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Disturbance to Brown Pelicans at Communal Roosts in Southern and Central California

Prepared for the
American Trader Trustee Council
California Department of Fish and Game
United States Fish and Wildlife Service
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EXECUTIVE SUMMARY

Disturbance to Brown Pelicans at communal roosts in southern and central California was assessed using data from 235 flushing events observed over the period 1986-2000. This study was conducted to provide quantitative information on frequency, severity and sources of disturbance, to aid the American Trader Trustee Council (ATTC) in selecting and prioritizing restoration projects intended to enhance roost quality for the California Brown Pelican. Disturbance frequency in southern California averaged 0.53 flushing events per hour. Frequency and severity of disturbances to roosting pelicans in southern California were greatest in natural habitats, such as river mouths and other estuaries, and lowest at harbors and man-made structures along the outer coast. Eighty-five percent of all pelicans observed to flush due to disturbance were roosting in natural landscapes. Disturbance occurred about once an hour at estuarine roosts versus once every four hours on artificial substrates. More than 90% of all disturbance incidents were directly due to humans, mostly recreationists, rather than natural factors. Pelicans demonstrated habituation to the most common types of boat traffic in harbors. Human disturbance at southern California natural areas may be incurring relatively high energetic costs to immature pelicans and precluding regular use of otherwise desirable habitats by adults. Efforts to reduce disturbance will target different user groups, primarily recreationists, and vary according to roost habitat type. Artificial structures along the southern California coast are a critical component of nonbreeding habitat for Brown Pelicans, however the results of this study suggest that restoration actions geared towards reducing human disturbance at existing roosts should prioritize natural areas. Public education, establishment of 25-30 meter buffer zones between traditional pelican sites and people, and habitat manipulation to enhance or create island roost habitat are recommended.

Disturbance indices for two key central California roost sites included in this study were higher than for any southern California sites. Human disturbance frequency increased greatly in 1999-2000 compared to levels documented in the 1980's. Kayaks and ecotourism, along with habitat and water level management changes at the Moss Landing WA were responsible for much of the disturbance documented. Kayaks and other boats caused 77% of all observed disturbance events at these roost sites in 1999-2000. Immediate management intervention is recommended.

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INTRODUCTION

Human disturbance causes direct and indirect effects on birds in nonbreeding habitats that are often difficult to measure. The most obvious direct effect is flight behavior, which in itself causes variable levels of energy expenditure, depending on the metabolic cost of flight by species, duration and type of flight (Pennycuik 1972). Chronic disturbance to nonbreeding birds can affect body condition, metabolic rate, habitat use, and subsequent reproductive success due to reduced lipid reserves (Stahlmaster 1983, Josselyn et al. 1989, Culik 1990, Gaston 1991). Long-term effects on bird distribution and habitat use have been inferred (Batten 1977, Burger 1981, Jaques and Anderson 1986, Cornelius et al. 2001).

Based on the anatomy, roost site selection and behavior of the California Brown Pelican (*Pelecanus occidentalis californicus*), it is evident that conserving energy is an important life history trait for these large migratory birds. Brown Pelicans spend much of their daily energy budget resting and maintaining plumage at traditional communal roosts (USFWS 1983, Croll et al. 1986). The less disturbance that pelicans experience at these roosts, the less energy they will expend responding to such events and the more energy they will be able to conserve by using favored locations of the coast and selected microhabitats within roosts. The quality of a roost site can be based then, in part, on measurements of disturbance frequency and severity.

Habitat availability, habitat selection, and disturbance to roosting Brown Pelicans are all interrelated. Brown Pelicans prefer to roost communally on dry substrate surrounded by water on all sides to avoid predators, particularly at night. During the day, locations that have less of a water buffer are often selected, since these areas may be in nearest proximity to food or have other attractive features (USFWS 1983, Strong and Jaques 2002). Roost sites that are not true islands are most vulnerable to disturbance. Nearshore island habitat is limited in southern California and human disturbance at roosts has been a management concern (USFWS, 1983, Jaques and Anderson 1988, Jaques et al. 1996, ATTC 2001, Capitolo et al. 2002).

This study was conducted to provide additional quantitative information on disturbance to Brown Pelicans in southern California, including analysis of frequency, severity and cause of disturbances. The results are intended to aid the American Trader Trustee Council (ATTC) in making plans for restoration projects intended to reduce disturbance and enhance roost quality.

METHODS

Observations and censuses of Brown Pelicans at communal roosts were made as part of ATTC restoration activities during 1999-2000 and as part of various projects for other purposes during 1986-1993. Disturbance data from 1986-1987 were collected as part of a master's thesis project (Jaques and Anderson 1987, Jaques 1994). Focused studies of disturbance and roost habitat use were made at and around Mugu Lagoon from 1991-1993 (Jaques et al. 1996) and at Moss Landing in 1987 (Jaques and Anderson 1988). Those data have been incorporated into this analysis where noted. Other data included in this report were collected incidental to a study of

survival of rehabilitated oiled birds (Anderson et al. 1996) and as part of an inventory of marine bird and mammal use of California State Parks (Jaques and Strong 1996). Methods and observers were fairly consistent throughout this period, allowing comparison of disturbance frequency and source, by habitat, for all of the data set. Information on Brown Pelican response to disturbance was available for a subset of the historical data and all of the data collected in 2000. Data were grouped as historical (all data collected from 1986-1993) and recent (1999-2000), for analyses of changes over time.

The time and duration of observation, weather conditions and sea state, were recorded at each roost site. Pelicans were censussed by location and habitat type, with a breakdown of birds by age category. Pelican roost habitat types were categorized as follows:

OSR: Offshore rock or island, open coast.
CRS: Cliff or Rocky shore, on mainland shore of open coast.
BCH: Mainland shore open coast beach, sand or with rocky structure.
EST: Estuary. Large estuaries always open to the sea
RMO, CMO: River or Creek mouths, that often form smaller estuaries.
LAG: Estuaries that are frequently closed off from the ocean by a beach berm.
HRB: Harbor. All roost structures associated with harbors.
BRW: Detached breakwater. A subhabitat in harbors.
JTY: Jetty, attached to mainland. Most often a subhabitat within a harbor, but used as primary habitat type when not in association with a harbor.
MMS: Other man-made structures. Most often a subhabitat in harbor, but a primary habitat if on the outer coast.

For disturbance analysis, roost subhabitats within harbors were grouped together and referred to under the "Harbor" except where noted otherwise. River mouths, lagoons, and other estuaries were also grouped together under the general category "Estuary" in many of the analysis. Disturbance observations were not made at offshore rocks or beaches in southern California.

Disturbance to pelicans was defined as an event causing birds to flush rapidly from a roost. The following parameters were recorded when possible: the cause of disturbance, estimated distance from the disturbance source when birds flushed, number of birds flushed, fate of flushed birds (depart roost, relocate to different area, or reland), and any associated information (response of other species, percent of total roost affected, etc.). Disturbance frequency was measured as the number of disturbances per hour of observation. A measure of disturbance severity was measured with a modification of the Disturbance Index, "D," developed by Jaques et al. (1996) as:

$$D = \text{SQR ROOT}\left(\frac{N*(n\ \text{depart}*3)+(n\ \text{relocate}*2)+n\ \text{reland}}{\text{Hours of observation}}\right)$$

where N= the number of disturbances, and n depart, relocate or reland= the number of pelicans showing that response. Multiplication factors are included to weight more severe disturbance effects (departure and relocation).

Sources of disturbance in southern California were grouped into 12 categories. Ground-based disturbances by people were grouped in the category "walker" unless the persons were clearly engaged in other more specific categories, such as working ("worker"), surfing (surfer), or fishing from shore ("fisher"). Disturbances from watercraft were divided into kayaks, jet skis, and all other boats (fishing boats are grouped with other boats). Aircraft were divided into helicopters and all other aircraft. Disturbances by dogs, including people walking dogs, were included in the category "dog." Gun-based hunting and target shooting were grouped together as "shoot." Natural disturbance categories included waves, other wildlife species, and unknowns (no human disturbance recognized, no obvious cause).

RESULTS

Southern California

Disturbance Frequency

We documented 100 incidents of disturbance to Brown Pelicans in 189 hours of observations at roosts along the southern California mainland. Forty-six of these disturbance events were documented in 1999-2000, and 54 were part of the historic data set (Table 1). An additional 133 disturbance events were recorded during focused observations at Mugu Lagoon during 1991-93 (Jaques et al. 1996); these data were not included in the pooled information for southern California in this report, except where noted.

Disturbance frequency in southern California was 0.53 flushing events per hour over the entire sample period. The overall disturbance rate was slightly higher in southern California in 1999-2000 than in 1986-93 (Table 1). Disturbance rates were higher at seven roosts, lower at two roosts, and unchanged at two roosts in the recent period. Observation hours were relatively low at many southern California sites, however.

Disturbed Habitats

Frequency and severity of disturbances to roosting Brown Pelicans in southern California were greatest in natural habitats, such as river mouths and other estuaries, and lowest at harbors and man-made structures along the outer coast (Fig. 1). Pelicans at natural roosts were disturbed by people about once every hour, while pelicans at artificial roost sites were disturbed about once every four hours (N= 189 hours). Within harbors, pelicans at detached breakwaters were disturbed less frequently than those at jetties (0.28 compared to 0.36 disturbances/hour). The total number of pelicans observed flushed from all sources was 4,779 birds. Of these, 85% were roosting on natural substrates, and 16% were on artificial structures. There was a tendency for a higher proportion of the birds present to flush from a disturbance in a natural setting, compared to a harbor. All natural roost sites where disturbance was documented had a higher disturbance index than the artificially created roost sites (Table 1).

Table 1. Disturbance frequency and hours of observation at selected Brown Pelican roosts in southern California, 1986-1993 and 1999-2000. Roost sites are listed roughly in order of most to least disturbed. Human and natural disturbances are expressed as the number of disturbance per hour of observation (N). "D" is the Disturbance Index and pertains to data collected in 1999-2000 only. The disturbance index is described in Methods.

Roost No.	Roost Site	Hab.	1986-1993			1999-2000			
			Human	Natural	N	Human	Natural	N	D
LA 16.0	Malibu Lagoon	LAG	0.88	0.15	(6.8)	2.58	0.32	(6.2)	29.7
SD 1.0	Tijuana Slough	EST	1.43	0.32	(6.3)	ND	ND	ND	
VN 7.0	Santa Clara River	RMO	1.13	0	(11.5)	1.35	0.19	(5.2)	8.1
SD 4.0	Point Loma Cliffs	CRS	2.29	0	1.8	ND	ND	(.1)	-
SD 10.0	La Jolla Cliffs	CRS	ND	ND	0	1.0	0	2.0	5.8
LA 11.0	King Harbor	HRB	0	0	(3.0)	0.75	0	(8.0)	4.9
OR 3.0	Dana Point Harbor	HRB	0.28	0	(14.2)	0.58	0	(6.9)	1.6
VN 5.0	Channel Islands Harbor	HRB	0.4	0	2.5	0.51	0	(3.9)	0.5
SD 3.5	Zuniga Point	JTY	1.7	0	1.8	0	0	(3.2)	0
VN 4.0	Mugu Lagoon	EST	0.31	0.10	(322)	ND	ND	0	-
VN 8.0	Ventura Harbor	HRB	0	0	(2.7)	0.35	0	(8.7)	1.3
SD 12.0	Agua Hedionda Lagoon	LAG	0	0	3.2	0.28	0	(7.1)	4.2
LA 12.0	Marina del Rey Harbor	HRB	0.29	0	(17.5)	0.26	0	(3.8)	0.6
SD 11.0	Batiquitos Lagoon	LAG	0	0	1.3	0	0	(1.4)	0
OR 10.1	Bolsa Chica Lag.	LAG	0	0	1.2	0	0	(0.1)	-
SD 13.0	Oceanside Harbor	HRB	ND	ND	0	0	0	(1.2)	0
SB 4.0	Santa Barbara Harbor	HRB	0	0	12.7	0	0	(2.3)	0
SB 3.0	Santa Barbara Outer Harbor	HRB	0	0	2.6	historic roost site			
VN 10.0	Mobil Oil Pier	MMS	0	0	8.9	historic roost site			
	***SOCAL TOTAL**		**0.43**	**0.03**	**(120)**	**0.62**	**0.04**	**(69)**	

* does not include Mugu Lagoon

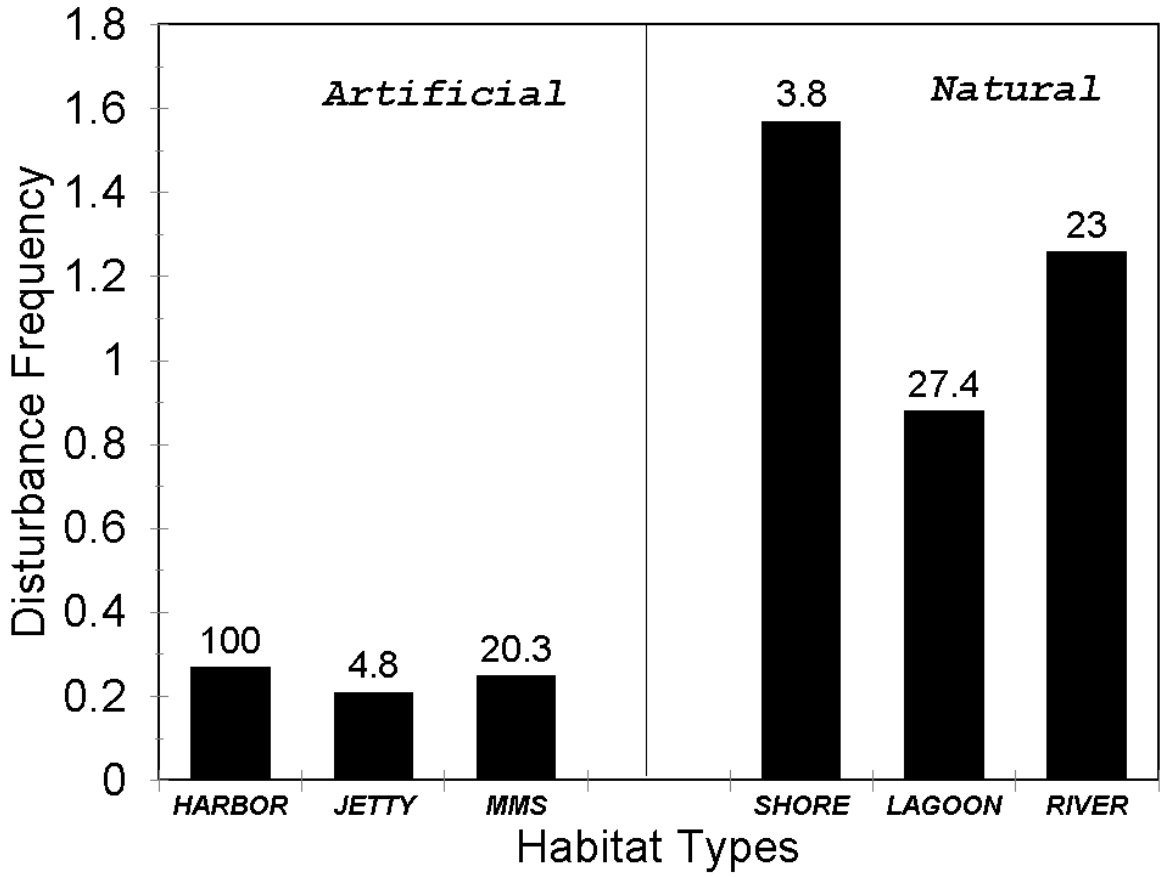

Figure 1. Frequency of human disturbance to Brown Pelicans at roosts in six general habitat types in Southern California. 'Disturbance frequency' is the number of disturbance events documented per hour of observation in each habitat type. The number of hours spent observing pelicans in each habitat is shown as the sample size on top of each bar. Habitat types are defined as follows: Harbor = all roosting substrates associated with harbors, including jetties, breakwaters and other man-made structures; Jetty= jetties on the outer coast, not closely associated with harbors; MMS= man-made structures not associated with harbors; Shore= mainland cliff or rocky shoreline; Lagoon= lagoon; River= river mouth.

Disturbance Types and Pelican Response

The greatest single source of disturbance was a person(s) on foot, approaching pelicans at a roost. This accounted for 32% of all disturbances seen from 1986-2000. In most cases the people were simply walking, but a few incidents involved more specific types of activities e.g., jogging, photographing. The second largest source of disturbance was from water-based recreational sports, including boating, surfing and fishing. Disturbances from watercraft and surfers were proportionally greater in 1999-2000 than in 1986-93 (Fig. 2). Collectively, these sports accounted for 13% of all disturbances in the early period compared to 37% in the latter period. In contrast, documented disturbances involving dogs decreased, from 17% of all disturbances in 1986-93, to 2% in 1999-2000. Natural disturbances were rare in southern California and accounted for less than 10% of all disturbances (N=100 disturbances).

Characteristic types of disturbance differed by habitat. In harbors, 50% of all disturbance events were caused by watercraft of some type, and 20% of disturbances were caused by fishermen on foot (Fig. 3). In estuarine habitats, 62% of all human disturbances were caused by people approaching pelicans on foot (including surfers); an additional 20% of events observed were caused by people with dogs.

The disturbance category causing the greatest total numbers of pelicans to flush was "walker" (Table 2). Boats, not including kayaks and jet skis, caused the fewest pelican to flush per incident on average. Disturbances by fishermen on foot caused the lowest total numbers of pelicans to flush, but these disturbances resulted in complete displacement of a relatively high proportion of birds from the roost site.

The most common pelican response to disturbance, after flushing, was to relocate within the same roost (Table 2). Of the disturbance events in which pelican fate could be tracked, 60% of the total relocated to a different area within the same roost, 26% returned to the same site within the roost, and 14% departed the roost entirely.

Flushing Distances

The distance at which pelicans flushed from a disturbance source varied by type of disturbance, roost habitat, and other variables. Pelicans flushed at the greatest distance from helicopters and allowed closest approach by kayaks (Fig. 4). Mean distances for each disturbance category indicated that pelicans allow closer approach by all types of boats than by persons approaching on foot. Pelicans flushed from walkers at a range of 20-50 meters and from boats at a range of 4-30 meters. Mean flushing distance in estuarine habitats was greater than mean flushing distance in harbors (26.3 versus 13.8 meters, respectively; N= 37 disturbance events).

Disturbed Locations

The most heavily disturbed traditional roost sites in Southern California were Malibu Lagoon, the Santa Clara River mouth, and Tijuana Slough. Each of these sites had disturbance frequencies exceeding one flushing event per hour. The harbors with the greatest disturbance problems in southern California appeared to be King Harbor and Dana Point. The primary roost

SOUTHERN CALIFORNIA

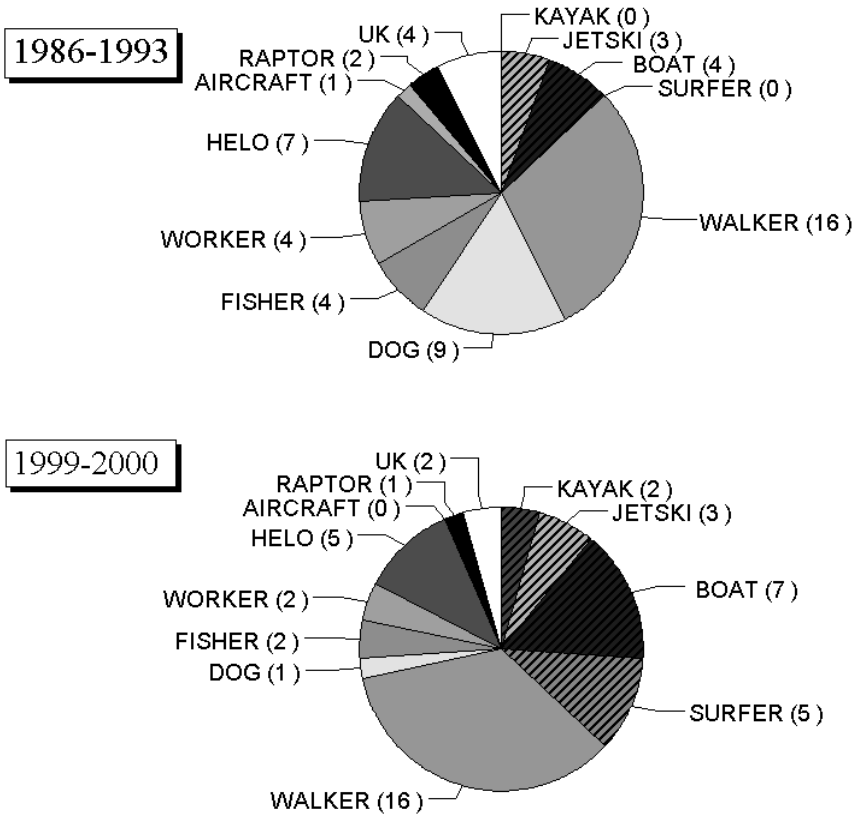

Figure 2. Sources of disturbance to Brown Pelicans at roosts in Southern California as observed in 1986-1993 (top chart) and 1999-2000 (bottom chart). See text for definition of source categories. The number in parenthesis represents the total number of observed disturbance events due to a given source in each time period. The shaded area indicates categories collectively referred to as "water sports" in text.

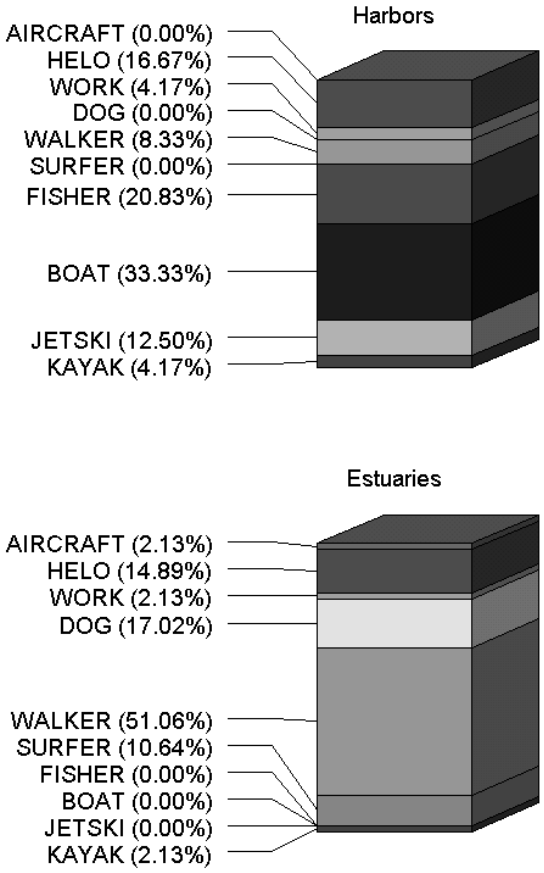

Figure 3. Sources of human disturbance to Brown Pelicans at roosts by habitat type in Southern California. "Harbors" refers to all types of roost substrates used within harbors, and "estuaries" refers to all estuarine habitats, including lagoons and river mouths. Disturbance categories are described in text. The number in parenthesis represents the percentage of the total observed disturbances caused by a given source within each habitat type.

Table 2. Brown Pelican response to different disturbance sources in Southern California.

Disturbance source category	**Number of events in sample**	**Number of pelicans flushed**	**Mean Number Flushed per event**	**Number that departed roost entirely**	**Number that relocated within roost**	**Number that returned to same site**
Fisherman	4	95	24	49	51	0
Surfer	5	125	25	11	66	45
Jetski	6	168	28	0	58	110
Kayak	2	202	101	3	199	0
Boat	11	206	19	18	81	87
Worker	5	330	66	44	153	133
Dog	6	360	60	58	128	210
Helicopter	8	443	55	46	191	206
Walker	26	2076	80	218	1086	79
Total		**4005**	**51**	**447**	**2013**	**870**

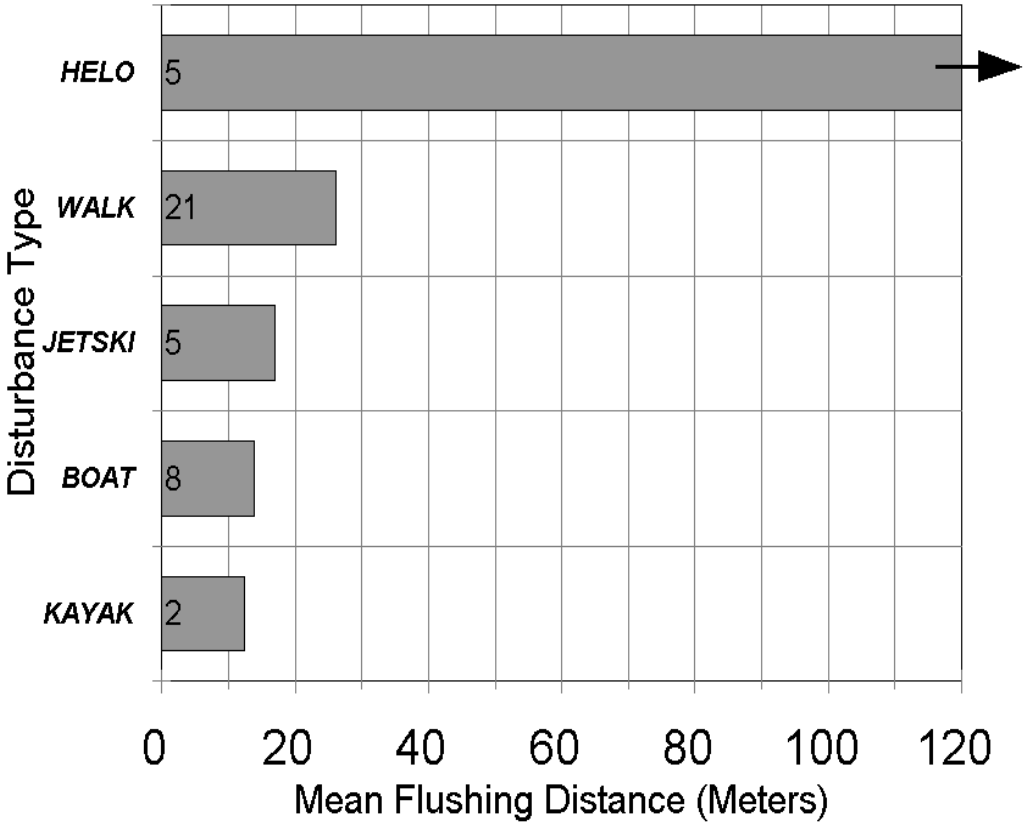

Figure 4. Mean distances (in meters) at which Brown Pelicans flushed from roosts in Southern California from various types of human disturbance. Disturbance types are defined in text. Number at base of bars represents the number of disturbance events in which flushing distance was estimated for each source. The mean flushing distance for helicopters was 312 meters.

sites at each of these harbors were attached jetties, rather than detached breakwaters. The examples below describe some of the dynamics of disturbance at these sites, including how it related to habitat characteristics at each roost.

Malibu Lagoon ***(LA 16.0)*** had the highest disturbance index of all sites observed in 1999-2000, due to high use by young pelicans and heavy disturbance from a variety of sources during the two dates it was visited (Table 1). As many as 339 pelicans were present (90% immature birds at peak census) and 18 disturbance events were recorded over 6.2 hours. Five disturbance events were caused by surfers walking or wading through the area and six were caused by other beach and park visitors, including one child who intentionally chased pelicans off of the beach berm. A kayaker that paddled through the middle of the small lagoon caused the most severe displacement of roosting and bathing birds. Three helicopter disturbances, and one patrol car disturbance also occurred, as well as two disturbances from unknown causes.

Roosting substrate availability and use varied according to lagoon configuration, tidal height and disturbance. When the lagoon was open, gravel bars surrounded by shallow water were available within the lagoon. When the lagoon was closed, these bars were submerged and the only island habitat available was a relatively small branched piece of driftwood. In this case the primary roost site was the sand berm separating the lagoon from the ocean, except during low tides, when a cobble bar was available in the intertidal region. Disturbance occurred in all of these locations and birds were forced to relocate within the roost numerous times, spending much of the time after disturbances floating in the water. Despite this, pelicans were tenacious to the site overall. Only 62 birds were known to depart the roost, of the total 1,146 bird flushes due to disturbance, during the two observation dates in 2000. The disturbance rate at Malibu Lagoon was higher than recorded in 1986-93 (Table 1).

The **Santa Clara River** mouth ***(VN 7.0)*** has historically been a relatively heavily disturbed roost site and continued to reflect this characteristic in 2000 (Table 1). The implications of variation in availability of roost habitat due to changes in water levels at this site were illustrated on the two dates the roost was observed in 2000. On the first date, the lagoon was open to the sea and sandbar roost habitat was available inside the lagoon. No human disturbances were recorded although public use of the surrounding area was high. The number of birds increased from 10 to 51 over the two-hour observation period. On the second date, the lagoon was closed and the birds roosted on the outer sand berm between the ocean and the estuary. Disturbance was chronic; birds were flushed seven times in three hours. The primary response to people walking on the beach was to relocate into the lagoon and remain swimming for many minutes before gradually coming back out onto the berm. In contrast to this, when an unleashed dog was allowed to chase the pelicans off the beach, most of them (30 of 38) departed the roost entirely. The chronic disturbance and lack of alternate dry roost habitat within the lagoon did not allow numbers of birds to increase; 13 pelicans were present at the start of observations, 74 were flushed, and 19 were present at the end of three hours. Like Malibu Lagoon, this site was used predominantly by young birds on the day of heavy disturbance (82% immature pelicans at peak census).

Historic data were limited for the **Tijuana River mouth *(SD 1.0)*** and it was not visited in 1999-2000. Pelicans attempting to use the site during two visits in 1986 were flushed repeatedly from inside and around the lagoon. Disturbance sources included recreational park users, illegal immigrants wading across the wetland, helicopters, horses and raptors. Like other heavily disturbed estuarine sites, this location was used predominantly by immature pelicans. Seven disturbances occurred in four hours on one date when up to 300 pelicans (90% immature) were present.

Pelicans roosted in three general areas of **King Harbor *(LA 11.0)***, on the long outer jetty, a short inner jetty, and on a bait barge. The outermost tip of the long jetty was used regularly by fishermen, so the birds tended to roost near the middle bend of the jetty. Each time a fisherman walked the length of the jetty pelicans were forced to move. The tip of a short inner jetty was also used as a secondary roost, presumably due to chronic disturbance on the long jetty. The inner jetty was disturbed by fisherman on foot as well as watercraft passing particularly close to the roost. A jet ski and a tour boat were the only vessels observed to disturb pelicans. Pelicans roosting on the bait barge flushed when the site was accessed for bait. On average, 76% of the pelicans that used this site in 2000 were immature (Strong and Jaques 2001).

At **Dana Point *(OR 3.0)***, the physical configuration of the harbor, roost site selection, and the types of disturbances that affected roosting pelicans were very similar to King Harbor. However, the main jetty at Dana Point is much longer than at King Harbor and people appear to be less likely to walk the entire length of it to reach the tip to fish. The boat disturbances noted at this site were from a jet ski and a canoe. Pelicans were clearly habituated to relatively close approach from other motorized boats. Adults comprised 55% of all brown pelicans surveyed at this site in 2000 (Strong and Jaques 2001), perhaps reflecting it's lower tendency for disturbance than at King Harbor.

Central California

We evaluated 95 disturbance events in the Moss Landing area (61 historic and 34 from 1999-2000) and 40 at Pismo-Shell Beach (23 historic and 17 from 1999-2000). Total observation hours for each site and each period are provided in Tables 3 and 4. Changes in frequency and type of disturbance characteristic to both of these central California areas were documented. Disturbance from shore-based fishermen, helicopters and dogs apparently decreased while disturbance from kayaks and tour boats increased (Figs. 5 and 6). The number of pelicans flushed in the Moss Landing area was 9,397 in the historic data set and 1,679 in 1999-2000. Numbers of pelicans observed flushed at Shell Beach was 1,307 historic and 753 in 1999-2000.

Pismo-Shell Beach Area

The Pismo-Shell Beach area consists of fairly contiguous band of offshore rocks, cliffs and pocket beaches. The rocks are the predominant roost type, although cliffs are also used by pelicans. There is one large rock (Pismo Rock) about 1/4 km offshore, but the remainder of the rocks are relatively small, very near to shore, and adjacent to the town of Shell Beach. Mainland

Table 3. Disturbance at Brown Pelican roosts in the Pismo and Shell Beach Rocks area, 1986-1991 and 1999-2000. Disturbance is presented as frequency of flushing events per hour of observation (N). " D" is the disturbance index described in Methods and pertains only to data collected in 1999-2000.

Roost No.	Roost Site	1986-1991			1999-2000			
		Human	Natural	N	Human	Natural	N	D
SL-1.0	Pismo Rock	0.09	0.05	(21.8)	0.0	0.0	(3.1)	0
SL-1.1	Pismo Rock area	0.64	0.21	(14.2)	ND	ND	0	-
SL-2.0	Shell Beach Rocks	0.20	0.12	(25.5)	1.16	0.16	(12.9)	31.0
	Pismo -Shell Beach Total	**0.26**	**0.12**	**(61.5)**	**0.94**	**0.13**	**(16.0)**	

Table 4. Disturbance at Brown Pelican roosts in the Moss Landing area, 1986-1991 and 1999-2000. Human and natural disturbance indicates the frequency of flushing events per hour of observation (N) for each category. "D" is the disturbance index described in Methods and pertains only to data collected in 1999-2000. Research and hunting-induced disturbance at Moss Landing were excluded from this analysis.

Roost No.	Roost Site	1986-1991			1999-2000			
		Human	Natural	N	Human	Natural	N	D
MO-17.0	Moss Landing Wildlife Area	0.03	0.06	(345)	0.55	0.17	(29.1)	33.7
MO-18	Elkhorn Slough	0	0	(0.5)	2.63	0.26	(3.8)	45.6
MO-16.0	Moss Landing Harbor	0.60	0.12	(18.4)	0.91	0	(1.1)	-
MO-15.0	Salinas River Mouth	0.77	0.39	(15.5)	4.0	0	(0.3)	-
	Moss Landing Area Total	**0.09**	**0.12**	**(379)**	**0.82**	**0.18**	**(34.3)**	

SHELL BEACH

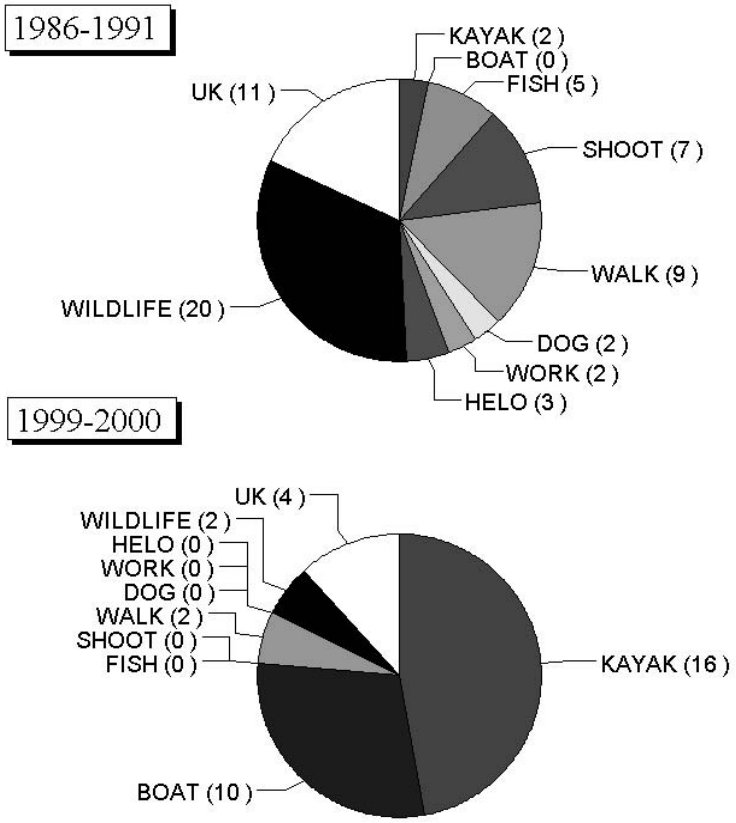

Figure 5. Sources of disturbance to Brown Pelicans in the Pismo-Shell Beach area as observed in 1986-91 (top chart) and 1999-2000 (bottom chart). See text for definition of source categories. The number in parenthesis represents the total number of observed disturbance events due to a given source in each time period.

