RESTORATION OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2007

REPORT TO THE *APEX HOUSTON* TRUSTEE COUNCIL
AND
COMMAND TRUSTEE COUNCIL

Gerard J. McChesney[1], Lisa E. Eigner[2], Peter J. Kappes[2], Travis B. Poitras[2], Deasy N. Lontoh[2], Sandra J. Rhoades[2], Nicholas J. Metheny[2], Richard T. Golightly[2], Phillip J. Capitolo[2], Harry R. Carter[3], Stephen W. Kress[4], and Michael W. Parker[5]

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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The Common Murre Restoration Project is conducted cooperatively by the U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex (USFWS-SFBNWRC), Humboldt State University (HSU), the National Audubon Society (NAS), and Carter Biological Consulting. In 2007, funding and oversight were provided by the *Apex Houston* Trustee Council (made up of USFWS, National Oceanic and Atmospheric Administration [NOAA], and California Department of Fish and Game [CDFG]) and the *Command* Trustee Council (made up of USFWS, NOAA, CDFG, California State Parks, and California State Lands Commission).

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EXECUTIVE SUMMARY

This report summarizes the twelfth year of seabird restoration and associated monitoring in central California conducted by the Common Murre Restoration Project (CMRP) in 2007. These efforts began in 1995 to restore breeding colonies of seabirds, especially Common Murres (*Uria aalge*), harmed by the 1986 *Apex Houston* oil spill, gill net fishing, and other factors. Our initial primary goal was to restore the extirpated Devil's Slide Rock murre colony, as well as to restore and assess other colonies impacted by the spill or other historical anthropogenic factors. In addition to direct restoration efforts, the CMRP has gathered baseline data on population size, reproductive success, and factors affecting seabird populations in central California. In 2005-07, the CMRP also gathered baseline data for assessing 1) impacts of human disturbance and 2) expected improvements in population size and reproductive success at breeding colonies resulting from reductions in human disturbances with restoration funds from the 1998 *Command* oil spill. The goal of this program is to restore affected breeding colonies mainly through reduction of human disturbance.

At Devil's Slide Rock, a murre colony was reestablished in 1996 using social attraction techniques. Social attraction techniques continued until 2005 to assist and ensure colony growth. In 2007, monitoring at Devil's Slide Rock focused on assessing the potential effects of: 1) social attraction equipment removal; 2) the continued growth of the colony; and 3) human and other disturbance. At other colonies, we focused on assessing the potential impacts of human and other disturbances to murres and other seabirds. Colonies or colony complexes monitored regularly included: Devil's Slide Rock and Mainland; Castle/Hurricane Colony Complex (including Bench Mark-227X, Castle Rocks and Mainland, and Hurricane Point Rocks); Point Reyes; Point Resistance; Millers Point Rocks; and Double Point Rocks. Besides recorded disturbances, for the Common Murre data gathered included: seasonal attendance patterns; breeding population sizes; breeding phenology; reproductive success; and adult co-attendance and chick provisioning rates (Devil's Slide Rock only). For the Brandt's Cormorant (*Phalacrocorax penicillatus*), data were collected on breeding phenology, breeding success, and breeding population sizes. We also surveyed breeding population sizes of Pelagic Cormorant (*P. pelagicus*), Black Oystercatcher *(Haematopus bachmani*), Western Gull (*Larus occidentalis*), and Pigeon Guillemot (*Cepphus columba*), and monitored productivity for the former three species on an opportunistic basis.

On Devil's Slide Rock in 2007, 394 breeding pairs of murres were estimated, a 9% increase from 2006 and the largest breeding population size since restoration efforts began in 1996. Breeding success of a sample of 134 nest sites was 0.55 chicks per pair, which is below the long-term mean (0.60) but substantially higher than in 2005 and 2006. Murres also bred on the Devil's Slide Mainland (50 pairs) for the third consecutive year and fledged 0.48 chicks per pair. Murre breeding success at Point Reyes (0.61) was above the long-term average. Large-scale Brown Pelican (*Pelecanus occidentalis*) disturbance at Castle Rocks and Mainland led to total breeding failure of our single monitored plot and near complete breeding failure of the entire Castle Rocks and Mainland and Hurricane Point Rocks colonies. For Brandt's Cormorants, breeding success was relatively high. Productivity of other seabird species varied, with relatively high success at Point Reyes and Devil's Slide and relatively low success at Castle/Hurricane. Human disturbance from aircraft increased from 2006 at both Devil's Slide and Castle/Hurricane Colony Complex, while aircraft disturbance rates remained similar at Point Reyes. Disturbance from watercraft was similar to other recent years at all three colony complexes. Common Ravens (*Corvus corax*) resulted in many murre flushing events and at least occasional nest predation at Point Reyes, Point Resistance, Miller's Point Rocks, and Double Point Rocks. Raven predation apparently led to partial abandonment of Miller's Point Rocks. Brown Pelicans, mainly single juveniles, caused several major disturbances to murres at Point Reyes and Double Point Rocks, including loss of eggs and chicks.

INTRODUCTION

Common Murre (*Uria aalge*) breeding colonies in central California occur on certain nearshore rocks and adjacent mainland points 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 by these mortality factors. Nearby San Pedro Rock was extirpated in the early 20th century primarily by commercial egg harvesters (Ray 1909; Carter et al. 2001). Since 1995, the Common Murre Restoration Project (CMRP) has sought to restore these and other central California colonies using social attraction and other techniques. Social attraction techniques were utilized at Devil's Slide Rock (1996-2005) and San Pedro Rock (1998-2004). Restoration efforts at other colonies in central California, especially the Castle/Hurricane Colony Complex in Monterey County, have focused mainly on documenting impacts to colonies and working with other agencies and the public to reduce disturbances and other mortality factors.

Small to moderate increases in the central California murre population occurred in the early 1990s, apparently due to partial restrictions on gill-net fishing and reduced oil pollution (Carter et al. 2001). However, Devil's Slide Rock was not recolonized by 1995 and most other colonies remained in a reduced state compared to the early 1980s. Extensive gill-net mortality of murres redeveloped in the mid-1990s and continued to at least 2000 (Forney et al. 2001; NOAA-National Marine Fisheries Service, unpubl. data). To halt the large-scale mortality of seabirds and marine mammals, the California Department of Fish and Game (CDFG) enacted an emergency closure of this gill-net fishery in September 2000, and a permanent closure on gill-net fishing in waters <60 fathoms depth from Point Reyes to Point Arguello was enacted in September 2002. In addition, 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 early 2000s) has continued to kill thousands of murres in central California (Carter 2003; Carter and Golightly 2003; Hampton et al. 2003; Roletto et al. 2003). Anthropogenic and avian disturbances have affected colonies as well (Rojek et al. 2007; USFWS, unpubl. data).

The *Apex Houston* Oil Spill

Between 28 January and 4 February 1986, the barge *Apex Houston* discharged approximately 20,000 gallons of San Joaquin Valley crude oil while in transit from San Francisco Bay to Long Beach Harbor, California. Between Sonoma and Monterey counties, an estimated 9,900 seabirds were killed, including about 6,300 Common Murres (Page et al. 1990, Carter et al. 2003). The murre colony at Devil's Slide Rock was subsequently abandoned (Takekawa et al. 1990; Carter et al. 2001, 2003).

In 1988, state and federal natural resource trustees began litigation against potentially responsible parties. In 1994, the case was settled in a Consent Decree for $6,400,000. The *Apex Houston* Trustee Council, with representatives from the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game, and National Oceanic and Atmospheric Administration (NOAA), was given the task of overseeing restoration actions for natural resources injured by the spill. A final restoration plan was published (USFWS 1995) and the amount of $4,916,430 was assigned to USFWS for the implementation of the Common Murre Restoration Project.

The *Command* Oil Spill

Shortly after departing San Francisco 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 (USFWS et al. 2004). An estimated 1,490 Common Murres and other seabirds were killed or injured from the spill.

The *Command* litigation resulted in a total settlement of $5,518,000, of which $4,007,242 was allocated to restoration of damaged natural resources. The Seabird Colony Protection Program (SCPP) is one of several projects funded by the *Command* Oil Spill Restoration Fund (USFWS et al. 2004). The goal of SCPP 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 SCPP. Another component of the program, conducted by the Gulf of the Farallones National Marine Sanctuary, focuses on education, outreach, and other methods that will lead to better protection of colonies from human disturbance.

Common Murre Restoration Project

The *Apex Houston* restoration plan consisted of a Scientific Program and an Environmental Education Program for the CMRP (USFWS 1995). Field work for the Scientific Program was intitiated in 1996 by USFWS-San Francisco Bay National Wildlife Refuge Complex (hereafter "Refuge"), in collaboration with the USFWS-Ecological Services (Sacramento Field Office), Humboldt State University (HSU), and the National Audubon Society. Since 1996, additional assistance has been provided by: Carter Biological Consulting; CDFG; U.S. Geological Survey (Western Ecological Research Center; USGS); Point Reyes Bird Observatory (PRBO); National Park Service (Point Reyes National Seashore); National Oceanic and Atmospheric Administration (NOAA; Gulf of the Farallones and Monterey Bay National Marine Sanctuaries); and California Department of Parks and Recreation; California Department of Transportation, among others.

The primary goals of the CMRP have been the restoration of extirpated Common Murre colonies at Devil's Slide and San Pedro Rocks (Figures 1, 2). Social attraction was selected as the best-available technique to be used to recolonize these rocks (Carter et al. 2003, Parker et al. 2007) because of its effective use elsewhere in encouraging seabirds to recolonize extirpated colonies (Kress 1983; Podolsky 1985; Kress and Nettleship 1988; Podolsky and Kress 1989, 1991; Schubel 1993). Secondary goals have been to restore other depleted colonies, such as the Castle/Hurricane Colony Complex (Figures 1, 3), by reducing anthropogenic impacts (e.g., disturbance, gill-net mortality) and avian predation. Monitoring at other more established nearshore/mainland colonies, such as Point Reyes (Figures 1, 4), has been conducted to compare with restoration sites, examine broad-scale patterns and trends in ecological parameters, and identify other potential restoration needs.

