

# **AERIAL PHOTOGRAPHIC SURVEYS OF BRANDT'S AND DOUBLE-CRESTED CORMORANT BREEDING COLONIES IN SOUTH CENTRAL CALIFORNIA IN JUNE 2010**

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## **FINAL REPORT**

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## EXECUTIVE SUMMARY

In 2010, using aerial photographic surveys, U.S. Fish and Wildlife Service (USFWS), University of California (Santa Cruz), and Humboldt State University determined locations and whole-colony counts of breeding colonies of Brandt's Cormorants (*Phalacrocorax penicillatus*) and Double-crested Cormorants (*P. auritus*) along the south central California coast from Point Sur to Point Mugu. Counts of roosting cormorants and California Brown Pelicans (*Pelecanus occidentalis californicus*) also were determined, mainly where roosts coincided with Brandt's or Double-crested Cormorant colonies. Black Oystercatchers (*Haematopus bachmani*) were counted when incidentally captured in photographs, and Western Gulls (*Larus occidentalis*) were counted only for certain colonies or subcolonies where photographic coverage of all possible nesting areas was complete. Additionally, aerial photographic surveys of nearly all Brandt's and sample Double-crested and Pelagic Cormorant colonies in the northern California Channel Islands were conducted, but counts were not determined. Results of these surveys will assist the Bureau of Land Management and other coastal partners within the Point Sur to Point Mugu Seabird Protection Network region to implement a seabird colony enhancement program as described within the *Torch/Platform Irene* Oil Spill Restoration Plan.

For Brandt's Cormorants, we counted 4071 nests at 19 colonies, while at least 22 other previously documented colonies were empty. Most nests (86%) occurred from Piedras Blancas Island south, with largest colonies at Morro Rock (1516 nests), Diablo Canyon Nuclear Power Plant South (890 nests), and Piedras Blancas Island (501 nests). North of Piedras Blancas Island, Cape San Martin (209 nests) and Partington Ridge North (190 nests) were the largest of eight active colonies. Possible human disturbance was suggested at Ragged Point Lodge Colony based on abandonment of 41 nests and territorial sites.

For Double-crested Cormorants, we counted 609 nests at four colonies. Most nests were concentrated at two colonies in trees: Fairbank Point (304 nests) and Shell Beach Rocks (268 nests). The Shell Beach Rocks colony occurs adjacent to a residential area and was apparently heavily disturbed. In 2010, the colony had shifted about 1 km south of the traditional colony area due to recent tree removal. Comparison of 2009 and 2010 aerial photographs indicated at least three trees that held nesting birds had been cut down sometime between 2009 and 2010 aerial surveys. At the main 2010 colony site, at least one homeowner, concerned about property damage and health hazards associated with cormorant guano, apparently was granted a depredation permit by USFWS to trim trees while active nests with chicks were present (see <http://calcoastnews.com/2010/07/shell-beach-residents-battling-sea-birds/>). Double-crested Cormorant nesting had occurred in trees at Shell Beach Rocks since at least 2000, when nesting was first detected during annual seabird colony surveys.

Complete counts of Western Gulls were determined for 10 small subcolonies; the largest of these were La Cruz Rock (15 nests and sites) and Subcolony 01 at Diablo Canyon Nuclear Power Plant South (23 nests and sites). Black Oystercatchers were detected only at La Cruz Rock (3 birds) and Piedras Blancas Island (2 birds). Roosting Brown Pelicans were counted at four sites; the largest roost was at Shell Beach Rocks (95 birds). Cormorant roosts of > 100 birds were detected at five locations; Point Conception was the largest roost (310 birds).

## INTRODUCTION

The *Torch/Platform Irene* Final Restoration Plan and Environmental Assessment selected reduction of human disturbance to seabird breeding colonies and roost sites as a restoration action to compensate for natural resource losses resulting from the 1997 *Torch/Platform Irene* Oil Spill (Torch/Platform Irene Trustee Council 2007). Ground surveys of seabird breeding colonies and roost sites along the south-central California coast will aim to detect human disturbance rates and shape outreach and enforcement efforts to reduce disturbance rates. In 2010, to assist implementation of and help assess these ground surveys, U.S. Fish and Wildlife Service (USFWS), University of California (Santa Cruz; UCSC), and Humboldt State University (HSU) conducted aerial photographic surveys of breeding colonies and roosting sites of surface-nesting seabirds from Point Sur to the Ventura-Los Angeles County border and at the northern Channel Islands. Results of previous aerial photographic surveys in 1979-1995 indicated human disturbance may have been affecting distribution and population sizes of seabird colonies in parts of this region (Carter et al. 1998).

Aerial photographic surveys have been used to estimate breeding population sizes of Brandt's Cormorants (*Phalacrocorax penicillatus*), Double-crested Cormorants (*P. auritus*), and Common Murres (*Uria aalge*) throughout coastal California since the mid to late 1970s (e.g., SOWLS et al. 1980; Takekawa et al. 1990; Carter et al. 1992, 1995, 1996, 1998, 2000, 2001, 2003; McChesney 1997; McChesney et al. 1998a; 2001; Capitolo et al. 2004, 2006, 2008a, 2010; USFWS, unpubl. data). They are the recommended method for monitoring breeding populations of these surface-nesting species because: 1) they provide coverage of extensive portions of breeding ranges; and 2) colonies are easily detected from aircraft and readily photographed completely. In contrast, most breeding colonies of Pelagic Cormorants (*P. pelagicus*) require boat- or land-based surveys for best viewing, though certain colonies can be surveyed well with aerial photographs. Western Gulls (*Larus occidentalis*) nest at lower densities than cormorants and murres, but with additional focused effort their colony sizes also can be estimated with aerial photographs (Capitolo et al. 2008b, 2009). Black Oystercatchers (*Haematopus bachmani*) and Pigeon Guillemots (*Cepphus columba*) are occasionally detected in aerial photographs but their populations are not surveyed effectively with this method.