MOSS LANDING

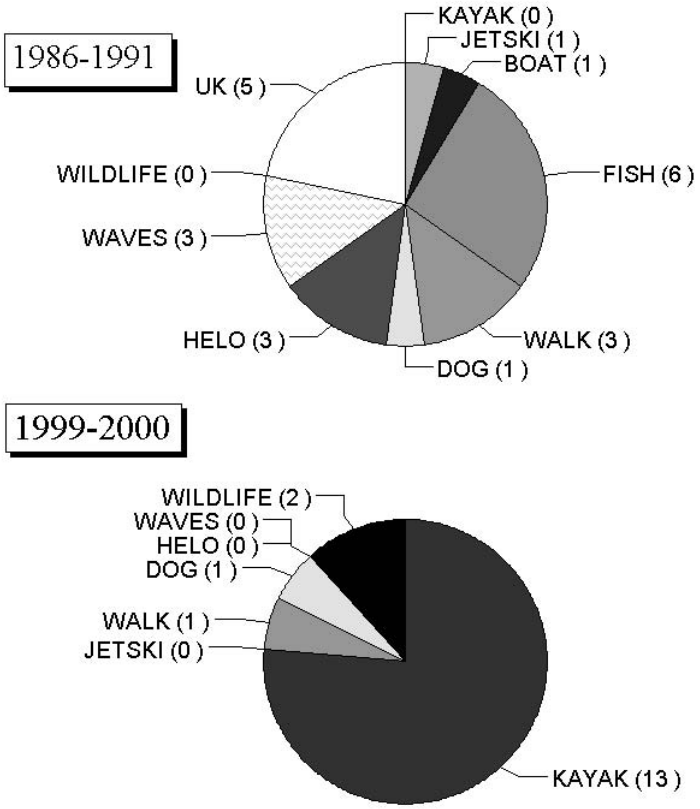

Figure 6. Sources of disturbance to Brown Pelicans in the Moss Landing area as observed in 1986-91 (top chart) and 1999-2000 (bottom chart). See text for definition of source categories. The number in parenthesis represents the total number of observed disturbance events due to a given source in each time period.

cliffs and beaches in the Pismo Rock area were grouped together as the 'Pismo Rock Area' roost. The frequency of human disturbance at the Pismo-Shell Beach Rocks increased and the type of disturbance changed over time. The documented disturbance rate at Shell Beach Rocks in 1999-2000 was 6 times greater than in 1986-91 (Table 3). This was due to the relatively new popularity of kayaking around the nearshore rocks. No kayak disturbances were documented in the historic period during 62 hours of observation, whereas 13 kayak disturbances were observed in 1999-2000 during 16 hours of observation (Fig.5). Kayaks accounted for 77% of all disturbances in the Pismo-Shell Beach area, and 87% of all human disturbances. People had been observed using rubber boats to land on the nearshore rocks during 1986-87. Although there was evidence that people still land or climb onto the rocks, no disturbances of this type were witnessed in 1999-2000. The mean number of pelicans flushed per hour at Pismo-Shell Beach rocks from all sources was 21.3 birds/hour in the historic period and 47.1 birds/ hour in 1999-2000.

No disturbances were documented at nearby Pismo Rock or in the 'Pismo Rock Area' in 1999-2000. Historic disturbance at Pismo Rock included one event where persons in wet suits swam out to the island and climbed up on it, flushing hundreds of birds. The potential for disturbance in the 'Pismo Rock Area' was lower due to loss of a previously used beach roost site. There was formerly a pocket beach below the cliffs that was inaccessible to the general public until a cliff top hotel built steps down to it in 1987. Pelicans appeared to have abandoned that site completely by 1999, leaving only cliff face roost habitat at the 'Pismo Rock Area' site.

Moss Landing Area

The roost sites in the Moss Landing area included three estuarine sites, the Moss Landing Wildlife Area (which is part of Elkhorn Slough), other areas in Elkhorn Slough, the Salinas River mouth, and the Moss Landing Harbor. A mix of natural and artificial roost substrates were used within Moss Landing Harbor. Roost site availability and selection at the Salinas River mouth varied depending on the water levels in the estuary. The primary roost types at the Moss Landing Wildlife Area (WA) were eroded exterior earthen levees along the north bank of Elkhorn Slough and interior managed wetland ponds. An eroding levee on the south bank of Elkhorn Slough, directly across from Moss Landing WA, was the second most frequently used roost site in the area and could be considered as part of the same roost as at the WA. Habitat conditions at Moss Landing and Elkhorn Slough have changed greatly since the late 1980's when most of the historical data were collected. Prior to reconstruction of the area by the CDFG in 1988, the primary pelican roost habitats were the interior levees of a former salt works operation and relic ponds with permanent shallow water (Jaques and Anderson 1988). Use of the Moss Landing Wildlife Area by pelicans was historically higher and use of other areas in Elkhorn Slough was negligible, compared to recent years.

Frequency of human disturbance to Brown Pelicans in Elkhorn Slough and the Moss Landing Wildlife Area was extremely high in 1999-2000 compared to the 1986-1991 level (Table 3). The two areas together were disturbed by human impacts nearly every hour (0.9 events/hr) in 1999-2000 compared to once every 33 hours historically (not including the waterfowl hunting season in either case). The Salinas River mouth and Moss Landing Harbor were found to be far more

heavily disturbed than the Elkhorn Slough sites historically, but not enough data were collected at these surrounding roosts in 1999-2000 to evaluate more recent status.

The increase in disturbance at Moss Landing and Elkhorn Slough reflected the changes in roost site availability and water level management within the Wildlife Area, along with increased disturbance due to an explosion of water-based "ecotourism" and kayak use in Elkhorn Slough. Kayaks and boats accounted for 77% of all disturbances in the Moss Landing area in 1999-2000 (Fig. 6). Only 2 kayak or boat-based disturbances were observed in the Moss Landing area (both in the harbor) during 380 hours of observation in the historic period, versus 26 events during 34 hours in recent period. Pelicans were relatively immune to boat based disturbances when they had adequate roost habitat in the interior regions of the Wildlife Area.

Natural disturbance by raptors and other birds was more common than human disturbance at the Moss Landing WA area in 1986-1991 (Table 3). Most of the historic disturbances by fishermen (including clammers) in the Moss Landing area took place in the harbor.

The mean number of pelicans flushed per hour in the Moss Landing area (due to both natural and anthropogenic sources) was 24.8 birds/hour in the historic period versus 49.4 birds/hour in the recent period.

DISCUSSION

Human disturbance in estuaries appears to have the most severe negative effects on roosting Brown Pelicans in southern California, relative to disturbance in other available habitats. Flushing distances were greater, disturbance was more frequent, and the total numbers of pelicans affected by disturbances were higher in these natural habitats compared to the artificial roost environments observed. Jaques et al (1996) also found that human disturbance in southern California tended to be greater in estuarine habitats than in harbors, based on more limited data. The severity of disturbance events in harbors tended to be fairly low, considering the intense level of human activity in the surrounding area. Pelicans displayed habituation to the most common type of boat traffic in harbors and chose roost sites that were relatively inaccessible to persons on foot. Artificial structures on the outer coast, other than those associated with harbors, have historically been some of the least disturbed sites, but there were few of these roosts remaining by 1999. We did not collect enough data in what remains of this habitat type (e.g. Rincon Island and Sandpiper Pier), to evaluate disturbance due to access issues.

Greater sensitivity of pelicans to human approach in estuarine settings compared to harbors may relate to the higher likelihood of natural mammalian predation and less effective buffers at coastal wetlands. Variation in responses to disturbance by the same species of birds in different habitats have been documented for other waterbirds (Joselyn et al. 1989, Bratton 1990). The flushing distances observed in southern California estuaries, however, were lower overall than reported for Moss Landing (Jaques and Anderson 1988) and observed in other regions of the Brown Pelican range (D. Jaques, unpublished). Data suggest that pelicans are more tolerant of or "habituated" to human presence in some southern California coastal areas, compared to roost

sites where human presence is relatively rare.

Human disturbance in southern California does appear to be an important factor involved in deterring pelicans from using natural habitats (i.e. estuaries, river mouths, creek mouths, lagoons, rocky shorelines and beaches) and favoring the use of artificial habitats. Data from the analysis of distribution and abundance in southern California showed that artificial roost sites supported 66% of roosting pelicans along the mainland on average, and that these sites were occupied more consistently than natural sites (Strong 2002). In the northern portions of the California Brown Pelican's nonbreeding range, natural habitats along the mainland, including creek mouths, river mouths, other estuarine sites, and some beaches, are used heavily as roost sites (Briggs et al. 1983, Jaques 1994) and artificial substrates comprise a relatively small portion of the habitat selected.

Jaques and Anderson (1987) found an inverse relationship between the presence of adult pelicans and disturbance level within various habitats in central California. These and other data suggested that Brown Pelicans learn, over time, to avoid chronically disturbed locations. Learned avoidance of heavily hunted areas has been documented in geese (Ebbinge 1991).

Observations of the worst cases of chronic disturbance that we documented in southern California involved a large proportion of immature birds. A recurring pattern of young birds being drawn to naturally attractive shoreline features such as rock promontories (e.g. Point Loma) and freshwater outlets, and then encountering high rates of human disturbance, seems to exist in southern California. Immature birds are the most likely to be energetically stressed due to lower foraging success than adults (Orians 1969), and have a high mortality rate in the first year (Anderson and Gress 1983), mostly due to starvation. It follows that birds that continually encounter high disturbance levels will have a lower chance of survival, compared to birds that learn to roost in relatively undisturbed habitats. This study indicates that disturbance in natural areas may be incurring relatively high costs to immature pelicans and precluding regular use of otherwise desirable habitats by adults.

Estuaries and other coastal wetlands were probably the key mainland roost sites prior to development of the southern California shoreline. These habitats serve a variety of functions for Brown Pelicans, including bathing, pouch-washing, and in some cases, foraging. Mugu Lagoon may be the only estuarine site in southern California that can be considered a regularly used, high quality roost for brown pelicans (Jaques et al 1996, Capitolo et al.2002, this report). Ownership and management by the U.S. Navy have restricted access and limited disturbance at the site, compared to other areas in southern California. In contrast, Malibu Lagoon and the Santa Clara River mouth are managed as State Parks and are subject to intense human recreation. Some of the lagoons in San Diego County are managed for wildlife and are well buffered from human disturbances, but lack roost habitat suitable for Brown Pelicans. Some roost habitat was historically available near the mouth of Batiquitos Lagoon, but this was eliminated by habitat modification for other endangered species. Man-made structures provided roost habitat in Agua Hedionda Lagoon, but this roost site was in the process of being purposely eliminated in 2000 (Strong 2002).

Although they are not managed as wildlife habitat, the many artificial structures and harbors along the southern California coast are a critical component of nonbreeding habitat for Brown Pelicans. The presence of large aggregations of pelicans in harbors, however, can have negative impacts as well. Pelicans using harbors to roost are more likely to encounter oil and other contaminants, are more likely to become entangled in monofilament, and may become regular scavengers or 'pan-handlers.' Pelicans frequenting harbors are also more likely to be involved in negative interactions with humans such as interfering with sport and commercial fishing, causing private property damage, becoming a public nuisance, or being maimed or killed by malicious persons.

Efforts to reduce human disturbance in southern California will target different user groups, primarily different types of recreationists, according to general roost site habitat. The key user groups in harbors that would need to be reached or restricted are boaters and fishermen, whereas the primary users in estuaries would be persons walking on the beach. The increase in the proportion of disturbance due small watercraft and surfers in the recent versus the historical period may reflect an increase in the popularity of these watersports.

Data in this report regarding the characteristic types and effects of disturbances for the Southern California region will aid in development of specific management or restoration recommendations. Recent data for individual sites in southern California were generally limited to a few hours of observation, however, and should not be considered comprehensive. The 1999-2000 observations also took place only in two periods, summer and early fall. There may be other factors that are important in winter and spring. Larger swell size, greater freshwater runoff, differences in fishing seasons and human recreation tendencies are examples of seasonal factors that may change patterns of roost use and human disturbance.

Other types of disturbance not identified in this study may be significant or may become relevant over time. Intense sodium lights from squid boats have been observed to disrupt activity patterns of Brown Pelicans at Anacapa Island (F. Gress, U.C. Davis, pers. Comm). Birdwatching and kite-flying are examples of recreational activities that could cause chronic disturbance at some roosts. Research has been identified as a source of disturbance to roosting pelicans (Jaques and Anderson 1988, Wright 2002). There is a need for review of potential conflicts wherever research field sites and major pelican roosts physically overlap. Changes in habitat, recreational trends, industrial developments, scientific interests, and other factors affecting human and pelican presence in the landscape will change the nature of disturbances at some sites. Periodic monitoring and adaptive management strategies may be required for long-term protection of roost sites that are vulnerable to disturbance.

RECOMMENDATIONS

Southern California

The results of this study, and the above discussion of harbors versus estuaries, suggest that restoration actions geared towards reducing human disturbance at existing roosts in southern California should prioritize natural areas. It may be more difficult to achieve the goal in natural

habitats, however, the long-term ecological benefits to pelicans and other waterbirds species are likely to be greater. Some harbor structures or man-made structures on the outer coast remain very good candidates for enhancement, as discussed below. Tables 5 and 6 summarize our recommendations.

Harbors

Recommendations to improve habitat in harbors have included installation of fences on jetties to prevent disturbance from people walking out to the tips (ATTC 2001). Fishermen were the only people that we observed on the tips of long jetties with important roosts. Both pelicans and fishermen appear to prefer the tips of jetties. Precluding fishermen from tips of jetties would probably be very effective in reducing disturbance, including the indirect disturbances that pelicans encounter when they move to less preferred habitats within the same harbor after a disturbance. This might lead to greater numbers of pelicans using those jetties where fencing was installed. However, the value of allowing more pelicans to rest undisturbed on jetties needs to be weighed against the negative implications of greater pelican use of harbors. This action would also likely be perceived as restriction of the rights of shore fishermen, a group that directly caused only 6% of all disturbances documented in southern California. Vandalism, an increase in negative perceptions of pelicans, and increased potential of intentional killing or maiming of pelicans by fishermen may result from this action at popular fishing locations. In contrast, jetties that are not associated with intensive public use and that can be restricted for other reasons may be good candidates for fencing. A jetty in Anaheim bay was fenced off historically due to restrictions associated with government property. Other jetties in California are closed to public access due to safety concerns.

Placement of buoys around breakwaters to create a buffer zone between boats and pelicans has also been discussed. This may effectively prevent some disturbances, such as from tourboats, but the buffer is likely to be violated by the users of watercraft such as jetskis, kayaks and other small boats. These smaller vessels caused the most disturbance. Enforcement of a buffer zone would be necessary if it were to be effective. The overall positive benefits to pelicans are likely to be fairly negligible if there is no enforcement. Problems associated with the buoys causing hazards to navigation in some fairly narrow channels also need to be considered. Based on observed flushing distances in this study, a buffer of 30 meters would preclude all boat-based disturbance, and a 20 meter buffer would eliminate 75% of disturbances. The distance at which most boats pass *without* causing disturbance, and the distance required for boats to safely pass through a given area should be evaluated and added to the assessment before specific plans are proposed for this type of potential restriction.

Table 5. Summary recommendations to reduce human disturbance of roosting pelicans in southern California estuaries.

Target Human User Group	***Project Description***	***Pros***	***Cons***	***Locations***
Walkers, Fishermen, Surfers, Kayakers, Dogs	*Develop education materials targeted to instill an awareness and ethic about protecting pelicans and other seabirds from disturbance*	*Decrease disturbance of roosting pelicans*	*Interpretive displays may be subject to vandalism*	*Malibu Lagoon, Santa Clara River mouth, Tijuana River mouth*
		Increase use of coastal wetland habitats by pelicans and associated waterbirds	*Success depends on voluntary behavioral modification*	
	Restrict human access within 25 m to 30 m by modifying trail patterns (may be temporary or permanent), create temporary closures to foot traffic or boats	*Same as above*	*Need for onsite management personnel to implement changes in trails and/or maintain experimental closures*	*Malibu Lagoon, Santa Clara River mouth, Tijuana River mouth*
		Creates or increases regulatory buffer distance between pelicans and people	*May require regulatory enforcement*	
General Disturbance including Walkers, Fishermen, Dogs	*Create island roost habitat within wetlands using natural or artificial substrates. Alternatives include earthen islands, artificial floating structures or pile-supported structures.*	*Increase habitat availability and decrease disturbance by providing dry substrate surrounded by water buffer*	*Permitting may be difficult*	*Mugu Lagoon, Bolsa Chica, Agua Hedionda, San Elijo, Batiquitos, south San Diego Bay*
		Does not restrict recreational opportunities or rely on voluntary changes in human behavior	*Costs for earthen islands may be relatively high, artificial structures may need to be maintained.*	
	Enhancement of roost sites by increasing elevation of existing islets	*Same as above, increased habitat during high water, may not be considered wetland fill*	*Permitting may be difficult*	*Same as above*
	Provide artificial roosting substrate such as driftwood	*Same as above, as well as relatively easy to implement and natural in appearance*	*Limited available space for pelicans on driftwood, may require annual replacement*	*Same as above.*

Table 6. Summary recommendations to reduce human disturbance of roosting pelicans in southern California harbors.

Target Human User Group	***Project Description***	***Pros***	***Cons***	***Locations***
Fishermen	*Installation of fences on tips of long jetties to block access to fishermen on foot*	*Decrease disturbance and displacement of pelicans from jetty roosts, may elevate status of some diurnal roosts to night roosts, may reduce pelican use of boats, piers, buildings, and other private property in harbors*	*May restrict rights of fishermen*	*The longest jetties at Dana Point, King Harbor, Oceanside, Anaheim Bay and potentially others*
			May increase pelican use of harbors overall, resulting in increased negative human-pelican interactions	
Kayaks, Jet skis, Other Boats	*Placement of signs informing boaters that landing on breakwaters and similar structures is not permissible*	*Decrease disturbance, flushing and displacement of pelicans by boaters landing on or near roosting sites*	*None identified*	*Breakwaters at Marina del Rey (priority site), Ventura Harbor, Channel Islands Harbor and potentially others*
	Placement of buoys around breakwaters to create a 20 m to 30 m buffer zone between boats and pelicans	*Decrease disturbance and flushing of roosting pelicans from near approaches by boats*	*May restrict activities of large, well-informed tour boats, but not small boats such as kayaks and jet skis (small boat operators were observed to cause the most disturbance)*	*Breakwaters at Marina Del Rey, Ventura Harbor, Channel Islands Harbor and potentially others*
			Enforcement important yet difficult	
			Buoys may cause navigation hazard	

The most severe disturbance scenario for harbors is having boats land on important breakwater roost sites. We observed people on breakwaters at Channel Islands Harbor and Ventura Harbor, but did not witness the landings and disturbance events directly. It is against Army Corps policy for persons to access the breakwaters, but there is no obvious source of public information on this. We recommend that signs be placed on the breakwaters and at boat access points, informing people that the structures are not available for public use. The most important breakwater to protect is at Marina del Rey.

Estuaries

Based on existing data, we recommend action to reduce disturbance at Malibu Lagoon and the Santa Clara River mouth. Creation or enhancement of roost habitat within less disturbed wetlands, such as South San Diego Bay or Batiquitos Lagoon, may be more successful and has been identified as a high priority (C. Gorbics, USFWS, pers. comm.). Provision of a high quality roost site in South San Diego Bay, may indirectly help alleviate problems at Tijuana Slough, by providing a nearby alternate roost.

Efforts to reduce disturbance at Malibu Lagoon and the Santa Clara River mouth should include working with the California Department of Parks and Recreation (CDPR) to develop interpretive materials to help instill an awareness and ethic about disturbing pelicans and other waterbirds. Review of the human traffic patterns and trails at Malibu Lagoon may reveal some specific options for modifying human access patterns to reduce disturbance to the wetland area. When the lagoons are closed, however, pelicans are likely to be on the outer beach where it may not be possible for a person to walk the beach at high tide without impacting pelicans at the edge of the lagoon. We recommend that experiments with temporary closures around typical beach berm or sand spit roost sites take place. These could be set up using cones, ropes or signs. We observed infrequent violation of Snowy Plover and Least Tern exclosures at State Parks. A minimum buffer zone of 25-30 meters between human traffic and pelicans would be required. A buffer distance of 30 m or more to protect wetland birds was recommended by Josselyn et al. (1989).

Changing the distribution of the pelicans by modifying habitat would be more effective in reducing disturbance than trying to alter the behavior of people. Enhancement of natural islets within the estuaries to raise the elevation of roost sites above the high water level or provision of additional natural substrate such as driftwood would be an effective means to provide a water buffer between park users and pelicans. Islets made of natural substrate may not be permanent due to erosion during heavy runoff periods, but could serve pelicans for a number of years. Sand spurs facing into the estuary off the estuary might be more easily created and would also reduce disturbance potential. Although habitat manipulation is accepted at wetlands managed for wildlife, the support for these projects may not be likely in dynamic coastal wetlands managed by the CDPR. Placement of woody debris in coastal estuaries has taken place as part of salmon enhancement efforts in northern California. While the woody debris option would provide substrate for fewer pelicans, it may be more likely to be permitted.

Creation or enhancement of island roost habitat would be effective at many coastal wetlands that have restricted or limited public use, including Mugu Lagoon, Bolsa Chica, Agua Hedionda,

San Elijo, Batiquitos, and South San Diego Bay. Artificial floating or piling-supported structures would probably be the most cost effective means to accomplish this. Formation of artificial or earthen islands surrounded by adequate permanent water buffers would result in reduced disturbance to pelicans without restricting recreational opportunities or relying on voluntary changes in human behavior.

Provision, enhancement, or retention of artificial structures outside of harbors on the outer coast remains a justifiable restoration objective. These sites may provide pelicans with the least disturbed environment and greatest benefits relative to detection of foraging opportunities.

Central California

A surprising result of this study was the finding that human disturbance at the locations we observed in central California in 2000 was more severe than that documented in most of southern California. The increase in disturbance at Elkhorn Slough and Shell Beach Rocks, which are two of the most important roost sites in the state of California, would seem to demand immediate attention by the natural resource agencies involved in managing those sites. Development of specific management plans, information and education efforts, and restrictions on public use for those areas is highly recommended. Specific recommendations can be provided if the American Trader Trustee council is considering implementing projects outside of southern California. The basic concepts presented in the restoration plan for these sites (ATTC 2001) were further validated by this study.

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APPENDIX J: Jaques, D.L. and C.S. Strong. 2003. Brown Pelican Night Roost Sites on the Southern California Coast. Unpublished report prepared for American Trader Trustee Council, U.S. Fish and Wildlife Service, California Department of Fish and Game and National Oceanic and Atmospheric Administration, prepared by Crescent Coastal Research, Crescent City, California. 19 pages.

Brown Pelican Night Roost Sites on the Southern California Coast

Prepared for the
AMERICAN TRADER TRUSTEE COUNCIL
California Department of Fish and Game
United States Fish and Wildlife Service
National Oceanic and Atmospheric Administration

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EXECUTIVE SUMMARY

Secure nocturnal roost habitat is a critical resource for California Brown Pelicans. Communal night roosting usually occurs on coastal islands where there is a water buffer to mammalian access and human disturbance. This report evaluates the status of night roosts in southern California, using data collected from 1986-2000, to aid the American Trader Trustee Council in planning restoration projects related to Brown Pelican non-breeding habitat. Brown Pelicans used at least 10 locations along the southern California mainland coast for communal night roosting in 1999-2000. All of the known night roosts were on artificial structures, with the exception of one natural estuarine site at Mugu Lagoon. Most night roosts in southern California fall under the jurisdiction of the U.S. Army Corps of Engineers. Five locations had mean dawn or dusk counts of more than 100 pelicans and were classified as major night roosts. Major traditional night roosts were located on the breakwaters at Marina del Rey and Long Beach, the jetties at Dana Point and Zuniga Point, and floating artificial structures in Agua Hedionda Lagoon. Privately owned structures have played an important role in providing temporary night roost substrate over the past 15 years. All major night roosts found in 1999-2000 were located in the southern portion of the study area. Data indicated that most pelicans that used the nearshore environment in the northern portion of the study area were commuting offshore to the northern Channel Islands to roost overnight.

Some of the main factors that appeared to be affecting or limiting use of known night roosts in coastal southern California were local abundance of pelicans, availability and capacity of roost substrate, buffer to predators, vertical aspect of roost, and human disturbance. Secure nocturnal roost habitat may be a limiting factor for pelicans at times along some regions of the southern California coast. Gaps in night roost habitat included much of the Santa Barbara, Orange, and San Diego County shorelines. Historic loss of natural night roost habitat presumably occurred with alteration of coastal wetlands and other shoreline development. During the past few decades, loss of night roost habitat has occurred due to removal of private artificial structures that once supported major roosts.

A key California Brown Pelican management goal is to ensure an adequate number of high quality, high capacity night roost sites dispersed along the Pacific west coast. Maintaining smaller secondary night roost sites is also important, so that pelicans can maximize use of a foraging area when prey is abundant and available within any given region. Provision of quality roosts sites where gaps exist should have a positive influence on pelican energy budgets by reducing the energetic costs of foraging, commuting, migrating, and responding to human disturbances. Three general types of restoration activities will improve night roost quality or availability, (1) creation of new islands, (2) structural improvements to existing roosts, and (3) increasing protection from human disturbance at existing roosts through management, public education, or installation of physical barriers. Recommendations for the application of these three principles at specific sites are provided.

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INTRODUCTION

California Brown Pelicans (*Pelecanus occidentalis californicus*) are visual predators that are generally inactive at traditional communal roosts at night (Briggs *et al.* 1983, Croll *et al.* 1986, Jaques and Anderson 1988). Brown Pelicans also roost onshore for much of the day. Suitable terrestrial roost sites are essential habitat for Brown Pelicans at all times of year, throughout their range (USFWS 1983). Basic physical requirements for roost sites include: (1) substrate where pelicans can keep their feathers dry while resting and maintaining plumage, (2) a barrier or buffer from mammalian predators and human disturbances, and (3) protection from strong wind and heavy surf. Proximity to schooling fishes is also a key factor in roost site selection; pelicans do not roost far from ocean or estuarine prey resources and often select areas where they can detect foraging opportunities directly from the roost (Jaques, unpublished). Brown Pelican communal roosts may function as information centers (Ward and Zahavi 1973) and play a role in other aspects of social behavior.

Requirements for night roost habitat are similar to that for day roosts, but the adequacy of the predator buffer becomes more critical at night. Along most of the Pacific coast, islands and large rocks within 1-2 km of the shoreline provide the primary night roosting habitat. In regions of Pacific northwest that lack offshore rocks, sand islands within large estuaries serve as the primary night roosts (Jaques 2001). In southern California, the coastal shoreline is predominantly sand, nearly all of the emerged rocks nearshore are small and of low relief, and the remaining estuaries either lack islands or are too small to provide adequate protection from mammalian predators. Prior to intense development and loss of coastal wetland habitat, estuarine islands and sand spits may have provided key natural night roost habitat for pelicans.

One of the goals of American Trader Restoration Plan (ATTC 2001) is to benefit the Brown Pelican population that was injured by the American Trader oil spill by restoring or enhancing critical non-breeding habitat. Enhancement, creation, or protection of communal roosts along the southern California coast is a means to accomplish this goal. Separate reports on disturbance, distribution and abundance of pelicans at diurnal roosts have been prepared (Jaques and Strong 2002, Strong and Jaques 2003). The purpose of this report is to summarize existing information on communal night roosts in southern California, to characterize their attributes in a way that aids efforts to create or enhance such sites, and to make recommendations for restoration action. This report also provides limited baseline data for before and after, regional or site-specific, restoration comparisons related to night roosts.

The American Trader Trustee Council funded a total 15 days of field surveys of pelicans at roosts in southern California during 1999-2000. Much of the information in this report was derived from previous studies. Mugu Lagoon is the only night roost that has been monitored regularly in southern California. Observations at the lagoon took place over 87 nights in 1991-1993 (Jaques *et al.* 1996) and were reinitiated in 2000 (Capitolo *et al.* 2002). Information on other night roosts was limited to an average three nights of observation per site over the period 1986-2000. This report does not provide in-depth information for any night roosts, nor does it represent a comprehensive survey of all potential night roost sites in southern California.

METHODS

The study area included the mainland coastline of southern California from Point Conception to the Mexican border (hereafter referred to as the southern California coast). Pelican use of offshore roost sites on the Channel Islands, were not included in this analysis. In 1999, the American Trader Trustee Council (ATTC) funded three days of field surveys in southern California to update and assess the general status of roost sites; some night roost data were collected in this effort In 2000, the ATTC funded 12 days of field work in southern California to evaluate night roost status, diurnal use, and disturbance issues at selected sites. Historical data pertaining to pelican night roosts were collected as part of other studies conducted in 1986 (Jaques and Anderson 1987) and from 1991 through 1993 (Jaques *et al.* 1996).

Methods developed by Jaques and Anderson (1988) were used and adapted to evaluate pelican use of roosts at night. Surveys were ideally conducted at dusk as well as the following dawn, however, in most cases this was not possible due to limited available field days or fog, and only a dusk or dawn observation was made at a given site. For dusk surveys, a base count of pelicans was made at a given site prior to failing light levels. After that, all arriving and departing birds were monitored through the twilight until darkness, in order to extrapolate a total count most representative of overnight numbers. Arrival and departure data were summed in 10 minute intervals and used to determine trends of net movement to or from the roost. The night roost count was the number counted at adequate light (base count) plus arrivals and minus departures seen after the base count. At dawn, the same procedure was used in reverse; arrivals and departures were monitored against the sky until light levels were adequate (and pelican movement was reduced enough), to obtain an instantaneous count of the roost group.

During each site survey, the following information was recorded:

a. time and duration of observation;
b. weather conditions; (swell height, tidal stage, wind, and seas);
c. census of pelicans by location and habitat type;
d. roost habitat type.

Roost habitat was categorized into 11 types based on physical habitat characteristics (Table 1).

Over six survey years, a total 57 night roost surveys were made from the ground or boat at 17 roost sites not including Mugu Lagoon. Each dawn or dusk survey was considered a separate count. At Mugu Lagoon, 142 dawn or dusk surveys were conducted over a total of 87 nights in 1991-1993. Aerial surveys were also conducted during the survey period and were used in this report to compare mean abundance of pelicans at roosts during the day versus night. Methods used in aerial photographic surveys are described in Strong and Jaques (2003).

Night roost sites were defined based on certainty of presence or absence of pelicans remaining overnight, and categorized by the mean number of birds using the site at night. A “Major” traditional roost was one with a mean night roost count that was > 100. “Minor” night roosts were those that had mean counts <100 birds. At some sites, small numbers of pelicans were present at dawn or dusk, but there were not enough data to conclude whether or not these sites

Table 1. Habitat types used by California Brown Pelicans in southern California.

Code	Habitat Description*
OSR	Offshore rock or island, open coast
CRS	Mainland shore of open coast, cliff or rocky shoreline
BCH	Mainland shore open coast beach, sand or with cobble structure
RMO	River or creek mouth, whether flowing to sea or not
EST	Estuary, river mouth with estuarine habitat or continuous exchange with the sea
LAG	Lagoon, a large water body having some deeper water (over 8 ft), with intermittent or continuous exchange with the sea
HRB	Harbor and structures within harbors (barges, pilings, boats, buoys, etc.)
BRW	Breakwater, a detached portion of harbor rip rap protection
JTY	Jetty, rip rap harbor protection attached to shore (accessible on foot)
MMS	Other man-made structures (oil platforms, offshore barges and buoys)
LEV	Levee (earthen levee)

*The distinction between estuary, lagoon, and river mouth habitats is difficult in southern California, since freshwater flow is generally seasonal, and physical connection to the sea may be intermittent.

were used overnight (i.e., there was a suspicion that pelicans may have moved to or from the site in the dark hours). The status of these is categorized as "Uncertain" and in need of further survey work. "Historic" night roosts were those that were present in the early survey period, but no longer existed in 1999 or 2000.

RESULTS

Location, Habitat Type, and Relative Importance of Night Roosts

Brown Pelicans were known to roost overnight at 10 locations in southern California in 1999-2000 (Figure 1). Two of these night roost sites were first documented in 2000, seven previously known sites were confirmed extant, and one was presumed to still exist (Table 2). Nocturnal use of an additional four roost sites that were surveyed was uncertain, and two night roosts that were present in the historical data set no longer existed in 2000. Other sites that were not surveyed may be used by Brown Pelicans overnight. In addition, night roosting probably takes place on all of the offshore islands in the Southern California Bight.

Only 17% of the 60 diurnal roost sites identified in coastal southern California by Strong and Jaques (2003) were known to be used at night. Pelican abundance at major night roosts was greater at dawn or dusk than during the day, reflecting the convergence of pelicans to these key roosts from other locations (Figure 2, Table 3). The average of the mean numbers of pelicans present at known night roosts sites was 173 birds, compared to 51 birds per roost during the day.

All of the known night roosts along the mainland coast were on artificial structures, with the exception of Mugu Lagoon. The habitat composition of 12 known sites (including the two historic) was as follows: breakwaters (3), jetties (3), floating artificial structures (5), estuary (1). All but two of the roosts occurred in harbor environments and most were under the jurisdiction of the U.S. Army Corps of Engineers (Table 3). Each night roost was surrounded by water on at least three sides and provided a relatively high degree of security from mammalian predators and human disturbance.

Major Night Roost Sites

Five locations had mean dawn or dusk counts of more than 100 pelicans and were classified as major night roosts (Figure 1, Table 2). The breakwaters at Marina del Rey and Long Beach Harbor supported the largest night roosting aggregations. The exceptionally long jetties at Dana Point and Zuniga Point were also favored night roosts. The fifth major site occurred on floating artificial structures at Agua Hedionda Lagoon. Efforts to deter pelicans from roosting at Agua Hedionda took place in 2000 and probably eliminated it as a key night roost by 2001, leaving only four known major sites. The only site that supported more than one thousand pelicans during our observations was Marina del Rey, which had a peak count of about 1,650 birds. It is likely that numbers of pelicans roosting overnight at the Long Beach breakwaters exceed 1,000 birds at times, but evaluation of this site was limited to one dawn count in 1986. Accurate censuses of the Long Beach breakwaters can only be made by boat or airplane. This was the one night roost that we presumed was still present without having recent data.

