{i+1}}{\text{No. of females seen in yr}_{i}}$$

Known individual adult females identified from 1977 to 1979 represented set 1, and from 1982 to 1984 represented set 2. We eliminated from our tabulations two groups of known females: 1) females not seen all three years (Siniff et al. 1977); and 2) those that did not have pups in year 1 because they may not have been sexually mature then. We included these two groups of females, however, when presenting a summary of pupping success. The probability of pupping (X) was estimated from a binomial pupping model (Siniff et al. 1977) with the equation $Xp = \frac{\Sigma P_i}{n}$, where P_i is years with pup for female$_i$ divided by total years female$_i$ was present, and n = the number of known females. Only known females present in three successive years were included in the model. If a female was determined to be pregnant by the size and shape of her abdomen, but was not seen attending a pup later, she was included in the sample as having pupped.

RESULTS

Seasonal and Spatial Use Patterns

Regional

Harbor seals were present year round at all locations censused within the Point Reyes area in 1983 and, as determined in the 1982 survey, the numbers fluctuated seasonally with more seals hauled out in spring ($\bar{x}$ = 1653.4, SE = 121.0, n = 9) and summer ($\bar{x}$ = 1270.1, SE = 210.6, n = 8) than in winter ($\bar{x}$ = 1089.1, SE = 70.1, n = 8)(Table 2). Seasonal means in 1982 versus those in 1983 were not significantly different (spring: t = 1.225, p > 0.1; summer: t = .3318, p > 0.1; winter: t = .7421, 0.2 > p > 0.1). The

highest counts for the region in 1983 occurred in May (2449) and July (2323) (Figure 2). Tomales Point, Drakes Estero, and Double Point were the areas of highest seal concentration contributing most to the total number of pups (Tables 1 and 3). Pups were first identified at haul-out sites in late March, and their numbers peaked during the first week of May for both years with 566 in 1982 and 527 in 1983. Pups represented 24% of the total count (2339) in 1982 and 22% (2449) in 1983 (Table 3). The mean percentage representation of subadult seals at Tomales Point, Point Reyes Headland, Drakes Estero, and Double Point was much the same for all seasons in 1983 (spring: $\bar{x}$ = 18.0, SD = 7.0, n = 8; summer: $\bar{x}$ = 17.4, SD = 3.0, n = 8; winter: $\bar{x}$ = 15.0, SD = 4.4, n = 9). As was observed in the 1982 survey, subadult representation declined in May 1983 ($\bar{x}$ = 8.5%) (173/1820, 79/1101).

The all day census conducted in June 1983 confirmed that more seals were present at all haul-out sites mid-day, a couple of hours after low tide, with only Tomales Bay being exceptional, but did not provide a maximum estimate for the seal population in the Point Reyes region (Table 4). More seals were counted in Tomales Bay early in the morning, but the numbers were only slightly lower mid-day. Though mid-day yielded maximum numbers, many seals remained at haul-out sites into mid-afternoon, despite rising tides. Duxbury Reef could accomodate large numbers of seals until about four hours after low tide when it was awash. Seals that hauled out on offshore rocks at Bird Rock and Double Point shifted to higher ground as the tide rose and consequently, even at five hours after low tide, many seals were hauled out. At estuarine locations haul-out space was reduced slightly beginning a couple of hours prior to high tide, and so a substantial number of seals

remained until late afternoon.

Coastal areas accomodated a large influx of seals during the breeding season ($\bar{x}$ = 992.7, SE = 75.8, n = 9) in comparison to estuarine sites ($\bar{x}$ = 660.8, SE = 59.0, n = 9). During the non-breeding season the coastal populations declined substantially ($\bar{x}$ = 618.3, SE = 83.1, n = 15), whereas estuarine ones declined only slightly ($\bar{x}$ = 595.9, SE = 37.6, n = 15). The log-linear model comparing coastal and estuarine locations during breeding and non-breeding seasons for 1982 and 1983 revealed that none of the variables were equal (X^2 = 26.45, $p < 0.001$). The variable which least fit the model was the figure for estuarine locations during the breeding season in 1983 (Table 5). The estuarine pattern changed significantly in 1983 with fewer seals recorded during the breeding season and more during the non-breeding season compared to that of 1982. Thus, the coastal pattern was similar though not identical for both years. These findings suggested that more seals were migrating to coastal areas than to estuaries during the breeding season.

The seasonal pattern for each haul-out site reflected this difference between coastal and estuarine groups, and when examining each we can identify where the deviation from the 1982 estuarine pattern took place.

Bodega Rock

Seals were seen hauled out on tidal reefs of this offshore sea stack. We counted a maximum of 54 seals in February 1984. Pups were not seen in 1983 (Table 1).

Tomales Bay

Seals hauled out predominantly on tidal sand bars extending from Toms Point to Sand Point in 1983. They were seen infrequently at Hog Island. Seasonal means revealed that numbers remained relatively stable throughout the spring and summer months and were slightly higher in winter (Table 2). The winter peak in 1983 was in contrast to a distinct decline in numbers in the winter of 1982. Here is where the main divergence from the estuarine model occurred. In 1983 both spring and summer numbers were markedly lower than those in 1982 (Appendix I), possibly because of disturbance. Though the frequency of disturbance was similar in 1982 and 1983 (1982: 16 of 26 censuses; 1983: 16 of 28 censuses), the level of human activity was much greater in 1983 (Allen and Huber 1984). A maximum of 45 pups was counted in May which is slightly lower than the figure in 1982 (58) and represents 16% (45/275) of the population in Tomales Bay and 10% (45/527) of all pups censused in the Point Reyes area. A graph of the average number of seals by month, combining data for 1982 and 1983, displays the apparent decline in attendance in early winter and again in June and July when visitor use in the area is high (Figure 3). Seal numbers in January through March were higher than for most other months. Herring, Clupea pallasii, spawn in Tomales Bay at this time [a known prey item of seals in the area (Miller 1983)], and may be related to increased seal abundance.

Tomales Point

The largest concentrations of seals in the vicinity of Tomales Point hauled out on Bird Rock, north tidal rocks and Driftwood Beach. The

seasonal haul-out patterns were nearly identical in 1982 and 1983 with most seals recorded during the breeding season (Table 2). A graph of the average number of seals present by month, combining data for 1982 and 1983 illustrates the rapid increase that occurs there in May, June and July, and the equally rapid decline from August through February (Figure 4). Tomales Point is one of the three most important breeding areas in the Point Reyes region with pups representing 24% (122/514) of total seals censused at the Point and 23% (120/527) of all pups censused in 1983.

Point Reyes Headland

Point Reyes Headland is a minor coastal haul-out area where seals were scattered along offshore rocks and in pocket beaches around Split Rock and Sea Lion Coves. Counts were highest during the breeding season (Table 2); one pup was seen in June. In contrast to 1982, the mean count during winter 1983 was slightly larger than that of the summer. The combined data of 1982 and 1983 reveal an irregular pattern: small numbers of seals were present during April and May, the peak of breeding, and again in winter, but were most abundant just prior to and just after the breeding season (Figure 5). Geographically, this point bisects the distance between two major coastal haul-out sites, and may be frequented by animals moving to or from breeding grounds. We often observed harbor seals sharing pocket beaches here with northern elephant seals, Mirounga angustirostrus, and occasionally observed them displaced by these larger seals.

Drakes Estero

Drakes Estero is one of the three largest breeding areas in the Point Reyes area. Seals hauled out on virtually every sand bar far up into the estero during the breeding season, and Limantour Spit was used primarily then. The 1983 pattern resembled closely that of 1982 with high counts during spring and summer and lower counts during winter (Table 2). A maximum of 122 pups was counted in May 1983, accounting for 19% (122/656) of the total breeding population there. Twenty-three percent (122/527) of all pups in the Point Reyes area occurred at Drakes Estero in 1983. A graph of the combined data from 1982 and 1983 reveals that seals were present in large numbers year round in contrast to the two other most important breeding areas, Tomales Point and Double Point (Figure 6).

Duxbury Reef

The majority of seals hauled out on an intertidal reef extending from Bolinas Headland; we identified a secondary haul-out site in 1983 which was another reef 1/2 mi further north at Bolinas Point. Duxbury Reef was the only coastal site in 1983 where the seasonal mean number of seals was higher in summer than in spring; the average in winter was similar to that in spring (Table 2). The monthly pattern exhibited in Figure 7 displayed a peak in September and October and a decline in July; numbers varied greatly, however, within July. Few pups ($\leq$5) were observed in 1982 and 1983.

Bolinas Lagoon

Bolinas Lagoon is an estuarine habitat where seals haul out on tidal mud

flats bordering two islands, Kent and Pickleweed. In a previous study, Kent Island was the preferred site for all seasons (Allen et al. 1985). In 1982 and 1983, however, Pickleweed Island was the preferred location. The seasonal pattern in 1983 was nearly identical to that of 1982 with a summer annual peak, rather than one in spring, and a much reduced number in winter (Table 2). Bolinas Lagoon was not an important pupping ground; only 17 pups were counted in May both of 1982 and 1983. Bolinas Lagoon, like Drakes Estero, did not display the monthly extremes in seal numbers characteristic of coastal colonies (Figure 8).

Double Point

The seasonal variation in the average number of seals at Double Point in 1983 followed the pattern recorded since 1976 with a large influx of animals occuring in spring and then dispersing rapidly in summer and winter (Table 2). Maximum numbers in 1982 and 1983 occurred during the months from April through July; we observed fewer seals from September through January (Figure 9). The months August/September and February/March were transition periods when numbers declined or increased, respectively. Counts during November reached the annual low. Pups accounted for 32% (262/832) of all seals censused at Double Point in May 1983 and 50% (262/527) of all pups censused in the Point Reyes area (Table 3).

Since 1976, pups have been initially sighted each year in late March or early April; the maximum pup count has occurred consistently during the first two weeks of May. The May peak for all years coincided with the annual peak for all age classes combined, but surprisingly more adult seals

hauled out in June (74%) and July (80%) than in May (59%). The peaks coincided with the mating period and the onset of molt, respectively (Figure 9, Table 6). Females come into estrus after pups are weaned, and mating apparently extends into August (Bigg 1969). We observed mating on four occasions in late May and early June 1983 (Allen 1985). Seals at Double Point molted from early June to early August.

The mean number of subadult seals was largest during the months flanking the breeding season, February and March and June and July (Figure 9, Table 6). During May, the number of subadults declined only slightly, but their proportion to all seals counted then was much lower than in other months. The percent representation of subadults was highest in September, October, and December (Table 6).

A closer examination of sex and age classes of the main herd at Double Point during the breeding season in 1984 revealed distinct trends in the representation of each category (Table 7). Early in the season females (33%), males (30%), and subadults (27%) were equally abundant. At the height of the season, though, the herd consisted primarily of females (38%), particularly females with pups (33%), and pups (39%). Late in the season, the herd also consisted mostly of females (38%) and pups (33%), but fewer females were with pups and the percentage of subadults began to increase. The representation of males remained low from April 17 through May 31.

