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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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ABSTRACT

Northern elephant seals (*Mirounga angustirostris*) at five islands in the Southern California Bight (SCB) were counted during 1981-2001 to monitor status and trends of the population. Counts, stratified by areas within each island, were made during winter breeding season at Santa Barbara Island (1984-2001), San Miguel Island (1985-2001), San Nicolas Island (1988-2001), and Santa Rosa Island (1990-2001) and year-round at San Clemente Island (1981-2001). At Santa Barbara Island the number of births declined at an average annual rate of -4.8 percent from 1984-2001 ($R^2 = 0.20$, slope = -0.05, $P = 0.08$). At San Clemente Island the number of births increased at an average annual rate of 13.4 percent from 1982-2001 ($R^2 = 0.506$, slope = 0.126, $P < 0.001$). At San Miguel Island the number of births increased at an average annual rate of 5.1 percent from 1985-1994 ($R^2 = 0.981$, slope = 0.050, $P < 0.001$) , but declined at -1.9 percent from 1994-2001 ($R^2 = 0.541$, slope = -0.019, $P = 0.096$). At San Nicolas Island the number of births increased at an average annual rate of 7.3 percent from 1988-2001 ($R^2 = 0.887$, slope = 0.070, $P < 0.001$). At Santa Rosa Island the number of births increased at an average annual rate of 41.8 percent from 1990-2001 ($R^2 = 0.928$, slope = 0.349, $P < 0.001$). Births of northern elephant seals in the SCB increased during 1981-2001. Declines in births which occurred in 1986-87 and 1995-98 were probably due to delayed effects of low pup survival during the 1983 and 1992 El Niño's which resulted in fewer adult females being recruited into the adult population.

INTRODUCTION

Northern elephant seals (*Mirounga angustirostris*) were hunted during the 19th century until they were commercially extinct in the mid-1800's (Bartholemew and Hubbs 1960). In 1890 they were found only at Guadalupe Island, Mexico and the population was estimated at that time to be less than 100 animals (Bartholemew and Hubbs 1960). Although some of the last remaining seals were killed for scientific museum collections or were poached (Huey 1930), enough survived until the Mexican government declared them a protected species in 1922 (Hanna 1925). With time, the population at Guadalupe Island increased and expanded its range to other islands in Baja California, Mexico and to islands in the United States. In 1991, the population was estimated to number approximately 127,000 seals with roughly 25% being in Mexico and 75% in the United States (Stewart et al. 1994).

This report summarizes counts of northern elephant seals, obtained, mostly during the winter breeding season, at five islands in the Southern California Bight (SCB, Figure 1). Counts were obtained by biologists on the ground or in a skiff, or from aerial color transparency photographs. These counts provide data for monitoring the status and trends of the elephant seal population in the United States (Boveng 1988, Barlow et al. 1993, 1995, 1997, and Forney et al 2000). Count data have also been used in environmental impact studies (Koski et al. 1998).

Although the National Marine Fisheries Service has the responsibility for managing the population of northern elephant seals, other governmental agencies in southern California have the responsibility of managing the natural resources of islands occupied by elephant seals. These agencies include the Department of the Navy, Channel Islands National Park, and Channel Islands National Marine Sanctuary. These agencies require abundance and distribution data for

each island for managing natural resources at each island under their guardianship. Studies conducted by Bonnell et al. (1978) during 1975-78, Stewart and Yochem (1984) during 1980-82, and Stewart (1989) during 1979-87 provide annual and seasonal information on abundance and distribution of elephant seals at islands managed by these agencies. Counts of northern elephant seals in this report augment previous studies and are stratified by areas within each island. Counts were made during the winter breeding season at Santa Barbara Island (1984-2001), San Miguel Island (1985-2001), San Nicolas Island (1988-2001), and Santa Rosa Island (1990-2001) and year-round at San Clemente Island (1981-2001).

METHODS

Techniques

Various techniques were utilized to obtain counts of northern elephant seals at five of eight islands in the SCB. Seals were counted by biologists on land at San Clemente Island, on land and offshore from skiffs or from aerial photographs at Santa Barbara Island, and from aerial photographs at San Miguel, San Nicolas and Santa Rosa Islands. The rookeries at San Clemente and Santa Barbara Islands are very small, making them suitable for counting by biologists on the ground in a single day. Ground surveys at San Miguel, San Nicolas and Santa Rosa Islands require several days to complete due to their large size, geography, and because of the large number of seals inhabiting these islands. Therefore, aerial photographic surveys were best suited for censussing elephant seals at San Miguel, San Nicolas and Santa Rosa Islands. Aerial photographic surveys were later adopted for censussing elephant seals at Santa Barbara Island

because it cost less to include the island in the aerial photographic survey of San Miguel, San Nicolas and Santa Rosa Islands than it would for biologists to visit the island to conduct a ground census.

Land based counting, using unaided eyes or hand held binoculars, was conducted from atop bluffs, behind naturally occurring structures (i.e., rocks, logs, vegetation, etc.), or by walking amongst or near seals. Offshore counts were made using unaided eyes or hand held binoculars from rigid-hull or inflatable skiffs brought within 10-30 meters of the shoreline. Aerial photographs were taken from an aircraft flying at an altitude between 244 and 366 meters (typically 259 meters), and a ground speed of 166 km/h to 204 km/h (90 to 110 kts).

Aerial photographic equipment

Elephant seals were photographed with a 229-mm-format RC-10 camera mounted in a Cessna 207 aircraft (1985-86) or a 126-mm-format Chicago Aerial Industries, Inc. KA-45A or KA-76 camera which was mounted in a Partenavia PN68C or PN68-observer model aircraft (1987-2001). The KA-45A or KA-76 camera was equipped with a 152 mm focal-length lens and image motion compensation (IMC). The RC-10, KA-45A, or KA-76 camera was mounted vertically inside the belly of the aircraft and operated at a cycle rate that achieved 67% overlap between adjacent frames. Kodak Aerochrome MS Film 2448, a very fine-grained, medium-speed, color transparency film, or Aerochrome HS Film SO-359, a very fine-grained, high-speed, color transparency film, was used.

One survey at Santa Barbara Island was photographed using a hand held 35-mm-format Pentax ME camera equipped with a 80-210 mm zoom lens and Kodak Ektachrome 200 color

transparency film. Photographs were obtained from a side window of the aircraft.

Surveys

At Santa Barbara Island, ground and skiff surveys were conducted during late February or March in 1981-1990 and 1992 (Lowry et al. 1987), and aerial photographic surveys were conducted in late January or February in 1991 and 1993-2001. Late-January or early-February censuses were done opportunistically during aerial photographic surveys of San Miguel, San Nicolas, and Santa Rosa Islands. The mid-to-late February or March surveys were targeted to obtain peak number of pups born before they went to sea. The timing of ground and skiff surveys were impacted also by availability of vessel transportation to and from Santa Barbara Island. In 1991, a 35-mm-format aerial photographic census was conducted opportunistically during a cetacean aerial survey of offshore waters because winter storms made landing on the island from a vessel too dangerous for the ground census.

At San Clemente Island, counts of elephant seals were done opportunistically while collecting food habits data on California sea lion (*Zalophus californianus*). Ground censuses were conducted during most months from 1981-84 and seasonally (January or February, April, July or August, and October) during 1985-2001 at the Southwest Fisheries Science Center (SWFSC) pinniped study area (Figure 2) located between Seal Cove (32E54.5'N, 118E32.2'W) and 1.5 nautical miles south of Mail Point (32E53.4'N, 118E31.1'W; Oliver and Lowry 1987, Oliver et al. 1988, Wexler and Oliver 1988, Oliver 1991a, 1991b, Oliver and Wexler 1991). Because the emphasis was on collecting data on sea lion food habits at San Clemente Island, elephant seals were not always censussed at peak periods for obtaining optimal counts of pups,

nor were they always counted by age/sex class. So few elephant seals were born at San Clemente Island (compared to other islands in the SCB), that their impact on the population was negligible. Aerial photographic surveys of the entire island were conducted during April, July, and October in 1998 and January, April, July in 1999 (Carretta et al. 2000) to document where elephant seals were found outside the SWFSC study area as part of an environmental impact study being conducted by the Department of the Navy.

At San Miguel, San Nicolas, and Santa Rosa Islands, aerial photographic surveys were conducted during late-January and/or February in 1985-2001, 1988-2001, and 1990-2001, respectively (no surveys were conducted in 1997 and 1999; Lowry et al. 1996). Late-January or early-February censuses were targeted when maximum numbers of adults were expected to occupy rookery sites and mid-to-late February censuses were targeted to obtain peak number of pups born.

Counts

Five age/sex class categories of elephant seals were identified: (1) pups, (2) yearlings or juveniles, (3) adult females, (4) subadult/adult males, and (5) seals of unknown age/sex class. In aerial photographs, carcasses of decomposed pups were also counted. The number of births is equal to the sum of live pups, pups of unknown condition, and pup carcasses. Male northern elephant seals that were three to seven years old may have been categorized as adult females because they are the same length (McLaren 1993) and sometimes are difficult to differentiate. These males are generally located along the periphery of harems or at non-breeding sites, but occasionally enter large harems (Le Boeuf 1974, Cox 1983). Le Boeuf (pers. comm. June 1994)

estimates that one percent or less of the aerial photographic count of adult females could be young males. Young males were distinguished from adult females by the presence of the penile opening or proboscis, by no appearance of being parturient, or by their position along the periphery of harems. In a few instances, those that could not be resolved were included in the unknown category, but there were so few of them that they have no affect on the count of other age/sex classes. Adult and subadult males were included within the same category because of the difficulty involved in distinguishing between the two age classes. Elephant seals were not counted by age/sex class at San Clemente Island during 1987-1991, except for January and April 1989.

A photographic light table equipped with a 7-70X zoom binocular microscope was used to illuminate the color transparencies in order to count seals directly from the photographs. A transparent acetate sheet was anchored over the photograph when it contained approximately 10 or more seals. Northern elephant seals were counted with a mechanical hand counter and each was marked on the acetate overlay with a permanent-ink pen (a different color was used for each sex/age class category). The photograph identification number was recorded onto the acetate in case the count had to be reexamined and the counts were recorded onto a data sheet. The marked acetate was then placed on an adjacent photograph corresponding to the exact location of the counted seals. Elephant seals were counted in this manner until the entire rookery was thoroughly inspected and all seals were counted.

Counts were stratified into areas for each island (Figures 2-6). Bureau of Land Management (BLM) codes were used for Santa Barbara Island and Santa Rosa Island (Bonnell et al. 1980). BLM area codes were either too numerous or covered too large an area at San Miguel

Island and San Nicolas Island, therefore, new SWFSC area codes were assigned for these islands. SWFSC area codes for San Miguel Island follow those used by Stewart (1989), with further stratification.

Statistical analysis

Linear regression analysis was used to calculate the average annual rate of increase/decrease for each island by regressing the natural logarithm of births against time. This analysis provided the (1) coefficient of determination (R^2) to describe the variation about the regression line, (2) the slope of the regression line, and (3) the significance level of the slope of the regression line.

Peak-breeding season counts and late-breeding season counts from aerial photographic surveys made within the same year at San Miguel, San Nicolas, and Santa Rosa Islands were made to (1) determine the optimal time period for censussing various age/sex classes during the breeding season and to (2) determine if the count of adult females at peak-breeding season could be used as a substitute for the maximum count of pups which occurs at the end of the breeding season. The following pairs of variables were compared: (1) numbers of peak-breeding season adult females and late-breeding season births, (2) numbers of peak-breeding season births and late-breeding season births, (3) numbers of peak-breeding season subadult/adult males and late-breeding season subadult/adult males, and (4) numbers of peak-breeding season total count and late-breeding season total count. Pairwise correlation analysis with the Bonferroni probability test (using Systat 6.0 for Windows) was used to determine the correlation coefficient and probabilities associated with each correlation coefficient. Paired t-test was used to test

differences between pairs of variables for each island. A randomized block design ANOVA was used to test for differences between pairs of variables for all islands together. The null hypothesis, that there is no difference in counts between peak-breeding season and late-breeding season, was rejected if probabilities were less than or equal to 0.05.

RESULTS

Santa Barbara Island

Northern elephant seals were found predominantly at BLM areas 304-305, 311, and 322 (Table 1, Figure 2). BLM area 311 was the area where the greatest number of pups occurred at Santa Barbara Island until 1998. In 1998-2001 most pups were found at BLM areas 304-305, and 322. The greatest number of pups was counted on 6 March 1989 (106 pups, Figure 7). The fewest numbers of pups were counted during El Niño periods on 26 February 1992 (18 pups) and 13 February 1998 (11 pups). The number of births declined at an average annual rate of -4.8 percent from 1984-2001 ($R^2 = 0.20$, slope = -0.05, P = 0.08).

San Clemente Island

San Clemente Island is the smallest elephant seal rookery in the SCB. Elephant seals were primarily found at Mail Point (Table 2 and 3, Figure 3). The greatest number of seals were found during spring (Figure 8). The fewest number of seals were found during summer and sometimes no animals were present. The greatest number of pups (n = 16) was counted on 3 February 1996, but some years no pups were born at San Clemente Island. The number of births increased at an average annual rate of 13.4 percent from 1982-2001 ($R^2 = 0.506$, slope = 0.126, P

< 0.001).