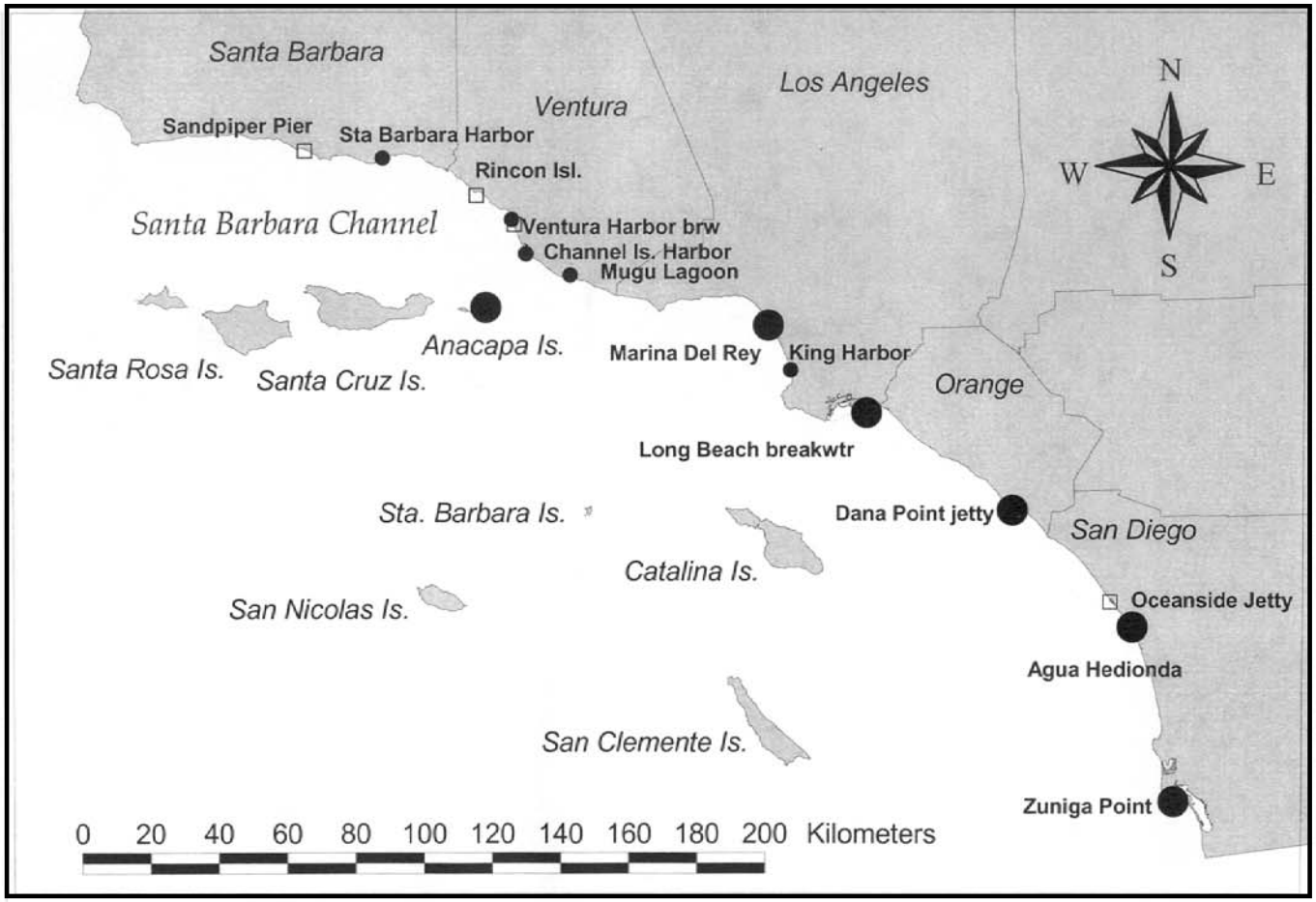

Figure 1. Southern California study area showing Brown Pelican night roost locations. Major night roosts (>100 birds on average) are represented by large circles, minor night roosts (<100 birds on average) are small circles, and roosts that were surveyed at dawn or dusk but remain of uncertain night roost status are indicated by open squares.

Table 2. Brown Pelican night roost survey data for southern California, 1986-2000.

Roost Number	Roost Name	Habitat Type	Year	Date	Count Type	Total Pelicans
	Major Night Roosts					
LA 12.0	Marina del Rey Breakwater	Breakwater	1991	12/19	dawn	1,642
			1992	2/2	dawn	1,426
			1992	8/24	dawn	347
			1992	10/28	dawn	611
			1992	11/16	dawn	636
			1993	10/2	dawn	601
			2000	7/9	dusk	1,208
LA 2.0	Long Beach Harbor Breakwaters	Breakwater	1986	11/5	dawn	584
SD 12.0	Agua Hedionda Lagoon	Artificial Stru.	1986	11/2	dusk	164
			1999	9/11	dusk	179
			1999	9/12	dawn	138
			2000	7/11	dawn	262
			2000	7/12	dawn	380
			2000	9/13	dusk	264
SD 3.5	Zuniga Point	Jetty	2000	9/12	dusk	245
			2000	9/13	dawn	193
OR 3.0	Dana Point Harbor	Jetty	1986	8/30	dusk	83
			1986	9/18	dusk	239
			1986	11/4	dusk	226
			1986	12/2	dusk	16
			1991	6/10	dusk	39
			2000	7/10	dawn	138

Table 2. (Ctd).

Roost Number	Roost Name	Habitat Type	Year	Date	Count Type	Total Pelicans
	Minor Night Roosts					
VN 4.0	Mugu Lagoon	Estuary	see Jaques et al., 1996; Capitolo et al., 2002			
LA 11.0	King Harbor	Jetty	1991	9/14	dusk	3
			2000	7/9	dusk	40
			2000	7/10	dawn	34
			2000	9/14	dusk	108
			2000	9/15	dawn	77
VN 8.0	Ventura Harbor	Breakwater	2000	7/8	dusk	55
			2000	7/9	dawn	31
			2000	9/11	dusk	21
VN 5.1	Channel Islands Harbor-inner	Artificial Stru.	1992	1/31	dawn	25
			1992	2/3	dawn	28
			2000	7/9	dawn	14
			2000	7/8	dusk	25
SB 4.0	Santa Barbara Harbor- inner	Artificial Stru.	1991	11/1	dawn	21
			1992	11/9	dawn	23
			2000	7/8	dawn	36
	Night Roost Status Uncertain					
VN 7.0	Santa Clara Rivermouth	Estuary	1991	4/7	dawn	14
			1992	1/31	dusk	0
LA 16.0	Malibu Lagoon	Estuary	2000	9/12	dawn	3
SD 13.0	Oceanside Harbor	Jetty	2000	7/10	dusk	28
VN 11.0	Rincon Island	Artificial Stru.	1992	10/27	dawn	0
			1999	9/13	dusk	0
			2000	7/7	dusk	0
			2000	9/10	dusk	2
			2000	9/11	dawn	0

Table 2. (Ctd).

Roost Number	Roost Name	Habitat Type	Year	Date	Count Type	Total Pelicans
	Historic Night Roosts					
SB 3.0	Santa Barbara Harbor- outer	Artificial Stru.	1992	4/9	dawn	147
			1992	11/9	dawn	160
VN 10.0	Mobil Oil Pier	Artificial Stru.	1991	11/1	dawn	49
			1992	9/21	dawn	9
			1992	10/27	dawn	51
			1993	4/7	dusk	32
	Other Sites checked					
LA 20	Leo Carillo St. Park	OSR	1991	6/13	Dawn	0
VN 5.0	Channel Islands Harbor	BRW	1992	2/3	Dawn	0
VN 5.0	Channel Islands Harbor	BRW	2000	7/8	Dusk	0
SD 9.5	La Jolla Rocks	OSR	2000	7/11	Dusk	0
SD 11	Batiquitos Lagoon	LAG	2000	9/14	Dawn	0

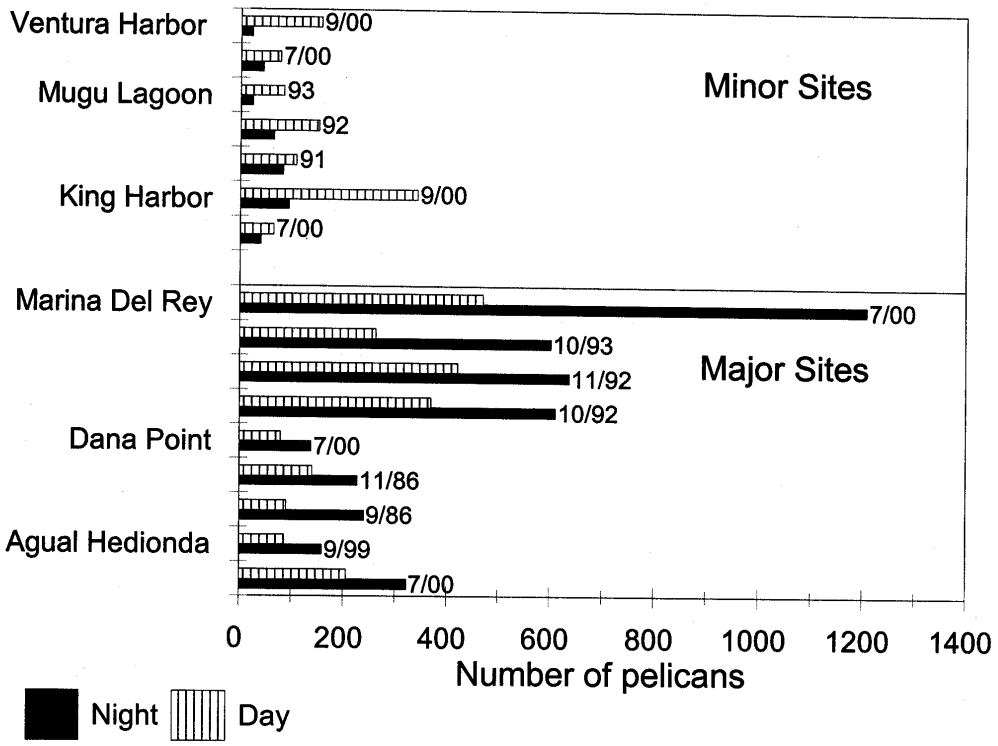

Figure 2. A comparison of day versus night roost numbers at minor and major night roost sites. Daytime counts are the average numbers seen on the day before or after a given night roost count. The time period for each survey sequence is shown at the end of each bar. Data for Mugu Lagoon are combined by year. All counts are from ground-based surveys.

Table 3. Summary of Brown Pelican night roost counts, jurisdiction and habitat type on the southern California mainland coast between 1986 and 2000, ordered south to north. Mean day counts are from aerial surveys. Mean night count is the average of any dawn or dusk counts. N= Number of dawn or dusk counts. ND= No data. See Table 1 for explanation of habitat codes.

Site ID	Roost Site Name	Owner or Manager	Night Roost type	Mean Day Count	Mean Night Count	N	Habitat
SD 3.5	Zuniga Point jetty	ACOE	major	158.2	219	2	JTY
SD 12	Agua Hedionda Lagoon	Private	major	36.7	231.7	6	MMS
SD 13	Oceanside Harbor jetty	ACOE	uncertain	52.4	28	1	JTY
OR 3	Dana Point Harbor jetties	ACOE	major	98.4	160.5	4	JTY
LA 1	Long Beach Harbor breakwaters	ACOE	major	470.7	586	1	BRW
LA 11	King Harbor	ACOE	minor	65.6	47.0	4	JTY
LA 12	Marina Del Rey breakwater	ACOE	major	323.1	924.4	7	BRW
VN 4	Mugu Lagoon	U.S. Navy	minor	122.4	59.1	142	EST
VN 5	Channel Islands Harbor breakwater	ACOE	uncertain	28.9	0	2	BRW
VN 5.1	Channel Islands Harbor docks	Private	minor	14.3	23.0	4	MMS
VN 7	Santa Clara River mouth	CDPR	uncertain	35.6	7	2	EST
VN 8	Ventura Harbor breakwater	ACOE	minor	71.2	35.7	3	BRW
VN 11	Rincon Island	Private	uncertain	97.1	0.4	5	MMS
SB 4	Santa Barbara Harbor, inner	S.B. Harbor	minor	32.0	26.6	3	MMS
SB 5	Sandpiper Pier	Private	ND, suspected	53.4	ND	0	MMS

Manager acronyms: ACOE = Army Corps of Engineers, CDPR = California Department of Parks and Recreation.

Minor Night Roost Sites

Five locations had mean counts of less than 100 pelicans and were classified as 'minor' night roosts (Figure 1, Table 2). Mugu Lagoon was the only confirmed natural night roost site used by pelicans along the southern California mainland. Sandbars in the lagoon have occasionally supported several hundred pelicans overnight. As many as 883 birds remained overnight in the central basin at Mugu Lagoon in June 1992, but this level of use was atypical during the study period, 1991-1993 (Jaques et al. 1996). The central basin was used by night roosting pelicans in summer 2001, but in 2002, pelicans did not use the traditional night roost area and were discovered in smaller numbers (less than 50) on a small sandbar in the western arm of the lagoon (Capitolo *et al.* 2003). The primary jetty at King Harbor and the breakwater at Ventura Harbor were the next most heavily used of the minor sites, following Mugu Lagoon. Small, privately owned floating structures at Channel Islands Harbor and Santa Barbara Harbor were used overnight by relatively few pelicans. The smallest night roost aggregation observed was 14 pelicans on a bait barge at Channel Islands Harbor. In contrast to major night roosts, smaller night roost sites tended to have more birds present during the day than at night (Figure 2). This pattern was described for Mugu Lagoon, where birds appeared to be regularly commuting to more favorable night roost habitat at Anacapa Island (Jaques *et al.* 1996).

Uncertain Night Roost Status

Our data were insufficient to determine night roost status at the following four sites: Oceanside Harbor jetty, Rincon Island seawall, Santa Clara River mouth, and Malibu Lagoon (Table 2). In some cases, a few birds were present at dusk or dawn, but more survey effort would be required to determine if pelicans typically remain overnight. Based on vulnerability to mammalian predators and human disturbance, the artificial roost sites (Rincon Island and Oceanside Jetty) seem more likely to be used overnight than the two small estuaries. Capitolo *et al.* (2003) confirmed that the Santa Clara River mouth was not used as a night roost during five dusk surveys in 2002.

Ten additional roost sites that have never been surveyed for night roost status, were identified as possible nocturnal roosts based on habitat characteristics (see Appendix A). These sites include artificial structures associated with military bases in San Diego Bay, the defunct oil platform off Coal Oil Point known as Sandpiper Pier, small nearshore rocks from Laguna Beach to Palos Verdes, and cliffs at Point Loma and Point Conception. Of these sites, Sandpiper Pier and Point Conception are most likely to serve as traditional communal night roosts because they are well protected from predators, human disturbance, and are not affected by tides. Overnight use of the other locations is expected to be low and irregular, if they are used at all. The small nearshore rocks do not provide protection against heavy surf and may be inundated at high tides. The cliffs at Point Loma are vulnerable to human disturbance and there is an alternate night roost site nearby (Zuniga Point jetty).

Dispersion of Night Roosts

Major night roost sites were located only in the southern portion of the study area (San Diego, Orange and Los Angeles Counties). There were no known major night roost sites along the

mainland in Ventura and Santa Barbara Counties although large diurnal roosts exist there. This assessment of regional night roost status coupled with diurnal distribution and abundance data from aerial surveys indicates that hundreds of pelicans using the nearshore environment in the Santa Barbara Channel during the day are commuting to the northern Channel Islands to roost at night.

Differences in commute distances to the Channel Islands, along with availability of suitable night roost habitat along the mainland shore, appeared to affect night roost site selection along the southern California coast. The southern Channel Islands are farther offshore from the mainland, compared to the northern Channel Islands. In the northern portion of the study area (Ventura-Santa Barbara Counties), the direct distance to the nearest point of land on the Channel Islands ranges from about 25-60 km. Thus, the minimum distance that pelicans fly to roost on the Channel Islands from some locations on the mainland coast ranges from 25-60 km. The commute distance to a large night roost for pelicans foraging in the Santa Barbara harbor area, for example, may be 40 km to Santa Cruz Island, 52 km to East Anacapa Island, or alternately, 65 km to Mugu Lagoon. The distance from the mainland to the nearest southern Channel Islands, San Clemente and Catalina Island, ranges from about 40-100 km. In comparison, the shoreline distance between the four major night roosts on the mainland in the southern portion of the study area ranged from about 50-60 km (mean = 54 km). The maximum distance that a pelican foraging or roosting along shore would have to fly to the nearest large mainland night roost in this area would therefore be about 30 km, which is less than to the nearest offshore island.

Night roost status and distribution on the Channel Islands are not well known. We have documented the presence of large night roosts only on East Anacapa Island and San Nicolas Island (Jaques *et al.* 1996, unpublished data). Pelicans are known to roost overnight on Prince Island, an islet off San Miguel (J. Adams, USGS, BRD, personal communication), and probably remain overnight in at least one location on each of the eight offshore islands. We are not aware of any specific efforts to document or map pelican night roost sites on the islands. Habitat selection for night roosts on the Channel Islands is also subject to the influences of mammalian predators and human disturbance.

Changes in Night Roost Availability

Although Brown Pelicans typically have a strong traditional use of night roosts, changes in roost site availability in southern California have resulted in use of some sites on a temporary basis. Various construction or dredge barges anchored in harbors have provided night roost habitat for periods of months to years. A small dredge barge in Santa Barbara Harbor served as a minor night roost site in 1999 and 2000, and a jetty construction barge in King Harbor served the same function in 1993. Pelicans have been observed to take advantage of other types of artificial structures fairly quickly, when human disturbance decreases. As oil extraction operations at the Mussel Shoals Mobil Oil Pier declined from the late 1980s to the 1990s, pelican use of that site increased. Pelicans roosted on the rails of the Imperial Beach Pier during a construction period in the 1980s when it was closed to the public. Major roost sites formed on two large semi-abandoned barges that were moored in the outer Santa Barbara Harbor during 1991-1992. These

changes indicate that night roost habitat on private and floating structures in southern California is dynamic on a scale of years to decades.

Night roosts on artificial structures that are privately owned are clearly not secure wildlife habitat features. If attempts to eliminate pelicans from Agua Hedionda Lagoon are successful, this will leave a large gap in roost site availability on the south coast. A major roost on the dilapidated Sandpiper Pier platform has been in jeopardy of removal, but ongoing CDFG efforts to save the site as roosting and nesting habitat for marine birds may prove successful (P. Kelly, CDFG, personal communication). The Sandpiper Pier site may be a key night roost for Brown Pelicans in Santa Barbara County.

Factors Affecting Use of Known Night Roosts

The key factors we identified that appeared to be affecting or limiting use of known night roosts in coastal southern California were:

- Local abundance of pelicans
- Availability and capacity of roost substrate
- Buffer to predators
- Vertical aspect of roost
- Human Disturbance

The following provides examples of how these factors have been observed to affect pelicans at specific roosts.

Regional and Local Pelican Abundance

Pelican distribution and abundance in southern California vary seasonally and annually and are influenced by timing and success of reproduction, migration patterns, ocean conditions, and the patchy and shifting distribution and availability of prey (Anderson and Anderson 1976, Ainley 1976, Briggs *et al.* 1981, Anderson and Gress 1983, Jaques *et al.* 1996). The use of and need for a large capacity night roost within a given region varies along with a broad spectrum of ecological correlates that affect pelican abundance within a given area. *Mugu Lagoon* is the only site in southern California where enough data have been collected to illustrate the change in use of a night roost along with seasonal and annual fluctuations in pelican abundance in southern California. Six aerial surveys along mainland and Channel Islands shorelines were conducted during the 1991-1993 study period. Total pelican counts in southern California, including the Channel Islands, ranged from a high of about 11,500 (June 1992) to 3,405 birds (June 1993). More than 340 birds roosted overnight at the lagoon on average during June 1992, compared to less than 50 on average in June 1993. The peak night roost count at Mugu Lagoon of 883 birds occurred in June 1992 during a strong wave of migration along the coast.

Availability and Capacity of Roost Substrate

Availability and size of artificial structures in the marine environment can affect use of a relatively large coastal region for nocturnal roosting. Historic data demonstrate that when attractive mainland night roosts were present in the Santa Barbara Channel region, more pelicans remained in the nearshore environment overnight. Night roost counts in Santa Barbara County were greatest when the two large out-of-commission barges, were temporarily available in the harbor (Table 2). Up to 1,400 pelicans had been documented on the barges during the day. The smaller structures currently available in *Santa Barbara Harbor* (a bait barge and a small suction dredge boat) have held 23-36 birds overnight. These small sites do not and could not support the hundreds of roosting pelicans that once used the barges.

Removal of the night roost site on the *Mobil Oil Pier* in northern Ventura County has apparently resulted in a loss of suitable night roost habitat between Ventura and Santa Barbara Harbors. Following demolition of the pier, numbers of birds roosting on the seawall at nearby *Rincon Island* during the day increased and it became a very large and important daytime roost (Strong and Jaques 2003). However, our limited data suggest that the seawall has not provided a substitute night roost (Table 2). A high count of nearly 1,000 pelicans was recorded on Rincon Island during the day in 2001 (Capitolo *et al.* 2002). If this site is indeed not used as a night roost, then the hundreds of birds that use the seawall by day must be regularly transiting the channel to go to and from nocturnal roosts on the Channel Islands.

The roost at *Agua Hedionda Lagoon* was the only location in southern California where we directly observed pelican behavior that indicated that the number of birds attempting to roost at the site was greater than what the structures could support at night. Pelican capacity was limited by the number and configuration of floating structures associated with a private mariculture operation. During the day, all of the suitable substrate was used, but at night the area nearest the shrubby eastern shore of the lagoon was left vacant and pelicans sparred for the remaining sites. Some birds departed the site at dusk after unsuccessfully procuring a space. We suspect that the proximity to potential predators was the reason that the structures near the eastern shoreline (which provided cover for predators) were not used at night. Thus, this night roost was limited not only by the available roost substrate, but by the extent of the water buffer between the structures and the vegetated shoreline.

Buffers to Predation

One of the most important physical features that distinguishes night roosts from other roosts is the adequacy of the buffer between pelicans and potential mammalian predators. Mammalian predators, such as foxes and coyotes, are more active at night when pelicans are less able to visually detect the approach of these animals in the dark compared to daylight. Deep water is the element most commonly selected as protection from predators at night roosts, but shallow water, steep cliffs, and long stretches of rip rap also serve as barriers to predators at some sites.

At *Mugu Lagoon*, sandbars and mudflats selected for night roosting were those that appeared to provide the greatest degree of protection from predation and human disturbance. The sediment patterns in the lagoon were dynamic, and site selection by night roosting pelicans changed with annual and seasonal changes in wetland configuration and human disturbance. The most

regularly used site was buffered from predator access by a relatively deep and wide tidal channel. Even so, at night pelicans generally stood as far from vegetated land as possible with their legs in the water. Horizontal distance, or width of water buffer, seems to be an important factor in shallow water situations. The combination of adequate water buffers and earthen island relief does not appear to be presently available in other southern California estuaries, with the exception of perhaps the man made seabird nesting islands at Bolsa Chica lagoon.

Pelicans roost overnight on the very long jetties at *Dana Point* and *King Harbor* but not on the many shorter jetties in southern California. This suggests that a buffer distance of 1-2 km of rip rap may be required for a jetty connected to land for adequate security from mammalian predators and human disturbance at night (unless the land at the base of the jetty is specially protected as described below for Zuniga Point).

Roost Site Height and Microclimate Options

The vertical aspect of a night roost is important when there is a possibility of inundation by tides or large waves. The breakwaters at *Marina del Rey and Long Beach Harbor* are higher than most in southern California and are above any observed tide or surf impacts. This, and the fact that they are large, true islands surrounded by deep water on all sides, makes them physically ideal night roost substrates. The roosts are also high enough to offer a range of microclimates for temperature regulation. Pelicans can choose between windward and wind sheltered, or sun and shade, by choosing one side of the breakwater wall over the other. In contrast, the breakwaters at Channel Islands Harbor and Ventura Harbor are relatively low and subject to overwash from the surf. This low relief may be the most important factor limiting their use as night roosts.

Regular tidal inundation of much of the roost at *Zuniga Point* jetty limits the capacity and quality of the roost overall. During our one night roost survey, we observed that pelicans moved off of the area subject to submersion at dusk and roosted only the concrete reinforced base of the jetty very near shore during the dark This is in contrast to most jetties, where pelicans roost on or near the tip at night, as far from mammalian access as possible. At Zuniga Point, pelicans appear to be sacrificing some degree of security from predators rather than risking surprise inundation by water or the need to relocate during the night. The base of the jetty is a restricted military area, and predator control has taken place on the beaches to protect the Snowy Plover. If this jetty were attached to a public beach, pelicans would probably not use it as a night roost at all due to disturbance factors.

Pelicans at *Mugu Lagoon* roost on a mudflat/islet that is subject to immersion during high tides and heavy freshwater outflow. Pelican night roosting at the lagoon became minimal during extended periods of high water when pelicans could not roost in secure locations without getting their feathers wet (Jaques *et al.* 1996). Although some pelicans remained floating in the water at night during this period, the nearly complete rejection of the area by pelicans during the high water episode seemed to demonstrate that the energetic costs associated with soaked plumage outweighed the costs of relocation to a secure, dry roost.

Human Disturbance

The same buffers that render night roosts relatively secure from mammalian predators protect them from most forms of human disturbance. Human disturbance has been documented during the day at many southern California night roosts (Jaques and Strong 2002), however, disturbance during the night at most locations seems less likely. For example, the jetty roosts at King Harbor and Dana Point are disturbed by fishermen on foot during the day, but at night it would be more difficult for fishermen to walk the length of the jetty and they are not as likely to attempt to fish in the dark. Disturbance at dusk and dawn by fishermen, however, has been observed at King Harbor.

The roost at Rincon Island, in contrast, may be equally or more vulnerable to disturbance at night as it is during the day. The primary source of potential disturbance at that site was human access to an observation platform on the seawall where the pelicans roost. Operations associated with the oil industry take place 24 hours a day and the platform is equally accessible to workers at night as it is in the day. Pelican response to human disturbance in darkness at East Sand Island, Oregon, was more severe than during daylight hours (Jaques, unpublished). Another potential disturbance factor at Rincon Island is the presence of feral cats (at least one cat observed on the island in 1999). Cat activity patterns and pelican response to cats may differ at night as opposed to day. Disturbance factors may be preventing the site from being used at night by pelicans

DISCUSSION AND MANAGEMENT RECOMMENDATIONS

This results of this report represent the first attempt to document and evaluate status of Brown Pelican night roosts throughout a broad geographical region of the Pacific west coast. The dispersion and quality of communal night roosts is expected to affect Brown Pelican energetics and survival. A management goal for the California Brown Pelican is to ensure an adequate number of high quality, high capacity night roost sites throughout the range of the subspecies. The question of how many roosts is adequate cannot be answered with this analysis alone. However, the following discussion describes those areas and situations within southern California where data and behavioral observations have indicated that night roost may be limited or of relatively low quality. Restoration of night roost habitat in these areas has the potential to have a positive long-term effect on the Brown Pelican population.

Roosts as Limiting Factors

Roost space may become limited in southern California on a range of spatial and temporal scales. For example, when prey availability concentrates pelicans in a particular region over a period of days to weeks, the nearest night roost to that prey patch may become saturated or over capacity, forcing pelicans to commute further from the prey patch to the next nearest available roost. This situation appeared to occur at Agua Hedionda Lagoon in San Diego County. More in depth observations at individual roosts would be required to document limitations of other sites in southern California. Basic survey data have provided evidence that capacity and quality of nearshore roost substrate are factors limiting use of mainland sites in the Santa Barbara

Channel region. When given a high quality site nearshore mainland roost (i.e., the abandoned barges of 1992-93), a large proportion of pelicans present during the day are likely to take advantage of the situation and forego the night roost commute to the Channel Islands.

When pelican numbers are very high on a seasonal or annual scale, for example during northward post-breeding dispersal, the ability of coastal mainland roosts to support the pelican population along the southern California mainland diminishes. For example, following widespread breeding failure in June 1992, more than 8,250 pelicans were counted along shore during a daylight aerial survey. The maximum numbers of pelicans ever recorded at each of the 10 known night roosts in this study render a total of 2,733 birds, or only 33% of the population that was present during that June 1992 survey. Some roost sites have a greater capacity than has been observed, but again, the limitations of available roosts will depend on pelican distribution. When peak numbers of pelicans are dispersed as large aggregations in various locations along the length of the southern California coast, data indicate that existing mainland night roosts can not accommodate all of the birds within some borad coastal regions, such as along much of the Santa Barbara, Orange, or San Diego County shorelines. The Long Beach Breakwaters alone, could probably physically support 10,000 pelicans, but pelican migration patterns and the distribution and abundance of prey in southern California is such that pelicans are not likely to concentrate to that extent in any one non-breeding location. It does appear likely that 1-2,000 pelicans could, at times, be seeking a night roost along any given region of the southern California shoreline.

Pelicans may be using marginal night roosts in the southern most counties of the study area due to large commute distances to the Channel Islands or other quality night roost sites. Zuniga Point jetty and the floats at Agua Hedionda Lagoon appear to be examples of relatively low quality night roost sites. In contrast, the high breakwaters at Marina del Rey and Long Beach Harbor clearly offer high quality night roost habitat. These breakwaters would be probably be heavily used by pelicans regardless of where they occurred on the southern California coast.

The net loss of night roost habitat in the past 15 years is of importance to restoration and management efforts. The Santa Barbara coast has the lowest night roost capacity, and large roosts in San Diego County and Orange Counties are either being eliminated (Agua Hedionda) or are compromised by tidal effects (Zuniga Point) and possibly human disturbance (Dana Point Harbor). The greatest benefits to pelicans may be accrued from night roost restoration efforts in these areas where gaps in high quality sites have been identified.

Restoration Opportunities for Enhancing Night Roosts

Priority Habitat

We recommend that restoration efforts related to Brown Pelican non-breeding habitat prioritize actions that create or improve communal night roosts. Night roost sites in southern California are more limited in number than diurnal roost sites. Night roosts also tend to be the highest

Table 4. Summary of Brown Pelican night roost restoration opportunities and recommended areas for roost creation or enhancement.

Treatment Type	Site ID	Roost Site Name	Night Roost Status	Project Description
Create new island habitat	SD 2.5	San Diego Bay NWR	No data	Modify existing earthen levees to create islands
	SD 11.0	Batiquitos Lagoon	None	Create earthen islands or install floating artificial structures
	SB 3.0	Outer Santa Barbara Harbor	Minor	Install floating artificial structures
Improve structure of existing night roosts	SD 3.5	Zuniga Point Jetty	Major	Add rip rap to increase height on portion of jetty
	VN 8.0	Ventura Harbor Breakwater	Minor	Add rip rap to increase height on portion of jetty
	VN 5.0	Channel Islands Breakwater	Uncertain	Add rip rap to increase height on portion of jetty
	SB 5.0	Sandpiper Pier	No data	Increase capacity and structural heterogeneity/microhabitat features
Protect existing roosts from Human Disturbance	OR 3.0	Dana Point Harbor Jetty	Major	Install fence-type barrier to portion of jetty, develop and enforce access restrictions, and/or implement public education program.
	LA 11.0	King Harbor Jetty	Minor	Install fence-type barrier to portion of jetty, develop and enforce access restrictions, and/or implement public education program.
	LA 12.0	Marina del Rey Breakwater	Major	Install educational/regulatory signs
	VN 11.0	Rincon Island Seawall	Uncertain	Develop management agreement/conservation easement with private owners to reduce disturbance from existing observation deck

quality diurnal roosts. Therefore, creating or enhancing night roosts will also benefit day roost habitat. Roosts that are successfully used at night are inherently protected from chronic human disturbance. Therefore, enhancement efforts should reduce the amount of human disturbance that pelicans encounter along the coast.

Restoration Actions

Three general types of restoration activities that will improve night roost quality or availability are (1) creation of new island habitat, (2) structural improvements to existing roost habitat, and (3) reduction in human disturbance at existing roosts through management, public education, or installation of physical barriers. Specific recommendations for roost creation and enhancement projects are provided in Table 4.

Restoration Selection Criteria

Key considerations for any night roost habitat restoration action are:

- Need and Location. Apparent geographical gaps in night roost availability are identified in this report.
- Predator buffer. Provide water barrier of adequate depth and width.
- Vertical relief. Ensure dry habitat free from overwash by waves and offer microhabitat options including shade and wind protection.
- Capacity. Provide space for 100 birds or more.
- Human disturbance. Establish management tools to prevent or limit human disturbance.
- Viewshed. Maintain open view of potential foraging areas and predator approaches.
- Substrate. Use substrates commonly used by pelicans (e.g., rock, wood, sand).

This report generally defines critical physical characteristics of night roosts. We recommend that specific information be compiled on relevant features at the existing high quality night roosts identified in this report including: (1) the height of the Marina Del Rey breakwater, (2) width and depth of water buffers at Agua Hedionda Lagoon, and (3) roosting pelican capacity per meter of breakwater at Long Beach and Marina del Rey. With attention to basic requirements, we believe it should be relatively easy to devise the physical aspects of roost island creation or enhancement and have a high certainty of success. One of the most simple designs for roost island creation would be to cover a small barge with rip rap and moor it in a suitable location on the outer coast or in an estuary. The legal liability, permitting, jurisdiction, and long-term maintenance issues associated with roost site restoration are likely to be the greatest obstacles to overcome for successful implementation of Brown Pelican habitat projects in the California coastal zone.

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APPENDIX A. Descriptive accounts of all known and potential night roosts on the southern California mainland are given below, ordered by size of the roost. Night roost survey data are found in Table 2.

Major Night Roosts

Long Beach Harbor breakwaters, LA 1 and 2

The eastern and central breakwaters protecting the outer harbor at Long Beach comprise the largest roost site in southern California in terms of physical capacity. The breakwaters extend for 9.4 km in length. Night roost surveys are not possible from shore due to their distance, but it is expected that night roost use would be higher than day use. Night roost use was confirmed during one dusk boat trip to the central breakwater in 1986 when 584 pelicans were counted on the detached breakwaters. An additional 59 birds occurred on the San Pedro Jetty (LA 3.0) but it is likely that these birds had moved over to the jetty from the breakwater by the time of the survey.

Marina Del Rey breakwater, LA 12

This is the second largest roost site on the southern California coast and appears to be the one most heavily used by pelicans. Night roost numbers are consistently higher than during the day, averaging 924 birds with a peak of 1,642 (Figure 2). Pelicans from up and down the coast converged at this site during all dusk surveys. At peak abundance, there was considerably more roost habitat available, suggesting that maximum capacity was far greater than 1,600 birds.

