RESTORATION OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2009

REPORT TO THE

COMMAND TRUSTEE COUNCIL

Lisa E. Eigner, Gerard J. McChesney, Sandra J. Rhoades, Mary W. Davis, Jonathan. A. Shore, Crystal A. Bechaver, Peter J. Kappes, and Richard T. Golightly

U.S. Fish and Wildlife Service
San Francisco Bay National Wildlife Refuge Complex
9500 Thornton Avenue
Newark, CA 94560 USA

FINAL REPORT
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ABBREVIATIONS USED IN ANNUAL REPORT 2009

CMRP = Common Murre Restoration Project

USFWS = U.S. Fish and Wildlife Service

NOAA = National Oceanic and Atmospheric Administration

CDFG = California Department of Fish and Game

GFNMS = Gulf of the Farallones National Marine Sanctuary

OSPR = Office of Spill Prevention and Response

SPN = Seabird Protection Network

PRH = Point Reyes Headlands

DBCC = Drakes Bay Colony Complex, which consists of Point Resistance, Millers Point Rocks, and Double Point Rocks

PRS = Point Resistance

MPR = Millers Point Rocks

DPR = Double Point Rocks

DSRM = Devil's Slide Rock & Mainland

DSR = Devil's Slide Rock

DSM = Devil's Slide Mainland

DSCC = Devil's Slide Rock Colony Complex, which consists of Devil's Slide Rock & Mainland San Pedro Rock Colony

CHCC = Castle-Hurricane Colony Complex , which consists of Bench Mark-227X, Castle Rocks & Mainland, and Hurricane Point Rocks

BM227X = Bench Mark-227X

CRM = Castle Rocks & Mainland

HPR = Hurricane Point Rocks

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

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Additional administrative support was provided by Mendel Stewart (Refuge Complex Manager), John Bradley (Deputy Refuge Complex Manager), Cindy Ballard (Administrative Officer), and Ellen Tong (Budget Technician) from the USFWS–San Francisco Bay National Wildlife Refuge Complex, as well as Pia Gabriel (Department of Wildlife, Humboldt State University) and the staff at Humboldt State University Sponsored Programs Foundation.

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EXECUTIVE SUMMARY

This report summarizes the 14th year of restoration and associated monitoring of central California seabird colonies conducted by the Common Murre Restoration Project (CMRP) in 2009. These efforts began in 1996 to restore breeding colonies of seabirds, especially Common Murres (*Uria aalge*), harmed by the 1986 *Apex Houston* and 1998 *Command* oil spills, gill net fishing, human disturbance, and other factors. From 1995 to 2005, our primary goal was to restore the previously extirpated Devil's Slide Rock colony using social attraction techniques and to assess restoration needs at other central California colonies. Since 2005, efforts have been redirected to surveillance of human disturbance to murre colonies, assessing the impacts of that disturbance, and assessing other factors affecting growth of colonies; additionally, we still monitor progress of the initial restoration efforts. This information is then used to guide outreach and education efforts conducted by the Gulf of the Farallones National Marine Sanctuary and to assess the success of those efforts. The goal of this program is to restore affected breeding colonies mainly through reduction of human disturbance. Surveillance and monitoring were conducted almost daily from mid-April to late July at the following Common Murre colonies in central California: Point Reyes; Devil's Slide Rock & Mainland; and the Castle-Hurricane Colony Complex. Another four colonies were surveyed weekly including three in the Drakes Bay area (Point Resistance, Millers Point Rocks, and Double Point Rocks) and at San Pedro Rock (near Devil's Slide). In addition to human disturbance, we measured seasonal attendance patterns, and reproductive performance of Common Murres and up to five other species as well as breeding population sizes for certain species. Periodic surveys were also conducted by volunteers at three colonies near the Golden Gate (Bird Island, Lobos Rock & Land's End, and Seal Rocks) to follow recent murre colonization attempts.

For aircraft, activity rates were measured as the number of fixed-wing planes and helicopters observed per hour that flew $\leq$ 305 m (1000 ft) above sea level (ASL) over colonies. Boat activity was measured as the number of vessels observed per hour that approached within 457 (1500 ft) of colonies. Aircraft, boat and other anthropogenic disturbance rates were measured as the number of disturbance events per hour. At Point Reyes, combined aircraft and boat activity in 2009 declined 27% from 2008 and overall disturbance rates also declined. In the Drakes Bay area, little aircraft or boat activity was observed at Point Resistance and Miller's Point Rocks; at Double Point Rocks, combined aircraft and boat activity rates increased from 2008 but disturbance rates decreased for planes and boats. At Devil's Slide Rock & Mainland, aircraft and boat activity and disturbance rates were the greatest of all colonies that are monitored almost daily. Although combined aircraft and boat activity rates were similar to 2008, plane overflights declined 9% but helicopters and boats increased 19% and 21%, respectively. At the Castle-Hurricane Colony Complex, combined activity rates increased 55% from 2008, including an 83% and 79% increase in plane and boat observation rates, respectively. Although observation rates increased in 2009, the overall disturbance rate decreased 79% from 2008.

Unmarked, "other" aircraft (i.e., private or charter) were the most commonly observed planes and helicopters and caused the most observed disturbances (95% of plane, 44% of helicopter overflights). The next most common source of aircraft disturbance was from U.S. Coast Guard planes (n =1) and helicopters (n = 10), including one flushing event. The majority of watercraft observed were recreational small private boats (64%) followed by kayaks (23%). Recreational small private boats and kayaks were responsible for nearly all disturbances (56% and 41%, respectively) and all flushing events (60% and 40%, respectively).

On Devil's Slide Rock in 2009, a new high count of 1,003 Common Murres was established since the colony was occupied in 1996. The number of breeding pairs within monitored plots increased 11% from 2008. However, for the first year since restoration efforts began in 1996, no murre chicks survived to departure from the Devil's Slide Rock & Mainland colony. Hatching success was extremely low (6.7%), with many eggs being abandoned. Murres bred on the Devil's Slide Mainland (32 pairs) for the fifth consecutive year but no chicks hatched. Murre breeding success at Point Reyes (0.27 chicks/pair) and Castle Rocks & Mainland (0.35 chicks/pair) was well below the long-term averages. All three Drakes Bay murre colonies suffered total or near total breeding failure. Brandt's Cormorants had low breeding population sizes and breeding success at all three monitored colonies, concomitant with a large spring starvation event. Numbers of breeding Pelagic Cormorants were similar to or lower than in 2008 at Point Reyes and Devil's Slide Rock & Mainland but were higher at the Castle-Hurricane Colony Complex; productivity of monitored nests was low. Western Gull numbers were higher than in 2008 but productivity was low. Low breeding success for most seabirds appeared to be caused by low prey availability, especially of small schooling baitfish. At certain colonies, disturbance exacerbated impacts of low prey. In particular, apparently emaciated California sea lions (*Zalophus californianus*) were observed climbing high up into murre breeding colonies at Point Reyes, Point Resistance and Double Point Rocks; at Point Reyes, sea lions were observed flushing murres off of eggs, contributing to high rates of abandonment by murres. This likely occurred at other colonies as well. Brown Pelicans were responsible for a limited amount of disturbances to murres at Devil's Slide Rock & Mainland and Castle-Hurricane. At Castle-Hurricane, anecdotal data suggests that pelican disturbance caused some murre egg loss at three subcolonies followed by fairly substantial relaying efforts. Chronic Common Raven disturbance may be contributing to a large decline in the Miller's Point Rocks colony. Frequent disturbance from aircraft and boats may have contributed to total breeding failure at Devil's Slide Rock & Mainland. Additional efforts are needed to reduce aircraft and boat activity at Devil's Slide and to address a recent increase in boat activity at Castle-Hurricane. Special Closures scheduled to occur at some colonies beginning in May 2010 should reduce boat disturbance to seabirds but this will need to be monitored and enforced.

INTRODUCTION

Breeding colonies of Common Murres (*Uria aalge*) in central California occur on nearshore rocks and adjacent mainland cliffs between Marin and Monterey counties as well as the North and South Farallon Islands, 20 to 40 km offshore of San Francisco (Carter et al. 1992, 2001). A steep decline in the central California population between 1980 and 1986 was attributed primarily to mortality in gill nets and oil spills, including the 1986 *Apex Houston* oil spill (Page et al. 1990; Takekawa et al. 1990; Carter et al. 2001, 2003). Between 1982 and 1986, a colony of about 3,000 breeding murres on Devil's Slide Rock in northern San Mateo County was extirpated. Since 1995, the Common Murre Restoration Project (CMRP) has sought to restore this and other central California colonies using social attraction and other techniques. Social attraction techniques were utilized at Devil's Slide Rock (DSR) beginning in 1996 (Parker et al. 2007). Murres quickly recolonized the rock and reached a 10-year restoration goal of 100 breeding pairs in five years. Social attraction was discontinued following the 2005 breeding season because the colony appeared to be well established (McChesney et al. 2006). Restoration efforts at other colonies in central California have focused mainly on documenting impacts to colonies and working with governmental agencies and the public to reduce human disturbance to the colonies and other impacts to murres such as gill-net mortality.

Since the early 1990s, the central California murre population has shown an increasing trend apparently due to restrictions on gill-net fishing, favorable prey conditions, and other factors (Carter et al. 2001; USFWS, unpubl. data). However, anthropogenic impacts to murres continue to occur and may continue to impact the population. Gill-net mortality continued (Forney et al. 2001) until the California Department of Fish and Game (CDFG) enacted an emergency closure of this gill-net fishery in September 2000 followed by a permanent closure in waters <60 fathoms depth from Point Reyes to Point Arguello in September 2002. Extensive oil pollution (e.g., 1998 *Command* Oil Spill and the series of oil releases from the sunken vessel *S.S. Jacob Luckenbach* from the early 1990s to the early 2000s) continued to kill thousands of murres in central California (Carter 2003; Carter and Golightly 2003; Hampton et al. 2003; Roletto et al. 2003). Disturbances from aircraft and boats have affected colonies as well (Rojek et al. 2007; USFWS, unpubl. data). Although several colonies have increased to levels observed in the early 1980s, others such as DSR and the Castle-Hurricane Colony Complex (CHCC) remain below historic numbers (McChesney et al. 2007; USFWS, unpubl. data). These colonies have been impacted in recent years by human disturbance, avian disturbance (from Brown Pelicans, *Pelecanus occidentalis*, and/or Common Ravens, *Corvus corax*), and poor prey conditions (from 2005 to 2009) that have contributed to reduced breeding success.

The *Command* Oil Spill

After departing San Francisco and bound for Panama on 26 September 1998, the T/V *Command* spilled approximately 3,000 gallons of Intermediate Bunker Fuel (IBF) 380, off the San Francisco and San Mateo county coasts (Command Trustee Council 2004). An estimated 1,490 Common Murres and other seabirds were killed or injured from the spill.

The litigation that resulted from the *Command* spill was settled for $5,518,000, of which $4,007,242 was allocated to restoration of damaged natural resources. The Seabird Colony Protection Program (SCPP), now known as the Seabird Protection Network (SPN), is one of several projects funded by the *Command* Oil Spill Restoration Fund (Command Trustee Council 2004). The goal of SPN is to restore seabird colonies damaged by the spill mainly by reducing human disturbance. The CMRP is conducting the colony surveillance and monitoring component of the SPN. A different component of the program, conducted by the Gulf of the Farallones National Marine Sanctuary, focuses on education, outreach, and other methods that leads to better protection of colonies from human disturbance. Surveillance and monitoring data from the colonies are utilized to guide education and outreach efforts and to assess the success of those efforts.

Colony surveillance and monitoring efforts have been focused at three colonies or colony complexes established as Common Murre restoration or reference sites in 1996 (as part of the *Apex Houston* oil spill restoration plan): Point Reyes (PRH); Devil's Slide Rock & Mainland (DSRM)-San Pedro Rock Colony Complex; and CHCC. Since 2005, less intensive surveys have been conducted at three additional colonies within Drakes Bay: Point Resistance (PRS); Millers Point Rocks (MPR); and Double Point Rocks (DPR). In 2009, surveys also were conducted about twice per week at seabird colonies at the mouth of the Golden Gate: Bird Island (off Point Bonita), Lobos Rock & Land's End, and Seal Rocks. In 2007 at Bird Island and Seal Rocks, Common Murres were recorded for the first time during the breeding season, mainly in July, among colonies of Brandt's Cormorants. Breeding of Common Murres was observed at Bird Island in 2008. Surveys at these colonies in 2009 were conducted by trained volunteers and aimed to document potential murre attendance and breeding at these colonies.

This report summarizes colony surveillance and monitoring efforts conducted at central California nearshore murre colonies in 2009. Similar to other years, data were gathered on aircraft, boat and other disturbances to seabirds, Common Murre seasonal attendance patterns, and reproductive performance. Additionally we recorded Brandt's Cormorant (*Phalacrocorax penicillatus*) relative breeding population size and reproductive performance; and population sizes and/or productivity of Pelagic Cormorants (*P. pelagicus*), Black Oystercatchers (*Haematopus bachmani*), Western Gulls (*Larus occidentalis*), and Pigeon Guillemots (*Cepphus columba*). Common Raven surveys were also conducted near CHCC. For the first year since 1999, adult co-attendance and chick provisioning surveys could not be conducted at DSR because of large-scale breeding failure.

METHODS

Study Sites

We conducted colony surveillance and monitoring at six colonies or colony complexes in 2009 (Figure 1). PRH (Figure 2), PRS, MPR, and DPR (Figure 3) are in the Point Reyes National Seashore, Marin County; the latter three colonies are sometimes grouped into the Point Resistance-Double, or Drakes Bay Colony Complex (DBCC). Colonies at the mouth of the Golden Gate within Golden Gate National Recreation Area included Bird Island, Marin County, as well as Lobos Rock & Lands End and Seal Rocks, San Francisco County (Figure 4). The Devil's Slide Colony Complex (DSCC), San Mateo County, consisted of DSRM and San Pedro Rock (Figure 5). The CHCC in Monterey County consisted of Bench Mark-227X (BM227X), Castle Rocks & Mainland (CRM), and Hurricane Point Rocks (HPR; Figure 6). The offshore rocks of DSCC and CHCC are within the California Coastal National Monument while adjacent mainland areas are privately owned. At each colony, individual rocks and mainland cliffs with nesting seabirds were identified by their recognized subcolony (SC) number, subcolony name, or subarea. In this report, colonies are ordered north to south within each section.

Disturbance

All observed anthropogenic disturbance events affecting murres and other seabirds at study colonies were recorded. Significant non-anthropogenic (e.g., avian) disturbances were also recorded. A disturbance event was defined as an event where adult birds were alarmed or agitated (e.g., head-bobbing in murres, raised head or wing flapping in cormorants), flushed (i.e., birds flew off) or otherwise displaced (i.e., birds moved from breeding or roosting site). The numbers of adults flushed or displaced and the numbers of eggs or chicks exposed, displaced, or depredated were recorded. For anthropogenic disturbances, numbers of disturbance events and numbers of disturbance events per observation hour during the "breeding season" (15 April until cessation of monitoring) were reported for comparisons between sites and years. Monitoring effort was calculated for each colony and colony complex (Table 1). For non-anthropogenic disturbances, we report the species that caused disturbances and summarize major events.

In addition to events causing disturbance, all aircraft flying at or below about 305 m (1,000 feet) ASL (hereafter, "overflight") and boats within about 457 m (1,500 feet) of the nearest seabird breeding or roosting area were recorded to examine use patterns of potential sources of anthropogenic disturbance. Information recorded included: aircraft or boat type, direction of travel, activity, distance from the nearest seabird nesting or roosting area, and aircraft/boat identification number or name (when possible). A rangefinder (Bushnell Yardage Pro 1000) and/or measured distances to known landmarks were used to approximate distances of watercraft from colonies. The elevation of aircraft was estimated using the known observer elevation and the elevations of several other landmarks surrounding the area.

Common Murre Seasonal Attendance Patterns

At each colony, seasonal attendance patterns of Common Murres were monitored from standardized mainland vantage points using 65-130X or 15-60X spotting scopes. Attending murres were counted at each colony, subcolony, or index plot. Details of each index plot are described in CMRP protocols. For each survey, three consecutive counts were performed and a mean was determined, except for some subcolonies at PRH (see below). Seasonal attendance data were collected at all active subcolonies periodically during the pre-breeding season (before 15 April) at DSRM and CHCC and regularly at all colonies throughout the breeding season (15 April until all chicks fledged and adult attendance ceased). Non-breeding season counts were conducted between 0700-1100 h when murres were more likely to be present. Breeding season counts were conducted during a standardized period between 1000-1400 h.

Point Reyes

Seasonal attendance patterns were determined for all murre subcolonies visible from mainland observation sites at least once per week from 21 April to 4 August (Figure 2). Attendance was recorded at established "Type II" index plots (see Birkhead and Nettleship 1980) on Lighthouse (Ledge, Edge, and Dugout plots), Boulder, Flattop, Middle, and Cone Rocks (Figure 2). Counts of index plots were conducted three times and the means calculated. Counts of all visible murres were conducted once per survey at all other subcolonies.

Drakes Bay Colony Complex

Murre attendance was monitored once per week (weather permitting) at PRS, MPR (22 April to 29 July), and DPR (25 April to 25 July; Figure 3). Four index plots (Club, Grotto Ledge, Lower Ledge, and Cup Plots) were used at PRS and five plots (Lower Left, Lower Right, Crack Pot, Pond, and Cliff Plots) on Stormy Stack (DPR) because of the large numbers of murres attending these colonies..

Bird Island, Lobos Rock & Land’s End, Seal Rocks

Murres were first recorded attending Bird Island and Seal Rocks among nesting Brandt’s Cormorants in 2007 (McChesney et al. 2008). In 2008, breeding was documented on Bird Island but no murres were observed on Seal Rocks (McChesney et al. 2009). To continue following these colonization attempts, in 2009 observations were conducted by trained volunteers 2 to 4 times per week at these colonies and nearby Lobos Rock & Land’s End. From 2 May to 30 July 2009, counts were conducted during two time periods: early morning (0700-0900 h) and late morning (1000-1200 h).

Colonies were observed from the same locations as in 2008. The north and south sides of Bird Island were observed from separate locations (McChesney et al. 2009). Lobos Rock & Land’s End was observed from an overlook adjacent to the coastal trail located below the Land’s End parking area on El Camino Del Mar. Counts of Seal Rocks were conducted from three different viewing locations: 1) Upper Sutro, a small bluff north of the historic Sutro Baths for view of subcolony 01; 2) Lower Sutro, downstairs from Upper Sutro for view of the north side of subcolony 02; 3) Cliff House, at the northwest corner of the Cliff House, lower level, for view of subcolony 01 south side, and west side of subcolonies 02. A fourth viewing location that was used in 2008 was not utilized in 2009 and subcolony 03 was not counted.

Devil's Slide Rock & Mainland, San Pedro Rock
"Pre-breeding season" attendance was monitored one to four days per month from 21 November 2008 to 14 April 2009. Breeding season (16 April to 29 July) counts of birds were conducted every other day (weather permitting).

On Devil's Slide Mainland (DSM), attendance patterns were determined once per week for six subareas (Figure 5): April's Finger (SC05); Mainland North (SC07), Upper Mainland South (SC05), Lower Mainland South (SC05), Mainland South Roost (SC05), and Turtlehead (SC05). At Turtlehead, murres attended the same subarea as in 2008, on top of a large boulder a few meters from the north base of Turtlehead proper ("Turtlehead Boulder"; Figure 19). To avoid disturbance to breeding Peregrine Falcons (*Falco peregrinus*), Mainland South and Turtlehead subareas were viewed only from Peregrine Falcon Point (or, "PEFA Pt.") until after falcon breeding activities ceased for the season (about 18 June). After 18 June, observations also were conducted from the Turtlehead Cove overlook. For SPR, bird counts were conducted once per week throughout the breeding season from Pipe Pullout. Locations of all overlooks are described in past CMRP annual reports.

Castle-Hurricane Colony Complex
Seasonal attendance patterns of murres were determined for all active subcolonies visible from mainland vantage points (Figure 6). Counts were conducted twice per week during the breeding season from 17 April to 6 August. At three subcolonies, separate subarea counts also were obtained: CRM-04 (productivity plot and entire rock); CRM-06South (north and south sides); and HPR-02 (Ledge and Hump plots).

Common Murre Productivity

As in prior years, productivity of Common Murres was monitored at PRH, DSRM, and CRM at least every two to three days (weather permitting) from standardized mainland vantage points using either 65-130x or 15-60x spotting scopes. At PRH and CRM, locations of returning or new breeding and territorial sites were identified using maps and photographs updated from the 2008 breeding season. At DSR, all sites were mapped and numbered using GIS maps and aerial photographs from previous years. A breeding site was defined as a site where an egg was observed or inferred based on adult behaviors. A territorial site was defined as a location with attendance greater than or equal to 15% of monitored days but where an egg was not observed or inferred based on adult behaviors. Some territorial sites likely were breeding sites where eggs were lost at or shortly after laying without our detection. A sporadic site was defined as a location attended on at least two days but on less than 15% of monitored days. Many possible sporadic sites were not identified because of frequent movement by visiting birds. Chicks were considered to have fledged if they survived to at least 15 days of age and were not known to perish afterwards. Results from 2009 were compared to previous long-term weighted means: DSR and CRM 1996-2008 (n = 13 years); and PRH, 1996-2002 and 2005-2008 (n = 11 years). All long-term means are reported as Mean ± Standard Error (SE).

Point Reyes
Murre productivity was monitored at PRH within two established Type I plots on Lighthouse

Rock (LHR). Ledge Plot and Edge Plot were located within the center and on the edge of the colony, respectively. All active sites in the plots were monitored beginning 20 April.

Devil's Slide Rock and Mainland

Due to widespread colony growth and increasing difficulty monitoring the entire colony, three Type I plots (A, B and C) were established on DSR in 2006 (McChesney et al. 2006; Figure 7). Boundary adjustments were made to plots A and C in 2007 and the same plots (A, B, and C) were utilized for monitoring in 2008 and 2009. At DSM, all visible sites were monitored within each of three active subareas: Upper Mainland South, Lower Mainland South, and Turtlehead Boulder (Figure 5). All active sites in plots were monitored beginning 20 April.

Castle/Hurricane Colony Complex

All active murre nesting sites were monitored within a productivity plot on CRM-04 (established in 1996) beginning 19 April. The ephemeral subcolony CRM-03East hosted breeding murres this season for the second time since 2005. All active sites on that rock were monitored beginning 24 April.

Common Murre Co-attendance and Chick Provisioning

Due to extensive breeding failure, co-attendance and chick provisioning observations were not conducted at DSR in 2009.

Nest Surveys

To assess relative breeding population sizes, nest and bird counts of all seabird species (except murres) were conducted weekly during the breeding season at all colonies. For Brandt's Cormorants, nest and territorial sites were counted. Nests and territorial sites were classified into five groups that roughly described nesting stages: 1) site with little or no nesting material; 2) poorly built nest; 3) fairly built nest; 4) well-built nest; and 5) nests with brooded chicks. In addition, large, wandering cormorant chicks were counted. See McChesney et al. (2007) for more detailed descriptions of nest categories.

To provide more complete colony coverage, nest surveys from mainland vantage points were augmented with boat surveys conducted at CHCC on 30 May, DSCC (from SPR to Pillar Point) on 31 May, and PRH and DBCC on 13 June. Boat surveys were conducted to survey areas not visible from mainland vantage points. The land nest count is the sum of high seasonal nest counts (well-built nests and nests brooding chicks) at each subcolony or subarea. The boat nest count is the total number of nests counted during the boat survey, although boat counts often included only nests that could not be seen from mainland vantage points. Combined counts include the highest count of the two survey methods for each subcolony/subarea, plus any nests known to be visible only with one method. Comparisons to 2008 are made between total counts (when available) or land counts only (where no boat survey was conducted in 2008).

Brandt's Cormorant Productivity

Breeding phenology and reproductive success (clutch sizes, brood sizes and chicks fledged per pair) of Brandt's Cormorants were monitored at PRH, DSRM, and CHCC. At PRH, Brandt's Cormorants were monitored at Pebble Point (PRH-05C), Arch Rock (PRH-11D), Spine and Wishbone Points (PRH-11E), and Border Rock (PRH-14C; Figure 2). At DSRM, monitoring was conducted at Devil's Slide Rock (DSR-01) and Upper Mainland South (DSRM-05A-Upper; Figure 5). At CHCC, monitoring was conducted at CRM-06South (south side; Figure 6).