San Miguel Island

San Miguel Island is the largest northern elephant seal rookery in the SCB. Elephant seals were found along the southern shoreline from Point Bennett (SWFSC area H) to Cardwell Point (SWFSC area A), and along certain sections on the northern shoreline, mainly in SWFSC area J (Table 4, Figure 4). Pup production peaked at 14,838 in 1994 and has declined since then. The number of births increased at an average annual rate of 5.1 percent from 1985-1994 (R^2 = 0.981, slope = 0.050, P < 0.001) , but declined at -1.9 percent from 1994-2001 (R^2 = 0.541, slope = -0.019, P = 0.096) . Through time, fewer elephant seals were counted at Point Bennet (SWFSC area H) on the west end of the island and more were counted at Cardwell Point (SWFSC area A) on the east end of the island. Number of births were significantly different during peak-breeding season and late-breeding season (P = 0.01), with 6.6 percent fewer pups counted during peak-breeding season than were counted during late-breeding season (Table 7). Numbers of adult females during peak-breeding season were correlated with late-season births (r = 0.90, Table 7), but the counts were significantly different (P <0.01) and averaged 9.4 percent less than births in late-breeding season (Figure 9). Counts of subadult and adult males in peak-breeding season were correlated (r = 0.92), but there were 8.3 percent less during late-breeding season.

San Nicolas Island

San Nicolas Island is the second largest northern elephant seal rookery in the SCB. Elephant seals were mainly found along the southern shoreline from SWFSC area A to SWFSC

area K, SWFSC area M and, more recently, in SWFSC area Q (Table 5, Figure 5). The number of pups counted has risen from 3,154 on 15 February 1988 to 9,794 on 11 February 2000. The number of births increased at an average annual rate of 7.3 percent from 1988-2001 ($R^2 = 0.887$, slope = 0.070, $P < 0.001$). Numbers of births were not significantly different during peak-breeding season and late breeding season (P=0.07). Numbers of adult females during peak-breeding season were correlated with late-breeding season births (r = 0.99, Table 7), but the counts were significantly different (P <0.01) and averaged 9.8 percent less than births in late-breeding season. Counts of subadult and adult males in peak-breeding season were correlated (r = 0.90), but there were 5.2 percent less during late-breeding season (Figure 9).

Santa Rosa Island

Santa Rosa Island is now the third largest northern elephant seal rookery in the SCB. Elephant seals were found at the western end of the island, in BLM areas 611 to 613 and 624 to 626 (Table 6, Figure 6). Numbers of pups have increased from 23 on 19 February 1990 to 1,567 on 15 February 2001. Number of births increased at an average annual growth rate of 41.8 percent from 1990-2001 ($R^2 = 0.928$, slope = 0.349, $P < 0.001$). Numbers of births were not significantly different during peak-breeding season and late breeding season (P=0.17). Numbers of adult females during peak-breeding season were correlated with late-season births (r = 1, Table 7), and no significant difference (P = 0.33) was found from births in late-breeding season. The count of subadult and adult males in peak-breeding season were correlated (r = 0.88), but there were 5.8 percent less during late-breeding season (Figure 9).

Peak-breeding season counts and late-breeding season counts

No difference was found between the count of subadult/adult males in peak-breeding season and late-breeding season when San Miguel, San Nicolas, and Santa Rosa Islands were analyzed together (df = 3, F-ratio = 1.76, P = 0.18). However, differences were found between counts of peak-breeding season births and late-breeding season births (df = 3, F-ratio = 4.22, P = 0.01), counts of peak-breeding season adult females and late-breeding season births (df = 3, F-ratio = 8.98, P <0.01), and counts of peak-breeding season total and late-breeding season total (df = 3, F-ratio = 69.39, P < 0.01). Peak-breeding season counts of births underestimated counts of late-breeding season births by 6.6 to 8.4 percent (Table 7). Peak-breeding season counts of adult females at large rookeries underestimated counts of late-breeding season births by 9.4 to 9.8 percent (Table 7). Peak-breeding season total counts of all elephant seals were 31.8 to 39.6 percent greater than late-breeding season total counts.

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DISCUSSION

Births of northern elephant seals in the SCB increased during 1981-2001 (Figure 10). Declines in births that occurred in 1986-87 and 1995-98 were likely due to delayed effects of low pup survival during the 1983 and 1992 El Niño's which resulted in fewer adult females being recruited into the adult population.

A dramatic increase in the number of elephant seals at Santa Rosa Island has occurred coincidental to the decrease in numbers of elephant seals at neighboring San Miguel Island. The number of elephant seals at San Nicolas Island has increased also in recent years, with new beaches being occupied on the north-eastern shore. Cursory examination of photographic images

taken at Point Bennett, San Miguel Island reveals that more California sea lions, *Zalophus californianus*, were present in later years than were present at the beginning of our photographic surveys. It is possible that the increase in the number of sea lions at San Miguel Island is forcing northern elephant seals to seek other localities to give birth.

Counts at peak-breeding season provide the highest count of adults, and counts at late-breeding season provide the greatest count of pups. Using peak-breeding season counts to estimate late-breeding season counts, or vice versa, could lead to gross errors. Caution should be exercised, therefore, when using counts from one part of the breeding season to estimate counts that would be obtained during another part of the breeding season. Also, even though no significant differences were found between peak-breeding season and late-breeding season births at San Nicolas and Santa Rosa Islands, there was a 6.8 percent and 8.4 percent difference in these counts at each island, respectively. This discrepancy is likely due to low power of the statistical test (each test had five or less degrees of freedom), as compared to that of San Miguel Island (with 9 degrees of freedom) where a significant difference between peak-breeding season and late-breeding season count of births was found.

When SWFSC biologists began counting elephant seals in 1982, ground surveys were the preferred technique (Stewart and Yochem 1984, Stewart 1989). In 1985-1986, an SWFSC pilot study determined that elephant seals could be censussed accurately with 229-mm-format aerial color photography. In 1987, SWFSC acquired military-surplus 126-mm-format image-motion-compensated aerial photographic cameras for censussing northern elephant seals and California sea lions, and for conducting studies of cetaceans in the wild. Counts of elephant seals obtained from color transparency photographs taken with the 229-mm-format and 126-mm-format camera

at San Miguel, San Nicolas and Santa Rosa islands were more accurate and precise than ground counts and were better at detecting trends than ground counts (Lowry et al. 1996). It also became apparent that aerial photographic censuses provide a nearly instantaneous look at a population that is spread out over a large geographical area with little, if any, disturbance to pinnipeds and birds, and, that photographs could be re-examined at a later date for further study. Consequently, aerial photographic censuses utilizing a 126-mm-format camera are preferred by SWFSC biologists for obtaining accurate and precise counts of northern elephant seals, as well as for obtaining accurate and precise counts of California sea lions (Lowry 1999) and Steller sea lions, *Eumetopias jubatus* (Westlake et al. 1997, Snyder et al. 2001).

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Table 1. Counts of northern elephant seals obtained at Santa Barbara Island, California, 1984-2001. No elephant seals were observed within other BLM areas.

BLM area code	Pups	Juveniles	Adult females	Subadult and adult males	Total
7-8 February 1984[1]**:** Ground and vessel count					
304-305	12	1	9	2	24
311	68	4	45	4	121
Total	80	5	54	6	145
7-14 March 1985[1]**:** Ground and vessel count					
323	15	0	11	1	27
304-305	1	0	2	0	3
311	73	0	2	2	77
322	4	0	3	0	7
Total	93	0	18	3	114
20 March 1986[1]**:** Ground and vessel count					
304-305	2	0	21	1	24
311	54	4	15	1	74
322	0	0	11	0	11
Total	56	4	47	2	109
3 March 1987: Ground and vessel count					
302	0	2	0	0	2
304-305	1	2	6	2	11
311	70	3	7	1	81
322	4	1	3	2	10
Total	75	8	16	5	104
5 March 1988: Ground count					
302	1	0	1	0	2
304-305	6	1	8	2	17
311	62	2	4	1	69
322	0	0	2	1	3
Total	69	3	15	4	91
6 March 1989: Ground and vessel count					
302	3	0	0	0	3
305	8	2	15	2	27
310, 311	79	5	5	1	90
322	16	0	1	0	17
Total	106	7	21	3	137
1 March 1990: Ground and vessel count					
304-305	7	0	11	1	19
311	55	0	2	1	58
322	7	1	0	0	8
Total	69	1	13	1	84

Table 1. (Continued)

BLM area code	Pups	Juveniles	Adult females	Subadult and adult males	Total
23 March 1991: 35-mm-format aerial photographs					
304-305	3	0	35	0	38
311	34	0	50	1	85
322	8	1	22	0	31
Total	45	1	107	1	154
26 February 1992: Ground and vessel count					
304-305	1	0	7	2	10
309	0	0	0	1	1
311	17	0	5	2	24
322	0	0	1	2	3
317	0	0	0	1	1
Total	18	0	13	8	39
29 January 1993: 126-mm-format aerial photographs					
302	0	0	0	1	1
305	30	0	41	2	73
309	0	0	6	2	8
311	5	0	32	1	38
317	0	0	1	1	2
322	18	0	29	2	49
Total[2]	53	0	109	9	171
15 February 1993: 126-mm-format aerial photographs					
304-305	6	0	3	5	14
309	0	0	0	1	1
311	26	0	15	3	44
323	0	0	0	3	3
317	0	0	0	1	1
322	2	0	3	1	6
Total[2]	34	0	21	14	69
13 February 1994: 126-mm-format aerial photographs					
303, 304-305	13	0	22	12	47
309	0	0	0	1	1
311,312	22	0	12	3	37
317	0	0	0	1	1
322	12	0	11	4	27
Total[2]	47	0	45	21	113

Table 1. (Continued)

BLM area code	Pups	Juveniles	Adult females	Subadult and adult males	Total
28 January 1995: 126-mm-format aerial photographs					
303, 304-305	11	0	41	7	59
309	2	0	4	6	12
311	15	0	65	1	81
323	0	0	0	2	2
322	0	0	3	2	5
Total[2]	28	0	113	18	159
15 February 1995: 126-mm-format aerial photographs					
303, 304-305	14	0	23	6	63
309	2	0	2	1	5
311	11	0	26	1	38
322	0	0	0	2	2
Total[2]	27	0	51	10	88
29 January 1996: 126-mm-format aerial photographs					
304-305	21	0	41	10	72
309	1	0	2	1	4
311	28	0	39	1	68
318	0	0	0	1	1
322	20	0	33	1	54
Total	70	0	115	14	199
23 February 1996: 126-mm-format aerial photographs					
304-305	19	0	4	3	26
309	0	0	1	1	2
311	13	0	5	1	19
322	2	0	3	1	6
Total	34		13	6	53
13 February 1998: 126-mm-format aerial photographs					
305	0	0	0	6	6
309	0	0	0	1	1
311	1	0	6	1	8
322	10	0	29	2	41
Total	11	0	35	10	56
11 February 2000: 126-mm-format aerial photographs					
302	0	0	0	1	1
305	22	0	19	2	43
311	13	0	10	1	24
322	32	0	27	1	60
Total	67	0	56	5	128

Table 1. (Continued)

BLM area code	Pups	Juveniles	Adult females	Subadult and adult males	Total
16 February 2001: 126-mm-format aerial photographs					
304	6	0	5	1	12
311	5	0	4	2	11
322	39	0	24	1	64
Total	50	0	33	4	87

[1]Lowry et al. 1987
[2]Lowry et al. 1996

Table 2. Counts of northern elephant seals from ground surveys conducted within the Mail Point/North Mail Point SWFSC pinniped study area (BLM areas 406 [northern half] and 407) at San Clemente Island, California, 1981-2001. Unless noted, no elephant seals were observed within BLM area 407.