These data have been used to: 1) monitor population trends over time, including identification of major changes (Carter et al. 1996, 2001; GIBBLE et al. 2010; Thibault et al. 2010; Capitolo et al., in prep.; McChesney et al., in prep.); 2) assess restoration of Common Murre populations in central California (e.g., McChesney et al. 2007, in prep.); 3) identify restoration opportunities, including for Common Murres in central California (Takekawa et al. 1990; Carter et al. 1998, 2001) and northern California (Thibault et al. 2010), and Brandt's Cormorants in central California (Carter et al. 1998) and southern California (Capitolo et al. 2008a); and 4) document colonies in need of special conservation actions, such as for the design of Marine Protected Areas. Furthermore, Brandt's Cormorants and Common Murres, in particular, are excellent indicator species for interpreting annual marine conditions; information on their annual population sizes in turn helps interpret potential impacts to seabirds from human disturbance.

In this report, we summarize the distribution and breeding population sizes of Brandt's and Double-crested Cormorant colonies in 2010 from Point Sur to the Ventura-Los Angeles

County border, as determined from aerial photographic surveys. Breeding Western Gulls and Black Oystercatchers, respectively, also were counted when photographic coverage of certain nesting areas was complete and when incidentally photographed. Roosting cormorants and Brown Pelicans (*Pelecanus occidentalis*) were counted when they occurred within or adjacent to known cormorant colonies, though not all roost sites were necessarily photographed. We also describe direct or potential human disturbance observed during the surveys and/or from the aerial photographs.

## METHODS

### Aerial Surveys

We aimed to photograph completely all breeding colonies of Brandt's Cormorants and all coastal breeding colonies of Double-crested Cormorants, from Point Sur to the Ventura-Los Angeles County border and at the northern Channel Islands (i.e., San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands). Locations where colonies have occurred in the past were surveyed and most other areas of the outer coast and island shorelines were inspected for new nesting areas. Cormorants and Brown Pelicans roosting adjacent to cormorant breeding colonies also were photographed, but roosting areas were not necessarily completely photographed. From Point Sur to Point Conception, colonies were surveyed once in early to mid June. South of Point Conception, surveys were conducted in April, May, and June, because of past wide variation of timing of breeding for Brandt's Cormorants and because of known later timing of breeding for Double-crested Cormorants (McChesney et al. 1998a, Capitolo et al. 2008a). We aimed to photograph all Brandt's Cormorant colonies in late May and all Double-crested Cormorant colonies in mid June, with certain sample Brandt's Cormorant colonies also photographed in April and June.

All surveys were conducted from a twin-engine, fixed-wing Partenavia aircraft operated by the California Department of Fish and Game (Air Services, Sacramento, California). From Point Sur to Point Conception, photographs were taken vertically through the belly port of the plane, with occasional oblique photographs through side windows for broader perspective of certain nesting areas. South of Point Conception and at the Channel Islands, photographs were taken obliquely. Colonies were photographed with digital SLR cameras by two observers. The lead photographer usually obtained complete coverage of colonies with close-up photographs using a 200 mm telephoto lens, while the second photographer took overview photographs and back-up close-ups with 50 mm, 70-200 mm, and 200 mm lenses. A third observer recorded data on hand-written flight logs. Survey altitude ranged from 700' to 1200' above sea level. Survey dates and personnel are summarized in Table 1.

Table 1. Summary of dates and personnel for aerial photographic surveys in the *Torch/Platform Irene* region of south central California in 2010.

Date	Photographers <sup>1</sup>	Data Recorder	Pilot	Locations Surveyed
4/19	P. Capitolo J. Davis	J. Davis	G. Woelfel	Northern Channel Islands (partial)
5/24	P. Capitolo P. Gaede	P. Gaede	W. Burnett	Port Hueneme Harbor
5/25	P. Capitolo P. Gaede	P. Gaede	W. Burnett	Northern Channel Islands (complete), Sandpiper Pier
6/3	G. McChesney L. Eigner	P. Capitolo	W. Burnett	Point Sur to North Pismo Beach Rocks (except Morro Bay area)
6/16	P. Capitolo S. Rhoades	P. Capitolo	W. Burnett	Morro Bay area, Pt. Arguello-Pt. Conception, San Miguel Island

<sup>1</sup>Camera 1 (lead photographer) listed first and Camera 2 (overview/backup photographer) listed second.