Monitored nests were examined every 2-7 days from mainland vantage points using binoculars and spotting scopes. Chicks were considered to have fledged if they survived to at least 30 days of age. After that age, chicks begin to wander from their nests and become impossible to associate with specific nests without marking (Carter and Hobson 1988, McChesney 1997). Results from 2009 were compared to prior long-term weighted means for DSRM (1997-2007; n = 11 years), CHCC (1997-2001, 2006-2008; n = 8 years) and PRH (1997-2001,(2006-2008; n = 8 years). All long-term means are reported as Mean ± Standard Error (SE).

Pelagic Cormorant, Black Oystercatcher, and Western Gull Productivity

Productivity (chicks fledged per pair) of Pelagic Cormorants, Western Gulls and Black Oystercatchers was determined at select nests that were easily visible from mainland vantage points at PRH, MPR, DPR, DSRM, and CHCC. Nests were examined at least once per week. Chicks were considered to have fledged if they survived to at least 30 days of age and were not known to perish afterwards.

Pigeon Guillemot Surveys

To assess population status and seasonal attendance patterns, weekly standardized counts were conducted of birds rafting on the water and roosting on land (intertidal and nesting areas) at PRH, DSCC, and CHCC. Surveys were conducted twice per week from mid-April to 5 May, when numbers often peak, and approximately once per week thereafter, between one-half hour after sunrise and 0830 h. Because of the large size of the PRH colony area, weekly counts there were conducted from just one location (Lighthouse) although a single survey of the entire PRH colony was conducted on 17 May. At DSCC, the entire area from the south side of San Pedro Rock to the south end of the DSRM colony boundary was surveyed. At CHCC, the entire area from Rocky Point to the south end of the HPR colony boundary was surveyed. Guillemots were also counted upon arrival (range 0920-1400 h) for weekly colony surveys at PRS, MPR, and DPR. Additionally, Pigeon Guillemots were counted during boat surveys of colonies.

Common Raven Surveys – Big Sur

Common Raven surveys were conducted to assess relative distribution and abundance near CHCC. Surveys were conducted while driving approximately 60 km/hr along a 26.4 km stretch of California State Highway 1 between Point Lobos and Point Sur. Two morning (before 0900 h) and two afternoon (after 1200 h) surveys were conducted weekly from 19 April to 29 July. Morning surveys traveled south from Point Lobos, while afternoon surveys traveled north from Point Sur. Each individual raven observed was considered a "detection". Locations were recorded on a DeLorme Earthmate PN-20 GPS unit and plotted on National Geographic Topo mapping software. For comparisons to previous years, the number of raven detections per km and number of raven detections per survey were calculated for the entire survey route and also for two sections of the survey area: 1) a 17.1 km segment from Point Lobos to Castle Pullout (Bixby Landing); and 2) a 9.3 km segment from Castle Pullout to Point Sur. The distances for the above sections were updated slightly from the 2008 season.

RESULTS

Anthropogenic Disturbance

A total of 276 aircraft overflights, including 223 (81%) planes and 53 (19%) helicopters, were recorded at PRH, DBCC, DSCC, and CHCC in 2009 (Table 2). Overall, 100 (36%) aircraft overflights caused some form of disturbance (i.e., agitation, displacement, and/or flushing; see Methods). Thirty-four percent (n = 75) of all planes and 47% (n = 25) of all helicopters resulted in disturbance. Three percent (n = 9) of overflights caused birds to flush. Two percent (n = 5) of all planes and 8% (n = 4) of all helicopters resulted in flushing. Unmarked, "other" aircraft (i.e., private or charter) were the most commonly observed planes and helicopters and also caused the most disturbances (Figure 8). The next most common source of aircraft disturbance was from U.S. Coast Guard planes (n =1) and helicopters (n = 10), including one flushing event.

Eighty-eight watercraft were observed at all colonies in 2009 (Table 3). The majority were recreational small private boats (64%) followed by kayaks (23%; Figure 9). Twenty-seven watercraft (31%) caused some form of seabird disturbance, including 20 (23%) that caused flushing. Fifteen (56%) recreational small private boats and 11 (41%) kayaks were responsible for nearly all disturbances. However, kayaks caused a greater percentage of disturbances: 55% (n = 11) of all kayaks caused a disturbance.

Point Reyes

Nine aircraft overflights (0.024/hr; including 7 planes and 2 helicopters) and 10 boat observations (0.027/hr) were documented at PRH in 2009 (Tables 4, 5; Appendixes 1, 2). Most observations of watercraft were small recreational boats fishing off the headlands. The peak boating period occurred during calm sea conditions during the July 4th holiday weekend. However, none of the boats caused noticeable disturbance.

Two aircraft disturbances occurred at Point Reyes; both were caused by US Coast Guard aircraft. One US Coast Guard helicopter overflight (0.003/hr), representing 1.1% of all overflights and 50% of helicopter overflights was flying 91 m (300 ft) ASL and 100 m horizontally from Lighthouse Rock when it caused murres to headbob. One plane (0.003/hr), a U.S. Coast Guard C-130, flushed 30 murres when it flew about 122 m (400 ft) ASL and 500 m from Lighthouse

Rock. In addition, during our colony-wide survey from a small inflatable boat on 16 June, 646 roosting Brandt's Cormorants were flushed during three disturbance events when we approached within 100 m of roosting rocks (46 flushed from PRH-02, 200 from PRH-19, and 400 from PRH-22).

Compared to 2008, the combined aircraft and boat activity rate (0.051/hr) declined 27%. The numbers of planes observed declined 27%, boats declined 33%, but helicopters increased 32%.

Drakes Bay Colony Complex
At DBCC, the combined aircraft and boat observation rate (0.239/hr) increased 102% from 2008 (0.117/hr). Planes increased 131%, helicopters increased 91%, and boats increased 74% compared to 2008.

Point Resistance – During standardized monitoring in 2009, there were three aircraft overflights (0.250/hr), all were the CMRP aerial survey plane which caused no discernable disturbance. No boats were observed (Table 6, Appendix 3). This compares to a rate of 0.049/hr for aircraft (one helicopter) and boats (none) in 2008.

Millers Point Rocks - There was one aircraft (helicopter; 0.030/hr), no boats, and no disturbances recorded in 2009 (Table 7, Appendix 4). No aircraft or boats were observed in 2008.

Double Point Rocks – A total of ten aircraft overflights (0.197/hr; 9 planes, 1 helicopter) and nine boat observations were recorded at DPR in 2009 (0.178/hr; Table 8; Appendixes 5, 6). Four overflights (one helicopter and three planes) caused some form of disturbance. The most severe disturbance occurred on 9 May when a loud prop plane, flying 213 m (700 ft) ASL and 50 m from Stormy Stack flushed 300 murres. On 23 May there was a low cloud ceiling of 213 m (700 ft) and a US Coast Guard helicopter flushed 5 murres while transiting 91 m (300 ft) ASL and 200 m from Stormy Stack. In addition, two separate incidents of a prop plane flying below 274 m (900 ft) and within 200 m from Stormy Stack caused murres to headbob. None of the boats observed at DPR caused discernable disturbance. This compares to observation rates of 0.102 aircraft/hr (planes) and 0.082 boats/hr in 2008, when one disturbance (boat; 0.020/hr) was observed.

Devil's Slide Rock and Mainland, San Pedro Rock
At DSR, 205 aircraft overflights (0.446/hr; including 164 planes and 41 helicopters) and 31 boat observations (0.068/hr) were documented in 2009 (Tables 9, 10; Appendixes 7, 8). Eight aircraft overflights (3.9%) resulted from the annual aerial photographic survey of the colony. Thirty-six (17.6%) aircraft overflights were recorded on 26 April 2009 during the Pacific Coast Dream Machines event at the Half Moon Bay Airport.

A total of 84 (41%) aircraft overflights caused some form of disturbance, including 64 by planes (39% of planes) and 20 by helicopters (49% of helicopters). Twenty boat observations (65%) caused disturbance. Five (2%) overflights and fifteen (48%) boat observations caused flushing or displacement of one or more seabirds, mainly Brandt's Cormorants and Common Murres. Low-flying (i.e., <305 m or 1,000 ft) planes accounted for 60% of aircraft flushing events.

The most severe disturbance caused by aircraft was a military helicopter flying at approximately 91 m (300 ft) ASL on 23 June that flushed 20 murres and eight Brandt's Cormorants from DSR; none of these birds were observed to return after the disturbance. Most vessel disturbances were caused by private recreational boats that were fishing in close proximity (range = 5–75 m) to DSR. All flushing events caused by vessels occurred over two weekend periods, which were accompanied by calm ocean conditions and little wind. Five flushing events occurred on 13-14 June, the first two days of the recreational rockfish season. An additional five flushing events occurred on 3-4 July during the holiday weekend which caused a large number of murres (range = 11-72) and Brandt's Cormorants (range = 1-50) to flush. Another five flushing events resulted from kayakers transiting within 50 to 200 m on west or east side of DSR.

The combined aircraft and boat observation rate was similar to 2008. Aircraft overflights declined by 5%, including a 9% decline in planes and a 19% increase in helicopters. The boat observation rate increased 21% from 2008 (Figure 10). In general, disturbance rates at DSRM have been increasing since disturbance monitoring became more standardized in 2001 (Figure 11). The overall disturbance rate (0.231/hr) and flush/displacement rate (0.044/hr) in 2009 increased 8% and 25% from 2008, respectively. Boat disturbance rates also increased 56% overall and 72% for flushing/displacement events.

Castle-Hurricane Colony Complex
A total of 37 aircraft (0.115/hr; including 33 planes and four helicopters) overflights and 25 boat observations (0.078/hr) were recorded at CHCC in 2009 (Tables 11, 12; Appendixes 9, 10). Twenty (54%) aircraft overflights were recorded during the annual aerial seabird colony survey.

Three (8%) overflights (0.01/hr) caused some level of disturbance, including one by a plane (3% of planes) and two by helicopters (50% of helicopters). On 17 April, one helicopter flying 152 m (500 ft) ASL over Castle Rocks & Mainland caused 20 and 35 murres to flush from CRM-02 and CRM-04, respectively. One boat that approached within 15 m of CRM-04 caused murres to headbob.

Aircraft overflight and boat observation rates (combined) increased 55% from 2008 due to an 83% and 79% increase in plane and boat observation rates, respectively (Figure 10). There was a 50% decrease in helicopter rate from 2008. Although observation rates increased in 2009, disturbance rates decreased. The overall disturbance rate decreased 79% from 2008, including an 86% decrease in the flushing/displacement rate.

Non-Anthropogenic Disturbance

Point Reyes
Of 13 recorded disturbance events at PRH, 8 resulted in displacement. Two disturbance events resulted in flushing and three agitation events were recorded. Eight disturbances (62%) were caused by California sea lions and three events (23%) by Common Ravens. Additionally, one disturbance was caused by Brown Pelicans and one by a Western Gull. All events impacted murres only.
California sea lions were present in unusually high numbers throughout the season. Several sea

lions climbed high up on murre breeding rocks, flushing and displacing murres, many of which left their eggs exposed. Most sea lions were immature and many appeared emaciated. Seven disturbances (affecting 50 to 4000 murres) by sea lions were observed on Lighthouse Rock between 17 May and 26 June. The largest of these occurred on 29 May when one sea lion flushed 4000 murres and exposed at least 236 eggs on Lighthouse Rock. One disturbance was also observed on Cone Rock in which 50 murres were flushed and 12 eggs were exposed. One raven and 5 gulls appeared after the disturbance began, but it was unknown if any eggs were damaged. This sea lion had an orange flipper tag. The Marine Mammal Center tags rehabilitated sea lions with orange tags before release.

Ravens commonly cause disturbances at PRH, but unlike most years, in 2009 they were not observed initiating disturbances. Only three raven disturbances (one each on Lighthouse, Face, and Cone Rocks) were observed during the breeding season. On 2 June, a raven took a murre egg that was likely abandoned during a prior sea lion disturbance at Cone Rock.

Drakes Bay Colony Complex

Point Resistance – All non-anthropogenic disturbances observed at PRS were avian (two by Common Ravens and one by a Brown Pelican). However, one California sea lion was observed on top of PRS on 17 June, the last day murres were observed on the rock in 2009. The 13 Western Gulls observed scavenging murre eggs that same day suggests that this sea lion may have flushed an unknown number of murres from their breeding sites prior to our arrival.

Millers Point Rocks – Only one disturbance (by Common Ravens) was observed in 2009. Two ravens took a Brandt's Cormorant egg from an unattended nest, mildly agitating neighboring cormorants. Additionally, a few raven-depredated murre eggs were recorded on the mainland at Millers Point.

Double Point Rocks – Two Common Raven flushing events were recorded at Stormy Stack (both on 9 May). One murre egg was taken by a Western Gull after the murres had flushed. California sea lions were observed frequently on this rock; however no flushing or displacement events were observed directly. Sea lions were seen regularly (April through July) in murre breeding areas and just below nesting murres on the left side of the rock. On 20 June, a sea lion was observed in Lower Left Plot surrounded by many abandoned eggs. On 27 June, 26 sea lions were counted on the main part of Stormy Stack where murres breed, and an additional 23 sea lions were counted on the lower roost area on the north side of the rock. Also on 27 June there was one sea lion observed walking through Lower Right Plot. Additionally, a sea lion was seen on 18 July above Cliff Plot. Many additional sea lion disturbances likely occurred when observers were not present.

Devil's Slide Rock and Mainland

Of 40 recorded disturbance events at DSRM, 26 resulted in flushing. Displacement (n = 13), and agitation (n = 1) events also occurred. Brown Pelicans were responsible for 22 disturbances to murres on DSR and one on Lower Mainland South. Murres flushed as pelicans tried to land or walked through the colony. On average, 20 ± 4 murres were flushed or displaced during each event (range = 1-75), with the majority of disturbances occurring on the east side of DSR. The most severe disturbance occurred on 30 May when a group of pelicans flew over DSR and one landed, causing 75 murres and one cormorant to flush; no eggs were lost. One event resulted in a murre abandoning its egg after it was flushed.

As a result of high abandonment rates, Western Gulls, Heermann's Gulls (*Larus heermanni*), and Common Ravens were observed scavenging DSR for abandoned murre eggs on several occasions. Five of these events caused murres and/or cormorants to flush or displace. Additionally, a Western Gull was recorded taking an egg from an incubating murre on 13 May. Western Gulls were also observed stalking murre chicks and were recorded taking and eating chicks on three occasions. In at least one instance the chick was not attended by the parent bird but was being "babysat" by another adult murre. Gull predation on murre chicks occurred on 5 July and 12 July when murre attendance was very low and adult murres could not defend the chick. One murre egg loss occurred when a roosting Brandt's Cormorant jabbed at a murre, causing the murre to be displaced and the egg to roll off a ledge. One Common Raven was observed taking an abandoned murre egg on two separate occasions (both events occurred on 6 June). This was the first year that ravens have been observed scavenging or depredating eggs on DSR.

Nesting Peregrine Falcons caused two murre flushing events on Lower Mainland South. One flushing event was caused when a falcon flew directly over the murre colony and one event occurred during an aerial food exchange between an adult female and her fledglings. A falcon also caused a pair of Black Oystercatchers to displace when it landed next to their nest.

Castle-Hurricane Colony Complex
Four Brown Pelican flushing events were recorded in 2009. All of these events were caused by flocks of pelicans flying over or close to murre subcolonies. In addition to documented disturbance events, pelicans were also recorded roosting within murre subcolonies. Roosting pelicans were in mixed age groups (adults, subadults and immatures) and occurred in groups ranging 11-44 birds. High numbers of pelicans (267 birds) were observed roosting on the edge of HPR-02-Ledge murre subcolony during the CHCC boat survey on 30 May, suggesting a possible major disturbance event. Pelican disturbances and observations took place during the murre incubation period (late April to late May). Additional documentation of an exposed murre egg and broken eggshells near roosting pelicans on CRM-02 (16 May) and HPR-02 (28 May) indicated that murre egg loss likely occurred. Murres attended these areas late into July, well beyond other subcolonies, suggesting that egg loss (possibly from pelican disturbance) may have resulted in a large number of murre second clutches.

Brown pelican disturbance in 2009 was similar to levels in 2008, but much lower than in previous years. Large-scale disturbance to murres caused by single juvenile pelicans resulted in near complete breeding failure at CRM in 2004-2007 and at HPR in 2007.

Western Gulls caused no direct disturbance in 2009 but were occasionally observed entering colonies to scavenge abandoned eggs of both murres and Brandt's Cormorants. Gulls were observed taking abandoned murre eggs on CRM-03East and CRM-02 and abandoned cormorant eggs on CRM-06South (south side).

Common Murre Seasonal Attendance Patterns

Point Reyes

Breeding was observed at all well-established nesting areas in 2009. Attendance patterns for Lighthouse, Boulder, and Cone rocks were fairly typical with highest counts in late April and low variability during most of the incubation and brooding periods (mid-May to mid-July; Figures 13, 14). At Beach Rock, however, murres were not observed attending until 12 May. Regular attendance there from late May to late July suggested delayed breeding. Attendance was more sporadic at the Aalge Ledge "club", where no breeding was documented in 2009. At Cone Plot, Beach Rock, and Aalge Ledge, attendance declined in mid-June then increased in late June-early July. In 2009, murres attended established breeding areas only (with the exception of the regularly attended Aalge Ledge club). In most years, murres prospect or attempt breeding at up to several ephemerally used subcolonies.

For most breeding areas, attendance started to decline during the late hatching period in mid-July as nests failed and chicks began to depart with their fathers. By the last survey on 4 August, only one bird with a late stage chick remained on Lighthouse Rock.

Drakes Bay Colony Complex

Point Resistance – A delayed onset for attendance was followed by lower numbers of birds than in other recent years (Figure 15). Murres were not observed attending PRS until early May. Attendance dropped sharply in mid-June when a California sea lion was found hauled-out on top of the rock and several gulls were scavenging abandoned murre eggs (see Non-anthropogenic Disturbance, above). By 24 June, the rock was abandoned for the season with no successful breeding.

Millers Point Rocks – At the North Rock (MPR-01), murres attended sporadically from at least late April to early July (Figure 15). Very little murre attendance was recorded at the larger South Rock (MPR-02) and Blue Cheese (MPR-05). The only evidence of breeding was from a few raven-depredated murre eggs found on the mainland at Millers Point.

Double Point Rocks - Attendance at Stormy Stack was lower than in 2008 (Figure 15). Very few murres (< 80 murres) were present on the first survey on 25 April, suggesting a late onset of attendance and breeding. Numbers declined through the month of June, with no birds present in plots on 27 June. Many sea lions were hauled-out on the rock on 27 June and only 100 murres were counted (see Non-anthropogenic Disturbance, above). Murre numbers increased slightly on 6 July and then declined steadily until no birds were observed on the rock on 25 July. In July the decrease of murres was accompanied by an increase in sea lions on the rock. Very low attendance on the upper, north portion of the rock indicated that successful breeding was not likely. Some successful breeding may have occurred on the lower, south side of the rock where murres bred alongside Brandt's Cormorants, but no murre chicks were observed. On Double Point North Rock (DPR-03) murres were only observed on 6 July (n = 2).

Bird Island, Lobos Rock and Land's End, and Seal Rocks

Bird Island –A total of 42 counts were conducted of Bird Island. Murres were observed on Bird Island on 19 May (early morning; 124 birds), 11 June (1 bird), and 17 June (mid-morning; 67

birds). Presence of murres coincided with the highest Brandt's Cormorant counts (1559 birds on 19 May and 85 birds on 17 June). In addition, hundreds of murres were observed on the water, flying around and circling Bird Island on five mornings in May. No murre breeding occurred on Bird Island in 2009.

Seal Rocks, Lobos Rock & Land's End –A total of 52 counts were conducted of these two colonies. Two murres were observed landing briefly on Seal Rocks subcolony 01 on 15 May at 1040 h. On 19 May approximately 80 murres were observed flying and on the water near Seal Rocks but none landed. At Lobos Rock & Land's End, one murre was observed alone on the nearshore rock (subcolony 06), at 1000 h on 12 May. This is the first record of murres occurring at this seabird colony.

Devil's Slide Rock and Mainland, San Pedro Rock

Devil's Slide Rock - Murres were observed on all count days between 21 November 2008 and 12 July 2009 (Figure 16). The greatest counts were recorded during the late pre-egg laying period. The maximum count of 1,003 murres (6 May) was the highest recorded since CMRP monitoring began in 1996 (previous high, 961 on 11 May 2008). Murre counts were extremely variable prior to the start of egg laying. A brief period of less variable attendance occurred around the mean egg lay date (28 May), but then declined in June as nests began to fail and eggs were abandoned. An increase in attendance between mid- and late June during the hatching period was followed by a sharp decline in early July as chicks perished. Murres stopped attending DSR after 12 July when all breeding activity ceased. Average murre counts were similar to 2008; however annual attendance ceased about one month earlier than in previous years. The count from the annual aerial photographic survey on 8 June 2009 was 403 murres (Figure 17). This was similar to the count conducted from land one hour after the aerial survey (410 murres counted from land).

Devil's Slide Mainland - Common Murres were observed in the same areas as in 2008 on Lower Mainland South, Upper Mainland South, and Turtlehead Boulder. Attendance was most consistent from late April to late May (late pre-egg laying to peak egg laying) then declined in June as breeding sites failed (Figure 18). High counts were: Lower Mainland South, 58 murres (20 May); Upper Mainland South, 45 murres (29 April); and Turtlehead Boulder, 46 murres (6 May). The greatest combined single day count for all subareas was 141 murres on 6 May. Overall attendance on the mainland was much lower than in 2008, reflecting the reduced number of breeding sites. Lower Mainland South average counts for the breeding season were 50% lower than in 2008, while Upper Mainland South and Turtlehead counts increased slightly. Changes in attendance reflected changes in numbers of observed breeding sites (see Common Murre Productivity). Dates that murres stopped attending the mainland coincided with the cessation of breeding activity in each subarea. All subareas were vacated for the season by the end of June.

San Pedro Rock - Murres were not observed on San Pedro Rock in 2009.

Castle/Hurricane Colony Complex

Most CHCC subcolonies displayed one of two general patterns: 1) peaks in attendance in mid- to late April and late June, relatively consistent attendance from early May to mid-June, and rapid decline in early to mid-July (e.g., CRM-03West, CRM-04, CRM-05 and CRM-07); or 2) peaks in attendance in mid- to late April or mid- to late July, relatively consistent attendance from early May to mid-July, and rapid decline in late July (e.g, CRM-02, CRM-06, HPR-01 and HPR-02; Figures 20-22). Cessation of attendance was highly variable, with attendance ceasing at some subcolonies as early as 3 June while others had adults and chicks attending as late as 29 July. All attendance had ceased by 6 August. Differences in attendance may have been associated with loss of many first clutches early in the incubation period at certain subcolonies, possibly because of pelican disturbance, followed by the laying of many second clutches. Success of these sites would have had breeding at least into late July. However, poor breeding success at certain subcolonies may also have resulted in earlier seasonal departure by many birds. Both of these scenarios may have contributed to these different patterns. Pelicans were observed roosting on CRM-02 and HPR-02 in late May or early June, where they were suspected of causing disturbance to breeding murres (see Non-anthropogenic Disturbance, above).

Breeding was observed at all attended subcolonies except BM227X-02 and CRM-06South (Northside). In addition, murres were recorded on the cliff ledges of Funt Cove (CRM-06North) on the boat survey. Unlike the two previous years, murres were not observed attending the mainland of BM227X (subcolony 03) in 2009. Only sporadic attendance in May occurred at BM227X-02 (Esselen Rock); no birds were seen in incubation posture and breeding was unlikely. Colony departure from CRM-03East in early June resulted from complete breeding failure early in the incubation period.

Common Murre Productivity

Point Reyes

A total of 150 sites were monitored between Ledge (n = 87; 58.0%) and Edge (n = 63; 42.0%) plots on Lighthouse Rock. In Ledge Plot, 70 (80.5%) sites were egg-laying and 17 (19.5%) were territorial. There was a 9% increase in the number of breeding sites from 2008. The mean egg lay date for first eggs in Ledge Plot was 30 May (range = 16 May-11 June; n = 61; Table 13), eight days later than the long-term average. The number of chicks fledged per breeding pair was 0.23, which was 63.5% lower than the long-term mean (0.63 ± 0.08; Figure 23).

In Edge Plot, 48 (76.2%) sites were breeding, 11 (17.5%) sites were territorial, and four (6.3%) were sporadic. The number of breeding sites was similar to 2008. The mean egg lay date for first eggs in Edge Plot was the same as the long-term mean of 27 May (range = 19 May-2 June; n = 33; Table 13). The number of chicks fledged per breeding pair was 0.34, which was 34.6% lower than the long-term mean (0.52 ± 0.07).