Date	BLM Area	Pups	Yearlings and juveniles	Adult females	Subadult and adult males	Unknown or undetermined	Total
18-19 Aug 1981[1]	406 [north]	0	0	0	0	0	0
9-11 Sep 1981[1]	406 [north]	0	0	0	0	0	0
14-15 Oct 1981[1]	406 [north]	0	12	0	0	3	15
13-17 Nov 1981[1]	406 [north]	0	16	0	0	0	16
19-21 Jan 1982[1]	406 [north]	1	3	4	1	0	9
27-29 Jan 1982[1]	406 [north]	3	2	5	2	0	12
3-5 Feb 1982[1]	406 [north]	4	2	5	3	0	14
9-11 Feb 1982[1]	406 [north]	3	1	4	2	0	10
23-24 Mar 1982[1]	406 [north]	0	0	3	3	3	9
27-29 Apr 1982[1]	406 [north]	1	0	0	0	47	48
13-14 May 1982[1]	406 [north]	0	0	0	0	39	39
26-28 May 1982[1]	406 [north]	0	10	0	5	0	15
11-14 Jun 1982[1]	406 [north]	0	3	0	0	4	7
30 Jun 1982[1]	406 [north]	0	1	0	0	0	1
13-14 Jul 1982[1]	406 [north]	0	0	0	0	0	0
27-29 Jul 1982[1]	406 [north]	0	0	0	0	0	0
20-23 Aug 1982[1]	406 [north]	0	0	0	0	0	0
15-20 Sep 1982[1]	406 [north]	0	4	0	0	0	4
2-5 Nov 1982[1]	406 [north]	0	17	0	0	1	18
28-30 Dec 1982[1]	406 [north]	0	15	0	0	0	15
24-28 Feb 1983[2]	406 [north]	0	0	0	0	0	0
17-21 Mar 1983[2]	406 [north]	0	3	4	0	0	7
14-18 Apr 1983[2]	406 [north]	0	44	0	0	0	44
12-16 May 1983[2]	406 [north]	0	36	0	0	0	36
23-27 Jun 1983[2]	406 [north]	0	1	0	0	0	1
21-25 Jul 1983[2]	406 [north]	0	0	0	0	0	0
18-22 Aug 1983[2]	406 [north]	0	0	0	0	0	0
15-19 Sep 1983[2]	406 [north]	0	5	0	0	0	5
3-7 Nov 1983[2]	406 [north]	0	11	0	0	0	11
15-19 Dec 1983[2]	406 [north]	0	19	0	0	0	19
19-23 Jan 1984[3]	406 [north]	2	12	2	6	0	22
23-27 Feb 1984[3]	406 [north]	3	1	1	0	0	5
23-26 Mar 1984[3]	406 [north]	3	5	4	0	1	13
3-7 May 1984[3]	406 [north]	0	45	1	0	7	53

Table 2. (Continued)

Date	BLM Area	Pups	Yearlings and juveniles	Adult females	Subadult and adult males	Unknown or undetermined	Total
14-18 Jun 1984[3]	406 [north]	0	0	0	0	1	1
20-23 Jul 1984[3]	406 [north]	0	0	0	0	0	0
19-24 Sep 1984[3]	406 [north]	0	7	0	0	8	15
16-19 Nov 1984[3]	406 [north]	0	15	0	0	0	15
11-14 Jan 1985[4]	406 [north]	0	20	0	2	0	22
8-11 Mar 1985[4]	406 [north]	2	2	1	0	0	5
7-10 Jun 1985[4]	406 [north]	0	3	0	0	4	7
2-5 Aug 1985[4]	406 [north]	0	0	0	0	0	0
5-9 Sep 1985[4]	406 [north]	0	3	0	0	0	3
28-31 Mar 1986[5]	406 [north]	1	19	0	0	4	24
12-13 Jun 1986[5]	406 [north]	0	0	0	0	0	0
25-28 Jul 1986[5]	406 [north]	0	1	0	0	0	1
12-15 Sep 1986[5]	406 [north]	0	0	2	0	0	2
17-18 Mar 1987[5]	406 [north]	1	2	1	0	0	4
1-3 Aug 1987[5]	406 [north]	0	0	1	0	1	2
16-18 Oct 1987[5]	406 [north]	0	0	0	0	31	31
20 Feb 1988[6]	406 [north]	0	0	0	0	0	0
16 Apr 1988[6]	406 [north]	0	0	0	0	88	88
30 Jul 1988[6]	406 [north]	0	0	0	0	0	0
15 Oct 1988[6]	406 [north]	0	1	0	0	48	49
7 Jan 1989[6]	406 [north]	0	12	0	0	2	14
15 Apr 1989[6]	406 [north]	0	81	0	0	0	81
22 Jul 1989[6]	406 [north]	0	0	0	0	0	0
14 Oct 1989[6]	406 [north]	0	0	0	0	30	30
6 Jan 1990[6]	406 [north]	0	0	0	0	11	11
7 Apr 1990[6]	406 [north]	0	0	0	0	57	57
21 Jul 1990[6]	406 [north]	0	0	0	0	0	0
14 Oct 1990[6]	406 [north]	0	0	0	0	35	35
13 Jan 1991[6]	406 [north]	3	0	0	0	13	16
	407	0	0	0	0	1	1
	Total	3	0	0	0	14	17
27 Apr 1991[6]	406 [north]	0	0	0	0	206	206
	407	0	0	0	0	2	2
	Total	0	0	0	0	208	208
14 Jul 1991[6]	406 [north]	0	0	0	0	0	0
27 Oct 1991[6]	406 [north]	0	0	0	0	59	59
18 Jan 1992	406 [north]	0	4	3	0	0	7

Table 2. (Continued)

Date	BLM Area	Pups	Yearlings and juveniles	Adult females	Subadult and adult males	Unknown or undetermined	Total
27 Jan 1992	406 [north]	3	1	0	0	0	4
25 Apr 1992	406 [north]	0	0	0	0	125	125
25 Jul 1992	406 [north]	0	0	0	0	0	0
24 Oct 1992	406 [north]	0	49	0	0	0	49
22 Jan 1993	406 [north]	2	12	3	2	0	19
18 Apr 1993	406 [north]	0	1	0	0	72	73
24 Jul 1993	406 [north]	0	0	0	0	0	0
30 Oct 1993	406 [north]	0	34	0	0	0	34
23 Jul 1994	406 [north]	0	0	0	0	1	1
6 Oct 1994	406 [north]	0	0	0	0	31	31
22 Feb 1995	406 [north]	12	1	3	5	0	21
26 Apr 1995	406 [north]	0	30	12	0	0	42
15 Aug 1995	406 [north]	0	0	0	0	1	1
3 Feb 1996	406 [north]	16	0	15	3	0	35
20 Apr 1996	406 [north]	2	47	11	0	0	60
13 Jul 1996	406 [north]	0	0	0	2	0	2
13 Oct. 1996	406 [north]	0	15	0	0	0	15
14 Oct. 1996	407	0	1	0	0	0	1
	Total	0	16	0	0	0	16
29 Jan 1997	406 [north]	12	1	18	2	0	33
9 Apr 1997	406 [north]	1	34	13	0	0	48
16 Jul 1997	406 [north]	0	0	0	1	0	1
8 Oct 1997	406 [north]	0	4	6	0	0	10
27 Jan 1998	406 [north]	14	2	17	1	0	34
14 Apr 1998[7]	407	1	0	0	0	0	1
15 Apr 1998[7]	406 [north]	4	60	15	0	0	79
	Total	5	60	15	0	0	80
18 Jul 1998[7]	406 [north]	0	0	0	0	0	0
24 Oct 1998[7]	406 [north]	0	7	13	0	0	20
30 Jan 1999[7]	406 [north]	6	3	13	1	0	23
21 Apr 1999[7]	406 [north]	0	0	0	0	60	60
14 Jul 1999[7]	406 [north]	0	0	0	0	0	0
12 Jan 2000	406 [north]	2	51	7	0	0	60
12 Apr 2000	406 [north]	0	56	12	0	0	68
26 Jul 2000	406 [north]	0	0	0	0	0	0

Table 2. (Continued)

Date	BLM Area	Pups	Yearlings and juveniles	Adult females	Subadult and adult males	Unknown or undetermined	Total
18 Oct 2000	406 [north]	0	32	0	0	0	32
	407	0	1	0	0	0	1
	Total	0	33	0	0	0	33
17 Jan 2001	406 [north]	11	18	17	1	0	47
	407	0	0	0	1	0	1
	Total	11	18	17	2	0	48
18 Apr 2001	406 [north]	6	10	110	0	0	126
17 Jul 2001	406 [north]	0	1	0	0	0	1

[1]Oliver and Lowry 1987
[2]Oliver et al. 1988
[3]Wexler and Oliver 1988
[4]Oliver and Wexler 1991
[5]Oliver 1991a
[6]Oliver 1991b
[7]Carretta et al. 2000

Table 3. Northern elephant seals counted from126-mm-format aerial color photographs taken at San Clemente Island, California (Carretta et al. 2000). Unless noted, no seals were sighted at other BLM areas during the aerial photographic survey.

Date	BLM Area	Pups	Yearlings and juveniles	Adult females	Subadult and adult males	Unknown or undetermined	Total
13 Apr 1998	404	0	1	0	0	0	1
	411	0	3	0	0	0	3
	406	8	53	22	0	0	83
	Total	8	57	22	0	0	87
26 Jul 1998	411	0	1	0	0	0	1
11 Oct 1998	411	0	0	1	0	0	1
	406	0	9	14	0	0	23
	Total	0	9	15	0	0	24
15 Jan 1999	406	1	15	5	0	0	21
23 Apr 1999	406	4	51	29	0	0	84
10 Jul 1999	Island	0	0	0	0	0	0

Table 4. Counts of northern elephant seals at San Miguel Island, California, 1985-2001. Counts were obtained from 229-mm-format (1985-1986) and 126-mm-format (1988-2001) aerial color transparency photographs

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
31 January 1985[1,3]							
Total	9,102	71		8,748	1,512	0	19,433
22 February 1985[1,3]							
Total	9,585	80		1,241	1,308	0	12,214
1 February 1986[1,3]							
Total	9,622	71		8,651	1,607	0	19,951
21 February 1986[1,3]							
Total	9,555	67		1,338	1,410	0	12,370
1-2 February 1987[2]							
E	776	5	0	837	89	0	1,707
F	1,002	21	0	1,118	146	0	2,287
G	1,778	26	0	1,955	235	0	3,994
H	4,840	84	0	5,473	969	0	11,366
1 February 1988							
A	121	1	0	136	63	0	321
B	143	5	0	126	29	0	303
C	1,900	18	1	1,932	169	0	4,019
D	475	3	0	455	78	0	1,011
E	819	12	0	876	94	0	1,801
F	746	10	0	722	101	0	1,579
G	1,012	15	0	1,067	107	0	2,201
H	4,852	104	1	4,880	1,057	0	10,894
I	0	0	0	0	0	0	0
J	78	0	1	72	7	0	158
K	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0
Total[1]	10,146	168	3	10,266	1,705	0	22,288

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
15 February 1988							
A	219	1	0	119	56	0	395
B	198	5	0	78	30	0	311
C	1,933	23	0	881	160	0	2,997
D	529	4	0	234	63	0	830
E	1,022	17	0	468	122	0	1,629
F	772	9	0	298	100	0	1,179
G	1,044	7	0	492	110	0	1,653
H	5,110	116	0	2,243	847	3	8,319
I	0	0	0	0	0	0	0
J	74	0	0	29	5	0	108
K	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0
Total[1]	10,901	182	0	4,842	1,493	3	17,421
28 January 1989							
A	216	1	2	240	73	1	533
B	508	4	5	555	54	0	1,126
C	2,204	32	3	2,218	223	0	4,680
D	269	2	0	283	91	0	645
E	815	15	0	827	96	0	1,753
F	899	15	4	918	149	0	1,985
G	935	9	1	937	135	0	2,017
H	4,163	67	4	4,365	825	6	9,430
I	0	0	0	0	0	0	0
J	104	2	1	117	14	0	238
K	0	0	0	0	1	0	1
L	1	0	0	1	1	0	3
M	0	0	0	0	0	0	0
N	0	0	0	0	1	0	1
Total[1]	10,114	147	20	10,461	1,663	7	22,412

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
16 February 1989							
A	253	2	0	107	90	0	452
B	512	4	0	197	34	0	747
C	2,386	35	0	718	204	0	3,343
D	359	4	1	79	86	0	529
E	865	15	0	284	85	0	1,249
F	956	9	0	312	126	0	1,403
G	1,006	10	0	341	114	0	1,471
H	4,653	96	2	1,677	871	0	7,299
I	0	0	0	0	7	0	7
J	126	0	0	56	24	0	206
K	0	0	0	0	2	0	2
L	1	0	0	0	1	0	2
M	0	0	0	0	0	0	0
N	0	0	0	1	4	0	5
Total[1]	11,117	175	3	3,772	1,648	0	16,715
3 February 1990							
A	363	8	3	340	118	0	832
B	559	3	0	448	44	0	1,054
C	3,146	36	0	2,575	279	0	6,036
D	322	2	1	264	133	0	722
E	1,060	13	1	866	131	0	2,071
F	1,055	11	0	836	172	0	2,074
G	1,069	8	0	857	104	0	2,038
H	4,444	77	1	3,705	922	0	9,149
I	17	0	0	17	14	0	48
J	147	0	0	136	39	0	322
K	0	0	0	1	31	0	32
L	3	0	0	3	2	0	8
M	0	0	0	0	1	0	1
N	0	0	0	0	0	0	0
Total[1]	12,185	158	6	10,048	1,990	0	24,387

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
19 February 1990							
A	361	4	0	82	88	0	535
B	581	3	0	68	47	0	699
C	3,039	50	0	537	242	0	3,868
D	418	1	0	46	120	0	585
E	1,072	14	0	200	122	0	1,408
F	1,045	9	0	190	146	1	1,391
G	1,100	11	0	203	132	0	1,446
H	4,459	91	1	954	811	0	6,316
I	19	0	0	2	13	2	36
J	143	0	0	36	37	0	216
K	2	0	0	1	15	0	18
L	2	0	0	1	3	0	6
M	0	0	0	0	0	0	0
N	0	0	0	0	3	0	3
Total[1]	12,241	183	1	2,320	1,779	3	16,527
1 February 1991							
A	599	7	2	571	151	0	1,330
B	679	8	2	628	68	0	1,385
C	3,415	40	1	3,080	317	0	6,853
D	335	3	0	314	111	0	763
E	1,069	12	0	934	147	0	2,162
F	1,318	17	0	1,191	196	0	2,722
G	1,090	14	0	1,025	151	0	2,280
H	4,206	79	1	3,983	844	0	9,113
I	9	0	0	10	29	0	48
J	152	0	1	150	31	0	334
K	2	0	0	2	13	0	17
L	9	0	0	10	3	0	22
M	0	0	0	0	0	0	0
N	0	0	0	0	4	0	4
Total[1]	12,883	180	7	11,898	2,065	0	27,033