### Photograph Counting

We determined whole-colony counts of nests, territorial sites, and birds for all cormorant colonies surveyed from Point Sur to the Ventura-Los Angeles County border. Although surveys of the northern Channel Islands also were conducted, no funds were obtained for photograph counting of those colonies at this time. Counts were determined from selected best images of each colony using image analysis software. Nests, sites, and birds were manually marked and automatically tallied for each image. Totals for each image were summed to determine total counts for each subcolony, and subcolony counts were summed to determine whole-colony counts. Subcolonies are distinct geographic areas within colonies, most of which had been previously defined by Carter et al. (1992, 1996).

Nests were categorized by their stage of development following a standardized protocol (McChesney et al. 1998a,b, 1999). Cormorant nest totals reported here are sums of: well-built nests (X), poorly-built nests (P), nests with chicks (C), abandoned nests (A), and empty nests (E). Total numbers of sites include territorial sites (Z), abandoned sites (AZ), and undetermined sites (S). Undetermined sites (S) were rarely recorded. Roosting cormorants were identified by: 1) location away from other breeding birds, often in non-breeding habitat (e.g. intertidal areas); 2) lack of observed breeding behaviors and nesting material; and 3) often denser groups of birds compared to birds attending nest sites. Most roosting cormorants likely were Brandt's Cormorants, but we categorized them as Unidentified because some Double-crested and Pelagic Cormorants also were likely present but not consistently distinguishable away from nest sites. Roosting Brown Pelicans were aged as adult or immature.

## RESULTS

### Brandt's Cormorant

We photographed Brandt's Cormorants at 19 breeding colonies (Fig. 1), while 22 previously documented colonies were empty, and one previously documented colony was uninspected (Rocky Point). Combined totals at these colonies were 4071 nests, 1159 territorial sites, and 5804 birds (Table 2). Additionally, we counted 1367 roosting cormorants, most of which were likely Brandt's Cormorants (Appendix 2). The largest colonies were Morro Rock (1516 nests), Diablo Canyon Nuclear Power Plant South (890 nests), and Piedras Blancas Island (501 nests), such that 77% of nests occurred from Piedras Blancas Island through the Diablo Canyon area (i.e., to Pecho Rock). North of Piedras Blancas Island, eight colonies were active; the largest were Cape San Martin (209 nests) and Partington Ridge North (190 nests). Only 8% of nests occurred south of Pecho Rock, with the largest colony at Sandpiper Pier Foundation (136 nests).

The relatively large number of territorial sites indicated some additional egg-laying may have occurred after mid June, especially north of Point Conception. All colonies north of Point Conception had some territorial sites (the colonies with largest nest totals also had the largest number of territorial sites), and nests with visible chicks were detected at only one colony (Morro Rock; 14% of nests). Breeding phenology was noticeably earlier south of Point Conception. In late May, Sandpiper Pier Foundation and Port Hueneme Harbor had 73% and 16% of nests with visible chicks, respectively.

We noted one instance of potential disturbance at Ragged Point Lodge Colony, where nearly all Brandt's Cormorant nests and sites had been abandoned. Only two Brandt's Cormorant and two Pelagic Cormorant nests remained active, whereas 12 abandoned nests and 29 abandoned territorial sites were counted. The abandoned nests were distinguished from abandoned territorial sites because they remained well-built with evident guano accumulation, indicating prolonged use and that egg-laying had likely occurred. However, some of the abandoned territorial sites also may have been breeding sites, with nesting material having become flattened and scattered and not obviously indicating egg-laying. It is highly unlikely these abandoned nests and sites reflected an early nesting effort that had completed, because nearby colonies were mostly in the incubation stage and no crèches or roosts with large fledglings were seen.

### Double-crested Cormorant

We photographed Double-crested Cormorants at four breeding colonies (Fig. 2) that totaled 609 nests, three territorial sites, and 742 birds (Table 2). Nesting was not detected at three other previously documented colonies where only 1-2 nests were last detected in 1989 from boat surveys (Carter et al. 1992). The small, recently-formed colony in trees at Goleta Slough was not photographed; because of its proximity to Santa Barbara Airport, permission to circle the area may or nor be granted by Air Traffic Control depending on conditions. A small colony (< 50 nests) also has been present at least since 2001 in trees at the Andree Clark Bird Refuge in Santa Barbara (P. Gaede, pers. comm.), but we only became aware of it recently and did not survey it

in 2010. Most nests occurred at two large colonies in trees: Fairbank Point (304 nests) and Shell Beach Rocks (268 nests). Breeding phenology was slightly advanced compared to Brandt's Cormorant colonies north of Point Conception, based on greater percentages of nests with visible chicks. At Morro Rock, Fairbank Point, and Shell Beach Rocks, 33%, 34%, and 19% of nests had visible chicks, respectively.

The Shell Beach Rocks colony was apparently heavily disturbed, with permission from USFWS due to health concerns for residents whose homes were adjacent to the nest trees (<http://calcoastnews.com/2010/07/shell-beach-residents-battling-sea-birds/>). The colony was first noted during annual aerial surveys in 2000, when 77 nests were counted in Monterey Cypress (*Cupressus macrocarpa*) trees (McChesney et al. 2001). The colony was not present in 1989 during statewide surveys of all California seabird colonies (Carter et al. 1992), but it is not known what year nesting first occurred because the coastal area near Shell Beach Rocks was not thoroughly inspected in all years between 1989 and 2000 during aerial surveys. The colony had grown to 130 nests by 2003 (Capitolo et al. 2004) and 204 nests by 2008 (UCSC and USFWS, unpubl. data).