Zuniga Point, San Diego Bay mouth, SD 3.5

This roost site is a jetty of variable height that extends out from the jetty on the south side of San Diego Harbor entrance. The roost appears as a series of detached rip rap and concrete "islands" at mid tides. Most of the rip rap is submerged at high tide. The concrete reinforced tip of Zuniga Point itself, at the base of the jetty, was used as a night roost during our single night of observation. Although this area is accessible from shore, human disturbance is restricted by the North Island Naval Base. Placement of additional rip rap on some of the sections of the jetty to provide more secure habitat for pelicans has been considered as a restoration alternative. The Los Coronados Islands (in Mexico) are within view of the site and support breeding Brown Pelicans (USFWS 1983). It is likely that the islands also support night roosting pelicans during the nonbreeding season and that the birds regularly commute between the islands and the San Diego Bay area.

Agua Hedionda Lagoon, SD 12

The primary roost at this site for the past few decades has been on floats set out by a mariculture company for shellfish production. This lagoon has been consistently used by pelicans in all surveys of southern California. Night time use has been much higher than that by day (Figure 2) with an peak of 380 birds counted. Capacity was limited by the number of stable floating structures, and maximum capacity of the roost has varied with the configuration of mariculture structures. Contact with the company owner (John Davis of Carlsbad Aqua-Farms), revealed

that the company was under order from the City of Carlsbad to eliminate the roost due to concerns of excess bacteria loading of the lagoon. During summer and fall of 2000, wire exclusion devices had been placed on the larger floats that pelicans used. The site was still used as a night roost, however, with over 200 pelicans using the remaining floats during our survey. Remaining floats available for roosting were round and less stable, and provided a reduced capacity and quality roost than existed previously. Some pelicans were in the water at dawn during 2000 surveys, probably because remaining floats were occupied or unsuitable. The entire roost may be eventually eliminated. The loss of this major site creates a need for an alternative night roost habitat in this area. Batiquitos Lagoon, 7 km to the south, is recommended as an appropriate site for roost creation (see Strong and Jaques 2003).

Dana Point Harbor jetties, OR 3

Dana Point Harbor was the most important roost site south of Long Beach Harbor in terms of consistent use by relatively large numbers of pelicans. Although accessible to foot traffic and small mammals, the outer jetty supported a consistent night roost, with up to 239 pelicans counted at dawn. The eastern inner jetty and other areas of the harbor were used by day, but at the approach of dusk, pelicans moved to the longer, outer jetty. The nearest known alternative night roost is at the Long Beach breakwater, about 55 km away. The lack of a nearby alternative large night roost is likely a contributing factor in the size and importance of this site. Prevention or reduction of human access to the outer jetty by using fencing and/or advisory signs might increase the size and quality of the night roost at this location.

Minor Night Roosts

Coal Oil Point, Sandpiper Pier, SB 5

This site was not visited from shore, since public access to the adjacent mainland is restricted. The artificial island is on a dilapidated oil production platform and has characteristics of a high quality night roost, the only one along 120 km of coastline between Ventura and Point Conception. The nearest offshore roost site is on Prince Island, 55 km away on the north side of Santa Cruz Island. Though not documented, this artificial island is expected to be a night roost based on the quality of habitat and lack of nearby alternate sites. Brandt's Cormorants nest on the platform from April to August, and limit the space available for pelican roosting. The platform has been in jeopardy of complete removal under conditions of the lease with the California State Lands Commission, however, CDFG is making progress in preserving and restoring the site (P. Kelly and Nora Rojek, CDFG, personal communication). Restoration at this site would consist of preventing its destruction and increasing roost surface area and heterogeneity.

Mugu Lagoon estuary, VN 4.0

Mugu Lagoon is one of two estuaries in southern California that has supported a consistent, large pelican roost, and the only estuary known to be used as a night roost. Restricted human access to the naval reservation, stewardship of natural resources by the U.S. Navy, and proximity to the

breeding and roosting sites on Anacapa Island are key factors affecting its consistent use by pelicans. In 1991-1993, pelicans used the site as a night roost on 83 of 87 nights of observation with a peak count of 883 birds (Jaques *et al.* 1996). Capitolo *et al.* (2002) had a peak count of 300 birds in summer 2001, and recorded night roost use on 17 of 18 night surveys in summer 2001; however, in fall 2001, pelicans abandoned the traditional night roost site. The main roost site has been on mudflats and sandbars just inside the estuary mouth. This habitat is dynamic in nature, since winter storms and floods alter the configuration of these substrates at irregular intervals. In 2002, pelicans were discovered roosting in smaller numbers in the western arm of Mugu Lagoon (Capitolo *et al.* 2003). An alternate night roost site for pelicans in this area is Anacapa Island, 26.5 km to the southwest. During the 1991-1993 study, many pelicans were regularly seen to depart towards Anacapa Island at dusk. More detail on this roost site can be found in Jaques *et al.* (1996), and Capitolo *et al.* (2002 and 2003).

King Harbor jetties, LA 11.0

The outer, northern jetty as well as floating structures within King Harbor (buoys, bait barge, construction barges) have been used as night roosts. Numbers were seen to decrease towards dusk, and departing birds flew north, presumably to the large roost at Marina Del Rey breakwater, 14 km to the north (see Figure 1). Fishermen walking the jetty at dusk disrupted the roost during observations in 2000, demonstrating the limitation of the habitat and the potential for improvement. Restoration activities (fencing and signs) could reduce shore and water craft disturbance and would enhance night roost quality, however, the net benefit of this action would be less than at Dana Point since an alternative high quality site (Marina Del Rey) is relatively near.

Ventura Harbor breakwater, VN 8

This site was used as a night roost in 1999 and 2000, when 21 to 55 pelicans remained overnight, but it was not used overnight during 1992 or 1993 dawn/dusk surveys. The roost is vulnerable to wave wash over the breakwater during higher swells, similar to Channel Islands Harbor, 11 km to the south, but its configuration offers slightly more protection from the surf. The addition of rock to the jetty top could result in a significant improvement to roost quality.

Oceanside Harbor north jetty, SD 13

The long jetty at the north end of Oceanside Harbor has characteristics similar to the jetties at Dana Point and King Harbors, and may function as a minor night roost. During the single dusk observation in 2000, all pelicans departed the roost (about 45 birds), but then they circled and at least some of them appeared to return to it as light failed. Fishermen accessed the jetty during our night of observation, and though no disturbance was noted, this demonstrated the vulnerability of the roost. Installing fencing and/or advisory signs to keep humans off the outer portion of the jetty might improve the quality of the night roost here.

Santa Barbara Harbor, SB 3 and 4

Up to 40 pelicans used a dredge barge in the inner harbor at Point Castillo as a night roost during 1999 and 2000. Varied and frequent human activity in the water and onshore preclude its use as a large pelican roost. Restoration activities here would consist of roost site creation in the outer harbor, at least 1 km from the main harbor area, in the form of a floating structure (such as a retired barge or military vessel, see Jaques *et al.* 1996). Considering the gap in roost availability along the Santa Barbara coastline and proven high use of the previous site, roost site creation here would be expected to have the greatest benefit to pelicans among all restoration opportunities considered for both diurnal and night roost habitat. Creation of higher quality habitat in the outer harbor may result in a reduction in use of the inner harbor, which would be considered a positive impact in this case.

Channel Islands Harbor, VN 5.0

The breakwater at Channel Islands Harbor did not support a night roost during two visits, although small numbers could remain overnight during low swell periods. Winter waves commonly wash over the breakwater, and even summer seas can send spray over much of the breakwater surface, rendering roost habitat insecure. The proximity to Mugu Lagoon and Anacapa Island allows the birds to find alternate sites if the breakwater is unsuitable. A persistent small night roost does exist inside the harbor on pilings and around a live bait container on docks in the southwest portion of the harbor. Numbers at that location have ranged from 14 to 28. It is recommended that, if restoration actions are pursued in this area, Ventura Harbor would be the preferred site to add material to the breakwater, since it is already of higher quality, farther from alternative sites, and has proven night use.

Santa Clara River estuary, VN 7.0

The habitat at this river mouth is not typical of a night roost, however, during one dawn survey in 1991, 14 pelicans were present. These birds may have flown to the river mouth prior to the survey from the nearby night roost at Ventura Harbor or another site. Night roosting was not seen on a 1992 survey. The habitat is dynamic, with irregular flooding when the beach berm closes and during winter storms.

Rincon Island, VN 11.0

This site is an artificial island used to support oil production activities. It is accessed by a bridge from the mainland. The primary roost site is on the outer seawall which is constructed of concrete dolos and rip rap. Only two pelicans were observed on the island in our five dawn/dusk observations from the adjacent mainland shore. The mainland does not offer a complete view of the seawall, but the lack of birds flying away from the site in the morning or to the site at dusk reinforced the appearance of a lack of use at night. Capitolo *et al.* (2003) assessed night use of the roost by five dusk surveys from the mainland in 2002. All visible birds had departed by one hour after sunset on four of the surveys, but about 50 appeared to remain on one survey. Surveys from the structure itself are needed to further evaluate its use by pelicans. The capacity of the roost is very high; up to 986 pelicans have been recorded during the day (Capitolo *et al* 2002). The roost site is subject to disturbance by workers at the site, particularly when they visit an

observation platform on the outer seawall. We observed at least one feral cat on the island during a daylight visit in 1999.

Areas that May be Night Roosts

The following roosts were not surveyed at dawn or dusk, but are considered to be locations that might serve as night roosts based on habitat type and use by pelicans during the day. Night roost surveys at these sites are recommended.

La Jolla Bird Rock and associated offshore rocks, SD 9 to SD 9.9

The rocky shoreline along the La Jolla shores area has several near-shore rocks. The largest and most consistently used diurnal roost is Bird Rock, at the south end of La Jolla. Two smaller rocks along the residential area of La Jolla were not used at night during a 2000 survey.

Fiddler's Cove recreation harbor, San Diego Bay, SD 2.8

A series of floating tires was installed in 1993 to protect a small harbor along Silver Strand. Up to 130 pelicans have been seen at the site during the day.

Bolsa Chica Nature Preserve, OR 10.0

Islands created to provide Least Tern nesting habitat within the wetlands at the south end of the preserve may provide suitable pelican night roost habitat. Over 300 pelicans have been seen here by day. Use by pelicans may interfere with tern breeding activities.

Point Conception, SB 11.0

Large ledges on an otherwise inaccessible cliff on the southwest side of the point provide a roost site protected from predators and disturbance. It is irregularly used by day. This is one of the few potential night roosts available to pelicans on the northern Santa Barbara coast.

Palos Verdes offshore rocks, LA 5.0 to LA 10.0

Seven small offshore rocks from White's Point to Lunada Bay are used by pelicans by day.

Laguna Beach Rocks, OR 6.0 to OR 9.1

A series of seven near-shore rocks (comprising two composite roosts in Table 3) from southern Laguna Beach to Corona Del Mar, including Emerald Bay, may support small numbers of pelicans overnight during periods of high abundance in this region. All rocks have a small surface area and are fairly exposed to weather and surf.

Naval Electronics Reservation at Point Loma, SD 5

Small offshore rocks and mainland cliffs in this area are irregularly used by pelicans by day.

Anaheim Bay Jetties, OR 11

Two jetties extending out from Seal Beach National Wildlife Refuge wetlands have supported up to 250 roosting pelicans during the day. The southern jetty is favored over the northern one.

Ballast Point Coast Guard and Naval Military Base, SD 2.8

If used as a night roost, the site can only be considered temporary as floating structures are relocated at irregular intervals in the course of harbor operations.

South San Diego Bay, SD 2.5

Earthen levees within South San Diego Bay National Wildlife Refuge are used by small numbers of pelicans during the day. The site may be accessible to some mammalian predators. There is potential for improving the quality of the roost and creating night roost habitat by alteration of existing levees, building new islands, or installing floating structures. A restoration project at this site is being considered (ATTC council, personal communication).

Day and Night Roost Monitoring of California Brown Pelicans (*Pelecanus occidentalis californicus)* at Marina del Rey Harbor, Los Angeles County, Los Angeles, California

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Final Report

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INTRODUCTION

Project Background

The U.S. Army Corps of Engineers Los Angeles District (Corps) dredged material from shoal areas at the Marina del Rey (MDR) north entrance channel, Los Angeles County, California, from January through March, 2007. The removal of approximately 255,000 cubic meters of clean sand by Corps' contractor J.E. McAmis, Inc., of Chico, California, restored the channel to the federal authorized depth of -20 feet Mean Lower Low Water (MLLW).

The contractor used an excavator mounted on a barge to remove the material and placed it into a split-hull scow. When full, the scow was towed to the nearshore disposal site off Dockweiler Beach, just north or Imperial Highway. There the scow "split open" and the sand dropped to the sea bottom at a depth of -15 to -25 feet MLLW. Each scow load carried approximately 1,000 cubic meters of sand; approximately six scow-loads of sand per day were placed in the 600-by-250 meter disposal area (Corps 2006).

MDR Harbor was last dredged in 1999, when the Corps removed about 525,000 cubic yards of sediment. In 1998, dredging removed 73,000 cubic meters. In 1996 and 1994, respectively, 183,000 cubic meters and 42,000 cubic meters were removed.

The MDR harbor includes breakwaters lining the north and south entrances as well as a detached breakwater to protect the entrance channel. The detached breakwater is a major roosting spot for the California brown pelican (*Pelecanus occidentalis californicus*) (Jaques et al. 1995), listed as endangered under both the federal and California Endangered Species acts. In fact, of 20 California brown pelican roosting sites examined from Point Conception to southern San Diego County, the MDR breakwater supported the second-highest number of roosting California brown pelicans, second only to the Port of Los Angeles (Jaques et al. 1995). During the 1999 MDR dredging project, California brown pelican behavior was monitored by Varanus (1999), on which this study is based, with modifications to methods recommended by Jaques (pers. comm.).

Brown Pelican Background

Appearance and Habitat Use

The California brown pelican is one of six recognized subspecies of brown pelican. Brown pelicans are distinguished by their large size and brown color with a long, pouched bill. The adult has a white head and dark body, but immature birds are dark with a white belly. Adults have a wingspan of over six feet. They have long, dark bills with big pouches for catching and holding fish. The brown pelican is easily distinguished from the American white pelican, the only other pelican in it's range, which is white with black primary and secondary flight feathers (Palmer 1962). California brown pelicans forage offshore and in rivers and estuaries, and roost on open beaches, lagoons, tidal rivers, rocky coasts, jetties and breakwaters, and islands (Briggs et al. 1981).

Listing Status

The California brown pelican (hereafter CBPE) was federally-listed in 1970 and state-listed in 1971 as endangered, and because of widespread pollutant-related reproductive failures. Pelicans are extremely sensitive to bioaccumulation of the pesticide DDT, which causes reproductive failure by altering calcium metabolism and thinning eggshells (USFWS 1983).

In 1985, brown pelicans on the Atlantic Coast had recovered enough that they could be removed from the endangered species list. Although California breeding populations have rebounded since the elimination of DDT use, persistent pesticide residues in the coastal environment continue to cause chronic reproductive problems. Despite the banning of DDT, some birds still show relatively high levels of pesticides in their tissues (USFWS 2007).

In mid-1995 the United States Fish and Wildlife Service (USFWS) informally proposed delisting the brown pelican in its entire range. A draft report on the proposal later noted that the Pacific Coast population failed to achieve the specific thresholds for determining when it could be delisted, due to some of the threats discussed below. Thus, the proposal to remove the CBPE from the federal Endangered Species list was abandoned (USFWS 2007). However, the California Fish and Game Commission voted in December 2006 to declare the CBPE a candidate for delisting from the California list of Endangered Species (CDFG 2006).

Foraging and Diet

Brown pelicans dive from flight to capture surface-schooling marine fishes. In California they feed primarily on Pacific sardine and northern anchovy, which have declined due to over-fishing, and also on Pacific mackerel (USFWS 1983). Anchovies comprise 90 percent of their diet during the breeding season. Breeding populations and nesting productivity vary dramatically from year to year depending on El Niño events and other climatic changes that affect the abundance and availability of prey fish (USFWS 2007).

Breeding

Pelicans breed in nesting colonies on islands without mammal predators, typically building a nest of sticks on the ground. All courtship occurs at the nest site. The male brings nesting materials to the female and she builds the nest. Normal clutch size is three eggs, which are laid in March or April. Both take turns incubating the eggs and rearing the chicks (USFWS 1983). CBPE breed along the Pacific Coast on the Channel Islands and several islands off Baja California: West Anacapa Island, Santa Barbara Island, Isla Coronado Medio, and Isla Coronado Norte. Between breeding seasons, pelicans from other populations join birds from these islands in wandering along the west coast of North America as far north as British Columbia (USFWS 2007).

Threats to the Population

Disease outbreaks have been known to affect and cause mortality among local pelican populations. However, the scale of mortalities from disease had not been large until more than 1,400 CBPE died in 1996 and another 150 died in 1997 due to an avian botulism outbreak at the

Salton Sea. The CBPE does not nest at the Salton Sea but large numbers gather there in the post-breeding season for roosting and foraging. Since CBPE from the Pacific coast and Mexico likely move to the Salton Sea after the breeding season, biologists do not know how many pelicans from the Pacific coast breeding population were among the botulism mortalities (USFWS 2007).

However, the Pacific coast population is threatened by such outbreaks elsewhere, along with many other phenomena. These include low productivity and colony failure, dependence on the northern anchovy (which fluctuates in abundance from year to year), diseases, oil and other spills from tanker traffic in the Santa Barbara Channel, the presence of relatively high levels of pesticides in the tissues of some pelicans, human and non-native-mammal disturbance at post-breeding roosts, physical injury and mortality due to fish hooks and entanglement of birds in abandoned fishing line, sea-kayaking and recreational boating close to nesting sites, and El Niño events that cause pelican prey fish to move away from pelican nesting islands (USFWS 2007).

In addition, in 1999, more than 50 percent of CBPE nests at Anacapa Island were abandoned, and chick mortality was relatively high, an unusual situation in a non-El Niño year. It was discovered that high nest abandonment and low productivity coincided with exposure to bright lights used by offshore squid fishing boats to raise spawning squid towards the water's surface (CDFG 2000). A Market Squid Fishery Management Plan that included measures to protect California brown pelian nesting sites from squid fishing practices was adopted by the California Fish and Game Commision in 2004 (CDFG 2004).

Roosting

In addition to providing pelican nesting areas, the Channel Islands also provide roosting habitat, with major roosting areas occurring on Scorpion Rock off of Santa Cruz Island and near the lighthouse on East Anacapa Island (Briggs et al. 1981).

As discussed above, CBPE are sensitive to disturbances at nesting sites; however, pelican behavioral changes have also been noted in response to human activities near roosting sites. Disturbances to roosting pelicans have been observed due to fishing activities, including the presence of vessels, noise, and lights, near roosting areas. Activities such as sea kayaking and recreational boating also can also affect distribution patterns of roosting pelicans (CDFG 2000).

CBPE roosting behavior at Mugu Lagoon was studied from October 1991 to 1993 by Jacques et al. (1995) to evaluate the effects of human disturbances, among other factors. The frequency and severity of disturbance to pelicans was highly variable. The measure of disturbance was a group of pelicans taking flight (flushing) from a roost in response to an observed stimulus. Pelicans were consistently flushed from their roosts at Mugu Lagoon an average of once every 2.5 hours. Using a disturbance index, it was found that waterfowl hunting and other recreational activities caused the greatest amount of disturbance, while air operations caused relatively little disturbance (Jaques et al. 1995). The study also included a census of pelican populations at other roosting sites in southern California and found the MDR detached breakwater supported high numbers of CBPE (Jaques et al. 1995).

Another study of pelican disturbances assessed 235 flushing events from 1986-2000 at communal CBPE roosts in southern and central California (Jaques and Strong 2002). Disturbance frequency in southern California averaged 0.53 flushing events per hour and was greatest (85%) in natural habitats such as river mouths and other estuaries, and lowest at harbors and man-made structures along the outer coast. Disturbance occurred about once an hour at estuarine roosts versus once every four hours on man-made roosts. More than 90% of disturbances were directly due to humans, mostly recreationists, rather than natural factors. Pelicans demonstrated habituation to boat traffic in harbors (Jaques and Strong 2002).

A study contracted by the Corps in 1999 at MDR Harbor by Varanus Biological Services (1999) monitored the extent of disturbance to CBPE at the MDR breakwater during maintenance dredging. Varanus documented CBPE behavior for four days prior to dredging and 14 days while the dredge was operating. Between 500 and 1,200 pelicans roosted on the east side (closest to the harbor) of the breakwater during the study period. Disturbances (pelicans flushing from the roost) included 6,529 incidents associated with dredging activities, 3,004 incidents associated with other disturbances, and 3,056 incidents for no apparent reason. The dredging activity that flushed the highest numbers of CBPE was the loud booming when the clamshell of the dredge contacted the hull of the dredge barge. However, flushings were short-lived, with CBPEs quickly returning to the same or a nearby location on the breakwater. Events that resulted in the longest periods of CBPE displacement following flushing from the breakwater were an earthquake, which resulted in CBPE abandonment of the breakwater for a 45-minute period; fireworks; and sudden illumination of the breakwater with high intensity floodlights (continual illumination associated with the dredge did not appear to flush pelicans from their roost). The incident using high intensity floodlights at close range of the breakwater, which was associated with law enforcement, not dredging, activity, was the single event resulting in the greatest disruption of pelicans throughout the entire study period (Varanus 1999).

The Varanus (1999) study concluded that:

- CBPE using the MDR breakwater are subject to disturbances of all types on a regular basis, not just to disturbances associated with the dredging activity. However, CBPE continued to use the breakwater as their primary roost despite these disturbances;
- although numbers of CBPEs varied throughout the study period, no significant change in the number of roosting CBPEs between the start and the end of each monitoring period was apparent, indicating that disturbances due to dredging activities resulted in no long-term effects on the roosting population.

Varanus (1999) recommended that dredging activity could minimize temporary impacts on roosting CBPE by:

- maintaining constant lighting and avoiding sudden illumination of the breakwater;
- limiting shutdown times, as start-up events are sudden and result in pelican flushing;
- avoiding approach toward CBPE roosts during night dredging activities and limiting work in close proximity to roosts to daylight hours;
- ensuring, if a barge is to be provided as an alternate roost site, that it is large enough to support the roosting CBPE population and that it be placed in an area where disturbance is minimal and where CBPEs can access it easily.

METHODS

In December 2006, KBC was contacted by Mr. Thomas Keeney of the Corps to monitor the behavior of CBPEs during the 2007 MDR dredging project. Mr. Keeney requested that study methods and monitoring data sheets follow those of Jaques and Strong (2002).

KBC reviewed Jaques and Strong (2002) as well as the Varanus (1999) report summarizing CBPE monitoring during the previous MDR dredging project, further discussed above. In addition, Kathy Keane of KBC spoke with Deborah Jaques, who conducted the Jaques et al. (2002) and Jaques (1995) studies on CBPE disturbance, and Ms. Jaques reviewed and provided comments on KBC's methods and monitoring log (Appendix A) developed for the project.

CBPE monitoring was accomplished to document numbers of CBPE roosting on the MDR detached (off-shore) breakwater (Figure 1). Monitoring was conducted for four sample days prior to the initiation of dredge operations (December 30 through January 4), for 24 sample days during dredge operations (January 8 through March 14), and for four sample days after dredging operations had ceased (March 31 through April 4). Because the Corps concern was primarily that CBPEs would be disturbed at their night roost by dredging activities and thereafter have difficulty finding another roosting spot, monitoring focused on nocturnal CBPE behavior. The Corps requested that monitoring extend each sampling night for seven hours; however, KBC believed that attention of biological monitors would wane over the seven-hour period. Thus, KBC monitored for four hours beginning at dusk and for another two hours prior to dawn, plus an hour of traveling to and from the monitoring vantage point, for a total of seven hours.

KBC monitors were all ornithologists with several years of experience monitoring populations of seabirds with monitoring the effect of human disturbance on one or more bird species. Each monitor was provided a training session so that vantage points and data recording on monitoring logs were consistent. Monitors were also provided data monitoring logs on waterproof paper due to the frequently heavy condensation that occurs at the Marina del Rey breakwaters at night. KBC monitors obtained parking permits from Mark Spiro at the Los Angeles County Department of Beaches and Harbors.

Monitoring occurred two to three days per week to include the Corps' request that 24 nights of monitoring be completed during dredging; however, we monitored an additional night to make up for the fact that the dredge was sometimes not operating when we arrived at dusk or before dawn. Monitoring at dusk began with a census of CBPEs roosting on the breakwater just prior to dark, followed by four hours of observing and recording disturbances noted by the occurrence of flushing events as defined by Jaques et al. (2002). For each flushing event, we recorded the number of CBPE flushed from the breakwater and the number that eventually returned to the same or nearby (within 100 feet) location, as well as the presumed cause of disturbance. For two hours prior to dawn the following morning, we again recorded flushing events and conducted a census at dawn of all CBPE on the breakwater. The difference between the dusk and dawn counts was calculated for an estimate of CBPEs that abandoned the breakwater during the night.

FIGURE 1. Study Area Location, Marina del Rey detached breakwater

KBC also recorded the location of the dredge for each monitoring period; locations were mapped using GPS and Google@ Earth. On some nights, the dredge remained in the same location, but often more than one location for the dredge was recorded during a monitoring period

At the beginning of the study, KBC attempted to obtain night-vision optics to promote accurate counts of CBPEs and flushing events, but the night vision scope we used during four nights of pre-dredge monitoring was inadequate. We attempted to purchase a more expensive and higher-quality model; however, once dredging began, ambient light from the dredge was sufficient to detect flushing behaviors by CBPEs and estimate their numbers. Post-dredge monitoring was scheduled during a full moon so that pelican flushing events could be observed.

KBC's monitoring station was one used by Varanus (1999); no additional monitoring stations were required since no temporary barge for pelican roosting was provided in 2007 as it had been during the Varanus (1999) study, and dredging in 2007 was limited to the northern portion of the MDR channel. Thus, KBC's monitoring station at the southern terminus of the north breakwater was sufficient to observe pelicans in the vicinity of dredging activities.

Data analysis followed that of Jaques (2002) to measure disturbance frequency (number of disturbances per hour of observation) for pre-dredging, during dredging and post-dredging periods. We did not attempt to measure disturbance severity as calculated by Jaques et al. (2002), since it was difficult to count pelicans relocating to parts of the breakwater not illuminated by light from the dredge, versus those relanding nearby.

RESULTS

A total of 190 hours of monitoring was conducted, including 16 hours of pre-dredge monitoring, 150 hours of monitoring during dredging, and 24 hours of post-dredge monitoring. Several instances of individual CBPEs and small groups of CBPEs leaving or flying into and landing on the breakwater occurred over the monitoring period; however, we only counted flushing events as described by Jaques (2002 and pers. comm.), in which gulls and large groups of CBPE suddenly flushed from the breakwater and flew to another location on the breakwater, or returned after one or more minutes to a similar location on the breakwater. Occasionally, CBPE flushed and landed in the water and remained there, or left the breakwater to forage.

KBC documented a total of 28 flushing events during the entire monitoring period, including three events due to apparent dredging activities and the remaining 25 due to other factors (Table 1). A total of 368 CBPEs were flushed from the breakwater due to apparent disturbances caused by dredging activities, compared with 3,274 CBPEs flushed from the breakwater due to other disturbances (Table 1). All 368 CBPEs disturbed due to apparent dredging activities were recorded as returning to the breakwater, although an estimated 436 individuals of the 3,274 CBPEs disturbed due to other factors did not return to the breakwater (Table 1). Flushing events per hour of monitoring were 0.147/hr for the entire monitoring period, 0.125/hr during pre- and post-dredge monitoring, and slightly higher (0.153/hr) during dredging (Table 1).

The single greatest disturbance was when approximately 300 CBPE flushed from the breakwater disturbed due to a helicopter flying low over the breakwater on March 7 (Table 1).

Average numbers of CBPEs at dusk counts for the entire breakwater during the entire monitoring period were 463; dawn counts averaged 348, with a difference between dusk and dawn counts averaging –122, meaning that an average of 122 CBPE counted the previous evening had departed the breakwater by the dawn count (Table 2). The average difference between CBPE dusk and dawn counts during pre- and post-dredge monitoring was +8.9 CBPE, compared with -176.4 during dredging (Table 2). However, 20 of the total 23 flushing events recorded during the dredging period were due to other causes rather than to dredging activities (Table 1), suggesting that the difference in roosting CBPE numbers at dusk and the following dawn cannot be attributed to dredging disturbances.

Dredge locations W, D, AI and J (Figure 2) were closest to the breakwater; however, only one of these, on January 26 (location J) was associated with a flushing event attributed to dredging activities (illumination from the dredge) (Table 2).

Table 1. Summary of Observed CBPE Disturbances (Flushing Events) during the 2007 MDR Dredging Project

DATE	TIME	DISTURBANCE (in bold if due to dredging activities)	monitoring period	Number of BRPE flushed	Number of BRPE returning	Net BRPE disturbed from roost
31-Dec	7:36 AM	Unknown	pre-dredge	9	6	3
1-Jan	5:38 PM	high-speed Sheriff boat	pre-dredge	25	3	22
1-Jan	5:40 PM	fireworks on the beach	pre-dredge	120	75	45
9-Jan	9:02 PM	Unknown	during dredging	30	15	15
23-Jan	5:52 PM	**dredge grinding sounds**	during dredging	12	12	0
27-Jan	7:07 AM	fishing vessel "In-Seine" along breakwater	during dredging	42	30	12
29-Jan	7:00 PM	**barge returned; dredge resumes operation**	during dredging	150	150	0
1-Feb	7:20 PM	U.S. Coast Guard helicopter w spotlight	during dredging	40	40	0
5-Feb	5:40 PM	Unknown	during dredging	38	38	0
12-Feb	5:35 PM	fishing vessel "Killer Skiff" along breakwater	during dredging	100	0	100
15-Feb	4:59 PM	police helicopter	during dredging	15	15	0
21-Feb	6:17 AM	kayaker along breakwater	during dredging	3	3	0
26-Feb	5:50 PM	fishing vessel at high speed &/or illumination from dredge	during dredging	250	250	0
27-Feb	5:30 AM	low-flying helicopter with spotlight	during dredging	200	unknown	unknown
27-Feb	6:23 PM	low-flying plane over breakwater	during dredging	75	75	0
28-Feb	6:31 PM	low-flying helicopter over breakwater	during dredging	30	30	0
1-Mar	6:00 AM	waves crashing over breakwater (due to high winds)	during dredging	13	12	1
1-Mar	6:40 AM	U.S. Coast Guard boat close to breakwater	during dredging	12	12	0
1-Mar	7:01 AM	fishing boat "Intrepid" close to breakwater	during dredging	2	2	0
7-Mar	6:33 PM	low-flying helicopter over breakwater	during dredging	300	300	0
9-Mar	6:09 PM	low-flying helicopter over breakwater	during dredging	2	2	0
9-Mar	8:10 PM	**dredge tugboat approaches breakwater to turn around**	during dredging	206	206	0
10-Mar	4:36 AM	fishing boat	during dredging	2	2	0
12-Mar	7:35 PM	Unknown	during dredging	38	0	38
12-Mar	7:42 PM	Unknown	during dredging	100	0	100
12-Mar	8:10 PM	LA County Fire Dept speeding along breakwater w spotlight	during dredging	200	unknown	unknown
1-Apr	7:15 PM	fishing boat "Total Slacker" back and forth along breakwater	post-dredge	200	100	100
1-Apr	7:25 PM	another fishing boat speeding along breakwater	post-dredge	25	25	0
TOTAL DISTURBANCES DURING ENTIRE MONITORING PERIOD:			28			
TOTAL DISTURBANCES DUE TO DREDGING ACTIVITIES:			3			
TOTAL DISTURBANCES DUE TO OTHER ACTIVITIES:			25	disturbed:	returned:	net disturbed:
TOTAL PELICANS DISTURBED DUE TO DREDGING ACTIVITIES			**368**	**368**	**368**	**0**
TOTAL PELICANS DISTURBED DUE TO OTHER ACTIVITIES			3274	3274	1471	436
DISTURBANCES/HR TOTAL			0.147			
DISTURBANCES/HR PRE- and POST-DREDGING			0.125			
DISTURBANCES/HR DURING DREDGING			0.153			

Table 2. Summary of the Dredge Location and CBPE Numbers during the 2007 MDR Dredging Project

					Pelican numbers			
Date	**Dredge Location**	**Dredge Latitude**	**Dredge Longitude**	**Map Reference**	**Dusk Count**	**Dawn Count**	**Difference**	**Notable Disturbances**
30-31 Dec	Pre-dredge	None	none	none	160	121	-39	none
1-2 Jan	Pre-dredge	None	none	none	161	182	21	high-speed sheriff boat; fireworks on beach
2-3 Jan	Pre-dredge	None	none	none	169	205	36	None
3-4 Jan	Pre-dredge	None	none	none	136	179	43	None
8-9 Jan	4A	33.962435°	-118.462661°	A	171	303	132	none; helicopter flyby, no disturbance
10-11 Jan	4A-5A line	33.962435°	-118.462661°	A	67	41	-26	unknown
15-16 Jan	4A-5A line	33.962435°	-118.462661°	B	203	118	-321	none
18-19 Jan	4A to 5A	33.961647°	-118.462742°	C	233	328	95	none
		33.963525°	-118.463506°	D				none
		33.963263°	-118.462520°	E				none
23-24 Jan	5A-6 line	33.963857°	-118.462473°	F	722	415	-307	dredge grinding sounds
24-25 Jan	5A	33.963243°	-118.462461°	G	1378	693	-685	none
		33.963633°	-118.462602°	H				none
26-27 Jan	6 for PM shift	33.963973°	-118.462368°	I	502	553	51	commercial fishing boat; illumination from dredge
	5A for AM shift	33.963321°	-118.463189°	J				
29-30 Jan	6	33.963555°	-118.461637°	K	679	474	-205	dredge resuming operation after stopping
		33.963721°	-118.462235°	L				
1-2 Feb	6	33.963798°	-118.461391°	M	1321	1048	-273	Coast Guard helicopter spotlight
		33.964051°	-118.462576°	N				
5-6 Feb	5A-6 line	33.963759°	-118.462611°	O	902	441	-461	unknown
		33.964382°	-118.461403°	P				
7-8 Feb	6	33.963409°	-118.461637°	Q	256	260	4	none
9-10 Feb	6	33.963526°	-118.461414°	R	670	313	-357	none
		33.964139°	-118.461719°	S				
12-13 Feb	5A	33.963370°	-118.462635°	T	703	270	-433	fishing boat; high winds and waves over breakwater
		33.962640°	-118.462247°	U				
13-14 Feb	4A-5A line	33.963603°	-118.462764°	V	176	222	46	high winds and waves over breakwater
		33.963301°	-118.463679°	W				
15-16 Feb	4A-5A line	33.962900°	-118.462581°	X	571	256	-315	LAPD helicopter low over breakwater
		33.963131°	-118.462017°	Y				
20-21 Feb	4A	33.961622°	-118.461683°	AB	590	261	-329	fishing boats; unknown
		33.962248°	-118.461842°	AC				
26-27 Feb	5A-6 line	33.963019°	-118.462120°	AG	539	334	-205	high-speed fishing vessel; helicopter w spotlight

Table 2. Summary of the Dredge Location and CBPE Numbers during the 2007 MDR Dredging Project

					Pelican numbers			
Date	**Dredge Location**	**Dredge Latitude**	**Dredge Longitude**	**Map Reference**	**Dusk Count**	**Dawn Count**	**Difference**	**Notable Disturbances**
27-28 Feb	5A	33.962893°	-118.462270°	AH	558	297	-261	low-flying plane
28 Feb-1 Mar	5A and 6	33.963220°	-118.463366°	AI	874	651	-223	helicopter low over breakwater
		33.962721°	-118.462207°	AJ				
		33.963236°	-118.461720°	AK				
1-2 Mar	6	33.963236°	-118.461720°	AM	325	204	-121	Unknown
5-6 Mar	6	33.963777°	-118.461625°	AO	361	139	-222	Unknown
7-8 Mar	6	33.963662°	-118.461568°	AP	546	223	-323	two passes by low-flying helicopter
		33.964376°	-118.461328°	AQ				
9-10 Mar	6	33.963340°	-118.461447°	AR	177	691	514	low-flying helicopter; tugboat close to breakwater
		33.963131°	-118.461606°	AS				
12-13 Mar	6	33.963217°	-118.461421°	AT	272	192	-80	LA County Fire Dept spotlighting breakwater
		33.963445°	-118.461430°	AU				
		33.963399°	-118.461503°	AV				
13-14 Mar	6	33.963283°	-118.461556°	AW	133	336	203	None
		33.963157°	-118.462206°	AX				
31 Mar-1 Apr	post-dredge	none	none	none	470	308	-162	None
1-2 Apr	post-dredge	none	none	none	440	638	198	small boats close to breakwater
2-3 Apr	post-dredge	none	none	none	484	343	-141	None
3-4 Apr	post-dredge	none	none	none	318	433	115	None
AVERAGES, ALL COUNTS:					463	348	-122	
AVERAGES PRE- & POST-					292.3	301.1	8.9	
AVERAGES DURING DREDGING					531.6	365.0	-176.4	

FIGURE 2. LOCATIONS OF DREDGE DURING MONITORING PERIOD (see Table 1)

DISCUSSION

In summary, during a total of 190 hours of monitoring, KBC documented a total of 28 CBPE flushing events; of these, three events were due to apparent dredging activities. A total of 368 CBPE were flushed from the breakwater due to dredging activities, compared with 3,274 CBPE flushed due to other disturbances. All 368 CBPE disturbed due to dredging returned to the breakwater, although 436 individuals disturbed by other factors did not return to the breakwater. Flushing events averaged 0.147/hr for the entire monitoring period. The single greatest observed disturbance was due to a low-flying helicopter.