In January 1996, social attraction equipment (murre decoys, mirror boxes, and two sound systems) was deployed on Devil's Slide Rock for the first time (Parker et al. 2007). Similar redeployment and gradual modification and reduction of equipment occurred each year until 2005 (McChesney et al. 2006). Breeding by six pairs of murres was recorded in 1996 and the number of breeding pairs has increased steadily since then. Because of continued growth of the Devil's Slide colony since 1996, and especially since 1999, the amount of social attraction equipment was reduced in later years to promote higher density nesting, provide additional breeding space within decoy areas, and prepare for eventual phase-out of equipment. In 2005, after the colony had grown to well over 100 breeding pairs, decoys and one sound system were redeployed only on the eastern half of the rock to examine the potential effects of large-scale decoy removal. No negative effects were detected, and breeding murres occupied space formerly occupied by decoys (McChesney et al. 2006). No decoys were deployed in 2006, and the remaining social attraction equipment (e.g., sound system, decoy mounting rods) was removed following the 2006 breeding season.

In 2005-2007, CMRP efforts to restore seabird colonies in central California were augmented by the *Command* Trustee Council. Under the *Command* Oil Spill Restoration Plan, the reduction of human disturbance to breeding colonies was identified as the main technique to restore seabird populations damaged from the spill. These additional efforts included disturbance surveillance and monitoring at previously studied colonies as well as Point Resistance, Millers Point Rocks, and Double Point Rocks.

This report summarizes restoration, colony surveillance, and monitoring efforts conducted by the CMRP in 2007. Similar to other years, data were gathered on: murre population sizes, seasonal attendance patterns, nesting phenology and productivity, and adult co-attendance patterns; Brandt's Cormorant (*Phalacrocorax penicillatus*) nest surveys, breeding phenology and productivity; population surveys and productivity of Pelagic Cormorants (*P. pelagicus*), Black Oystercatchers (*Haematopus bachmani*), Western Gulls (*Larus occidentalis*), and Pigeon Guillemots (*Cepphus columba*); disturbances to seabird colonies; and Common Raven (*Corvus corax*) surveys conducted near the Castle/Hurricane Colony Complex. In addition, baseline rates of murre and cormorant departures were determined at Devil's Slide Rock for assessing potential flushing events from disturbances.

METHODS

Study Sites

The Common Murre Restoration Project conducted monitoring at four colony complexes in 2007 (Figures 1-5): Devil's Slide Colony Complex (DSCC; San Mateo County; Figure 2); Castle/Hurricane Colony Complex (CHCC; Monterey County; Figure 3); Point Reyes (PRH; Marin County; Figure 4); and Point Resistance/Double Point Colony Complex (or, Drakes Bay; DBCC; Figure 5). DSCC included the Devil's Slide Rock and Mainland (DSRM) and San Pedro Rock (SPR) colonies. CHCC included the Bench Mark-227X (BM227X), Castle Rocks and Mainland (CRM), and Hurricane Point Rocks (HPR) colonies. DBCC included the Point Resistance (PRS), Millers Point Rocks (MPR), and Double Point Rocks (DPR) colonies.

Field site monitoring was conducted mainly by: L. Eigner, D. Lontoh and S. Rhoades (DSCC); T. Poitras (CHCC); and P. Kappes and N. Metheny (PRH and DBCC), all with assistance from G. McChesney.

Devil's Slide Rock Video System Reinstallation

The remote video system was reinstalled on Devil's Slide Rock (DSR) on 3 March 2007 to enhance monitoring, research, and provide public outreach. Two high resolution video cameras were anchored to the top ridge of the rock: one each on the east and west sides. Both cameras were connected to a transmitter that sent live-streaming images to a receiving station at the Point Montara Lighthouse Hostel, 4.5 km south of DSR, as well as to a portable, manually operated receiving system on the mainland adjacent to DSR. The receiving system included a desktop computer equipped with software for remote control of the cameras, with zoom, tilt, and panning capabilities, squirter and wiper for lens cleaning, and the ability to take still pictures and videos. At the hostel, the receiving system was connected to the internet for viewing and control from off-site computers and a live web cam hosted by the National Audubon Society.

The video cameras experienced significant technical difficulties during the 2007 season. On 25 March, a trip to DSR was made to repair a loose cable connection. The west camera stopped transmitting video and audio on 29 April and was nonfunctional for the remainder of the season. This greatly impeded monitoring efforts on the west side of the rock where large numbers of murres bred, and limited diet watches to the east side. Beginning on 10 July, loss of power caused by several days of thick fog prevented use of the east camera for much of the remainder of July. Each day, batteries only partially charged, limiting camera use to 2-3 hours per day at most. When sunny conditions resumed following the breeding season, batteries recharged and camera function was restored. Both video cameras were removed from the rock on 30 August 2007.

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. For each survey, three consecutive counts were performed and a mean was determined, except for certain subcolonies at PRH (see below). Seasonal attendance data were collected at all active subcolonies during the "pre-breeding season" (before 15 April) at DSRM and CHCC and at all colonies throughout the "breeding season" (15 April until all chicks fledged and adult attendance ceased). Non-breeding season counts were conducted between 0730-1100 h when murres were more likely to be present. Breeding season counts were conducted between 1000-1400 h when murre numbers are less variable.

Devil's Slide Rock and Mainland, San Pedro Rock

On DSR, pre-breeding season attendance was monitored one to four times per month from 24 October 2006 to 12 April 2007. Breeding season (15 April to 16 August) counts were conducted every other day (weather permitting).

On Devil's Slide Mainland (DSM), counts were conducted once per week at six subareas (Figure 2): April's Finger, Upper Mainland South, Lower Mainland South, Mainland South Roost, and Turtlehead (all subcolony 05), and Mainland North (subcolony 07). Mainland South subareas and Turtlehead were viewed from two viewing locations: the traditional Turtlehead Cove overlook and Peregrine Falcon Point (or, "PEFA Pt."). PEFA Pt. was first utilized in 2006 to avoid disturbance of nesting Peregrine Falcons (*Falco peregrinus*) (see McChesney et al. 2006).

For SPR, counts were conducted once per week throughout the breeding season from Pipe Pullout.

Castle/Hurricane Colony Complex

Seasonal attendance patterns of murres were determined for 11 subcolonies at BM227X, CRM, and HPR (Figure 3). Counts were conducted sporadically during the pre-breeding season and twice per week during the breeding season. At four subcolonies, separate subarea counts also were obtained: CRM-03West (south and north sides); CRM-04 (productivity plot and entire rock); CRM-06 South (south and north sides); and HPR-02 (Ledge and Hump plots).

Point Reyes

Seasonal attendance patterns of Common Murres were determined for all murre subcolonies visible from mainland observation sites from 20 April to 6 August (Figure 4). In 2007, 17 mainland and 21 nearshore subcolonies were monitored from 10 standardized observation locations once per week at a minimum. 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 (Lower portion) rocks. Counts of index plots were conducted three times and the means reported. Other subcolonies were counted once per survey of entire visible areas. Ledge Plot was subdivided into two "subplots" to coincide with a reduction in the productivity plot in 2006. However, this subdivision for attendance counts was not done until 2007.

Drakes Bay Colony Complex
Murre attendance was monitored at PRS, MPR, and DPR between 22 April and 5 August (Figure 5). Type II index plots were established at PRS and Stormy Stack (DPR) because of large numbers of murres attending these colonies. 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.

Common Murre Productivity

As in prior years, productivity of Common Murres was monitored at DSRM, CRM and PRH every two to three days at minimum (weather permitting) from standardized mainland vantage points using either 65-130x or 15-60x spotting scopes. At DSR, a remote video camera was also used. Locations of returning or new breeding and territorial sites were identified using maps and photographs updated from the 2006 breeding season. A "breeding site" was defined where an egg was laid. A "territorial site" was defined as a location with attendance greater than or equal to 15% of monitored days but an egg was not recorded. Some territorial sites likely were breeding sites where eggs were lost at or shortly after lay without our detection. A "sporadic site" was defined as a location attended on at least two days but on less than 15% of 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. Data from 2007 were then compared to the long-term weighted means for DSR and CRM, (1996-2006; 11 years), and PRH (1996-2002 and 2005-2006; nine years).

Devil's Slide Rock and Mainland
Due to widespread colony growth and increasing difficulty monitoring the entire colony, three "Type I" plots were established on DSR in 2006 (see McChesney et al. 2006). The same plots (A, B, and C) were utilized for monitoring in 2007. Adjustments were made to plots A and C prior to the breeding season to better delineate boundaries (Figure 6). Plot A was reduced by approximately 30 sites, which eased monitoring difficulty. In addition, long-term plot boundary markers were installed on 25 September 2006 and 3 March 2007. Plot corners were marked with twenty-five brightly-painted polyvinyl chloride (PVC) pipes each placed over a piece of rebar (1.5 ft, or 0.46 m long) anchored into the rock. Certain plot edges also were marked with five 2" x 2" (0.61m x 0.61m) wooden boards of various lengths.

To determine the total number of breeding pairs on DSR and roughly compare plots to the entire colony, active murre sites located outside of plot boundaries were monitored during seven weekly surveys during egg and chick periods (15 May and 6 July). Breeding status of each bird was determined by confirmed presence of an egg or chick, or inferred by two or more consecutive observations of a bird in incubation or brooding posture. A territorial site was determined by the presence of a bird for at least two surveys with no evidence of breeding.

Castle/Hurricane Colony Complex
All active and inactive murre nesting sites were monitored within one productivity plot on CRM-04 (established in 1996). An additional study plot on CRM-03 East, established in 1999, did not contain breeding murres in 2007.

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. To reduce monitoring effort, Ledge Plot was reduced by about half beginning in 2006.

Common Murre Co-attendance and Chick Provisioning

Co-attendance and chick provisioning observations were conducted at DSR after approximately 66% of breeding sites had chicks. Observations were conducted from sunrise to sunset on 26 June, 30 June, and 9 July following standardized methods (see Parker 2005, McChesney et al. 2006). Eighteen total breeding sites were monitored over three surveys but a maximum of 14 sites were followed each day, for a total of 42 site-days. High powered spotting scopes (65-130X) were used to conduct observations. Adult arrivals, departures, and food deliveries to chicks (including prey type, size, and fate) at each monitored site were recorded to the nearest minute. In addition, the number of birds at each site was recorded every 15 minutes throughout the entire watch.

Nest Surveys

To assess breeding population sizes, nest and bird counts of all seabird species (except murres) were conducted weekly during the breeding season. For Brandt's Cormorant, nest and territorial sites were counted. Nests were classified into five groups that roughly described nesting stages: poorly built nest; fairly built nest; well-built nest; and brooded chicks. In addition, large cormorant chicks (*ca.* >30 days old; often outside of nests) were counted. See McChesney et al. (2007) for descriptions of nest categories.

