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Status of Pinnipeds on Santa Catalina Island

by

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The aim of this study was to assess the number and distribution of pinnipeds on Santa Catalina Island, the diet of California sea lions, *Zalophus californianus*, the incidence of pinniped strandings, and the significance of dead pinnipeds as a source of food and of organochlorine contamination for local bald eagles, *Haliaeetus leucocephalus*. Twenty-four censuses were conducted from February to November 2000. A maximum of 70 California sea lions was recorded in March; numbers decreased to at least half this size in summer and then increased again in the fall. The majority of sea lions were adult males (64%), no pups were observed, and most animals inhabited the southwest side of the island, 87% of them at Seal Rocks. Market squid, *Loligo opalescens*, was the dominant prey in February and March. The number of harbor seals, *Phoca vitulina*, peaked at 121 individuals during the spring breeding season, and the seals were most numerous on the southwest side of the island. Only eight dead pinnipeds were observed during the study period, DDT residue levels in sea lion blubber were low, and bald eagles were never observed feeding on the carcasses. This suggests that dead pinnipeds are not an important source of food or contamination for the bald eagles of Santa Catalina Island. Santa Catalina Island is a haul-out site of minor importance for California sea lions, as reflected by low numbers observed and the absence of breeding; colony numbers of both pinnipeds are in equilibrium.

The pinnipeds of Santa Catalina Island are of interest because of the island's location in the Southern California Bight (Fig. 1). First, the island is close to an ocean dumping site, and only 24 nautical miles from the sewage outfall on the Palos Verdes Shelf in Los Angeles where large quantities of DDT residues were discharged between 1948 and 1970 and still remain on the ocean floor (MacGregor 1974; Chartrand et al. 1985). Pinnipeds, especially the California sea lion, *Zalophus californianus,* accumulate high organochlorine pesticide levels from their diet (Le Boeuf and Bonnell 1971; DeLong et al. 1973; Buhler et al. 1975; Gilmartin et al. 1976; Lieberg-Clark et al. 1995). Pinnipeds on Santa Catalina Island might exhibit greater than normal contaminant loads, compared with animals from other islands in the Southern California Bight, if their prey are contaminated from feeding near the dumpsites. If so, the dead bodies of these pinnipeds might be a source of contamination for scavenging birds (Garcelon 1994a). Second, due to the island's close proximity to a large metropolitan area, it supports the largest year-round resident population of humans of all the islands in southern California, a high influx of transient tourists from spring through fall, and attendant large-scale recreational boating activities. This might disturb the pinnipeds, limiting their number, affecting their temporal and spatial use of the island, and reducing their reproduction. The aim of this paper is to address the validity of this logic by presenting data on number, distribution, mortality and diet of the pinnipeds on this island.

Reports of pinnipeds on Santa Catalina Island date back to at least the beginning of this century (Rowley 1929). Early reports, however, were unreliable and unsystematic, failing to distinguish between California sea lions and Steller sea lions, *Eumetopias jubatus*. Early surveys by California Fish and Game in the Southern California Bight focussed on sea lions but ignored the harbor seal, *Phoca vitulina*. Some investigators censused the major rookeries in the Southern California Bight but omitted Santa Catalina Island possibly because of its low colony numbers (e.g., Bartholomew and Boolootian 1960; Lowry et al. 1992).