The average reduction in roosting CBPE numbers from dusk to at dawn counts is likely due to factors other than dredging activities, since 20 of the 23 flushing events recorded during the dredging period were due to factors other than dredging activities. This conclusion is supported by the fact that of the four dredge locations closest to the breakwater, only one was associated with a flushing event attributed to dredging activities. Thus, activities associated with 2007 dredging at Marina del Rey occasionally disturbed CBPEs, but disturbances due to other human activities were far more frequent and disturbed more CBPE.

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APPENDIX A
MARINA DEL REY 2007 DREDGING PROJECT
CALIFORNIA BROWN PELICAN
MONITORING DATA SHEET

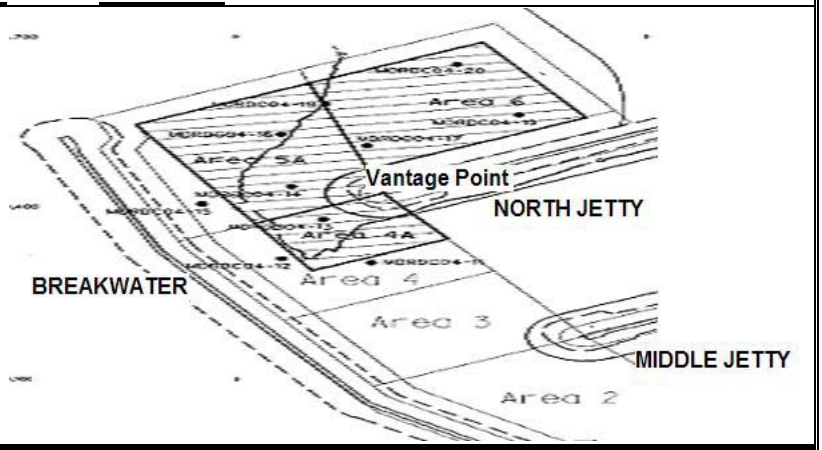
KEANE BIOLOGICAL CONSULTING BIOLOGICAL MONITORING LOG

ACOE MARINA DEL REY DREDGING PROJECT 2007

MONITORING OF CALIFORNIA BROWN PELICAN (BRPE) BEHAVIOR

Date:	Time Begin[1]:	Time End[1]:	Name of Monitor:
Actual Times Monitored[1]:			
Weather and Wind Conditions Time Begin:			
Weather and Wind Conditions Time End:			
# OF PELICANS: TIME BEGIN AT AREAS: 5A: 4A: 2-3: TIME END AT AREAS: 5A: 4A: 2-3:			
# OF ROOSTING BRPE (circle:) JUST BEFORE DARK or AT DAWN: 5A: AREA 4A: 2-3:			

Location of Dredge (Mark on adjacent map) & describe dredging activity in detail, number of associated vessels, and estimated distance from breakwater:



BRPE DISTURBANCE RECORD

Record # BRPE flushing as a result of disturbance and # of those returning to same area (within 100 ft.) of breakwater

Disturbance type: ***D*** *(dredge or associated vessels),* ***V*** *(other vessel),* ***S*** *(spotlighting),* ***O*** *(other: number and describe below);* ***U*** *(unknown). You can also use O1 etc. to further describe other disturbances below; just change the O to the appropriate letter.*

TIME	# BRPE FLUSH-ING	# BRPE return-ing	Dist. Type & Area	TIME	# BRPE FLUSH-ING	# BRPE return-ing	Dist. Type & Area	TIME	# BRPE FLUSH-ING	# BRPE return-ing	Dist. Type & Area

O1:	O9:
O2:	O10:
O3:	O11:
O4:	O12:
O5:	O13:
O6:	O14:
O7:	O15:
O8:	O16:

OTHER BIRD SPECIES OBSERVED (use AOU codes):

[1] you may take one or more breaks of any length **but must record data for a total of 4 hrs from sunset to midnite, or a total of 2 hrs from midnite to daybreak**

THE SAME DAY OF MONITORING: FAX (562-377-1200), OR SCAN & EMAIL, THIS FORM TO keanebio@yahoo.com
2892 N. Bellflower Blvd., Suite 480, Long Beach, CA 90815; Phone: 562-708-7657

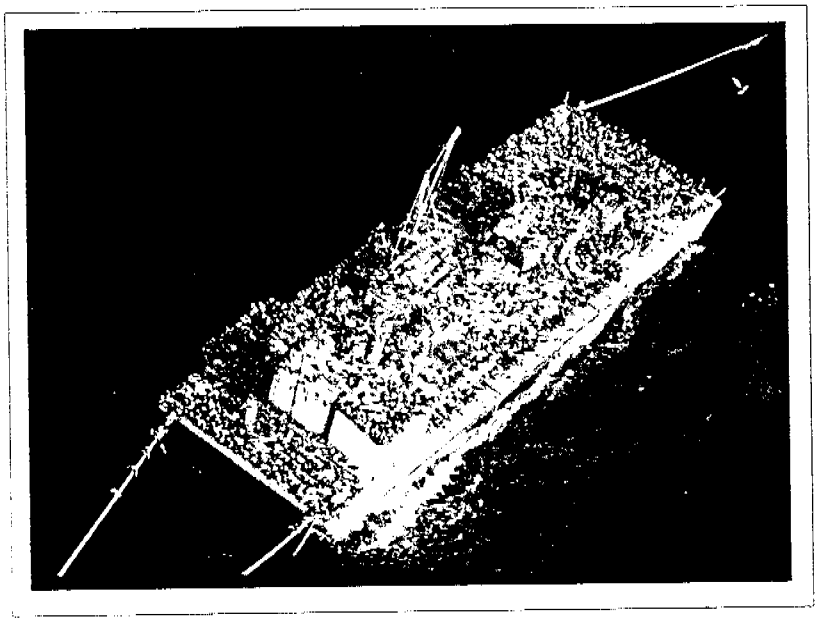
APPENDIX B
BIRDS OBSERVED DURING
MARINA DEL REY 2007 DREDGING PROJECT
CALIFORNIA BROWN PELICAN SURVEYS

Family and Scientific Name	Common Name
Podicipedidae	**Grebes**
Podilymbus podiceps	Pied-billed Grebe
Podiceps auritus	Horned Grebe
Podiceps nigricollis	Eared Grebe
Aechmophorus occidentalis	Western Grebe
Aechmophorus clarkii	Clark's Grebe
Pelecanidae	**Pelicans**
Pelecanus occidentalis	Brown Pelican
Phalacrocoracidae	**Cormorants**
Phalacrocorax auritus	Double-crested Cormorant
Phalacrocorax penicillatus	Brandt's Cormorant
Phalacrocorax pelagicus	Pelagic Cormorant
Ardeidae	**Herons**
Ardea herodias	Great Blue Heron
Casmerodius albus	Great Egret
Egretta thula	Snowy Egret
Nycticorax nycticorax	Black-crowned Night-Heron
Anatidae	**Waterfowl**
Branta bernicla	Brant
Anas platyrhynchos	Mallard
Melanitta perspicillata	Surf Scoter
Bucephala clangula	Common Goldeneye
Bucephala albeola	Bufflehead
Mergus serrator	Red-breasted Merganser
Accipitridae	**Hawks**
Pandion haliaetus	Osprey
Falconidae	**Falcons**
Falco peregrinus	Peregrine Falcon
Charadriidae	**Plovers**
Pluvialis squatarola	Black-bellied Plover
Pluvialis fulva	Pacific Golden-Plover
Charadrius vociferus	Killdeer
Haematopodidae	**Oystercatchers**
Haematopus bachmani	Black Oystercatcher
Scolopacidae	**Sandpipers**
Catoptrophorus semipalmatus	Willet
Heteroscelus incanus	Wandering Tattler
Aphriza virgata	Surfbird
Actitis macularia	Spotted Sandpiper

Scolopacidae (continued)	**Sandpipers (continued)**
Numenius phaeopus	Whimbrel
Numenius americanus	Long-billed Curlew
Limosa fedoa	Marbled Godwit
Arenaria interpres	Ruddy Turnstone
Arenaria melanocephala	Black Turnstone
Calidris alba	Sanderling
Calidris mauri	Western Sandpiper
Calidris minutilla	Least Sandpiper
Limnodromus scolopaceus	Long-billed Dowitcher
Laridae	**Gulls, Terns**
Stercorarius parasiticus	Parasitic Jaeger
Larus philadelphia	Bonaparte's Gull
Larus heermanni	Heermann's Gull
Larus canus	Mew Gull
Larus delawarensis	Ring-billed Gull
Larus californicus	California Gull
Larus argentatus	Herring Gull
Larus occidentalis	Western Gull
Larus glaucescens	Glaucous-winged Gull
Sterna caspia	Caspian Tern
Sterna maxima	Royal Tern
Sterna forsteri	Forster's Tern
Rynchops niger	Black Skimmer
Columbidae	**Pigeons, Doves**
* *Columba livia*	Rock Dove
Tyrannidae	**Tyrant Flycatchers**
Sayornis nigricans	Black Phoebe
Corvidae	**Jays, Crows**
Corvus brachyrhynchos	American Crow
Parulidae	**Warblers**
Dendroica coronata	Yellow-rumped Warbler
Fringillidae	**Finches**
Carpodacus mexicanus	House Finch
Passeridae	**Old World Sparrows**
* *Passer domesticus*	House Sparrow

APPENDIX L: Strong, C.S. and D.L. Jaques. 2003. Brown Pelican roost sites on the mainland coast of Southern California. Unpublished report prepared for American Trader Trustee Council, U.S. Fish and Wildlife Service, California Department of Fish and Game and National Oceanic and Atmospheric Administration, prepared by Crescent Coastal Research, Crescent City, California. 40 pages.

BROWN PELICAN ROOST SITES ON THE MAINLAND COAST OF SOUTHERN CALIFORNIA



Prepared for the
AMERICAN TRADER TRUSTEE COUNCIL
California Department of Fish and Game
United States Fish and Wildlife Service
National Oceanic and Atmospheric Administration

by

Craig S. Strong and Deborah L. Jaques
Crescent Coastal Research
112 West Exchange
Astoria, Oregon
97103

9 January 2003

Cover Photo: 1,324 Brown Pelicans roosting on a barge in the outer Santa Barbara Harbor (roost SB 3.0) on June 11 1992. Photo by Deborah Jaques, Crescent Coastal Research.

BROWN PELICAN ROOST SITES ON THE MAINLAND COAST OF SOUTHERN CALIFORNIA

Prepared for the
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97103

10 January 2003

EXECUTIVE SUMMARY

Brown Pelican (*Pelecanus occidentalis californicus*) distribution along the southern California mainland coast was analyzed using aerial survey data from 1986-2000 to provide management information on use of communal roost habitat. Sixty traditional roosts were identified, of which 4 were ranked as being of "major importance" (mean count >100 birds), and 25 as "important" sites (mean > 30 birds). The breakwaters at Long Beach Harbor and Marina Del Rey provided the highest quality habitat and supported the largest roosting aggregations. Most roost habitat consisted of artificial structures, and most roosts were owned and managed by federal agencies. Roosts on private structures were subject to removal or alteration; two roosts on private structures were temporary and were eliminated during the study period, and others were in jeopardy. Gaps in the availability of quality roost habitat occurred at the north end (Santa Barbara Co. and northern Ventura Co.) and south end (San Diego County) of the study area. Recommendations for restoration and improvement of roost habitat for Brown Pelicans include creation of high quality roosts in south San Diego Bay, Batiquitos Lagoon, and the outer harbor at Santa Barbara.

ACKNOWLEDGMENTS

This analysis was supported by the American Trader Trustee Council (ATTC) and the National Fish & Wildlife Foundation. We thank the American Trader Trustee Council and California Dept. of Fish and Game Office of Oil Spill Prevention and Response (OSPR) for supporting aerial surveys in 1998 and 1999. Aircraft and pilots were provided by CDFG Air Services in Sacramento (Larry Heitz, director, and pilots Bob Morgan, Wayne Burnet, Bob Cole, Ron VanBenthuysen, Kevin McBride, and Rich Anthes) and Ontario (Jeff Veal). Aerial photographic surveys in 2000 were conducted by the U.S. Geologic Survey and Humboldt State University, with support from the U.S. Geologic Survey, U.S. Navy (Naval Air Station Point Mugu), and CDFG Office of Oil Spill Prevention and Response. We appreciate the efforts of Harry Carter (USGS Western Ecol. Res. Ctr, Dixon) and Paul Kelly (CDFG OSPR program) in developing the data sharing agreement between this study and that of USGS/HSU.

Field Observers who assisted with aerial surveys included Brad Keitt (Island Conservation & Ecology Group), Tom Keeney and Grace Smith (U.S. Navy, Point Mugu), Chris Depkin, and John Scholl. Thanks to ATTC members Carol Gorbics (USFWS Carlsbad Office), Paul Kelly (CDFG-OSPR), and Jennifer Boyce (NOAA Restoration Ctr.) for guidance and suggestions on this project, and to Carol Gorbics for review and improvements to this report. Carol Gorbics and Emilie Luciani (USFWS) provided map graphics as well. Rebecca Kramer and Anna Weinstein (National Fish & Wildlife Foundation) provided contract and accounting support.

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INTRODUCTION

The California Brown Pelican (*Pelecanus occidentalis californicus*) is a common resident and migrant of the southern California coastline and Channel Islands. The species is currently listed as federally Endangered, largely due to DDT and PCB pollution that caused widespread reproductive failure during the 1960's and early 1970's (USFWS 1983). In the U.S., nesting only occurs on Anacapa and Santa Barbara Islands in the Channel Islands National Park. Additional nesting occurs on islands along the Pacific coast of Baja California and in the Gulf of California, Mexico (USFWS 1983). In 2001, the number of nest attempts and fledglings produced by the southern California nesting population was estimated at 3180 and 2550 individuals, respectively, though the number of nest attempts and fledglings produced is variable by year (range 1486 to 5400 and 372 to 5530, respectively, during the past ten years (1992 to 2001, Gress 2002). Nesting takes place from February through June, and birds disperse throughout the Pacific coast between Mexico and British Columbia from about June through October (Anderson and Anderson 1976, Jaques 1994). Peak numbers occur along the southern California coast following the nesting season, from June through October (Anderson and Anderson 1976, Briggs *et al*. 1981, Jaques *et al.* 1996).

Throughout their range, Brown Pelicans rely on a variety of shoreline structures as roost habitat to rest and restore their plumage. Roost habitat is essential habitat for pelicans, as their plumage becomes soaked with prolonged water contact, and flying is energetically expensive (Rijke 1970, Pennycuik 1972, USFWS 1983). Roost sites are generally communal and traditional in that the birds are found in groups rather than singly, and the same sites are used consistently over years. Overnight roost sites are restricted to the most secure roosts and have a strong traditional component, thus night roosts tend to be larger and fewer than diurnal ones. Throughout much of their non-breeding range, roosts are found on offshore rocks and islands where there is protection from mammalian predators and human disturbance. On the southern California coast, natural roosting habitat for these birds is limited, and the majority of roosts are found on artificial structures (Jaques *et al.* 1996). Protection of roosting areas has become an increasingly important management issue in California, as awareness of the potential adverse impact caused by human disturbance and habitat alteration has grown. For these reasons, the protection, creation and enhancement of roost habitat was selected as an effective means of restoring injuries to Brown Pelicans caused by the *American Trader* oil spill of 1990 (American Trader Trustee Council 2001). The American Trader Restoration Plan details how creation, enhancement, and protection of Brown Pelican roost sites will benefit Brown Pelicans along the southern California coast.

This report provides a summary of the current status of roost sites in southern California with information on recent changes (since 1986), and a comparison of pelican abundance in southern California relative to the rest of the state. The report is intended to provide information to aid in the selection of restoration projects and as a baseline for quantifying the success of implemented restoration projects. We include descriptions of all regularly used roost sites, assessments of roost quality, and identification of regional gaps in suitable roost habitat.

METHODS

Data Collection

In 1986 and 1987 and again in 1992 and 1993, we conducted a series of air surveys of pelicans throughout southern California. These data were reported in Jaques and Anderson (1987), Jaques (1994) and Jaques *et al.* (1996), and are summarized in this report. From 1998 to 2000 additional fall air surveys were conducted. We carried out fall aerial surveys in 1998 and 1999 as a part of the present study (source data in Appendix. B). Aerial photographic surveys in 2000 were conducted by the U.S. Geologic Survey and Humboldt State University, with support from the U.S. Geologic Survey, U.S. Navy (Naval Air Station Point Mugu), and CDFG Office of Oil Spill Prevention and Response. Aerial surveys were also completed for central and northern California in the 1998-2000 period using the same methods.

Aerial survey flights were conducted in California DFG aircraft from 1986 to 1987 and 1998 to 2000, and in Aspen Air Services aircraft in 1992 and 1993. Most surveys were conducted during fall, when peak pelican populations in California usually occur, with additional surveys conducted in June and December. In total, 15 air surveys were conducted from the Mexican Border to Point Conception, though fog and airspace restrictions limited the coverage on some surveys (Table 1 and Figure 1). Point Conception itself was included in the central California total, as it was considered more representative of that region. Along with the pilot, two observers were aboard during most surveys: the primary roost photographer and an overview photographer/data recorder who also tallied actively foraging pelicans on the seaward side of the plane.

The survey plane flew at approximately 500 ft above sea level immediately offshore from the shoreline or roost habitat. All large roost sites were photographed with a 35 mm camera and 200-300 mm lens out an open window at an oblique angle. Pelicans were later counted individually from projected transparencies. Numbers of pelicans at small roosts (generally <20 birds) and active birds (flying or feeding) within about 1 km of shore were tallied during the flight. Roost habitat was categorized into 11 habitat types based on physical habitat characteristics (Table 2).

Ground surveys of selected roost sites were made in September 1999 and in July and September of 2000 primarily for the purpose of studying night roost status and disturbance effects. Description of methods and results are contained in separate reports (Strong and Jaques 2002, Jaques and Strong 2002), but some counts based on ground surveys are mentioned here.

Analysis

All aerial roost counts from June through November were used for evaluating sites as roosts and calculating mean use and frequency of use. December numbers were so low on the mainland coast that those data were not considered representative of roost site use. We considered a location a roost site if three or more pelicans were present on more than one visit. Areas where roosting birds were present with some consistency but at variable adjacent locations with similar

habitat were combined into a single roost "site." This occurred within harbors, along the rocky shores of Laguna Beach and Palos Verdes, and along the beaches of northern Ventura and northern Santa Barbara Counties. Habitat type of the roost site was also simplified to name the most commonly used or important roost substrate. For example, at Palos Verdes, where pelicans roosted both on the shore and on small offshore rocks, the habitat was categorized as "offshore rocks" (OSR) because it represented the more important roost substrate.

RESULTS

We identified 60 Brown Pelican roost sites on the southern California mainland coast based on fall surveys in 1986-2000 (Tables 3a to 3e). Four roost sites that were identified in 1986 were no longer available to pelicans in the 1998-2000 surveys (noted as "historic" in the tables). Two additional small roosts in Channel Islands and Ventura harbors were noted from the ground but not in aerial surveys, and additional small roosts may have occurred within other harbors farther south. We considered a roost to be an important site if the mean number of birds present was over 30 and frequency of occurrence was over 50%. A total of 25 roosts met these criteria (Figure 1). Only 4 sites were considered major roosts, with mean counts of over 100. The largest of these were the breakwaters of Long Beach Harbor and Marina Del Rey, followed by Zuniga Point breakwater and Mugu lagoon estuary (Figure 1). Maps of roost locations are given for all important sites in Appendix B.

The major roosts (mean counts > 100 birds) described in this report are the same as found by Jaques *et al.* (1996) using the 1992-93 data alone, with the exclusion of the Santa Barbara outer harbor and Mobil Oil Pier sites, now removed and unavailable to pelicans. Most important roost sites are also in common between the two studies, though the rank order varied between the two data sets. Rank was assigned based on mean number of birds at the roost sites during our surveys.

Roost Habitat

Breakwaters were by far the most important single habitat type, supporting 42.4% of all roosting pelicans, based on an average of all surveys of the southern California coast. Jetties were a distant second, with 13.5% of roosting birds, followed by other habitat types, each holding less than 10% of the total (Figure 2a). Artificial substrate comprised 22 of the 60 roosts, but supported 66% of roosting pelicans. Offshore rocks were the most common roost type (and actually there are many more than the 13 indicated in Figure 2a, but these were grouped into single roosts if they were along similar coastline) but the rocks off southern California are small and supported just 7% of the total.

Artificial structures, Mugu Lagoon estuary and Malibu Lagoon estuary were used on more than 60% of surveys (Figure 2b). The lower frequency of use of natural habitats is largely due to their small size (offshore rocks) or higher incidence of disturbance (beaches, mainland shore, lagoon, and river mouths).

Roost Ownership and Management

The Army Corps of Engineers is in charge of maintaining most breakwaters and jetties, 48.7% of all pelicans, on average, roosted on habitat under their management (Figure 3). However, management of the structures usually involves a cooperative agreement between the U.S. Army Corps of Engineers and the respective local harbor district whose waters are protected by the jetty/breakwater structures.

Other federal entities own or manage sites where 22.7% of the pelicans roosted (for a federal total of 71.4%). The BLM recently assumed management of all offshore rocks from California Dept. of Fish and Game, thus the state portion of roost management has been reduced. An average 10.6% of all pelicans roosted on sites managed by the State of California. The most important state managed roosts are those at Bolsa Chica Wetlands State Reserve (CDFG), Santa Clara River mouth (McGrath State Park), Malibu Lagoon (Malibu Lagoon State Park), and Batiquitos Lagoon (CDFG). Just 11.5% of pelicans roosted on private structures in 1998-2000 surveys, but this figure was 23.5% when historical data (1986-1993) are included.

Loss and Alteration of Roost Habitat

Since 1986, two major roost sites have been removed, two important roosts are under threat of removal or are being removed, one important site has been degraded, and two minor roosts have been lost to pelican use. No new roost sites have been created. All site losses have been on privately owned property except one minor site (San Luis Rey river, SD 12.5).

Private barges in the outer Santa Barbara Harbor and the Mobil Oil Pier, both in Santa Barbara County, were among the largest roosts during the early 1990's. At that time, they ranked 3rd and 4th in average use for the entire southern California coast. The barges used at Santa Barbara Harbor were only available as roosts for a few years and were removed in fall 1992. The Mobil Oil Pier was removed under direction from State Lands Commission in 1996.

The following describes additional current or possible future losses of individual roost sites:

- Efforts are being made to remove the roost at Agua Hedionda (SD 12) under the direction of the city of Carlsbad, because the city is concerned that water quality and ongoing mariculture operations may be adversely affected by the roost. This may have already been accomplished as we do not have data for the 2001 season.
- There is a directive from the State Lands Commission to remove the Arco oil platform near Coal Oil Point, Santa Barbara County (Roost SB 5, ‘Sandpiper Pier’).
- The historic roost site at Batiquitos Lagoon was removed by CDFG in the mid 1990's. Currently the lagoon supports a minor roost on tidally exposed flats.
- A bait barge and other floating structures south of Malibu Lagoon were removed in 1993.
- A constructed island roost habitat at Luis Rey river mouth in Oceanside was eroded by winter storms in 1992 and has not been replaced.
- Roost substrate within harbors can be variable on a scale of months to years as private structures are relocated or altered.

Seasonal and inter-annual effects

The number of pelicans using a given roost site along the southern California coast varies in a somewhat regular pattern by season, and is more variable inter-annually. Anderson and Anderson (1976), Briggs *et al.* (1981), and Jaques *et al.* (1996) describe a seasonal low in pelican numbers from December to May along the southern California coast, when most birds are at nesting areas. Conversely, there is a higher abundance between June and October when pelicans move from nesting areas to mainly coastal roost sites. The majority of birds pass through southern California and on to central California, Oregon and Washington during their annual post-breeding dispersal (Jaques 1994). Distribution and local areas of concentration during summer and fall varies between years. Peaks in abundance in southern California regions occur during a pulse of migration or when prey availability is high. During these times, large numbers of pelicans can converge on an area making suitable local roost habitat a potentially limiting factor, and alternate or anomalous roost sites may be used during the day. An example of this occurred in June 1992 when over 500 pelicans were counted on Will Rogers State Beach (the beach was closed due to water pollution), and hundreds more were seen on nearby beaches in northern Los Angeles and southern Ventura Counties. Some of these sites never held over 3 birds before or since and therefore did not qualify as traditional roosts in this analysis.

During the El Nino event of 1992-93, few pelicans bred successfully in Mexico or on the Channel Islands (Gress *et al.* 1995), and numbers along the mainland shore of southern California were unusually high during both summer and winter (Figure 4). In other years, post-breeding birds may move rapidly through southern California to more northern points, resulting in very low fall survey totals. These effects cause high variability in roost counts, thus a series of surveys, such as presented in this report, are needed to provide representative information on roost site use.

Roost Habitat Distribution

Gaps in roosting habitat along the coast can increase the energy requirements for pelicans as they must access foraging areas over longer distances. Long stretches of shoreline lacking or with minimal roost habitat occur north and south from Santa Barbara Harbor (23.6 and 23.9 km, respectively), from Rincon Island to Ventura Harbor (19.3 km), between Mugu Lagoon and Malibu Lagoon (41.1 km), from Malibu Lagoon to Santa Monica 'breakwater' (17 km), and from Dana Point to Oceanside Harbor (38.1 km). Most gaps in diurnal roost habitat are in the northern half of the study area (Figure 1). The distribution of suitable night roosts is more limited than that of diurnal roosts. A summary of night roost size and distribution is contained in Strong and Jaques 2002.

State-wide Distribution

Southern California supported fewer pelicans than central or northern California on all recent fall surveys (1998-2000) having just 10-11% of the total in each year (Table 4). Central California was clearly the most important region, supporting 69 to 75 percent of the total in each year

(Table 4). Central California had more roost sites and larger roosts (118 sites, average size of 186 birds) compared with southern (60 sites, 51 birds on average) and northern (98 sites, 51 birds on average) California. Great concentrations of pelicans in the Shell Beach area, at Monterey Bay roosts, at Ano Nuevo Island, and at estuaries and offshore rocks of Marin County during the 1998-2000 period contributed to the large mean roost size in central California

Roost Quality

Quality of a roost site can best be understood in terms of (a) capacity and (b) security from disturbance and adverse environmental conditions.

Capacity: Maximum capacity can not be easily estimated other than by counts during episodes of high pelican abundance. At these times, behavioral observations show that birds are being displaced by other birds or that birds are actively searching for suitable alternate roost locations. Pelicans were concentrated in central San Diego County during the 2000 air surveys, and the Bird Rock roost (SD 9.0) was 'overflowing' in that pelicans were roosting on the adjacent mainland shore. From ground observations, roost sites at capacity occurred only on the artificial structures in Agua Hedionda Lagoon on 07/11/00 and 09/13/00 and at Shell Beach rocks north of Pismo Beach in central California on 09/09-10/00. At both locations all available roosting sites were occupied as dusk approached, and arriving birds were forced to land in water or continue flying. Birds were seen in the water the following dawn at both sites, and they quickly relocated onto shore at first light. Capacity is expected to be limited at times on small rock roosts (such as at Laguna Beach), during tidal inundation (such as at Zuniga Point breakwater), and on smaller man-made structures such as at the Sandpiper Pier, Agua Hedionda, or on boats and barges in harbors. Breakwaters, jetties, and beach or rocky shorelines are often of potentially unlimited capacity, but quality can be affected by disturbance or environmental effects as described below.

"Disturbance" is defined here as any event that causes pelicans to flush suddenly from their roost. Disturbance from human sources (human presence, boats, dogs, autos, aircraft) and natural sources (falcon, eagle, mammals) is the greatest identifiable source of observed roost quality degradation. Virtually all high quality roosts have a water buffer limiting or preventing human and mammalian access. On the southern California coast, roosts with a water buffer are limited to breakwaters and the small rocks at Point Loma, Laguna Beach, and Palos Verdes. With the growing number and variety of watercraft, even these island habitats may be subject to increasing levels of disturbance. A quantification and discussion of disturbance effects on southern California roost is contained in Jaques and Strong (2002).

Environmental effects are those largely due to weather and sea conditions. Examples of environmental effects on roost habitat quality are seen at the Ventura and Channel Islands Harbor breakwaters, where large swells spray or wash over much of the breakwater, eliminating roost habitat. Since large swells are most common in winter, this is typically a seasonal effect. Daily environmental effects are seen at Zuniga Point, where tidal inundation eliminates much of the roost at regular intervals. Winter storm flooding and shifting sand configurations alter roost habitat at river mouths and estuaries on a scale from years to decades. The quality of roost

habitat at Tijuana River, Malibu Lagoon, Mugu Lagoon, and Santa Clara River mouth is variable due to changing configuration of sandbars and water buffers between people and roosting areas. Exposure to wind and rain is more acute at some roosts than others, such as exposed beaches and probably on Sandpiper Pier (SB 5.0).

Site Descriptions

Brief site descriptions follow for roosts categorized as 'important' (mean count > 30) or that have significance in terms of restoration potential, ordered south to north. Leading each account is the site name and number (for cross-reference to Tables 3a to 3e and appendix B maps), ownership and management jurisdiction.

Tijuana River estuary, SD 1 Map 1

Owner/manager: U.S. Fish and Wildlife Service (USFWS), San Diego National Wildlife Refuge (NWR) and CDPR. CDPR property is on the south side of the river mouth, but most pelican use occurs on the NWR. The capacity and quality of this roost is variable, depending on tidal state and tidal and flood effects on sandbar configuration over the seasons. This area is also subject to frequent disturbance from ground and helicopter traffic associated with immigrants trying to get into the San Diego area and U.S. immigration officials patrolling for illegal border crossings. It is unlikely that meaningful roost habitat improvements could be achieved here due to disturbance effects and varying natural conditions at the site.

South San Diego Bay levees, SD 2.5 Map 1

Owner/manager: Western Salt Company / USFWS San Diego NWR.
Earthen levees used for salt evaporation in the south bay provide limited roosting habitat for pelicans, as well as nesting and roosting habitat for other waterbird species. The main roost site is at the southwest corner of the bay, on a peninsula formed by a defunct levee. We have not recorded high numbers here (the average was 6.5 birds from air surveys, with a peak count of 183 during ground surveys), but use appears to have increased since 1986. Pelicans were also seen at other levee structures and at the marina at Chula Vista, but use appears to be sporadic and with low numbers in general. There is considerable potential for improving the quality and quantity of roost habitat associated with or adjacent to the salt evaporation levees, and for the establishment of a night roost. The south end of the bay has extensive open water habitat with low water velocities and little watercraft activity. Restoration activity would target island habitat creation by alteration of existing levees, building islands, or installing floating structures. The lack of quality roost sites nearby, particularly of night roosts, would add further to the value of roost site improvements here. There is potential for development of a large, high quality roost habitat at this site with collaboration from the USFWS San Diego NWR.

San Diego Bay, SD 2.8 Map 1

Owner/manager: Private, U.S. Navy, Shelter Island Harbor.
Private and military structures along Silver Strand beach and at the north end of the bay support significant numbers of pelicans by day. A roost site at Crown Cove Marina was removed in the early 1990's, but another was created on a makeshift tire breakwater at Fiddler's Cove (a military

recreation harbor along Silver Strand). Shelter Cove harbor, North Island Naval Air Station, and the Coast Guard/military harbor around Ballast Point also have roost structures (barges, floating docks, pilings, buoys), but these are subject to alteration depending on activities of the military and private owners of the structures. Coverage of these sites has been incomplete during some air surveys, and description of exact location unclear, thus they were combined here. Improvements to roost habitat in these areas is not considered desirable because of private ownership, heavy recreational boat traffic, military use, and the nuisance and potential endangerment of having pelicans associated with inner harbors.

Zuniga Point, San Diego Bay mouth, SD 3.5 Map 1

Owner/manager: U.S. Navy, U.S. Army Corps of Engineers.

Breakwater rocks extending out from the jetty on the south side of San Diego Harbor entrance are the preferred roost site. Pelican use is limited by tidal height, as much of the structure is submerged at high tides. Birds also use the concrete jetty and rocks on the mainland point if the breakwater is unavailable or crowded. Human presence is restricted on the point by the North Island Naval Base, and mammalian predators have been controlled to protect Least Tern nesting habitat. Pelicans largely avoided the elevated channel marker structures towards the tip of the breakwater, and preferred the low rocks that were subject to inundation. California sea lions are common on the outer channel marker, but we have no explanation for why the other two elevated platforms were used so little. Recreational boats, shipping traffic, and frequent overflights by low altitude military aircraft are potential disturbance sources, but no disturbances were seen at this location. Restoration activities here would involve supplementing the breakwater above high water with rip-rap to create a larger and higher quality night roost.

Naval Reservation, Electronics Lab., SD 5 Map 1

Owner/manager: U.S. Navy.

Cliff ledges and a few small offshore rocks provide roost habitat for highly variable numbers of pelicans along approximately 2 km of coastline within the Naval reserve. Restricted access on the military property is likely critical to maintenance of the roost by limiting disturbance. Most birds have been seen on the mainland ledges, but both the ledges and offshore rocks are used. Night roost status is unknown.