To provide more complete colony coverage, mainland nest surveys were augmented with boat surveys conducted at the Devil's Slide area on 2 June, CHCC on 3 June, and PRH to DBCC on 20 June.

Brandt's Cormorant Productivity

Breeding phenology and productivity of Brandt's Cormorants were monitored at DSRM (DSR, April's Finger, and Turtlehead), CHCC (CRM-03 East and CRM-03 West), and PRH (Beach Rock, East Rock, Wishbone Point, Area B Mainland, Border Rock, and Miwok Rock). Monitored nests were checked every 2-7 days from mainland vantage points using binoculars, spotting scopes, or remote video cameras (DSR only, 25 March to 10 July). Phenology and productivity data from 2007 were then compared to long-term weighted means for DSR (1997-2006; 10 years); and CHCC and PRH (1997-2001 and 2006; six years). 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). Breeding success per nest was defined as the number of nests that fledged at least one chick divided by the total number of nests that laid eggs. Non confident data were excluded from analysis.

Pelagic Cormorant, Black Oystercatcher, and Western Gull Productivity

Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls was determined at select nests that were easily visible from mainland vantage points. Nests were checked at least once per week at DSRM, CHCC, PRH, DPR, and MPR.

Pigeon Guillemot Surveys

Because Pigeon Guillemots are crevice nesters, we counted the number of birds rafting on the water and roosting on land (intertidal and nesting areas) to assess relative population size and seasonal attendance patterns at DSCC, CHCC, and PRH. Surveys were conducted approximately once per week from standardized observation points between one-half hour after sunrise and 0830 h, from mid-April to late July. At PRH, in addition to standardized weekly counts of the lighthouse area, a single survey of the entire Point Reyes colony was conducted on 5 May 2007. Pigeon Guillemots were also counted during boat surveys of colonies.

Disturbance

All observed anthropogenic disturbance events affecting murres and other seabirds at study colonies were recorded. Significant non-anthropogenic (e.g., avian) disturbances also were recorded. A disturbance event was defined 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 from rock) or otherwise displaced (i.e., birds moved from nest site or roosting site). The numbers of birds affected 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 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 causing disturbances and summarize major events.

In addition to events causing disturbance, all aircraft flying at or below about 1,000 feet (305 m) above sea level (ASL) and boats within about 1,500 feet (460 m) of the nearest seabird nesting or roosting area were recorded to examine use patterns of potential sources of anthropogenic disturbance. Information recorded included: aircraft or boat type, identification number or name, direction of travel, activity, and distance from the nearest seabird nesting or roosting area.

Common Murre and Brandt's Cormorant Departure Rates

Surveys were conducted at DSR to examine typical colony departure rates of Common Murres and Brandt's Cormorants during the breeding season. These baseline data will be used to distinguish minor flushing events caused by disturbance from typical colony departures. Using a 60x spotting scope, numbers of murres and cormorants departing the colony were recorded in 10 second intervals for 30 minutes. Counts of all birds within the field of view from the mainland vantage point (Bunker) were recorded at the beginning and end of each survey. One observer counted birds and departures while another observer recorded all information onto a data sheet.

A total of 18 surveys were conducted over three time periods (0600-1000 h, 1000-1400 h, and 1400-1800 h) and throughout three breeding periods for Common Murres: early egg-laying (23-28 May); mid- to late incubation (18-23 June); and mid-chick rearing (6-18 July). For Brandt's Cormorants, these periods coincided with mid- to late incubation, mid-chick rearing, and late chick rearing/fledging. Surveys of east and west portions of DSR were distributed evenly. Average numbers of birds departing the rock per ten second interval were calculated for each 30-minute survey. The departure rate was divided by the start count and then multiplied by 100 to determine mean departure rates per 100 birds. Since start and end counts of birds were similar (see Results below), the start count was used to calculate departure rates per 100 birds.

Common Raven Surveys

As in 2005 and 2006, Common Raven surveys were conducted between Point Lobos and Point Sur to assess relative distribution and abundance near CHCC. Surveys were conducted from a vehicle along California State Highway 1 while in transit to and from CHCC observation locations. Each morning (0500-0630 h), a survey was conducted while driving south from Point Lobos to the Castle Pullout (16.6 km). Afternoon surveys (12:30-15:00 h) were also conducted irregularly throughout the breeding season while driving north from Point Sur to Point Lobos (25.8 km)**.** Each individual raven seen was considered a "detection". All raven detections were recorded on a Garmin Etrex GPS unit and plotted on National Geographic Topo mapping software.

RESULTS

Common Murre Seasonal Attendance Patterns

Devil's Slide Rock and Mainland, San Pedro Rock

Devil's Slide Rock - Murres were observed on all count days between 9 January and 8 August 2007 (Figure 7). Murres were not recorded attending DSR after all remaining chicks fledged. Pre-breeding season counts averaged 466 ± 85 (SD) murres per count (n = 8; counts of zero birds from 24 October and 11 November were excluded since murres may not have returned to the colony yet), somewhat higher than pre-breeding season counts in 2006 (402 ± 167). As usual, greatest counts were recorded during the late pre-egg laying and early egg-laying periods. The maximum count of 740 murres (28 April) was the highest recorded since CRMP monitoring began in 1996 (previous high, 670 on 28 April 2006). A separate count of 740 murres was obtained from aerial photographs taken on 29 May 2007, which was considerably higher than counts from mainland vantage points during the same period (Figure 7). Increased attendance mostly reflected expansion of nesting areas on the edges of the colony (Figure 8). Murre counts were lower but remained variable during the incubation and brooding periods, then began a rapid decline in mid-July as chicks fledged and adults departed from the colony. Murres (n = 7) were last observed on 6 August.

Devil's Slide Mainland - Common Murres were observed among nesting Brandt's Cormorants on April's Finger, Lower Mainland South, Upper Mainland South, and Turtlehead (Figure 9). Lower Mainland South had the greatest and most consistent attendance throughout the pre-breeding and breeding seasons (Figure 7). High counts were: April's Finger, 5 (22 May); Lower Mainland South, 163 (24 April); Upper Mainland South, 19 (19 June); Mainland South Roost, 9 (27 June); and Turtlehead, 9 (31 July). The greatest combined single day count for all subareas was 166 birds on 24 April. Upper Mainland South and April's Finger counts were similar to 2006. Attendance increased 58% on Lower Mainland South (average 68.2 in 2007 vs. 43.3 in 2006), reflecting an increase in breeding sites. The DSM aerial survey count on 29 May was 122 murres for all areas combined, considerably higher than other counts during the same period (Figure 7). Nest prospecting behavior by Common Murres was observed at all subareas, but breeding was recorded only at Lower Mainland South and April's Finger.

San Pedro Rock - Murres were observed on 4 of 16 (25%) count days between 18 April and 9 August 2007. A high count of 49 birds was recorded on 10 July, including 37 birds and 12 birds on west and nose areas, respectively. This is the highest murre count on SPR recorded since CMRP monitoring began in 1996 (previous high, 26 birds in 1998 when decoys were present). No murres were documented on SPR in 2006 and only one bird was recorded in 2005.

Castle/Hurricane Colony Complex
Most subcolonies with confirmed breeding in 2007 were attended consistently from mid-March to mid-June (Figures 10-12). At CRM-03 East, murres attended previously used breeding areas through mid-May then abandoned the rock without known breeding. Murres were last recorded breeding on CRM-03 East in 2005. For the first known time, murres were observed attending the mainland of BM227X (subcolony 03) in 2007, among nesting Brandt's Cormorants (Figure 10). Few birds were ever observed in incubation postures and breeding was unlikely. In addition, murres were recorded inside Funt Cove (CRM-06 North; chicks observed) and CRM-08 (new subcolony, but breeding not confirmed) during aerial and boat surveys. These subareas are not visible from mainland vantage points. The CHCC aerial survey count on 31 May (3,312 murres) included: 1,967 birds on CRM; 935 birds on HPR; and 410 birds on BM227X. The total count was 12.5% lower than in 2006, mainly due to 18% lower numbers at CRM.

Attendance at CHCC was substantially reduced during a prolonged period (12 June - 5 July) of major disturbances by a single immature Brown Pelican (see Non-anthropogenic Disturbance, below). The CRM rocks were first affected, followed by the CRM mainland (CRM-06), and then both HPR subcolonies (beginning 28 June). By 18 June, most CRM murre subcolonies (CRM-02, 03 West, 04, 05, 06 South, and 07) were abandoned. HPR subcolonies were abandoned by 12 July.

Pelican disturbance was not documented at BM227X-02, the only CHCC murre breeding area that apparently was not affected in 2007. Murre attendance at BM227X-02 was reduced moderately in mid-June, then this subcolony was suddenly abandoned on 5 July for unknown reasons. Cessation of breeding (i.e., chick fledging) was possible but unlikely based on 2007 phenology at the CRM-04 plot. Predation was documented here in 2005 (McChesney et al. 2006) and this may have been involved in 2007.

Point Reyes
All well-established nesting areas (see McChesney et al. 2006) were active with confirmed breeding in 2007. Attendance patterns throughout established subcolonies on the headlands were typical with highest counts early in the season (mid-April), low variability during the incubation and breeding periods, followed by declines from mid-July to early August as chicks fledged and birds left most breeding areas (see Figures 13 and 14). Several areas still had small numbers of murres present on the last survey on 6 August, suggesting that some chicks may not have fledged by this date although fledging was completed in productivity plots (see below). In addition, murre attendance was recorded at several "ephemeral" subcolonies (i.e., not attended each year; Figure 14). All ephemeral murre subcolonies were in association with nesting or prospecting Brandt's Cormorants, but murre breeding was not confirmed. At Aalge Ledge, a large murre roost, no breeding was observed in 2007 although small numbers bred in 2006. Murres were recorded attending Greentop (subcolony 08) as well as Upper Cone and Cone Shoulder portions of Cone Rock (subcolony 13) until early May while prospecting cormorants were present, but cormorants and murres then abandoned these areas. Murres also attended Trinity Point (subcolony 08) and both West and East Cliff Colonies (subcolony 09) later in the season in association with late-breeding Brandt's Cormorants. After an initial effort of nest building and egg laying, cormorants abandoned these mainland subcolonies, presumably due to a land-based predator, and murre attendance ceased. In late July, murres were also seen prospecting at Area B Mainland (subcolony 14E), among fledgling Brandt's Cormorant chicks. Similar to 2006, murres attended Border Rock (subcolony 14C) for the entire season, but breeding was difficult to confirm due to incomplete views. However, frequent and prolonged attendance as well as breeding behavior (e.g., incubation postures) suggested that breeding occurred. Consistent murre attendance was also observed at Miwok Rock (subcolony 14D), the farthest east attended murre subcolony at PRH.