When Edge and Ledge plots are combined, the mean egg-laying date was 29 May (range = 16 May-11 June; n = 94), five days later than the long-term mean. No replacement eggs were laid in either plot. Overall productivity of 0.27 chicks fledged per pair was 55.0% lower than the long-term average (0.60 ± 0.07). This was mainly due to very low hatching success (35%). Fledged chicks remained on the rock for an average of 25 days and 28 days in Ledge and Edge plots, respectively. The last chicks observed in Edge and Ledge plots were seen on 2 August.

Devil's Slide Rock and Mainland
Of 210 sites documented within DSR plots, 153 (72.9%) were breeding, 45 (21.4%) were territorial, and 12 (5.7%) were sporadic. There was an 11% increase in the number of breeding sites from 2008. At all sites combined, the mean egg-laying date of first eggs was 28 May (range = 12 May-27 June, n = 124; Table 13), three days later than the long-term average. Eleven replacement eggs were laid. Hatching success was extremely low (5.6%), and for the first year since the DSR colony was restored in 1996, no chicks successfully fledged (Figure 23). Seven of the eleven chicks (64%) that hatched were documented as being unattended and/or being brooded by a neighboring adult. Three unattended chicks were observed being attacked by a Western Gull and two of these chicks were taken and eaten by the gull (see Non-anthropogenic Disturbance, above). Only three chicks survived for longer than seven days, and the last chick was observed on 11 July.
On DSM, breeding murres were documented for the fifth consecutive year on the Lower Mainland South subarea. This was the second consecutive year breeding was observed on Upper Mainland South and on Turtlehead Boulder; Figure 19). Brandt's Cormorants also nested in these areas in previous years but not in 2009.

Breeding sites on DSM decreased 52% from 2008. Of 99 total sites monitored in the three subareas, 32 (32.3%) were breeding, 54 (55.5%) were territorial, and 13 (13.1%) were sporadically attended. The mean egg-laying date was 29 May (range = 17 May-8 June, n = 24; Table 13). There were no replacement eggs recorded. Most eggs were abandoned or disappeared and no eggs hatched. Murres stopped attending mainland subareas after all breeding failed (range = 5-30 June).

Castle-Hurricane Colony Complex
Of 120 monitored sites in the CRM-04 plot in 2009, 78 (65.0%) were egg-laying and 41 (34.2%) were territorial (Table 13). The number of breeding sites decreased 6% from 2008. The first eggs in the plot were observed on 29 April. The mean egg-laying date of 10 May (range = 28 April-9 June; n = 55) was 6 days earlier than the long-term average. There were nine replacement eggs laid. Productivity in the plot was not dramatically reduced by disturbances from Brown Pelicans as in certain previous years (2004-2007). Lower than average hatching success (51.7%) and fledging success (60.0%) led to overall productivity of 0.35 chicks per pair for CRM-04, 26% lower than the long-term average (0.47 ± 0.07 chicks per pair; Figure 23).

For the second consecutive year, murres bred on CRM-03East; murres failed to breed on this rock after raven disturbance and predation caused major breeding failures in 2003-2004. Of the 69 sites monitored on CRM-03East, 25 (36%) were breeding, 20 (29%) were territorial and 11 (16%) were sporadic. The number of breeding sites decreased 30% from 2008. The majority of egg-laying pairs on CRM-03East lost eggs within 1-2 days of laying; therefore several sites classified as territorial may have laid and subsequently lost eggs on days between monitoring. The first egg was observed on 6 May and the mean egg lay date was 16 May (range = 6 May-3 June; n= 22; Table 13). Four replacement clutches were laid. No eggs hatched on in 2009 due to widespread abandonment. Murres were not recorded attending the subcolony after breeding activity ceased. The long-term mean for productivity on CRM-03East was 0.49 ± 0.09 chicks per pair.

Brandt's Cormorant Nest Surveys and Productivity

Point Reyes

Nest surveys - Brandt's Cormorant nest surveys were conducted from 21 April to 4 August (Figure 24). In 2009, cormorants had a reduced nesting effort with a delayed egg laying period. Well-built nests were recorded at Pebble Point (PRH-05C), Slide (PRH-06B), Hooves (PRH-07A), Arch Rock (PRH-11D), Spine Point (PRH-11-E), and Wishbone Point (PRH-11-E).

Few cormorants were present before nest initiations began. Nest building was first observed on 8 May and the first egg was recorded on 12 May. The peak total count of 195 well-built nests on 16 June (Table 15) was 63% higher than the peak of 120 nests in 2008 but 69% below the peak of 628 nests in 2007. One dead cormorant was observed on a roosting rock at the headlands during the cormorant mortality event that occurred along the central California coast from mid-April to mid-May.

Productivity - A total of 110 nests were monitored at six subareas (Table 14). All clearly visible egg laying sites were monitored on Arch Rock (PRH-11D), Spine Point (PRH-11E) Wishbone Point (PRH-11E), a small islet off Sloppy Joe (PRH-11-Islet), and Border Rock (PRH-14C) as well as a sample of nests at Pebble Point (PRH-05C) that were initiated later in the season (mid-June). Many nest builders at Pebble Point never laid eggs and all nests at this site were abandoned in early July, possibly due to a predation event.

Breeding phenology and success varied between subareas. For all subareas combined, the average clutch initiation date of 31 May (range = 12 May-30 June; n = 107; Table 14) was 16 days later than the long-term mean (15 May). Clutch sizes averaged 2.8 eggs and two replacement clutches were recorded (one on Pebble Point and one on Wishbone Point). Overall productivity of 1.06 chicks fledged per pair (subarea range = 0.0-1.69) was 43.9% lower than the long-term average of 1.89 ± 0.2 (Figure 25). Breeding success per nest of 0.63 indicates a relatively high rate of nest abandonment.

Drakes Bay Colony Complex

Nest surveys – One well-built nest was seen at PRS on 26 May in 2009 (Table 15). Subsequently, a few partially built nests appeared but then disappeared. Two poorly built nests was recorded on 10 June. At MPR, the first well-built nests were observed on 22 April at Millers Point North Rock (MPR-01; Figure 24). The peak count of 36 well-built nests on 3 June was 227% higher than the high count of 11 nests in 2008 at MPR. All well-built nests observed in 2009 were on MPR-01, which had no nests in 2008.

At DPR, Brandt's Cormorants nested on Stormy Stack. The first well-built nests were recorded on 25 April. The peak count of 48 nests on 6 June was 26% higher than the peak count of 38 nests in 2008. Two dead cormorants were observed at DBCC (one at MPR-01 and one at DPR-03) during the first week of May that coincided with the cormorant mortality event.

Bird Island, Lobos Rock & Land's End, Seal Rocks

Nest surveys - At Lobos Rock & Land's End, cormorants bred only on the nearshore rock (subcolony 06). Nesting activity began on 15 May. A high count of 19 birds with partially built nests was recorded on 24 May and the first egg was observed on 26 May. The number of nests decreased to four by 1 June. There was an increase in nest-building in June but many nests quickly disappeared. Eight nests remained by 10 July and 12 chicks (all older than 20 days old) were recorded on 30 July. Brandt's Cormorants did not breed at Bird Island or on Seal Rocks colony in 2009. Although Bird Island often is a major roost site, cormorants were only observed on 62% of all surveys.

Twenty-four dead cormorants were recorded in the first two weeks of May during the cormorant mortality event that occurred along the central California coast. Fifteen dead birds were documented at Lobos Rock & Land's End, four dead birds at Seal Rocks, and five dead birds at Bird Island.

Devil's Slide Rock and Mainland, San Pedro Rock

Nest surveys –Nest and territorial sites were counted at all nesting areas between 21 April and 29 July (Figure 26). Similar to 2008, Brandt's Cormorants had a delayed and reduced nesting effort in 2009. Nesting occurred only at Devil's Slide Rock (DSR-01) and Upper Mainland South (DSR-05A-Upper). Territorial sites were first recorded on 29 April, but numbers of displaying birds declined during the first two weeks of May. During the same time period, three dead cormorants were observed on the rocks or in the water at DSRM, consistent with other reports of dead and dying cormorants along the central California coast. The first well-built nests were recorded on 26 May. However, most nests were abandoned within a few days and peak counts of well-built nests (n = 7) for all subcolonies were recorded on 2 June. This is 91% lower than the 2008 peak count of 77 well-built nests and 98% lower than the 2007 peak count of 322. Only four nests (all on Upper Mainland South) remained until hatching.

Productivity – A total of 18 nests were monitored at DSR and Upper Mainland South. All five egg-laying nests on DSR failed before clutches were complete. The mean clutch initiation date of 28 May (range = 24 May-3 June; n = 5) was three weeks later than the long-term mean (6 May). Lay dates, clutch sizes, and numbers of chicks hatched could not be determined for monitored nests at Upper Mainland South due to inadequate viewing conditions. No replacement clutches were recorded for these nests and only one nest fledged chicks. Overall productivity of 0.25 chicks per pair was 88% lower than the long-term average (2.0 ± 0.1; Figure 25).

Castle-Hurricane Colony Complex

Nest surveys - Brandt's Cormorant nest surveys were conducted from 19 April to 6 August (Figure 27). The only subcolonies with observed breeding in 2009 were CRM-06South and CRM-08 (not visible from land-based vantage points). Fair to well-built nests were also recorded on HPR-04 and CRM-09 although no eggs were laid and nest building was abandoned by 6 May and 16 May, respectively. Due to poor viewing conditions of CRM-06South (south side) from the Hurricane Point overlook, many nests had to be classified as unknown during nest surveys. The first well-built nest on CRM-06South (south side) was observed on 29 April, consistent with the onset of clutch initiation. The first well-built nest on CRM-06South (north side) was observed over a month later on 4 June. The peak single-day count of 60 well-built nests on CRM-06South (south side) was on 12 June, while the peak single-day count of 47 well-built nests on CRM-06South (north side) occurred over two weeks later on 30 June. The sum of the high counts for all subcolonies obtained from land was 108 nests (including 1 well-built nest on HPR-04; Table 15). Inclusion of one additional nest recorded during the boat survey (not visible from land) raised the total 2009 nest count at CHCC to 110 nests (Table 15), 75% higher than the 2008 total nest count (63 nests).

Three dead cormorants were recorded during the cormorant mortality event that occurred along the central California coast. Two dead birds were observed low on the rock at HPR-02 and CRM-02. Additionally one dead cormorant was seen on top of an empty nest in late May at CRM-06South.

Productivity - Brandt's Cormorant productivity was monitored at 66 nests on CRM-06South (south side; Table 14). Because of a delay in finding a suitable viewing location, productivity monitoring did not begin until 21 May. Clutch initiation dates were determined by backdating from confident hatch dates for nests that already contained complete clutches (n = 20 nests).

The mean clutch initiation date of 31 May (range = 3 May-27 June, n = 63) was 33 days later than the long-term mean. Average clutch size was 2.5 eggs and two replacement clutches were recorded. First chicks were observed on 2 June. Hatching success was low (58%), and a brood size of 2.1 chicks was slightly below the long-term average of 2.6 chicks. Overall productivity of 0.65 chicks per pair was 64% lower than the long-term average of 1.8 ± 0.3 chicks per pair (Figure 25). Breeding success per nest of 0.44 chicks indicates a relatively high rate of nest abandonment.

Pelagic Cormorant, Black Oystercatcher, Western Gull, and Pigeon Guillemot

Nest and bird surveys

High weekly counts of nests (cormorant, gull, oystercatcher) or birds (guillemot) from land, single boat counts, and combined land/boat counts are summarized in Tables 16 and 15

Pelagic Cormorant – In 2009, nest counts were lower at PRH (-26%) and MPR (-47%), 88% higher at CHCC (BM227X, CRM, and HPR combined), and were similar to 2008 at PRS, DPR and DSRM (Table 15). Well-built nests were first observed at CRM on 19 April, at DBCC on 22 April, at PRH on 28 April and at DSRM on 29 April. Eggs were first recorded at CRM and DBCC on 13 May, at DSRM on 20 May, and at PRH on 30 May.

Western Gull - Nest counts were higher at PRH (+13%) and CHCC (+24%), lower at DSRM (-38%), and similar to 2008 at other colonies.

Pigeon Guillemot - At PRH, the high standardized count from the lighthouse of 156 birds on 21 April was 33% higher than in 2008. Surveys of the entire headlands also resulted in higher counts compared to 2008: +9% from the land-based count and +242% from the boat-based count (Table 16). Although surveys of Drake's Bay colonies were not done at standardized times, counts were similar at PRS but about double 2008 counts at MPR and DPR. At DSCC (SPR and DSRM), the high count of 142 guillemots on 28 April was 45% lower than the 2008 high count but the boat count was similar to 2008. No birds were seen carrying fish at DSCC. At CHCC, the high land count of 50 birds on 24 July was 22% higher while the boat count was 675% higher than in 2008 (Table 16). Several birds were seen carrying fish in the cove below Esselen overlook (BM227X) on 30 June and 14 July. Guillemots were also observed entering and leaving crevice sites at CRM-04 and CRM-06South (south side) throughout the breeding season.

Productivity

Pelagic Cormorant - Nests were monitored at PRH, DSRM, and CHCC (Table 17). At DSRM, the same mainland subcolony (DSRM-04) was followed as in 2008. Pelagic Cormorant productivity was 40% lower at PRH and 8% lower at DSRM than in 2008. Only one Pelagic Cormorant nest was monitored at CHCC (on CRM-07) in 2009; this pair fledged one chick in early July.

Black Oystercatcher - Productivity was determined in 2009 at PRH (0.0 chicks/pair; n = 5), DSRM (0.0 chicks/pair; n = 1), and CHCC (0.2 chicks/pair; n = 5) (Table 17).

Western Gull – Gulls had low breeding success (range = 0.22-0.50 chicks/pair) at all colonies (Table 17). Productivity was 20% lower at PRH, 63% lower at DSRM, and 64% at CRM than in 2008. Both low hatching and low fledging success appeared to contribute to low productivity at DSRM and PRH, whereas low productivity was mainly affected by low fledging success at CHCC.

Common Raven Surveys – Big Sur

In 2009, 49 Common Raven surveys were conducted along Highway 1 between Point Lobos and Point Sur. A total of 33 raven detections were recorded (Figure 28), corresponding to 0.67 ± 0.9 SD detections/survey (range = 0-3) and 0.026 detections/km. On a per kilometer basis, ravens were detected at a higher rate in the southern portion (Castle Pullout to Point Sur; 0.035/km, or 0.33 detections/survey; n = 16 detections) than in the northern portion (Point Lobos to Bixby Landing; 0.020/km, or 0.35 detections/survey; n = 17 detections). Ravens were observed most often between Soberanes Point and Joshua Creek in the north (especially at parking pullouts for Garrapata State Park) and from Hurricane Point to the Little Sur River in the south. There also appeared to be an association between raven observations and groves of eucalyptus or cypress trees.)

The overall detection rates in 2009 were similar to 2008 rates (0.58 ± 0.8 detections/survey and 0.022 detections/km). The detection rates in the northern portion was slightly higher than in 2008 (0.016/km) but was slightly lower in the southern portion (0.048/km in 2008). .

Incidentally, ravens were occasionally observed on the mainland during colony monitoring, especially at Castle and Hurricane pullouts. However, no nesting pairs were evident near CHCC and none were observed landing on or otherwise disrupting the colonies.

DISCUSSION

Anthropogenic Disturbance

Point Reyes continued to have the lowest combined aircraft and boat observation and disturbance rates of the three colony complexes with more frequent monitoring (i.e., > once per week; PRH, DSRM, CHCC). Overall, aircraft and boat observation and disturbance rates declined from 2008. However, DPR continued to show fairly high activity rates for both aircraft and boats (mostly small recreational fishing boats) and observation rates increased from 2008. Overflight disturbance rates also increased from 2008, but not boat disturbance. Higher boat traffic at DPR than at other Drakes Bay colonies likely reflects the closer proximity to the harbor at Bolinas Lagoon.

DSRM continued to have the highest combined aircraft and boat activity rates, including the highest for both planes and helicopters. Overall disturbance rates increased from 2008 and continued to be much higher than other monitored sites. Boat observations and disturbances also increased from 2008. Of additional concern is that 41% of all overflights elicited some type of reaction (i.e., agitation, displacement or flushing) from one or more species of seabirds. The main cause of higher aircraft rates at this location is due to the close proximity of the Half Moon Bay Airport and possibly aircraft from aircraft transiting between San Francisco International Airport and points farther south. As in previous years, the Pacific Coast Dream Machines event at the Half Moon Bay Airport was a source of high plane activity. While the number of aircraft overflights recorded during this event declined from 2008, the number of disturbances was similar.

At CHCC, both aircraft and boat activity increased dramatically from 2008 and were the highest rates recorded in nine years. Fortunately, there was not a concomitant increase in disturbance rates, which were lower than in 2008. In fact, the lack of apparent disturbance during some very close boat approaches was surprising. In general, disturbance rates at CHCC have decreased since 2003 (Figure 11). However, in 2008 both observation and disturbance rates increased from other recent years. The higher activity rates in 2008 and 2009 may signify a change in trends.

Of particular note at all colonies was that most boat activity, and all boat disturbances at DSRM, occurred during periods of very calm sea conditions. In particular, boat activity was especially high at PRH and DSRM during very calm conditions on the opening weekend of rockfish season and 4th of July; at DSRM, all boat disturbances occurred during these two events.

Non-Anthropogenic Disturbance

In 2009, the most severe disturbances to murres were caused by California sea lions at PRH and most likely at PRS and DPR as well. Sea lions that were apparently in an emaciated state climbed high onto rocks, causing hundreds if not more eggs to be abandoned or crushed. Sea lion disturbance may have caused the premature abandonment of PRS and most of DPR. This behavior was associated with a large starvation event in California (Bensen 2009; Marine Mammal Center, unpubl. data; R.L. DeLong, pers. comm.). While sea lions do not normally climb high onto these rocks, such behavior has been recorded in the past, especially during El Niño events when prey resources are low (e.g., Parker et al. 1999).

Generally, fewer and less severe avian disturbances were observed in 2009 than in other recent years. However, at some colonies, at least, fewer disturbances may have simply resulted from lower seabird attendance (e.g., fewer birds to disturb). On the other hand, some patterns appeared to continue while potentially new patterns of concern may have been initiated.

Since the early 2000s, Brown Pelicans have been responsible for major disturbances to murres at nearly every monitored colony, most frequently and with the greatest impacts at CHCC. While no major pelican disturbances were observed in 2009, at CHCC pelicans were observed roosting within three murre subcolonies, with broken eggshells recorded at two subcolonies (CRM-02 and HPR-02) at these times. Prolonged murre breeding at these two subcolonies suggests that roosting pelicans did cause murre egg loss and subsequent laying of replacement clutches. Thus, the pattern of nearly annual major disturbance from pelicans at CHCC continued but with less impacts than several other years.

Disturbance and predation by Common Ravens mainly occurs at colonies within Point Reyes National Seashore, where raven numbers are artificially inflated by anthropogenic food sources (mainly from dairies) (Kelly et al. 2002). Impacts from raven disturbance appear to be especially high at MPR, where seasonal attendance by murres has been highly variable and abandonment rates have been high most years since monitoring began there in 2005, apparently a result of high raven disturbance. At PRH and DBCC, observed disturbance and predation by ravens was considerably lower in 2009 than in other recent years. However, very low murre attendance was observed at MPR in 2009 and the only evidence of breeding was from a small number of raven-depredated eggshells found on the adjacent mainland. Given the infrequent monitoring of this colony, it is unclear if low murre attendance was mainly due to unobserved raven disturbance, poor feeding conditions, or a combination of factors.

Of potential concern was the first recorded scavenging of murre eggs by a raven at DSR. On the nearby mainland cliffs, ravens have successfully nested in recent years but they have not traditionally disturbed the nearby breeding seabirds. However, in 2009 one raven discovered several abandoned murre eggs on DSR and caused disturbance to both murres and Brandt's Cormorants while it scavenged the eggs. Scavenging and depredating seabird eggs and young appears to be a learned behavior in ravens (McChesney et al. 2004). This raven's discovery of the DSR colony could result in future activity at the rock, with possible major impacts to the murre colony.

Western and Heermann's gulls also caused disturbances to murres while scavenging for abandoned eggs at the DSR colony. Western Gulls were also observed scavenging abandoned eggs at CHCC but did not cause any observed disturbance. For the first time ever at DSR, Western Gulls were recorded depredating murre chicks on three separate occasions. On one occasion the depredated chick was not attended by the parent bird but was being attended by another adult murre. Unattended chicks in combination with low colony attendance left chicks exposed and vulnerable to predation.

Attendance Patterns and Reproductive Performance

Attendance and breeding success were low for most species and colonies in 2009. For Common Murres, attendance patterns were more variable than normal between colonies but unsuccessful breeding resulted in early departure at most colonies. While all colonies experienced very low breeding success, several colonies experienced complete reproductive failure, including MPR, DSRM, and possibly PRS and DPR. At DSR, this was the first year since the colony was restored in 1996 that no successful breeding occurred. Murre breeding phenology was later than average at both PRH and DSR but six days earlier than average at CRM.

At PRH, murre attendance was fairly typical during the pre-breeding and egg-laying period but numbers declined as nests failed during the hatching and chick period. At the Drakes Bay colonies, regular attendance began relatively late. At MPR, only sporadic attendance occurred, with most attendance on the typically smaller North Rock subcolony. Similar to 2008 but unlike most years, murres only bred at established colonies and subcolonies. Typically at PRH, CHCC, and less often at other colonies, relatively small numbers of murres breed at irregularly attended, or "ephemeral", subcolonies in association with nesting Brandt's Cormorants. Possible exceptions were at CRM-03East and CRM-06, where murres bred among or near nesting cormorants in 2009, but these subcolonies at least have been attended for several consecutive years although breeding has not occurred every year. The pattern in 2009 also pertained to colonies near the Golden Gate, with little attendance and no breeding at Bird Island and no attendance recorded at Seal Rocks. Both of these colonies had their first documented murre attendance in 2007 (McChesney et al. 2008) with the first documented murre breeding at Bird Island in 2008 (McChesney et al. 2009). Lack of attendance at ephemeral murre breeding areas in 2009 likely resulted from a combination of poor foraging conditions that reduced breeding populations as well as low numbers and delayed breeding by nesting Brandt's Cormorants.

At DSR, a new high count (1,003 birds) was established since restoration began in 1996 (previous high count of 961 murres in 2008). Numbers of breeding sites in monitored plots also increased. However, numbers of murres attending DSR during the bulk of the breeding season were similar to or lower than in 2008, mainly because of high abandonment rates. Similar to the last few years, attendance patterns during the breeding season were considerably more variable than at most other colonies. Also, murres stopped attending DSR about one month earlier than normal due to complete breeding failure. At DSM, murre attendance and numbers of breeding sites were much lower than in 2008. By the end of June, all murre attendance had ceased for the season because of failed breeding.

For the second consecutive year, Brandt's Cormorants had delayed arrival at colonies, delayed breeding, low breeding population sizes and very poor reproductive success. Associated with these parameters was an unprecedented mortality event along the central California coast that began abruptly in mid-April. In addition to large numbers recorded by local beached bird survey programs and rehabilitation centers, dead cormorants were recorded at all monitored colony complexes with the highest numbers observed at the Golden Gate area colonies. When this mortality event began, colonies were unusually devoid of Brandt's Cormorants and breeding activity had not yet begun. Eventually, birds did arrive at most colonies but breeding was delayed by two to four weeks on average. High rates of nest abandonment resulted in overall productivity that was 44-88% below average. Despite the low numbers, however, numbers of nests counted from mainland vantage points and productivity were higher than in 2008 at PRH, DBCC (nest counts only), and CHCC.

Numbers of Pelagic Cormorant nests were similar to or lower than 2008 at most colonies, except for CHCC where they increased. Western Gull numbers increased at all colonies except for DSRM. Breeding success for Pelagic Cormorants and Western Gulls was low at all colonies and declined from 2008. Pelagic Cormorants were not as severely impacted as Brandt's Cormorant's; this is likely due to foraging and diet differences. Pelagic Cormorants can feed on nonschooling fish and invertebrates while Brandt's Cormorants prefer schooling fish (Hobson 1997, Wallace and Wallace 1998). This provides further support that a decline in schooling forage fish, such as northern anchovy contributed to the low breeding success of Brandt's Cormorant's observed in 2009.

Low breeding population sizes and breeding success for most species in 2009 appears to have been caused by a variety of factors, mainly poor foraging conditions. Ocean conditions leading up to the 2009 breeding season were characterized by a La Niña event, with higher than average upwelling and lower than average sea surface temperatures, (McClatchie et al. 2009; PaCOOS 2009). Despite these normally productive conditions, ecosystem responses have been surprisingly variable. The main factor affecting seabirds appears to have been a lack of small schooling fish, such as Northern anchovies (*Engraulis mordax*) (Warzybok and Bradley 2009). Schooling prey such as anchovies are an important component in the diet of Common Murres and probably other species such as Brandt's Cormorants in central California (Miller and Sydeman 2004, Mills et al. 2007, Eigner 2009). Low prey availability also had a dramatic impact on California sea lions. The apparently emaciated animals that hauled up into murre colonies at PRH and DBCC likely caused further reductions in breeding success of murres.