Bird Rock, La Jolla, SD 9.0 Map 1

Owner/manager: BLM Calif. Coastal National Monument

This is the largest and farthest offshore of several small rocks around the south end of La Jolla. The flat top above reach of wave wash appears to provide a high quality roost, although it rarely supported over 20 birds. It is a suitable night roost but night use has not been checked. Capacity is limited by the rocks size; in and exceptional count during the 2000 air survey, 359 birds were listed at the rock, but over half of these were ‘overflow’ from the rock and roosted on the adjacent mainland.

La Jolla Caves area, SD 10 Map 1

Owner/manager: City of La Jolla.

The rocky shoreline west of La Jolla Caves is a frequently used day roost. The area is lightly fenced and has advisory signs to keep people from cliff edges. It is heavily used by people and, although pelicans have habituated to human proximity here, several disturbances were noted during a two hour observation. There is good potential for low cost restoration action here through improvement to the existing fence and more effective advisory signs.

Batiquitos Lagoon, SD 11 Map 2

Owner/manager: California Department of Fish and Game.

This lagoon lies about 7 km south of Agua Hedionda. Low numbers of pelicans consistently use the lagoon as a day roost, relying on the banks or sand islands exposed at low tide as substrate. During 1992 and 1993 surveys the lagoon was used more heavily, with a peak count of 362 pelicans occurring near the mouth of the lagoon. The area is managed by CDFG, which has invested considerable resources to stabilize the lagoon mouth and establish a Least Tern nesting area. These habitat modifications caused a loss of preferred pelican roost habitat near the mouth, and the birds now use only sandbars and mudflats farther up the lagoon. There is potential for development of large, high quality roost habitat at this site. The lagoon has a large acreage of open water of moderate depth with low recreational use and low current velocities where roost creation is possible. The persistent use by pelicans on the existing low quality habitat indicates a high potential for success if secure roosts were created. Roost site creation here would provide some mitigating compensation for the impending removal of the roost at Agua Hedionda, as well as the habitat loss described above.

Agua Hedionda Lagoon, SD 12 Map 2

Owner/manager: San Diego Gas and Electric/Carlsbad Aqua Farms.

The primary roost at this site has been on floats set out by a mariculture company for shellfish production. This lagoon has been consistently used by pelicans in all prior surveys of southern California, with an average count of 70 birds present. Night roost use is higher than day use, with an average count of over 200. During ground surveys we noted the maximum capacity the roost has varied around 250 to 380 or more depending on the configuration of mariculture structures. Disturbance from mariculture activities is persistent and occurs several times a day, but there is little other disturbance. Contact with the company revealed that they were under order from the City of Carlsbad to eliminate the roost due to concerns of excess bacteria loading of the lagoon. During summer and fall 2000, wire exclusion devices had been placed on the larger floats that pelicans used. The site was still used, but remaining floats available for roosting were round and less stable, and provided a reduced capacity and lower quality roost than existed previously. The entire roost may be (or has been) eliminated. Roost site creation or enhancement here appears to be in conflict with current management goals at Agua Hedionda.

Oceanside Harbor Jetty, SD 13 Map 2

Owner/Manager: Oceanside Harbor/ U.S. Army Corps of Engineers.

The roost site is on a long jetty with difficult human access from shore. It was used as a minor night roost in our observations; there are few alternative night roosts in the area. Disturbance sources are fishermen accessing the jetty by walking or by boat, watercraft, and low flying aircraft. Restoration action could include signs or fencing to reduce disturbance.

Dana Point Harbor jetties, OR 3 Map 3

Owner/manager: Dana Point Harbor District/ U.S. Army Corps of Engineers.

Pelicans roost on both jetties and on a bait barge in Dana Point harbor, and occasionally at San Juan Creek mouth in Doheney State Park just south of the harbor (OR 2.9). The long north jetty receives the least disturbance and is used as a night roost. Pelicans were habituated and tolerant of close watercraft at Dana point, but disturbance to small numbers of pelicans from close boat approaches were fairly common. Pelicans, herons, and gulls pose a nuisance to commercial bait barge operations within the harbor. Information was not available to assess the issue of human disturbance by fisherman using the jetty. Restoration here could involve fencing to restrict shore access to the night roost area and signs to limit watercraft approaches. This may be the largest night roost south of Long Beach Harbor with the elimination of the Agua Hedionda site. There is the potential for increase in night roost use if human access was curtailed.

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Bolsa Chica Wetlands, OR 10.1, Map 4

Owner/manager: CDFG/ Bolsa Chica Conservancy.

Created island habitats near the south end of the wetlands area at Bolsa Chica provide the roost substrate. The islands have a permanent water buffer and are suitable night roost habitat, but it is not known if they are used at night. The Long Beach breakwaters provide alternate high quality roost habitat 9 km to the north. The islands were created and are managed to provide nesting habitat for endangered Least Terns. Presence of large pelican groups here has potential for disruption of tern nesting activities and may be in conflict with existing management objectives.

Anaheim Bay jetties OR 11 Map 4

Owner/manager: U.S. Army Corps of Engineers/ USFWS Seal Beach NWR.

The jetties on either side of Anaheim Bay, at the entrance to Seal Beach NWR, support a large day roost for pelicans. Night roost status has not been determined. The longer southern jetty is the main roost, and often the only one with pelicans on it. Fishermen access both jetties with an unknown frequency, and cause disturbance when they do. Pelicans sometimes forage within the wetlands of Seal Beach NWR, but there is little roost habitat available there. Protecting the jetty roost habitat from fisherman access would improve the quality of the site, and creation or improvement of roost habitat within Seal Beach NWR would provide an alternate site adjacent to an estuarine foraging area.

Long Beach Harbor breakwaters, LA 1 and 2 Map 5

Owner/manager: Long Beach Harbor /U.S. Army Corps of Engineers.

The combined eastern and central breakwaters protecting the outer harbor at Long Beach are the largest roost site on the southern California coast, and probably the highest quality. The combined breakwaters extend for 9.4 km in length, are broad and somewhat protected from winter surf, providing virtually unlimited capacity. It is expected that night roost numbers would be higher than during the day, but observations were not possible from shore. Potential disturbances to this roost are from recreational fishermen and boaters, but disturbance data is lacking. The distance to shore and heavy shipping traffic in the harbor may reduce disturbance from recreational boats relative to smaller harbors. If boats access one part of the breakwater, alternate sites are found elsewhere on the structures, since they are so large.

San Pedro Jetty, LA 3 Map 5

Owner/manager: Long Beach Harbor /U.S. Army Corps of Engineers.

The jetty extending 1.6 km out from the north side of Long Beach Harbor provides a day roost for pelicans. The jetty surface is relatively flat and easily accessed by people, but is still used by significant numbers of pelicans. No restoration action is considered suitable here.

King Harbor jetties, LA 11 Map 5

Owner/manager: King Harbor District/U.S. Army Corps of Engineers.

Both jetties and floating structures (bait barge, other barges, buoys) provide roost substrate. The 1 km long outer jetty was used as a night roost by small numbers of birds, as were buoys in the harbor. Fishermen on the jetty at night disrupted the night roost during our observations, demonstrating the limitation of the habitat and the potential for improvement. Disturbance from shore, water, and air were seen at this roost. Restoration activities (fencing and signs) could limit shore and watercraft disturbance and would enhance night roost quality.

Marina Del Rey breakwater, LA 12 Map 6

Owner/manager: Marina Del Rey/U.S. Army Corps of Engineers.

This breakwater is 0.8 km long and provides a major day roost, comparable with that of the Long Beach breakwaters. Night roost use tends to be even higher. Winter surf could reach the top of the breakwater, but this was not recorded in our observations. The site is subject to a host of watercraft using the harbor, including rafts, kayaks, jet skis, powerboats, and sailboats, as well as aircraft overflights. Pelicans were tolerant of all but the closest approaches during our observations. Restoration activities here would include placement of signs to keep watercraft from approaching too closely.

Malibu Lagoon, LA 16 Map 6

Owner/manager: California Department of Parks and Recreation.

Pelicans roost on ephemeral islands within the lagoon, in shallow water, on the beach berm between the lagoon and ocean and an intertidal gravel bar near the surf zone. The gravel shoreline of the lagoon is flooded and reduces roost substrate during periods when the mouth is closed, which happens at irregular intervals. Despite frequent disturbance by park visitors, this was a fairly heavily used site; alternative sites are over 25 km away (Marina Del Rey).

Restoration action here could include advisory signs to keep people and dogs from entering areas close to the lagoon edge where pelicans typically roost. Reduced human presence in the estuary would also benefit roosting Snowy Plovers, Least Terns, and a host of wetland bird species.

Mugu Lagoon estuary, VN 4 Map 7

Owner/manager: U.S. Navy.

The major roost at Mugu Lagoon estuary ranks 4th largest on the coast. Due to naval reservation access restrictions and proximity to the breeding and roosting sites on Anacapa Island, Mugu Lagoon is one of two estuaries in southern California to support a consistent, large pelican roost, and the only estuary to have a relatively consistent night roost. The roost was intensively studied in 1992 and 1993 and readers are referred to that report (Jaques *et al.* 1996) for further detail. Currently another intensive research effort is underway at the site (Capitolo *et al.* 2002). The roost habitat is dynamic in nature, since winter storms and floods alter the configuration of islets and sandbars at the mouth, where the pelicans concentrate. The U.S. Navy Point Mugu Naval Air Weapons Station is involved in management and preservation of the roost site (Jaques *et al.* 1996, USFWS 2001).

Santa Clara River estuary, VN 7 Map 8

Owner/manager: California Department of Parks and Recreation, McGrath State Beach unit.

The physical structure of this estuary is quite dynamic, being altered by winter flooding, tidal effects, and temporary formation of lagoons when the beach berm seals off the river mouth from the ocean. It is a consistently used day roost with widely fluctuating numbers, but is not used at night. An exceptional peak count of 1540 birds was recorded from the ground in September 1988. The changing physical structure results in variable exposure to disturbance and predators. Persistent use of this site even when roost habitat appears marginal illustrates the site fidelity behavior involved in maintaining roost sites. Restoration actions here would consist of permanent signs at beach access locations and portable signs restricting access to the sensitive areas of the estuary when used by pelicans. Protection of pelican roost habitat would also benefit Snowy Plover and Least Tern nesting and roosting areas.

Ventura Harbor, VN 8 Map 8

Owner/manager: Harbor district /U.S. Army Corps of Engineers.

The Ventura Harbor breakwater is 0.75 km long and is constructed with a small angle and a 'spur' jutting out on the landward side. The spur provides the most wave protected area, and small numbers of birds stayed there overnight in 1999, but not in 1992 or 1993. Large waves wash over the breakwater, limiting roost habitat at times, particularly in winter. Channel Islands Harbor breakwater, 11 km to the south, is lower and more exposed to wave wash and had correspondingly fewer birds roosting on average. The proximity to Mugu Lagoon and Anacapa Island allows the birds to find alternate sites if the breakwaters are unsuitable. The interior of Ventura harbor supported up to 30 pelicans on various structures. The breakwater roost was subject to disturbance from a variety of watercraft and fishermen, but the birds appeared habituated to all but the closest approaches. Restoration at this site would consist of adding material to the breakwater to provide protection from winter storm surf, such that it could serve as a secure night roost. Another action would be to install advisory buoys or signs to reduce

watercraft disturbance and landing on the structure. Considering the proximity of alternate sites, this may have limited benefit.

Mobil Oil pier and Rincon Island, VN 10 and 11 Map 8

Owner/manager: Windsor Energy Corporation.

These privately owned artificial structures had become important roost sites in the eastern Santa Barbara Channel. The oil pier was a very important site in the early 1990's, ranking third behind the large breakwaters, but it was removed by 1997. The Rincon Island site, 1.5 km north of the previous oil pier, has roost habitat around the perimeter where the island is protected from the seas by huge concrete 'dolo' forms that provide the roost substrate. . Our mean count at Rincon Island from 1986-1999 was 97 pelicans, making it the 6th largest roost in southern California in this analysis. Use of Rincon Island has increased since removal of the Mobil pier in 1997. Capitolo *et al.* (2002) had a mean of 644 birds at Rincon Island in 2001. The current relative importance of this site would be better assessed by using data collected after 1997. Industrial activities and human disturbance may negatively impact use of the site. Restoration options would include actions to limit human access to the primary roosting areas. A conservation easement on the south and west sides of the island perimeter has been discussed, as well as installation of visual barriers between an existing ocean viewing deck and the outer seawall roosting area.

Outer Santa Barbara Harbor, SB 3 Map 9

Owner/manager: Santa Barbara Harbor District.

Pelican numbers in the Santa Barbara area were very low during the 1998 to 2000 period, during both aerial and ground based surveys. In the early 1990's, pelicans used two out-of-service mariculture barges in the outer harbor consistently as a day and night roost, with a peak count of 1,480 birds, when the barge was near its capacity as a roost (Jaques *et al.* 1996). There have been no comparable structures available since these barges were removed in fall 1992. Restoration activities here would consist of roost site creation in the outer harbor in the form of a floating structure (such as a retired barge, military vessel or fishing boat). Considering the gap in roost availability along the Santa Barbara coastline and proven high use of the previous site, roost site creation here would be expected to have the greatest benefit to pelicans among all restoration options considered.

Santa Barbara Harbor, SB 4.0 Map 9

Owner/manager: Santa Barbara Harbor Dist./private.

Pelicans roost on a variety of structures in the harbor area, most consistently on the Wharf roof tops, dredge barge, and buoys. A dredge barge was the largest roost area in 1998-1999 and provided night roost habitat, although temporary. Pelicans scavenged at the wharf and live bait storage areas and negative interactions with people were observed. Use of the inner harbor appears to have increased in recent years; the mean count during the 1986-1993 period was 11.7 where in 1998-2000 it was 87.2. Creation of higher quality habitat in the outer harbor may cause a reduction in use of the inner harbor.

Sandpiper Pier, Coal Oil Point, SB 5 Map 10

Owner/manager: Arco Oil / State Lands Commission.
This artificial island on a defunct oil production platform about 700 m from shore provides a secure roost and consistently supports Brown Pelicans. Pelican use is limited by space, some of which is occupied by Brandt's Cormorants that nest on the platform from April to August. It is a suitable night roost, though we have not documented use at night. With the loss of the privately owned roost sites in Santa Barbara, this remains the only significant secure roost site in Santa Barbara county. The platform is in jeopardy of removal by the owners (Arco) at request of the California State Lands Commission. Restoration at this site would consist of preventing its destruction and increasing roost surface area and stability. If the platform is removed, it is recommended that mitigation for loss of this high quality roost site be pursued and roost site creation be enacted at another location.

Northern Santa Barbara County beaches, SB 8 and 9 maps 10 and 11

Owner/manager: Santa Barbara County and California Department of Parks and Recreation (8) and the Hollister Ranch (9).
Limited human access and a lack of offshore roost habitat are probably the main factors making this area an important roost site for pelicans. Birds were consistently present at the south end of El Capitan State Beach, near Gaviota, and near Government Point just south of Point Conception, and sporadically present at many other locations. Although we did not survey these areas at dark, it is highly unlikely that the beaches are used as a night roost. The nearest alternate day and night roost sites are on the Channel Islands, about 45 km away.

MANAGEMENT RECOMMENDATIONS

This study suggests that the greatest need for enhancement or creation of roost habitat along the southern California mainland lies in Santa Barbara and San Diego counties, due to lack of major roost sites in those areas. All of the existing highest quality roost sites are located in the central portion of the coastline. Enhancements should provide long-term stability of roost sites and management oversight by resource agencies. Education is needed both of the public and the site managers to ensure that current roost sites and potential future roost sites are adequately maintained and protected. We recommend that restoration efforts be developed that first enhance night roost sites since these are most critical. Specific recommendations on night roost restoration opportunities can be found in Strong and Jaques (2002).

The following summarizes recommendations for enhancement of diurnal roost sites and identifies those areas where such enhancement would also benefit night roost sites.

High Priority (south to north)

- Expansion of day and night roost availability in San Diego NWR through modifications of levees associated with salt ponds or installation of floating structures.
- Development of a high quality day and night roost habitat at Batiquitos Lagoon with collaboration from the CDFG.

- Considering the gap in roost availability along the Santa Barbara coastline and proven high use of the outer Santa Barbara Harbor sites lost in the early 1990s, roost site creation here would be expected to have the greatest benefit to pelicans among all restoration options considered for both day and night roost habitat.

Moderate Priority (south to north)

- La Jolla Caves fencing and signs could be improved to provide better day roost habitat.
- Restoration at Dana Point Harbor jetties would involve fencing to restrict shore access to the night roost area and signs to limit watercraft approaches. There is the potential for significant increase in night roost use if human access were eliminated.
- Restoration activities at King Harbor Jetties (fencing and signs) could limit shore and watercraft disturbance and would enhance night roost quality.
- Marina Del Rey breakwater restoration activities would include placement of signs to keep watercraft from approaching too closely which would enhance day and night roosts.
- Restoration actions at Malibu Lagoon and Santa Clara River would involve advisory signs to keep people and dogs from entering areas close to the lagoon edge where pelicans typically roost during the day and night. Reduced human presence in the estuary would also benefit roosting Snowy Plovers, Least Terns, and a host of wetland bird species. California Dept. of Parks and Recreation is the resource management entity for both areas.
- Securing some management control over the fate of the Sandpiper Pier oil platform to prevent its destruction would provide significant benefit to pelicans and nesting Brandt's Cormorants. Alternatively, requiring the owner/managers of the platform to recognize the value of resources associated with the structure under the ESA and Migratory Bird Treaty Act would aid in obtaining mitigation if the structure is removed.

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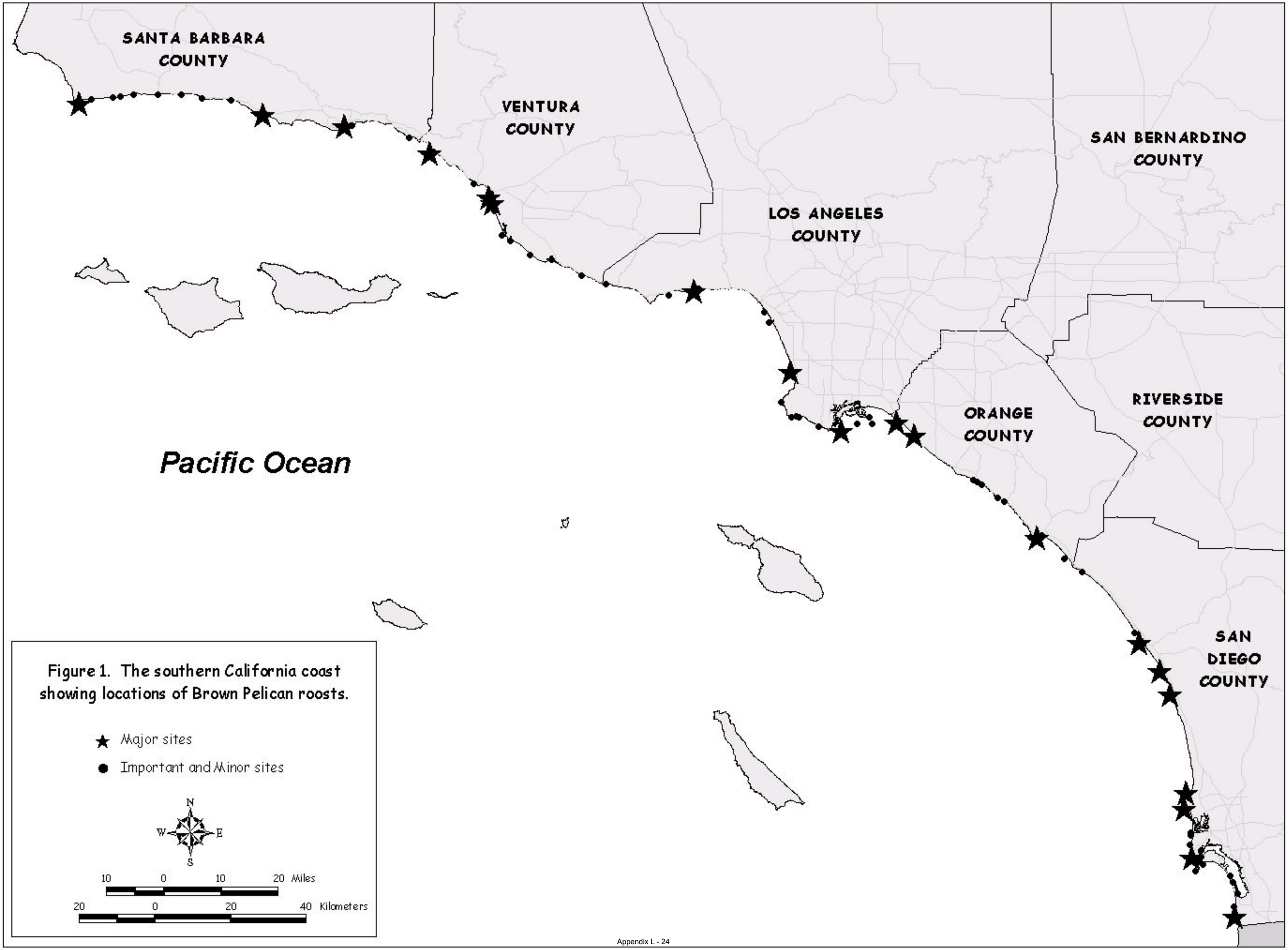


Figure 1. The southern California coast showing locations of Brown Pelican roosts.

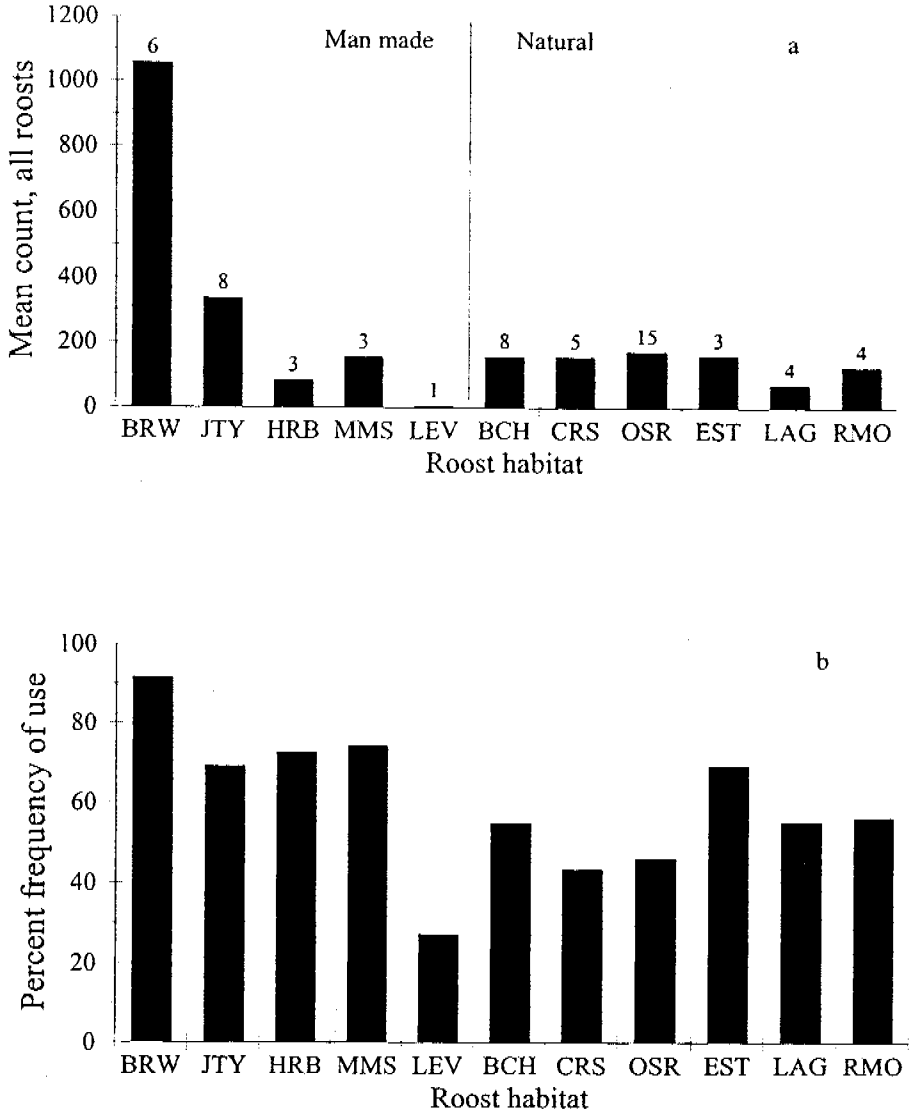


Figure 2 a and b. Brown Pelican roost habitat on the southern California mainland. Top (a) shows the number of birds using each habitat type from a mean of all aerial surveys, with the number of roosts of each habitat type at top of bars. Bottom (b) shows the mean frequency with which pelicans used all roosts in each habitat type. See Table 2 for habitat category descriptions.

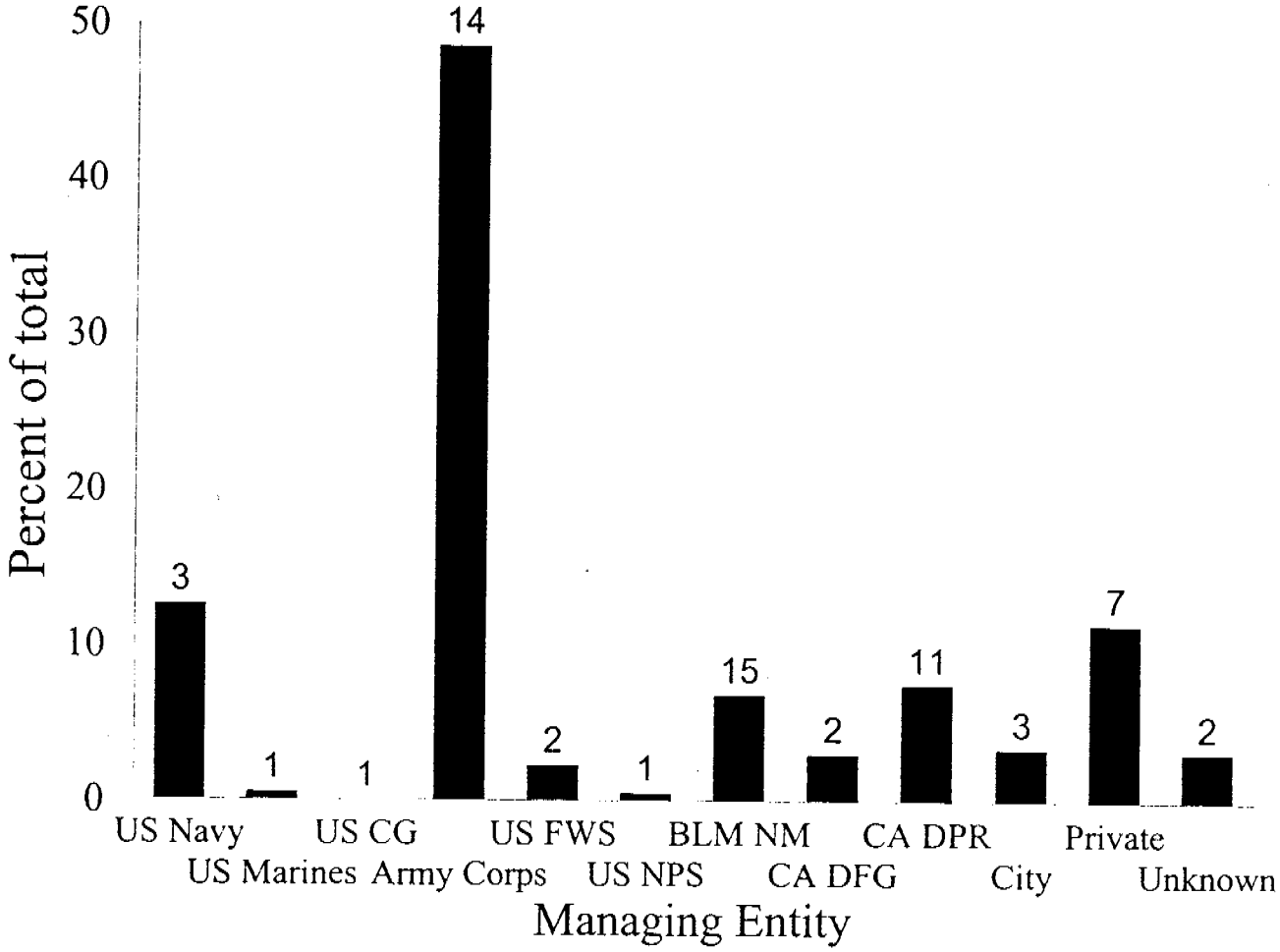


Figure 3. Percent of Brown Pelican roost use by managing entity. Percent is based on the mean number of pelicans under each managing entity on all aerial surveys of southern California, 1986 to 2000 (excluding historic sites). Numbers at top of bars are the number of roosts (ownership divisions in roosts SD 2.8 and SD 15 result in 62 roosts). Agency acronyms are:

US CG - United States Coast Guard
Army Corps - U.S. Army Corps of Engineers
US FWS - United States Fish & Wildlife Service
US NPS - United States National Park Service
BLM NM - Bureau of Land Management, California Islands National Monument
CA DFG - California Dept. of Fish & Game
CA DPR - California Dept. of Parks and Recreation

Table 1. Summary of Brown Pelican aerial survey effort along the southern California mainland coast from 1986 to 2000.

DATE	AREA SURVEYED	NOTES
28 August 1986	Tijuana R. to Pt. Conception	Fog obscured portions of coast
15 September 1986	Tijuana R. to Pt. Conception	LA harbor surveyed twice
16 September 1986	LA Harbor	
31 October 1986	Tijuana R. to LA Harbor	
1 December 1986	Tijuana R. to Pt. Conception	
21 July 1987	Tijuana R. to Pt. Conception	except Marina Del Rey (air traffic)
13 October 1987	Tijuana R. to Gaviota	
8 December 1987	Tijuana R. to Pt. Conception	
11 June 1992	Tijuana R. to Pt. Conception	
19 August 1992	Tijuana R. to Pt. Conception	
24 September 1992	Tijuana R. to Pt. Conception	
10 November 1992	Tijuana R. to Pt. Conception	
10 June 1993	Tijuana R. to Pt. Conception	
28 September 1993	Tijuana R. to Pt. Conception	
25 September 1998	Tijuana R. to Pt. Conception	except Marina Del Rey (air traffic)
25 August 1999	Tijuana R. to Oxnard	
26 August 1999	Oxnard to Pt. Conception	
11 September 2000	Tijuana R. to Orange Co. Line	
12 September 2000	S. Orange Co. to Pt. Conception	

Table 2. Habitat Types used by California Brown Pelicans in southern California.

Code	Habitat Description*
OSR	Offshore rock or island, open coast
CRS	Mainland shore of open coast, cliff or rocky shoreline
BCH	Mainland shore open coast, beach sand or with cobble structure
RMO	River or creek mouth, whether flowing to sea or not
EST	Estuary, river mouth with estuarine habitat or continuous exchange with the sea
LAG	Lagoon, a large water body having some deeper water (over 8 ft), with intermittent or continuous exchange with the sea
HRB	Harbor and structures within harbors (barges, pilings, boats, buoys, etc.)
BRW	Breakwater, a detached portion of harbor rip-rap protection
JTY	Jetty, rip-rap harbor protection attached to shore (accessible on foot)
MMS	Other Man-made structures (oil platforms, offshore barges and buoys)
LEV	Levee (the only levee structure was in San Diego Bay)

*The distinction between Estuary, lagoon, and river mouth habitats is difficult in southern California, since freshwater flow is generally seasonal, and physical connection to the sea may be intermittent.

Table 3a. Diurnal roost site summary on the Southern California mainland coast from fall air surveys 1986-87, 1992-93 and 1998-2000: San Diego County. Rank is the order of the mean count of all roosts. See Table 2 for Habitat Type codes.

Location		Abundance					Characteristics	
ID loc.	Roost site name	Mean count	Rank	Range	% use	no. obs	Habitat Type	Km to night roost
SD 1	Tijuana River	52.5	13	0 - 350	53.9	14	EST	17
SD 2.5	South San Diego Bay	5.9	49	0 - 26	30.0	11	LEV	12
SD 2.8	San Diego Bay harbors	29.5	26	0 - 130	70.0	11	HRB	3-8
SD 3.5	Zuniga Point	158.2	3	0 - 700	92.3	13	BRW	0
SD 4	Point Loma shoreline	12.5	37	0 - 50	38.5	13	CRS	8
SD 5	Naval Res. Electronics Lab.	32.8	22	0 - 247	38.5	14	CRS	9
SD 6	Azure Vista rocks	21.1	30	0 - 162	23.1	14	OSR	13
SD 7	Ocean Beach pier	5.8	51	0 - 47	46.2	14	MMS	15
SD 8	Mission Bay	13.1	35	0 - 110	38.5	14	JTY	16
SD 9	Bird Rock, La Jolla	32.6	23	0 - 359	76.9	14	OSR	21
SD 9.9	Point La Jolla	18.8	32	0 - 81	33.3	13	CRS	23
SD 10	La Jolla Caves	35.9	18	0 - 239	38.5	14	CRS	26
SD 11	Batiquitos Lagoon	43.7	15	0 - 362	41.7	12	HRB	7
SD 12	Agua Hedionda Lagoon	36.7	17	0 - 116	91.7	12	LAG	0
SD 12.5	San Luis Rey River (historic)	4.7	-	0 - 26	41.5	12	RMO	3
SD 13	Oceanside Harbor jetty	52.4	14	0 - 284	75.0	13	JTY	0
SD 14	Santa Margarita River mouth	12.4	38	0 - 99	41.5	13	RMO	2.5
SD 15	Camp Pendleton & San Onofre	3.9	55	0 - 29	33.3	14	BCH	12

Table 3b. Diurnal roost site summary on the Southern California mainland coast from fall air surveys 1986-87, 1992-93 and 1998-2000: Orange County. Rank is the order of the mean count of all roosts. See Table 2 for Habitat Type codes.

Location		Abundance					Characteristics	
ID loc.	Roost site name	Mean count	Rank	Range	% use	no. obs	Habitat Type	Km to night roost
OR 2	San Mateo Rocks	7.2	47	0 - 75	38.5	13	OSR	10
OR 2.9	Doheney SB	2.0	57	0 - 5	60.0	5	RMO	1
OR 3	Dana Point Harbor jetties	98.4	5	6 - 341	100	13	JTY	0
OR 4	Dana Point, San Juan rocks	5.8	52	0 - 43	58.3	13	OSR	1
OR 7.5	Laguna Beach rocks	20.7	31	0 - 133	84.6	14	OSR	13.5
OR 8.5	Laguna Beach, Emerald Bay	5.1	54	0 - 51	50.0	14	OSR	15
OR 9.0	Crystal Cove/Pelican Point	7.8	44	0 - 41	38.5	13	OSR	19.5
OR 9.1	Arch Rock, Corona Del Mar	2.2	56	0 - 17	23.1	13	OSR	21
OR 9.2	Newport Bay jetty	7.3	46	0 - 45	40.0	10	JTY	22.5
OR 10.1	Bolsa Chica Wetlands	33.5	21	0 - 265	50.0	14	LAG	9
OR 11	Anaheim Bay jetties	68.1	9	0 - 250	92.9	14	JTY	4

Table 3c. Diurnal roost site summary on the Southern California mainland coast from fall air surveys 1986-87, 1992-93 and 1998-2000: Los Angeles County. Rank is the order of the mean count of all roosts. See Table 2 for Habitat Type codes.