California sea lions and harbor seals are commonly found on Santa Catalina Island. California sea lions have been recorded on this island periodically during boat and aerial censuses conducted since the 1920s. Thirty-six censuses were conducted between 1927 and 1983 (Bonnot 1928, 1929; Fry 1939; Bureau of Marine Fisheries 1947; Bonnot and Ripley 1948; Ripley et al., 1962; Odell 1971; Carlisle and Aplin 1966, 1971; Frey and Aplin 1970; Mate 1977; Bonnell et al. 1981; C. Oliver in Seagars et al. 1985), most of them concentrated in the years 1975–1978, part of a large pinniped assessment study of the Southern California Bight (Bonnell et al. 1981). These censuses indicate that: 1) no breeding occurred on this island, contrary to the claim of Rowley (1929) and Bonnot (1929); 2) less than 100 total animals were observed during the highest counts in 13 of the 18 years censused; 3) unusually greater numbers were observed in December 1977 (384) and March 1978 (971); 4) numbers were always least during the summer months from April through September; 5) there has been no growth trend in colony number, as reflected by 15 censuses in June spanning the years 1927 to 1977; 6) the majority of sea lions (94%) were observed along a 30-km segment on the southwest side of the island between Catalina Harbor (the isthmus) and Seal Rocks, the southeastern point on the island (Fig. 1); and 7) Seal Rocks supports the majority of sea lions (77%) found on the island.

Harbor seals in the Southern California Bight were not given as much attention as sea lions during the first half of the century. They were first recorded on Santa Catalina Island in June 1964 (Odell 1971). Twenty-five aerial censuses were conducted during the period 1975–1987 (Bonnell et al. 1981; Stewart 1982; Hanan et al. 1986a, 1986b, 1987, 1988; Hanan 1996). Bonnell et al. (1981) noted that harbor seals reproduce here in spring. The greatest number were recorded during March, April and May, in the range of 120 to 205 seals with year-to-year counts being relatively stable.

The bald eagle, *Haliaeetus leucocephalus,* was a common resident of Santa Catalina and the other Channel Islands from at least 1860 to the late 1950s (Kiff 1980). Although attempts to reintroduce them on Santa Catalina were initiated in 1980, six years after DDT production stopped in this country, the eagles continued to exhibit high DDE residues, egg-shell thinning, and difficulty breeding unassisted (Garcelon 1988; 1994a; Garcelon et al. 1989). The most likely sources of contamination are the prey they eat. Bald eagles of Santa Catalina Island feed primarily on fishes (80–86%), birds (10–16%), mammals (1.5–3.5%) and invertebrates (0.9–2.3%) (Garcelon 1994b, 1994c). In these studies, some bald eagles were observed scavenging on dead pinnipeds that washed up on the island's beaches. As top trophic level predators, pinnipeds accumulate high levels of this persistent chemical from their fish and cephalopod diet (Le Boeuf and Bonnell 1971; Shaw 1971; DeLong, Gilmartin and Simpson 1973; Anas 1974; Buhler et al. 1975; Gilmartin et al. 1976; Lieberg-Clark et al. 1995). Thus, it is important to determine the frequency, magnitude, and importance of bald eagles scavenging on dead pinnipeds on this island as well as the contaminant levels of the dead pinnipeds that wash up on its shores.

The specific aims of this report are to: 1) update the status of California sea lions and harbor seals on Santa Catalina Island by providing colony numbers by age, sex, island location, and time of year; 2) document stranded pinnipeds by number, location, time of year, and duration of availability; 3) census bald eagles in areas where pinnipeds are found and record the incidence of eagles feeding on dead pinnipeds; 4) determine the DDT residue load in the blubber of dead California sea lions; and 5) estimate sea lion diet from scat samples.