Drakes Bay Colony Complex
Point Resistance - Murre attendance at PRS was lower than in 2006, likely due in part to an unobserved disturbance event in early May that left at least 5 murre carcasses in a large roosting area at the south end of the rock. Murres avoided this area for the rest of the season. Additionally, frequent raven disturbance and predation was documented throughout the season (see Non-anthropogenic Disturbance, below).

Millers Point Rocks - At MPR, chronic disturbance from a pair of ravens apparently caused abandonment of East Plot on MPR North Rock, where murres were last recorded on 13 May. Murres in the West Plot fledged chicks (based on large chicks observed) but had lower attendance than in 2006; with no murres seen after 7 July. Murres attended and appeared to be prospecting at the small islet east of MPR South Rock (where breeding was believed to have occurred in 2006), but this area was abandoned after 27 May presumably due to raven disturbance.

Double Point Rocks - At DPR, attendance at Stormy Stack in 2007 appeared lower than in 2006, especially during the chick period. From 29 June to 16 July, several disturbance events by a single juvenile Brown Pelican apparently led to early abandonment of breeding sites in and around the Pond Plot. Prior to 29 June, Pond Plot had consistent attendance of about 175 birds with numerous chicks observed. After 6 July, less than 50 birds were counted, whereas other portions of the rock remained more active until later in July. At the small DPR North Rock, where a small number of birds bred in 2006, only irregular attendance by roosting birds was observed.

Common Murre Productivity

Devil's Slide Rock and Mainland

Of 518 sites documented both within and outside of plots on DSR in 2007, 394 (76.1%) were breeding, 117 (22.6%) were territorial, and seven (1.4%) were sporadic. The number of breeding sites increased 9.1% from 2006 (Figure 16). Of all active sites, 164 (31.7%) were in monitored plots and 354 (68.3%) were outside of plots.

Within DSR plots, 134 (81.7%) sites were breeding, 23 (14.0%) were territorial and 7 (4.3%) were sporadic. At all breeding sites combined, the mean egg-laying date of first eggs was 18 May (range = 3 May-22 July, n =132; Table 2), six days earlier than the long-term average. A total of 150 eggs were laid, including 16 replacement eggs. Hatching success was low, but fledging success was high. An average of 0.55 chicks fledged per pair, 9.8% lower than the long-term average but considerably higher than in 2006 (0.29 chicks/pair) or 2005 (0.32 chicks/pair). By applying estimated breeding success (assumed to be representative) to the total number of breeding pairs recorded, an estimated 217 chicks fledged from DSR in 2007. Fledged chicks were recorded on the rock for an average of 24.3 days after hatching and the last chick was seen on 6 August.

Outside DSR productivity plots, weekly surveys recorded 260 (73.4%) breeding and 94 (26.6%) territorial sites. Given lower survey frequency, some eggs may have been laid and lost between checks. However, some sites inferred to be breeding (by consecutive days of incubation posture but an egg was not confirmed) may not have been breeding sites. Based on these surveys, first eggs were recorded on 30 April, egg laying peaked in mid-May, and hatching peaked between 20 and 27 June. One hundred forty-one chicks were recorded (roughly 54% hatching success per site), with the last chick observed on 6 August. Birds within and outside plots had similar breeding phenology and breeding success.

On DSM, breeding murres were documented for the third consecutive year on the Lower Mainland South subarea (Figure 9). In addition, one breeding site was recorded on April's Finger. Murres had been seen attending April's Finger sporadically since 2003, but breeding was first documented in 2007. Aerial photographs of an area on Upper Mainland South that was difficult to view from the mainland showed two to three murres in incubating postures, indicating that breeding possibly occurred for the first time in this subarea. All breeding sites on the mainland were located among colonies of nesting Brandt's Cormorants. No murre breeding sites were recorded on Turtlehead, although small numbers of murres sporadically attended (see Seasonal Attendance).

Breeding sites on DSM increased by 52% to 50 (49 on LMS and one on AF) in 2007. Of the 70 total sites monitored in both subareas, 50 (71.4%) were breeding, 17 (24.3%) were territorial, and three (4.3%) were sporadically attended. The mean egg-laying date was 20 May (range = 3 May-15 June, n = 35; Table 2). Hatching success was low but fledging success was fairly high. No replacement eggs were recorded. The number of chicks fledged per pair was 0.48, 45.5% higher than in 2006. Chicks fledged at an average age of 22.4 days and the last chick was seen on 6 August.

Combining DSR and DSM, 444 breeding sites were documented at DSRM in 2007. Breeding success was 0.53 chicks per pair and an estimated 241 chicks fledged.

Castle/Hurricane Colony Complex
Of 112 total monitored sites in the CRM-04 plot in 2007, 85 (75.9%) were breeding and 27 (24.1%) were territorial. Breeding sites decreased by 10% from 2006. The mean egg-laying date of 10 May (range = 26 April-27 May; n = 79; Table 2) was ten days earlier than the long-term average. Two replacement eggs were recorded. Low hatching (29.4%) and fledging (0.0%) success resulted mainly from chronic disturbance by a juvenile Brown Pelican between 12 June and 5 July (see Disturbance, below). This event occurred during the late incubation and early hatching periods, with losses of 60 eggs and 26 chicks within the plot, culminating in complete breeding failure. Pelican disturbance has caused large-scale breeding failure at this colony for four consecutive years.

Point Reyes
A total of 140 sites were monitored between Ledge (n = 81; 57.9%) and Edge (n = 59; 42.1%) plots on Lighthouse Rock. In Ledge Plot, 65 (80.2%) sites were breeding and 16 (19.8%) were territorial, an increase of only one breeding site from 2006. The mean egg lay date for first eggs in Ledge Plot was 22 May (range = 8 May-17 June; n = 53; Table 2) and eight pairs laid replacement eggs. The number of chicks fledged per breeding pair was 0.71, 16.7% higher than the long-term average (0.61; Table 2).

In Edge Plot, 50 (84.7%) sites were breeding (a decrease of one breeding site from 2006) and nine (15.3%) sites were territorial. The mean egg lay date for first eggs in Edge Plot was 27 May (range = 14 May-20 June; n = 33; Table 2), and six pairs laid replacement eggs. The number of chicks fledged per breeding pair was 0.48, 9.4% lower than the long-term average (0.53; Table 2). The addition of nine newly established breeding sites in the plot (all failed) contributed to low breeding success.

Combining Edge and Ledge plots, the mean egg-laying date was 24 May (range = 8 May-20 June; n = 86; Table 2), the same as the long-term average. Productivity of 0.61 chicks fledged per pair was similar to 2006 (0.63) but 3.3% higher than the long-term average (0.59). Fledged chicks remained on the rock for an average of 24.7 and 23.4 days in the Ledge and Edge plots, respectively. The last chicks observed in Ledge and Edge plots were seen on 6 August and 31 July, respectively.

Common Murre Co-attendance and Chick Provisioning

At DSR, mean percent of sampling period spent in co-attendance was 15.1% (range = 4.8-33.8%; n = 18), the same as the long-term (1999-2006) average. During co-attendance surveys, 214 mate arrivals were recorded. On average, mates arrived 0.37 times per site per hour (range = 0.21-0.77; n = 18). Of all mate arrivals seen, 55.4% were observed with prey, 42.7% had no prey, and 1.9% were unknown if prey delivery occurred. Of prey deliveries, 97.5% were consumed by chicks, two(1.7%) prey items were stolen, and one (0.8%) was eaten by the adult. The mean chick provisioning rate was 0.18 feedings per hour (range = 0.00-0.26; n = 18), 20% lower than the long-term average but similar to 2005-2006. In addition, six feeding events involved a chick being fed by a neighboring adult murre, and two events involved chicks being fed fish stolen from another murre. If these eight events were included, the mean chick provisioning rate was 0.21 feedings per hour (range = 0.11-0.35; n = 18).

Brandt's Cormorant Nest Surveys and Productivity

Devil's Slide Rock Colony Complex

Nest surveys - Brandt's Cormorants bred on DSR and several mainland subareas: April's Finger, Mainland South, and Turtlehead (Figure 2). Nest and territorial sites were counted at all nesting areas between 4 April and 25 July (Figure 17). Territorial sites were first recorded in mid-March, but nest building activity was not observed until April. The first well-built nests were recorded on 12 April, just before egg laying began at monitored sites. Peak counts of well-built nests (n = 322) were recorded for nearly all subcolonies on 22 May, about one week before the first chicks began hatching at monitored nests. Counts of well-built nests declined as chicks began to creche and nests were destroyed by heavy use.

Productivity - A total of 152 nests were monitored at DSR, April's Finger, and Turtlehead. For all subareas combined, the mean clutch initiation date of 5 May (range = 13 April-3 June; n = 146; Table 3) was similar to the long-term average (6 May). Clutch sizes averaged 3.1 eggs. Three replacement clutches were recorded on DSR; and each nest successfully fledged 2-3 chicks. Overall productivity of 2.1 chicks per pair (Table 3) was similar to the long-term average (2.0). Productivity was much higher than in 2006 (1.6) when an apparent disturbance event caused breeding failures on April's Finger (McChesney et al. 2007). For DSR and Turtlehead (unaffected by disturbance in 2006), productivity was similar to 2006.

An unusually high occurrence of extended intra-clutch egg laying was observed at DSRM in 2007. Seven nests were recorded to have greater than a 3-day interval between laying of the first and second eggs. Brandt's Cormorant eggs are typically laid at 2-day intervals (Boekelheide et al. 1990). Such extended intra-clutch egg laying was not recorded in 2006, but occurred in at least three nests in 2005.

Brandt's Cormorants were observed nesting on SPR, the first-known nesting since 1908 (Ray 1909). Four nests were recorded on top of the west ridge, and at least three nests hatched chicks. Due to difficult viewing conditions, successful fledging could not be confirmed. Small numbers of Brandt's Cormorant nests also were documented during aerial surveys on 29 May 2007, but poor photo quality precluded obtaining an accurate count.

