Brown Pelican Night Roost Sites on the Southern California Coast

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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.

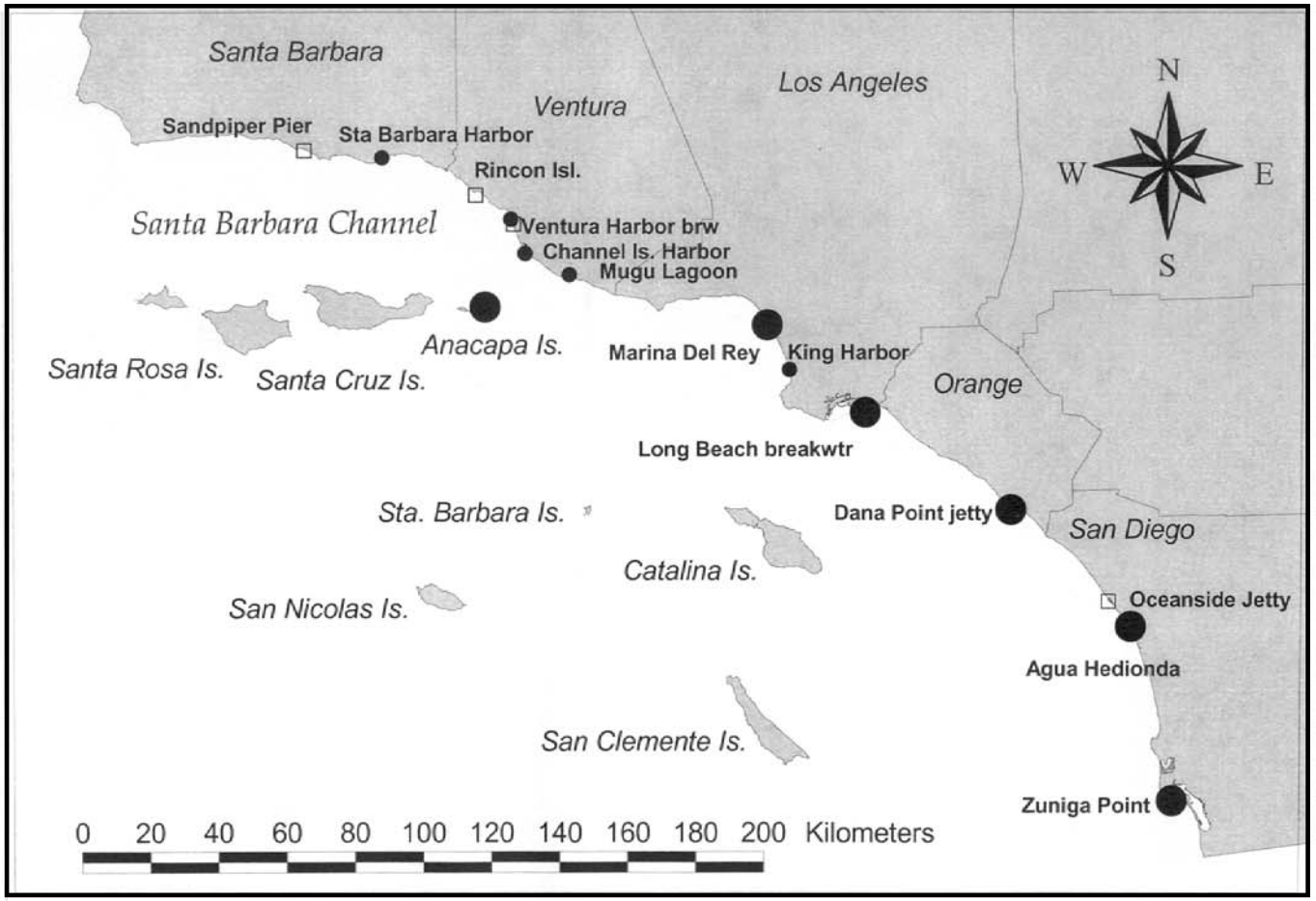

Figure 1. Southern California study area showing Brown Pelican night roost locations. Major night roosts (>100 birds on average) are represented by large circles, minor night roosts (<100 birds on average) are small circles, and roosts that were surveyed at dawn or dusk but remain of uncertain night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

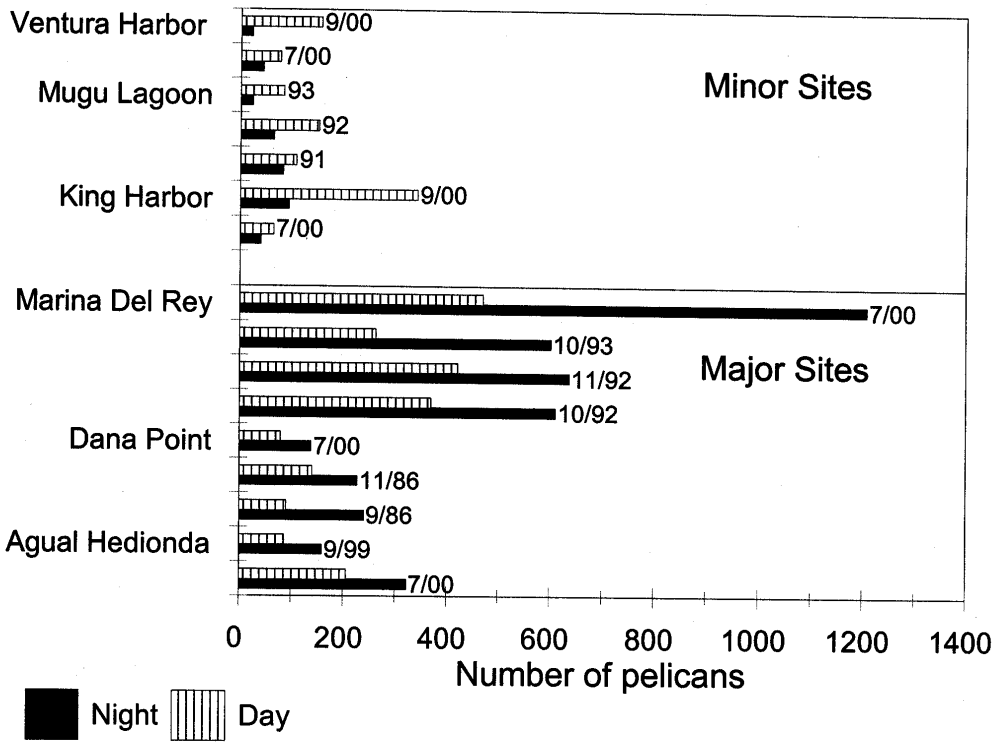

Figure 2. A comparison of day versus night roost numbers at minor and major night roost sites. Daytime counts are the average numbers seen on the day before or after a given night roost count. The time period for each survey sequence is shown at the end of each bar. Data for Mugu Lagoon are combined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

*Buffer*s *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).