While breeding population sizes and breeding success of Pelagic Cormorants were generally lower than in 2008, they were relatively high compared to murres and Brandt's Cormorants. Instead of specializing in schooling prey, Pelagic Cormorants mainly feed on small fish and invertebrates captured among rocky bottom habitats (Ainley et al. 1990).

The overall impacts of human disturbance at colonies is not entirely clear. Chronic disturbance at DSR may have contributed to reduced breeding success although it does not appear to have been the main cause. Aircraft disturbance has been shown to cause an increase in energy expenditure in emperor penguins (*Aptenodytes forsteri*) (Regel and Putz 1997). Therefore, it is likely that during periods of high stress, such as from low prey availability, disturbance has a greater effect on bird behavior than during less stressful periods.

Recommendations for future management, monitoring and research

Additional outreach, education, and enforcement are needed to reduce aircraft disturbance at the DSRM colony. Aircraft activity and disturbance there has increased dramatically since the early 2000s and threatens the continued recovery of this restored colony. Continuing and increasing coordination, outreach and education efforts with event organizers, pilots, and the Federal Aviation Administration are needed to reduce aircraft disturbance during the annual Dream Machines event at Half Moon Bay Airport. Also, additional outreach efforts are needed when seas are especially calm during the recreational groundfish season; this is when most activity occurs near colonies.

The establishment of Special Closures at PRH, PRS, Stormy Stack, and DSR, as well as a marine reserve surrounding PRH, effective 1 May 2010 under the California Marine Life Protection Act

(CDFG. 2004). Initiative, should substantially reduce disturbance to seabirds from boats. However, appropriate information will need to be provided to boaters to assure that closure and reserve boundaries are known and these will need to be monitored and enforced. Increased monitoring at the Drakes Bay colonies will be needed to document adherence to Special Closures at PRS and Stormy Stack. Given increased boating activity at CHCC in 2008 and 2009, Special Closures should be considered for those colonies as well. At minimum, outreach and education efforts are needed to reduce boat approaches there.

While annual aerial surveys of central and northern California murre, Brandt's Cormorant and Double-crested colonies continued in 2009 (in cooperation with California Department of Fish and Game and U.C. Santa Cruz), no funds are currently available to count nests and birds from the photographs. These aerial surveys have provided the baseline for assessing population trends of these species since the 1980s and must be continued to track the success of murre recovery efforts as well as murre and cormorant population changes caused by natural and anthropogenic sources. From 1996-2006, these counts were funded by the *Apex Houston* Trustee Council.

Additional monitoring is needed at MPR to better determine factors affecting this murre colony. Since land-based monitoring began in 2005, this colony has experienced near total reproductive failure almost every year and appears to be in serious decline. We suspect that chronic disturbance and egg predation by Common Ravens was the primary factor affecting this colony.

Additional research on factors affecting murre, Brandt's Cormorant, and other seabird breeding efforts and success are needed. For example, despite La Niña conditions, reproductive success of several species (especially Brandt's Cormorants and Common Murres) have been very low for the past two years. In particular, Brandt's Cormorants had very poor breeding efforts in both 2008 and 2009, with an unprecedented starvation event in spring 2009. More research on foraging ecology, including prey use and prey availability, would help assess these events.

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Table 1. Monitoring effort of study colonies or colony complexes, November 2008 to August 2009.

Colony/Colony Complex	Start date	End date	No. of obs. days	Total hours
Point Reyes	14 Apr 09	14 Aug 09	100	370.65
Point Resistance	22 Apr 09	29 July 09	16	12.02
Millers Point Rocks	22 Apr 09	29 July 09	16	33.33
Double Point Rocks	25 Apr 09	18 July 09	12	50.68
San Pedro Rock	21 Apr 09	29 July 09	29	16.43
Devil's Slide Rock & Mainland				
Pre-breeding season	21 Nov 08	14 April 09	6	6.27
Breeding season	16 Apr 09	18 Aug 09	95	458.03
Castle-Hurricane Colony Complex				
Pre-breeding season	5 Mar 09	10 Mar 09	2	1.22
Breeding season	17 Apr 09	06 Aug 09	82	320.35

[1] Does not include Common Raven survey hours (19.30 h).

Table 2. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle Hurricane Colony Complex 2009. Number and percentage of events are reported for each type.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	2	0	1 (50%)	0	0	0	0	0	1 (50%)
Research	37	0	3 (8%)	0	0	0	0	0	3 (8%)	0
U.S. Coast Guard	1	19	0	9 (47%)	0	0	1 (100%)	1 (5%)	1 (100%)	10 (53%)
Military	3	6	0	2 (33%)	0	0	0	1 (17%)	0	3 (50%)
Law Enforcement	0	1	0	0	0	0	0	0	0	0
Other[1]	178	23	67 (38%)	9 (39%)	0	0	4 (2%)	2 (9%)	71 (40%)	11 (48%)
Unknown[2]	4	2	0	0	0	0	0	0	0	0
Total	223	53	70 (31%)	21 (40%)	0	0	5 (2%)	4 (8%)	75 (34%)	25 (47%)

[1] Other refers to unmarked aircraft that are either privately-owned or unmarked charter aircraft.
[2] Unknown aircraft were not viewed adequately to categorize.

Table 3. Numbers of observed watercraft and resulting disturbance events recorded at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle Hurricane Colony Complex in 2009. Number and percentage of events are reported for each type.

Watercraft Type	Total Observations	#No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	8	1 (13%)	0	0	1 (13%)
Recreational (<25') Small Private	56	3 (5%)	0	12 (21%)	15 (27%)
Recreational (>25') Large Private	2	0	0	0	0
Charter	1	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	20	3 (15%)	0	8 (40%)	11 (55%)
Law Enforcement	0	0	0	0	0
USCG	0	0	0	0	0
Other	1	0	0	0	0
Unknown	0	0	0	0	0
Total	88	7 (8%)	0	20 (23%)	27 (31%)

Table 4. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) at Point Reyes, 2009. Total number observed and number per observer hour are reported.

			No. Disturbance Events			No. Disturbance Events/hr	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr
Plane	7	0.019	1	0	1	0.005	0.003
Helicopter	2	0.005	1	0	0	0.003	0
Boat	10*	0.027	0	0	0	0	0
Humans on foot	0	0	0	0	0	0	0
Total	19	0.051	2	0	1	0.008	0.003

[1] Events where birds exhibited agitation (A), flushing (F), or displacement (D).

Table 5. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Point Reyes, 2009.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean No. Seabirds Flushed/ Displaced	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	30	1	30	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	30.0 (30-30)	1	30	0	0	0	0	0	0	0	0	0	0	0	0

Table 6. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) at Point Resistance, 2009. Total number observed and number per observer hour are reported.

Source	Total Obser-vations	No. Obs/hr	No. Disturbance Events: A	No. Disturbance Events: D	No. Disturbance Events: F	No. Disturbance Events/hr: Total/hr[1]	No. Disturbance Events/hr: Flush or Displace/hr	Mean No. Seabirds Flushed/ Displaced	COMU Disturbance: No Events	COMU Disturbance: Mean No. birds	BRCO Disturbance: No Events	BRCO Disturbance: Mean No. birds	BRPE Disturbance: No. Events	BRPE Disturbance: Mean No. birds
Plane	3	0.250	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3	0.250	0	0	0	0	0	0	0	0	0	0	0	0

[1] Events where birds exhibited agitation (A), flushing (F), or displacement (D).

Table 7. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) at Miller's Point Rocks, 2009. Total number observed and number per observer hour are reported.

			No. Disturbance Events			No. Disturbance Events/hr			COMU Disturbance		BRCO Disturbance		BRPE Disturbance	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/ hr[1]	Flush or Displace/ hr	Mean No. Seabirds Flushed/ Displaced	No Events	Mean No. birds	No Events	Mean No. birds	No. Events	Mean No. birds
Plane	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	1	0.030	0	0	0	0	0	0	0	0	0	0	0	0
Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0.030	0	0	0	0	0	0	0	0	0	0	0	0

[1] Events where birds exhibited agitation (A), flushing (F), or displacement (D).

Table 8. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) at Double Point Rocks, 2009. Includes total numbers observed and numbers per observer hour.

			No. Disturbance Events			No. Disturbance Events/hr			COMU Disturbance		BRCO Disturbance		BRPE Disturbance	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/ hr[1]	Flush or Displace/ hr	Mean No. Seabirds Flushed/ Displaced	No Events	Mean No. birds	No Events	Mean No. birds	No. Events	Mean No. birds
Plane	9	0.178	2	0	1	0.059	0.020	300	1	300	0	0	0	0
Helicopter	1	0.020	0	0	1	0.020	0.020	5	1	5	0	0	0	0
Boat	9	0.178	0	0	0	0	0	0	0	0	0	0	0	0
Total	19	0.375	2	0	2	0.118	0.039	152.5 (5-300)	2	152.5 (5-300)	0	0	0	0

[1] Events where birds exhibited agitation (A), flushing (F), or displacement (D).

Table 9. Numbers and hourly rates of observed boats, aircraft overflights, and resulting disturbances to all seabirds at Devil's Slide Rock & Mainland, 2009.

			No. Disturbance Events			No. Disturbance Events/hr	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/hr[1]	Flush or Displace/hr
Plane	164	0.358	61	0	3	0.140	0.007
Helicopter	41	0.090	18	0	2	0.044	0.004
Boat	31	0.068	5	0	15	0.044	0.033
Other (truck)	2	0.004	2	0	0	0.004	0.0
Total	238	0.520	86	0	20	0.231	0.044

[1] Events where birds exhibited agitation or alert behaviors (A), flushing (F), or displacement (D).

Table 10. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Devil's Slide Rock & Mainland, 2009.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean No. Seabirds Flushed/ Displaced	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	4 (3-5)	3	4 (3-5)	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	17 (5-28)	2	13 (5-20)	1	8	0	0	0	0	0	0	0	0	0	0
Boat	48 (11-104)	7	22 (1-72)	15	32 (1-100)	0	0	4	3 (1-6)	6	5 (2-10)	1	2	2	20 (2-38)
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	38 (3-104)	12	16 (1-72)	16	31 (1-100)	0	0	4	3 (1-6)	6	5 (2-10)	1	2	2	20 (2-38)

Table 11. Numbers and hourly rates of observed boats, aircraft overflights, and resulting disturbances to all seabirds at the Castle-Hurricane Colony Complex, 2009.

Source	Total Obser-vations	No. Obs/hr	No. Disturbance Events			No. Disturbance Events/hr	
			A	D	F	Total/hr[1]	Flush or Displace/hr
Plane	33	0.103	1	0	0	0.003	0.000
Helicopter	4	0.012	1	0	1	0.006	0.003
Boat	25	0.078	1	0	0	0.003	0.000
Other (Truck)	-	-	1	0	0	0.003	0.000
Total	62	0.194	4	0	1	0.016	0.003

[1] Events where birds exhibited agitation (A), flushing (F), or displacement (D).

Table 12. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at the Castle-Hurricane Colony Complex, 2009.

Source	Mean No. Seabirds Flushed/ Displaced	COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
		No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	55	1	55	0	0	0	0	0	0	0	0	0	0	0	0
Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	55	0	0	0	0	0	0	0	0	0	0	0	0

Table 13. Common Murre breeding phenology and reproductive success at Point Reyes (2 plots and combined), Devil's Slide Rock & Mainland (DSR, 3 plots; DSM; and combined), and Castle Rocks & Mainland (2 plots), 2009. Means (range; n) are reported.

Colony/Plot	No. Sites Monitored	No. Egg Laying Sites	Mean Lay Date[1]	No. Eggs Laid	Mean Hatch Date	Hatching Success[2]	Mean Fledge Date	Fledging Success[3]	Chicks Fledged per Pair
Point Reyes (PRH)									
PRH-Ledge	87	70	30 May	70	29 June	28.6%	24 July	80.0%	0.23
			(5/16-6/11;61)		(6/18-7/7; 20)	(70)	(7/12-8/3; 16)	(20)	(70)
PRH-Edge	63	48	27 May	48	1 July	44.7%	29 July	80.0%	0.34
			(5/19-6/2;33)		(6/22-7/7; 19)	(47)	(7/16-8/3; 16)	(20)	(47)
PRH-(combined)	150	118	29 May	118	30 June	35.0%	26 July	80.0%	0.27
			(5/16-6/11; 94)		(6/18-7/7; 39)	(117)	(7/12-8/3; 32)	(40)	(117)
Devil's Slide Rock and Mainland (DSRM)									
DSR-A	96	76	28 May	84	26 June	4.8%	-	0.0%	0.0
			(5/12-6/6;64)		(6/21-6/30;4)	(84)		(4)	(76)
DSR-B	89	73	27 May	76	27 June	9.2%	-	0.0%	0.0
			(5/16-6/27;56)		(6/18-7/2;7)	(76)		(7)	(73)
DSR-C	25	4	3 June	4	-	0.0%	-	0.0%	0.0
			(6/1-6/4;4)			(4)		(0)	(4)
DSR (combined)	210	153	28 May	164	26 June	6.7%	-	0.0%	0.0
			(5/12-6/27;124)		(6/18-7/2;11)	(164)		(11)	(153)
DSM	99	32	29 May	32	-	0.0%	-	0.0%	0.0
			(5/17-6/8;24)			(32)		(0)	(32)
DSR, DSM (combined)	309	185	28 May	196	26 June	5.6%	-	0.0%	0.0%
			(5/12-6/27;148)		(6/18-7/2;11)	(196)		(11)	(185)
Castle Rocks and Mainland (CRM)									
CRM-04	120	78	10 May	87	11 June	51.7%	30 June	60.0%	0.35
			(4/28-6/9;55)		(5/28-7/2; 40)	(87)	(6/19-7/4; 27)	(45)	(78)
CRM-03B	69	25	16 May	29	-	0	-	0	0
			(5/6-6/3;22)			(29)		(0)	(25)

Table 13 (con't).

[1] Calculated using first eggs only; i.e., does not include replacement clutches.
[2] Hatching success is defined as the number of eggs hatched per eggs laid (includes both first and replacement clutches).
[3] Fledging success is defined as the number of chicks fledged per eggs hatched (includes both first and replacement clutches).

Table 14. Brandt's Cormorant breeding phenology and reproductive success at Point Reyes, Devil's Slide Rock & Mainland, and Castle Rocks & Mainland, 2009. Reported are means (range; n).

Colony/ Subcolony	No. Sites Monitored	Clutch Initiation Date[1]	Clutch Size[1]	No. Chicks Hatched/Pair[2]	Hatching Success[2]	Fledging Success[2]	Breeding Success[2]	No. Chicks Fledged/Pair[2]	Breeding Success/ Nest[3]
Point Reyes									
Pebble Point (PRH-05-C)	20	16 June (6/9-6/30; 20)	2.4 (1-3; 20)	0.00 (0; 21)	0.0% (0; 48)	0.0% (0; 0)	0.0% (0; 48)	0.00 (0; 20)	0.00 (20)
PRH-11-Islet	1	7 June (6/7; 1)	2.0 (2;1)	0.00 (0; 1)	0.0% (0; 2)	0.0% (0; 0)	0.0% (0; 2)	0.00 (0; 1)	0.00 (1)
Arch Rock (PRH-11-D)	15	30 May (5/24-6/15; 14)	2.8 (1-4; 14)	2.07 (0-3; 15)	72.1% (0-100; 43)	64.5% (0-100; 31)	46.5% (0-100; 43)	1.33 (1-3; 15)	0.87 (15)
Spine Point (PRH-11-E)	38	23 May (5/12-6/6; 37)	3.2 (2-4; 37)	2.53 (0-4; 38)	79.3% (0-100; 121)	66.7% (0-100; 81)	51.9% (0-100; 104)	1.69 (1-3; 32)	0.88 (32)
Wishbone (PRH-11-E)	35	1 June (5/18-6/29; 34)	2.6 (1-4; 34)	1.78 (0-3; 36)	68.9% (0-100; 93)	58.9% (0-100; 56)	40.2% (0-100; 82)	1.06 (1-2; 31)	0.70 (30)
Border Rock (PRH-14-C)	1	12 June (6/12; 1)	2.0 (2; 1)	0.00 (0; 1)	0.0% (0; 2)	0.0% (0; 0)	0.0% (0; 2)	0.00 (0; 1)	0.00 (1)
Total - Point Reyes	110	31 May (5/12-6/30; 107)	2.8 (1-4; 107)	1.71 (0-4; 112)	61.8% (0-100; 309)	63.7% (0-100; 168)	38.1% (0-100; 281)	1.06 (0-3; 101)	0.63 (99)
Devil's Slide Rock & Mainland									
Devil's Slide Rock (DSR-01)	10	5/28/2009 (5/24-6/3; 5)	1.7[4] (1-3; 3)	0.00	0.0%	0.0%	0.0%	0.00	0.00
Mainland South (DSR-05)	8	ND	ND	ND	ND	ND	ND	0.25 (0-1; 4)	0.25 (0-1; 4)
Total – Devil's Slide	18	5/28/2009 (5/24-6/3; 5)	1.7[4] (1-3; 3)	ND	ND	ND	ND	0.11 (0-1; 9)	0.11 (0-1; 9)
Castle Rocks & Mainland	71	31 May (5/3-6/27; 63)	2.5 (1-4; 62)	1.28 (0-3; 69)	57.7% (0-100; 149)	47.7% (0-100; 88)	26.3% (0-100; 160)	0.65 (0-3; 66)	0.44 (66)

[1] Includes first clutches only. [2] Includes replacement clutches. See text for details

[3] Breeding success per nest is defined as the proportion of egg-laying nests that fledged at least one chick [3]

[4] All nests failed prior to clutch completion.

Table 15. High counts of nests for Brandt's Cormorants (BRCO), Pelagic Cormorant (PECO), obtained during land, boat, and combined land/boat counts (total), 2009. ND = No Data.

Species	Colony	Land[1]	Boat	Total Count[2]
Brandt's Cormorant	Point Reyes	213	40	228
	Point Resistance	1	0	1
	Miller's Point Rocks	40	0	40
	Double Point Rocks	48	20	68
	Bird Island (Point Bonita)	0	-	0
	Lobos Rock & Land's End	14	-	14
	Seal Rocks	0	-	0
	Devil's Slide Rock & Mainland	7	6	13
	San Pedro Rock	0	0	0
	Bench Mark-227X	0	0	0
	Castle Rocks & Mainland	108	65	109
	Hurricane Point Rocks	1	0	1
Pelagic Cormorant	Point Reyes	13	113	119
	Point Resistance	0	11	11
	Miller's Point Rocks	4	6	10
	Double Point Rocks	0	2	2
	Devil's Slide Rock & Mainland	24	50	51
	San Pedro Rock	0	0	0
	Bench Mark-227X	0	0	0
	Castle Rocks & Mainland	2	14	14
	Hurricane Point Rocks	1	1	1

[1] Sum of high seasonal counts at each subcolony or subarea.
[2] Nests that may have been counted on both surveys were included only once towards the total nest count.
[3] For Brandt's Cormorants, only nests that could not be seen from mainland vantage points were counted.

Table 16. High counts of nests for Black Oystercatcher (BLOY), Western Gull (WEGU), and of birds for Pigeon Guillemot (PIGU), obtained during land, boat, and combined land/boat counts (total count), in 2009. ND = No Data.

Species	Colony	Land[1]	Boat[2]	Total Count[3]
Black Oystercatcher	Point Reyes	2	1	3
	Point Resistance	1	0	1
	Miller's Point Rocks	1	0	1
	Double Point Rocks	2	0	2
	Devil's Slide Rock & Mainland	1	1	1
	Bench Mark-227X	0	0	0
	Castle Rocks & Mainland	3	2	3
	Hurricane Point Rocks	2	2	2
Western Gull	Point Reyes	124	82	204
	Point Resistance	1	1	2
	Miller's Point Rocks	8	6	14
	Double Point Rocks	8	11	17
	Devil's Slide Rock & Mainland	9	10	10
	San Pedro Rock	4	7	7
	Bench Mark-227X	10	3	11
	Castle Rocks & Mainland	17	16	19
	Hurricane Point Rocks	6	39	42
Pigeon Guillemot	Point Reyes	253[4]	352	-
	Point Resistance	29	12	-
	Miller's Point Rocks	44	21	-
	Double Point Rocks	48	13	-
	Devil's Slide Colony Complex	142	172	-
	Castle/Hurricane Colony Complex	50	31	-

[1] Sum of high seasonal counts at each subcolony.

[2] In several cases, oystercatcher and gull nests were counted only if they could not be seen from mainland vantage points.

[3] Oystercatcher and gull nests that may have been counted on both surveys were included only once towards the total count.

[4] Single day survey of entire Point Reyes colony

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Table 17. Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls at Castle Rocks & Mainland, Devil's Slide Rock & Mainland, and Point Reyes in 2009. Reported are means (range; n) or (n).

	Castle Rocks and Mainland				Devil's Slide Rock and Mainland				Point Reyes			
Species	N	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	N	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	N	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]
Pelagic Cormorant	1	1	1.0 (1;1)	1.00 (1)	22	33	1.65 (0-4;20)	0.70 (20)	15	8	0.53 (0-3;15)	0.33 (15)
Black Oystercatcher	5	1	0.2 (0-1;5)	0.20 (5)	1	0	0.0 (0; 1)	0.0 (1)	2	0	0.0 (0; 2)	0.0 (2)
Western Gull	10	5	0.5 (0-2;10)	0.33 (10)	9	2	0.22 (0-2;9)	0.11 (9)	8	3	0.4 (0-3; 7)	0.14 (7)

[1] Breeding success per nest is defined as the proportion of egg-laying nests that fledged at least one chick.

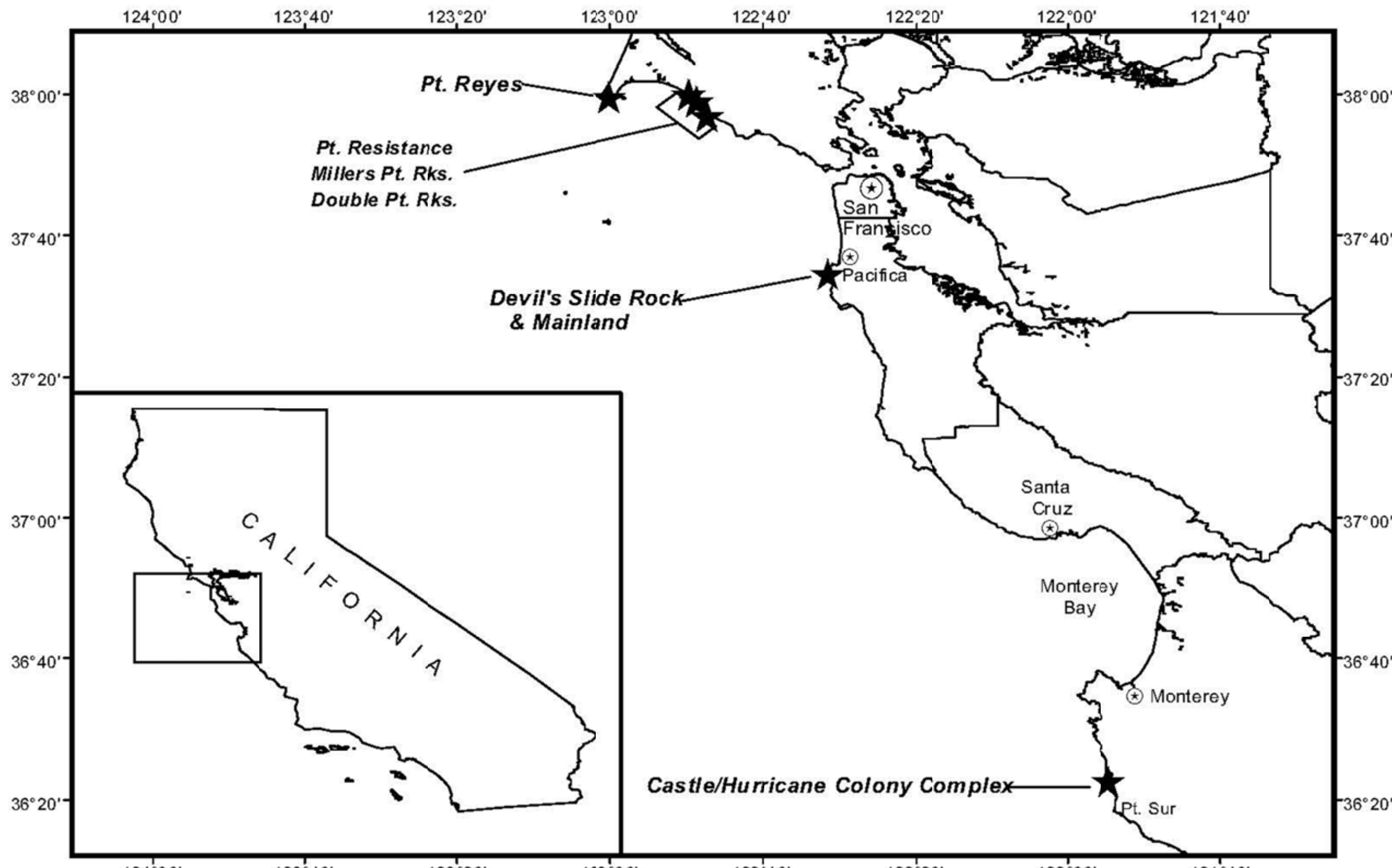


Figure 1. Map of the study area showing locations of study colonies or colony complexes.