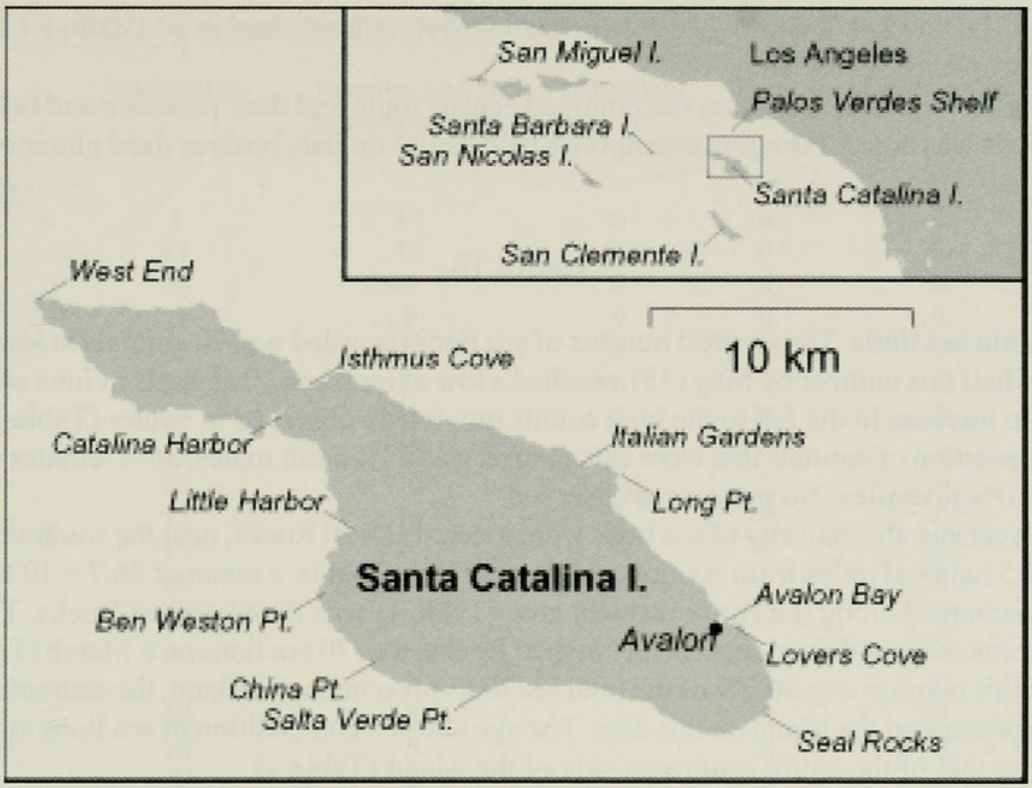

FIGURE 1. Schematic map of Santa Catalina Island in relation to the mainland, the Palos Verdes Shelf, Los Angeles, and other islands in the Southern California Bight.

METHODS

Twenty-four censuses were conducted on Santa Catalina Island from February to November 2000, at least one per month. Most censuses began at dawn and were conducted from a small boat motoring slowly along the shoreline, supplemented during inclement weather in winter by land counts from areas such as Little Harbor and Ben Weston Point (Fig. 1). The island was surveyed on March 10, by circumnavigating the island to determine the areas where pinnipeds were located. Ten monthly censuses covered the southwest side, from Avalon Bay to Catalina Harbor, where virtually all of the pinnipeds associated with Santa Catalina Island were found. Thirteen censuses were restricted to the principal haul-out site of California sea lions, the Seal Rocks area and vicinity. Approximately 80 hours were spent in censusing and observing activities.

Sea lions were categorized as adult males, females or immature males, juveniles, or pups (Peterson and Bartholomew 1967). Harbor seals were categorized as adults or juvenile/pups.

Nineteen sea lion scats were collected during February and March at Seal Rocks where sea lions rest. Scats were processed and prey hard parts identified at Moss Landing Marine Laboratories (Moss Landing, California) using the method described in Wiese (1999).

The location, sex, standard length, estimated age, and condition of dead pinnipeds found on beaches and in adjacent waters was recorded. When possible, the number of days dead pinnipeds remained in the area was recorded. A blubber tissue sample, from outer skin to muscle, approximately 150 grams, was excised from the medial ventrum region of six dead sea lions at the level of the axilla. The samples were deposited in clean jars and refrigerated until organochlorine analysis was conducted following the methods described by Tanabe et al. (1994) and Watanabe et al. (1999). Total DDT residues (∑DDT) in blubber are reported in µg/g wet weight and µg/g lipid weight. ∑DDT refers to all constituents of DDT and its metabolities: *p, p'*-DDT (1,1, 1-trichloro-2, 2-*bis*(*p*-chlorophenyl)

ethane), *p, p'*-DDD (1, 1-dchloro-2, 2-*bis* (*p*chorophenyll ethane), and *p, p'*-DDE (1,1-dichloro-2, 2-*bis* (*p*-chlorophenyl)) ethylene).