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
18 February 1991							
A	601	9	0	183	134	0	927
B	661	11	0	150	61	0	883
C	3,480	40	0	852	347	0	4,719
D	357	5	0	69	123	0	554
E	1,061	14	0	255	136	0	1,466
F	1,318	11	0	308	172	0	1,809
G	1,104	9	0	287	163	0	1,563
H	4,273	63	1	1,198	860	0	6,395
I	10	0	0	5	28	0	43
J	157	0	0	45	39	0	241
K	2	0	0	2	17	0	21
L	5	0	0	1	1	0	7
M	0	0	0	3	0	0	3
N	0	0	0	0	3	0	3
Total[1]	13,029	162	1	3,358	2,084	0	18,634
3 February 1992							
A	892	10	3	830	213	0	1,948
B	594	3	1	515	62	0	1,175
D	375	4	0	327	138	0	844
E	1,165	6	0	996	163	0	2,330
F	1,228	8	2	1,060	186	0	2,484
G	1,002	6	1	851	112	0	1,972
H	3,925	62	0	3,542	921	0	8,450
I	17	0	0	11	25	0	53
J	178	0	1	172	41	0	392
K	3	0	1	3	13	0	20
L	6	0	0	6	3	0	15
M	3	0	0	3	6	0	12
N	0	0	0	0	8	0	8

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
17 February 1992							
A	902	15	1	303	217	0	1,438
B	521	0	0	112	41	0	674
C	3,650	44	1	1,040	403	0	5,138
D	428	4	0	118	103	0	653
E	1,137	14	0	412	165	0	1,728
F	1,242	16	3	420	167	0	1,848
G	986	8	0	337	116	0	1,447
H	4,027	125	0	1,451	941	1	6,545
I	19	0	0	10	13	0	42
J	187	1	1	71	66	0	326
K	5	0	0	4	23	0	32
L	10	0	0	3	5	0	18
M	2	0	0	1	5	0	8
N	0	0	0	0	7	0	7
Total[1]	13,116	227	6	4,282	2,272	1	19,904
29 January 1993							
A	1,235	11	0	1,250	215	0	2,711
B	372	4	0	317	88	0	781
C	3,599	87	0	3,589	363	0	7,638
D	386	1	0	396	132	0	915
E	1,289	22	0	1,302	205	0	2,818
F	1,092	10	1	1,067	170	0	2,340
G	1,175	16	4	1,150	129	0	2,474
H	3,660	105	6	3,768	869	0	8,408
I	26	0	4	27	47	0	104
J	230	0	5	244	50	0	529
K	7	0	2	4	15	0	28
L	14	0	0	17	6	0	37
M	11	1	0	13	14	0	39
N	0	0	0	1	7	0	8
Total[1]	13,096	257	22	13,145	2,310	0	28,830

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
15 February 1993							
A	1,293	14	2	531	205	0	2,045
B	377	2	0	110	58	0	547
C	3,734	50	1	1,447	384	0	5,616
D	404	2	1	193	128	0	728
E	1,379	15	0	514	186	0	2,094
F	1,132	8	0	408	157	0	1,705
G	1,215	7	1	481	138	0	1,842
H	3,881	79	0	1,678	905	0	6,543
I	23	0	0	8	38	0	69
J	253	1	0	107	50	0	411
K	6	0	0	2	14	0	22
L	11	1	0	4	5	0	21
M	12	1	0	6	20	0	39
N	0	0	0	0	4	0	4
Total[1]	13,720	180	5	5,489	2,292	0	21,686
13 February 1994							
A	1,452	23	0	882	190	0	2,547
B	932	3	0	332	72	0	1,339
C	4,211	60	0	2,194	431	0	6,896
D	406	3	0	209	124	0	742
E	1,280	19	0	692	181	1	2,173
F	1,381	16	1	736	176	0	2,310
G	1,101	18	1	628	125	0	1,873
H	3,509	78	0	2,136	934	0	6,657
I	20	1	1	13	23	1	59
J	265	1	0	150	40	0	456
K	13	0	0	11	62	0	86
L	33	0	0	21	5	0	59
M	4	0	0	4	34	0	42
N	9	0	0	2	6	0	17
Total[1]	14,616	222	3	8,010	2,403	2	25,256

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
28 January 1995							
A	1,667	32	8	2,002	338	0	4,047
B	102	0	1	109	82	0	294
C	3,174	70	2	3,674	388	0	7,308
D	525	9	1	642	257	0	1,434
E	993	17	0	1,366	236	0	2,612
F	790	14	1	919	177	0	1,901
G	826	33	1	1,028	136	0	2,024
H	2,519	82	3	3,105	892	0	6,601
I	4	0	0	7	41	0	52
J	253	1	5	308	66	0	633
K	20	0	1	21	46	0	88
L	53	0	1	69	9	0	132
M	21	0	0	31	38	0	90
N	0	0	1	1	7	0	9
Total[1]	10,947	258	25	13,282	2,713	0	27,225
15 February 1995							
A	2,015	67	0	1,175	321	0	3,578
B	111	3	0	53	69	0	236
C	3,476	140	0	1,784	377	0	5,777
D	576	16	0	386	123	0	1,101
E	1,420	43	0	973	205	0	2,641
F	959	30	0	504	182	0	1,675
G	945	20	0	550	147	0	1,662
H	3,099	129	2	1,898	783	0	5,911
I	7	0	0	6	44	0	57
J	309	2	0	176	75	0	562
K	19	0	0	7	36	0	62
L	63	0	1	33	12	0	109
M	12	0	0	10	27	0	49
N	1	0	0	1	10	0	12
Total[1]	13,012	450	3	7,556	2,411	0	23,432

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
29 January 1996							
A	1,440	19	7	1,676	240	0	3,382
B	761	5	1	901	103	0	1,771
C	3,444	45	5	3,797	344	0	7,635
D	332	2	1	396	173	0	904
E	1,026	14	1	1,169	182	0	2,392
F	1,034	14	5	1,177	213	0	2,443
G	902	8	4	1,010	173	0	2,097
H	2,284	30	10	2,629	715	0	5,668
I	7	0	1	10	24	0	42
J	250	1	0	304	43	0	598
K	14	0	0	18	32	0	64
L	69	0	2	85	6	0	162
M	28	0	2	30	23	0	83
N	26	0	4	26	18	0	74
Total	11,617	138	43	13,228	2,289	0	27,315
23 February 1996							
A	1,773	24	0	442	225	0	2,464
B	839	6	0	130	52	0	1,027
C	4,092	34	0	824	344	0	5,294
D	441	1	0	104	137	0	683
E	1,240	8	0	262	146	0	1,656
F	1,193	23	0	219	156	0	1,591
G	1,011	7	0	185	100	0	1,303
H	2,694	85	2	648	613	0	4,042
I	8	0	0	15	12	0	35
J	284	1	1	79	59	0	424
K	17	0	0	3	37	0	57
L	63	2	0	16	9	0	90
M	23	0	0	5	28	0	56
N	25	0	0	5	17	0	47
Total	13,703	191	3	2,937	1,935	0	18,769

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
13 February 1998							
A	2,533	92	4	2,184	308	0	5,121
B	288	3	0	4	14	0	309
C	3,750	86	1	2,045	259	0	6,141
D	586	4	0	669	124	0	1,383
E	1,527	42	1	1,161	182	0	2,913
F	1,138	37	1	679	59	0	1,914
G	798	2	0	514	67	0	1,381
H	2,689	106	0	1,879	550	0	5,224
I	0	0	0	0	3	0	3
J	352	2	1	220	47	0	622
K	31	0	0	28	38	0	97
L	97	0	0	76	3	0	176
M	41	0	1	23	34	0	99
N	0	0	0	0	0	0	0
Total	13,830	374	9	9,482	1,688	0	25,383
12 February 2000							
A	1,870	39	0	1,453	263	0	3,625
B	1,078	7	0	609	77	0	1,771
C	3,595	73	0	2,472	271	0	6,411
D	348	5	0	287	98	0	738
E	1,021	17	0	745	109	0	1,892
F	997	14	1	718	113	0	1,843
G	651	4	0	483	74	0	1,212
H	1,742	22	0	1,372	394	0	3,530
I	42	0	0	30	19	0	91
J	308	0	0	230	41	0	579
K	28	0	0	22	37	0	87
L	99	0	0	83	6	0	188
M	47	0	0	42	25	0	114
N	34	0	0	21	3	0	58
Total	11,860	181	1	8,567	1,530	0	22,139

Table 4. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
15 February 2001							
A	2,596	46	0	1,306	240	0	4,188
B	894	2	1	446	64	0	1,407
C	3,510	32	1	1,533	280	0	5,356
D	603	3	0	248	88	0	942
E	1,141	7	0	611	86	0	1,845
F	1,090	1	0	548	119	0	1,758
G	667	5	0	331	75	0	1,078
H	1,862	5	0	917	372	0	3,156
I	8	0	0	3	13	0	24
J	360	0	0	180	43	0	583
K	32	0	0	15	27	0	74
L	94	0	0	66	6	0	166
M	99	0	0	42	27	0	168
N	29	0	0	6	8	0	43
Total	12,985	101	2	6,252	1,448	0	20,788

[1]Lowry et al. 1996.

[2]Portions of areas A-D were not photographed during survey.

[3]Only total counts are available for 1985 and 1986; juveniles were not counted in 1985 and 1986.

Table 5. Counts of northern elephant at San Nicolas Island, California, 1988-2001. Counts were obtained from 126-mm-format aerial color transparency photographs.

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
15 February 1988							
A	1	0	0	0	1	0	2
B	6	0	0	5	4	0	15
C	143	1	0	109	19	0	272
D	232	3	0	134	39	0	408
E	307	4	0	186	35	0	532
F	343	5	0	177	35	0	560
G	609	11	0	342	62	0	1,024
H	222	0	0	56	30	0	308
I	572	5	0	351	62	0	990
J	232	2	0	145	40	0	419
K	453	3	0	227	97	0	780
L	0	0	0	0	6	0	6
M	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0
Total[1]	3,120	34	0	1,732	430	0	5,316
28 January 1989							
A	0	0	0	1	2	0	3
B	79	2	4	87	6	0	178
C	166	5	0	188	32	0	391
D	456	4	2	469	50	0	981
E	348	2	3	350	37	0	740
F	488	3	4	531	65	1	1,092
G	438	4	0	423	46	0	911
H	500	5	2	534	85	2	1,128
I	617	10	0	646	61	0	1,334
J	525	13	0	545	44	0	1,127
K	507	2	1	539	93	0	1,142
L	0	0	0	0	28	0	28
M	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0
Total[1]	4,124	50	16	4,313	549	3	9,055

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
16 February 1989							
A	5	0	0	2	11	0	18
B	79	2	0	45	4	0	130
C	197	6	0	79	24	0	306
D	519	6	0	170	58	0	753
E	364	2	0	117	31	0	514
F	580	3	0	204	63	0	850
G	486	5	0	152	44	0	687
H	567	9	0	178	67	0	821
I	716	15	0	298	66	0	1,095
J	574	13	0	169	26	0	782
K	597	2	0	234	100	0	933
L	0	0	0	0	24	0	24
M	4	0	0	1	19	0	24
N	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0
Total[1]	4,688	63	0	1,649	537	0	6,937
3 February 1990							
A	15	0	0	15	5	0	35
B	37	0	0	36	2	0	75
C	249	3	0	221	20	0	493
D	420	4	0	345	54	0	823
E	399	4	0	346	46	0	795
F	472	4	2	382	51	0	911
G	474	8	1	384	54	2	923
H	431	9	2	359	47	0	848
I	664	6	0	559	41	0	1,270
J	440	9	0	353	25	0	827
K	489	8	0	438	112	1	1,048
L	0	0	0	0	12	0	12
M	2	0	0	1	4	0	7
N	0	0	0	0	1	0	1
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	1	0	1
Total[1]	4,092	55	5	3,439	475	3	8,069

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
19 February 1990							
A	13	0	0	2	7	0	22
B	36	0	0	15	4	0	55
C	205	6	0	45	17	0	273
D	466	5	0	125	39	0	635
E	347	3	1	82	29	0	462
F	518	3	0	94	51	0	666
G	471	7	0	106	45	0	629
H	433	6	0	111	53	0	603
I	664	10	0	179	43	0	896
J	430	6	0	84	31	0	551
K	495	6	1	133	85	0	720
L	0	0	0	0	11	0	11
M	1	0	0	0	10	2	13
N	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0
Total[1]	4,079	52	2	976	425	2	5,536
2 February 1991							
A	21	0	0	25	5	0	51
B	45	0	0	49	6	0	100
C	264	2	0	238	25	0	529
D	434	7	1	389	59	0	890
E	380	5	0	343	30	0	758
F	591	3	0	531	53	0	1,178
G	495	6	0	426	45	0	972
H	479	7	1	436	74	0	997
I	702	14	0	629	42	0	1,387
J	519	15	0	450	33	0	1,017
K	560	8	0	492	93	0	1,153
L	2	0	0	2	20	0	24
M	11	0	0	9	14	0	34
N	0	0	0	0	1	0	1
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	2	0	2
Total[1]	4,503	67	2	4,019	502	0	9,093