A comparison of the mean number of seals counted during the 1976 breeding season ($\bar{x}$ = 195.2, SE = 17.6, n = 14, range = 112-320) with that of 1984 ($\bar{x}$ = 578.3, SE = 41.5, n = 22, range = 101-897) showed a three-fold increase. The change in abundance for each year, however, was not linear

over this nine-year period (Table 8). For most years there was no change, but in 1977 and 1982 seal numbers rose. The summer and winter seasonal means for 1976 (summer: $\bar{x}$ = 165.7, SE = 35.7, n = 13; winter: $\bar{x}$ = 123.8, SE = 34.0, n = 9) and 1977 (summer: $\bar{x}$ = 222.6, SE = 35.9, n = 21; winter: $\bar{x}$ = 106.8, SE = 22.1, n = 10) were not substantially different from those of 1983 (summer: $\bar{x}$ = 174.3, SE = 53.7, n = 14; winter: $\bar{x}$ = 215.8, SE = 32.2, n = 15).

Daily Variability

The variability in the number of seals hauled out at Double Point over successive days was greater during the breeding season than during the molt (Table 9). The same was true for the herd in Bolinas Lagoon. At the end of the molting period (August), the daily variability increased substantially at Double Point, but in Bolinas Lagoon it remained the same. Disturbance and inclement weather at Double Point are partially responsible for the increased variation during the breeding season. Because of these uncontrolled factors influencing the daily variability, we are not completely confident with the results of these analyses.

Reproductive Rates

A summary of pupping success of known individual females is presented in Table 10. The proportion of known females observed in a given year that had pups was similar for all years. A small proportion of females were not seen in successive years with the exception of 1984. A larger proportion of females also did not bear pups in 1984. A total of 13 females (present all

three years) were observed with pups in 1977. Eleven of the females were resighted with pups in the second year, yielding a pupping rate of 0.85 (11/13). The proportion of known females that pupped all three years for this set was 0.77 (10/13). In the second set, a total of 11 females (present all three years) were seen with pups and all of these were resighted with pups in 1983. This yielded a pupping rate of 1.0 (11/11); the proportion of females that pupped all three years was 9/11 for a rate of 0.82. Both three-year sets yielded a high probability that females with pups in year 1 would have a pup in successive years. The probability of pupping was 0.89 for set 1 and 0.92 for set 2.

DISCUSSION

The results of the 1982 survey in combination with those of 1983 provide a much clearer understanding of harbor seal aggregations in Point Reyes. We have identified when and where seals are seasonally abundant and when is the optimum time to census. In 1982 we determined that diurnal and tidal effects on seal haul-out behavior vary within an optimum range from mid-day to late afternoon at low to medium tides depending upon the physical attributes of each location. This was verified in the all day simultaneous census in June, 1983. The diurnal pattern was similar to that of other locations in California: Mowry Slough in San Francisco Bay (Fancher 1979), Southeast Farallon Island (Ainley et al. 1977), Bolinas Lagoon (Allen et al. 1985), and San Miguel Island (Stewart 1984).

It is apparent that the Point Reyes area accomodates a large harbor seal breeding population. Peak figures tabulated in May (2449) and

July (2323) 1983 and in May (2339) and June (2502) 1982 are comparable. Population estimates by the California Department of Fish and Game (CDFG) based on aerial surveys in April and June, 1982 and 1983 (Miller 1983; D. Hanan 1985), are similar to our censuses for those months. The Point Reyes harbor seal population during the breeding season represented 19% of the total estimated California population, excluding the Channel Islands, in 1982 considered to be the largest concentration in the state (Miller 1983). Preliminary analysis of the CDFG survey in 1983 confirms this estimate with a state-wide figure of 9,010 animals in April and 10,763 in June, including an estimated 1852 and 1985 seals, respectively, in Point Reyes (D. Hanan, pers. comm.). Miller calculated an estimate of 1309 pups in California, excluding the Channel Islands, in April 1982. The April 1983 pup count for the state was 642 (D. Hanan pers. comm.). The respective pup estimates calculated by CDFG for Point Reyes were 217 (10% of the total state pup estimate) in 1982 and 157 (25% of the total pup estimate) in 1983. Nearly three-quarters of pups censused by CDFG in Point Reyes in 1983 were at Double Point. The representation of pups at Point Reyes to the state-wide estimate is likely even greater because most pups are born in May rather than April. Consequently, Point Reyes is perhaps even more important as a breeding ground for harbor seals.

Coastal areas accomodated the major portion of migratory animals again in 1983. There was no evidence that estuarine animals shifted to coastal areas to breed. However, a subadult, male seal, rescued from Tomales Bay on 4 March 1984 by the California Marine Mammal Center and released the following day at Point Reyes Headland with a rear flipper tag was identified

by us at Double Point on April 11 and 12, 1984 (L. Amaya, California Marine Mammal Center, Fort Cronkhite, CA., pers. comm.). That the animal arrived at a major coastal haul-out site rather than returning to an estuarine one indicates that the animal was probably familiar with the area. Although seals radio-tagged by Brown and Mate (1983) traveled locally between a coastal haul-out site and estuarine ones, the majority of migrants in the Point Reyes area likely travel from outlying areas. A comparison of aerial surveys conducted by Dohl (1982) in May and January suggested a northward movement of seals from this region to Sonoma and Mendocino Counties in winter. Slater and Markowitz (1983) believed that adult seals dispersed from San Mateo County haul-out sites during the breeding season.

The large influx of animals to coastal areas in Point Reyes during the breeding season is composed primarily of adult seals. The absence of subadult seals during the breeding season also has been documented in other harbor seal populations (Naito and Konno 1979, Slater and Markowitz 1983). Based on our analysis of herd composition at Double Point, adult females may be the primary migrants to the region in April and May. "Nursery" herds in harbor seals have been remarked upon by others (Brown and Mate 1983, Knudtson 1975, Naito and Konno 1979, Slater and Markowitz 1983). In addition, we have documented seasonal breeding site fidelity in females at Double Point where several known females were resighted over successive years. We did not gather information on the sex composition of the herd in June at Double Point; we would expect, though, that males would represent an increasingly larger proportion then because June is the mating season and the onset of molt. The larger number of adult animals at Double Point in

June and July rather than May corroborates this. Thus there may actually be two distinct waves of migrants to rookeries in coastal areas, the first one consisting of mostly pregnant, adult females, and the second one mostly of adult males.

There is little information available for determining whether seal abundance has been increasing in the Point Reyes region. Earlier surveys (Carlisle and Alpin 1966 and 1971, Mate 1977, Risebrough et al. 1978) and data collected at Double Point indicates an increase during the breeding season, but there is no indication that the resident population has changed because summer and winter averages at Double Point have been about the same since 1976. Nevertheless, the rate of expansion in seal numbers at Double Point has not been constant. Instead, 1977 and 1982 are remarkable as years when seal numbers rose substantially and then leveled out during the intervening years. Why these increases occurred is not known.

SUMMARY

1. The optimum time during a day to census seals in Point Reyes is from mid-day to late afternoon at low to medium tides depending upon the physical attributes of each location.

2. Day to day variability in the number of seals at haul-out sites appears to be less during the molt than during the breeding season. We feel a minimum of three successive-day censuses are required for more reliable estimates during the breeding season because of the unpredictable influences of other factors such as human disturbance and extreme weather conditions.

3. Seals should be censused in the first two weeks of May, when pup representation is highest in order to determine an index on the health of the breeding population. A second census in late June or early July, when more adult seals are present at haul-out sites to molt, would provide more reliable estimates for the total population.

4. Annual censuses would provide data for determining trends in abundance. Data at Double Point indicate that the growth rate is not constant.

5. Information on summer and winter movements of breeding animals would be invaluable for any long-term management programs since the breeding population in Point Reyes represents a sizeable proportion of the state population and since these animals migrate from unknown areas. Radio-tagging is the most reliable method for tracking seal movements.

PART B. SEA LIONS

Harriet R. Huber

INTRODUCTION

A two-year survey of the California (Zalophus californianus) and northern (Steller) sea lion (Eumetopias jubatus) populations in the Point Reyes/Farallon Islands National Marine Sanctuary was initiated in March 1982. This survey was designed to determine the size of the Point Reyes sea lion population, its breeding status, seasonal and diurnal fluctuations in haul-out patterns, and how the Pacific herring (Clupea pallasi) run in Tomales Bay affects sea lion numbers along the coast.

Historical information on the Point Reyes sea lion population is sketchy, because identification of the two species was frequently confused during the 1800's. However, both species were present at the Farallones and at Seal Rock in San Francisco, and so presumably they were present at the Point Reyes Headlands as well. During the 1800's northern sea lions apparently bred on the Farallones and California sea lions hauled out in large numbers during the non-breeding season (Allen 1870, Scammon 1874, Allen 1880). In the early twentieth century, mostly northern sea lions occupied what is now Marine Sanctuary waters and only northern sea lions bred there (Everman 1921, Starks 1921, Rowley 1929). California Department of Fish and Game censuses of 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, Carlisle and Alpin

1966, 1971, Frey and Alpin 1970, Ripley et al. 1962) and other censuses (Chan 1979, Dohl 1982, Mate 1977, BLM 1981) are summarized in Allen and Huber 1983, as are the results of the first year of this study (March 1982 to February 1983). These articles describe fluctuations in numbers on the mainland in recent years.

METHODS

We censused California and northern sea lions at the Point Reyes Headlands (Figure 1) twice a month for the first year (March 1982-February 1983) and weekly during the second year (March 1983-February 1984). During both breeding seasons we censused once a week, checking for evidence of births. One census each month lasted from 0700 h to 1800 h to assess sea lion haul-out patterns, to discover when maximum numbers haul out and to determine how seasonal, diurnal and tidal changes affect each species. Some censuses were incomplete because weather (fog, rain, high winds or heat waves) impeded the count. We censused California sea lions at Bodega Rock once a month during the first year and twice a month during the second year. During the herring run in Tomales Bay (December to March) we conducted censuses by boat of California sea lions in the water; nine occurred during the first year and five during in the second year.

All counts of the Point Reyes Headlands were made from Sea Lion Overlook with a 25X spotting scope. In August 1982, a hidden cove containing up to 100 animals was found south of the main haul-out site; from then on we censused regularly from the antenna emplacement 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, we separated both sea lion species into five age and sex classes: adult male, subadult male, female-size, immature, and pup. Adult males were defined as full-grown males with completely developed sagital crests, sub-adult males were animals with the beginnings of a sagital crest, female-size were large immature animals of either sex without evidence of sagital crest (this size also included adult females), immatures were small animals of either sex (yearlings and 2 year olds) and pups were pups of the year (May through December). These categories were fairly easy to distinguish among northern sea lions and all animals of this species described as female were indeed females. With California sea lions almost all female-size animals were, in fact, immature males. If we assume that sex ratios of animals hauled out at Point Reyes are similar to animals hauled out at the Farallones, then the number of females changed from virtually no females in the years prior to 1983 to a proportion of one female to every three males in 1983-84 in the female-size and smaller category. We compared mainland censuses with weekly sea lion censuses from 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 only four age classes: male, female-size, immature, and pup. Males were defined as any animal with a sagital crest.

RESULTS

California sea lions

Major differences in the number of California sea lions present and the seasonal variation in age/sex classes occurred in all three areas during the second year of censusing (March 1983 to February 1984).

The peak number of animals was 763 on 5 August 1983 at the Point Reyes Headlands (Table 11), 1530 on 31 October at Bodega Head (Table 12), and 5570 on 28 July at the Farallones. These counts are all two to three times greater than peak numbers counted in the first year of the study. Up to 116 Zalophus (95% of them immatures) were counted at Double Point between May and August 1983, another indication of increased numbers at Point Reyes. No California sea lions had been seen at Double Point during theprevious seven years (Allen, unpubl. data).