Location		Abundance					Characteristics	
ID loc.	Roost site name	Mean count	Rank	Range	% use	no. obs	Habitat Type	Km to night roost
LA 1	Long Beach Hrb. E. breakwater	234.9	1*	53 -690	100	19	BRW	0
LA 2	Long Beach Hrb. Mid brw	235.8	1*	31 -650	100	19	BRW	0
LA 3	San Pedro jetty	31.4	25	0 - 175	94.4	18	JTY	1
LA 3.5	Long Beach Harbor other loc	23.3	28	0 - 69	55.6	9	HRB	2
LA 5	Palos Verdes, White's Point	15.1	34	0 - 91	50.0	12	OSR	8
LA 6.2	Palos Verdes, Portugese Point	12.9	36	0 - 76	54.5	11	OSR	14
LA 6.5	Abalone Cove rocks & shore	11.3	41	0 - 64	41.7	12	OSR	13
LA 8.5	Palos Verdes, Pt. Vicente area	12.0	40	0 - 66	50.0	12	OSR	12
LA 10	Palos Verdes, Lunada Bay	5.3	53	0 - 34	27.3	11	OSR	9
LA 11	King Harbor	65.6	10	0 - 195	76.9	13	JTY	0
LA 12	Marina Del Rey breakwater	323.1	2	31 -640	100	11	BRW	0
LA 12.1	Dockweiler 'breakwater'	6.3	50	0 - 50	30.0	10	BRW	6
LA 15	Malibu area (historic)	14.5	-	0 - 80	45.5	11	MMS	22
LA 16	Malibu Lagoon	40.2	16	0 - 235	66.7	12	EST	24
LA 19	Point Dume and beaches south	12.4	39	0 - 74	23.1	13	OSR	31.5
LA 20	Leo Carillo, Sequit Point	1.0	60	0 - 4	28.5	8	OSR	15.7

* Long Beach breakwaters were counted separately, but function as a single roost.

Table 3d. Diurnal roost site summary on the Southern California mainland coast from fall air surveys 1986-87, 1992-93 and 1998-2000: Ventura County. Rank is the order of the mean count of all roosts. See Table 2 for Habitat Type codes.

Location		Abundance					Characteristics	
ID loc.	Roost site name	Mean count	Rank	Range	% use	no. obs	Habitat Type	Km to night roost
VN 3	Ventura Co. Beaches, south	10.4	42	0 - 44	27.3	11	BCH	10
VN 4	Mugu Lagoon	122.4	4	1 -313	100	12	EST	0
VN 4.1	Pt. Mugu beaches	6.6	48	0 - 34	25.0	12	BCH	2
VN 4.3	Port Hueneme jetty and beach	1.7	58	0 - 19	16.7	12	JTY	2
VN 5	Channel Islands Harbor	28.9	27	5 - 80	92.3	13	BRW	0
VN 6	McGrath Lake	1.3	59	0 - 7	25.0	12	LAG	4
VN 7	Santa Clara River mouth	35.6	19	0 - 151	84.6	13	RMO	1.5
VN 8	Ventura Harbor breakwater	71.2	7	7 - 237	100	13	BRW	0
VN 9	Ventura River mouth	8.5	43	0 - 84	36.4	11	RMO	4.5
VN 10	Mobil Oil Pier (historic)	179.1	-	0 - 739	72.7	11	MMS	19
VN 11	Rincon Island oil platform	97.1	6	0 - 429	83.3	12	MMS	19.5

Table 3e. Diurnal roost site summary on the Southern California mainland coast from fall air surveys 1986-87, 1992-93 and 1998-2000: Santa Barbara County. Rank is the order of the mean count of all roosts. See Table 2 for Habitat Type codes.

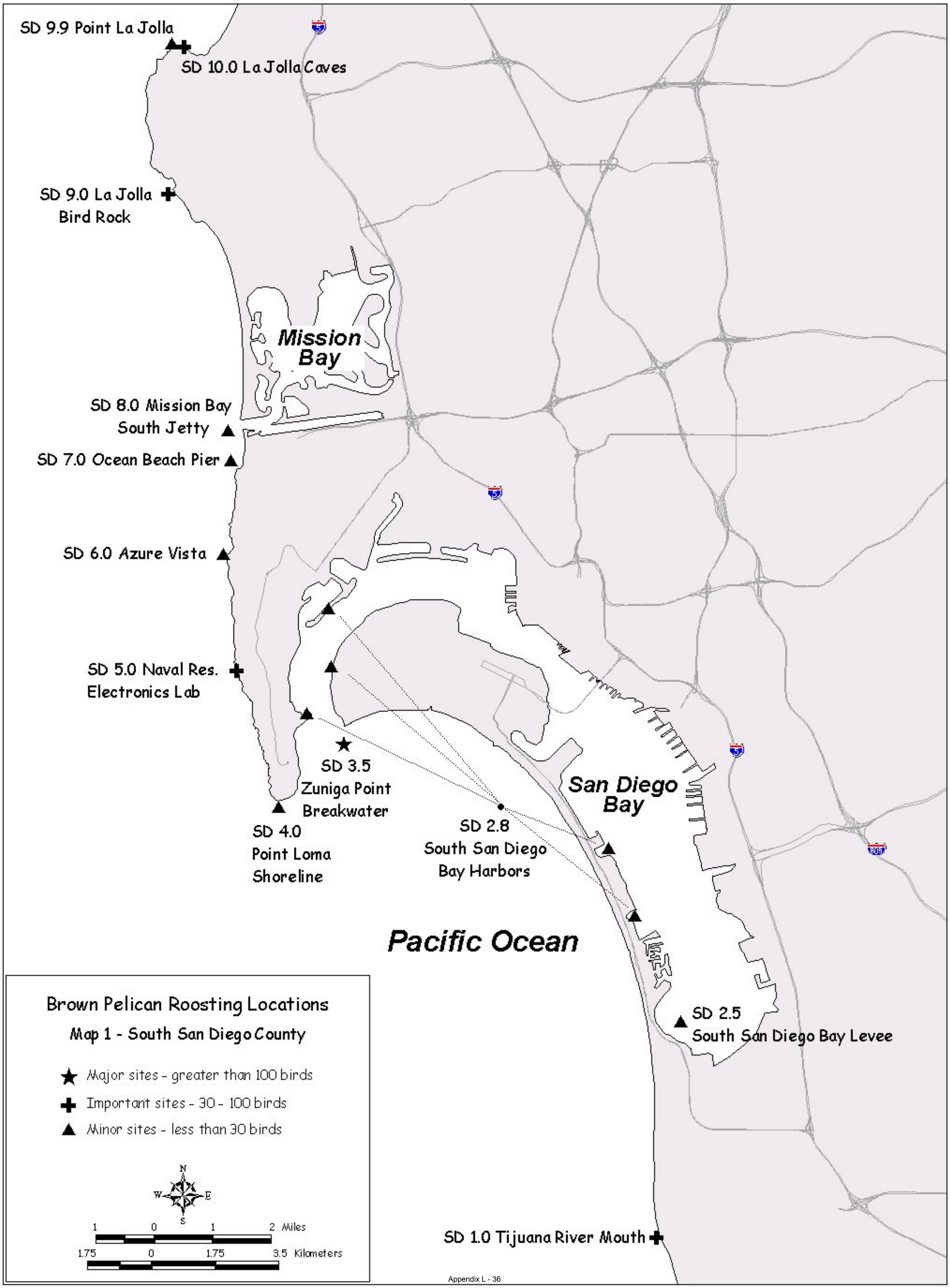
Location		Abundance					Characteristics	
ID loc.	Roost site name	Mean count	Rank	Range	% use	no. obs	Habitat Type	Km to night roost
SB 1.5	South Santa Barbara beaches	7.6	45	0 - 28	60.0	12	BCH	10
SB 3	Santa Barbara Harbor outer (historic)	180.8	-	0 -1480	76.9	13	MMS	41*
SB 4	Santa Barbara Harbor, inner	32.0	24	0 - 93	84.6	13	HRB	42*
SB 5	Sandpiper Pier, Coal Oil Pt.	53.4	12	12 -160	100	13	MMS	0
SB 6	Bell Canyon beach area	16.4	33	0 - 76	61.5	13	BCH	3
SB 7	Santa Barbara County beaches: Naples - El Capitan	22.5	29	0 - 60	53.8	13	BCH	54*
SB 8	Santa Barbara County beaches El Capitan to Gaviota	34.9	20	5 - 107	100	12	BCH	55 *
SB 9	Santa Barbara County beaches Gaviota to Pt. Conception	63.0	8	0 - 481	90.9	9	BCH	51 *
SB 10	Government Point	57.3	11	0 - 248	62.7	10	CRS	49*

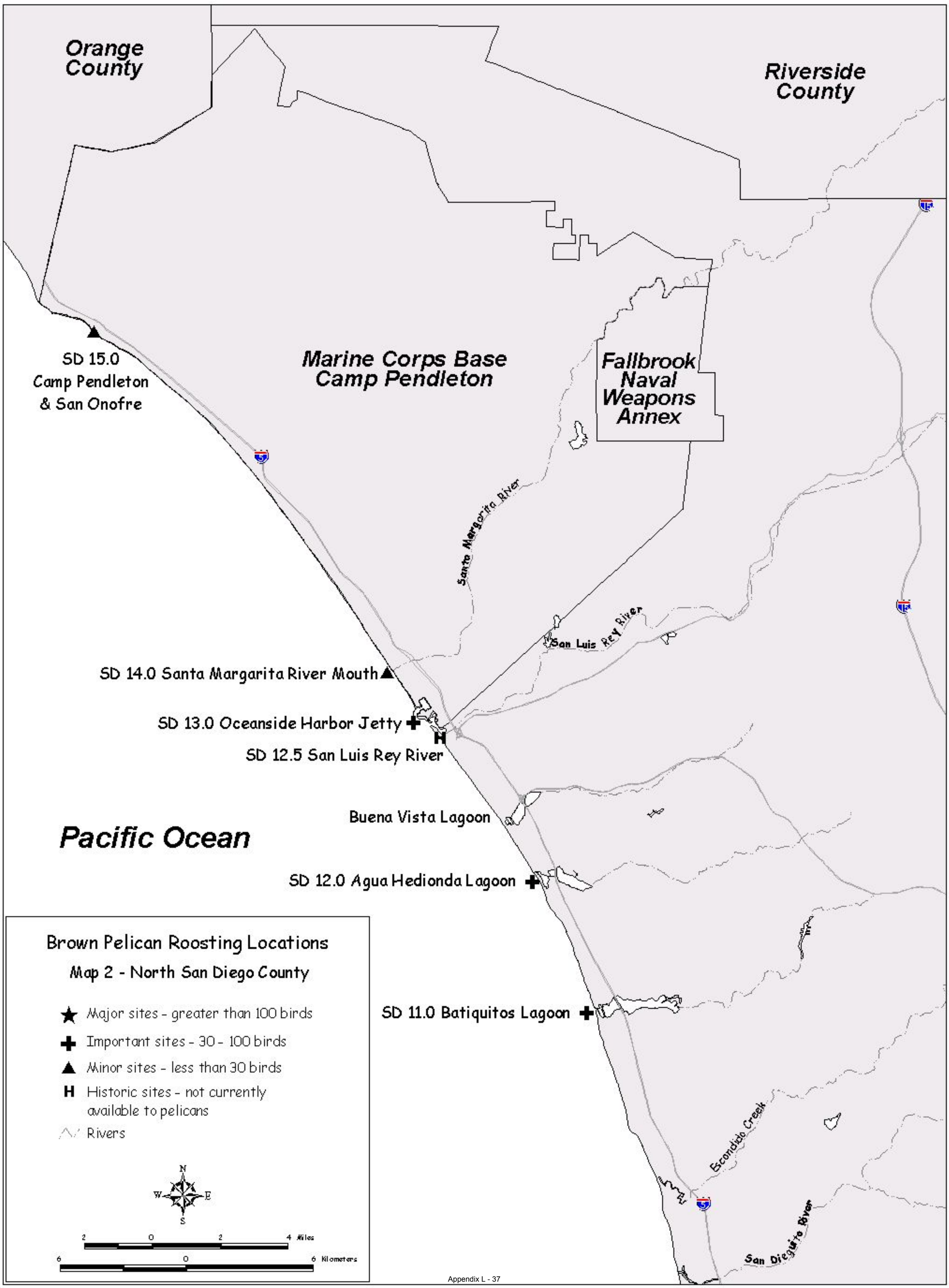
* distance to Channel Islands roosts

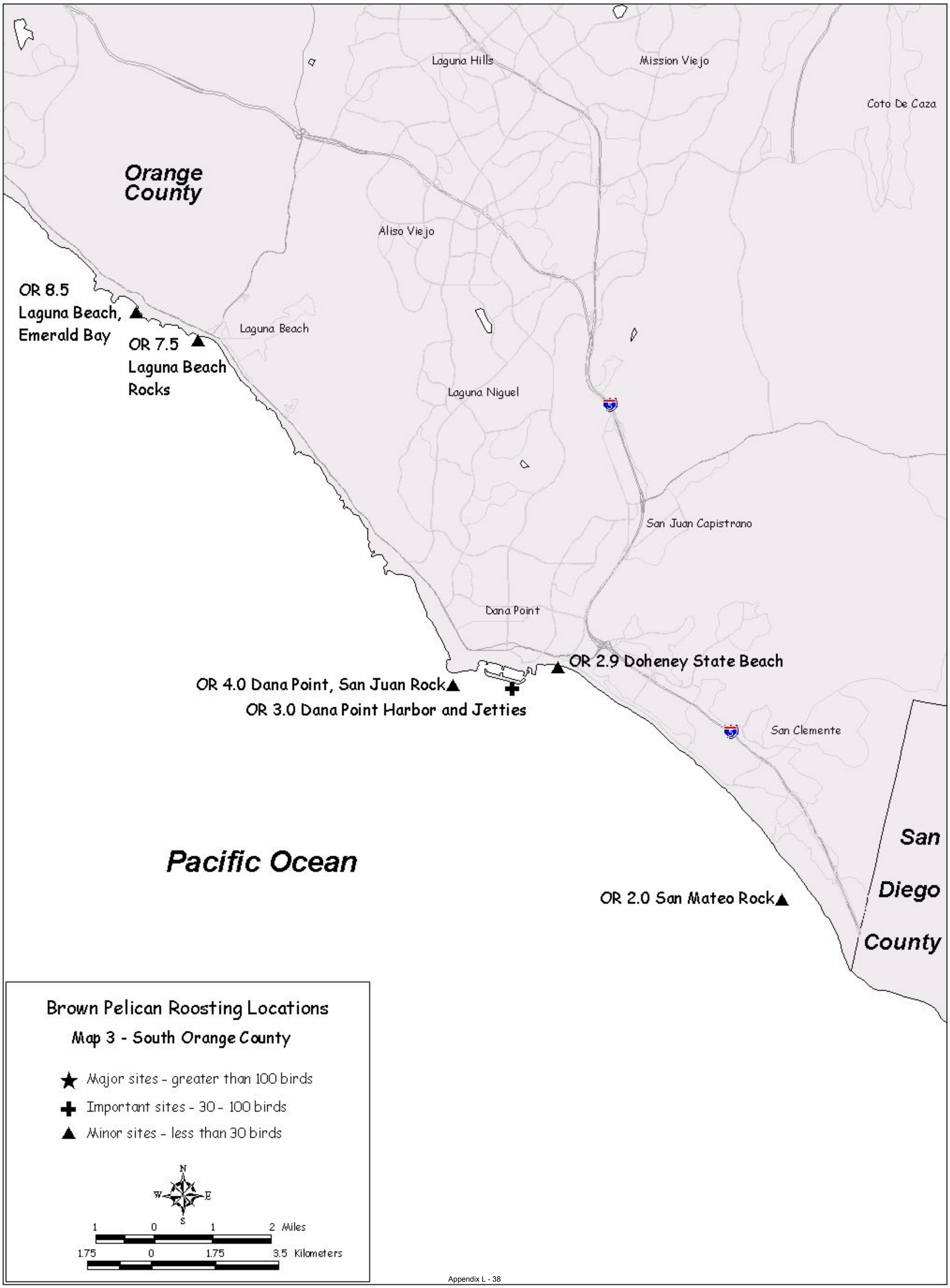
Table 4. Total number of Brown Pelicans at mainland roosts in three regions of California during fall surveys in 1998, 1999, and 2000. Southern California 2000 data area provided by USGS/Humboldt State University. Northern California includes from Oregon to Point Reyes, Central California from Drake's Bay to Point Conception, and southern from Government Point to Mexico.

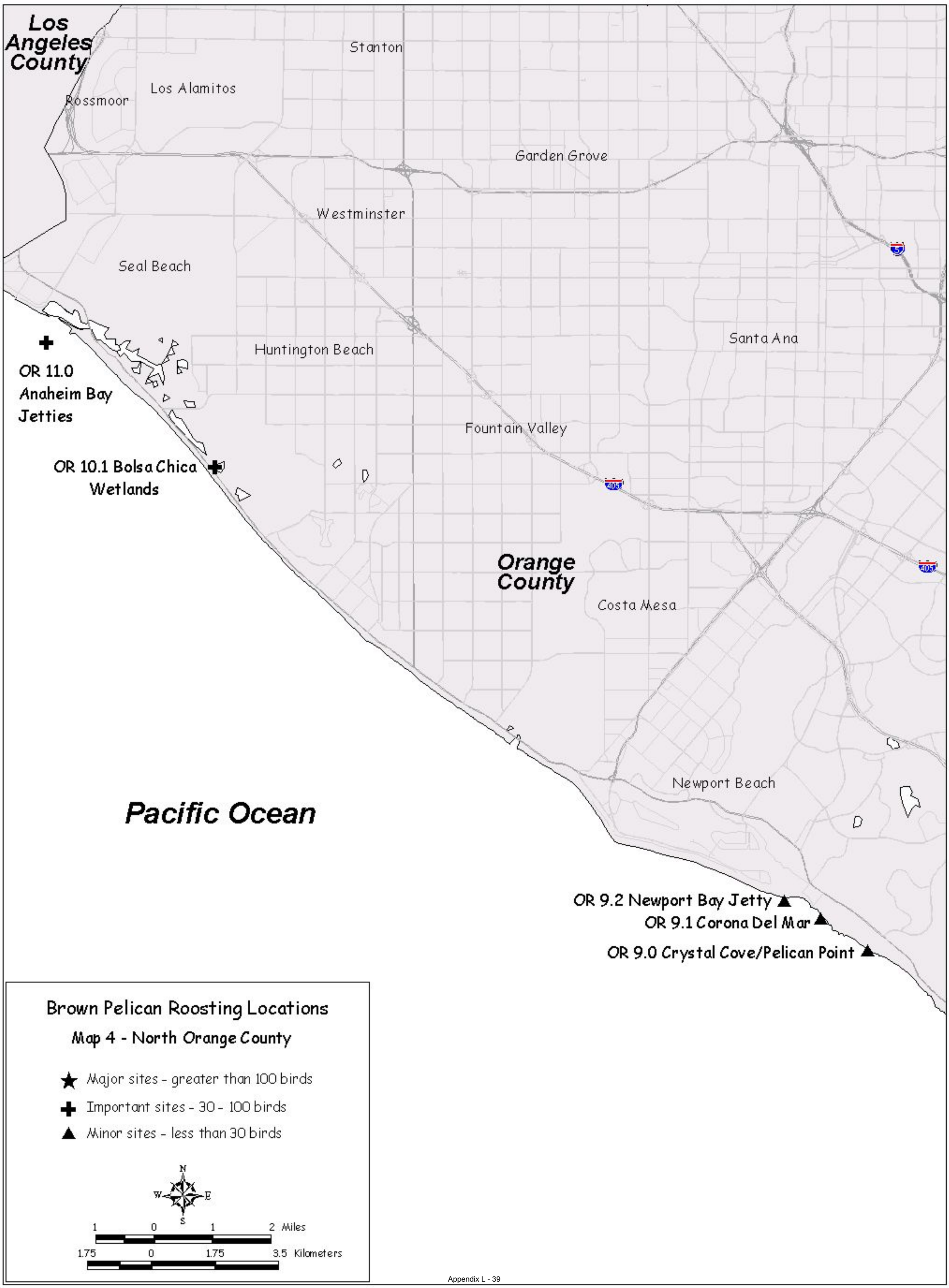
Region	1998	1999	2000	3 year mean
Northern	4,770 (17.0%)	4,918 (20.1%)	5,300 (14.4%)	4,996 (16.8%)
Central	20,262 (72.0%)	16,939 (69.3%)	27,728 (75.5%)	21,643 (72.7%)
Southern	3,092 (11.0%)	2,604 (10.6%)	3,711 (10.1%)	3,136 (10.5%)
Statewide	28,124	24,461	36,739	29,775

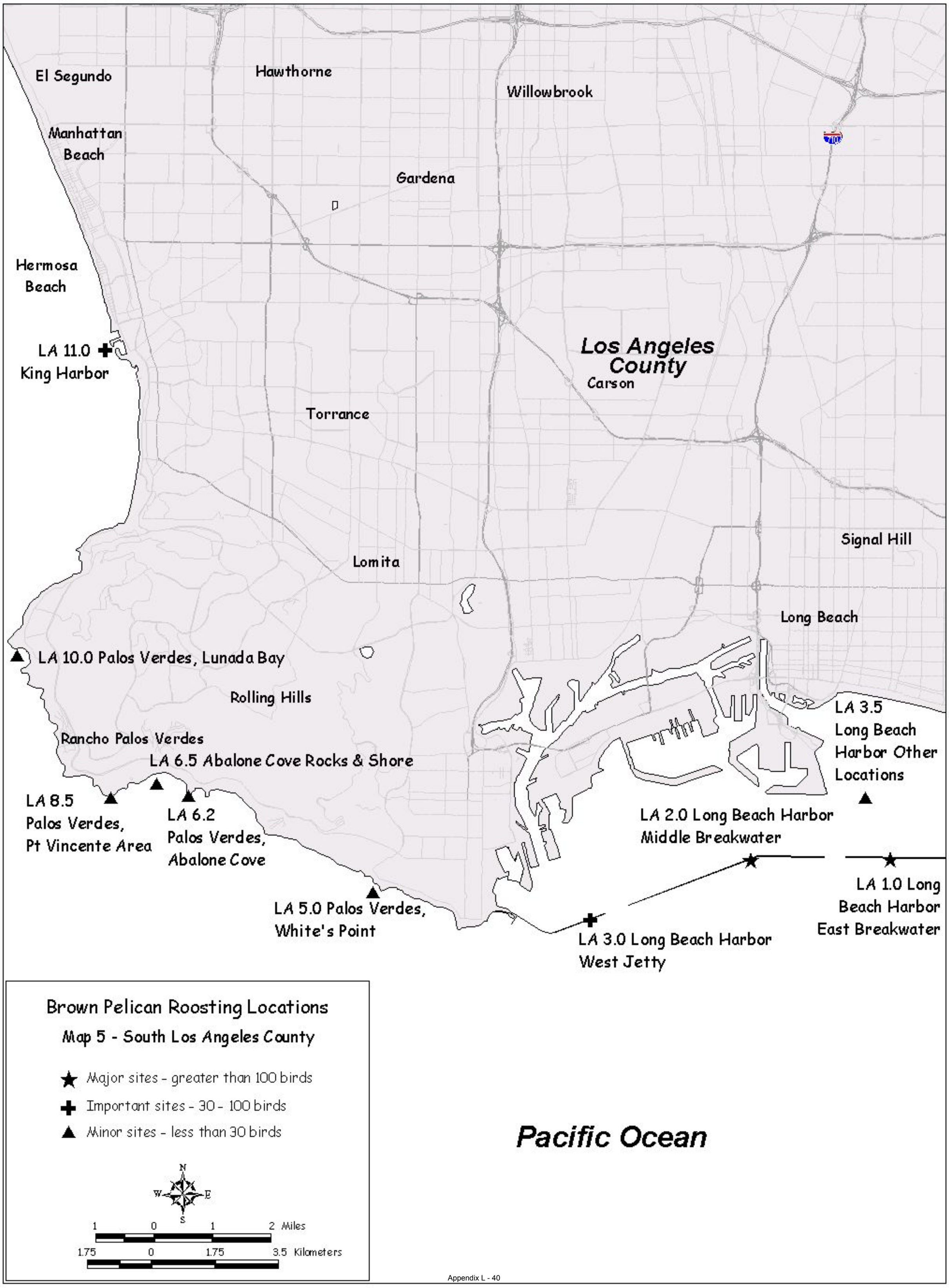
Appendix A. Maps of Brown Pelican roost sites in southern California.

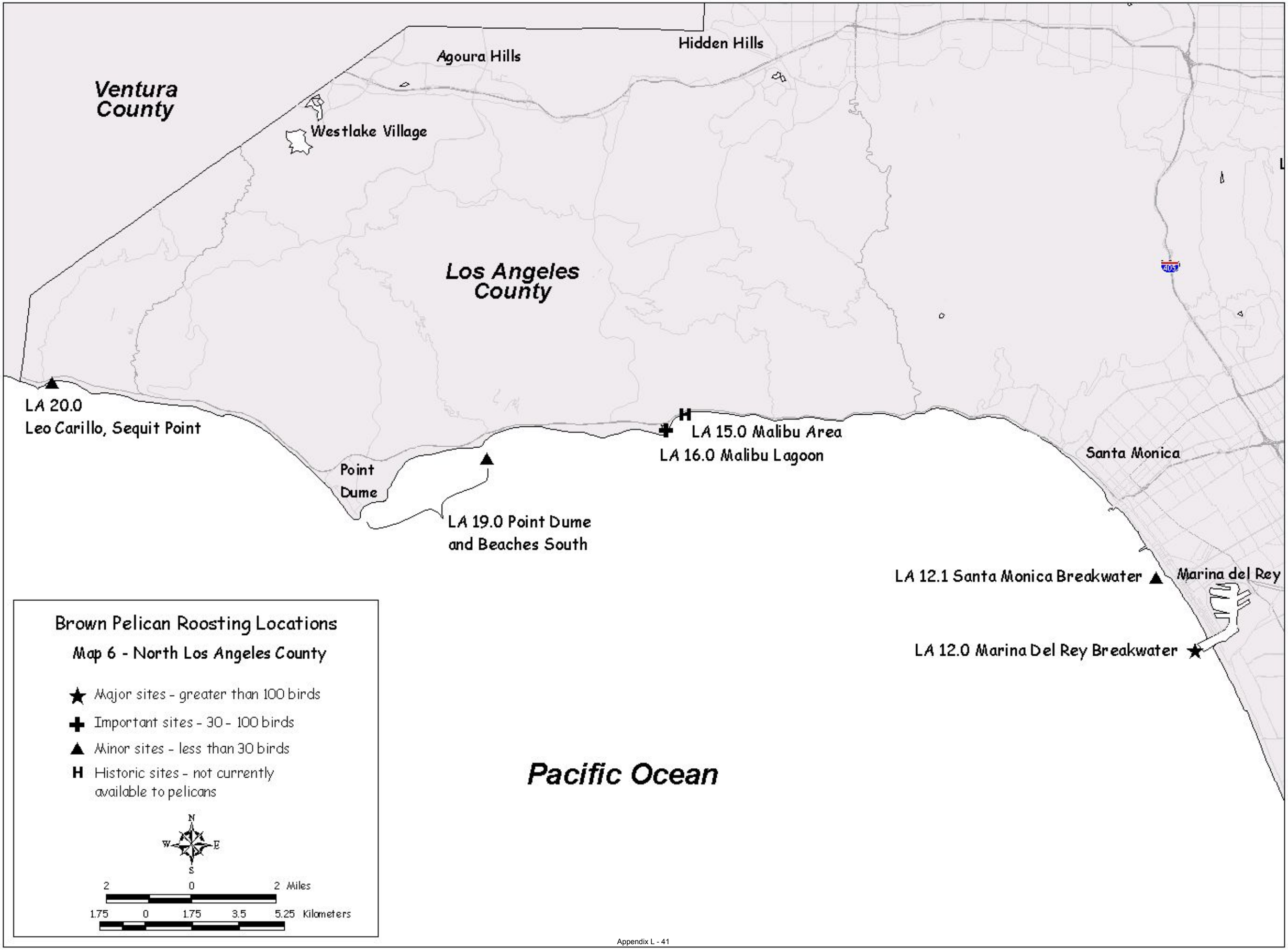

SD 9.9 Point La Jolla
SD 10.0 La Jolla Caves
SD 9.0 La Jolla
Bird Rock
Mission
Bay
SD 8.0 Mission Bay
South Jetty
SD 7.0 Ocean Beach Pier
SD 6.0 Azure Vista
SD 5.0 Naval Res.
Electronics Lab
SD 3.5
Zuniga Point
Breakwater
SD 4.0
Point Loma
Shoreline
SD 2.8
South San Diego
Bay Harbors
San Diego
Bay
Pacific Ocean
SD 2.5
South San Diego Bay Levee
SD 1.0 Tijuana River Mouth
Brown Pelican Roosting Locations
Map 1 - South San Diego County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
N
W
E
S
1 0 1 2 Miles
1.75 0 1.75 3.5 Kilometers

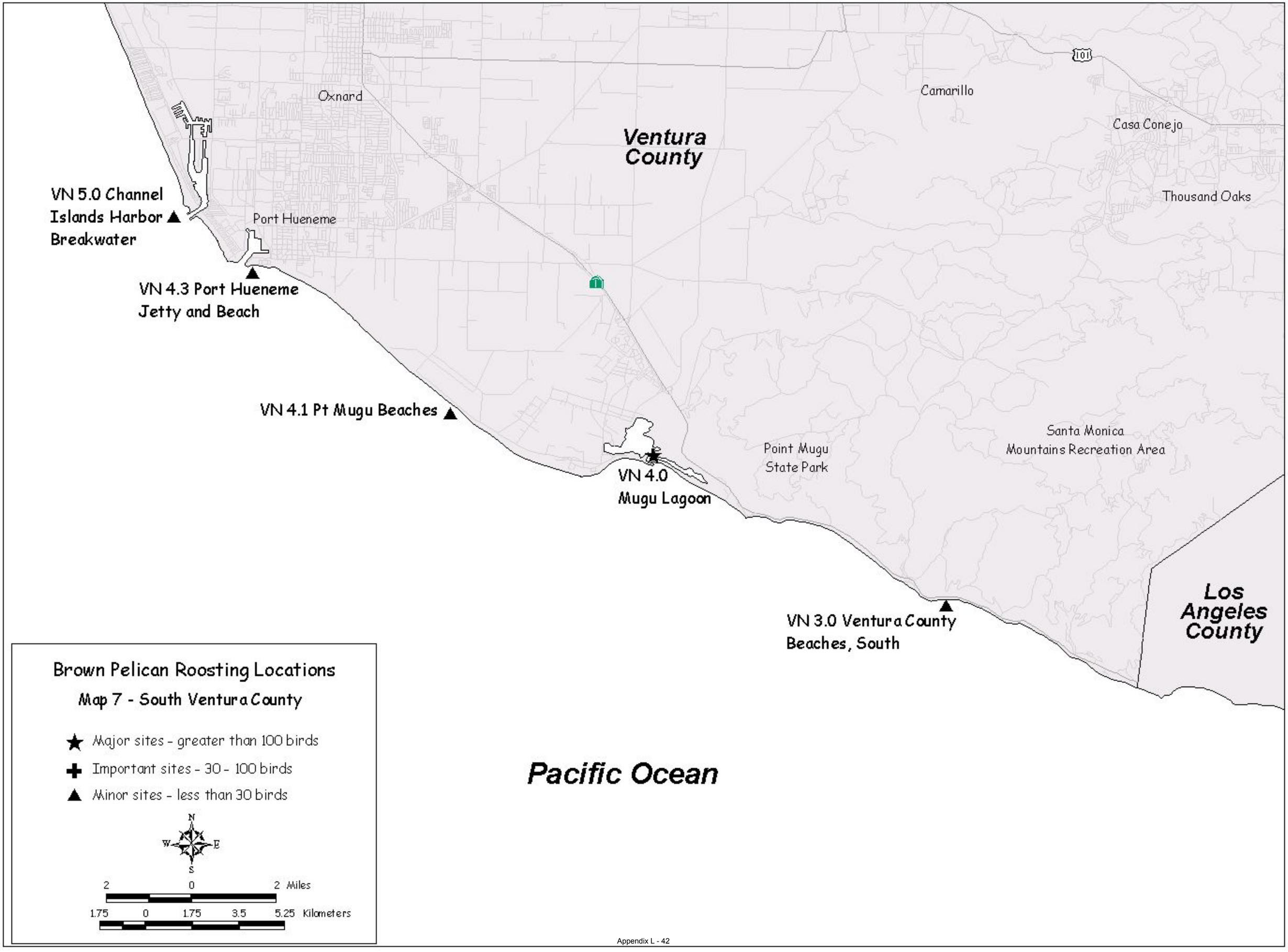

Orange County
Riverside County
Marine Corps Base Camp Pendleton
Fallbrook Naval Weapons Annex
SD 15.0 Camp Pendleton & San Onofre
Santa Margarita River
San Luis Rey River
SD 14.0 Santa Margarita River Mouth
SD 13.0 Oceanside Harbor Jetty
SD 12.5 San Luis Rey River
Buena Vista Lagoon
Pacific Ocean
SD 12.0 Agua Hedionda Lagoon
SD 11.0 Batiquitos Lagoon
Escondido Creek
San Dieguito River
Brown Pelican Roosting Locations
Map 2 - North San Diego County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
H Historic sites - not currently available to pelicans
Rivers
N
W
E
S
2 0 2 4 Miles
6 0 6 Kilometers