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
18 February 1991							
A	24	0	0	18	6	0	48
B	45	0	0	15	6	0	66
C	262	3	1	73	22	0	361
D	441	6	0	127	45	0	619
E	345	6	0	100	31	0	482
F	640	6	0	158	55	0	859
G	505	1	1	130	47	0	684
H	491	4	0	158	50	0	703
I	722	10	1	231	53	0	1,017
J	496	8	0	119	31	0	654
K	565	7	0	181	100	0	853
L	0	0	0	1	15	0	16
M	11	0	0	5	7	0	23
N	0	0	0	0	1	0	1
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0
Total[1]	4,547	51	3	1,316	469	0	6,386
3 February 1992							
A	78	2	1	63	23	1	168
B	63	0	0	71	3	0	137
C	470	9	0	410	38	0	927
D	762	15	0	649	66	0	1,492
E	515	4	0	432	43	0	994
F	641	6	0	547	84	0	1,278
G	609	8	0	516	59	0	1,192
H	493	6	2	427	79	0	1,007
I	660	8	0	592	58	0	1,318
J	472	15	0	430	25	0	942
K	686	5	2	585	117	0	1,395
L	1	0	0	1	20	0	22
M	32	0	0	22	19	0	73
N	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0
Total[1]	5,482	78	5	4,745	634	1	10,945

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
17 February 1992							
A	77	3	0	23	14	0	117
B	50	0	0	24	3	0	77
C	445	11	0	150	42	0	648
D	781	17	0	224	63	0	1,085
E[2]	302	2	0	97	51	0	452
F[2]	610	2	0	168	60	0	840
G	591	8	0	186	59	0	844
H	472	5	0	148	46	0	671
I	681	4	0	262	60	0	1,007
J	483	5	0	119	33	0	640
K	641	4	0	205	98	0	948
L	1	0	0	0	24	0	25
M	32	0	1	8	17	0	58
N	0	0	0	0	1	0	1
O	0	0	0	0	1	0	1
P	0	0	0	0	1	0	1
Q	0	0	0	0	2	0	2
Total[2]	5,166	61	1	1,614	575	0	7,417
29 January 1993							
A	133	0	2	139	14	0	288
B	48	1	2	51	5	0	107
C	449	1	3	437	34	0	924
D	508	10	3	468	95	0	1,084
E	466	4	4	456	32	0	962
F	537	9	1	526	56	0	1,129
G	547	11	2	557	43	0	1,160
H	391	5	0	386	48	0	830
I	648	8	1	632	48	0	1,337
J	477	6	0	477	36	0	996
K	696	8	4	704	84	0	1,496
L	2	0	0	3	30	0	35
M	38	0	1	40	23	0	102
N	0	0	0	0	0	0	0
O	0	0	0	0	2	0	2
P	0	0	0	0	2	0	2
Q	0	0	0	2	2	0	4
Total[1]	4,940	63	23	4,878	554	0	10,458

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
15 February 1993							
A	130	0	2	53	20	0	205
B	40	0	0	24	5	0	69
C	463	0	3	159	42	0	667
D	553	6	1	200	71	0	831
E	462	1	1	194	43	0	701
F	582	4	0	200	74	0	860
G	582	7	1	266	56	0	912
H	432	3	0	135	44	0	614
I	680	4	0	303	59	0	1,046
J	476	6	0	163	32	0	677
K	730	6	0	256	96	0	1,088
L	2	0	0	0	20	0	22
M	37	0	0	18	25	0	80
N	0	0	0	0	3	0	3
O	0	0	0	0	3	0	3
P	0	0	0	0	1	0	1
Q	2	0	0	2	8	0	12
Total[1]	5,171	37	8	1,973	602	0	7,791
13 February 1994							
A	104	0	0	74	20	0	198
B	103	1	1	66	5	0	176
C	614	8	0	302	54	0	978
D	708	7	0	340	94	0	1,149
E	530	10	1	262	41	0	844
F	686	6	1	369	86	0	1,148
G	458	6	0	254	42	2	762
H	511	5	1	247	47	0	811
I	621	8	0	338	64	0	1,031
J	606	7	0	300	36	0	949
K	764	5	1	428	112	0	1,310
L	2	0	0	1	19	1	23
M	17	0	2	14	19	0	52
N	3	0	0	3	2	0	8
O	0	0	0	0	2	0	2
P	0	0	0	0	0	0	0
Q	0	0	0	0	5	0	5
Total[1]	5,727	63	7	2,998	648	3	9,446

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
28 January 1995							
A	289	2	4	343	43	0	681
B	66	0	0	79	10	0	155
C	817	12	2	946	58	0	1,835
D	817	7	4	940	119	0	1,887
E	560	6	1	664	41	0	1,272
F	434	6	2	507	74	0	1,023
G	557	15	1	677	46	0	1,296
H	177	2	1	198	57	0	435
I	486	7	0	572	50	0	1,115
J	208	1	0	249	20	0	478
K	743	4	6	966	140	0	1,859
L	0	0	1	1	21	0	23
M	56	0	2	80	24	0	162
N	0	0	0	0	3	0	3
O	0	0	0	0	2	0	2
P	0	0	0	0	1	0	1
Q	8	0	3	10	15	0	36
Total[1]	5,218	62	27	6,232	724	0	12,263
15 February 1995							
A	357	7	0	197	45	0	606
B	63	0	0	42	9	0	114
C	1,033	21	0	571	68	0	1,693
D	1,016	7	0	513	105	0	1,641
E	679	9	0	384	38	0	1,110
F	543	4	0	301	70	0	918
G	713	13	0	416	59	0	1,201
H	195	0	0	88	32	0	315
I	568	19	1	291	47	0	926
J	243	4	0	128	28	0	403
K	975	5	1	586	106	0	1,673
L	0	0	0	0	20	0	20
M	87	0	0	62	31	0	180
N	0	0	0	0	2	0	2
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	14	0	0	11	13	0	38
Total[1]	6,486	89	2	3,590	673	0	10,840

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
29 January 1996							
A	201	1	3	244	35	0	484
B	135	1	2	155	9	0	302
C	688	7	0	722	51	0	1,468
D	770	2	1	841	102	0	1,716
E	495	7	1	536	37	0	1,076
F	591	3	0	669	69	0	1,332
G	446	7	2	480	40	0	975
H	406	5	1	449	64	0	925
I	461	9	1	511	44	0	1,026
J	437	3	0	501	29	0	970
K	656	4	3	722	127	0	1,512
L	2	0	0	3	16	0	21
M	18	0	0	19	8	0	45
N	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	1	0	1
Q	0	0	1	1	6	0	8
Total	5,306	49	15	5,853	638	0	11,861
23 February 1996							
A	259	4	0	70	33	0	366
B	129	0	0	17	8	0	154
C	758	12	0	133	65	0	968
D	932	3	0	157	79	0	1,171
E	589	2	0	130	37	0	758
F	693	5	0	133	60	0	891
G	540	3	0	115	51	0	709
H	464	2	0	71	40	0	577
I	535	7	0	105	41	0	688
J	476	2	0	116	33	0	627
K	789	3	0	181	97	0	1,070
L	2	0	0	1	13	0	16
M	22	1	0	8	10	0	41
N	0	0	0	0	2	0	2
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	0
Total	6,188	44	0	1,237	569	0	8,038

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
13 February 1998							
A	325	5	3	236	26	0	595
B	77	1	0	29	8	0	115
C	1,002	38	1	651	85	0	1,777
D	970	19	0	570	105	0	1,664
E	670	20	0	509	34	0	1,233
F	637	12	0	339	63	0	1,051
G	646	24	0	422	48	0	1,140
H	294	4	1	139	39	0	477
I	524	18	0	350	29	0	921
J	195	7	3	61	8	0	274
K	826	18	0	521	106	0	1,471
L	0	0	0	0	18	0	18
M	25	1	0	24	15	0	65
N	0	0	0	0	0	0	0
O	0	0	0	1	2	0	3
P	0	0	0	0	1	0	1
Q	9	0	0	4	8	0	21
Total	6,200	167	8	3,856	595	0	10,826
11 February 2000							
A	820	7	0	727	48	0	1,602
B	349	1	1	196	14	0	561
C	1,591	23	0	1,264	59	0	2,937
D	1,423	22	1	1,092	115	0	2,653
E	970	2	0	796	57	0	1,825
F	804	3	0	605	63	0	1,475
G	438	1	0	365	34	0	838
H	539	3	0	389	41	0	972
I	619	6	0	501	38	0	1,164
J	577	5	0	383	20	0	985
K	1,029	4	0	744	91	0	1,868
L	22	0	0	15	10	0	47
M	305	4	0	255	30	0	594
N	52	0	0	47	8	0	107
O	2	0	0	2	7	0	11
P	0	0	0	0	0	0	0
Q	173	0	0	179	32	0	384
Total	9,713	81	2	7,560	667	0	18,023

Table 5. (Continued)

Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
16 February 2001							
A	889	13	0	391	62	0	1,355
B	126	1	0	50	10	0	187
C	1,617	20	0	735	52	0	2,424
D	1,411	10	0	640	119	0	2,180
E	863	6	0	389	45	0	1,303
F	735	4	0	333	63	0	1,135
G	552	6	0	263	38	0	859
H	427	3	1	160	31	0	622
I	666	6	0	328	32	0	1,032
J	326	1	0	153	20	0	500
K	1,112	4	0	457	89	0	1,662
L	6	0	0	0	29	0	35
M	227	0	0	122	27	0	376
N	37	0	0	25	11	0	73
O	5	0	0	1	1	0	7
P	0	0	0	0	0	0	0
Q	122	1	1	64	18	0	206
Total	9,121	75	2	4,111	647	0	13,956

[1]Lowry et al. 1996

[2]Incomplete count (animals missed due to incomplete photographic coverage).

Table 6. Counts of northern elephant seals at Santa Rosa Island, California, 1991-2001. Counts were obtained from 126-mm-format aerial color transparency photographs.

BLM Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
2 February 1991							
625	1	0	0	2	17	0	20
626	85	0	0	84	20	0	189
Total[1]	86	0	0	86	37	0	209
18 February 1991							
625	1	0	0	0	31	0	32
626	82	0	0	24	14	0	120
Total[1]	83	0	0	24	45	0	152
3 February 1992							
611	0	0	0	0	10	0	10
625	0	0	0	0	23	0	23
626	67	0	0	68	19	0	154
Total[1]	67	0	0	68	52	0	187
17 February 1992							
625	0	0	0	0	14	0	14
626	64	0	0	29	26	0	119
Total[1]	64	0	0	29	40	0	133
29 January 1993							
611	2	0	2	3	14	0	21
625	0	0	0	0	19	0	19
626	108	0	1	116	39	0	264
Total[1]	110	0	3	119	72	0	304
15 February 1993							
611	2	0	0	0	16	0	18
612	0	0	0	0	11	0	11
625	0	0	0	0	10	0	10
626	121	0	0	48	20	0	189
Total[1]	123	0	0	48	57	0	228
13 February 1994							
611	7	0	0	6	39	0	52
612	3	0	0	3	7	0	13
625	9	0	0	9	54	0	72
626	296	0	0	155	41	0	492
Total[1]	315	0	0	173	141	0	629

Table 6. (Continued)

BLM Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
28 January 1995							
611	5	0	2	6	20	0	33
612	0	0	0	0	3	0	3
625	0	0	0	0	15	0	15
626	138	0	0	169	31	0	338
Total[1]	143	0	2	175	69	0	389
15 February 1995							
611	7	0	0	4	18	0	29
612	0	0	0	0	8	0	8
625	0	0	0	0	30	0	30
626	179	0	0	110	25	0	314
Total[1]	186	0	0	114	81	0	381
29 January 1996							
611	8	0	0	8	11	0	27
612	0	0	0	0	1	0	1
625	14	0	0	21	45	0	80
626	330	2	3	386	40	0	761
Total	352	2	3	415	97	0	869
23 February 1996							
611	10	1	0	2	16	0	29
625	38	0	0	12	41	0	91
626	372	3	0	68	37	0	480
Total	420	4	0	82	94	0	600
13 February 1998							
611	15	0	1	11	8	0	35
612	10	0	0	3	2	0	15
625	39	1	0	24	31	0	95
626	441	2	0	288	31	0	762
Total	505	3	1	326	72	0	907
12 February 2000							
611	60	1	0	54	25	0	140
624	348	3	0	226	33	0	610
625	176	1	0	147	54	0	378
626	674	2	0	351	59	0	1,086
Total	1,258	7	0	778	171	0	2,214

Table 6. (Continued)

BLM Area	Pups		Juveniles	Adult females	Subadult and adult males	Unknown age/sex class	Total
	Alive and unknown	Decomposed carcasses					
15 February 2001							
611	70	0	0	40	9	0	119
612	15	0	0	6	4	0	25
613	1	0	0	0	16	0	17
624	526	0	1	259	38	0	824
625	203	2	0	94	85	0	384
626	749	1	0	280	64	0	1,094
Total	1,564	3	1	679	216	0	2,463

[1]Lowry et al. 1996

Table 7. Pearson correlations and paired t-test analysis of counts for four age/sex class categories obtained from aerial color-transparency photographs taken during peak-breeding season and late-breeding season surveys at San Miguel Island (SMI), San Nicolas Island (SNI), and Santa Rosa Island (SRI), California.