Bald eagles were counted along the pinniped census route and their presence and behavior near dead pinnipeds was noted. Foraging attempts by bald eagles on fish, birds or dead pinnipeds were recorded.

RESULTS

California sea lions. The greatest number of sea lions recorded was 70 animals in March; counts decreased to half this number by May (35), reached a low of less than 10 animals in June and July, and then began to increase in the fall to the high counts previously observed in winter (Table 1). The age and sex composition of animals that were categorized was 64% adult males, 26% females or subadult males, and 10% juveniles. No pups were observed.

On each census, the majority of sea lions were located at Seal Rocks, near the southwestern tip of the island, 2.5 nautical miles from Avalon and Avalon Bay. That is, a mean of 86.7 ± 10.8 percent of the sea lions counted along the entire resident area (Table 1) was found at Seal Rocks. The greatest count of all censuses conducted specifically at Seal Rocks, was 70 sea lions on 6 March (Table 2). Assuming that this number was 86.7% of the total sea lions present on the island, the estimated total was 81 sea lions present on the island on this date. The age and sex composition of sea lions at Seal Rocks was similar to that of the entire southwest side of the island (Table 1).

Sea lion diet. Scat analysis revealed that two cephalopods, Market squid, *Loligo opalescens,* and Octopus, *Octopus* spp., and three fishes, Pacific Whiting, *Merluccius productus,* Northern anchovy, *Engraulis mordax,* and rockfish, *Sebastes* spp., were the principal prey consumed in February and March (Table 3). Market squid was the most common prey, appearing in 74% of the samples. Liquid scats, commonly observed when sea lions feed on squid, were prevalent on Seal Rocks in late March in the location where sea lions rested. Moreover, squid was being fished in the area at the time.

Harbor seals. The greatest number of harbor seals was counted in March through May; counts after June were a quarter to a third lower than the high count in March (Table 4). The seals were concentrated in large groups in March through May and pupping was observed in April. Most seals at this time of year were observed between China Point and Ben Weston Point. For example, 92% of the seals

TABLE 1. California sea lion censuses of Santa Catalina Island in 2000. All censuses covered the principal haul-out sites of sea lions, from Seal Rocks to Catalina Harbor. The March 10 census covered the entire island.

Date	Adult males	Females and/or immature males	Juveniles	Pups	Unidentified	Total
4 March	41	17	6	0	1	65
10 March	32	8	4	0	26	70
23 March	20	12	4	0	0	36
13 April	52	0	1	0	0	53
12 May	18	8	9	0	0	35
15 June	3	1	1	0	0	5
11 July	3	6	0	0	0	9
17 August	0	13	2	0	0	15
14 September	7	5	0	0	1	13
18 October	9	9	1	0	3	22
15 November	10	0	4	0	0	14
Relative % of identified	63.7	25.8	10.5			

TABLE 2. Censuses of California sea lions at Seal Rocks,Santa Catalina Island in 2000.

Date	Adult males	Females and/or immature males	Juveniles	Pups	Unidentified	Totals
28 February	–	–	–	–	41	41
4 March	1	17	6	0	0	64
6 March	51	15	4	0	0	70
7 March	26	5	0	0	0	31
9 March	21	9	0	0	0	30
10 March	32	8	4	0	0	44
11 March	26	13	6	0	0	45
12 March	22	12	8	0	0	42
13 March	18	12	6	0	0	36
19 March	26	12	4	0	0	42
20 March	12	16	3	0	0	31
21 March	12	16	4	0	0	32
22 March	21	14	5	0	0	40
23 March	20	10	4	0	0	34
24 March	–	–	–	–	26	26
25 March	–	–	–	–	31	31
13 April	50	0	1	0	0	51
12 May	18	6	7	0	0	31
15 June	3	1	0	0	0	4
11 July	2	6	0	0	0	8
17 August	0	13	0	0	0	13
14 September	6	5	0	0	0	11
18 October	9	9	1	0	0	19
15 November	10	–	4	0	0	14
Relative % of identified	59.2	30.5	10.3			