Castle/Hurricane Colony Complex
Nest surveys - Brandt's Cormorant nest surveys were conducted from 22 March to 30 July (Figure 18). In 2007 breeding was confirmed at: BM227X-02 (Esselen Rock) and 03 (Esselen mainland); and CRM-03 West, 03 East, 06 South (North side), 08 and 09. Courtship displays and nest-building began by mid-March, although many of these sites were abandoned by early April. Well-built nests were first observed on 5 April, 16 days before the first egg was recorded at monitored nests. The peak total count of 153 well-built nests on 1 June occurred 18 days after the last egg was laid and just prior to chick hatching at monitored nests. The largest subcolonies occurred at BM227X-02 and 03, where nest initiation was more protracted than at monitored nests. Nesting at CRM-08 was documented during aerial and boat surveys only.

Productivity - Brandt's Cormorant productivity was monitored for 15 nests at CRM subcolonies 03 East (n = 5) and 03 West (n = 10). The mean clutch initiation date of 2 May (range = 21 April-14 May, n = 12) was later than the long-term average (26 April; Table 3), but nesting phenology at monitored sites began later and was less variable than other parts of the colony (see Nest Surveys above). Average clutch size was 3.3 eggs and no replacement clutches were recorded. Overall productivity of 2.4 chicks per pair was higher than the long-term average (2.0).

Point Reyes
Nest surveys - In 2007, Brandt's Cormorant nest counts were conducted between 21 April and 27 July (Figure 19). Cormorants had a large nesting effort with subcolonies spread throughout the western portion of the headlands, including: Slide (subcolony 06); Trinity Point (08); Cliff Colony East and West (09); Beach Rock, Flattop, and East Rock (10); Arch Rock, Wishbone and Spine Points (11); Cone Rock (13); Area B, and Border Rock (14); and Miwok Rock (15).

Nest building had already begun at several locations when monitoring began on 21 April. Well-built nests were first observed on 29 April, just before the first egg was recorded on 2 May. The peak total count of 628 well-built nests occurred during the week of 6 June, coinciding with the last clutch initiation and first chicks observed at monitored nests. Counts of well-built nests declined when chicks began to creche and nests were destroyed or dismantled. However, by the first week of July all nests at Trinity Point and the Cliff colonies were abandoned. These subcolonies are located on the mainland and may have been disturbed by land-based predators.

Productivity - A total of 189 nests were monitored at six subcolonies in 2007. All clearly visible breeding sites on Wishbone Point (subcolony 11E), Area B Mainland (subcolony 14E), Border Rock (subcolony 14C), and Miwok Rock (subcolony 14D) were monitored as well as large, contiguous areas of nests on Beach Rock (subcolony 10E) and East Rock (subcolony 10D). For all subcolonies combined, the average clutch initiation date of 12 May (range = 2-22 May ; n = 180; Table 3) was three days later than the long-term average (9 May). Clutch sizes averaged 3.2 eggs per nest (range = 2.8 Area B Mainland - 3.4 Border Rock) and one replacement clutch was recorded (Border Rock) which fledged two chicks from three eggs. Overall productivity of 2.2 chicks fledged per pair (range = 1.7 at Area B Mainland - 2.5 at Miwok Rock; Table 3) was similar to the long-term average (2.1). Similar to DSM, an unusually high occurrence of extended intra-clutch egg laying was observed at PRH in 2007. Five nests had greater than a 3-day interval between laying of first and second eggs. Extended intra-clutch egg laying was not recorded in 2006.

Drakes Bay Colony Complex

Nest surveys - Brandt's Cormorant nests were counted at DBCC between 28 April and 27 July (Figure 20). No nests or prospecting were observed at PRS, but breeding was confirmed at MPR (North and South Rocks) and DPR (Stormy Stack). Peak counts of well-built nests were 10 June at MPR (98 nests) and 20 May at DPR (62 nests). Breeding phenology at MPR appeared to be similar to PRH but may have been earlier at DPR.

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

Nest and bird surveys- High counts of nests (cormorant, oystercatcher, gull) or birds (guillemot) at each colony are summarized in Table 4. High weekly counts from land counts and single boat counts are shown as well as combined land/boat counts. Boat surveys were generally more complete since they covered areas not visible from mainland vantage points. Comparisons to 2006 are made between total counts (when available) or land counts only (where no boat survey was conducted in 2006).

Pelagic Cormorant counts increased from 2006 to 2007 at: DSRM (19 nests to 45 nests), MPR (5 nests to 13 nests), and DPR (0 nests to 8 nests). However, counts decreased from 2006 to 2007 at: PRH (145 nests to 127) and CHCC (16 nests to 7 nests, not including BM227X). Two nests were seen on SPR (first since 2002). Generally, Pelagic Cormorants nested considerably later than Brandt's Cormorants in 2007. Although territorial sites were observed at DSRM on 15 March, nest-building activities were not seen until mid-May. Well-built nests and eggs were first observed during the week of 20 May. At MPR, an early nest was observed on 2 May. At PRH and DPR, eggs were first observed on 19 and 20 May, respectively.

Western Gull nest counts increased at SPR (14 in 2007 vs. 4 in 2006), declined at PRH (164 vs. 187), and remained the similar at other colonies. Lower numbers at PRH may have resulted from reduced nesting habitat at the largest Western Gull subcolony on Beach Rock, where a large Brandt's Cormorant colony displaced many gulls from breeding territories prior to gull egg laying.

The highest Pigeon Guillemot count at the DSCC was 256 birds on 22 May. Counts were generally higher in April and May and declined after the high count. Presumably fewer birds were counted after this because many birds were incubating in nest crevices. Land-based counts were similar to 2006, but the boat count (between DSR and SPR) was slightly higher in 2007 (164 birds compared to 123 birds). Five birds carrying fish were seen in mid- and late July, indicating that successful hatching and chick rearing was taking place for at least some nests. The high count at CHCC on 23 April (33 birds) was similar to 2006 (38 birds). All count methods at PRH indicated increases from 2006 with a high weekly count of the Lighthouse area of 113 birds on 3 May (vs. 97 birds in 2006).

Productivity - Pelagic Cormorant nests were monitored at both DSRM and PRH (Table 5). At DSRM, the same mainland subcolony was followed as in 2006 but sample size was increased in 2007 by adding a new viewing location with 13 sites visible. This subcolony was observed daily to monitor for possible disturbance to nesting cormorants from CalTrans construction of a retaining wall above the colony. Pelagic Cormorant productivity increased 40% at DSRM and 118% at PRH from 2006. Western Gull productivity increased 146% at DSRM, 31% at PRH, and 400% at CRM (from 0.1 to 0.5 chicks per pair from 2006 to 2007, Table 5). Two Black Oystercatcher nests each were followed at CRM (0.0 chicks/pair) and PRH (2.0 chicks/pair).

Anthropogenic Disturbance

Devil's Slide Rock and Mainland

A total of 459 aircraft overflights (0.811/hr) and 33 watercraft observations (0.058/hr) were documented at DSRM in 2007 (Table 6; Appendix 1). Twelve aircraft overflights resulted from CMRP aerial photographic surveys of the colony. The rate of overflights (aircraft/hr) was 79.4% higher in 2007 than in 2006. Plane overflight rates increased 96.0% and helicopter overflight rates increased 52.8%. Twenty-six (5.7%) overflights were recorded on 29 April 2007 during the Pacific Coast Dream Machines event at the Half Moon Bay airport. A small decrease (-6.0%) in the rate of watercraft observations (watercraft/hr) occurred from 2006 to 2007.

All disturbance events observed involved either Common Murres or Brandt's Cormorants. Twenty-nine overflights caused flushing of roosting seabirds; six of these events occurred on 29 April 2007 during the Pacific Coast Dream Machines event. Two boat observations caused seabirds to be displaced from nesting sites. An additional 94 aircraft and six watercraft resulted in alarm behaviors. Disturbance rates for flushing/displacement (aircraft and watercraft combined) increased 97.3% from 2006 to 2007, mainly because of a 170% increase in aircraft disturbances (0.051/hr). On the other hand, watercraft disturbance (0.004/hr) decreased 56% from 2006. Low-flying (<1,000 ft) helicopters accounted for 83% of aircraft flushing events. One helicopter flying at approximately 600 ft ASL on 16 June flushed 10 Brandt's Cormorants and 16 murres including two murres flushed from eggs. One egg rolled away from the site and was lost. The other was incubated when the bird returned, but this egg never hatched. When alarm behaviors are included in disturbance rates, planes elicited higher rates (0.136/hr) than helicopters (0.081/hr) mainly because of their much higher overflight rate.

San Pedro Rock

A total of seven aircraft overflights and three watercraft observations were documented at SPR in 2007, including two disturbance events. One low-flying plane caused 30 roosting Brandt's Cormorants to flush and one boat caused 100 roosting cormorants to flush. Observation per hour are not reported because of distant viewing (about 2km) and difficulty documenting disturbance.

Castle/Hurricane Colony Complex

Two boats (0.004/hr), one helicopter (two total overflights; 0.004/hr), and two planes (18 total overflights; 0.036/hr) were documented at CHCC in 2007 (Table 7; Appendix 2). One helicopter (U.S. Military) caused 120 murres to flush from two subcolonies while flying at about 1,000 ft ASL. Seventeen aircraft overflights were conducted during the CMRP aerial seabird colony surveys. These surveys were conducted under permit from Monterey Bay National Marine Sanctuary. Overflight activity was slightly higher in 2007 than in 2006.

Point Reyes

A total of 22 aircraft overflights (0.046/hr) and 43 watercraft observations (0.090/hr) were documented at PRH in 2007 (Table 8; Appendix 3). Eight overflights resulted from CMRP aerial photographic surveys, although several more overflights occurred but were not viewed from the mainland vantage point. Aircraft and watercraft observations and disturbance rates were similar in 2007 to 2006. Three watercraft flushed/displaced Common Murres or Brandt's Cormorants while fishing close (range = 20-460 m) to the colony. Most watercraft were recreational fishing boats, including several that were apparently fishing in violation of the Point Reyes Headlands State Marine Conservation Area. These apparent violations were reported to both CDFG and Point Reyes National Seashore law enforcement.

Drakes Bay Colony Complex

At PRS, a total of two aircraft (0.183/hr) and two watercraft (0.183/hr) observations were documented in 2007 (Table 9; Appendix 4), similar to rates in 2006. On 7 July, a U.S. Coast Guard helicopter flew at about 350 ft ASL and caused 93 murres to flush, but no other disturbances were observed.

At MPR, a total of two aircraft (0.113/hr) and 10 watercraft (0.565/hr) observations were documented in 2007 (Table 10; Appendix 5). No disturbances were recorded.