Age/sex class comparison	Island	Number of observations (years)	Pearson correlation		Average difference in counts (%)	Paired t-test	
			Coefficient (*r*)	Probability (*P*)		Degrees of freedom	Probability (*P*)
Peak-season adult females *vs* Late-season births	SMI	10	0.90	<0.01	-9.4	9	<0.01
	SNI	6	1.00	<0.01	-9.8	5	<0.01
	SRI	5	1.00	<0.01	-0.3	4	0.33
Peak-season births *vs* Late-season births	SMI	10	0.87	0.02	-6.6	9	0.01
	SNI	6	0.92	0.22	-6.8	5	0.07
	SRI	5	1.00	<0.01	-8.4	4	0.17
Peak-season subadult/adult males *vs* Late-season subadult/adult males	SMI	10	0.92	<0.01	8.3	9	0.02
	SNI	6	0.90	0.33	5.2	5	0.18
	SRI	5	0.88	0.05	5.8	4	0.66
Peak-season total *vs* Late-season total	SMI	10	0.89	0.01	39.6	9	<0.01
	SNI	6	0.90	0.29	35.6	5	<0.01
	SRI	5	0.97	0.01	31.8	4	0.11

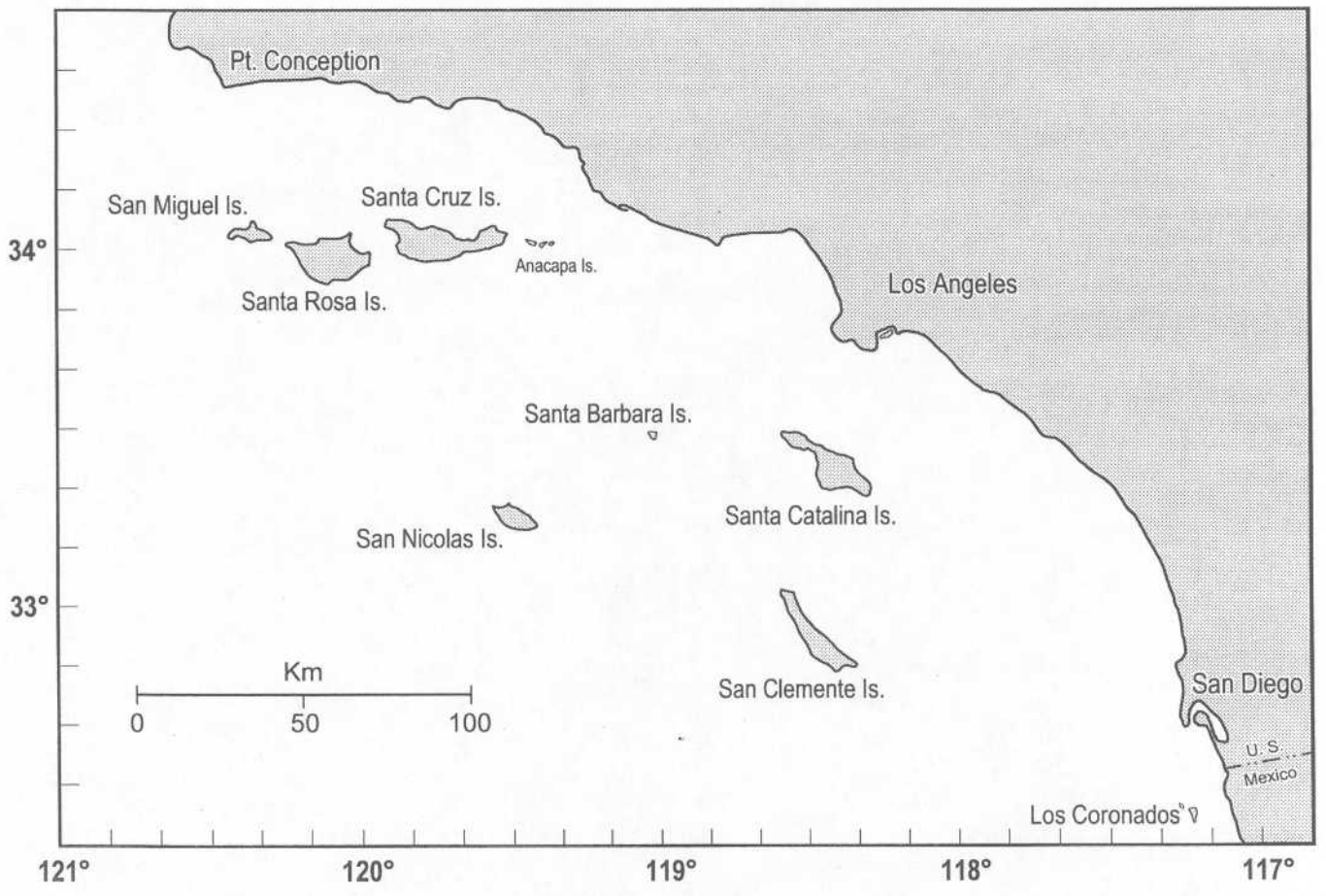

Figure 1. Map of Southern California Bight.

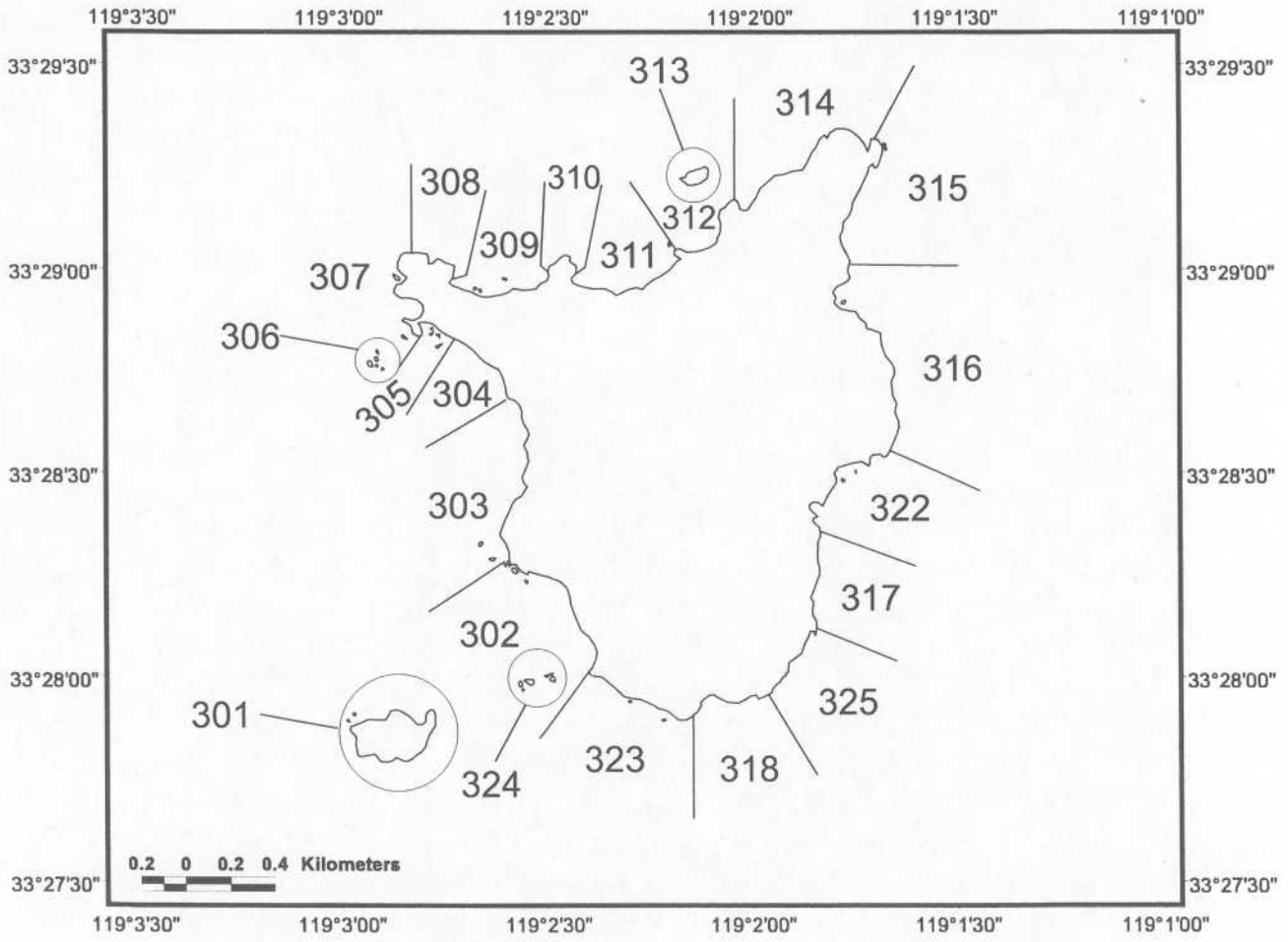

Figure 2. Map of Santa Barbara Island showing Bureau of Land Management (BLM) area codes.

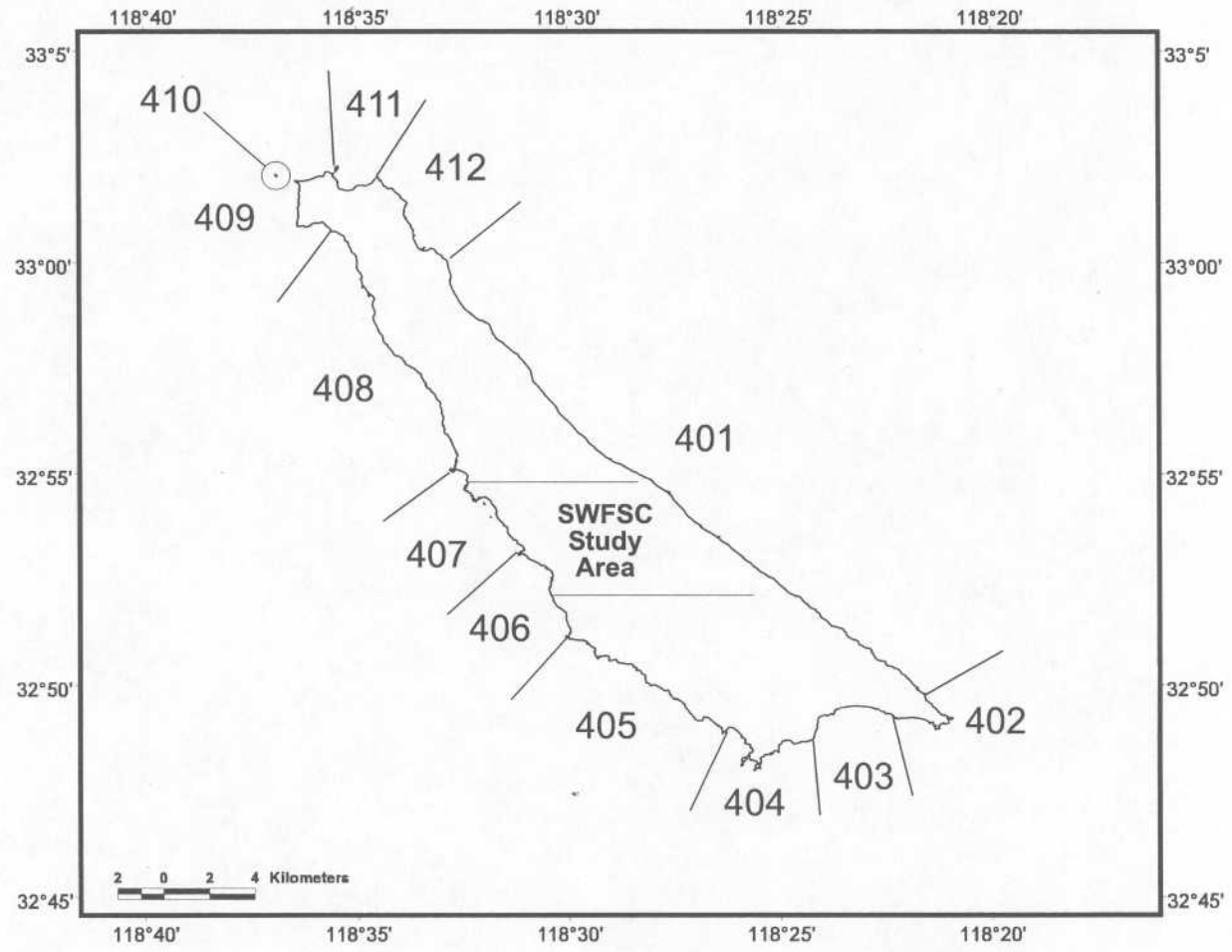

Figure 3. Map of San Clemente Island showing Bureau of Land Management (BLM) area codes and the Southwest Fisheries Science Center (SWFSC) pinniped study area.