However, in 2010 the colony had shifted about 1 km to the south to a different grove of trees. Comparison of 2010 aerial photographs with 2009 aerial photographs showed that several trees at the original colony location had been cut down between the two breeding seasons. In 2010, only 14 nests (including 10 abandoned) were present at the original colony location (Subcolony 09), whereas 254 nests (including one abandoned) were at the new, southern location (Subcolony 10; Figs. 3, 4). News reports confirmed that trees on private property had been removed in the vicinity of the original colony location in recent years. The purpose for removing the trees was not clearly stated, but reduction of impacts of cormorant guano on nearby homes and property seemed likely. In 2010, however, the trees to which cormorants shifted nesting were still on private properties. Homeowners contacted Pismo Beach city officials and USFWS representatives. Eventually, a depredation permit was granted to trim trees and remove nests once nestlings were capable of flight. However, images associated with the article seem to indicate nestlings still dependent on adults were present in nearby nests while workers were in trees with chainsaws. The future of this large Double-crested Cormorant colony is uncertain.

## **Other Species**

Complete counts of Western Gulls were determined for 10 small colonies and subcolonies; the largest of these were La Cruz Rock (15 nests and sites) and Subcolony 01 at Diablo Canyon Nuclear Power Plant South (23 nests and sites). Black Oystercatchers were detected only at La Cruz Rock (3 birds) and Piedras Blancas Island (2 birds; Appendix 1). Roosting Brown Pelicans were counted at four sites; the largest roost was at Shell Beach Rocks (95 birds). Cormorant roosts of > 100 birds were detected at five locations; Point Conception was the largest roost (310 birds; Appendix 2).



Figure 1. Locations of Brandt's Cormorant breeding colonies known to be active in coastal south central California in 2010.

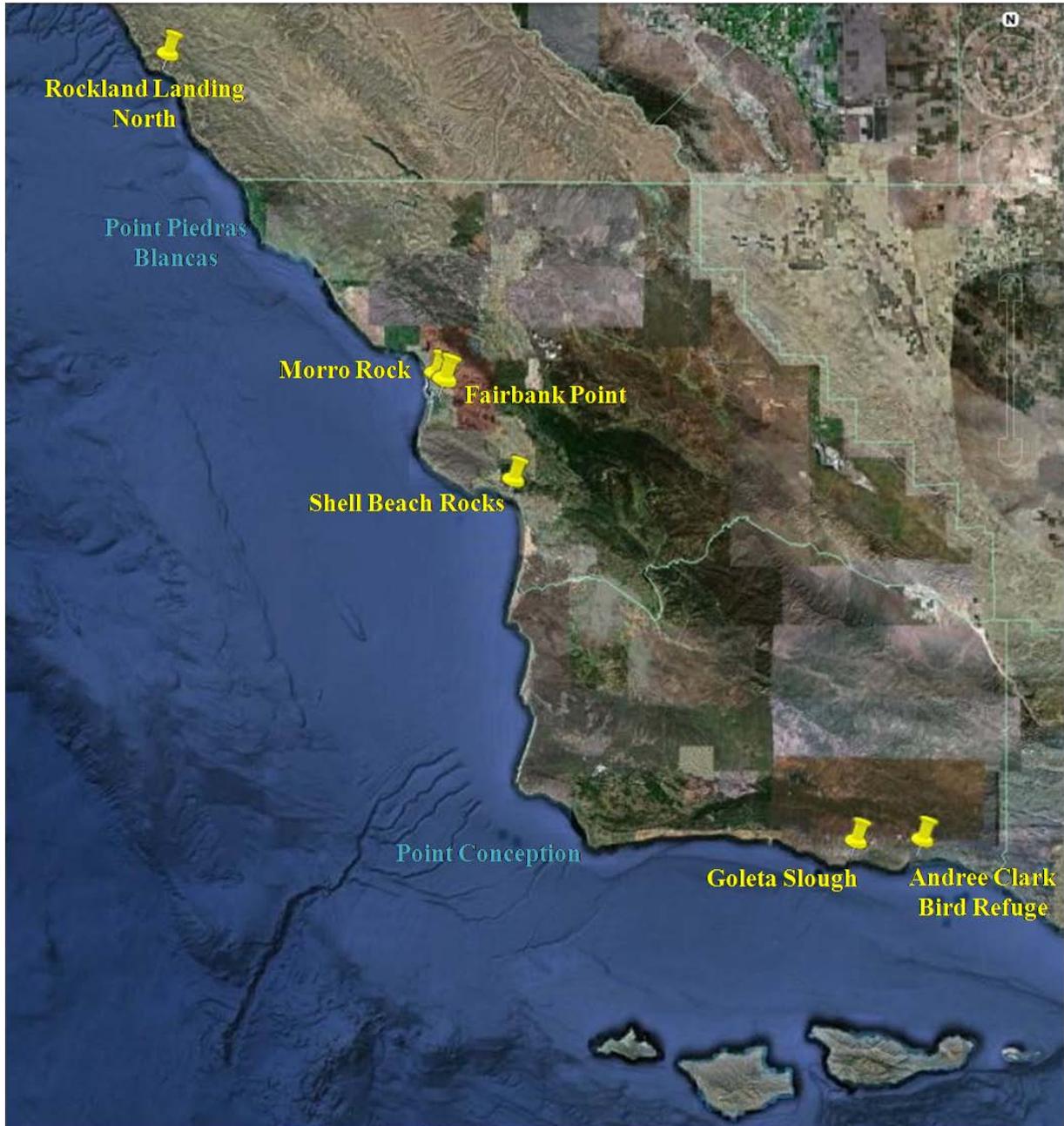


Figure 2. Locations of Double-crested Cormorant breeding colonies known to be active in coastal south central California in 2010.