At DPR, a total of one aircraft (0.018/hr) and 12 watercraft (0.212/hr) observations were documented in 2007 (Table 11; Appendix 6). One private boat fishing within 200 m of the colony caused 50 roosting Brandt's Cormorants to be displaced.

Non-Anthropogenic Disturbance

Devil's Slide Rock and Mainland

Only one minor non-anthropogenic disturbance to murres was recorded at DSR in 2007. On 22 April, a roosting immature Brown Pelican caused 20 murres to be displaced. Nearby nesting Brandt's Cormorants jabbed repeatedly at the pelican, deterring it from walking further into the colony. Murre egg laying had not yet commenced.

Castle/Hurricane Colony Complex

In 2007, Brown Pelicans were responsible for a large number of recorded disturbances to murres (n = 86) at CHCC but many more unrecorded flushing events also occurred. In many (n = 22) cases migrating pelicans flocks passed low over breeding areas, flushing murres. This indirectly contributed to the predation of two murre chicks by Western Gulls.

The most severe disturbances resulted from a single juvenile pelican that visited the colony complex from 12 June to 5 July. Similar to several past events, this bird flew from rock to rock, landing among breeding murres and often walking through the colony, resulting in a series of repeated murre flushing events. From 12 June to as late as 28 June, the pelican's activities were confined to the offshore rock subcolonies of CRM. After large-scale breeding failure occurred and murres began abandoning those areas, the pelican began landing among breeding murre groups on the mainland CRM-06 subcolony. It was first documented at CRM-06 north with certainty during boat-based observations on 28 June, although activity there was suspected prior to that date (this subarea is out of view from mainland observation sites). This same day, the pelican also landed on HPR-01 and HPR-02 for the first known time documented. Many murres flushed, and two chicks were seen jumping from the HPR-02 nesting area. One chick was killed by a Western Gull, and one successfully made it to the water but was separated from the parent bird. Most nests failed throughout CRM and HPR subcolonies as a result of the prolonged disturbance event, resulting in nearly complete breeding failure and premature colony abandonment.

Point Reyes
Avian disturbances were frequently observed at PRH in 2007. Of 48 recorded disturbances, most were caused by Common Ravens (73%) and Brown Pelicans (19%). Most events (77%) impacted murres only. Raven disturbances were typically observed in the vicinity of raven nests (at subcolonies 02-03 and subcolonies 11-14). One murre egg was observed being taken by a raven. Ravens carrying murre eggs and eggshells also were observed along the headlands, often near known raven roosts. One Western Gull was observed stealing a murre egg as a direct result of a raven disturbance.

Similar to CHCC and DPR, Brown Pelican disturbances also were observed at PRH. Most disturbances consisted of some murre flushing and displacement when a group of pelicans flew over a colony or landed on the edge of a subcolony. However, between 19 and 31 July, three events at Lighthouse Rock were observed in which a lone juvenile pelican landed and slowly walked through the colony. Each event lasted a minimum of 20 minutes, with the pelican repeatedly taking off and landing at different parts of the subcolony, resulting in thousands to tens of thousands of adults flushing or displacing, and hundreds to thousands of chicks exposed and/or displaced. In each event, at least 80-90% of the Lighthouse Rock subcolony was affected. Since most sites had chicks, low levels of egg loss and depredation were recorded. However, gulls were observed scavenging abandoned eggs in the colony. Chick mortality was difficult to document during these events but likely occurred.

In addition to observed events, abandonment by Brandt's Cormorants and murres from mainland nesting areas at Trinity Point (subcolony 08A) and both East and West Cliff Colonies (subcolony 09) in June suggested disturbance, possibly from a land-based mammalian predator.

Drakes Bay Colony Complex
Point Resistance - At PRS, a pair of Common Ravens was observed harassing and flushing murres throughout the 2007 season, probably by the same pair that harassed this colony in 2006. No eggs were observed being taken, but fragments of murre eggshells were found on the cliff top of the adjacent mainland.

Millers Point Rocks - At MPR, intense raven disturbance at Millers Point North Rock apparently resulted in murre abandonment of the East Plot by mid-May. Additionally, the West Plot had much lower murre attendance compared to 2006 and abandoned the rock by mid-July, probably because of raven disturbance and predation. Raven disturbance may have also caused Brandt's and Pelagic Cormorant nest abandonment. At Millers Point South Rock, ravens were observed taking several eggs and numerous depredated murre eggshells were found on Millers Point, a known raven roost. Raven disturbances also were recorded at this subcolony in 2005 but not in 2006.

Double Point Rocks - At DPR, four disturbance events by pelicans resulted in documenting numerous exposed/displaced chicks. Additionally, six eggs were depredated by Western Gulls as a direct result of these disturbances. Pelicans were first observed on 29 June, concentrated in and around the Pond Plot area. This area had no chicks present after the first week of July. Murre chicks and adults remained on all other areas of Stormy Stack through July.

Common Murre and Brandt's Cormorant Departure Rates

To quantify departure rates, averages of 211 Common Murres and 60 Brandt's Cormorants were observed per survey at DSR. End counts were slightly larger on average than start counts by +2.8% (range = -16.2 to 23.7%) for murres and by +3.0% (range = -10.0 to 15.4%) for cormorants. Departure rates are reported as the numbers of bids/100 birds/10 sec. Murre departures over all daily and seasonal periods averaged 0.18 (range = 0.06-0.40). Murre departure rates were highest (mean = 0.23 Table 12) during the early morning time period and the mid-chick rearing period. Overall, average departure rates were similar (about 0.15) for the mid-morning and afternoon time periods, as well as the early and late egg-laying periods. The maximum single departure rate recorded was 5.0. Over 98% of 10-second scans recorded less than two birds per 100 birds departing. Departure rate frequencies during 10-second scans were: 0 (73.6%); 0.5-1.4 (25.1%); 1.5-2.4 (1.1%); 2.5-3.4 (0.1%); 3.5-4.4 (0.1%); and 4.5-5.0 (0.03%).

Cormorant departure rates were higher than murres. Cormorant departures over all daily and seasonal periods averaged 0.31 (range = 0.12-0.68). Cormorant departure rates were highest (mean = 0.37) in the early morning, especially during the mid to late incubation period (Table 12). Departures decreased later in the day, with the lowest rate in the late afternoon (mean = 0.22). The maximum single departure rate recorded was 6.7. Over 96% of 10-second scans recorded less than three birds per 100 birds. Departure rate frequencies during 10-second scans were: 0 (83.9%); 0.5-1.4 (5.9%); 1.5-2.4 (6.7%); 2.5-3.4 (2.7%); 3.5-4.4 (0.6%); 4.5-5.4 (0.1 %); 5.5-6.4 (0.1 %); 6.5-6.7 (0.04%).

Common Raven Surveys

Castle/Hurricane Colony Complex

In 2007, 124 Common Raven surveys were conducted along Highway 1 within the northern survey area between Pt. Lobos and Bixby Landing, resulting in 65 raven detections (0.52/survey or 0.032/km). Similar mean detection rates were found in 2006 (0.036/km). In addition, 58 surveys were conducted in the southern area of Highway 1 (Bixby Landing and Pt. Sur), with 11 raven detections recorded (0.19/survey or 0.020/km), considerably lower than in 2006 (0.062/km). A relatively large proportion of all raven detections (38%; n = 29) were located close to the Soberanes Pt. trailhead where a pair of ravens was frequently observed. Lower proportions were found in the Garrapata Beach vicinity (12%; n = 9) and near Point Sur (11%; n = 8). Remaining detections (39%; n = 31) occurred at various other locations (Figure 21). As in 2005 and 2006, the highest concentration of ravens was observed between Yankee Point and Soberanes Point. No nesting pairs were evident near CHCC and no ravens were observed disturbing seabird colonies, as had occurred in 2004 and 2005.

DISCUSSION

Colony Attendance and Productivity

In 2007, the CMRP conducted the 12th consecutive year of seabird restoration and monitoring efforts in central California. Restoration efforts at DSR continued to show promising progress in 2007 towards eventual complete recovery of this colony. Murre attendance and breeding sites continued to increase even though use of social attraction equipment ceased after 2005. The colony appears to be well-established and no longer requires social attraction techniques to attract birds to the colony or to keep birds at the colony unless colony conditions change dramatically in the future. The estimated 394 breeding pairs in 2007 was the highest recorded since the colony was reestablished in 1996, and was 9% higher than in 2006. Use of plots to monitor murre productivity in 2006 and 2007 has proved extremely useful for continuing intensive monitoring of murre reproductive performance for a large portion (34% in 2007) of the DSR colony. Similar productivity and phenology in 2006 and 2007 between murre nest sites located within and outside of plots indicated that plots were reasonably representative of the DSR colony.

At Devil's Slide mainland, murres bred for the third consecutive year. This newer subcolony is an indirect benefit of restoration efforts at DSR. Since these birds were almost certainly attracted to the area by the combination of the DSR murre colony and the mainland cormorant colony. Overall attendance and numbers of breeders continued to increase, with 50 breeding pairs in 2007. When combined with DSR, the overall DSRM colony increased 15.3% from 2006. Continued population size increases, high attendance by territorial and other prospecting birds, and spreading of the colony into new areas suggests that further colony growth can be expected in future years, barring any dramatic anthropogenic or natural impacts.

At SPR in 2007, a recent record high of 49 murres were recorded attending on 10 July. Prospecting murres were also observed at DSR on 10 July in conjunction with a large mixed raft of birds feeding offshore that may have influenced colony visitation. Social attraction techniques were used at SPR from 1998 to 2004 but were not successful at attracting breeding murres to the colony. Continued population increases at DSR and DSRM and murres recorded attending SPR may also suggest a large subadult population at DSCC. In addition, a small colony of Brandt's Cormorants on the top ridge of SPR was the first documented nesting since 1908 (Ray 1909).

Breeding by murres occurred earlier than average at all three monitored colonies, following two years of delayed breeding associated with poor foraging conditions (McChesney et al. 2006, 2007). Increased murre productivity from 2006 at DSRM and PRH-Ledge Plot, as well as increased adult co-attendance rates by murre breeding pairs at DSR, also reflected improved foraging conditions in 2007. On the other hand, productivity was nearly 10% below the long-term (1996-2007) average at DSR (mainly due to low hatching success) and also was relatively low at PRH-Edge Plot (due to low hatching and fledging success). Breeding success at all CMRP monitored plots was considerably lower than plots at the offshore Southeast Farallon Island colony (0.82 and 0.77 chicks per pair at two plots, respectively; Warzybok and Bradley 2007). At PRH-Edge Plot, low productivity was influenced by several newly established pairs that suffered total breeding failure. Causes of low hatching success at DSR are less clear, but also may reflect many newly established breeding sites on the rock plus some impacts from chronic anthropogenic disturbance. Age and breeding experience have been shown to positively influence breeding success in murres (Harris et al. 1997). How these aspects of demography interact with anthropogenic and natural disturbances requires further study.