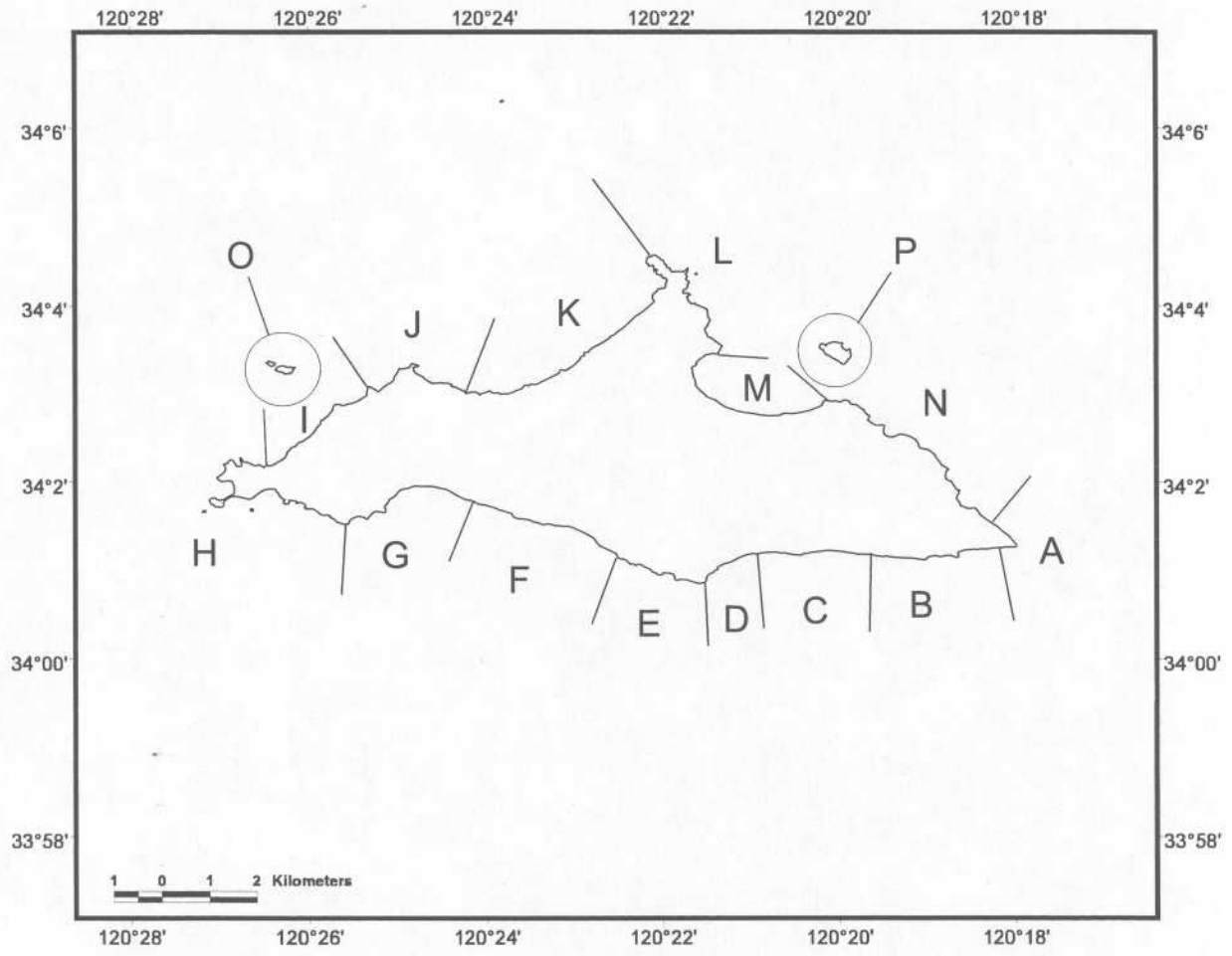

Figure 4. Map of San Miguel Island showing Southwest Fisheries Science Center (SWFSC) area codes.

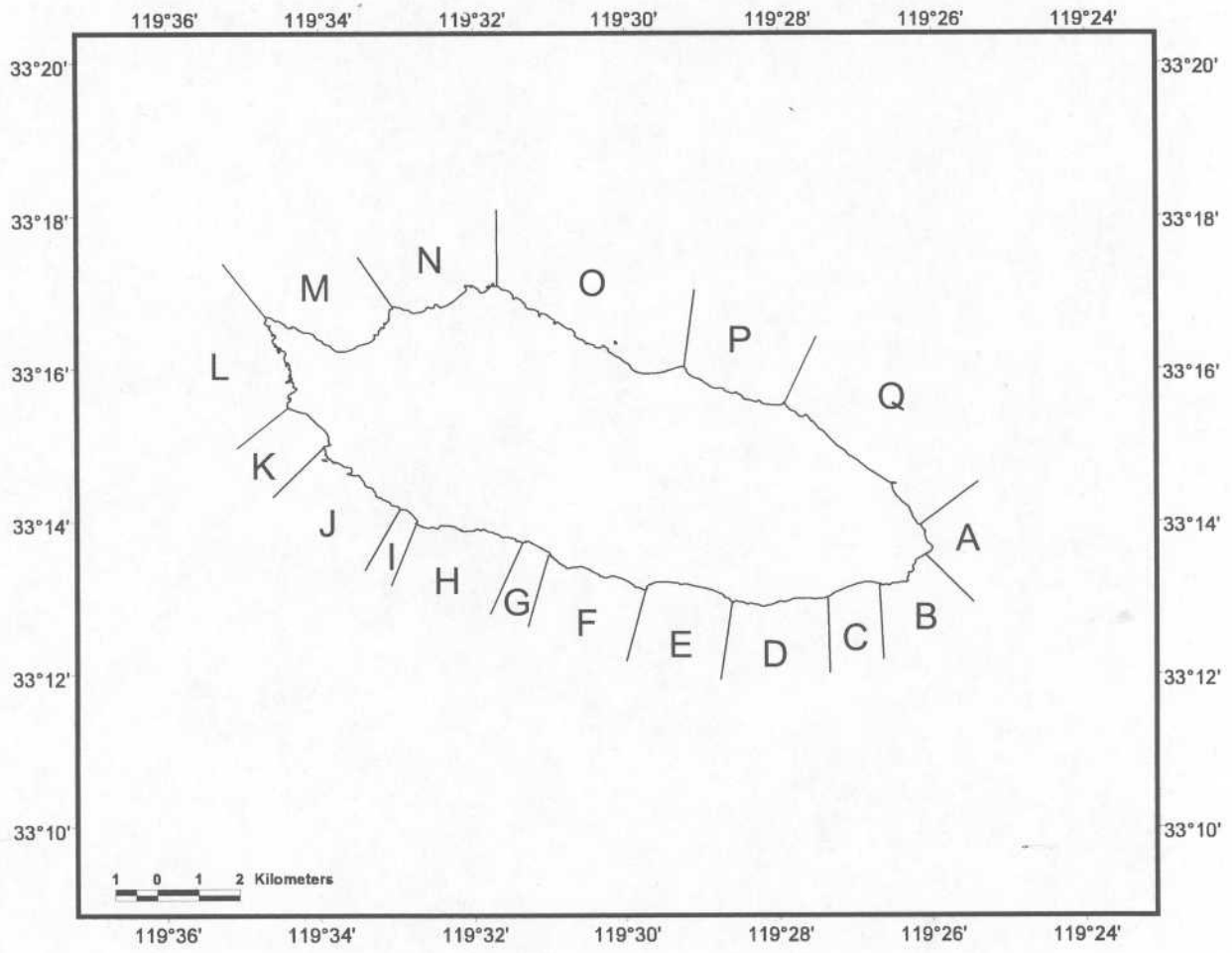

Figure 5. Map of San Nicolas Island showing Southwest Fisheries Science Center (SWFSC) area codes.

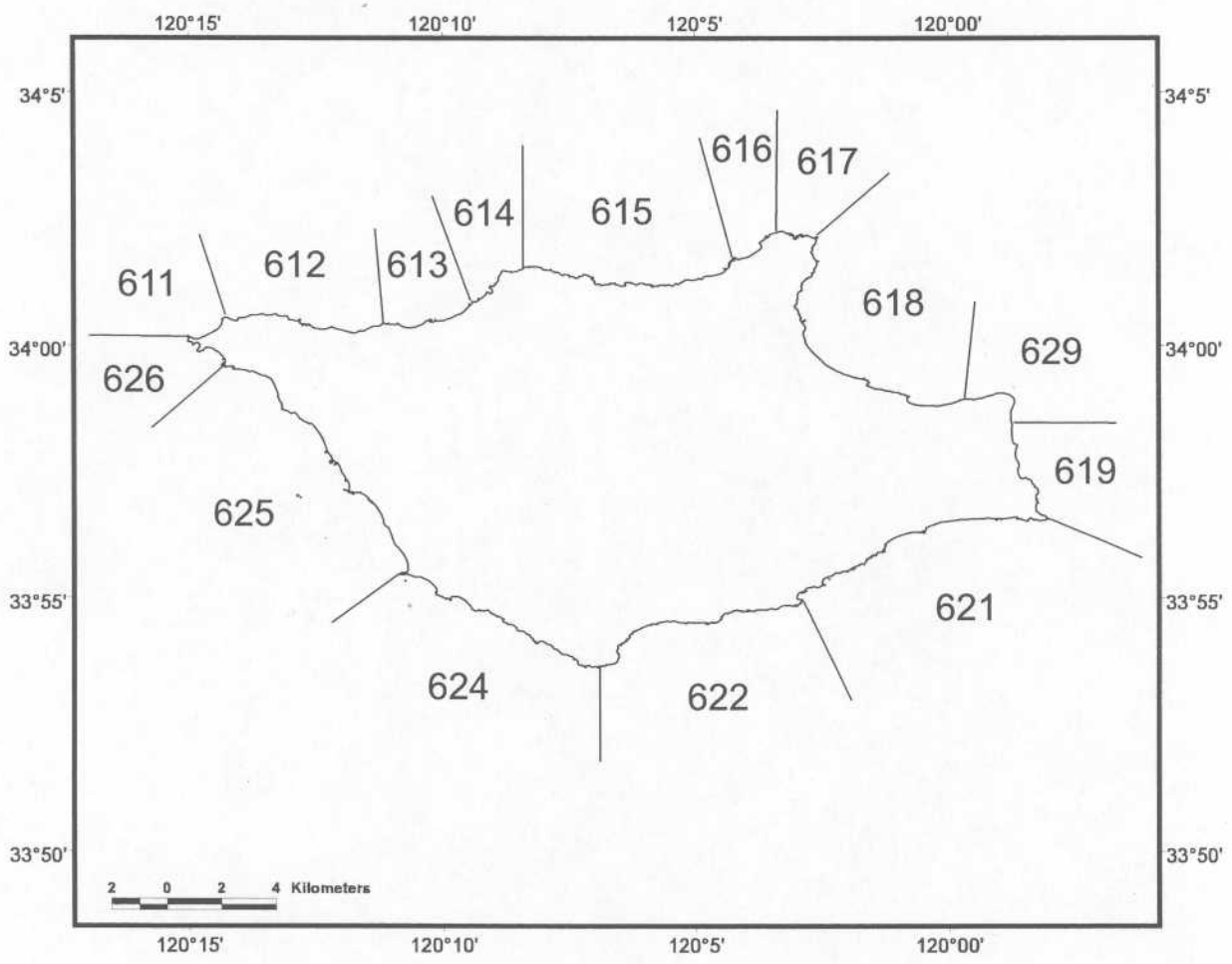

Figure 6. Map of Santa Rosa Island showing Bureau of Land Management (BLM) area codes.