Table 2. Total numbers of nests, sites, and birds counted at Brandt's and Double-crested Cormorant breeding colonies in south central California, June 2010. Dashes (-) indicate nesting has not been documented. CCN = California Colony Number; USFWSCN = U.S. Fish and Wildlife Service Colony Number (see Carter et al. 1992).

COLONY	CCN	USFWSCN	Date	Brandt's Cormorant			Double-crested Cormorant		
				Nests	Sites	Birds	Nests	Sites	Birds
Cooper Point & Islands	MO-360-03	454-031	3 June	0	0	0	-	-	-
Pfeiffer Point	MO-360-04	454-032	3 June	0	0	0	-	-	-
Grimes Point	MO-360-06	454-033	3 June	0	0	0	-	-	-
Lafler Rock & Mainland	MO-360-07	454-034	3 June	0	0	0	-	-	-
Torre Canyon Rocks	MO-360-08	454-013	3 June	0	0	0	-	-	-
Partington Ridge North	MO-360-10	454-014	3 June	190	40	237	0	0	0
McWay Rocks	MO-360-11	454-015	3 June	0	0	0	-	-	-
Partington Ridge South	MO-360-12	454-035	3 June	0	0	0	-	-	-
Anderson Canyon Rocks	MO-360-13	454-016	3 June	0	0	0	0	0	0
Burns Creek Rocks	MO-360-14	454-017	3 June	24	27	58	-	-	-
Dolan Rock	MO-360-16	454-018	3 June	0	0	0	-	-	-
Square Black Rock	MO-360-18	454-019	3 June	0	0	0	-	-	-
Gamboa Point	MO-360-19	454-053	3 June	0	0	0	-	-	-
Lopez Rock	MO-360-21	454-020	3 June	0	0	0	-	-	-
Rockland Landing North	MO-360-23	454-037	3 June	12	4	18	10	0	10
Gorda Area	MO-354-05	477-040	3 June	0	0	0	-	-	-
Plaskett Rock	MO-354-07	477-002	3 June	0	0	0	-	-	-
Cape San Martin	MO-354-08	477-003	3 June	209	12	235	0	0	0
Unnamed Rock	MO-354-09	477-004	3 June	0	0	0	-	-	-
Redwood Gulch Rock	MO-354-12	477-005	3 June	56	3	64	-	-	-
Seastack S. of Redwood Gulch	MO-354-13	477-018	3 June	0	0	0	-	-	-
Unmapped Island	MO-354-14	477-019	3 June	19	22	46	-	-	-
Ragged Point Lodge Colony	SL-354-01	477-022	3 June	14 <sup>1</sup>	0	2	-	-	-
3 Rocks	SL-354-03	477-023	3 June	62	14	83	-	-	-
La Cruz Rock	SL-354-04	477-006	3 June	0	0	0	-	-	-
Piedras Blancas Island	SL-352-01	477-007	3 June	501	113	673	-	-	-
Morro Rock & Pillar Rock	SL-352-07	477-026	16 June	1516	578	2327	27	1	33
Fairbank Point	SL-352-08	477-044	16 June	-	-	-	304	2	423
Point Buchon	SL-350-02	477-009	3 June	52	7	75	-	-	-
Unnamed Rocks	SL-350-03	477-010	3 June	137	13	169	-	-	-
Pup Rock & Adj. Mainland	SL-350-04	477-028	3 June	0	0	0	-	-	-

Table 2 continued.

COLONY	CCN	USFWSCN	Date	Brandt's Cormorant			Double-crested Cormorant		
				Nests	Sites	Birds	Nests	Sites	Birds
Lion Rock	SL-350-05	477-011	3 June	0	0	0	-	-	-
Diablo Rock & Adj. Mainland	SL-350-06	477-029	3 June	0	0	0	-	-	-
Diablo Cyn NPPS	SL-350-07	477-030	3 June	890	216	1164	-	-	-
Pecho Rock	SL-350-09	477-032	3 June	57	13	75	-	-	-
Shell Beach Rocks	SL-350-13	477-035	3 June	25	42	76	268	0	276
North Pismo Beach Rocks	SL-350-14	477-036	3 June	0	0	0	-	-	-
Lion Rock at Point Sal	SB-344-04	501-008	16 June	0	0	0	-	-	-
Point Arguello	SB-342-04	501-011	16 June	109	16	150	-	-	-
Rocky Point	SB-342-05	501-012	16 June	ND	ND	ND	-	-	-
Point Conception	SB-342-06	501-013	16 June	17	37	73	-	-	-
Sandpiper Pier Foundation	SB-342-07	502-029	25 May	136	2	200	-	-	-
Goleta Slough <sup>2</sup>	SB-	-	-	-	-	-	ND	ND	ND
Andree Clark Bird Refuge <sup>2</sup>	SB-	-	-	-	-	-	ND	ND	ND
Port Hueneme Harbor	VE-390-08	502-030	24 May	45	0	79	-	-	-
<b>TOTAL</b>				<b>4071</b>	<b>1159</b>	<b>5804</b>	<b>609</b>	<b>3</b>	<b>742</b>