At the CHCC, Brown Pelican disturbance caused complete breeding failure of murres in the monitored plot at CRM-04, and almost complete failure in the rest of the complex. Such large-scale disturbance for the fourth consecutive year has been mainly caused by single juvenile pelicans that visit the complex for several days to weeks at a time. Similar large-scale pelican disturbances also were observed at PRH and DPR in 2007, indicating a growing and wider occurrence of this phenomenon. In addition, frequent disturbance and egg predation by Common Ravens continued at PRH and all DBCC colonies. Ravens appear to have caused the partial abandonment of the MPR colony. Continued large-scale disturbances could have dramatic long-term impacts for murres, especially at smaller colonies (e.g, CHCC and MPR) where reductions in recruitment or colony abandonment may result.

Productivity monitoring for Brandt's Cormorants and other seabirds allows further assessment of: factors affecting colony growth in murres; impacts of disturbance; and environmental factors affecting seabirds in the region. In 2007, Brandt's Cormorant breeding phenology and productivity at DSRM were close to their long-term averages. Clutch initiation began later than normal at PRH but productivity was similar to previous years. Nest abandonment at the mainland Trinity Point and Cliff Colonies suggested possible mammalian predation or disturbance. Productivity at CRM appeared to be similar to DSRM and PRH, but breeding occurred earlier.

Population surveys of Pelagic Cormorants, Western Gulls, and Pigeon Guillemots showed no clear changes from 2006 to 2007. Based on long-term averages at the South Farallon Islands (Warzybok and Bradley 2007), productivity of Pelagic Cormorants and Western Gulls was above average at DSRM and PRH and was higher than in 2006. However, at CRM, breeding success was low for Western Gulls and no Pelagic Cormorant nests were monitored because of low nesting effort.

Disturbance

Anthropogenic disturbance to seabirds increased sharply (97% from 2006) at DSRM. Low-flying aircraft, especially helicopters, caused most disturbances that resulted in flushed or displaced birds. However, frequent overflights by planes often caused agitation/alert responses. Increased disturbance was consistent with increased air traffic mainly associated with the nearby Half Moon Bay Airport. Anthropogenic disturbance rates in 2007 at PRH remained relatively low and were similar to 2006, although motor vessel traffic has increased dramatically in recent years as a result of increased recreational fishing. At CHCC, aircraft and boat disturbances remained at much lower levels than in 1997-1999 (Rojek et al. 2007).

Increasing rates of anthropogenic disturbance at DSRM may affect continued colony growth. In 2007, two murres were observed to be flushed from eggs at DSR. Frequent disturbance also may result in: reduced breeding success due to egg and chick losses, elevated stress levels which may contribute to nest abandonment (e.g., Beale and Monaghan 2004), and reduced numbers of breeding Brandt's Cormorants. At DSRM, 56% of all disturbances in 2007 occurred prior to egg laying, when birds may be more prone to flushing (Rojek et al. 2007). Impacts of disturbance during this period are not well understood, but may include: disruption of courtship activities; delayed breeding;; or failure to establish a breeding site (Rojek et al. 2007). Such impacts may affect certain breeding pairs but not others. In particular, experienced birds may be less affected than first-time breeders.

In 2007 avian disturbance and predation strongly affected murres at CRM, PRH, and DBCC. Similar to 2004-2006 (McChesney et al. 2005, 2006, 2007), large-scale pelican disturbance resulted in nest abandonment, early colony departure, and breeding failure for most CRM birds in 2007, and HPR was heavily impacted as well. Without sufficient future recruitment, and possible abandonment by breeding pairs, decline and possible colony loss may occur in the future if such high impacts continue. Both raven and pelican disturbances were recorded at PRH and DBCC, with high levels of nest loss in some areas. At least 3-5 pairs of ravens were actively foraging within the PRH complex. Raven disturbance and predation apparently caused near to total breeding failure for murres at MPR. While impacts of current raven predation levels may not be significant in large murre colonies such as Lighthouse Rock, greater impacts likely occur at smaller colonies or subcolonies such as MPR.

Departure rates of Common Murres and Brandt’s Cormorants at DSR in 2007 rarely exceeded one bird and 3.5 birds/100 birds/10 sec (>1.5% occurrence), respectively. This baseline information will aid assessments of potential small-scale disturbance events.

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Table 1. Monitoring effort at study colonies or colony complexes, October 2006 to September 2007.

Colony/Colony Complex	Monitoring technique	Start date	End date	No. of obs. days	Total hours	Person hours
Devil's Slide Rock & Mainland						
Pre-breeding season	Combined techniques	24 Oct 06	12 Apr 07	13	29.4	37.0
Breeding season	Video system	17 Apr 07	08 Jul 07	25	96.9	104.9
	Scope & binocular	16 Apr 07	16 Aug 07	104	566.0	1205.2
	Combined techniques	16 Apr 07	16 Aug 07	107	662.9	1310.0
Castle/Hurricane Colony Complex						
Pre-breeding season	Scope & binocular	5 Mar 07	5 Apr 07	3	11.5	11.5
Breeding season	Scope & binocular	18 Apr 07	30 Jul 07	73	497.3	515.2
Point Reyes	Scope & binocular	20 Apr 07	01 Sep 07	87	478.3	657.3
Millers Point Rocks	Scope & binocular	02 May 07	27 Jul 07	10	17.7	19.5
Point Resistance	Scope & binocular	02 May 07	27 Jul 07	10	10.9	12.3
Double Point Rocks	Scope & binocular	28 Apr 07	29 Jul 07	14	56.7	62.3

Table 2. Common Murre breeding phenology and reproductive success at Devil's Slide Rock (DSR), Devil's Slide Mainland (DSM; 2 plots combined), Castle Rocks and Mainland (CRM), and Point Reyes (PRH) in 2007. 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]	No. Chicks Fledged per Pair
Devil's Slide Rock & Mainland (DSRM)									
DSR- A	81	66	19 May (5/5-6/11; 64)	70	21 June (6/5-7/17; 43)	62.9% (70)	16 July (7/1-8/4; 39)	88.6% (44)	0.59 (66)
DSR- B	64	57	17 May (5/5-6/22; 57)	67	20 June (6/7-7/22; 30)	47.8% (67)	15 July (7/1-8/9; 31)	96.9% (32)	0.54 (57)
DSR- C	19	11	23 May (5/3-6/9; 11)	13	01 July (6/23-7/9; 2)	30.8% (13)	30 July (7/18-8/6; 4)	100% (4)	0.36 (11)
DSR (combined)	164	134	18 May (5/3-6/22; 132)	150	21 June (6/5-7/22; 76)	53.3% (150)	16 July (7/1-8/9; 74)	92.5% (80)	0.55 (134)
DSM	70	50	20 May (5/3-6/15; 35)	50	22 June (6/4-7/16; 25)	56.0% (50)	16 July (6/27-8/9; 24)	85.7% (28)	0.48 (50)
Total - DSRM	234	184	19 May (5/3-6/22; 167)	200	21 June (6/4-7/22; 101)	54.0% (200)	16 July (6/27-8/9; 98)	90.7% (108)	0.53 (184)
Castle Rocks & Mainland		85	10 May (4/26-5/27; 79)	87	6 June (5/27-6/11; 25)	29.9% (87)	-	0 (26)	0 (85)
Point Reyes (PRH)									
PRH-Ledge	81	65	22 May (5/8-6/17; 53)	73	24 June (6/11-7/21; 40)	67.1% (73)	17 July (7/7-8/6; 45)	93.9% (49)	0.71 (65)
PRH-Edge	59	50	27 May (5/14-6/20; 33)	56	29 June (6/19-7/11; 31)	58.9% (56)	21 July (7/12-7/31; 24)	72.7% (33)	0.48 (50)
Total - PRH	140	115	24 May (5/8-6/20; 86)	129	26 June (6/11-7/21; 71)	63.6% (129)	18 July (7/7-8/6; 69)	85.4% (82)	0.61 (115)

[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 3. Brandt's Cormorant breeding phenology and reproductive success at Devil's Slide Rock and Mainland, Castle Rocks and Mainland, and Point Reyes 2007. Reported are means (range; N).

Colony/ Subcolony	No. of Sites Monitored	Clutch Initiation Date[1]	Clutch Size[1]	Brood Size[2]	Hatching Success[2]	Fledging Success[2]	No. of Chicks Fledged/Pair[2]	Breeding Success/ Nest[3]
Devil's Slide Rock & Mainland (DSRM)								
Devil's Slide Rock	101	2 May (13 April-26 May; 94)	3.1 (1-5; 98)	2.2 (0-3; 101)	71% (0-3 ; 312)	92% (0-100; 222)	2.1 (0-3; 95)	0.91 (98)
April's Finger	30	13 May (30 April-3 June; 30)	3.2 (2-4; 30)	2.3 (0-3; 30)	72% (0-3; 96)	90% (0-100; 69)	2.1 (0-3; 29)	0.87 (30)
Turtlehead	30	9 May (26 April-20 May; 22)	3.2 (1-5; 24)	2.3 (0-4; 24)	72% (0-4; 76)	82% (0-100; 55)	2.0 (0-4; 22)	0.92 (24)
Total - DSRM	161	5 May (13 April- 3 June; 146)	3.1 (1-5;152)	2.2 (0-4; 155)	71% (0-4; 484)	90% (0-100; 346)	2.1 (0-4; 146)	0.90 (152)
Castle Rocks & Mainland	15	2 May (21 Apr-14 May; 12)	3.3 (2-4; 12)	2.7 (2-3; 13)	83% (0-100; 35)	89% (0-100; 31)	2.4 (2-3; 13)	1.0 (13)
Point Reyes								
Beach Rock	48	10 May (3-20 May; 48)	3.3 (1-4; 48)	2.6 (0-4; 48)	79% (0-100; 160)	84% (0-100;124)	2.3 (0-4; 47)	0.96 (48)
East Rock	58	12 May (3-22 May; 56)	3.1 (2-4; 23)	2.4 (0-4; 58)	80% (0-100; 180)	93% (0-100; 142)	2.3 (0-3; 58)	0.98 (58)
Wishbone Point	40	15 May (9-20 May; 33)	3.2 (2-5; 36)	2.4 (0-3; 37)	76% (0-100; 116)	88% (0-100; 89)	2.1 (0-3; 37)	0.96 (37)
Area B	10	14 May (7-19 May; 9)	2.8 (2-3; 9)	2.1 (1-3; 9)	74% (33-100; 26)	83% (33-100; 19)	1.7 (1-3; 9)	1.00 (9)
Border Rock	25	11 May (2-21 June; 23)	3.4 (3-4; 23)	2.5 (0-4; 48)	73% (0-100; 81)	86% (0-100; 62)	2.3 (0-3; 25)	0.96 (25)
Miwok Rock	12	10 May (4-15 May; 11)	3.3 (3-4; 11)	2.7 (2-3; 12)	81% (67-100; 26)	97% (67-100; 89)	2.5 (2-3; 10)	1.00 (12)
Total - Point Reyes	194	12 May (2-22 May; 180)	3.2 (1-5; 185)	2.5 (0-4; 189)	78% (0-100; 599)	88% (0-100; 462)	2.2 (0-4; 186)	0.97 (189)

[1] Includes first clutches only & [2] Includes first and 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.