At Bodega Rock the two years were similar with peaks during the spring and fall migration. Numbers during the second year, however, exhibited a third peak coincident with the Tomales Bay herring run (Figure 10). At the other two sites there was less similarity between years. The monthly mean number of California sea lions was significantly larger during the second year from May to August at Point Reyes (Mann-Whitney U-test $p<0.05$) and from July to September at the Farallones (Mann-Whitney U-test $p<0.025$).

At Point Reyes and the Farallones, not only did the number of animals change between the two years but so did the yearly pattern. In the first year there were three peaks at Point Reyes: in March at the beginning of

the southward migration to the breeding rookeries, in early September during the northward migration, and in late December during the herring run in Tomales Bay (Figure 11). In 1983-84, there was one large peak from May to August which began during the southward migration and lasted through the period of the northward migration. This was followed by a much smaller peak coinciding with the herring run in late December (Figure 11). At the Farallones during 1982-83, there were two peaks, which corresponded to the spring and fall migrations (Figure 12). In 1983-84, a peak persisted through the breeding season when there is normally a decline in numbers (Figure 12), similar to the situation at Point Reyes Headlands.

In looking at the proportion of different age classes in the Point Reyes Zalophus population during 1982-83, we found adult males present in large numbers from March through the first week of June, when numbers dropped dramatically. Numbers remained low during the summer breeding season except for a short peak in August. These peaks in the number of adult males coincided with migration to and from southern rookeries and is the same pattern we have found on the Farallones from 1972 to 1982. The pattern for adult males in 1983-84 was quite different. The southward migration peak began earlier (in March) and was essentially completed by mid-May. During the summer of 1983 the actual number of adult male California sea lions was three times larger than in 1982 but the proportion of adult males in the population dropped significantly from about 20% in 1982 to 10% in 1983 (t-test, $p<0.05$). This indicates that the increase in total numbers was due to a tremendous influx of immature animals rather than an equal increase in all age classes.

At the Farallones, where census results for adult and subadult males were combined into a single category, the changes are not quite as clear. The Farallon situation appears to be similar, however, for during the first year the highest monthly mean number of males and the highest proportion of males (over a third of the population) occurred during the same months, May and October. This indicates that peak numbers were the result of males stopping briefly at the Farallones during migration. In 1983-84, the highest monthly means were in June, July, and August, when adult males comprised only 12 to 14% of the population, again indicating that peak numbers in the summer of 1983 were due to higher numbers of immature animals.

During censuses we noted the presence of up to 22 immature California sea lions tagged on the Channel Islands. Ten of these were tagged at San Miguel Island and 12 were tagged at San Nicolas Island.

Northern sea lions

The difference between 1983-84 and the previous year of study was not as distinct with the northern sea lions as with the California sea lions. The northern sea lion population is quite small at both Point Reyes and the Farallones, and the numbers remained essentially the same for the two years. The yearly patterns in both areas were similar: low numbers in fall and winter with a peak during the breeding season (Figure 13, Figure 14). Maximum numbers reached 20 on 8 May at Point Reyes (Table 13) and 141 on 2 June at the Farallones in 1983-84. When comparing the monthly mean numbers we found no significant differences between the two years in either area (Mann-Whitney U-test, $p>0.05$).

Patterns in occurrence of the various age and sex classes differed between years. At Point Reyes, in 1983 adult males arrived three weeks later and remained six weeks longer than in 1982 whereas subadult males arrived earlier and stayed into November. This was three months longer than in 1982, a "normal" year. Immature animals, seen throughout the year in 1982, disappeared in 1983 after the end of August. Adult females were present the entire year (Table 13). These changes at Point Reyes Headlands reflect similar changes on the Farallones.

Two adult females, one adult male, and one subadult male northern sea lion recognizable by distinctive scars were seen on both Point Reyes and the Farallones.

All day watches

Regardless of season, the sea lions exhibited a strong diurnal haul-out pattern, with low counts morning and evening and a sustained peak from 1100 h to 1600 h (Table 14, Table 15). Two other factors affected numbers at Point Reyes as well: tidal and weather conditions. Lower numbers occurred when the haul-out area was reduced by high tides or large swells, as well as on calm hot days when sea lions frequently went into the water.

No pupping or breeding was observed in either species in 1983-84 at Pt. Reyes.

Tomales Bay

During the winter herring run we censused California sea lions in Tomales Bay five times. A peak number of 37 Zalophus were seen on 20

January 1983. Few Zalophus were seen on other censuses. Five percent of all animals seen in December 1983 and January 1984 were adult males compared to 20% in the previous year.

DISCUSSION

It was fortunate that this study took place between 1982-1984, for we were able to document some dramatic changes in the sea lion populations within the Point Reyes/Farallon Islands National Marine Sanctuary. The changes, which we attribute to the effects of warm waters associated with El Nino, include a remarkable three-fold increase in the California sea lion population and a shift in the haul out pattern of age and sex classes in both species.

The warmer than usual water temperature measured at the Farallones (PRBO, unpublished) and throughout the northeast Pacific altered the distribution of fish species and reduced numbers and breeding success of marine birds and mammals in California (Heath and Francis 1983, DeLong pers. comm., Stewart pers. comm., PRBO unpubl.). Both California and northern sea lions are at the edge of their breeding ranges in the Point Reyes/Farallon Islands National Marine Sanctuary, therefore any unfavorable perturbation to food supply such as occurred during El Niño, may have significant effect on local populations. California sea lions breed primarily south of Point Conception with major rookeries at San Miguel and San Nicolas Islands, California, and the islands off Baja California, 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 where up to 27 northern and up to 3 California sea lion pups have been born each year since 1974 (Huber et al. 1985). Ten northern sea lion pups and 3 Zalophus pups were born in 1983 on the Farallones. No cows of either species gave birth on the mainland in 1982 or 1983.

California sea lions

The population of California sea lions has increased throughout its range in the last 50 years; since 1960 the increase has been about 5% each year in California (DeMaster et al. 1982). In the past, only adult and subadult males migrated north, while adult females and juveniles remained near the southern rookeries (Bartholmew 1967). A change in migration pattern was first noted at the Farallones in 1978 when large numbers of immature sea lions began to haul out in the fall. By 1981 the population at the Farallones had tripled. Ainley et al. (1981) proposed that the increase in numbers and in the proportion of immatures at the Farallones was due primarily to changes in the availability of Pacific whiting (Merluccius productus), a primary prey species, 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 to see if similar changes occurred there.

Changes in the Farallon California sea lion population from 1972 to

1984 are summarized in Figure 12. Prior to 1978 there was only one peak (in the spring) at the Farallones. Between 1978 and 1981 the number of Zalophus on the Farallones grew by 15 to 20% each year, a much higher rate than the rest of the state. This growth which was due primarily to immature animals created a second peak (in the fall). The remarkable increase that occurred during the 1983 breeding season was unprecedented, although the numbers for the rest of the 1983 were within normal ranges. Most of the summer increase in both areas was due to large numbers of one to four year old animals, the number of adult males increased to double the number seen the previous year.

The population at Point Reyes (Figure 11) reflected the same trend that we saw on the Farallones 1982-84. During this time, Heath and Francis (1983) reported reduced numbers of breeding animals at the Channel Islands. Apparently many adult Zalophus remained in central California rather than migrating to southern rookeries during the El Nino summer of 1983. We do not know for certain why so many immature sea lions congregated at the Farallones and Point Reyes, but we can speculate that it was likely the result of an altered distribution of prey.

High numbers of California sea lions seen at Bodega Head and Point Reyes Headland during the 1983-84 winter were probably attracted to the herring spawn in Tomales Bay. That this peak was not recorded at Bodega Head in December 1982 (Figure 10) is probably due to the large winter swells which reduced available haul-out area during censuses.

Northern sea lions

At Point Reyes, little change in the numbers of northern sea lions occurred between 1982-83 and 1983-84 despite great changes in the marine environment during the second year. The population on the mainland is quite small and as a result it was difficult to discover what effects, if any, El Nino had. In 1983-84, peak numbers of animals occurred in May, before the breeding season, whereas in 1982-83 the peak occurred in August, after the breeding season. Numbers during the rest of the year were similar (Figure 13).

The mortality of northern sea lion pups born on the Farallones was higher in 1983 than at any time in the last 10 years but that may be related more to a problem of premature pupping in Eumetopias (Huber et al 1984) than to the effects of El Nino. Although numbers during the breeding season in 1982-83 were higher than in 1983-84 (Figure 14), neither year was significantly different from the monthly means during 1972-81 (t-test $p>0.05$).

In fall 1983 the absence of immature northern sea lions and the extended attendance of subadult males at both coastal and off-shore sites may possibly be related to the El Nino conditions and their effect on prey availability.

We suspect that sea lion populations within the Sanctuary will return to pre-1983 numbers and age-class ratios after the widespread residual effects of El Nino recede.

SUMMARY

1. The California sea lion population hauling out at mainland sites in the Point Reyes/Farallon Islands National Marine Sanctuary is comprised primarily of migrating animals. Numbers peaked at 338 in 1982-83 and at 1530 in 1983-84 at the Point Reyes Headlands. The northern sea lion population reached a maximum of 20 animals at Point Reyes. There is some interchange of animals between the Farallon and Point Reyes populations.

2. Neither species gave birth nor bred at Point Reyes from 1982-84. On the Farallones up to three California sea lion pups and up to 27 northern sea lion pups have been born each year since 1974.

3. Peak numbers of Zalophus occurred during the southern spring migration and northern fall migration to and from breeding rookeries in southern California and Mexico. The population peak of Eumetopias occurred during the summer breeding season.

4. Maximum numbers of both species hauled out between 1100 h to 1600 h. Where high tides and large swells decreased the haul out area, the highest numbers were counted when low tides occurred at mid-day. Numbers decreased on hot, calm days when many animals went into the water.

5. A peak in California sea lions on the coast in December corresponded to the herring run in Tomales Bay. A winter peak was not observed at the Farallones.

6. Numbers of California sea lions within the Sanctuary were greatly inflated during 1983-84, due to an influx of immature animals. This was probably related to the warm waters of El Niño; "normal" numbers are probably closer to the results of censuses in 1982-83.

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Table 1. Harbor seal counts for all sites in the Point Reyes region for 1983-84. Census days during which disturbance occurred are noted with an asterisk. Numbers following a slash indicate pups.