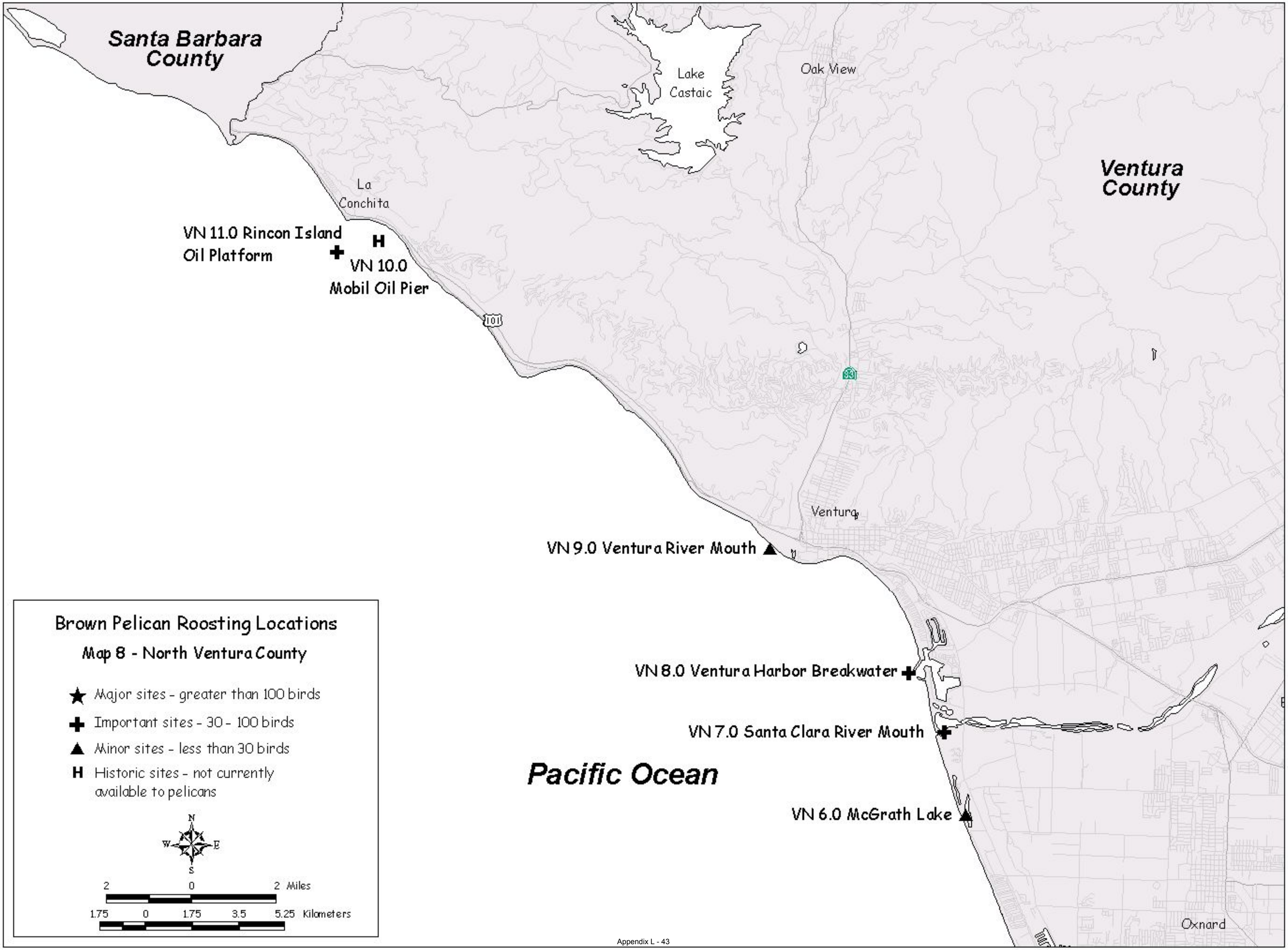

Laguna Hills
Mission Viejo
Coto De Caza
Orange County
Aliso Viejo
OR 8.5
Laguna Beach,
Emerald Bay
Laguna Beach
OR 7.5
Laguna Beach
Rocks
Laguna Niguel
San Juan Capistrano
Dana Point
OR 2.9 Doheney State Beach
OR 4.0 Dana Point, San Juan Rock
OR 3.0 Dana Point Harbor and Jetties
San Clemente
Pacific Ocean
OR 2.0 San Mateo Rock
San Diego County
Brown Pelican Roosting Locations
Map 3 - South Orange County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
N
W
E
S
1 0 1 2 Miles
1.75 0 1.75 3.5 Kilometers

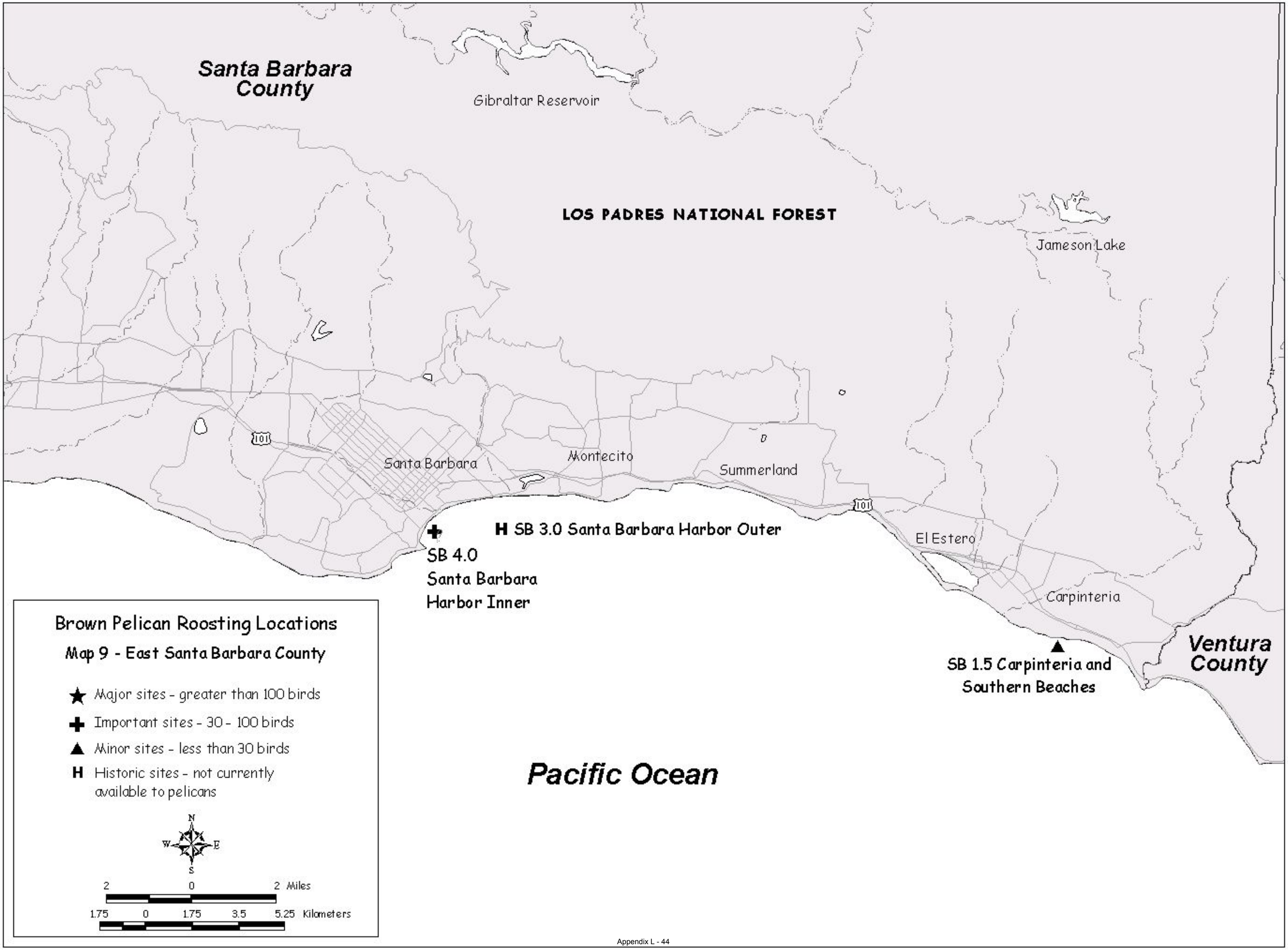

Los Angeles County
Stanton
Los Alamitos
Rossmoor
Garden Grove
Westminster
Seal Beach
Huntington Beach
Santa Ana
OR 11.0 Anaheim Bay Jetties
Fountain Valley
OR 10.1 Bolsa Chica Wetlands
Orange County
Costa Mesa
Newport Beach
Pacific Ocean
OR 9.2 Newport Bay Jetty
OR 9.1 Corona Del Mar
OR 9.0 Crystal Cove/Pelican Point
Brown Pelican Roosting Locations
Map 4 - North Orange County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
N
W
E
S
1 0 1 2 Miles
1.75 0 1.75 3.5 Kilometers

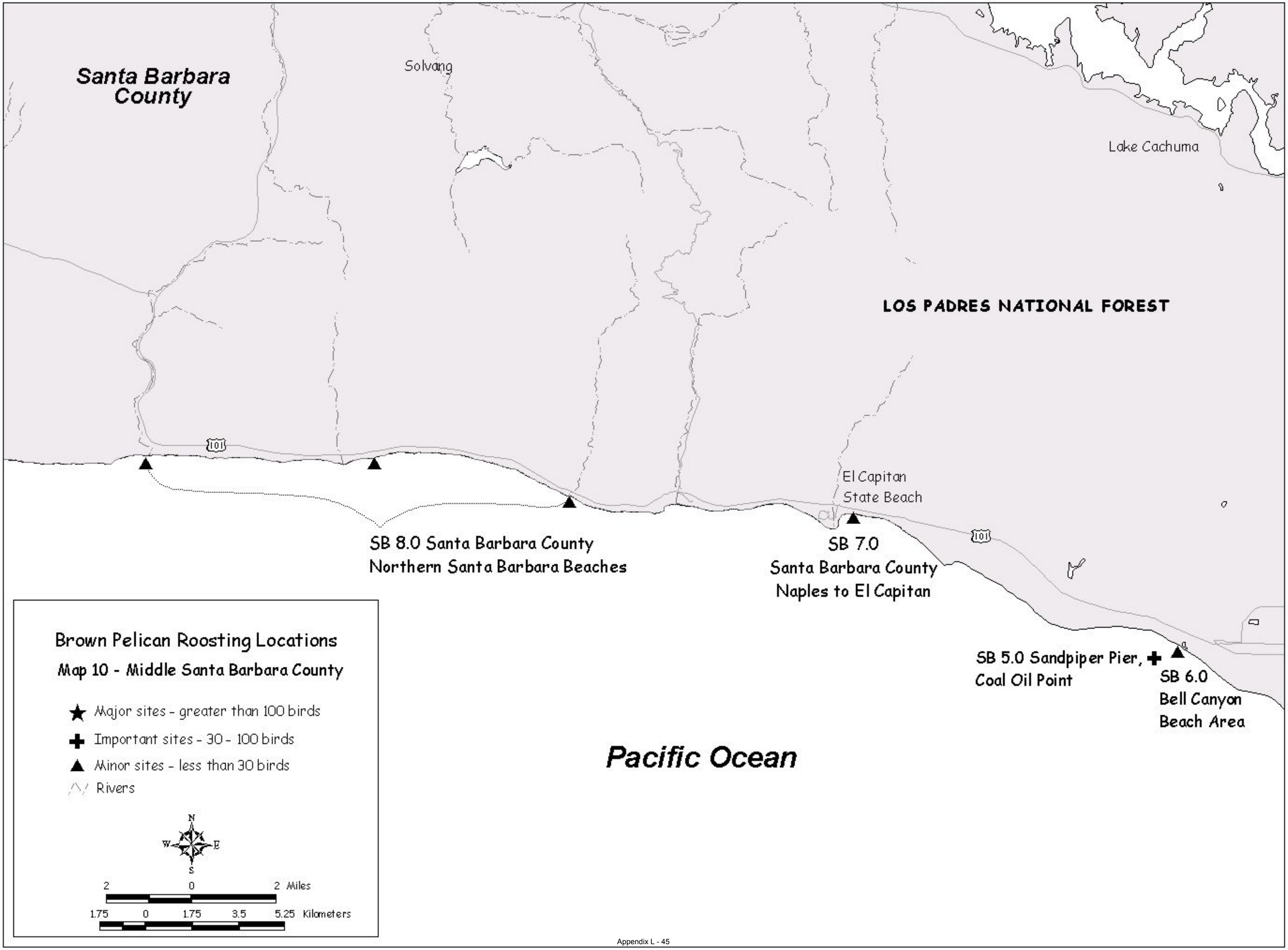

El Segundo
Hawthorne
Willowbrook
Manhattan Beach
Gardena
Hermosa Beach
LA 11.0
King Harbor
Los Angeles County
Carson
Torrance
Signal Hill
Lomita
Long Beach
LA 10.0 Palos Verdes, Lunada Bay
Rolling Hills
LA 3.5
Long Beach Harbor Other Locations
Rancho Palos Verdes
LA 6.5 Abalone Cove Rocks & Shore
LA 8.5
Palos Verdes, Pt Vincente Area
LA 6.2
Palos Verdes, Abalone Cove
LA 2.0 Long Beach Harbor Middle Breakwater
LA 1.0 Long Beach Harbor East Breakwater
LA 5.0 Palos Verdes, White's Point
LA 3.0 Long Beach Harbor West Jetty
Pacific Ocean
Brown Pelican Roosting Locations
Map 5 - South Los Angeles County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
N
W
E
S
1 0 1 2 Miles
1.75 0 1.75 3.5 Kilometers

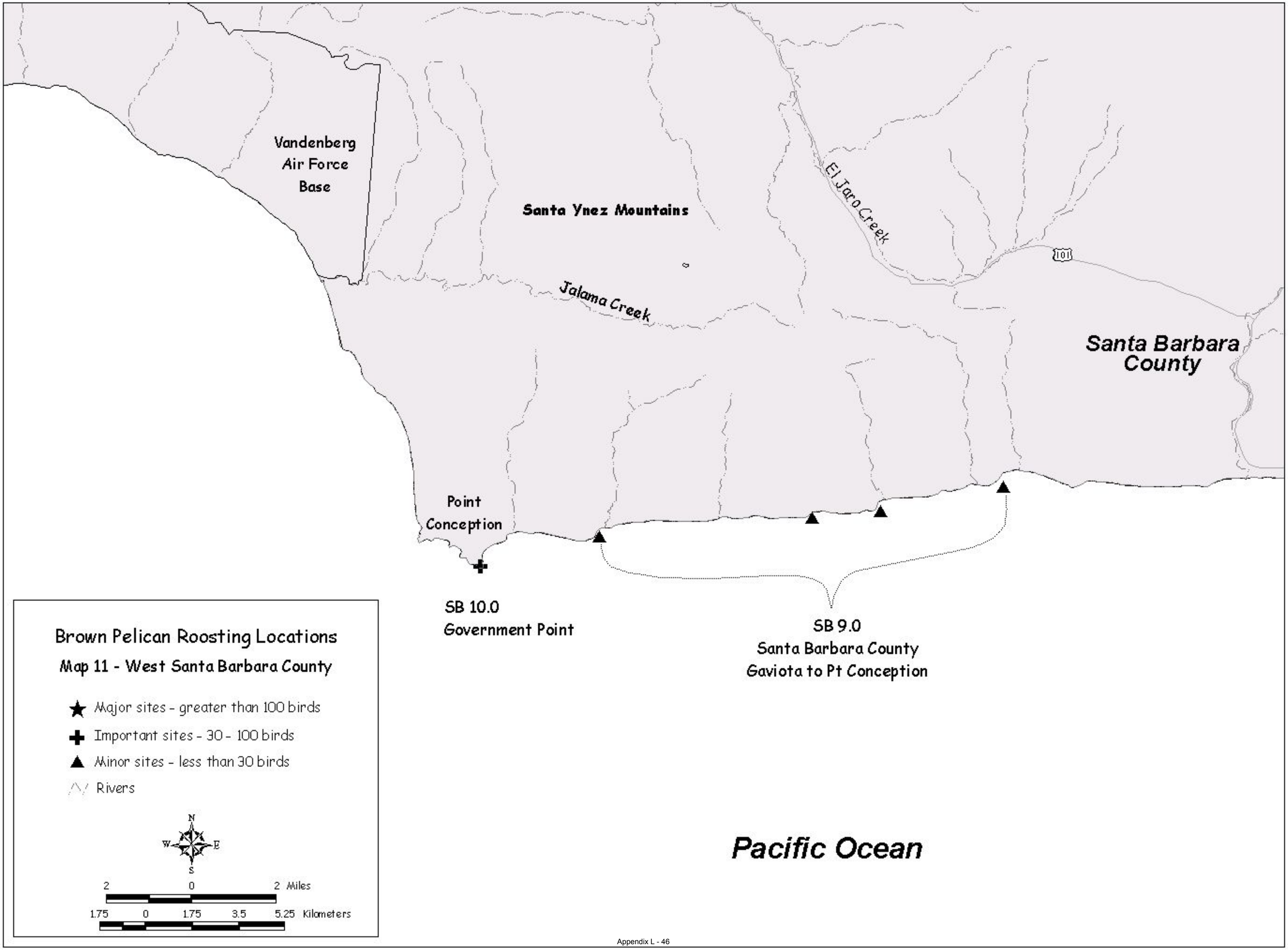

Ventura County
Agoura Hills
Hidden Hills
Westlake Village
Los Angeles County
LA 20.0
Leo Carillo, Sequit Point
LA 15.0 Malibu Area
LA 16.0 Malibu Lagoon
Santa Monica
Point Dume
LA 19.0 Point Dume and Beaches South
LA 12.1 Santa Monica Breakwater
Marina del Rey
LA 12.0 Marina Del Rey Breakwater
Pacific Ocean
Brown Pelican Roosting Locations
Map 6 - North Los Angeles County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
H Historic sites - not currently available to pelicans
N
W
E
S
2 0 2 Miles
1.75 0 1.75 3.5 5.25 Kilometers


Oxnard
Ventura County
Camarillo
101
Casa Conejo
Thousand Oaks
VN 5.0 Channel Islands Harbor Breakwater
Port Hueneme
VN 4.3 Port Hueneme Jetty and Beach
VN 4.1 Pt Mugu Beaches
Point Mugu State Park
Santa Monica Mountains Recreation Area
VN 4.0 Mugu Lagoon
VN 3.0 Ventura County Beaches, South
Los Angeles County
Pacific Ocean
Brown Pelican Roosting Locations
Map 7 - South Ventura County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
N
W
E
S
2 0 2 Miles
1.75 0 1.75 3.5 5.25 Kilometers


Santa Barbara County
Lake Castaic
Oak View
Ventura County
La Conchita
VN 11.0 Rincon Island Oil Platform
H
VN 10.0 Mobil Oil Pier
101
33
Ventura
VN 9.0 Ventura River Mouth
VN 8.0 Ventura Harbor Breakwater
VN 7.0 Santa Clara River Mouth
Pacific Ocean
VN 6.0 McGrath Lake
Oxnard
Brown Pelican Roosting Locations
Map 8 - North Ventura County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
H Historic sites - not currently available to pelicans
N
W
E
S
2 0 2 Miles
1.75 0 1.75 3.5 5.25 Kilometers


Santa Barbara County
Gibraltar Reservoir
LOS PADRES NATIONAL FOREST
Jameson Lake
101
Santa Barbara
Montecito
Summerland
101
H SB 3.0 Santa Barbara Harbor Outer
El Estero
SB 4.0
Santa Barbara
Harbor Inner
Carpinteria
Ventura County
SB 1.5 Carpinteria and
Southern Beaches
Pacific Ocean
Brown Pelican Roosting Locations
Map 9 - East Santa Barbara County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
H Historic sites - not currently available to pelicans
N
W
E
S
2 0 2 Miles
1.75 0 1.75 3.5 5.25 Kilometers


Santa Barbara County
Solvang
Lake Cachuma
LOS PADRES NATIONAL FOREST
101
El Capitan State Beach
SB 8.0 Santa Barbara County Northern Santa Barbara Beaches
SB 7.0 Santa Barbara County Naples to El Capitan
SB 5.0 Sandpiper Pier, Coal Oil Point
SB 6.0 Bell Canyon Beach Area
Pacific Ocean
Brown Pelican Roosting Locations
Map 10 - Middle Santa Barbara County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
Rivers
N
W
E
S
2 0 2 Miles
1.75 0 1.75 3.5 5.25 Kilometers


Vandenberg Air Force Base
Santa Ynez Mountains
El Jaro Creek
101
Jalama Creek
Santa Barbara County
Point Conception
SB 10.0
Government Point
SB 9.0
Santa Barbara County
Gaviota to Pt Conception
Pacific Ocean
Brown Pelican Roosting Locations
Map 11 - West Santa Barbara County
Major sites - greater than 100 birds
Important sites - 30 - 100 birds
Minor sites - less than 30 birds
Rivers
N
W
E
S
2 0 2 Miles
1.75 0 1.75 3.5 5.25 Kilometers

Appendix B. Aerial survey counts of Brown Pelicans at roost sites in southern California

County codes: SD= San Diego, OR= Orange, LA= Los Angeles, VN= Ventura, and SB= Santa Barbara.
Manage are categories of agencies with primary management jurisdiction.
Habitat categories are described in the text, Table 2.
Total BRPE is the total roost count.

Month	Day	Year	Co	Rst. No.	Location	Own	Manage	Habitat	Total BRPE	NOTE
9	25	1998	SD	1.0	TIJUANA RIVER	PUBL	FWS NWR	RMO	25	
8	25	1999	SD	1.0	TIJUANA RIVER	PUBL	FWS NWR	RMO	34	
9	25	1998	SD	2.5	SOUTH SAN DIEGO BAY	PRIV	FWS NWR	LEV	26	
8	25	1999	SD	2.5	SOUTH SAN DIEGO BAY	PRIV	FWS NWR	LEV	0	
9	25	1998	SD	2.8	SAN DIEGO BAY	PRIV	PRIV/MILL	HRB	1	INCOMPLETE COV.
8	25	1999	SD	2.8	SAN DIEGO BAY	PRIV	PRIV/MILL	HRB	96	
9	25	1998	SD	3.5	ZUNIGA POINT	PUBL	ARMY CORPS	BRW	377	
8	25	1999	SD	3.5	ZUNIGA POINT	PUBL	ARMY CORPS	BRW	221	
9	25	1998	SD	4.0	POINT LOMA	PUBL	BLM	CRS	24	
8	25	1999	SD	4.0	POINT LOMA	PUBL	BLM	CRS	0	
9	25	1998	SD	5.0	NAVY ELECTRONICS LAB	MILL	USNAVY	CRS	0	
8	25	1999	SD	5.0	NAVY ELECTRONICS LAB	MILL	USNAVY	CRS	0	
9	25	1998	SD	6.0	AZURE VISTA ROCKS	PUBL	BLM	OSR	0	
8	25	1999	SD	6.0	AZURE VISTA ROCKS	PUBL	BLM	OSR	0	
9	25	1998	SD	7.0	OCEAN BEACH PIER	PRIV	PRIV	MMS	3	
8	25	1999	SD	7.0	OCEAN BEACH PIER	PRIV	PRIV	MMS	0	
9	25	1998	SD	8.0	MISSION BAY S. JETTY	PUBL	ARMY CORPS	JTY	0	
8	25	1999	SD	8.0	MISSION BAY S. JETTY	PUBL	ARMY CORPS	JTY	0	
9	25	1998	SD	9.0	BIRD ROCK, LA JOLLA	PUBL	BLM	OSR	4	
8	25	1999	SD	9.0	BIRD ROCK, LA JOLLA	PUBL	BLM	OSR	0	
9	25	1998	SD	9.9	POINT LA JOLLA	PUBL	LA JOLLA	CRS	0	
8	25	1999	SD	9.9	POINT LA JOLLA	PUBL	LA JOLLA	CRS	75	
9	25	1998	SD	10.0	LA JOLLA CAVES	PUBL	LA JOLLA	CRS	88	
8	25	1999	SD	10.0	LA JOLLA CAVES	PUBL	LA JOLLA	CRS	0	
9	25	1998	SD	10.5	SAN ELIJO LAGOON	PUBL	CDPR	LAG	1	
8	25	1999	SD	10.5	SAN ELIJO LAGOON	PUBL	CDPR	LAG	0	
9	25	1998	SD	11.0	BATIQUITOS LAGOON	PUBL	CDFG	LAG	0	
8	25	1999	SD	11.0	BATIQUITOS LAGOON	PUBL	CDFG	LAG	0	
9	25	1998	SD	12.0	AGUA HEDIONDA LAGOON	PRIV	PRIV/CITY	LAG	30	LAG.COV. INCOMPLETE, +27(23/2)OFFSH
8	25	1999	SD	12.0	AGUA HEDIONDA LAGOON	PRIV	PRIV/CITY	LAG	116	
9	25	1998	SD	13.0	OCEANSIDE HARBOR	PUBL	ARMY CORPS	JTY	75	
8	25	1999	SD	13.0	OCEANSIDE HARBOR	PUBL	ARMY CORPS	JTY	0	
9	25	1998	SD	14.0	SANTA MARGARITA RIVER	MILL	US ARMY	RMO	99	
8	25	1999	SD	14.0	SANTA MARGARITA RIVER	MILL	US ARMY	RMO	0	
9	25	1998	SD	14.1	CAMP PENDELTON	MILL	US MARINES	BCH	0	
8	25	1999	SD	14.1	CAMP PENDELTON	MILL	US MARINES	BCH	0	
9	25	1998	SD	15.0	SAN ONOFRE SB	PUBL	CDPR	BCH	0	
8	25	1999	SD	15.0	SAN ONOFRE SB	PUBL	CDPR	BCH	0	
9	25	1998	OR	2.0	SAN MATEO ROCK	PUBL	BLM	OSR	0	
8	25	1999	OR	2.0	SAN MATEO ROCK	PUBL	BLM	OSR	0	
9	25	1998	OR	2.9	DOHENEY STATE BEACH	PUBL	CDPR	RMO	4	
8	25	1999	OR	2.9	DOHENEY STATE BEACH	PUBL	CDPR	RMO	0	
9	25	1998	OR	3.0	DANA POINT HARBOR	PUBL	ARMY CORPS	JTY	133	
8	25	1999	OR	3.0	DANA POINT HARBOR	PUBL	ARMY CORPS	JTY	124	
9	25	1998	OR	4.0	SAN JUAN ROCKS	PUBL	BLM	OSR	3	
8	25	1999	OR	4.0	SAN JUAN ROCKS	PUBL	BLM	OSR	0	
9	25	1998	OR	5.0	MUSSEL COVE	PUBL	BLM	OSR	0	
8	25	1999	OR	5.0	MUSSEL COVE	PUBL	BLM	OSR	0	
9	25	1998	OR	6.0	ALISO POINT ROCKS	PUBL	BLM	OSR	0	
8	25	1999	OR	6.0	ALISO POINT ROCKS	PUBL	BLM	OSR	0	
9	25	1998	OR	7.5	LAGUNA BEACH ROCKS	PUBL	BLM	OSR	133	INCL. ALL LAGUNA BCH AREA
8	25	1999	OR	7.5	LAGUNA BEACH ROCKS	PUBL	BLM	OSR	8	
9	25	1998	OR	8.5	EMERALD BAY ROCKS	PUBL	BLM	OSR	0	
8	25	1999	OR	8.5	EMERALD BAY ROCKS	PUBL	BLM	OSR	0	
9	25	1998	OR	9.0	PELICAN POINT	PUBL	BLM	OSR	0	
8	25	1999	OR	9.0	PELICAN POINT	PUBL	BLM	OSR	0	
9	25	1998	OR	9.1	ARCH ROCK	PUBL	BLM	OSR	0	
8	25	1999	OR	9.1	ARCH ROCK	PUBL	BLM	OSR	0	
9	25	1998	OR	9.2	NEWPORT BAY JETTY	PUBL	ARMY CORPS	JTY	0	
8	25	1999	OR	9.2	NEWPORT BAY JETTY	PUBL	ARMY CORPS	JTY	0	
9	25	1998	OR	10.1	BOLSA CHICA WETLANDS	PUBL	CDFG/B.C.	LAG	69	
8	25	1999	OR	10.1	BOLSA CHICA WETLANDS	PUBL	CDFG/B.C.	LAG	0	
9	25	1998	OR	11.0	ANAHEIM BAY S JETTY	PUBL	ARMY CORPS	JTY	224	
8	25	1999	OR	11.0	ANAHEIM BAY S JETTY	PUBL	ARMY CORPS	JTY	7	
9	25	1998	LA	1.0	LONG BEACH HRB EAST BRW	PUBL	ARMY CORPS	BRW	293	
8	25	1999	LA	1.0	LONG BEACH HRB EAST BRW	PUBL	ARMY CORPS	BRW	72	
9	25	1998	LA	2.0	LONG BEACH HRB MID BRW	PUBL	ARMY CORPS	BRW	244	
8	25	1999	LA	2.0	LONG BEACH HRB MID BRW	PUBL	ARMY CORPS	BRW	31	

Month	Day	Year	Co	Rst. No.	Location	Own	Manage	Habitat	Total BRPE	NOTE
9	25	1998	LA	3.0	SAN PEDRO JETTY	PUBL	ARMY CORPS	JTY	17	
8	25	1999	LA	3.0	SAN PEDRO JETTY	PUBL	ARMY CORPS	JTY	9	
9	25	1998	LA	3.5	LONG BEACH HARBOR OTHER		UK	HRB	70	31 ON LEVEE, 38 ON INDUST. BARGE
8	25	1999	LA	3.5	LONG BEACH HARBOR OTHER		UK	HRB	5	
9	25	1998	LA	5.0	WHITE'S POINT	PUBL	BLM	OSR	6	
8	26	1999	LA	5.0	WHITE'S POINT	PUBL	BLM	OSR		NO SURVEY
9	25	1998	LA	6.2	PORTUGUESE POINT	PUBL	BLM	OSR	1	
8	26	1999	LA	6.2	PORTUGUESE POINT	PUBL	BLM	OSR		NO SURVEY
9	25	1998	LA	6.5	ABALONE COVE ROCKS	PUBL	BLM	OSR	13	
9	25	1998	LA	8.5	LONG POINT	PUBL	BLM	OSR	0	
9	25	1998	LA	10.0	LUNADA BAY ROCKS	PUBL	BLM	OSR	0	
9	25	1998	LA	11.0	KING HARBOR	PUBL	ARMY CORPS	JTY	48	
8	26	1999	LA	11.0	KING HARBOR	PUBL	ARMY CORPS	JTY	35	9/11/99 GROUND DATA
9	25	1998	LA	12.0	MARINA DEL REY	PUBL	ARMY CORPS	BRW		NO SURVEY, CONT. @ TOPANGA CYN
9	11	1999	LA	12.0	MARINA DEL REY	PUBL	ARMY CORPS	BRW	299	9/11/99 GROUND DATA
9	25	1998	LA	12.1	DOCKWEILER REEF	PUBL	ARMY CORPS	BRW	0	
8	26	1999	LA	12.1	DOCKWEILER REEF	PUBL	ARMY CORPS	BRW	0	
9	25	1998	LA	14.0	LAS FLORES ROCK	PUBL	BLM	OSR	0	
8	26	1999	LA	14.0	LAS FLORES ROCK	PUBL	BLM	OSR	0	
9	25	1998	LA	16.0	MALIBU LAGOON	PUBL	CDPR	EST	97	
8	26	1999	LA	16.0	MALIBU LAGOON	PUBL	CDPR	EST	78	
9	25	1998	LA	19.0	POINT DUME	PUBL	BLM/CDPR	CRS	0	
8	26	1999	LA	19.0	CORRAL BEACH	PUBL	BLM/CDPR	OSR	52	
9	25	1998	LA	20.0	LEO CARILLO SB	PUBL	BLM/CDPR	OSR	0	
8	26	1999	LA	20.0	LEO CARILLO SB	PUBL	BLM/CDPR	OSR	0	
9	25	1998	VN	3.0	VENTURA CO. BEACHES S.	PUBL	CDPR	BCH	0	
8	26	1999	VN	3.0	VENTURA CO. BEACHES S.	PUBL	CDPR	BCH	0	
9	25	1998	VN	4.0	MUGU LAGOON	MILL	US NAVY	EST	115	
8	26	1999	VN	4.0	MUGU LAGOON	MILL	US NAVY	EST	56	
9	25	1998	VN	4.1	PT MUGU BEACHES	MILL	US NAVY	BCH	27	
8	26	1999	VN	4.1	PT MUGU BEACHES	MILL	US NAVY	BCH	0	
9	25	1998	VN	4.3	PORT HUENEME	PUBL	ARMY CORPS	JTY	0	
8	26	1999	VN	4.3	PORT HUENEME	PUBL	ARMY CORPS	JTY	0	
9	25	1998	VN	5.0	CHANNEL ISLANDS HARBOR	PUBL	ARMY CORPS	BRW	7	
8	26	1999	VN	5.0	CHANNEL ISLANDS HARBOR	PUBL	ARMY CORPS	BRW	46	
9	25	1998	VN	6.0	MCGRATH LAKE	PUBL	CDPR	LAG	0	
8	26	1999	VN	6.0	MCGRATH LAKE	PUBL	CDPR	LAG	0	
9	25	1998	VN	7.0	SANTA CLARA RIVER	PUBL	CDPR	RMO	43	
8	26	1999	VN	7.0	SANTA CLARA RIVER	PUBL	CDPR	RMO	151	
9	25	1998	VN	8.0	VENTURA HARBOR	PUBL	ARMY CORPS	BRW	59	WEAK PHOTO COVERAGE
8	26	1999	VN	8.0	VENTURA HARBOR	PUBL	ARMY CORPS	BRW	237	
9	25	1998	VN	9.0	VENTURA RIVER	PUBL	CDPR	RMO	5	
8	26	1999	VN	9.0	VENTURA RIVER	PUBL	CDPR	RMO	0	
9	25	1998	VN	11.0	RINCON ISLAND	PRIV	PRIV	MMS	129	
8	26	1999	VN	11.0	RINCON ISLAND	PRIV	PRIV	MMS	429	
9	25	1998	SB	1.5	SOUTH SANTA BARBARA	PUBL	CDPR	BCH	28	11 CARPINTERIA, 17 S STA BARB BCH
9	26	1999	SB	1.5	SOUTH SANTA BARBARA	PUBL	CDPR	BCH	0	
9	25	1998	SB	3.0	SANTA BARBARA OUTER	PRIV	PRIV	MMS	0	
8	26	1999	SB	3.0	SANTA BARBARA OUTER	PRIV	PRIV	MMS	0	
9	25	1998	SB	4.0	SANTA BARBARA INNER	PUBL	STA BARB.	HRB	93	
8	26	1999	SB	4.0	SANTA BARBARA INNER	PUBL	STA BARB.	HRB	64	
9	25	1998	SB	5.0	COAL OIL POINT/SANDPIPER	PRIV	ST. LANDS	MMS	72	
8	26	1999	SB	5.0	COAL OIL POINT/SANDPIPER	PRIV	ST. LANDS	MMS	160	
9	25	1998	SB	6.0	BEACHES	PUBL	CDPR/SB CO	RMO	15	1MI N OF COAL OIL PT.
8	26	1999	SB	6.0	BEACHES	PUBL	CDPR/SB CO	RMO	65	
9	25	1998	SB	7.0	BEACHES	PUBL	CDPR/SB CO	BCH	8	JUST S EL CAPITAN
8	26	1999	SB	7.0	BEACHES	PUBL	CDPR/SB CO	BCH	0	
9	25	1998	SB	8.0	EL CAPITAN BEACHES	PUBL	CDPR/SB CO	BCH	69	
8	26	1999	SB	8.0	EL CAPITAN BEACHES	PUBL	CDPR/SB CO	BCH	71	
9	25	1998	SB	9.0	BEACHES	PRIV	PRIV/HOLLI	BCH	5	
8	26	1999	SB	9.0	BEACHES	PRIV	PRIV/HOLLI	BCH	60	
9	25	1998	SB	10.0	GOVERNMENT POINT		UK	CRS	0	
8	26	1999	SB	10.0	GOVERNMENT POINT		UK	CRS	0	
9	25	1998	SB	11.0	PT CONCEPTION NORTH	MILL	UK	CRS	0	
8	26	1999	SB	11.0	PT CONCEPTION NORTH	MILL	UK	CRS	0	

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