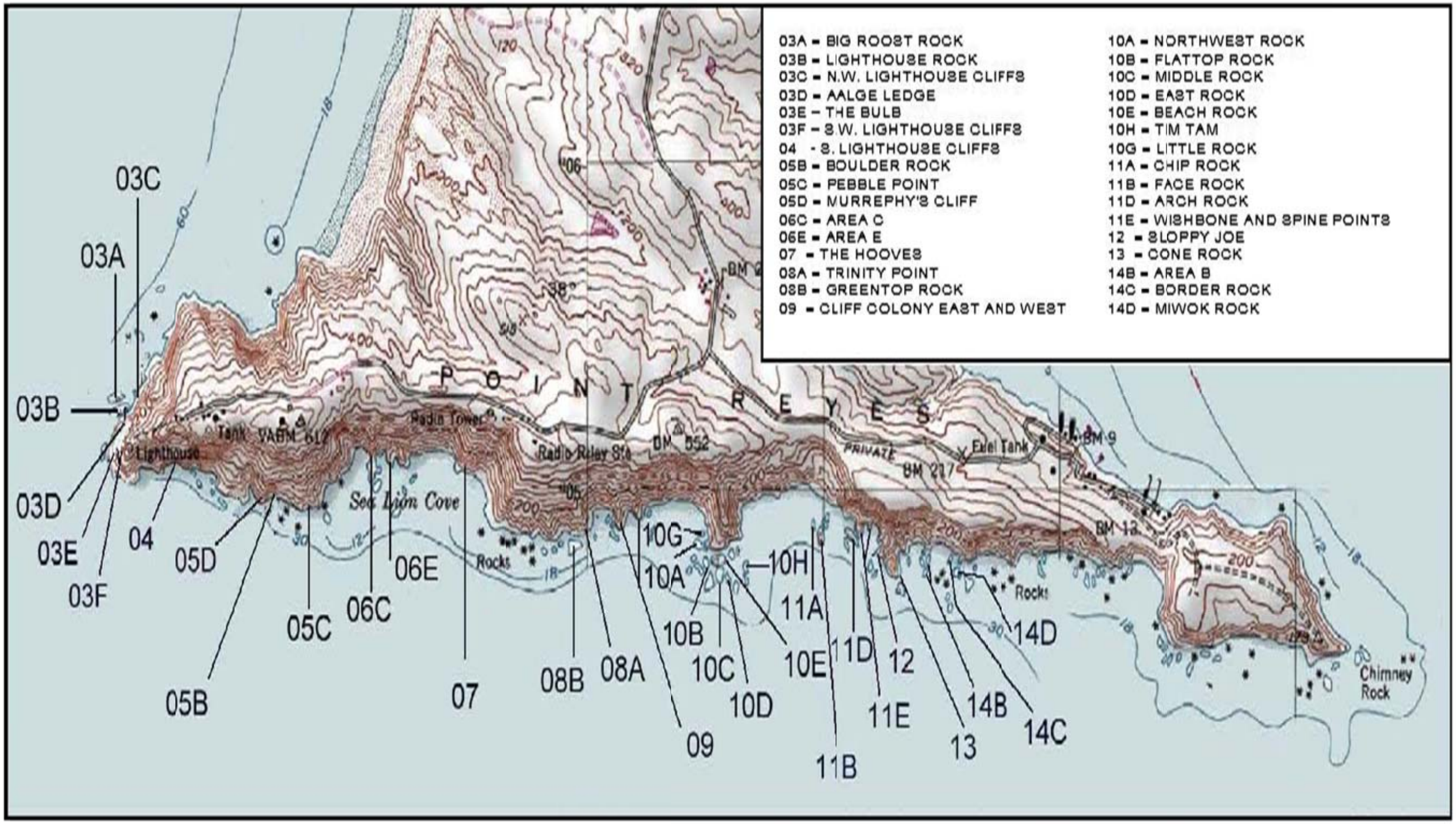


Figure 2. Point Reyes Headlands, including subcolonies mentioned in this report.

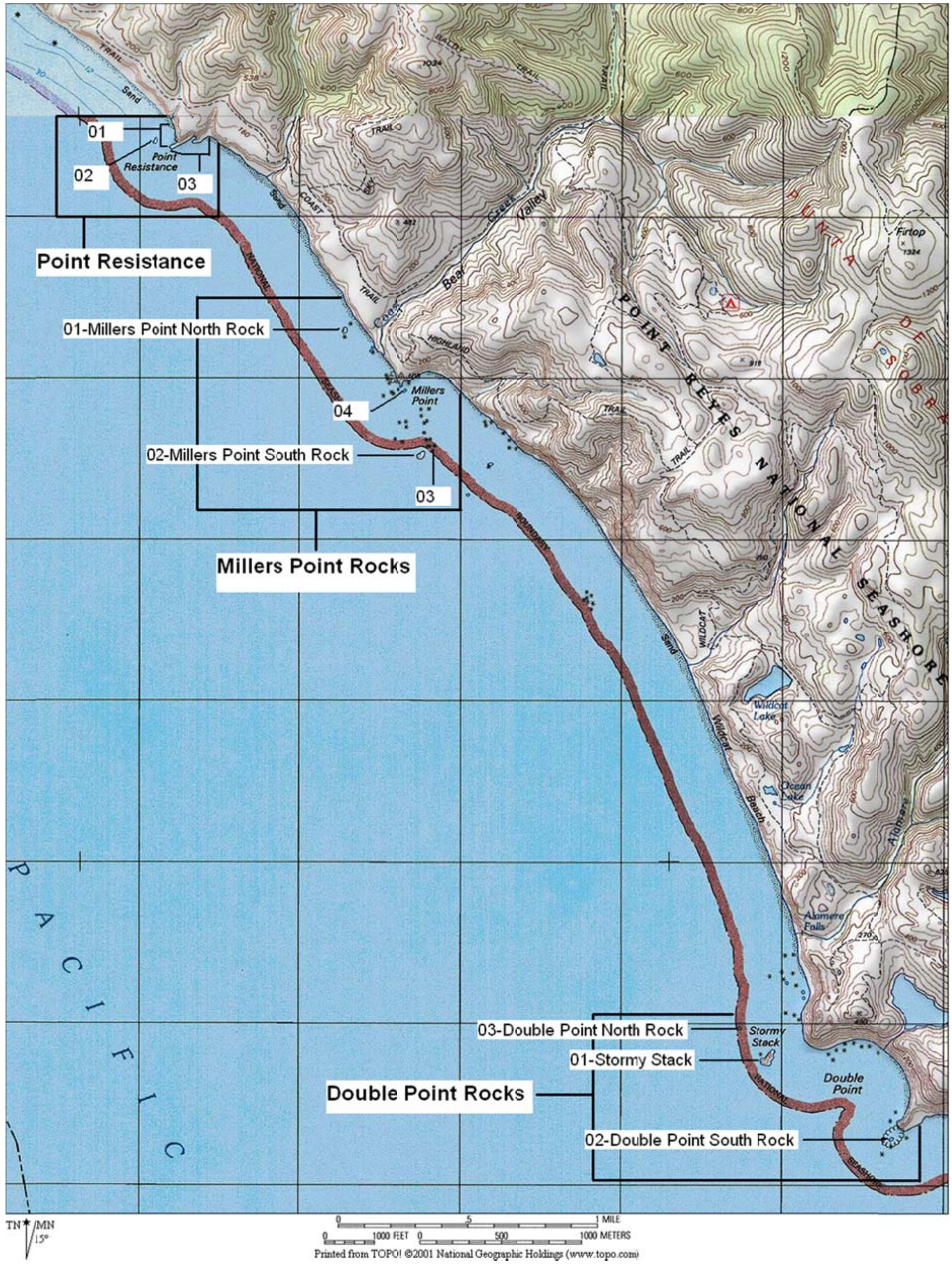


Figure 3. Map of the Drakes Bay Colony Complex, including Point Resistance, Millers Point Rocks and Double Point Rocks colonies and subcolonies.

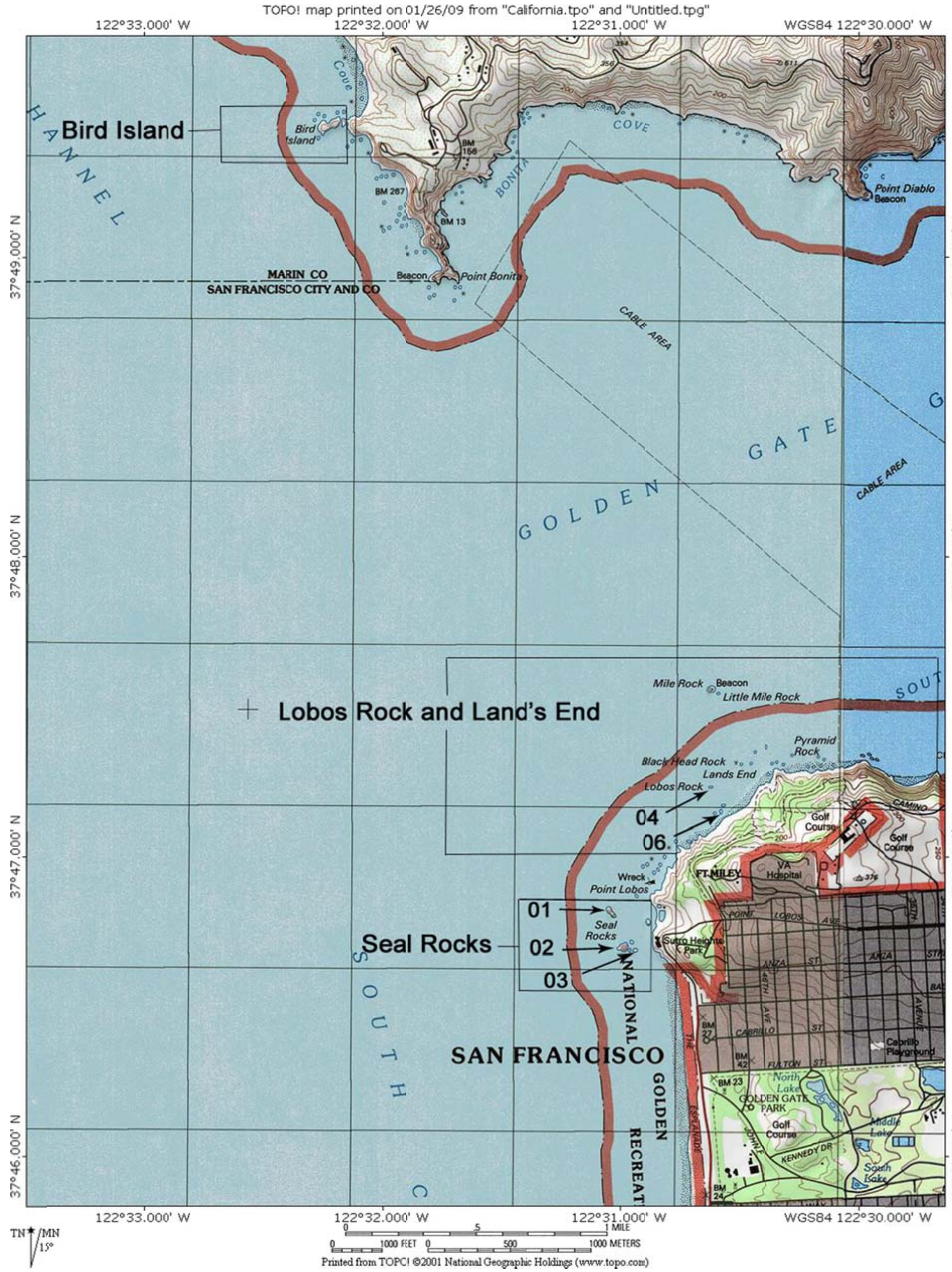


Figure 4. Map of colonies monitored at the mouth of the Golden Gate, including Bird Island, Lobos Rock and Land's End, and Seal Rocks.

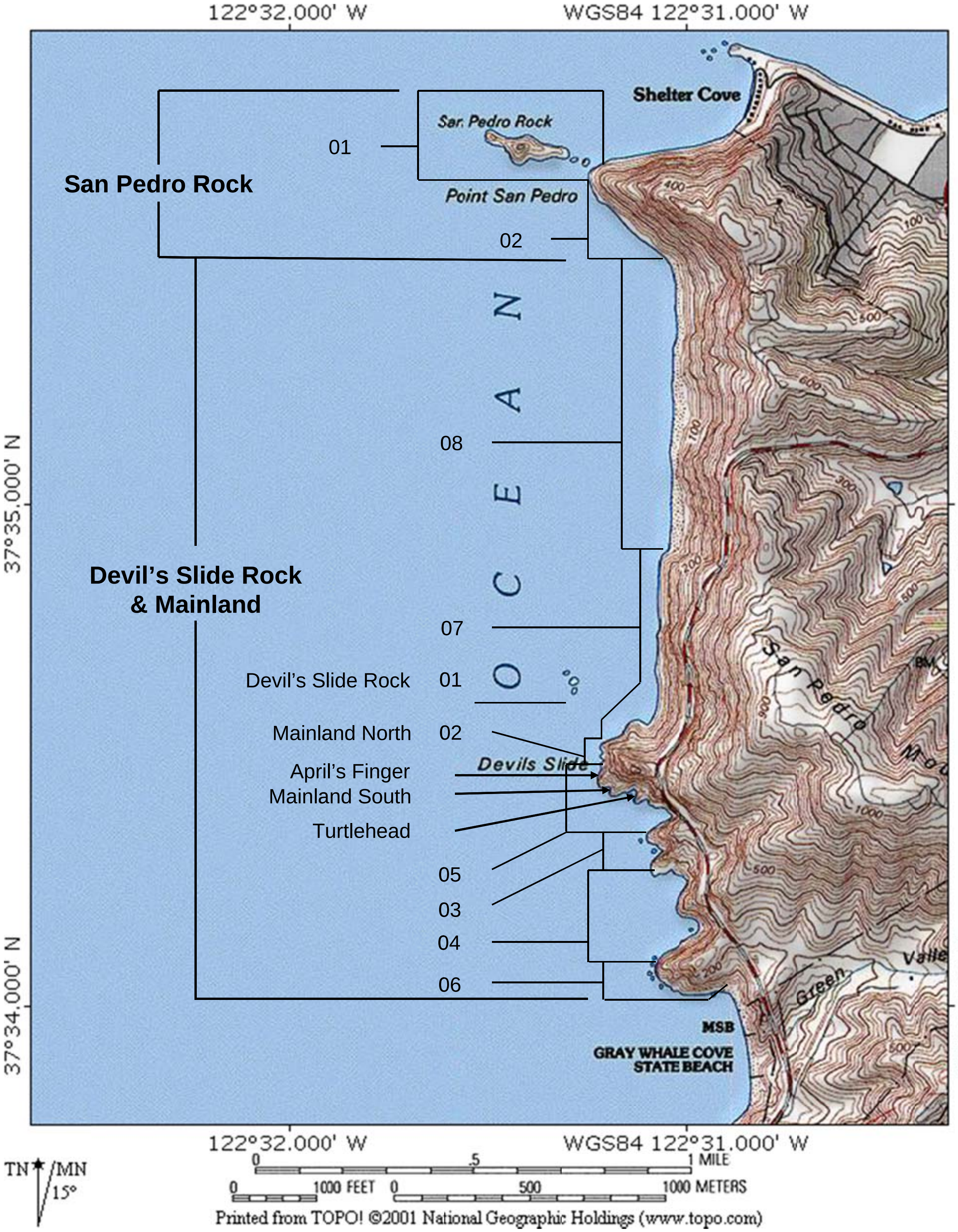


Figure 5. Map of the Devil's Slide Colony Complex, including San Pedro Rock and Devil's Slide Rock & Mainland colonies and subcolonies.

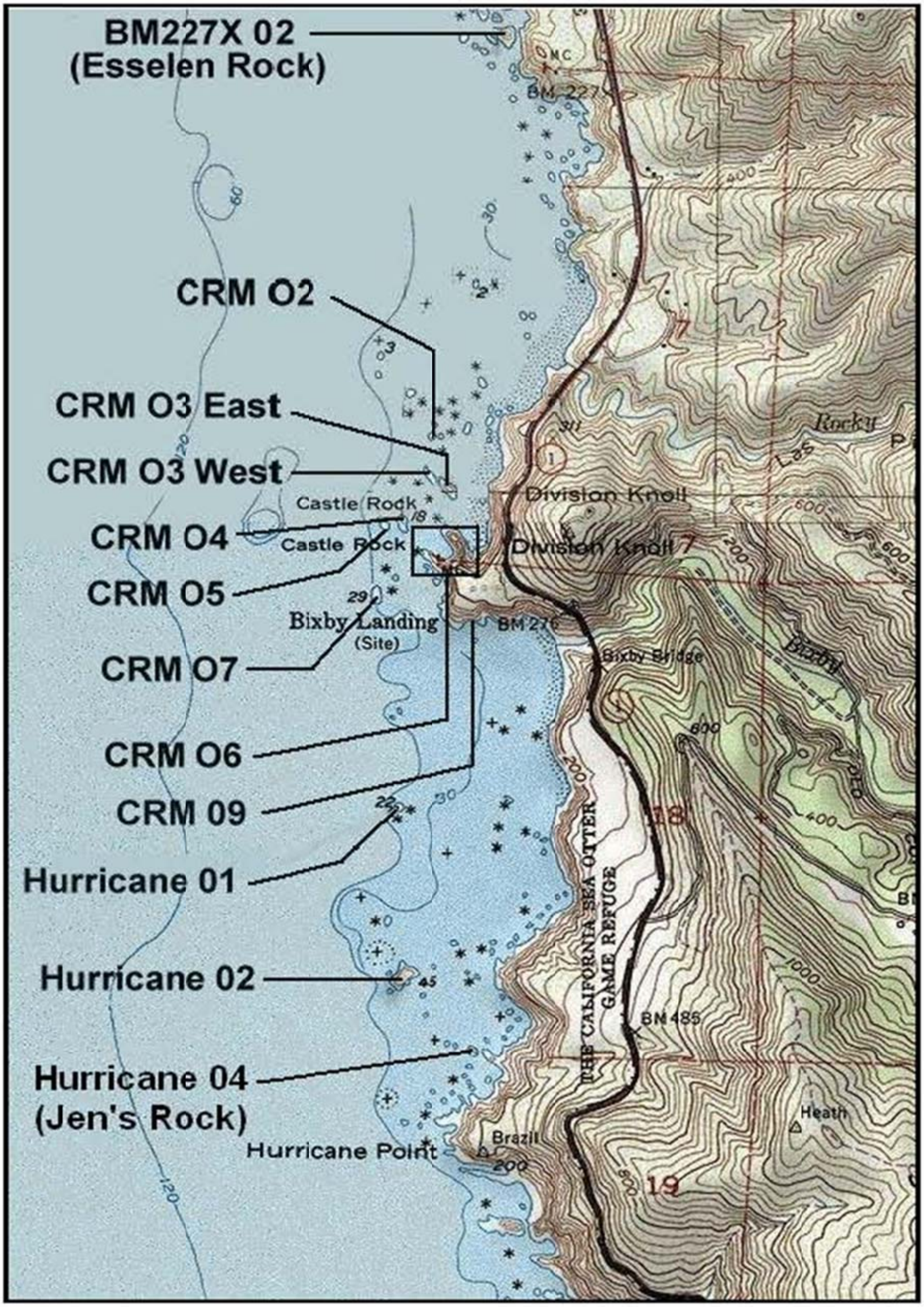


Figure 6. Map of Castle-Hurricane Colony Complex, including Bench Mark-227X (BM227X), Castle Rocks & Mainland (CRM), and Hurricane Point Rocks (Hurricane) colonies and subcolonies.

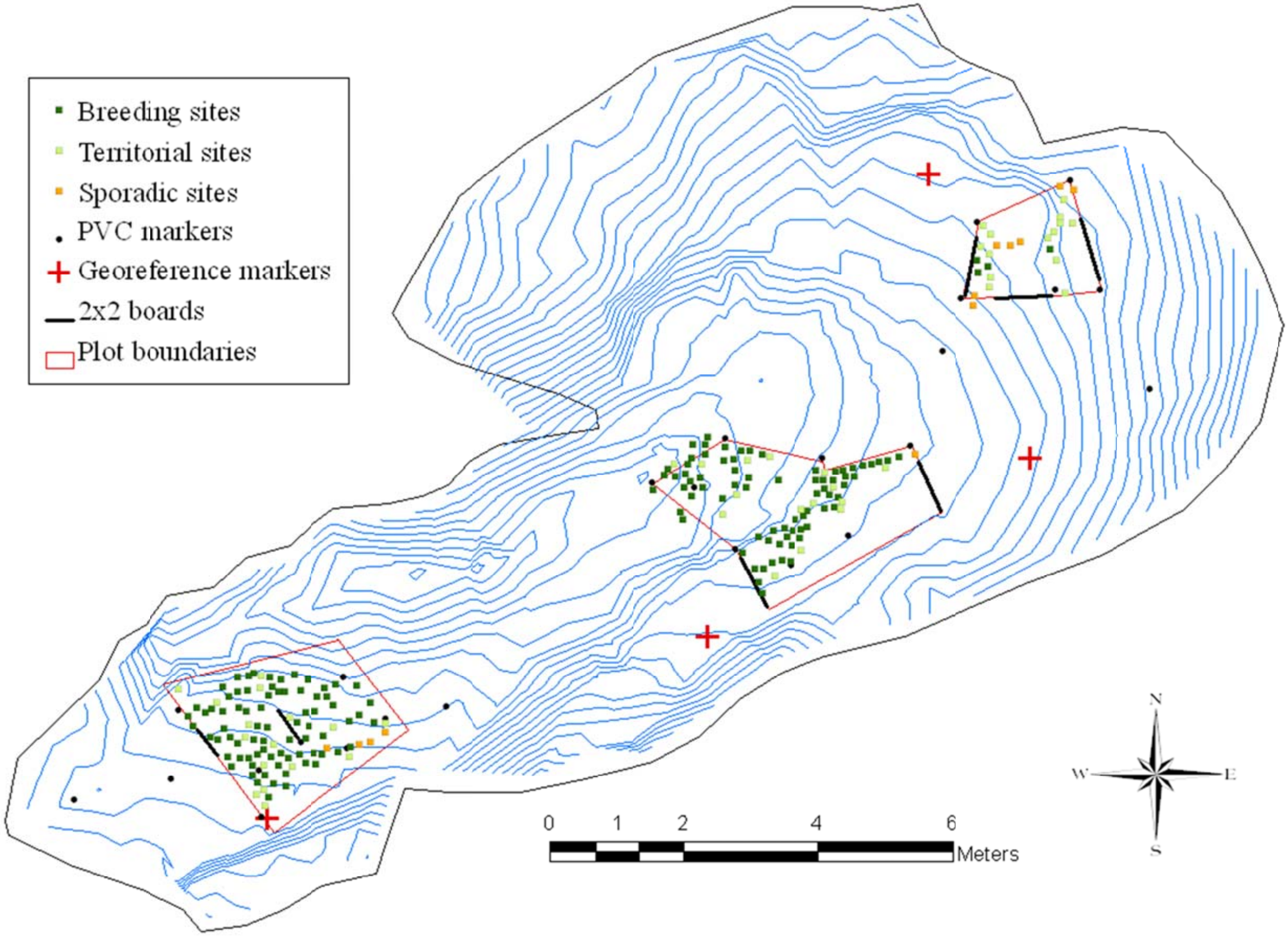


Figure 7. GIS map of Devil's Slide Rock, 2009. Shown are Common Murre breeding, territorial, and sporadic sites, plot boundaries, markers, and other features.

Figure 8. Observed aircraft overflights at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle Hurricane Colony Complex 2009, categorized by type.