<sup>1</sup>Includes 12 abandoned nests, but an additional 29 abandoned sites also were counted; <sup>2</sup>Colony numbers to be assigned

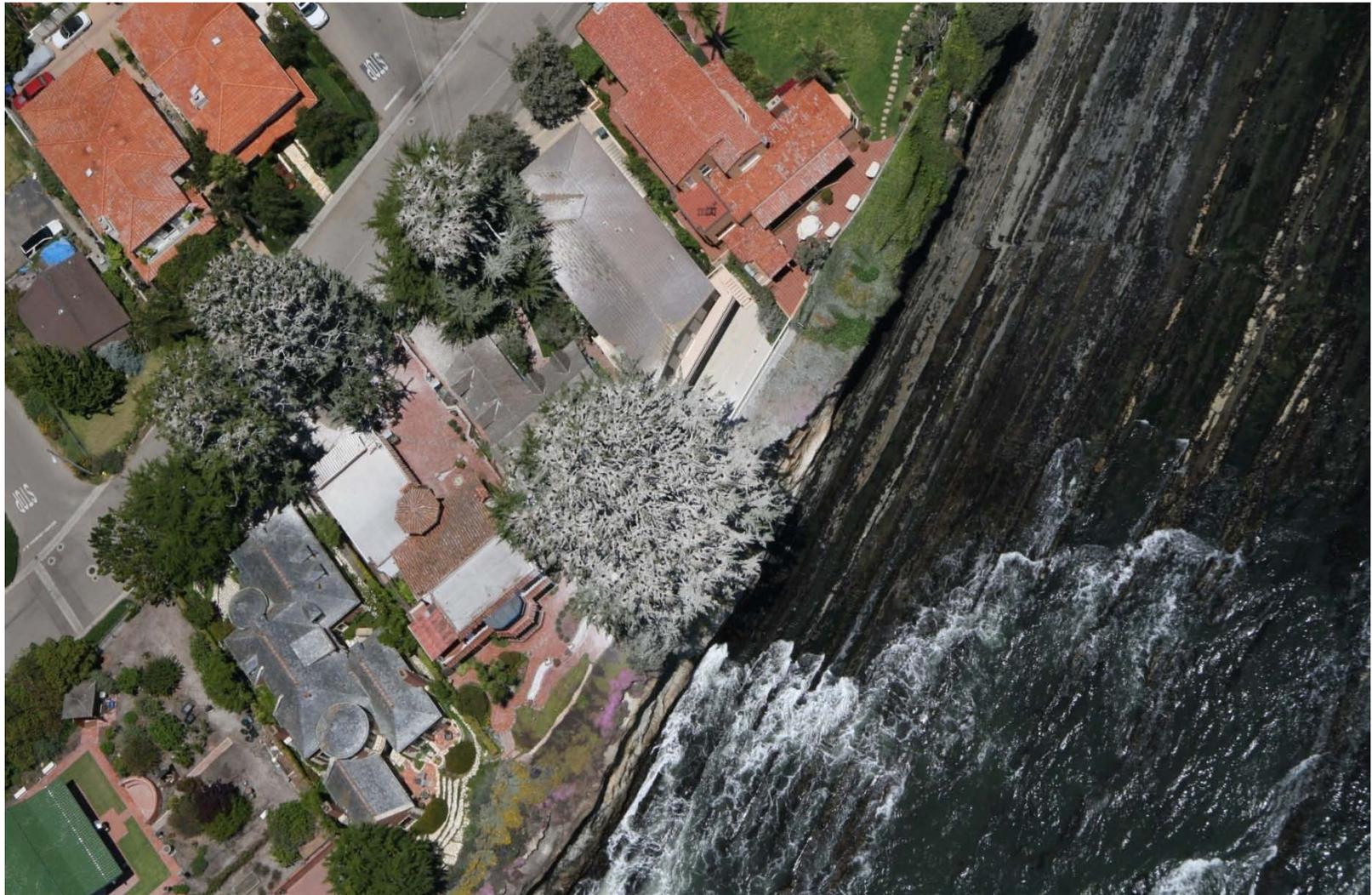


Figure 3. Overview photograph of Double-crested Cormorant nest trees on the mainland at Shell Beach Rocks, Subcolony 10, 3 June 2010.



Figure 4. Double-crested Cormorant nest trees on the mainland at Shell Beach Rocks following trimming, 24 September 2010. Photo from California Coastal Records Project (<http://www.californiacoastline.org/>).