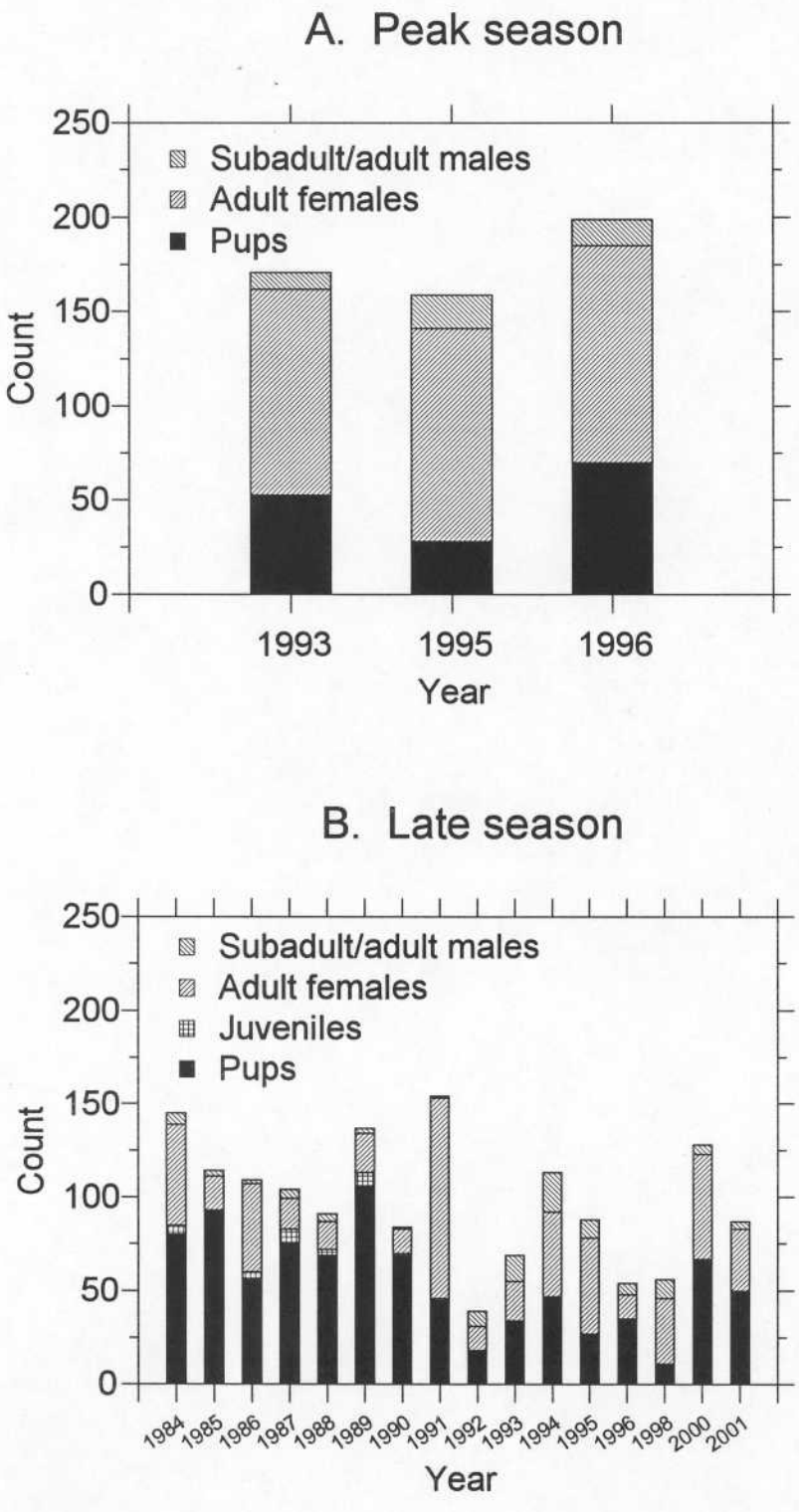

Figure 7. Counts of northern elephant seals (*Mirounga angustirostris*) by age/sex class at Santa Barbara Island, California during (A) peak-breeding season and (B) late-breeding season.

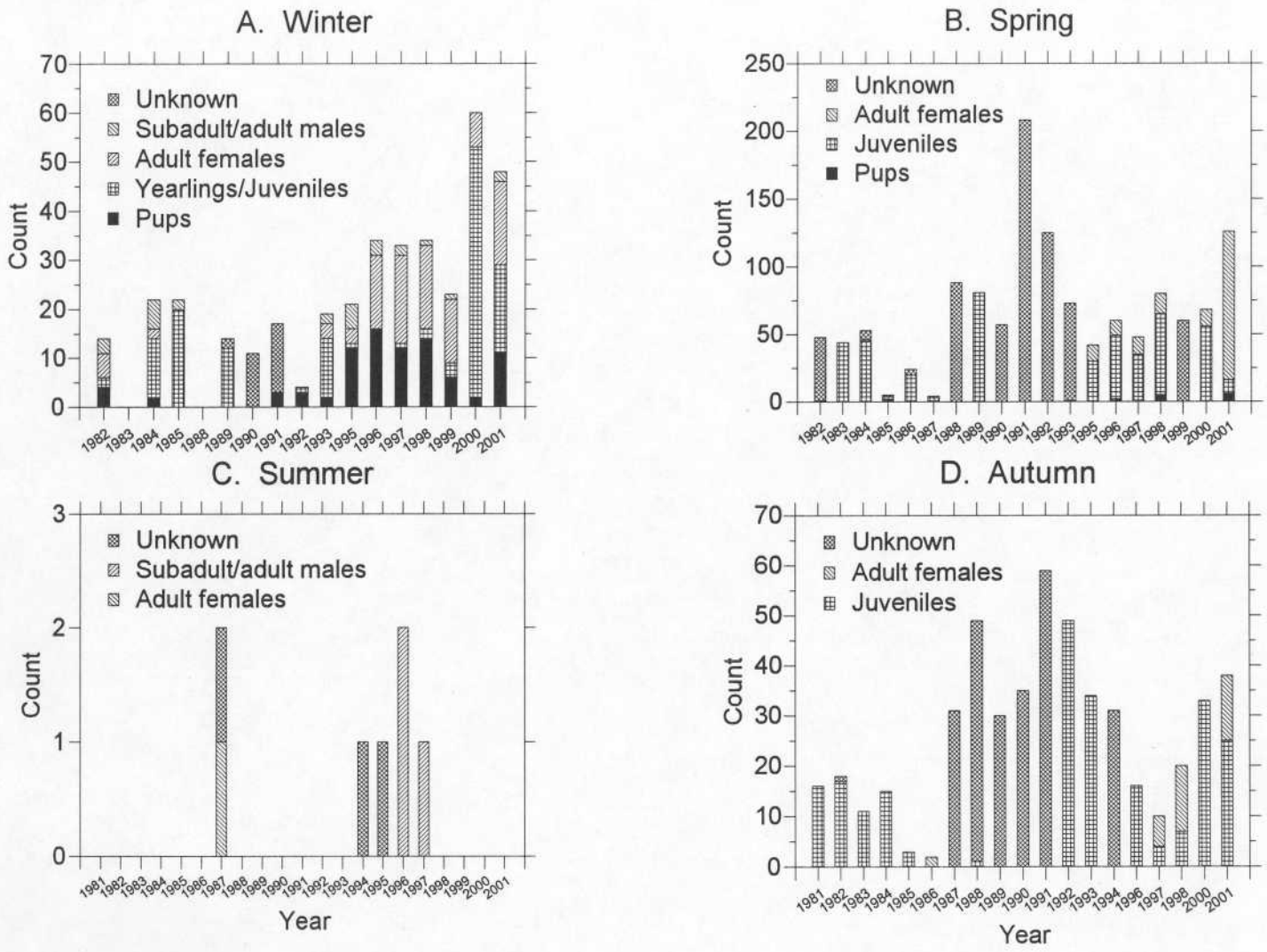

Figure 8. Counts of northern elephant seals (*Mirounga angustirostris*) by age/sex class at San Clemente Island, California during (A) winter, (B) spring, (C) summer, and (D) autumn.

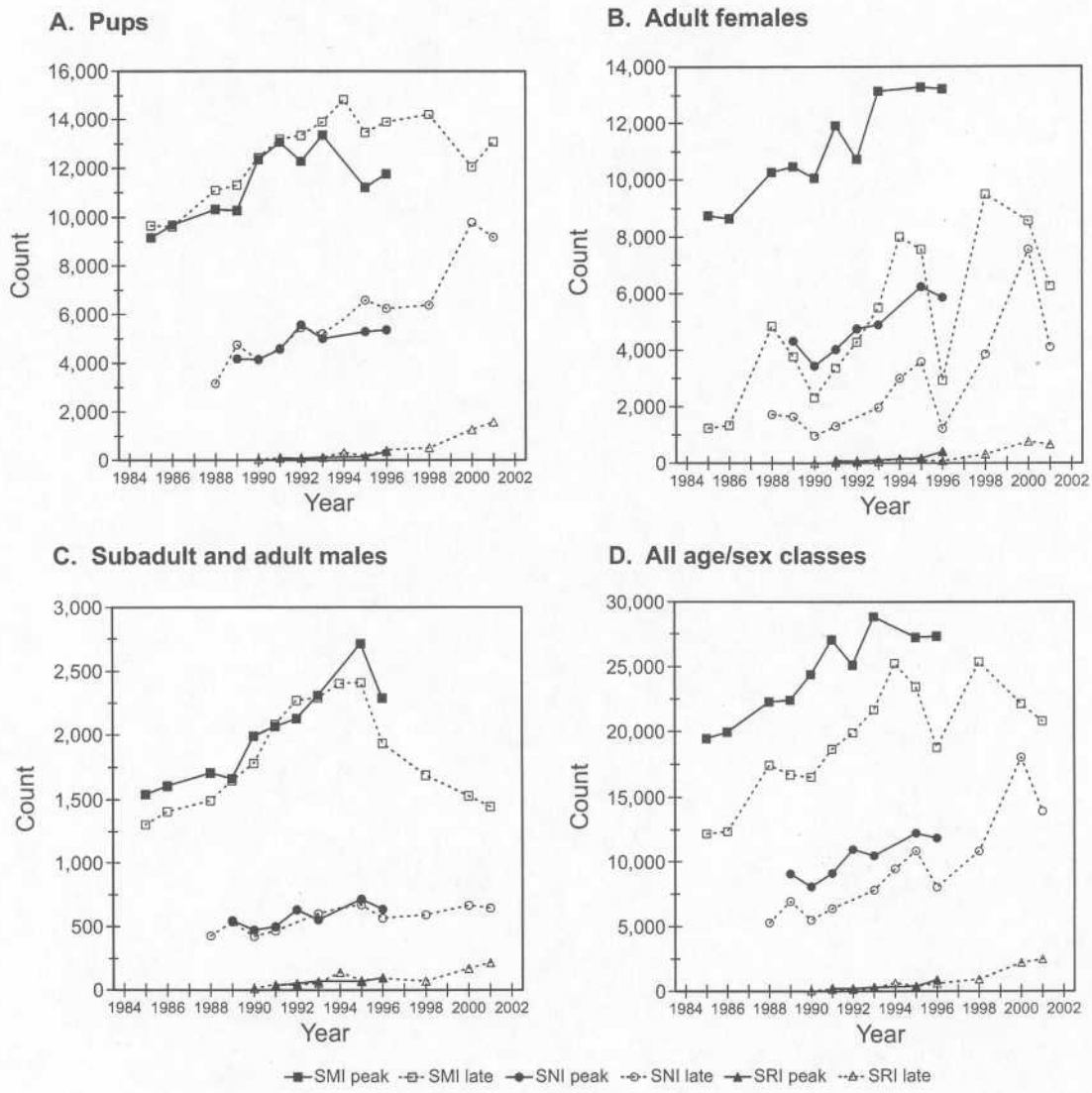

Figure 9. Counts of northen elephant seals (*Mirounga angustirostris*) made from 126-mm-format aerial color photographs taken during peak-breeding season and late-breeding season at San Miguel Island (SMI), San Nicolas Island (SNI), and Santa Rosa Island (SRI). (A) Counts of pups. (B) Counts of adult females. (C) Counts of subadult and adult males. (D) Counts of all age/sex classes.

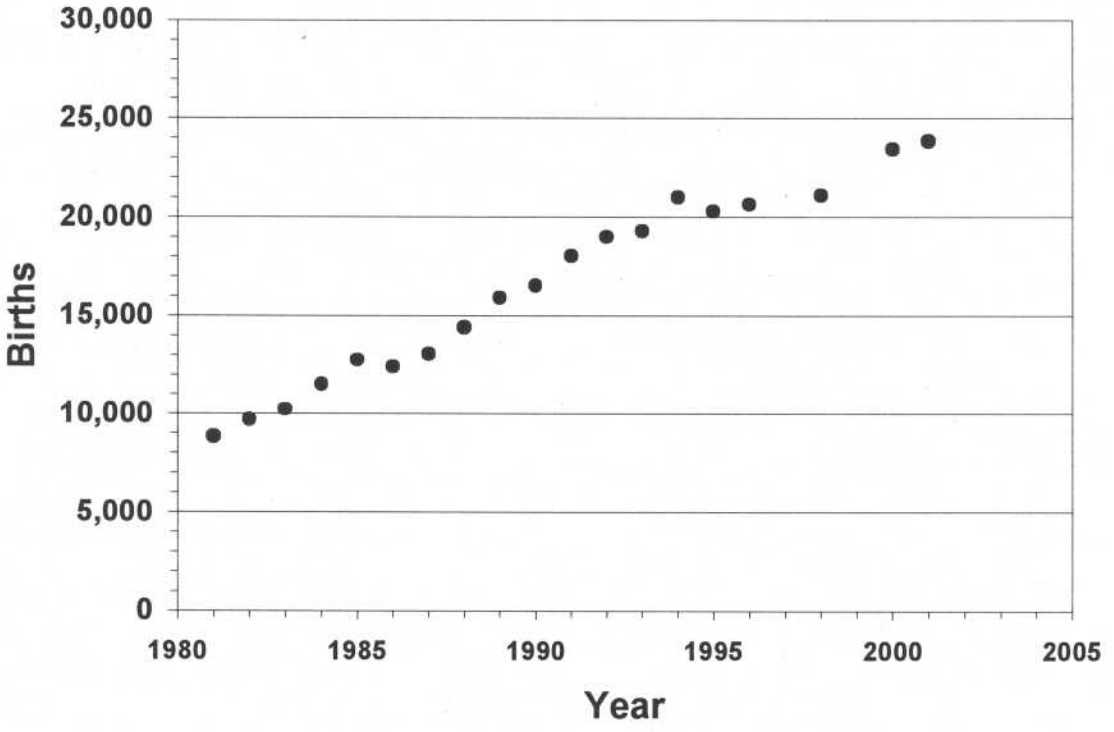

Figure 10. Total number of northern elephant seal births in the Southern California Bight (SCB) from counts obtained during this study and from Stewart et al. (1994). When more than one count was available for each island, the average was taken.

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