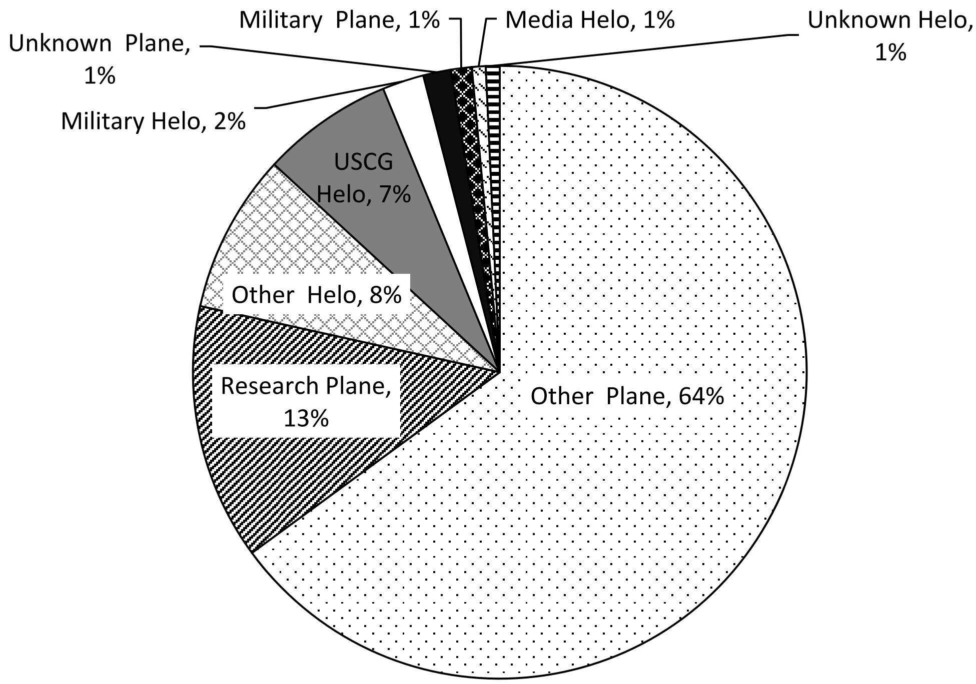
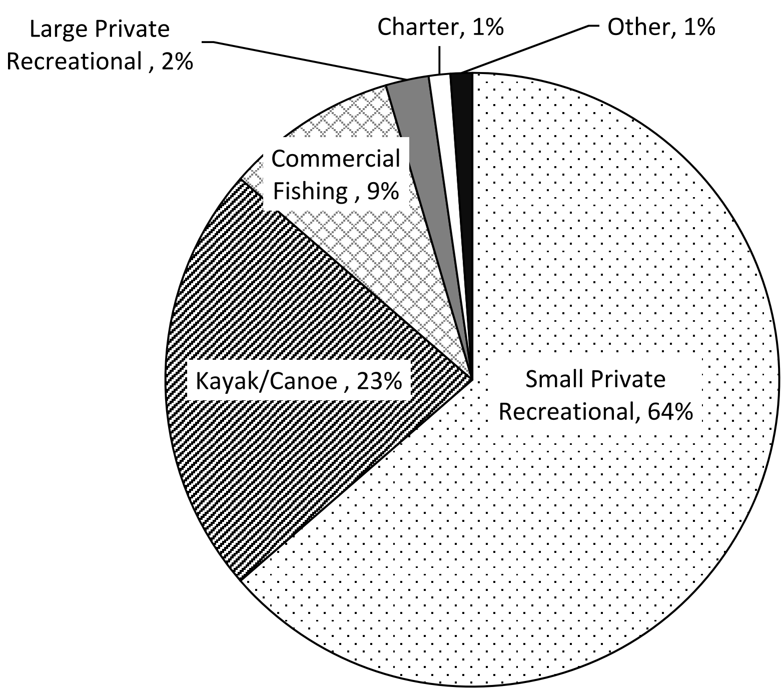


Figure 9. Observed watercraft at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle Hurricane Colony Complex 2009, categorized by type.



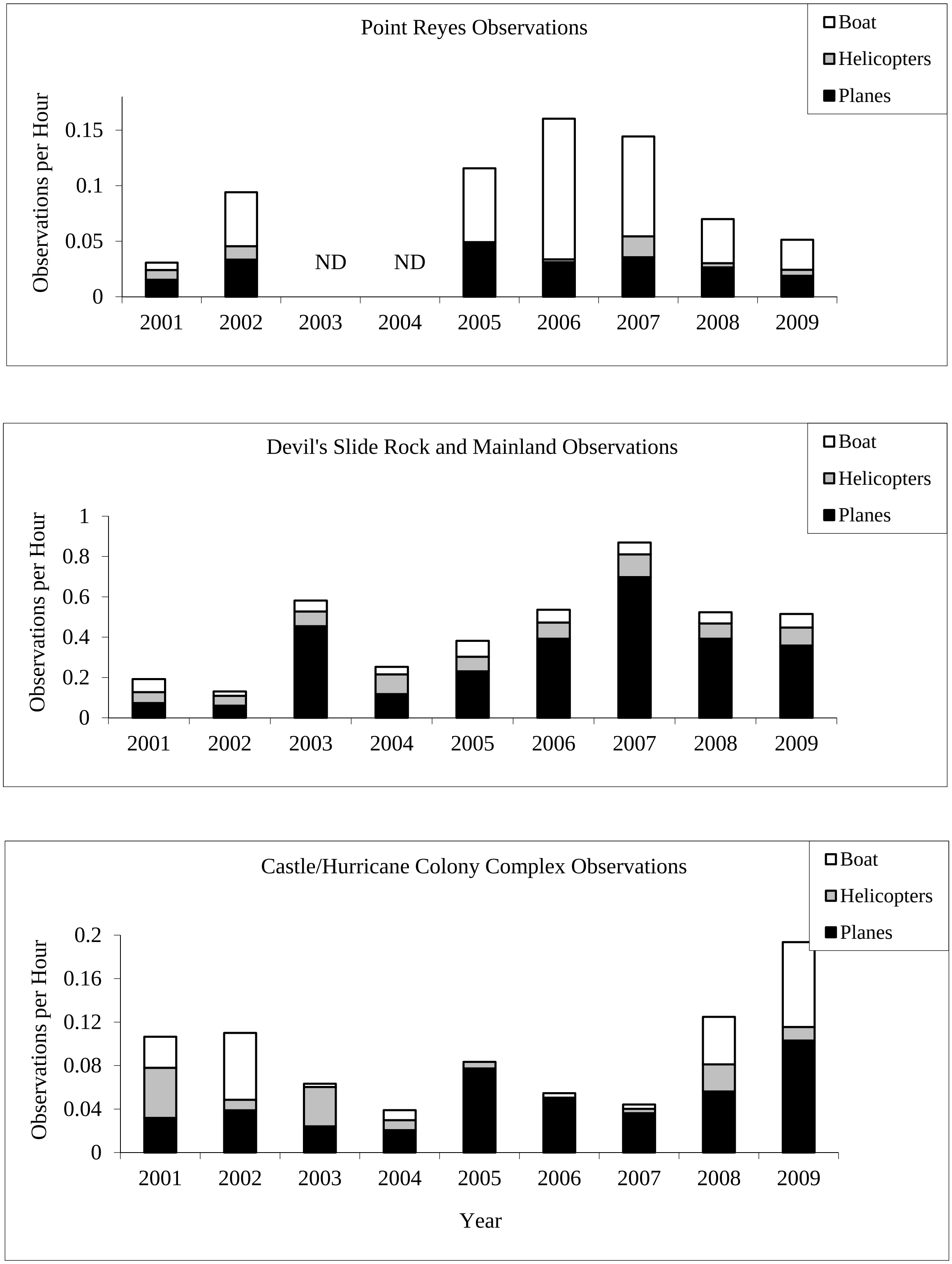
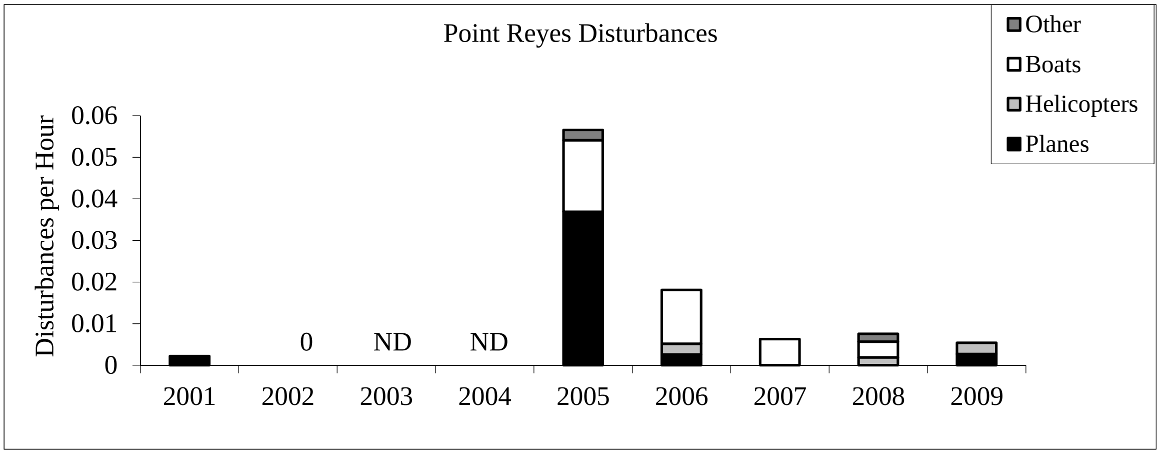
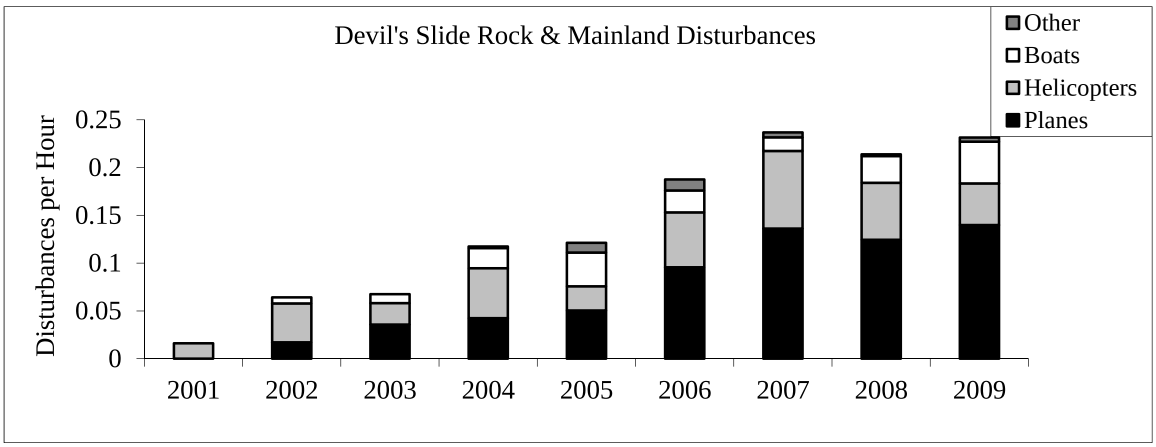


Figure 10. Observation rates (numbers/observation hour) of boats, helicopters, and planes at Point Reyes, Devil's Slide Rock & Mainland, and Castle Hurricane Colony Complex, 2001 to 2009. Please note the different scales on the y-axis.





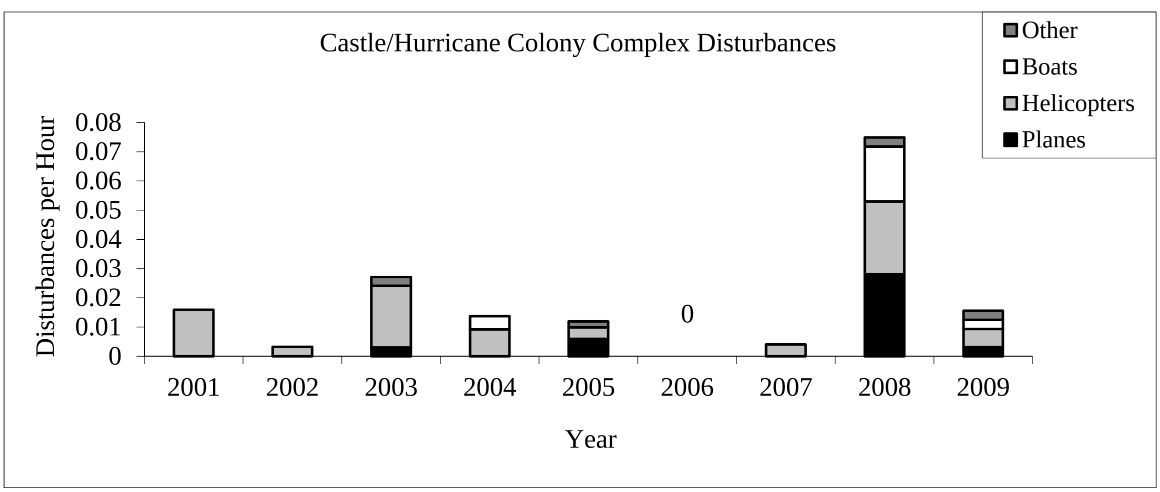
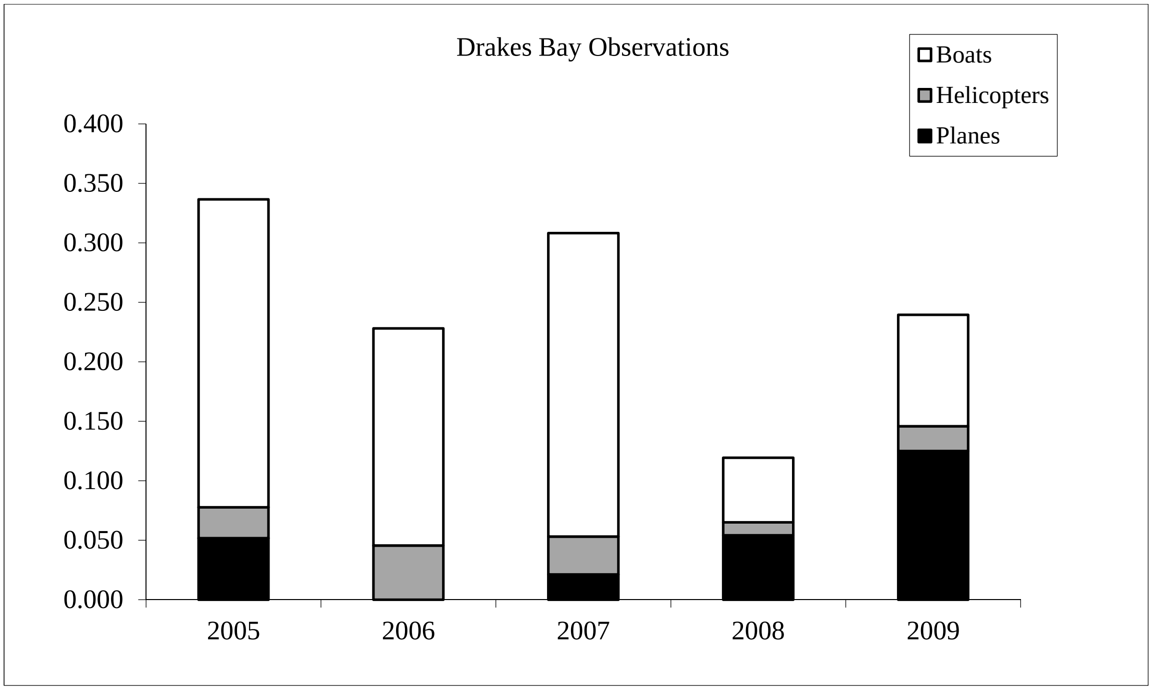


Figure 11. Disturbance rates (numbers per observation hour) of seabirds from boats, helicopters, planes, and other human sources at Point Reyes, Devil's Slide Rock 7 Mainland, and the Castle Hurricane Colony Complex, 2001-2009. Please note the different scales on the y-axis.



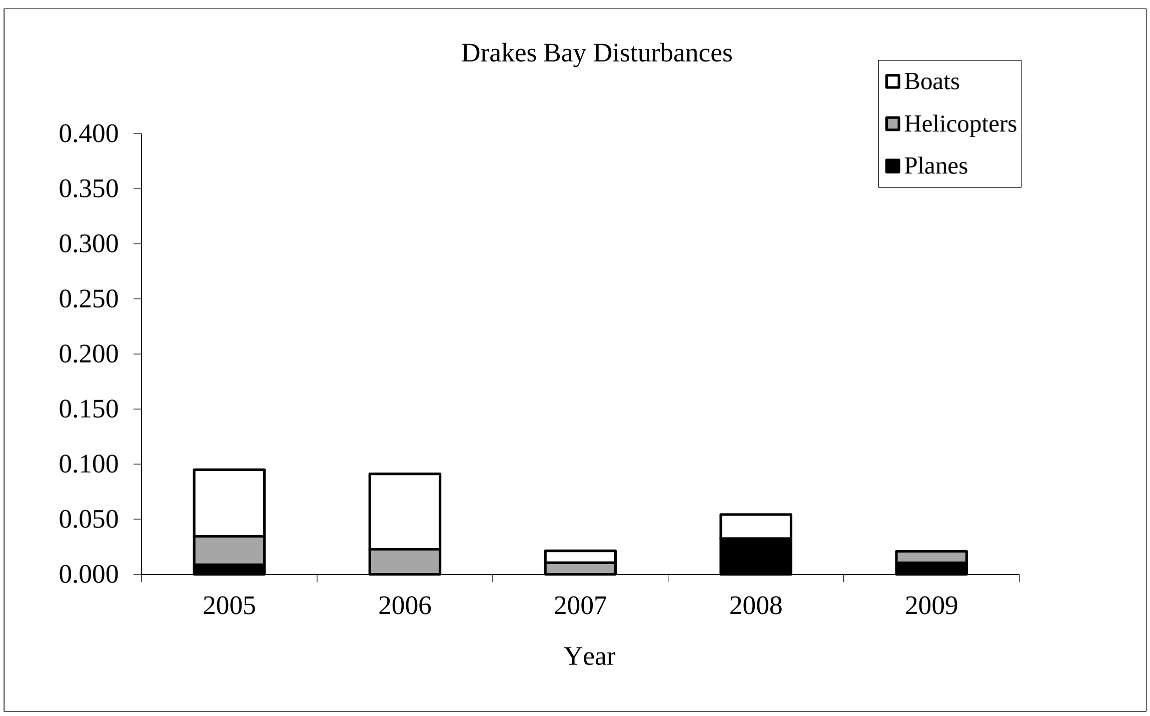


Figure 12. Observation and disturbance rates (numbers/observation hour) of boats, helicopters, and planes at Drakes Bay Colonies, 2005 to 2009.

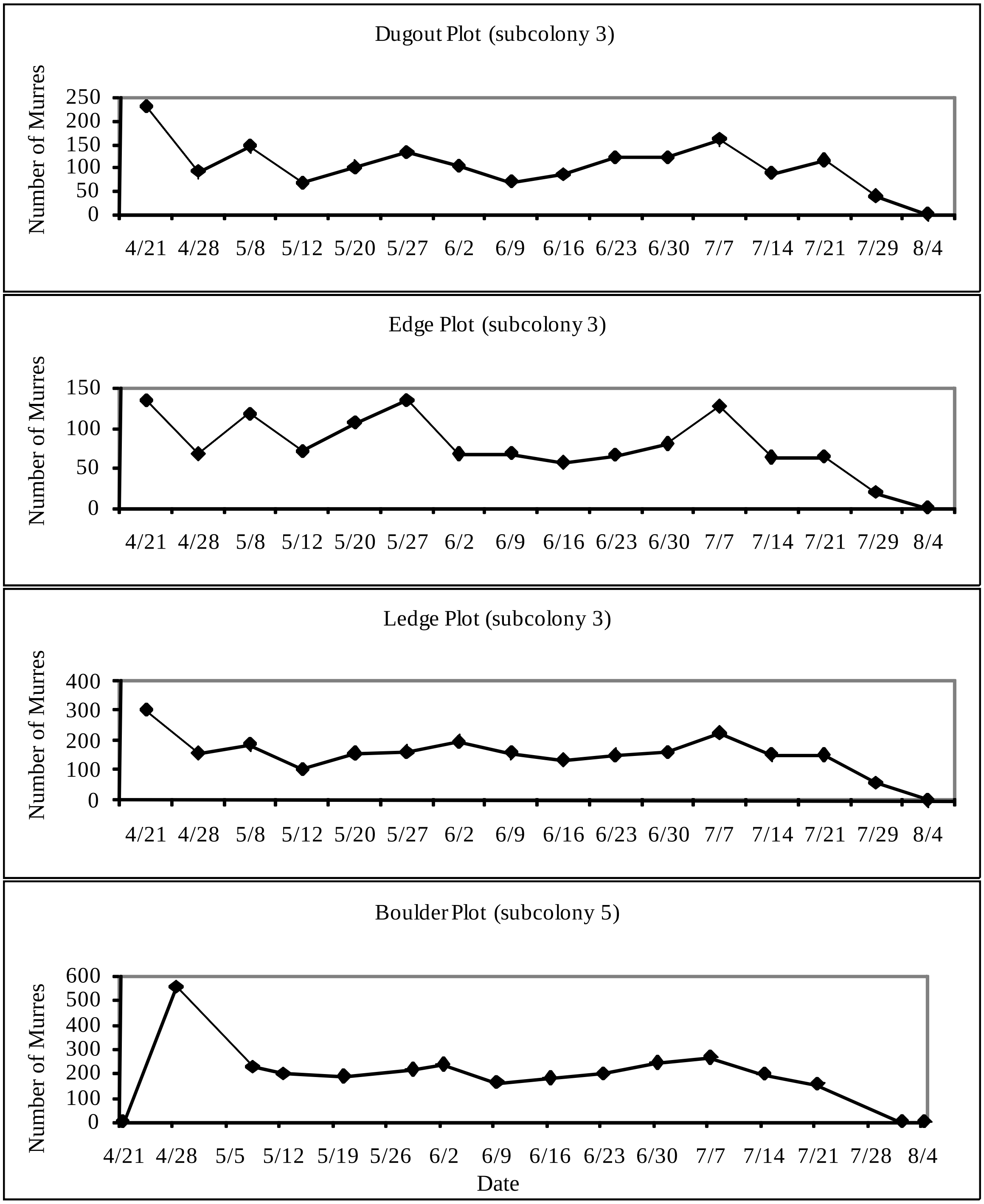


Figure 13. Seasonal attendance patterns of Common Murres at Dugout, Edge, Ledge and Boulder Plots, 21 April to 4 August 2009.

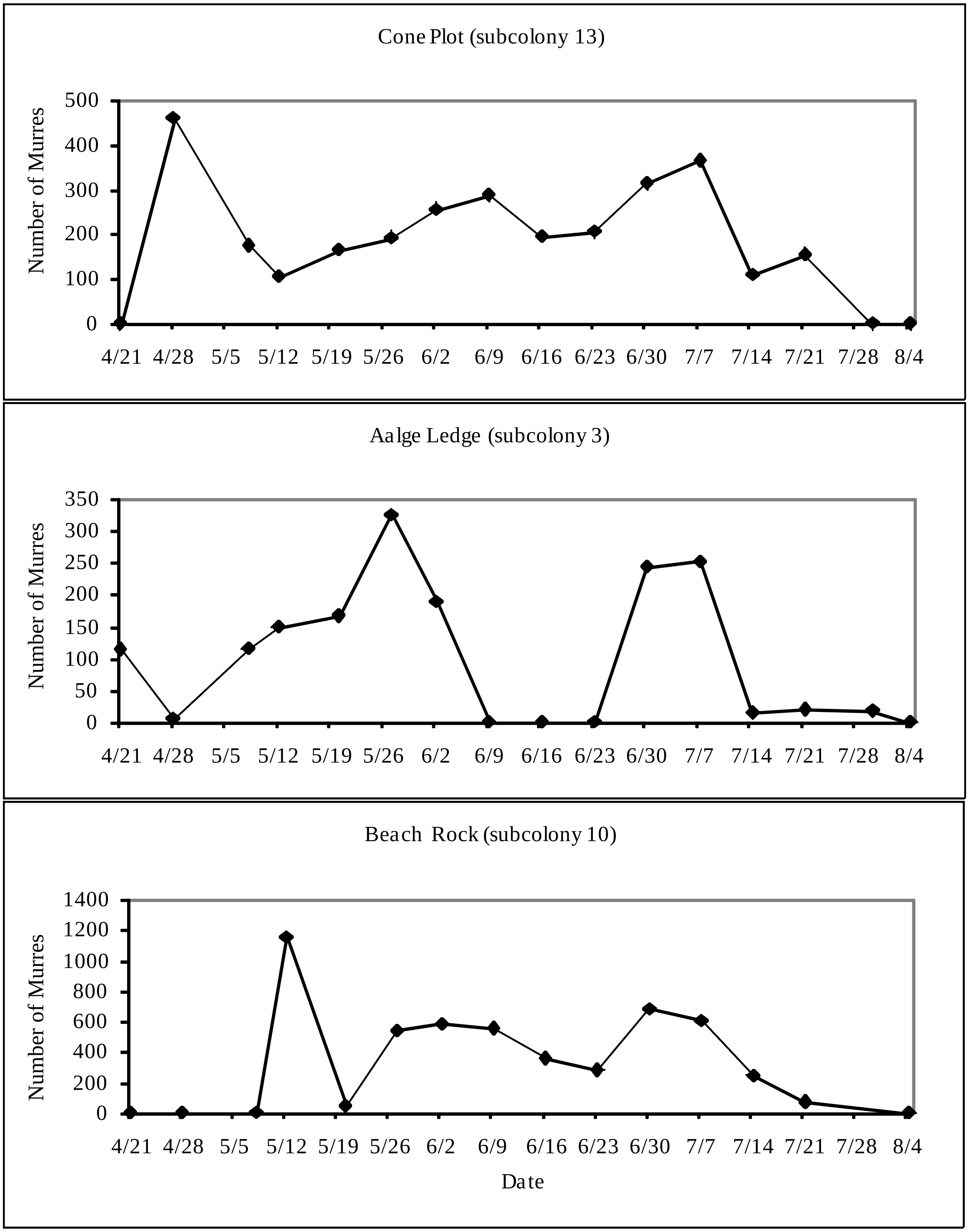


Figure 14. Seasonal attendance patterns of Common Murres at Cone Plot, Aalge Ledge, and Beach Rock, 21 April to 4 August 2009.