counted on 13 April and 88% of the seals counted on 12 May were in this area. The largest aggregations were centered in the China Point area. During the rest of the year, harbor seals were distributed in small numbers from Seal Rocks to Ben Weston Point; a group of 8–10 seals was observed on the east side of the island 1 km west of Isthmus Cove on 10 March and 12 May. Unlike sea lions, Seal Rocks was not a preferred site, however, 2–5 seals were found often at this site.

TABLE 3. Minimum number of individuals (MNI) and percentage frequency occurrence (% FO) of prey species (identified from otoliths and beaks) in nineteen California sea lion fecal samples collected on Santa Catalina Island, California, February and March 2000.

Prey Species			
Common name	Scientific name	MNI	% FO
Market Squid	*Loligo opalescens*	197	73.7
Pacific Whiting	*Merluccius productus*	34	50
Northern Anchovy	*Engraulis mordax*	5	15.8
Rockfish	*Sebastes* spp.	4	15.8
Octopus	*Octopus* spp	3	10.5
Unidentified	—	1	5.3

TABLE 4. Harbor seal censuses on Santa Catalina Island in 2000. All censuses covered the principal haul-out sites of sea lions, from Seal Rocks to Catalina Harbor. The March 10 census covered the entire island.

Date	Adults	Juveniles and pups	Unidentified	Total
4 March	–	–	8	8
10 March	–	–	121	121
23 March	–	–	71	71
13 April	57	14	–	71
12 May	2	–	80	82
15 June	5	–	19	24
11 July	31	–	14	45
17 August	5	–	5	10
14 September	–	–	5	5
18 October	27	–	0	27
15 November	5	–	0	5
Relative % of identified	90.4	9.6		

Dead pinnipeds. During 4 of the 24 censuses, we saw seven dead pinnipeds in the water or beaches (Table 5); an eighth carcass washed up near Isthmus Cove on the north side of the island and was reported to us by G. Long. All stranded animals were California sea lions, except one, which was unidentified. Four of the sea lions were found in Little Harbor. The three carcasses observed on 9 and 20 March, which were marked, remained on the beach for only one day. Evidently, they moved out to sea with the tidal flow and were not observed again in the 4–5 days that followed. Three other carcasses were found floating in the water; two carcasses had puncture holes indicating gulls had fed on them; a western gull, *Larus Occiodentalis,* was perched on one. Gulls also were feeding on the unidentifiable carcass on the beach at China Point.

Mean ∑DDT in the blubber of six sea lions sampled (Table 6) was 13.0 ± 12.0 μg/g wet weight (geometric mean = 9.1 μg/g wet weight) and 55.0 ± 62.8 μg/g lipid weight (geometric mean = 37.0 μg/g lipid weight). Discarding the sample with the very low lipid value (ZC051300) lowers the mean ∑DDT value from 55 to 30 μg/g lipid weight.

Bald eagle sightings. During 10 censuses totaling 80 hours in duration, we observed 15 bald eagles. The eagles were observed for a total of 10 hours. Nine sightings were at Seal Rocks; three were sightings of a pair of eagles and the rest were of single eagles. In all but one case, the eagles were perched on the rocks above Seal Rocks or on rocks over the adjacent beach to the northwest. In addition, a pair of eagles was observed near Catalina Harbor and lone eagles were observed between Seal Rocks and Salta Verde Point. We never saw eagles feeding on fish, birds or pinniped carcasses.

On 12 and 13 July, while not censusing pinnipeds, we observed a lone eagle feeding on fish at Lover's Cove, near Avalon, and two adults and a juvenile feeding on fish at Italian Gardens and Long Point on the east side of the island.