## DISCUSSION

### Timing of Breeding

Aerial surveys in 2010 appeared appropriately timed to capture near-peak nesting activity for Brandt's and Double-crested Cormorants in the *Torch/Platform Irene* restoration area. Most Brandt's Cormorant colonies were well-established by 3 June, and at Morro Rock many nests had chicks by 16 June. However, the relatively large proportion of territorial sites suggested that some degree of egg-laying also likely occurred after June surveys. Farther north in central California in the Gulf of the Farallones, peak numbers of Brandt's Cormorant nests at Devils Slide Rock & Mainland occurred in the final week of June. Clutch initiation was about three weeks later than the long-term mean, and egg-laying occurred at least as late as 17 July. Small numbers of nests with chicks were active into September at Devils Slide Rock & Mainland (USFWS, unpubl. data) and at Seacliff Cement Ship Pier in Monterey Bay (D. Suddjian, unpubl. data). Double-crested Cormorants in coastal California typically have less variable or protracted timing of breeding than Brandt's Cormorants. At the largest Double-crested Cormorant colonies, the relatively high percentage of nests with visible chicks indicated near-peak nesting.

### Focal Colonies for Ground-Monitoring

A majority of the Brandt's and Double-crested Cormorant breeding populations along the south central coast occurred in a region where focal colonies for ground-monitoring of disturbance and productivity have been identified. Among Brandt's Cormorant breeding colonies, the large colonies at Morro Rock and Piedras Blancas Island are targeted for monitoring by volunteers and trained biologists, respectively (D. Robinette, pers. comm.). However, most nesting areas at these colonies typically occur on western portions that are not visible from mainland vantage points, and numbers of nests available for monitoring may be relatively small. At other sites targeted for monitoring (i.e., Point Buchon area, Shell Beach Rocks, and Point Arguello area), smaller numbers of nests occur, but a greater proportion may be visible from mainland vantage points.

Large numbers of roosting cormorants and Brown Pelicans also regularly occur at ground-monitoring focal sites. Shell Beach Rocks is an important diurnal and night roosting site for Brown Pelicans (H. Carter, unpubl. data, D. Jaques, unpubl. data), and more than 1200 Brown Pelicans were counted at Morro Rock from 31 May 2007 aerial photographs (USFWS, unpubl. data). Monitoring of disturbance to roosting and foraging cormorants in Morro Bay also may be a cost-effective allocation of observer effort, given the large Double-crested Cormorant colony at Fairbank Point, as well as likely foraging in Morro Bay by Brandt's Cormorants.

### Disturbance

In 2010, we detected one observation of potential disturbance to Brandt's Cormorants and one observation of confirmed disturbance to Double-crested Cormorants (see above). Potential causes of abandonment by Brandt's Cormorants at Ragged Point Lodge Colony include both human and natural disturbances. Boats too close to the mainland cliff may have caused birds to flush, or disturbance may have originated from the bluff above the colony, where an inn is located. Alternatively, avian or mammalian predators may have accessed the colony. Similar

abandonment was not noted elsewhere in the region, suggesting abandonment was not related to reduced prey availability. Upon completion of counting of archived aerial photographs from the 1996-2009 period, all observations of potential disturbance observed from aerial photographs will be summarized. Other past observations of potential disturbance from aerial photographs include nest abandonments, boats or kayaks in close proximity to breeding or roosting habitat, and people on foot within colonies.

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Appendix 1. Subcolony counts of nests, territorial sites, and birds at active Brandt's (BRCO) and Double-crested Cormorant (DCCO) breeding colonies in south central California, June 2010. Black Oystercatchers (BLOY) and Western Gulls (WEGU) were only counted at certain subcolonies (see text). CCN = California Colony Number; USFWSCN = U.S. Fish and Wildlife Service Colony Number; SC# = Subcolony Number (see Carter et al. 1992).

Colony Name	CCN	USFWSCN	SC #	Date	Species	Nests	Sites	Birds
Partington Ridge North	MO-360-10	454-014	5	3 June	BRCO	190	40	237
Partington Ridge North	MO-360-10	454-014	5	3 June	WEGU	1	3	4
Burns Creek Rocks	MO-360-14	454-017	2	3 June	BRCO	24	27	58
Burns Creek Rocks	MO-360-14	454-017	2	3 June	WEGU	2	0	2
Rockland Landing North	MO-360-23	454-037	1	3 June	BRCO	3	0	3
Rockland Landing North	MO-360-23	454-037	2	3 June	BRCO	9	4	15
Rockland Landing North	MO-360-23	454-037	2	3 June	DCCO	10	0	10
Plaskett Rock	MO-354-07	477-002	1	3 June	WEGU	1	0	2
Cape San Martin	MO-354-08	477-003	1	3 June	BRCO	209	12	235
Redwood Gulch Rock	MO-354-12	477-005	1	3 June	BRCO	56	3	64
Redwood Gulch Rock	MO-354-12	477-005	1	3 June	WEGU	2	0	2
Unmapped Island	MO-354-14	477-019	1	3 June	BRCO	19	22	46
Unmapped Island	MO-354-14	477-019	1	3 June	WEGU	1	0	1
Ragged Point Lodge Colony	SL-354-01	477-022	1	3 June	BRCO	14	0	1
3 Rocks	SL-354-03	477-023	3	3 June	BRCO	62	14	83
3 Rocks	SL-354-03	477-023	3	3 June	WEGU	4	6	14
La Cruz Rock	SL-354-04	477-006	1	3 June	BLOY	2	0	3
La Cruz Rock	SL-354-04	477-006	1	3 June	WEGU	14	1	18
Piedras Blancas Island	SL-352-01	477-007	1	3 June	BRCO	501	113	673
Piedras Blancas Island	SL-352-01	477-007	1	3 June	BLOY	0	0	2
Piedras Blancas Island	SL-352-01	477-007	1	3 June	WEGU	1	0	1
Morro Rock and Pillar Rock	SL-352-07	477-026	1	16 June	BRCO	1516	578	2327
Morro Rock and Pillar Rock	SL-352-07	477-026	1	16 June	DCCO	27	1	33
Morro Rock and Pillar Rock	SL-352-07	477-026	2	16 June	WEGU	1	0	3

Appendix 1 continued.