		LOCATION											
DATE	Bodega Rock	Tomales Bay	Hog Island	Bird Rock	Tomales Point	Point Reyes	Drakes Estero	Limant. Spit	Double Point	Duxbury Reef	Bolinas Lagoon	Total Pups	Totals
1983													
March 9		146	54	123	123	92	363	0	273	99	64		1337
25		148*	25*	162/1	252	179	414	0	404	41	76	1	1701
31	47												
April 7	12	202/2*	0*	102/1	165	71	209*	0	313/22	101	67/1	26	1242
21	30	189/11*	0	164/13	196/14	92/1	334/19	0	634/128	67	65/3	189	1771
2/3				142	56				104*				
9/10		148/3*	0	163/1	120		322*	0	387/33				
16/17		105/3*	0	55/7*			168/4*	0	250/65				
21									595/144*				
23/24				189/18			485/36*	0	634/107*				
30/1				193/29*					623/167				
May 6		275/45	0	229/42	285/78	25	461/104	141/8	820/241	116	97/17	527	2449
20		169/34*	0	161/48	171/48	fog	218/62*	fog	551/157	122/3	70/10	362	1462
7/8		156/24*		207/38*			480/102*	176/20	716/226*				
12	25												
14/15		89/19*		159/48*			370/90	122/16	267/118*				
21/22	16	152/5*		204/38			249/71*	238/25*	567/173*				
28/29		148/23*		161/17*			83/7*	362/28	335				
June 3		84/2*	0	137/12	70/16	69/1	71/3	340/14	463/48	166/3	67/3	102	1467
16		93/2*	0	229/6*	74/2	50	354/8	150/10	455/103	100/2*	95/2*	135	1600
30		--	-	269/14	122/3	74/1	270/3	350	438/91	85/3	136	115	1894
4/5							69/3*	345/6					
17	15												
18/19									583/20				
25/26		158*		132/13									
30	44												

DATE	Bodega Rock	Tomales Bay	Hog Island	Bird Rock	Tomales Point	Point Reyes	Drakes Estero	Limant. Spit	Double Point	Duxbury Reef	Bolinas Lagoon	Total Pups	Totals
1983 (cont'd)													
July 5		74	0	336	255	68	516	115	747	61	151		2323
18		93	0	315	265	45	422	150	316	118	174		1898
16/17		89*		215									
19	50												
22							410						
30/31							305*	250	353				
Aug 1	22	54*	0	232	131	60	324	207	301	138	122		1591
15		168	0	fog	fog	fog	362	0	51	fog	80		661
29/30		241	0	33	74	35	310	63	13	0	102		871
6/7				215									
13/14		268*							77*				
17	30												
27/28		213		41*			380						
31	2												
Sept 9		--	--	19	84	16	240	0	155	92	54		660
19		134	0	fog	81	46	298	45	50	270	70		994
3/4													
6	21												
18	14*												
24/25				26*			252*	74					
Oct 3		113	0	48	167	65	322	0	34	220	102		1071
17		122	0	38	47	58	137	0	33	254	85		774
15/16									32				
22/23	15	95*									60*		
29/30	35						141	40					
Nov 2		93	0*	51	15	113	415	0	0	235	107		1029
16		136	0	64	163	84	198	48	1	87	74		855
5/6				49									
15	47												
26/27							246*	59					
29	31												

DATE	Bodega Rock	Tomales Bay	Hog Island	Bird Rock	Tomales Point	Point Reyes	Drakes Estero	Limant. Spit	Double Point	Duxbury Reef	Bolinas Lagoon	Total Pups	Totals
1983 (cont'd)													
Dec 1		--	--	30	67	5	243	15	136	79	46		621
15		135	0	46	143	fog	248	24	244	100	38		978
29		150	0	46	59	fog	250	25	283*	104	38		955
3/4				48					142				
17/18		118*											
20	11												
27	49												
28									348*				
31				71*			368	0	281				
1984													
Jan 12		105*	250	63	129	29	313	0	267	45	2		1203
26		226*	0	50	100	70	321	0	285*	76	26		1154
14/15				56*									
17						57							
21/22													
23	35												
28/29							387/1*	0	32*			1	
31						66							
Feb 10		195	0	78	192	83	363	13	395	106	73		1498
24		202	0	60	93	34	286	0	237	91	38		1041
3							206						
8						100							
11/12		188*											
16	54												
18/19													
23		331	0										
25/26				63			250*		303				
28	41												
Mar 17		195	0										
25		100	0										

Table 2. The average number of harbor seals hauled out by season during censuses in the Point Reyes area in 1983-84; $\bar{x}$ 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 Estero.

	LOCATION							
	Tomales Bay	Tomales Point	Point Reyes	Drakes Estero	Double Point	Duxbury Reef	Bolinas Lagoon	All Sites
Breeding								
$\bar{x}$	155.7	337.1	81.5	420.2	501.9	99.7	81.9	1653.4
SE	12.3	31.6	15.9	34.3	32.8	11.7	8.0	121.0
n	16	9	8	17	30	9	9	9
range	84-275	207-514	25-179	168-656	104-832	41-166	64-136	1230-2449
Summer								
$\bar{x}$	138.7	265.6	49.1	393.1	174.3	144.1	100.0	1270.1
SE	19.9	77.4	6.2	41.0	53.7	34.0	12.4	210.6
n	12	8	8	14	14	8	10	8
range	54-268	81-591	16-68	181-631	13-747	61-270	54-174	661-2323
Winter								
$\bar{x}$	193.5	161.0	64.1	304.6	215.8	101.2	49.1	1089.1
SE	84.0	21.9	10.6	16.1	32.2	17.7	11.0	70.1
n	11	9	10	14	15	9	9	8
range	93-355	66-270	5-113	206-415	0-395	44-235	2-107	855-1498

Table 3. Maximum number of harbor seal pups counted at each haul-out site by month in 1982 and 1983.

	LOCATION					
Date	Tomales Bay	Tomales Point	Point Reyes	Drakes Estero	Double Point	Bolinas Lagoon
1982						
April	22	19	1	101	262	0
May	58	135	19	170	263	17
June	23	54	18	60	90	4
1983						
April	11	29	1	36	186	3
May	45	120	0	122	262	17
June	2	28	1	18	103.	3

Table 4. The hourly presence of harbor seals at primary locations in the Point Reyes area on June 16, 1983. Low tide was -.7' at 1032 hr, and high tide was 5.2' at 1803 hr. An asterisk (*) indicates disturbance.

	HOUR											
LOCATION	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
Tomales Bay	91	93	77*	72*	64	81	82	85	77	70	--	--
Bird Rock	133	169	72*	108	173	146	200	234	212	159	148	165
Drakes Estero	151	274	343	370	430	504	491	332	316	218	39	30
Double Point	275	318	325	330	348	375	408	434	455	426	397	212
Duxbury Reef	84	93	95	100	82	54	95	14	0	0	0	0
Bolinas Lagoon	51	65	76	88	91	95	86	87	80	59	43	11
TOTALS	785	1012	988	1068	1188	1255	1362	1186	1140	932	627	418

Table 5. Freeman-Tukey deviates (FT) for the deviation of the observed from the expected for a log-linear model of independence of year, seal location, and seal reproductive status. The numbers given are the total number of seals counted for each zone during each season.

	Coastal	Estuary
1982		
Breeding	9299	7213
F-T	-1.67	1.93
Non-breeding	7957	7592
F-T	1.83	-1.85
1983		
Breeding	8934	5947
F-T	1.73	-2.09*
Non-Breeding	9275	8938
F-T	-1.68	1.73

* F-T deviate is significant at $\alpha = 0.05$.

Table 6. The average monthly number of harbor seals hauled out at Double Point from 1976 to 1984 for adults, subadults, and all age classes combined. Only those censuses when immatures were distinguished were included in the sample; $\bar{x}$ is the mean number of seals, 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	13	15	25	51	52	28	20	15	12	12	9	16
All Age Classes												
$\bar{x}$	128.2	252.2	239.0	372.8	517.9	413.3	397.2	143.6	123.3	82.2	32.7	151.9
SE	26.4	25.4	16.7	25.8	24.4	36.4	29.3	17.2	21.5	21.1	5.2	27.0
Adults												
$\bar{x}$	99.5	204.9	191.9	241.5	304.7	304.3	317.2	97.6	76.7	50.2	22.7	110.5
SE	21.9	21.9	12.7	16.0	16.3	29.6	24.7	15.1	16.9	14.8	5.4	22.3
Subadults												
$\bar{x}$	22.8	41.8	41.5	36.0	36.0	52.5	40.6	19.3	31.4	17.3	4.6	31.6
SE	7.4	6.8	5.4	4.2	3.2	8.8	6.6	3.6	6.4	7.8	1.3	7.0
% Subadult to Total	17.8	16.6	17.4	9.7	7.0	12.7	10.2	13.4	25.5	21.1	14.1	20.8
% Adult to Total	77.6	81.3	80.3	64.8	58.8	73.6	79.9	68.0	62.2	61.1	69.4	72.8

Table 7. The average percentage of sex and age classes of harbor seals at Double Point during the early, middle, and late periods of the breeding season, 1984; $\bar{x}$ is the mean percent of each class, SD is the standard deviation, and n is the sample size.

		CATEGORY				
		Males	Females	Females w/pups	Subadults	Pups
EARLY	$\bar{x}$	29.8	32.6	7.6	26.6	10.2
n = 6	SD	5.5	2.2	9.0	6.5	9.2
MIDDLE	$\bar{x}$	12.8	37.9	32.7	10.0	39.3
n = 7	SD	3.9	3.9	4.2	2.1	6.2
LATE	$\bar{x}$	11.9	37.9	25.3	16.9	32.9
n = 5	SD	3.9	4.0	10.6	8.5	7.2

Table 8. The yearly changes in abundance at Double Point during the breeding season, 1976 to 1984; $\bar{x}$ is the average number of seals censused for the season and n is the sample size. Rate of increase is calculated from $\lambda = \frac{\bar{N}_{t+1}}{\bar{N}_t}$

Year	n	$\bar{x}$	Rate of Increase
1976	14	195.2	
1977	30	304.5	1.6
1978	19	330.1	1.1
1979	10	287.7	0.9
1980	5	318.0	1.1
1981	13	383.8	1.2
1982	33	525.1	1.4
1983	29	512.7	1.0
1984	22	578.3	1.1

Table 9. The daily variability in the number of seals hauled out at Double Point and Bolinas Lagoon during the breeding season, the molt (July), and the end of molt (August).
CV = coefficient of variation. All censuses were taken from 1200-1300 hrs and 1-3 hrs after low tide.

	Breeding CV	Molt CV	Molt end CV
Double Point	.18	.07	.45
Bolinas Lagoon	.44	.24	.30

Table 10. Summary of pupping success of known female harbor seals at Double Point first identified in 1977 or 1982 and observed over the next two years (Siniff et al. 1977). $\bar{x}$ is the average for the two three-year sets.

	YEAR						
PARAMETER	77	78	79	82	83	84	$\bar{x}$
Females seen with pup	14	14	14	16	15	11	
Females seen without pup	2	2	1	2	1	3	
Females not seen in given year	--	0	1	--	2	4	
TOTAL	16	16	16	18	18	18	
Proportion of total with pup	.88	.88	.88	.89	.83	.61	.83
Proportion of those seen in given year that had pup	.88	.88	.93	.89	.94	.79	.89
Proportion not seen in given year	--	0	.06	--	.11	.22	.10

Table 11. Maximum counts of California sea lions at Pt. Reyes Headlands, 1983-84.

Date	Total	Adult Male	Subadult Male	Female Size	Immature	Unidentified
1983						
Mar 5	188	72	46	56	14	
11	201	101	46	44	9	
20	150	62	38	34	16	
31	112	68	25	15	4	
Apr 7	103	44	22	14	23	
12	88	14	56	9	6	
23	211	70	45	39	17	45
May 8	547	20	121	100	16	290
12	662	119	104	265	35	150
18	569	114	156	227	57	128
24	485	120	107	110	13	38
Jun 1	587	150	148	116	130	43
8	584	36	172	38	110	264
23	164	2	16	78	68	
27	428	19	13	75	271	50
Jul 15	389	28	41	46	186	88
22	412	25	45	68	226	48
28	499	40	31	79	310	39
Aug 5	763	52	98	191	96	326
11	595	23	117	206	112	57
19	523	27	103	174	76	143
26	460	13	123	191	38	95
Sep 6	190	15	15	51	47	12
12	420	35	29	69	104	183
23	417	28	108	165	72	44
27	489	27	104	286	45	27
Oct 6	316	18	44	151	31	72
14	368	86	38	116	51	77
19	207	7	28	112	18	42
26	176	7	43	111	15	
Nov 5	128	42	37	30	19	
15	105	27	39	23	16	
21	61	22	21	12	6	

Table 11. (cont'd)

Date	Total	Adult Male	Subadult Male	Female Size	Immature	Unidentified
1983 (cont'd)						
Dec 5	103	30	29	36	8	
15	321	153	97	62	9	
20	262	49	74	126	13	
27	180	106	46	17	11	
1984						
Jan 2	228	116	40	58	14	
13	18	15	2	1		
18	110	67	20	14	9	
26	81	51	10	13	7	
Feb 1	204	79	30	48	49	
14	239	86	30	85	38	
23	304	159	69	47	29	

Table 12. Maximum counts of California sea lions at Bodega Rock, 1983-84.