DISCUSSION

Our observations confirm the conclusions from earlier researchers. Sea lions no longer breed on Santa Catalina Island, as they did before the 1920s (Bonnot 1929; Rowley 1929), but rather use it exclusively as a haul-out site. Fewer than 100 animals are seen usually on the island, with the greatest number occurring in winter and the fewest in summer. The majority of sea lions reside in a 30-km area on the southwest side of the island between Catalina Harbor and Seal Rocks. Because approximately

TABLE 5. Dead pinnipeds observed during pinniped censuses at Catalina Island in 2000.

Date	Identification	Genus	Sex	Age	Location	Condition
9 March	ZC030900-1	*Zalophus*	?	juvenile	Little Harbor, on beach	lower half only
	ZC030900-2	*Zalophus*	male	subadult	Little Harbor, on beach	decomoposed
21 March	ZC032100	*Zalophus*	male	juvenile	Little Harbor, on beach	missing head
13 April	Unidentified	?	?	?	China Point, on beach	not approachable
	ZC041300	*Zalophus*	male	adult	Little Harbor, in water	decomposed, fed on by gulls
13 May	ZC051300	*Zalophus*	?	adult	Isthmus Cove, on beach	fresh dead
15 June	ZC061500-1	*Zalophus*	male	adult	1 km W of Salta Verde Pt., in water	decomposed, fed on by gulls
	ZC061500-2	*Zalophus*	male	adult	Salta Verde Pt., in water	decomposed

86% of the sea lions on the island were counted on Seal Rocks, one can make a reasonable prediction of total island number from this location alone, when other parts of the island are inaccessible due to inclement weather. The majority of sea lions that use the island are adults and subadult males; the rest are juveniles and possibly some non-parous females.

A comparison of all available sea lion counts from Santa Catalina Island, most of which were in June (Table 7), indicates that colony size is not increasing but rather has remained relatively stable during the last 80 years, even during the years 1948 to 1970 when large quantities of DDT residues were being discharged on the nearby Palos Verdes Shelf. Unusual peaks in number, however, were recorded, such as 233 in June 1958 (Ripley et al. 1962), 277 in March 1977, 282 in October 1977, 384 in December 1977 and 971 in March 1978 (Bonnell et al. 1981). These high counts appear to have been associated with large concentrations of market squid spawning near the island. Local squid fishermen report that squid were unusually abundant in 1977 and 1978. Our scat sample analysis confirms that sea lion diet in late winter and early spring of 2000 was mainly market squid. An earlier study indicated that market squid also was the most common prey of sea lions in the fall of 1980 and 1983 (Lowry and Folk 1987). Thus, sea lions use Santa Catalina Island as a resting place from which they make foraging forays in the nearby waters. When squid are abundant, sea lion numbers may double or even increase tenfold.

The decline in sea lion numbers during the summer, a reliable pattern over the years, may simply reflect adults departing to breed on nearby rookeries, such as Santa Barbara, San Nicolas, San Clemente, or San Miguel Islands. Breeding on Santa Catalina Island may be discouraged by the large influx of tourists and recreational boating activity during summer, especially because females require undisturbed sites to give birth and nurse their pups. Moreover, tourists congregate on the expansive sandy beaches, the preferred habitat of breeding sea lions.

It is unlikely that dead sea lions in the vicinity are an important source of food, and hence, organochlorine contaminants, for the bald eagles of Santa Catalina Island. Few pinniped carcasses, most of them sea lions, were observed during censusing, which follows from the low number of animals in residence, and also indicates that few carcasses originating elsewhere in the Southern California Bight strand here. Three of the five carcasses observed on beaches were present for only one day. No carcass was found near Seal Rocks where sea lions were most numerous. No eagle was ever seen feeding on a pinniped carcass. Moreover, the mean ΣDDT levels in the blubber of the dead sea lions sampled

TABLE 6. Total DDT residues in the blubber of dead California sea lions collected at Santa Catalina Island in 2000.