Colony Name	CCN	USFWSCN	SC #	Date	Species	Nests	Sites	Birds
Fairbank Point	SL-352-08	477-044	1	16 June	DCCO	304	2	423
Point Buchon	SL-350-02	477-009	3	3 June	BRCO	6	0	8
Point Buchon	SL-350-02	477-009	4	3 June	BRCO	46	7	67
Unnamed Rocks	SL-350-03	477-010	16	3 June	BRCO	137	13	169
Diablo Cyn Nuclear Power Plant South	SL-350-07	477-030	1	3 June	BRCO	890	216	1164
Diablo Cyn Nuclear Power Plant South	SL-350-07	477-030	1	3 June	WEGU	18	5	43
Pecho Rock	SL-350-09	477-032	1	3 June	BRCO	57	13	75
Shell Beach Rocks	SL-350-13	477-035	7	3 June	BRCO	25	42	76
Shell Beach Rocks	SL-350-13	477-035	9	3 June	DCCO	14	0	4
Shell Beach Rocks	SL-350-13	477-035	10	3 June	DCCO	254	0	272
Shell Beach Rocks	SL-350-13	477-035	3	3 June	WEGU	9	2	17
Point Arguello	SB-342-04	501-011	10	16 June	BRCO	79	16	116
Point Arguello	SB-342-04	501-011	12	16 June	BRCO	30	0	34
Point Arguello	SB-342-04	501-011	10	16 June	PECO	3	0	18
Rocky Point	SB-342-05	501-012	99	16 June	BRCO	ND	ND	ND
Point Conception	SB-342-06	501-013	1	16 June	BRCO	17	37	73
Point Conception	SB-342-06	501-013	1	16 June	PECO	0	2	2
Sandpiper Pier Foundation <sup>1</sup>	SB-342-07	502-029	1	25 May	BRCO	35	0	48
Sandpiper Pier Foundation <sup>1</sup>	SB-342-07	502-029	2	25 May	BRCO	35	1	50
Sandpiper Pier Foundation <sup>1</sup>	SB-342-07	502-029	3	25 May	BRCO	31	1	51
Sandpiper Pier Foundation <sup>1</sup>	SB-342-07	502-029	4	25 May	BRCO	35	0	51
Port Hueneme Harbor <sup>1</sup>	VE-390-08	502-030	1	24 May	BRCO	45	0	79

<sup>1</sup>See Capitolo et al. (2008a) for subcolony designations.

Appendix 2. Subcolony counts of roosting unidentified cormorants (UNCO) and Brown Pelicans (BRPE) in south central California, June 2010. CCN = California Colony Number; USFWSCN = U.S. Fish and Wildlife Service Colony Number; SC# = Subcolony Number (see Carter et al. 1992).

Colony	CCN	USFWSCN	SC #	Date	Time	UNCO	BRPE			Total
							Adult	Imm.	Unk.	
Lopez Rock	MO-360-21	454-020	01	3 June	1154	4	0	0	0	0
Rockland Landing North	MO-360-23	454-037	01	3 June	1157	44	0	0	0	0
Rockland Landing North	MO-360-23	454-037	02	3 June	1157	108	0	0	0	0
Plaskett Rock	MO-354-07	477-002	01	3 June	1201	10	0	0	0	0
Cape San Martin	MO-354-08	477-003	01	3 June	1204	0	6	0	0	6
Unmapped Island	MO-354-14	477-019	01	3 June	1211	3	0	0	0	0
Ragged Point Lodge Colony	SL-354-01	477-022	99	3 June	1215	20	0	0	0	0
La Cruz Rock	SL-354-04	477-006	03	3 June	1218	93	0	0	0	0
Piedras Blancas Island	SL-352-01	477-007	01	3 June	1221	13	0	0	0	0
Morro Rock & Pillar Rock	SL-352-07	477-026	01	16 June	1052	99	0	0	0	0
Morro Rock & Pillar Rock	SL-352-07	477-026	02	16 June	1052	144	0	0	0	0
Point Buchon	SL-350-02	477-009	03	3 June	1300	28	0	0	0	0
Diablo Cyn NPPS	SL-350-07	477-030	01	3 June	1252	5	0	0	0	0
Pecho Rock	SL-350-09	477-032	01	3 June	1304	29	0	0	0	0
Shell Beach Rocks	SL-350-13	477-035	03	3 June	1313	95	65	25	5	95
Shell Beach Rocks	SL-350-13	477-035	07	3 June	1313	2	0	0	0	0
Shell Beach Rocks	SL-350-13	477-035	11	3 June	1313	151	0	0	0	0
N. Pismo Beach Rocks	SL-350-14	477-036	03	3 June	1313	137	0	0	0	0
Lion Rock at Point Sal	SB-344-04	501-008	01	16 June	1136	72	4	0	1	5
Point Conception	SB-342-06	501-013	01	16 June	1150	310	33	9	3	45