Date	Total	Adult Males	Unidentified
1983			
Mar 3	198	14	184
Apr 7	84	4	80
21	13	3	10
May 12	529	8	521
22	427	19	408
Jun 17	71	9	62
30	21		21
Jul 19	100	11	89
Aug 1	420	32	388
17	707	15	692
31	781	24	734
Sep 6	864	26	838
18	685	15	670
Oct 22	1270		1270
31	1530		1530
Nov 15	820		
29	635		
Dec 20	1295		
27	1100		
1984			
Jan 23	421		421
Feb 16	684	10	674
28	275		275
Mar 21	135		135

Table 13. Maximum counts of northern sea lions at Pt. Reyes Headlands, 1983-84.

Date	Total	Adult Male	Subadult Male	Female Size	Immature
1983					
Mar 5	3		2	1	
11	5		1	4	
20	4		1	3	
31	3			3	
Apr 7	3		1	1	1
12	1		0	1	0
23	4		2	2	0
30	3		2	1	0
May 8	20	2	7	7	4
12	19	5	9	5	0
18	17	2	6	5	4
24	19	2	6	6	5
Jun 1	11	4	1	1	5
8	9	1	1	4	3
23	9	0	3	4	1
27	16	3	3	7	3
Jul 7	13	2	3	6	2
15	10	0	3	4	3
22	13	1	2	5	5
28	11	1	1	7	2
Aug 5	13	1	3	7	2
11	8	1	2	5	0
19	9	0	3	5	1
26	8	1	3	4	0
Sep 6	3			3	
12	2			2	
23	7		4	3	
27	14		4	9	
Oct 6	6		2	4	
14	4		2	2	
19	1		1		
26	10	1	1	8	
Nov 3	1			1	
5	2			2	
15	2			2	
21	4			1	

Table 13. (cont'd)

Date	Total	Adult Male	Subadult Male	Female Size	Immature
1983 (cont'd)					
Dec 5	2			2	
15	4			4	
20	5		2	3	
27	2			2	
1984					
Jan 2	2			2	
13	1			1	
18	2			2	
26	3			3	
Feb 1	5		1	4	
14	7	1	1	5	
23	5		1		

Table 14. Hourly counts of California sea lions at Pt. Reyes Headlands, 1982-83 and 1983-84.

	1982-83			1983-84		
	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
0700	59.0	17.4	4	66.7	40.6	4
0800	67.2	61.8	9	176.6	160.1	11
0900	91.5	71.6	11	199.4	177.8	12
1000	94.6	72.8	12	216.4	181.4	12
1100	116.5	70.6	13	229.9	156.3	12
1200	121.3	60.5	13	256.0	171.1	12
1300	115.5	66.4	12	260.3	166.1	12
1400	104.4	65.6	13	267.6	184.4	12
1500	102.9	67.4	10	270.1	177.7	11
1600	102.1	71.9	8	248.4	176.1	12
1700	75.4	21.8	7	208.3	179.9	9
1800	69.2	18.5	6	239.6	162.5	5

Table 15. Hourly counts of northern sea lions at Pt. Reyes Headlands, 1982-83 and 1983-84.

	1982-83			1983-84		
	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
0700	1.0	0.0	3	2.2	2.6	4
0800	3.3	2.1	6	3.1	3.4	9
0900	4.1	2.9	8	3.5	5.0	12
1000	6.4	4.8	9	4.0	5.2	12
1100	7.7	3.9	9	4.5	5.1	12
1200	7.5	5.2	10	4.3	4.4	12
1300	7.8	5.6	10	4.4	5.3	12
1400	7.0	4.8	10	4.3	5.4	12
1500	7.3	5.9	9	4.5	5.2	10
1600	7.3	5.7	7	4.4	5.8	10
1700	5.6	4.8	6	3.0	5.0	9
1800	5.2	4.1	6	3.2	4.1	5

FIGURE 1

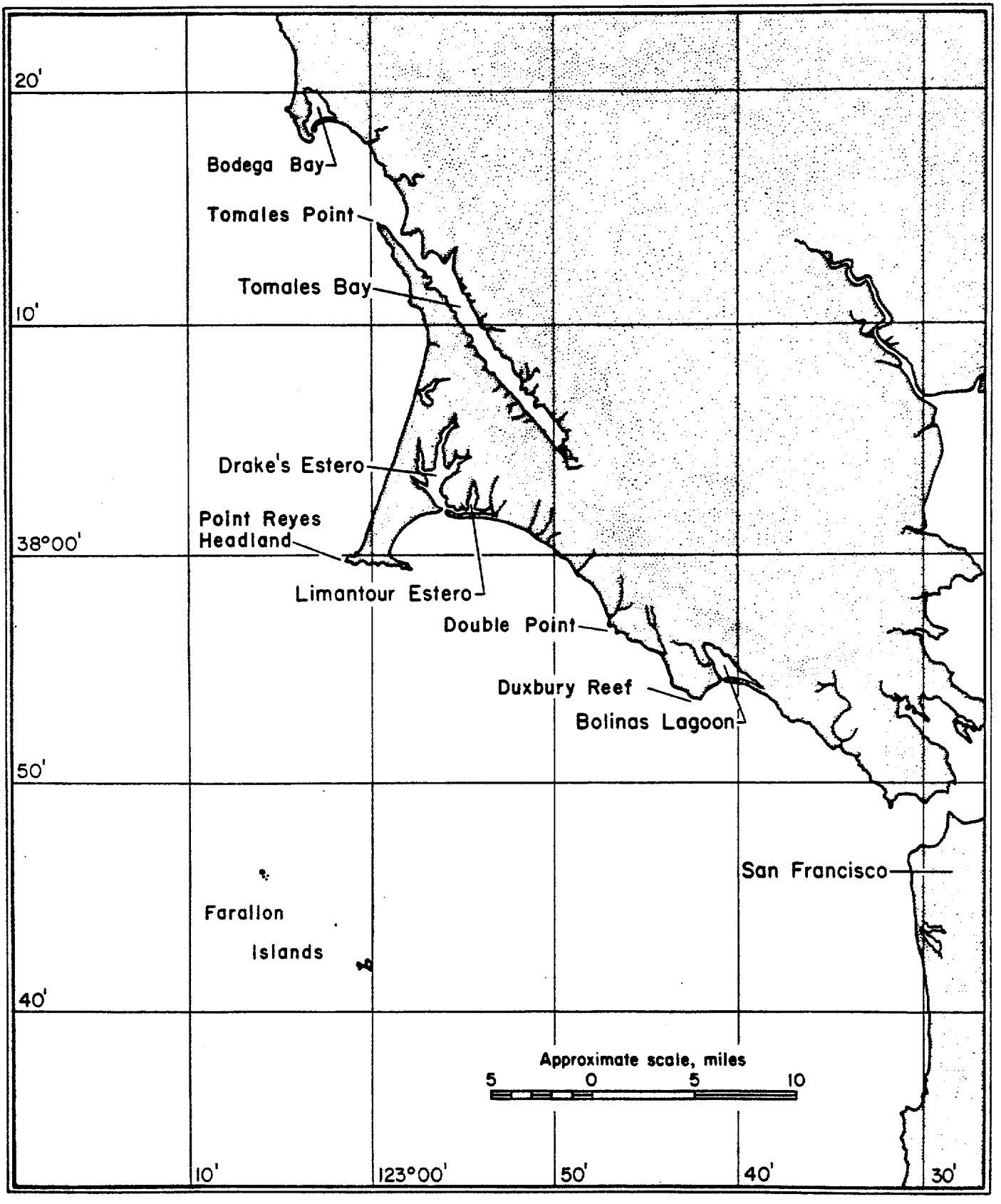
20'
10'
38°00'
50'
40'
Bodega Bay
Tomales Point
Tomales Bay
Drake's Estero
Point Reyes
Headland
Limantour Estero
Double Point
Duxbury Reef
Bolinas Lagoon
San Francisco
Farallon
Islands
Approximate scale, miles
5 0 5 10
10'
123°00'
50'
40'
30'