			DDT Residues	
Identification	Age Category	% Lipid	Wet wt. μg/g	Lipid wt. μg/g
ZC030900-1	juvenile	41.1	7.2	17.5
ZC030900-22	subadult	21.9	4.0	18.3
ZC032100	juvenile	37.7	7.6	20.2
ZC041300	adult	64.0	32.1	50.0
ZC051300	adult	1.8	3.3	150.0
ZC061500-1	adult	54.0	23.8	44.0
Arithmetic mean		36.8	13.0	55.0
Standard deviation		22.4	12.0	62.8
Geometric mean		24.4	9.1	37.0

was only 13 parts per million (ppm) wet weight, almost two orders of magnitude below the mean level of 911 ppm wet weight observed in 1970 (Le Boeuf and Bonnell 1971) and similar to levels reported from central California in 1988–1992 (Lieberg-Clark et al. 1995). This level is only marginally greater than the mean level of DDE reported in Western gulls, *Larus occidentalis,* from Santa Catalina Island in 1992, 7.4 ppm (range = 0.9–28.2 ppm) (Garcelon 1994c). In lieu of these points—and because Santa Catalina eagles feed primarily on fish, followed by piscivorous birds such as gulls, and rarely on dead mammals and invertebrates (0.9–2.3%) (Garcelon 1994b, 1994c)—it is unlikely that the major source of the contaminant loads of bald eagles comes from stranded pinnipeds.

Santa Catalina Island supports a resident breeding population of approximately 100 harbor seals. The majority of them inhabit an isolated, rugged section of the southwestern coast on the weather side of the island that is not easily approached by land or sea. Their number is highest during the spring breeding season and decreases by about half this number during the rest of the year. Census counts vary considerably with the number of seals in the water foraging, the latter being correlated with tidal conditions and sea state. Overall, their numbers have been relatively stable over the years as reflected by the four censuses conducted in March and the ten censuses conducted in June (Table 8).

In conclusion, the California sea lion and harbor seal colonies on Santa Catalina are in equilibrium. In most years, Santa Catalina is a minor haul-out site between foraging bouts for less than 100 sea lions. As reflected by the low numbers observed, and the absence of breeding, the island is of little importance for the California sea lion population, which is estimated at over 200,000 for the U. S. (Forney et al. 2000). The major source of high organochlorine contaminant loads in local bald eagles does not appear to be dead sea lions or seals because few are available, they are not available for long, they may not be consumed frequently by eagles, and the contaminant loads of sea lions have decreased considerably during the last three decades.

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TABLE 7. Total California sea lions censused on Santa Catalina Island since 1927, by month of year.

	Year																	
Month	1927	1928	1938	1939	1946	1947	1958	1961	1964	1965	1969	1970	1975	1976	1977	1978	1983	2000
January														26	117	184		
February																		
March				30										10	277	971		69
April															106			53
May													2	57				35
June	15	40	15		104	20	233	30	92	35	107	39	0	14	106			5
July													0		6		0	9
August													17	33				15
September														45	93			13
October													0		282			22
November																		
December														30	384			

Sources for 1927–1983: Bonnot (1928, 1929), Fry (1939), Bureau of Marine Fisheries (1947), Bonnot and Ripley (1948), Ripley et al. (1947, 1962), Odell (1971), Carlisle and Aplin (1966, 1971), Frey and Aplin (1970), Mate (1977), Bonnell et al. (1981), and C. Oliver *in* Seagars et al. (1985).

TABLE 8. Total harbor seals recorded on Santa Catalina Island since 1964, by month of year.

	Year											
Month	1964	1975	1976	1977	1978	1982	1983	1984	1985	1986	1987	2000
January			0	21	65							
February												
March			150	119	127							121
April				183								71
May		152	103								205	72
June	107	0	25	20			82	174	117	37		24
July		0		0			0					45
August		0	15									10
September			0	19								5
October		0		1								27
November												
December			20	3								

Sources for data: Odell (1971), Bonnell et al. (1981), Stewart (1982), Stewart and Yochem (1984a, b), C. Oliver *in* Seagars et al. (1985), Hanan et al. (1986a, 1986b, 1987, 1988).

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