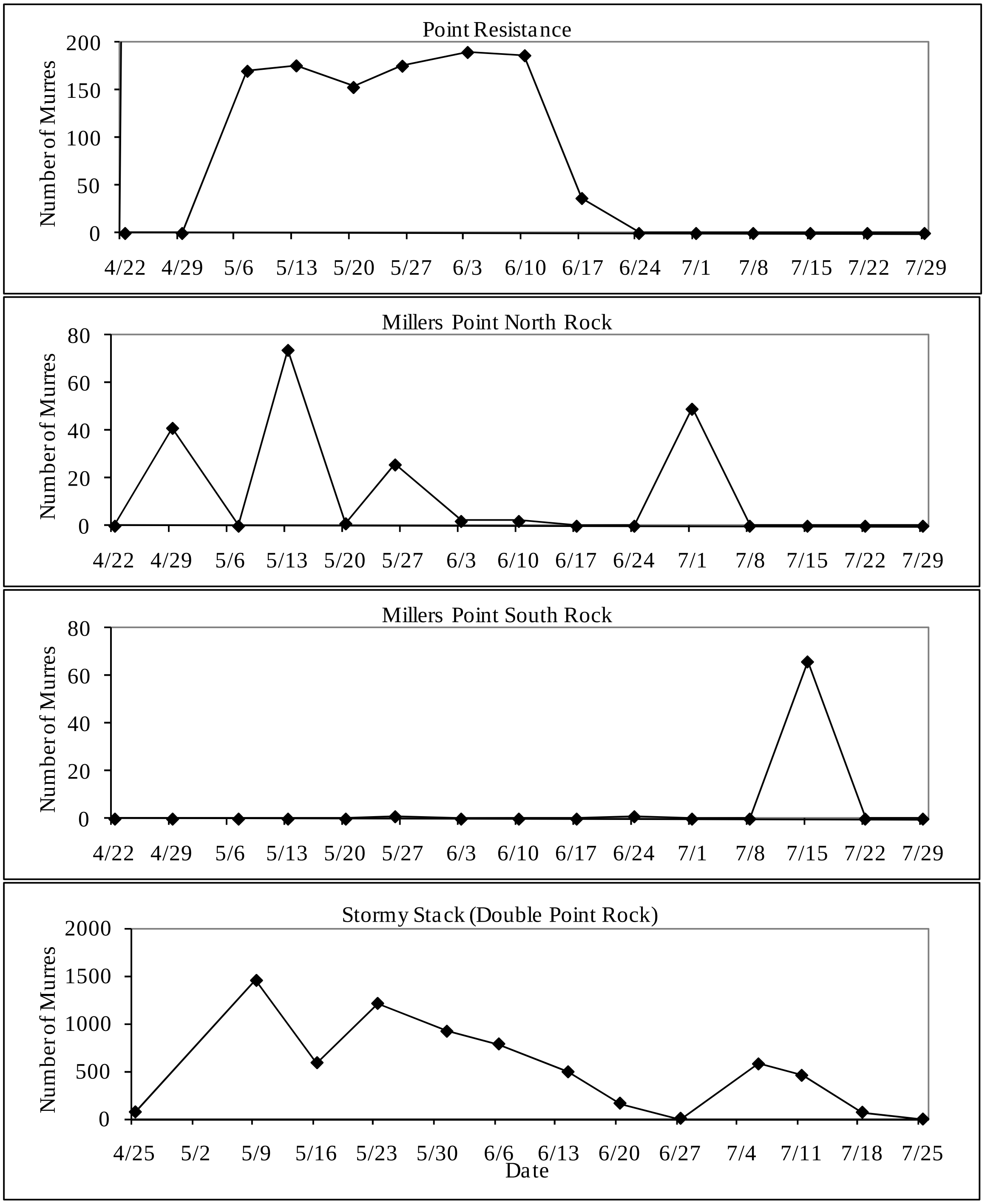


Figure 15. Seasonal attendance patterns of Common Murres at Drakes Bay: Point Resistance, Millers Point Rocks, and Stormy Stack, 25 April to 25 July 2009.

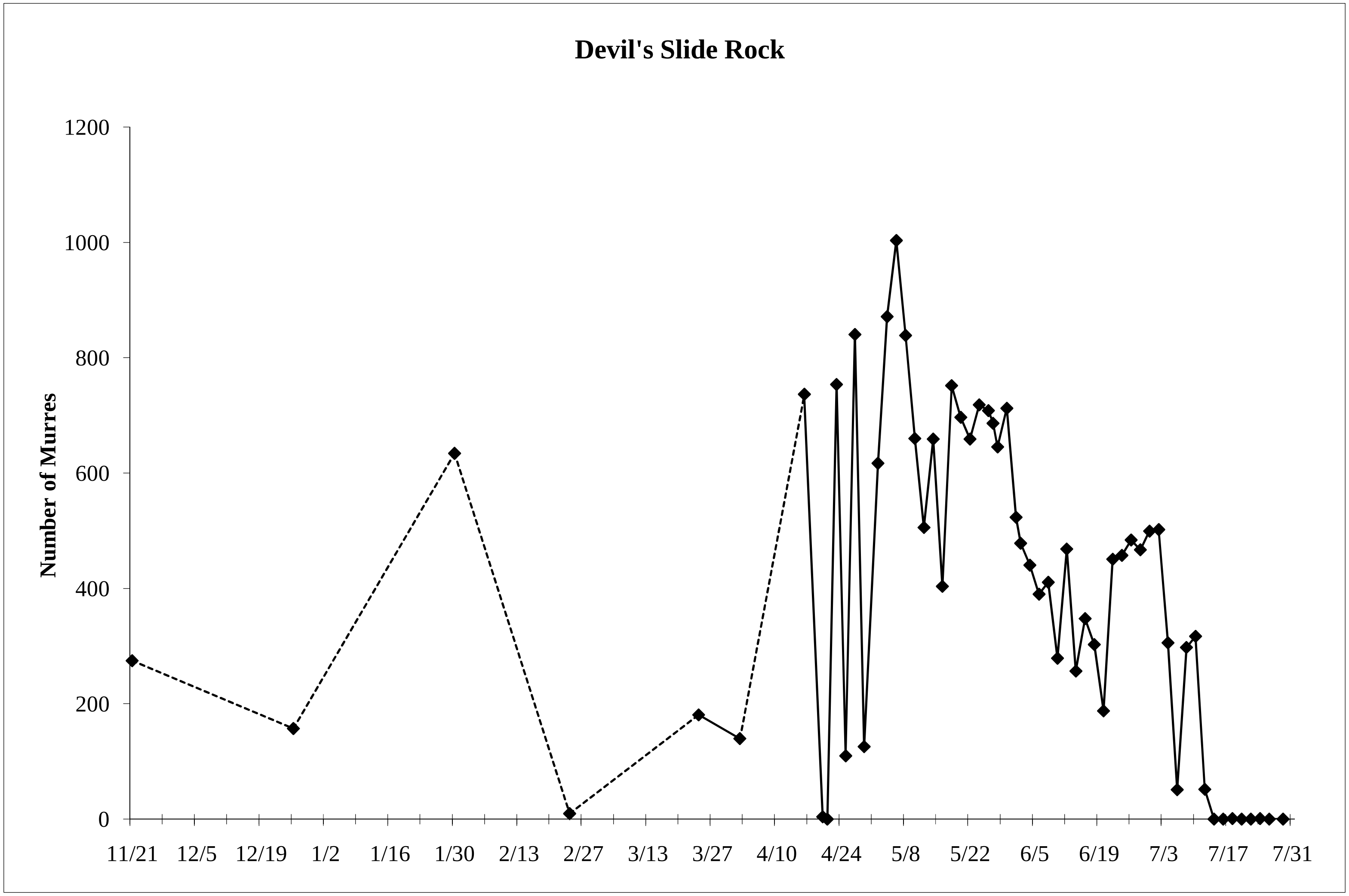


Figure 16. Seasonal attendance of Common Murres at Devil's Slide Rock, 21 November 2008 to 31 July 2009. Dashed line indicates pre-breeding season counts and solid line indicates breeding season counts.

Figure 17. Aerial photograph of Devil's Slide Rock, 8 June 2009, showing the distribution of the Common Murre breeding colony. Note lack of nesting Brandt's Cormorants.

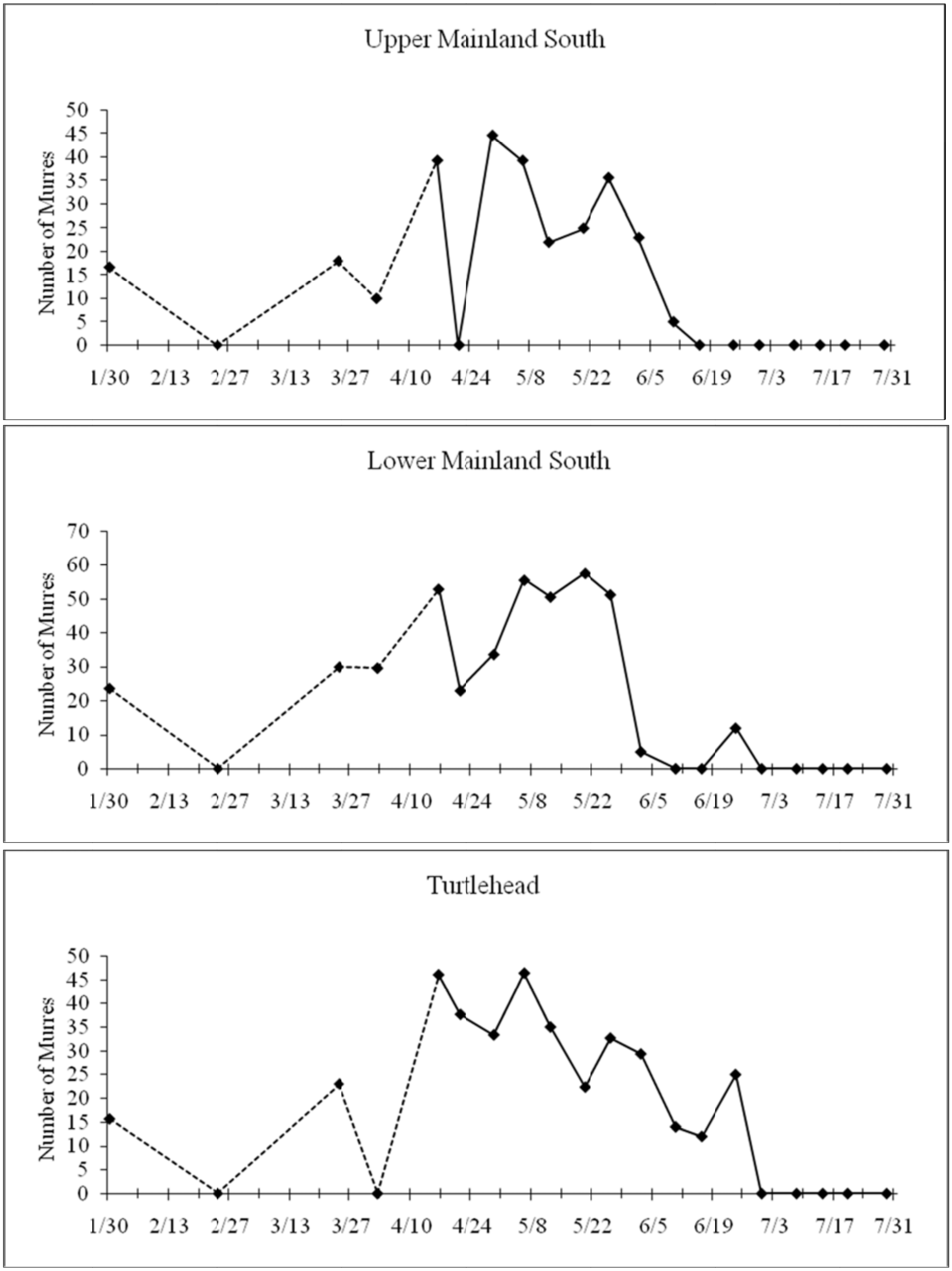


Figure 18. Seasonal attendance of Common Murres at Upper and Lower Mainland South and Turtlehead areas, 30 January 2009 to 31 July 2009. Dashed lines indicate pre-breeding season counts and solid lines indicate breeding season counts.

Figure 19. Location of breeding sites at Devil's Slide Mainland on top of a large boulder near the base of Turtlehead (SC05), "Turtlehead Boulder". Photo taken on 12 June 2009.

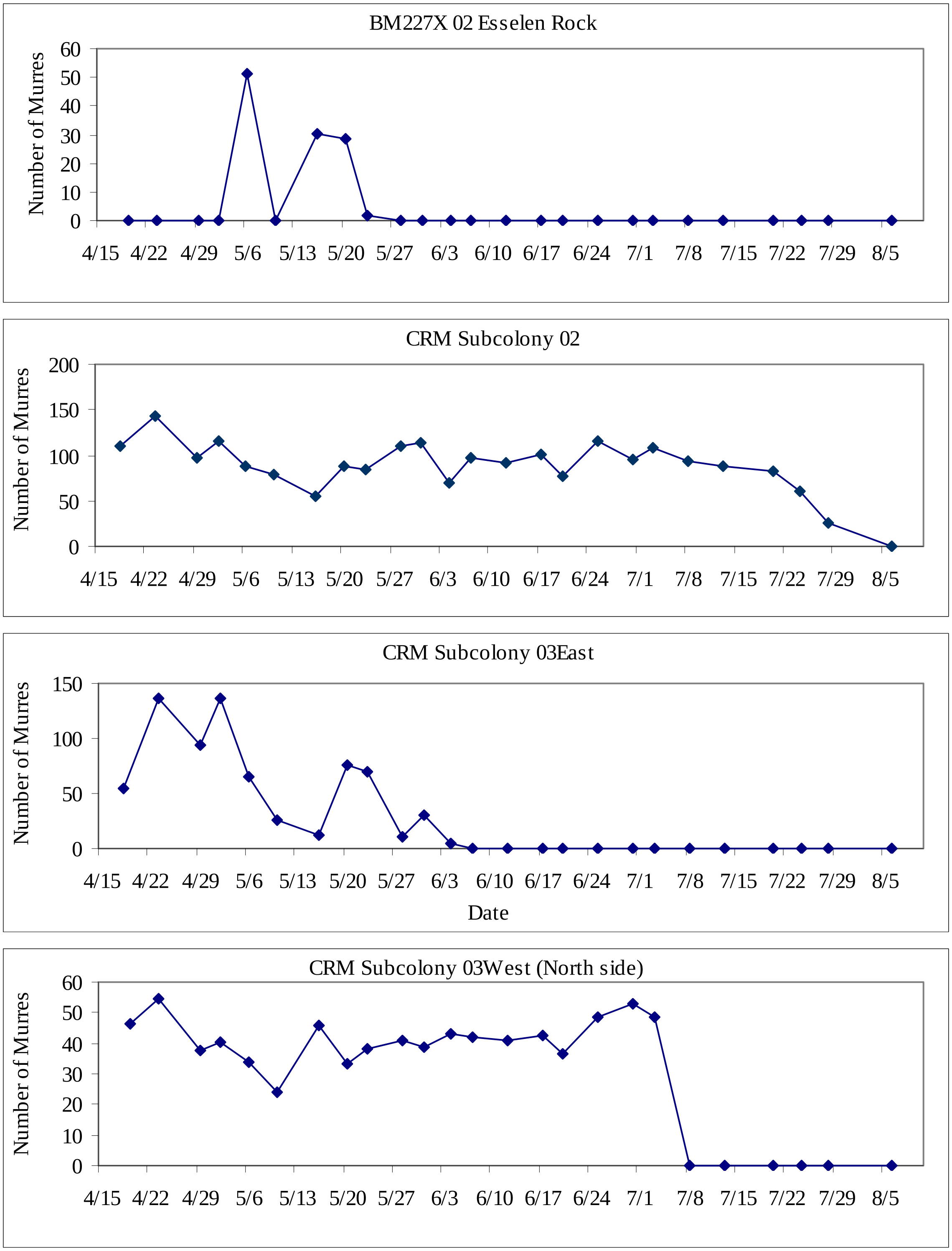


Figure 20. Seasonal attendance patterns of Common Murres at Bench Mark-227X subcolony 02 and Castle Rocks & Mainland subcolonies 02, 03East and 03West (North side), 18 April to 6 August 2009.

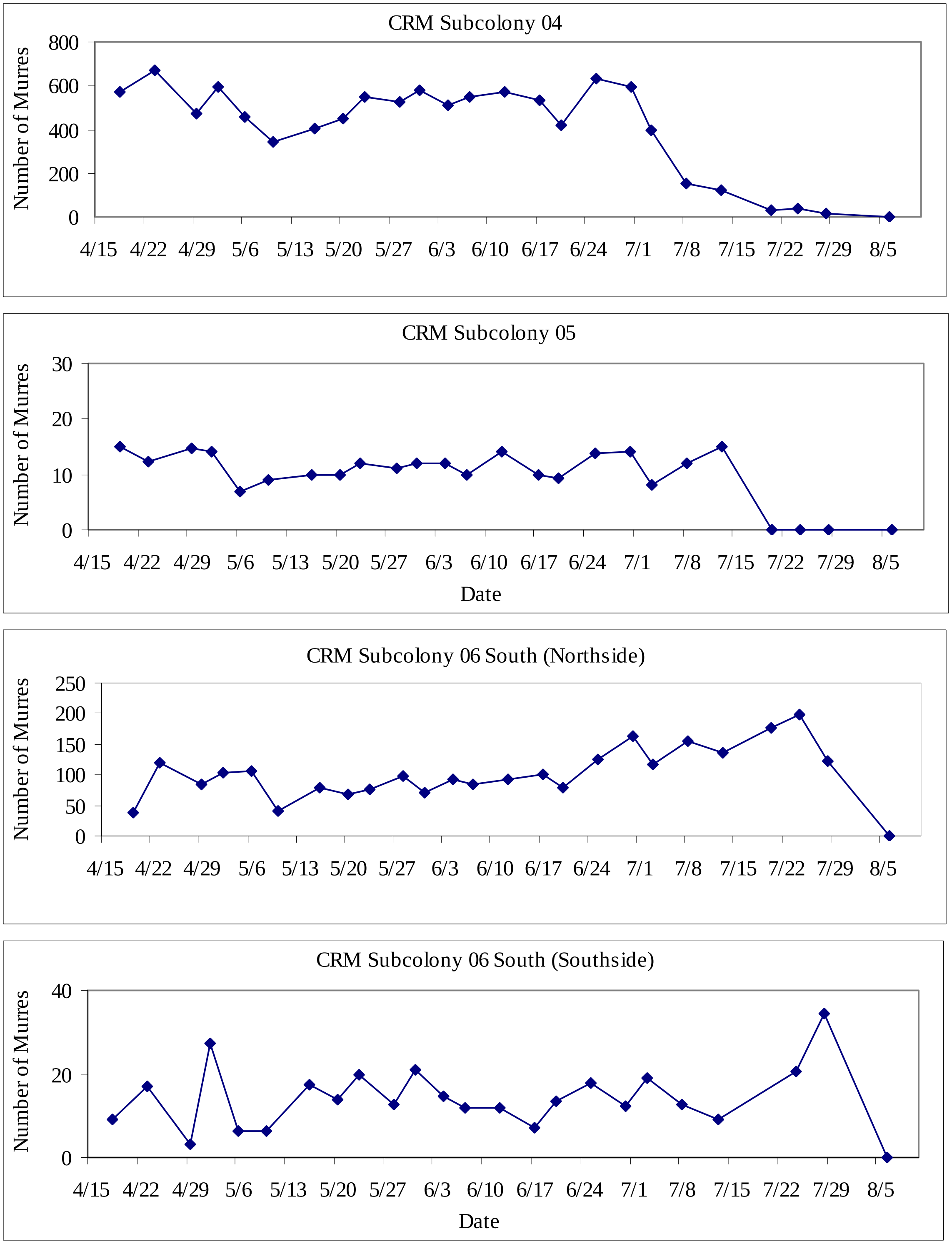


Figure 21. Seasonal attendance patterns of Common Murres at Castle Rocks & Mainland subcolonies 04, 05, 06South (north side) and 06South (south side), 18 April to 6 August 2009.

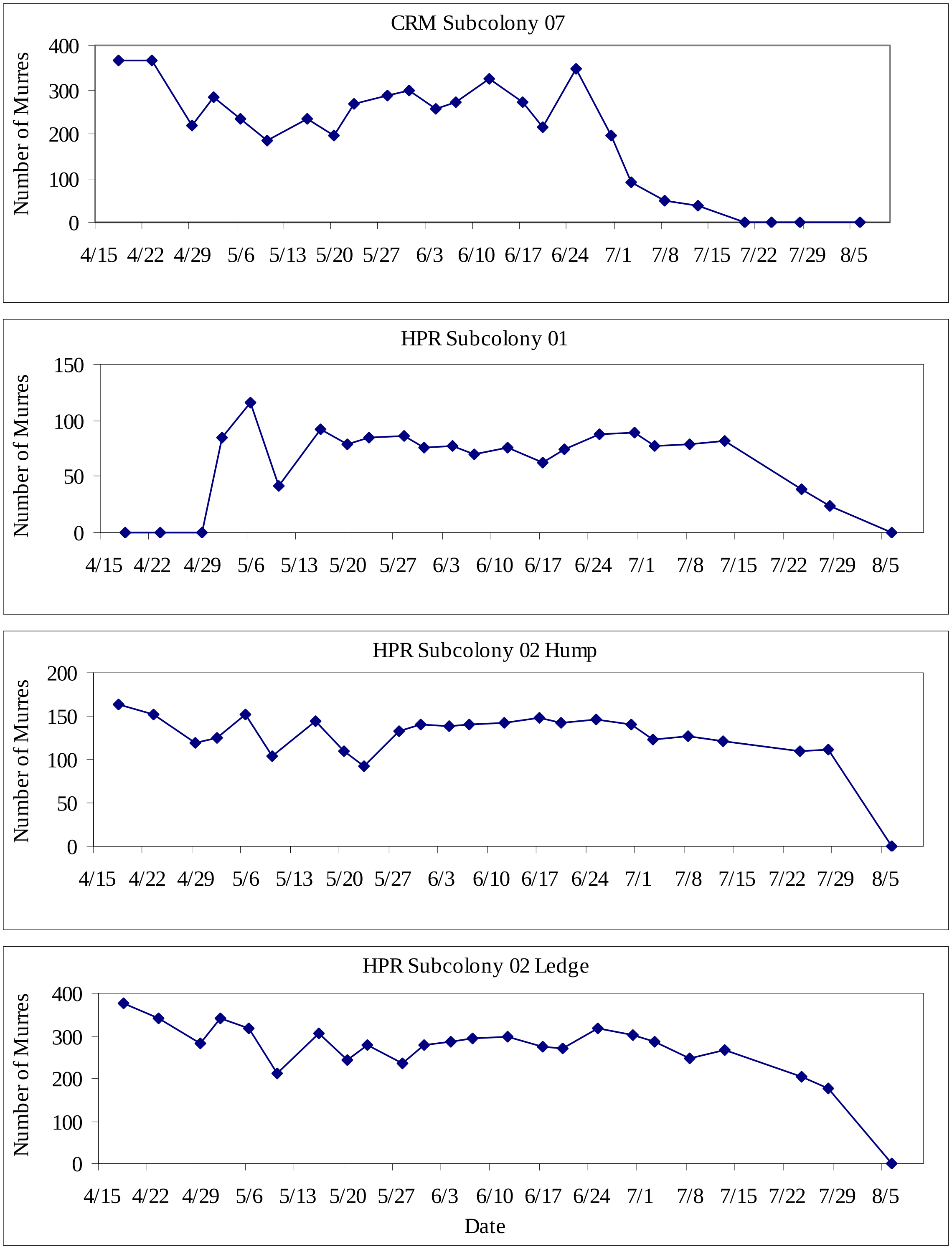


Figure 22. Seasonal attendance patterns of Common Murres at Castle Rocks & Mainland subcolony 07 and Hurricane Point Rocks subcolonies 01 and 02 (Hump and Ledge subareas), 18 April to 6 August 2009.