FIGURE 2

MAXIMUM NUMBER OF HARBOR SEALS BY MONTH POINT REYES, 1983-84

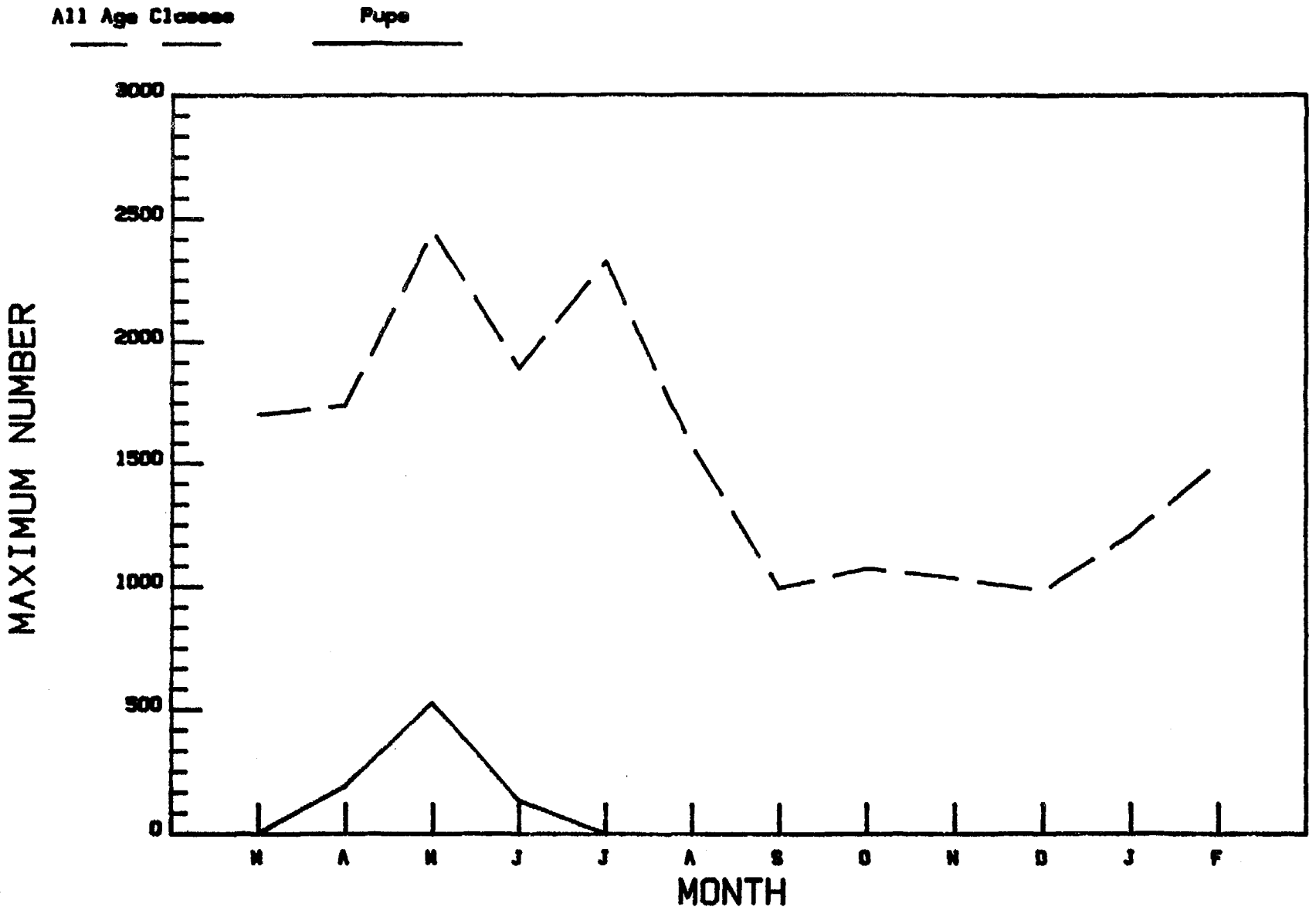

FIGURE 3

Monthly Mean Number of Harbor Seals 1982-84
Tomales Bay

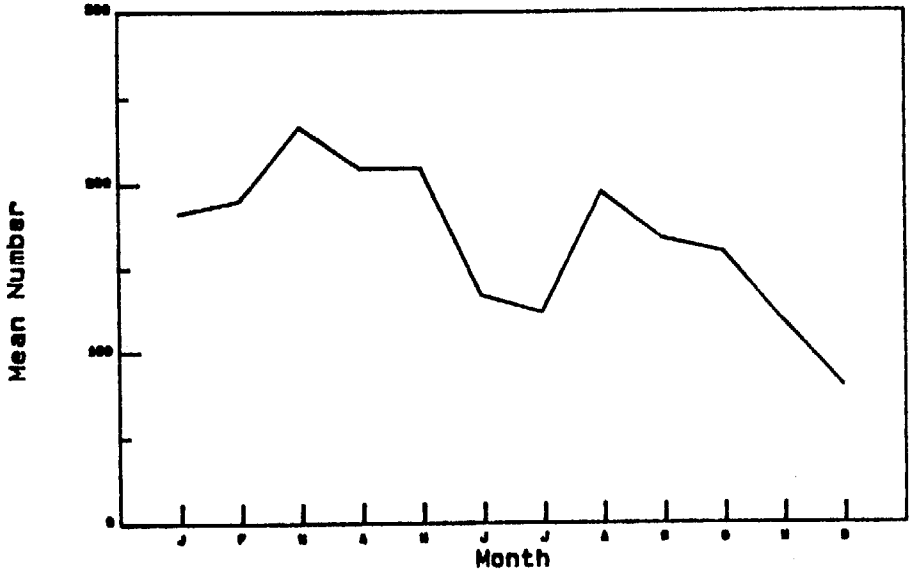

FIGURE 4

Monthly Mean Number of Harbor Seals 1982-84
Tomales Point

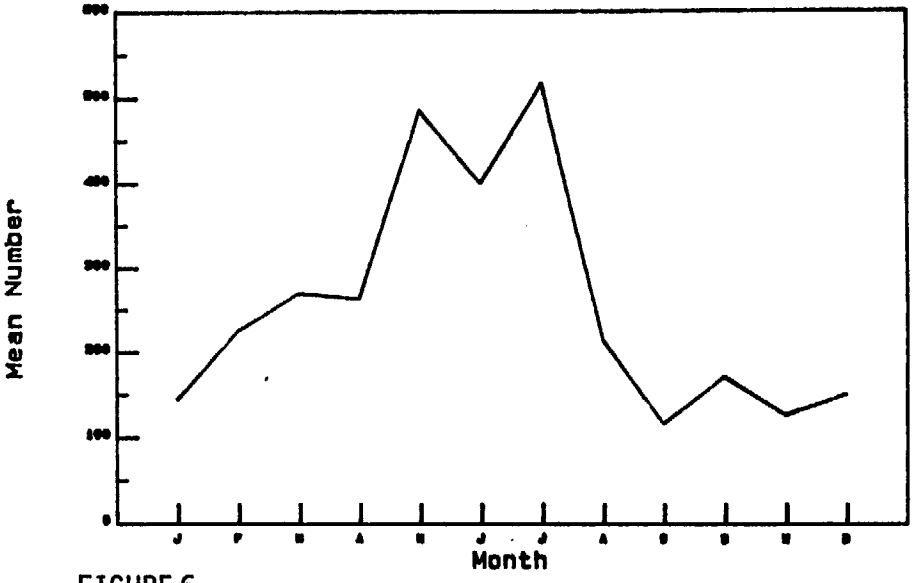

FIGURE 5

Monthly Mean Number of Harbor Seals 1982-84
Point Reyes Headland

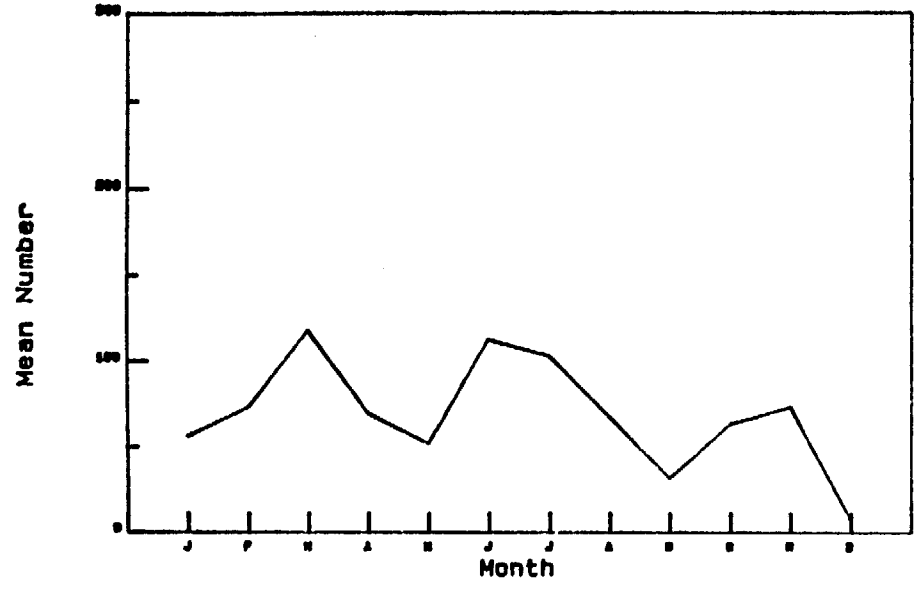

FIGURE 6

Monthly Mean Number of Harbor Seals 1982-84
Drakes Estero

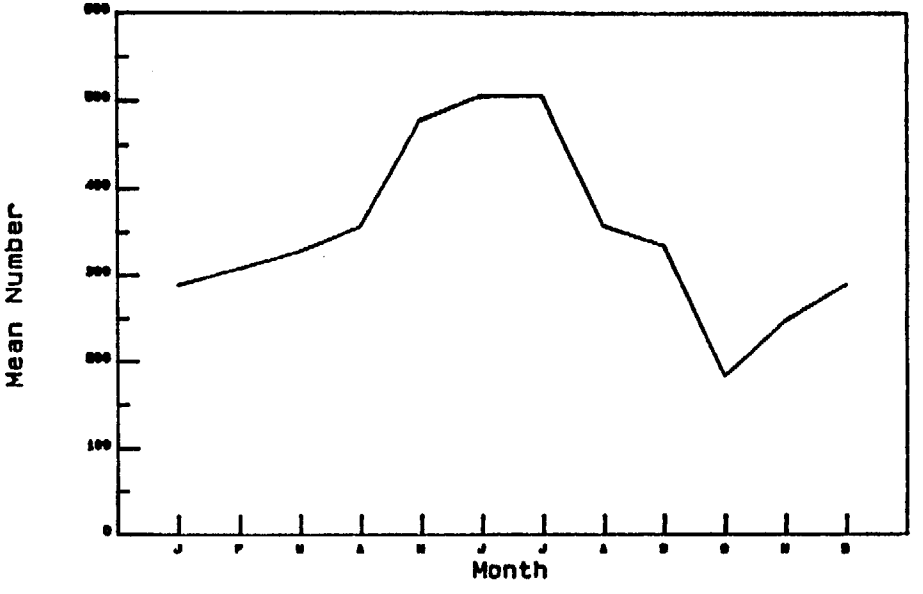

FIGURE 7

Monthly Mean Number of Harbor Seals 1982-84
Duxbury Reef

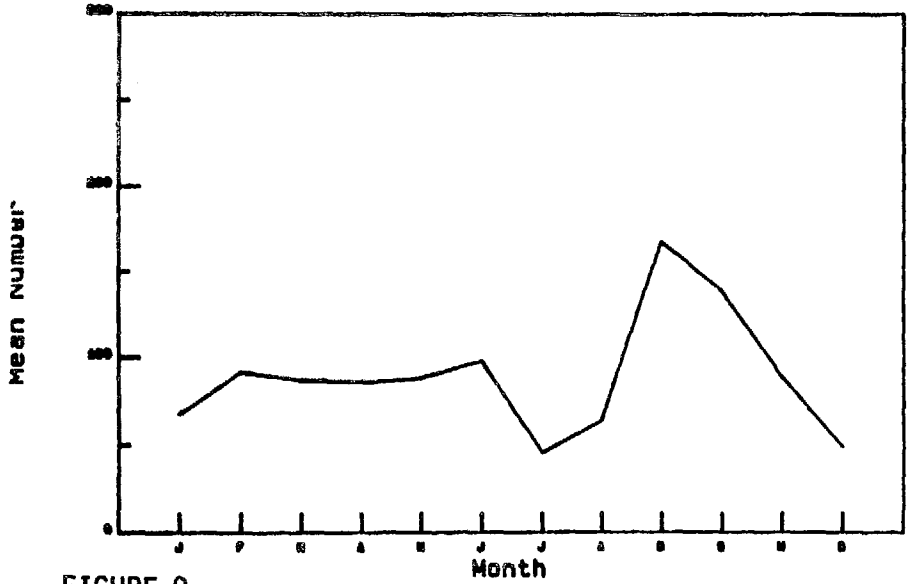

FIGURE 8

Monthly Mean Number of Harbor Seals 1982-84
Bolinas Lagoon

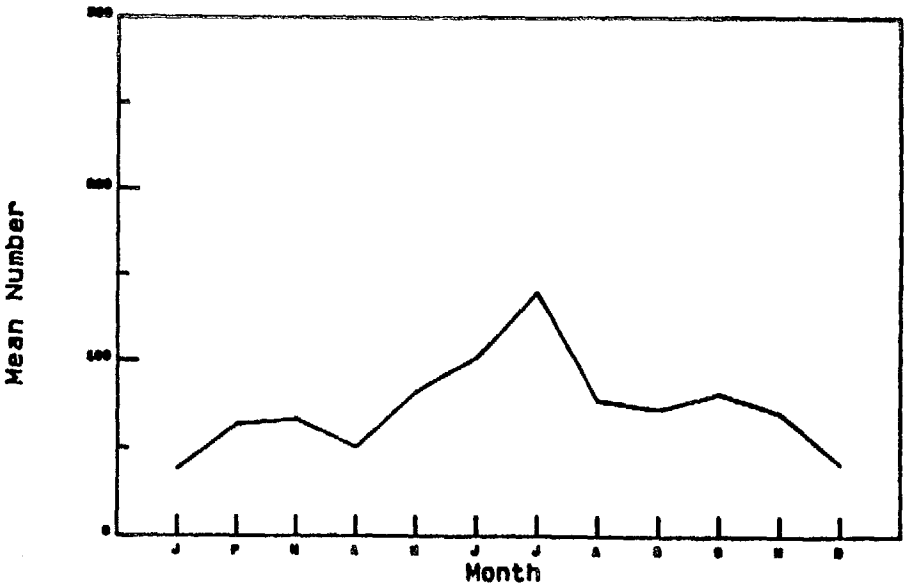

FIGURE 9

Monthly Mean Number of Harbor Seals 1976-84
Double Point

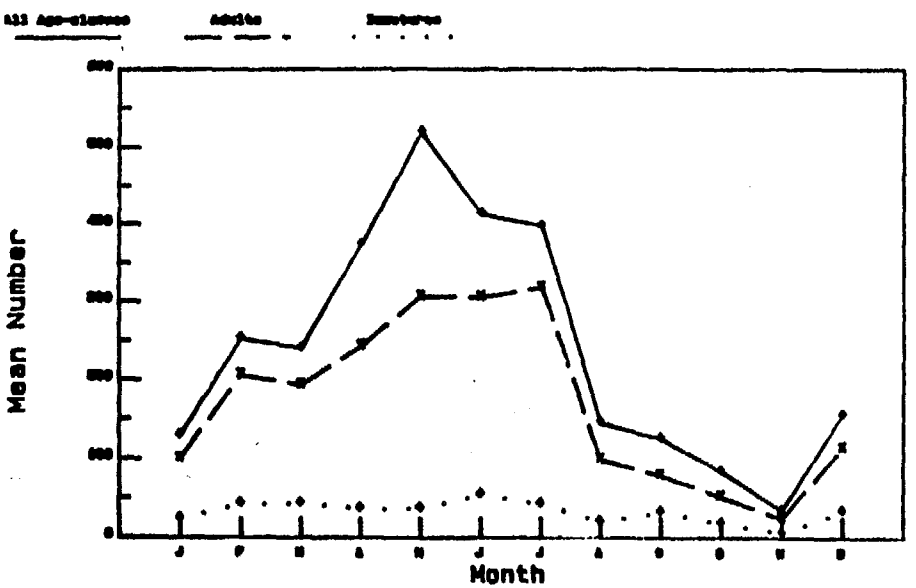

FIGURE 10

MONTHLY MEAN NUMBER OF CALIFORNIA SEA LIONS AT BODEGA ROCK

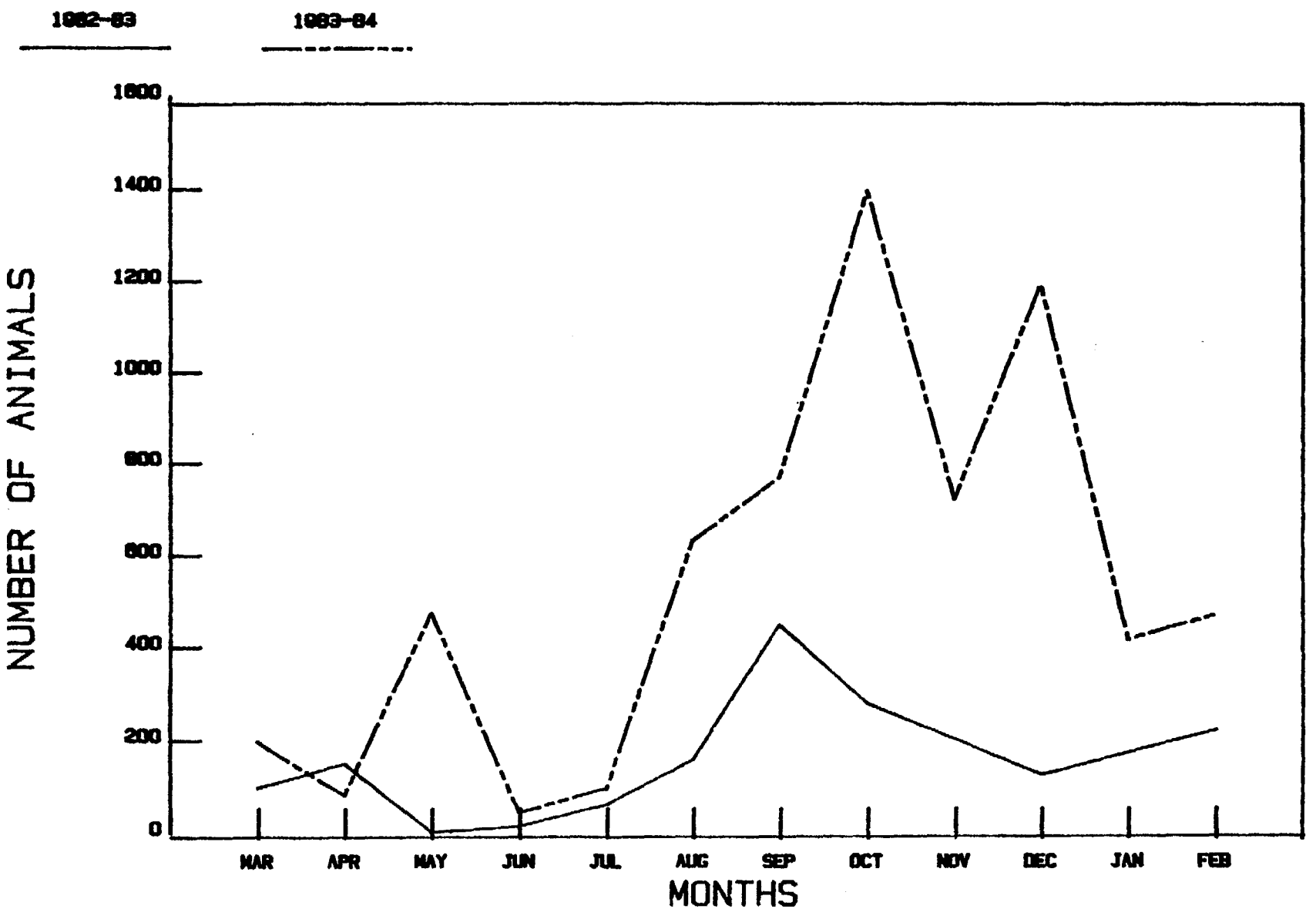

FIGURE 11

MONTHLY MEAN NUMBER OF CALIFORNIA SEA LIONS AT POINT REYES

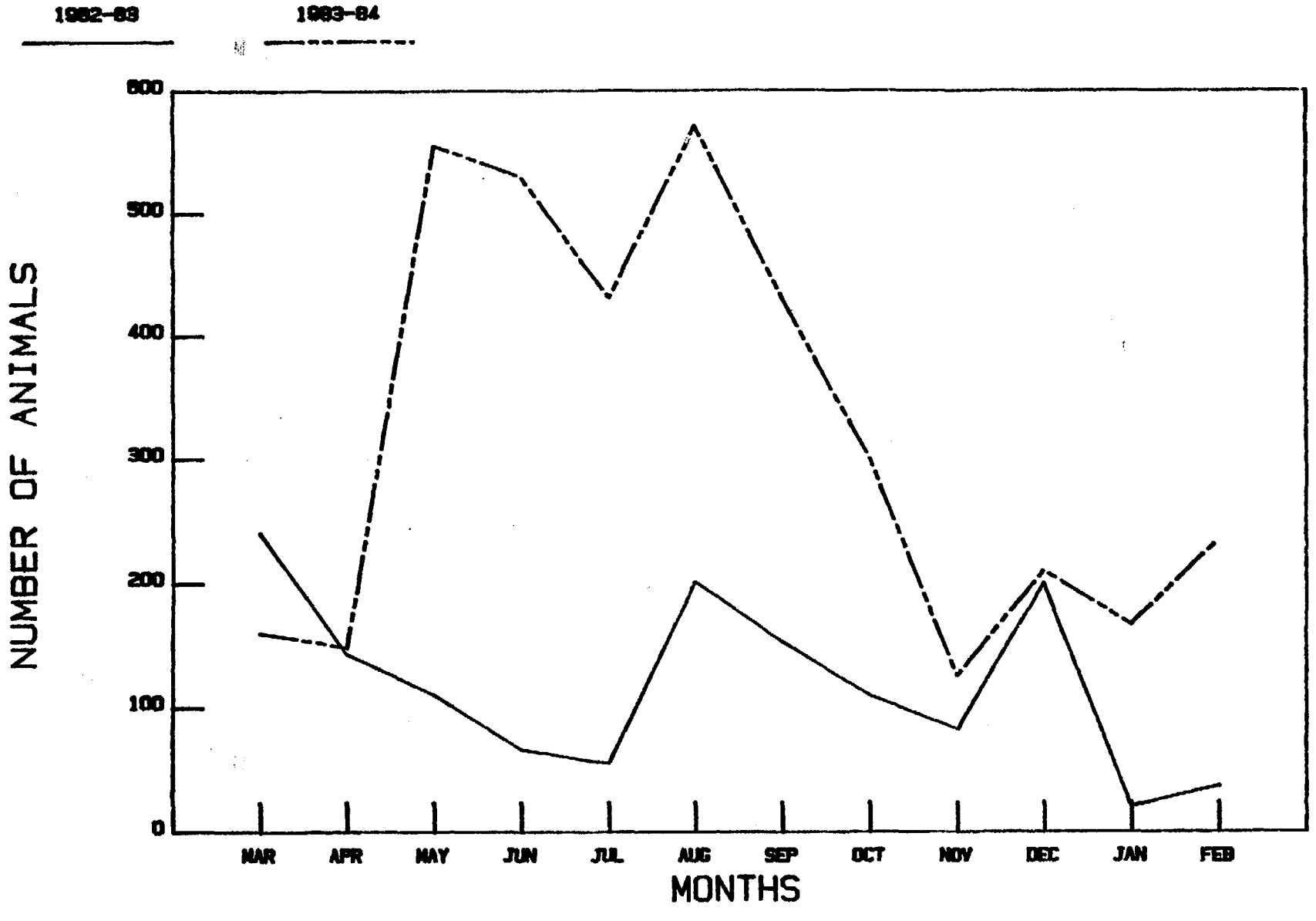

FIGURE 12

MONTHLY MEAN NUMBER OF CALIFORNIA SEA LIONS AT THE FARALLONES