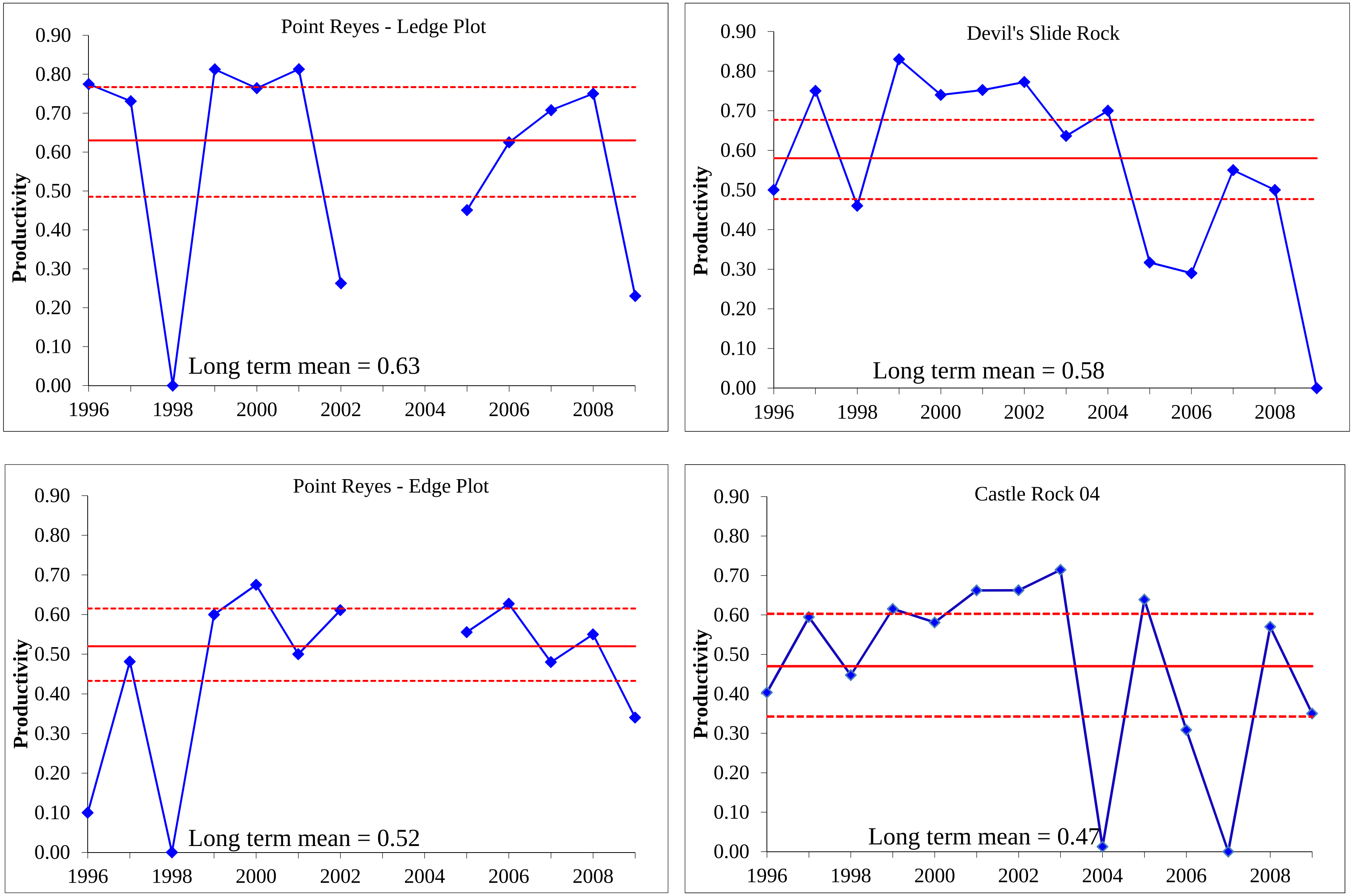


Figure 23. Productivity of Common Murres at Point Reyes (Ledge and Edge plots), Devil's Slide Rock, and Castle Rock 04 plot, 1996-2009. The solid horizontal line indicates the long term weighted mean and dashed lines represent the 95% confidence interval.

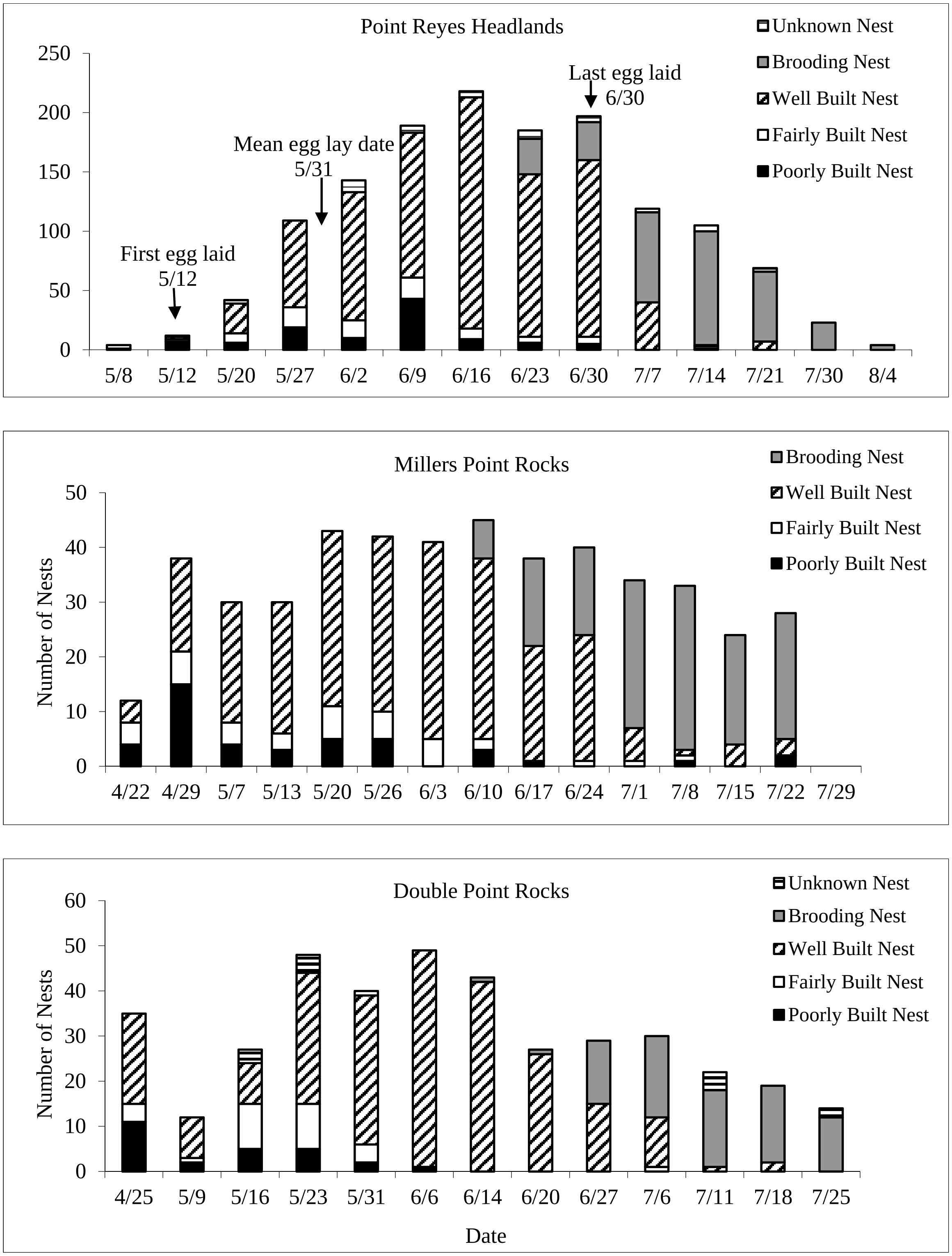


Figure 24. Numbers of Brandt's Cormorant nests counted weekly at Point Reyes Headlands and Drakes Bay, 22 April to 25 July 2009, in relation to breeding phenology at monitored nests.

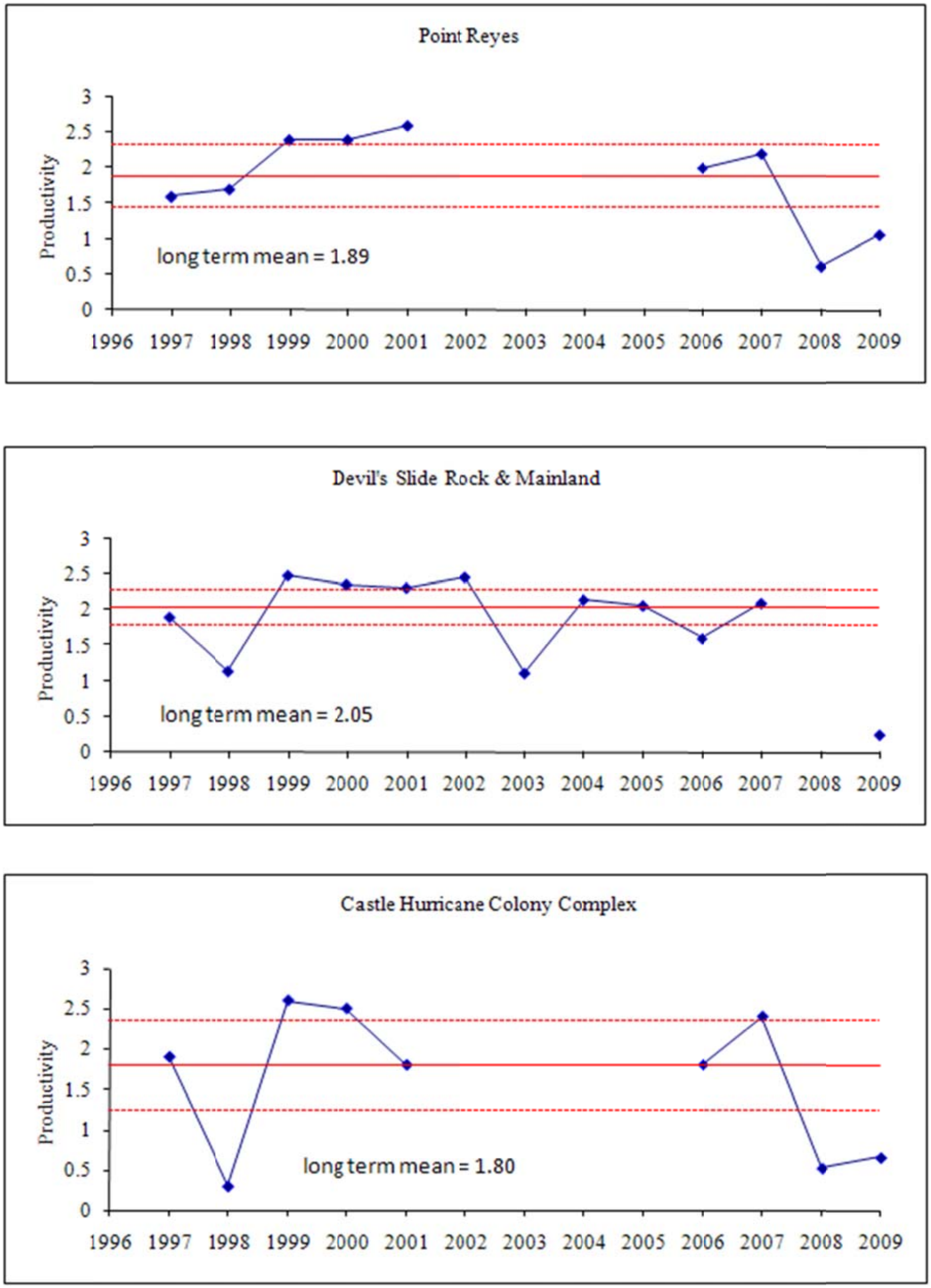


Figure 25. Long term Brandt's Cormorant productivity at Point Reyes, Devil's Slide Rock & Mainland, and Castle Hurricane Colony Complex (Long term mean, 95% CI).

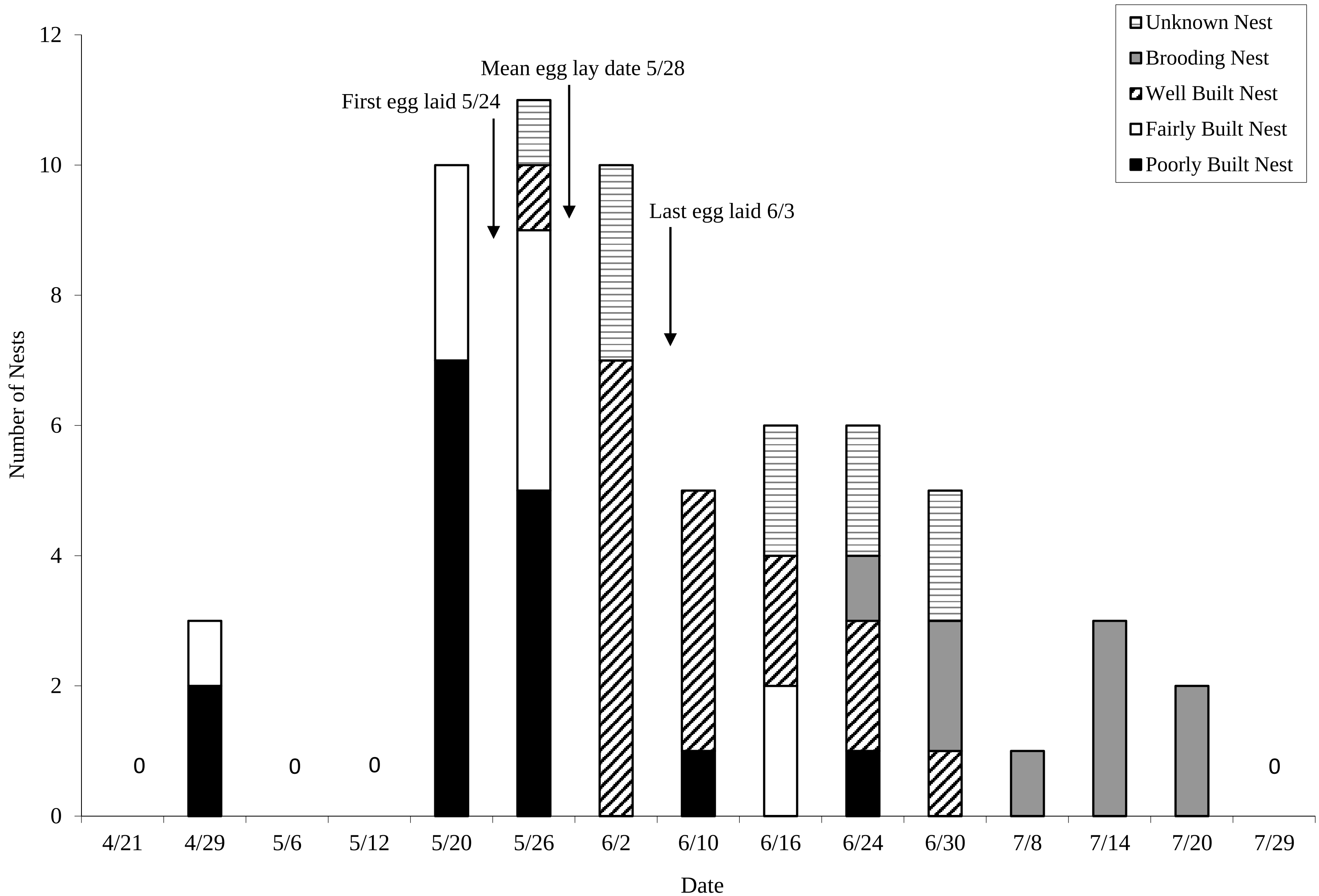


Figure 26. Numbers of Brandt's Cormorant nests counted weekly at Devil's Slide Rock & Mainland, 21 April to 29 July 2009, in relation to breeding phenology at monitored nests.

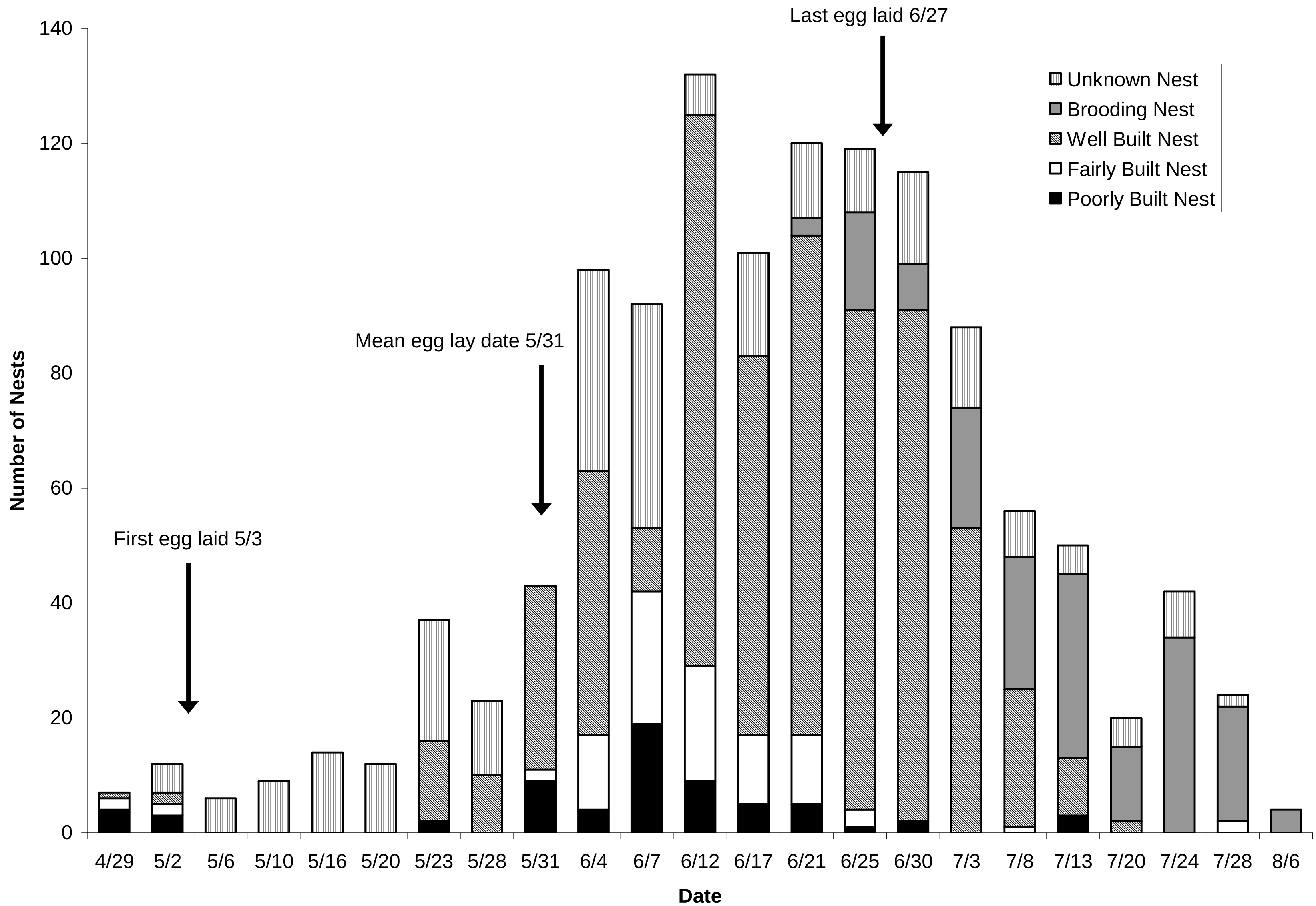


Figure 27. Numbers of Brandt's Cormorant nests counted bi-weekly at Castle-Hurricane Colony Complex, 29 April to 6 August 2009, in relation to breeding phenology at monitored nests. Survey on 20 July was incomplete.

Figure 28. Locations of Common Raven detections along Highway 1 between Point Lobos and Point Sur, California, 2009.

Appendix 1. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at Point Reyes, 2009.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	1	0	0	0	0	0	0	0	0	0
USCG	1	2	0	1	0	0	1	0	1	1
Military	1	0	0	0	0	0	0	0	unk	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	4	0	1	0	0	0	0	0	1	0
Unknown	0	0	0	0	0	0	0	0	0	0

Appendix 2. Numbers of observed watercraft categorized by type and resulting disturbance events recorded at Point Reyes, 2009.

Watercraft Type	Total Observations	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	0	0	0	0	0
Recreational (≤25') Small Private	10	0	0	0	0
Recreational (>25') Large Private	1	0	0	0	0
Charter	1	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	0	0	0	0	0
Law Enforcement	0	0	0	0	0
USCG	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

Appendix 3. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at Point Resistance, 2009.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	3	0	0	0	0	0	0	0	0	0
USCG	0	0	0	0	0	0	0	0	0	0
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Appendix 4. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at Miller's Point Rocks, 2009.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	0	0	0	0	0	0	0	0	0	0
USCG	0	0	0	0	0	0	0	0	0	0
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	0	1	0	0	0	0	0	0	unk	0
Unknown	0	0	0	0	0	0	0	0	0	0

Appendix 5. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at Double Point Rocks, 2009.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	1	0	0	0	0	0	0	0	0	0
USCG	0	1	0	0	0	0	0	1	0	1
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	7	0	2	0	0	0	1	0	3	0
Unknown	1	0	0	0	0	0	0	0	0	0

Appendix 6. Numbers of observed watercraft categorized by type and resulting disturbance events recorded at Double Point Rocks, 2009.

Watercraft Type	Total Observations	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	1	0	0	0	0
Recreational (≤25') Small Private	7	0	0	0	0
Recreational (>25') Large Private	0	0	0	0	0
Charter	0	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	0	0	0	0	0
Law Enforcement	0	0	0	0	0
USCG	0	0	0	0	0
Other	1	0	0	0	0
Unknown	0	0	0	0	0

Appendix 7. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at Devil's Slide Rock & Mainland, 2009.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	6	0	2	0	0	0	0	0	2	0
USCG	0	16	0	8	0	0	0	0	0	8
Military	0	6	0	2	0	0	0	1	0	3
Law Enforcement	0	1	0	0	0	0	0	0	0	0
Other	163	21	64	9	0	0	3	1	67	10
Unknown	1	0	0	0	0	0	0	0	0	0

Appendix 8. Numbers of observed watercraft categorized by type and resulting disturbance events recorded at Devil's Slide Rock & Mainland, 2009.

Watercraft Type	Total Observations	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	0	0	0	0	0
Recreational (≤25') Small Private	24	3	0	12	15
Recreational (>25') Large Private	0	0	0	0	0
Charter	0	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	17	3	0	8	11
Law Enforcement	0	0	0	0	0
USCG	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

Appendix 9. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at the Castle Hurricane Colony Complex, 2009.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	2	0	1	0	0	0	0	0	1
Research	26	0	1	0	0	0	0	0	1	0
USCG	0	0	0	0	0	0	0	0	0	0
Military	2	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	4	1	0	0	0	0	0	1	0	1
Unknown	2	2	0	0	0	0	0	0	0	0

Appendix 10. Numbers of observed watercraft categorized by type and resulting disturbance events recorded at the Castle Hurricane Colony Complex, 2009.

Watercraft Type	Total Observations	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	7	1	0	0	1
Recreational (≤25') Small Private	15	0	0	0	0
Recreational (>25') Large Private	1	0	0	0	0
Charter	0	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	3	0	0	0	0
Law Enforcement	0	0	0	0	0
USCG	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0