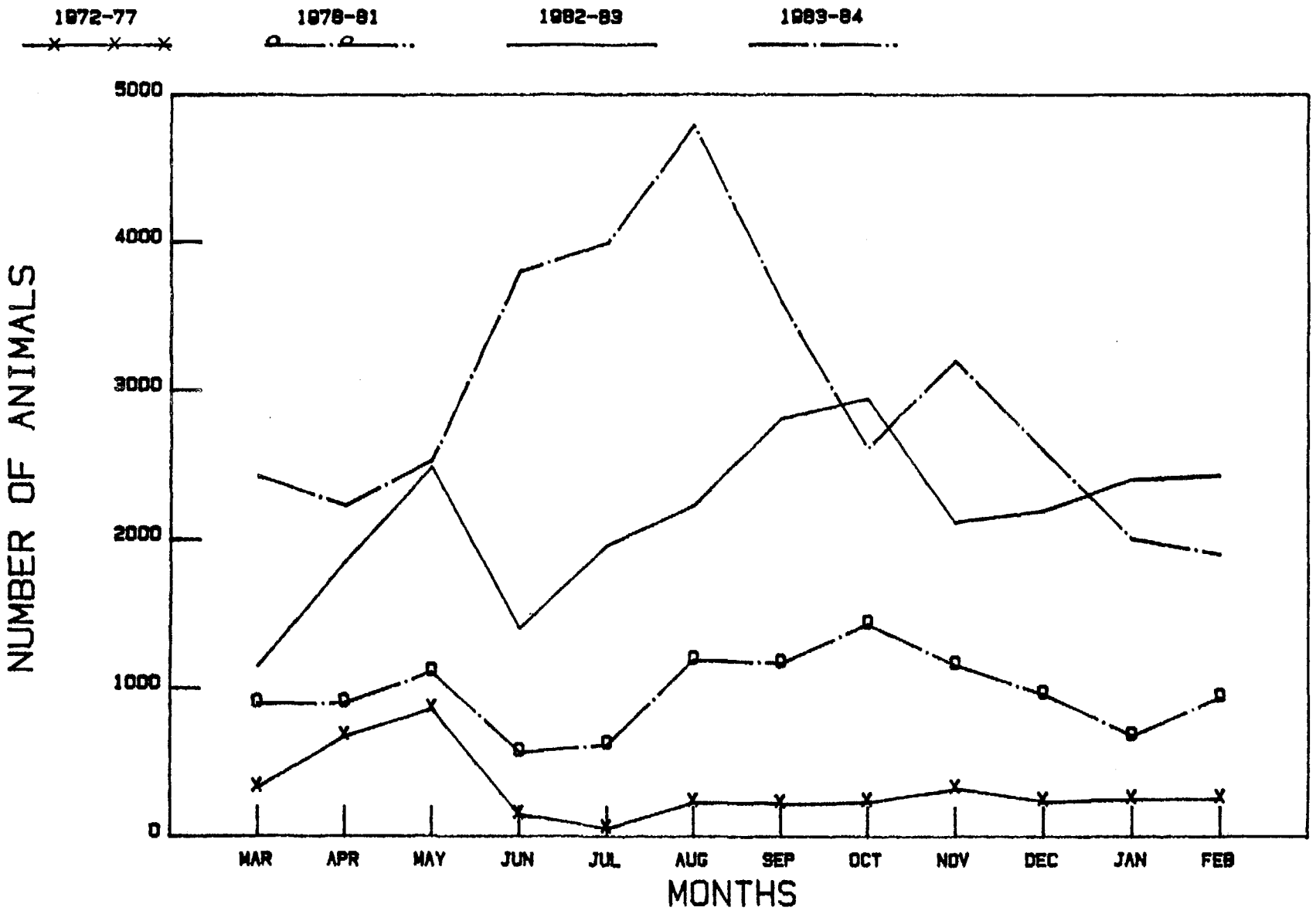

FIGURE 13

MONTHLY MEAN NUMBER OF NORTHERN SEA LIONS AT POINT REYES

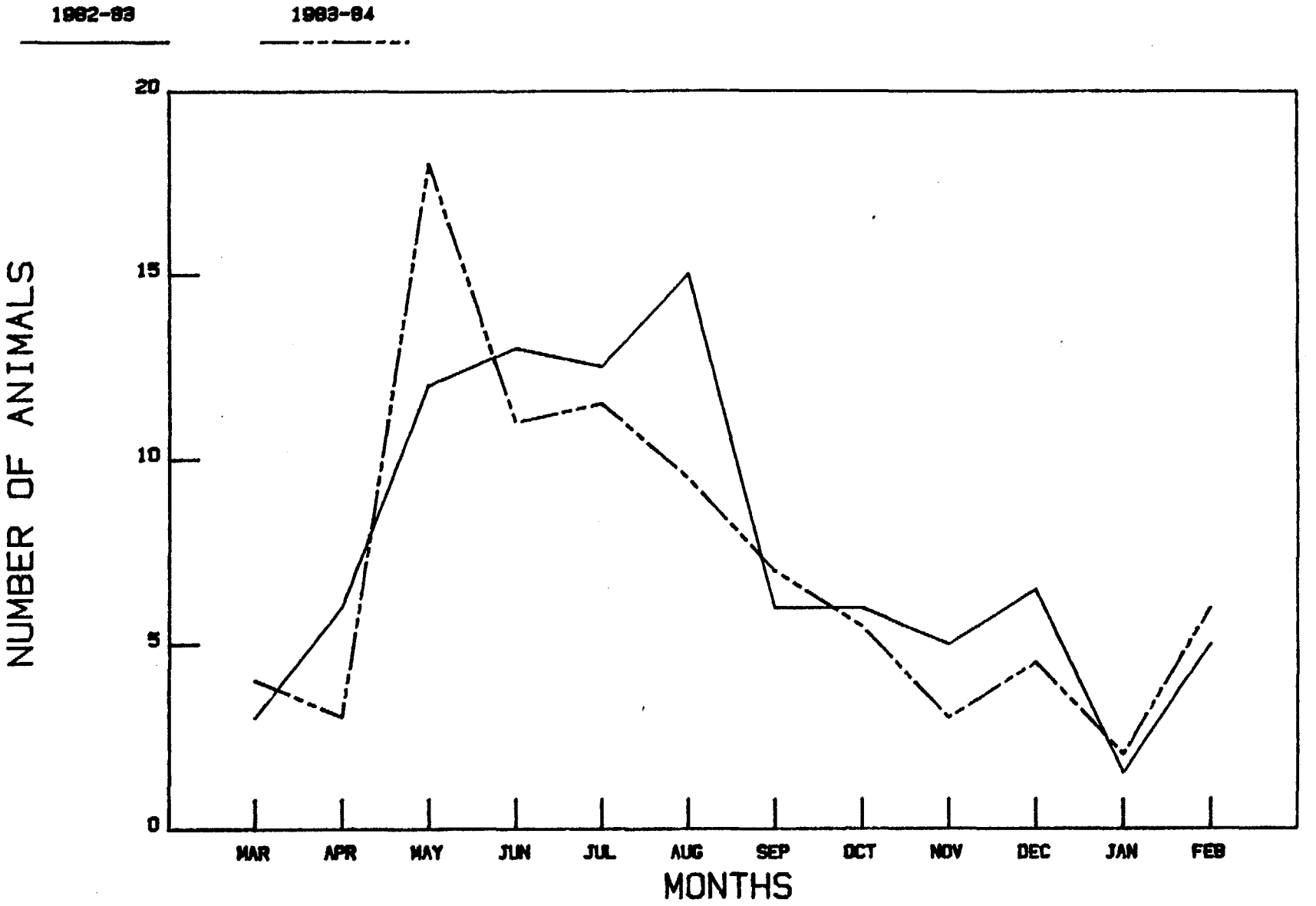

FIGURE 14

MONTHLY MEAN NUMBER OF NORTHERN SEA LIONS AT THE FARALLONES

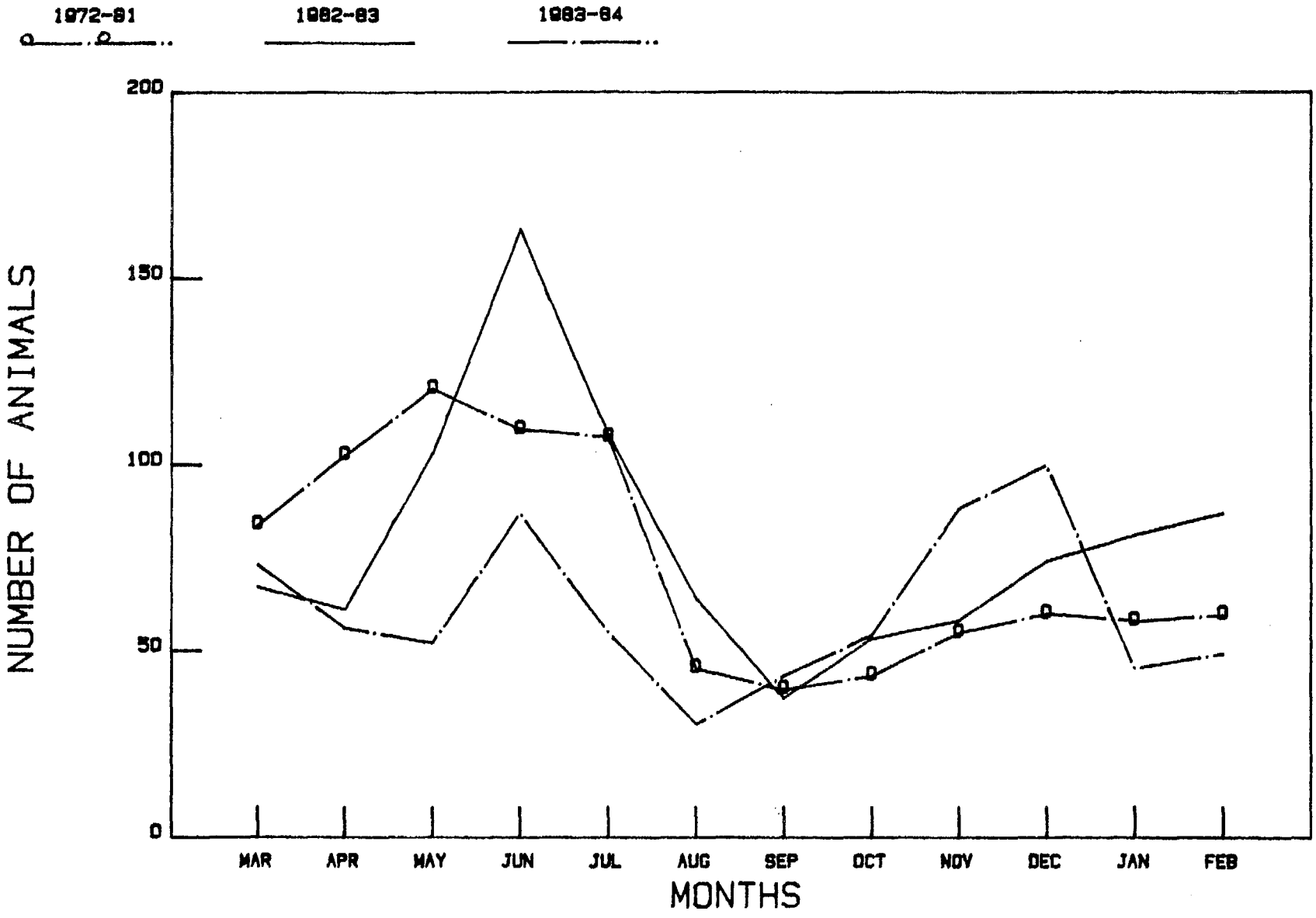

Table 2. The average number of harbor seals hauled out by season during simultaneous censuses in the Point Reyes/Farallon Islands Marine Sanctuary in 1982 - 83; $\bar{x}$ is the mean number of seals, SE is the standard error, and n is the sample size. Tomales Bay includes Hog Island, Tomales Point includes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