Table 4. High counts of four seabird species obtained during land, boat, and combined land/boat counts, in 2007.

Species	Colony	Land[1]	Boat	Total Count[2]
Pelagic Cormorant	Devil's Slide Rock & Mainland	40	45	45
	San Pedro Rock	0	2	2
	Bench Mark-227X	0	5	5
	Castle Rocks and Mainland	3	3	6
	Hurricane Point Rocks	4	2	4
	Point Reyes	19	117	127
	Point Resistance	0	7	7
	Miller's Point Rocks	13	7	20
	Double Point Rocks	8	5	8
Black Oystercatcher	Devil's Slide Rock & Mainland	0	0	0
	Bench Mark-227X	0	0	0
	Castle Rocks and Mainland	2	0	2
	Hurricane Point Rocks	0	0	0
	Point Reyes	2	4	5
	Point Resistance	0	0	0
	Miller's Point Rocks	0	0	0
	Double Point Rocks	1	0	1
Western Gull	Devil's Slide Rock & Mainland	12	19	20
	San Pedro Rock	1	14	14
	Bench Mark-227X	6	10	15
	Castle Rocks and Mainland	9	11	13
	Hurricane Point Rocks	3	20	20
	Point Reyes	95	81	164
	Point Resistance	0	1	1
	Miller's Point Rocks	6	8	8
	Double Point Rocks	10	15	15
Pigeon Guillemot	Devil's Slide Colony Complex	256	164	-
	Castle/Hurricane Colony Complex	33	15	-
	Point Reyes	323[3]	454	-
	Point Resistance	ND	4	-
	Miller's Point Rocks	ND	12	-
	Double Point Rocks	ND	24	-

[1] Sum of high seasonal counts at each subcolony.
[2] Combination of land and boat counts. Nests that may have been counted on both surveys were only included once towards the total nest count.
[3] Single day survey of entire Point Reyes coloy.

Table 5. Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls at Castle Rocks and Mainland, Devil's Slide Rock and Mainland, and Point Reyes in 2007. Reported are means (range; N).

	Castle Rocks & Mainland			Devil's Slide & Mainland			Point Reyes		
Species	N	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	N	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	N	Chicks Fledged/ Pair	Breeding Success/ Nest[1]
Pelagic Cormorant	0	0	0 (0)	19	2.1 (0-3;19)	0.95 (19)	8	2.4 (1-3;8)	1.00 (8)
Black Oystercatcher	2	0 (2;2)	0 (2)	0	0 (0;0)	0 (0)	2	2.0 (2;2)	1.00 (2)
Western Gull	9	0.5 (1-2; 6)	0.33 (9)	10	1.4 (0-3;8)	0.60 (10)	21	1.7 (0-3;19)	0.81 (21)

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

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 Devil's Slide Rock and Mainland, 2007. Total number observed and number per observer hour are reported.

			No. Disturbance Events			No. Disturbance Events/hr		Mean No. Seabirds	COMU Flushed/Displaced		BRCO Flushed/Displaced		BRPE Flushed/Displaced	
Source	Total Obser-vations	No. Obs/hr	A[1]	D[1]	F[1]	Total/ hr[2]	Flush or Displace/ hr	Flushed/ Displaced (range)	No. Events	Mean No. birds (range)	No. Events	Mean No. birds (range)	No. Events	Mean No. birds (range)
Plane	395	0.698	72	0	5	0.136	0.009	31 (6-105)	4	35 (3-105)	3	6 (3-10)	0	0
Helicopter	64	0.113	22	0	24	0.081	0.042	39 (5-180)	12	13 (3-30)	22	35 (2-150)	0	0
Boat	33	0.058	6	2	0	0.014	0.004	30 (10-50)	0	0	2	30 (10-50)	0	0
Truck/ Motorcycle	-	-	3	0	0	0.005	0	0	0	0	0	0	0	0
Total	495	0.875	103	2	29	0.237	0.055	37 (6-105)	16	16 (3-105)	27	32 (2-150)	0	0

[1] A = Alert/agitation behaviors; D = Displacement behaviors; F = Flushing (F).
[2] 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 Castle Rocks and Mainland, 2007. Total number observed and number per observer hour are reported.[1]

			No. Disturbance Events			No. Disturbance Events/hr		Mean No. Seabirds	COMU Flushed/Displaced		BRCO Flushed/Displaced		BRPE Flushed/Displaced	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/ hr	Flush or Displace/ hr	Flushed/ Displaced (range)	No. Events	Mean No. birds (range)	No. Events	Mean No. birds (range)	No. Events	Mean No. birds (range)
Plane	18	0.036	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	2	0.004	0	0	2	0.004	0.004	60 (10-110)	2	60 (10-110)	0	0	0	0
Boat	2[2]	0.004	0	0	0	0	0	0	0	0	0	0	0	0
Total	22	0.044	0	0	2	0.004	0.004	60 (10-110)	2	60 (10-110)	0	0	0	0

[1] See Table 6 for descriptions.

[2] Numbers do not include two project boat surveys conducted on 3 June and 28 June, 2007.

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 Point Reyes, 2007. Total number observed and number per observer hour are reported.[1]

Source	Total Obser-vations	No. Obs/hr	No. Disturbance Events: A	D	F	No. Disturbance Events/hr: Total/hr	Flush or Displace/hr	Mean No. Seabirds Flushed/Displaced (range)	COMU Flushed/Displaced: No. Events	Mean No. birds (range)	BRCO Flushed/Displaced: No. Events	Mean No. birds (range)	BRPE Flushed/Displaced: No. Events	Mean No. birds (range)
Plane	16	0.033	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	6	0.013	0	0	0	0	0	0	0	0	0	0	0	0
Boat	43	0.090	0	0	3	0.006	0.006	70 (3-205)	1	200	3	4 (3-5)	0	0
Truck/ Motorcycle	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	58	0.136	0	0	3	0.006	0.006	70 (3-205)	1	200	3	4 (3-5)	0	0

[1] See Table 6 for descriptions.

Table 9. 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, 2007. Total number observed and number per observer hour are reported.[1]

			No. Disturbance Events			No. Disturbance Events/hr			COMU Flushed/Displaced		BRCO Flushed/Displaced		BRPE Flushed/Displaced	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/ hr	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	2	.183	0	0	1	.092	.092	93	1	93	0	0	0	0
Boat	2	.183	0	0	0	0	0	0	0	0	0	0	0	0
Total	4	.367	0	0	0	.092	.092	93	1	93	0	0	0	0

[1] See Table 6 for descriptions.

Table 10. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) at Millers Point Rocks, 2007. Total number observed and number per observer hour are reported.[1]

Source	Total Obser-vations	No. Obs/hr	No. Disturbance Events: A	D	F	No. Disturbance Events/hr: Total/hr	Flush or Displace/hr	Mean No. Seabirds Flushed/Displaced	COMU Flushed/Displaced: No. Events	Mean No. birds	BRCO Flushed/Displaced: No. Events	Mean No. birds	BRPE Flushed/Displaced: No. Events	Mean No. birds
Plane	1	.056	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	1	.056	0	0	0	0	0	0	0	0	0	0	0	0
Boat	10	.565	0	0	0	0	0	0	0	0	0	0	0	0
Truck/	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	12	.678	0	0	0	0	0	0	0	0	0	0	0	0

[1] See Table 6 for descriptions.

Table 11. 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, 2007. Total number observed and number per observer hour are reported.[1]

Source	Total Obser-vations	No. Obs/hr	No. Disturbance Events: A	D	F	No. Disturbance Events/hr: Total/hr	Flush or Displace/hr	Mean No. Seabirds Flushed/Displaced	COMU Flushed/Displaced: No. Events	Mean No. birds	BRCO Flushed/Displaced: No. Events	Mean No. birds	BRPE Flushed/Displaced: No. Events	Mean No. birds
Plane	1	.018	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	12	.212	0	1	0	.018	.018	50	0	0	1	50	0	0
Truck/	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	13	.229	0	1	0	.018	.018	50	0	0	1	50	0	0

[1] See Table 6 for descriptions.

Table 12. Seasonal and daily departure rates (birds/100 birds/10 sec) for Common Murres and Brandt's Cormorants at Devil's Slide Rock in 2007.

			Common Murre			Brandt's Cormorant		
Season	Time Period	N	Mean Departure Rate	Min	Max	Mean Departure Rate	Min	Max
Early Egg-laying	0600 - 1000	360	0.277	0.0	3.0	0.517	0.0	5.6
	1000 - 1400	360	0.074	0.0	0.9	- [1]	- [1]	- [1]
	1400 - 1800	360	0.111	0.0	1.4	0.354	0.0	3.4
Late Egg-laying	0600 - 1000	360	0.154	0.0	2.0	0.210	0.0	2.9
	1000 - 1400	360	0.147	0.0	1.7	0.464	0.0	4.1
	1400 - 1800	360	0.151	0.0	2.0	0.149	0.0	2.9
Peak Chick Rearing	0600 - 1000	360	0.247	0.0	1.6	0.384	0.0	6.7
	1000 - 1400	360	0.216	0.0	1.5	0.222	0.0	5.0
	1400 - 1800	360	0.210	0.0	5.0	0.216	0.0	2.6

[1]Brandt's Cormorants were not counted during these surveys.

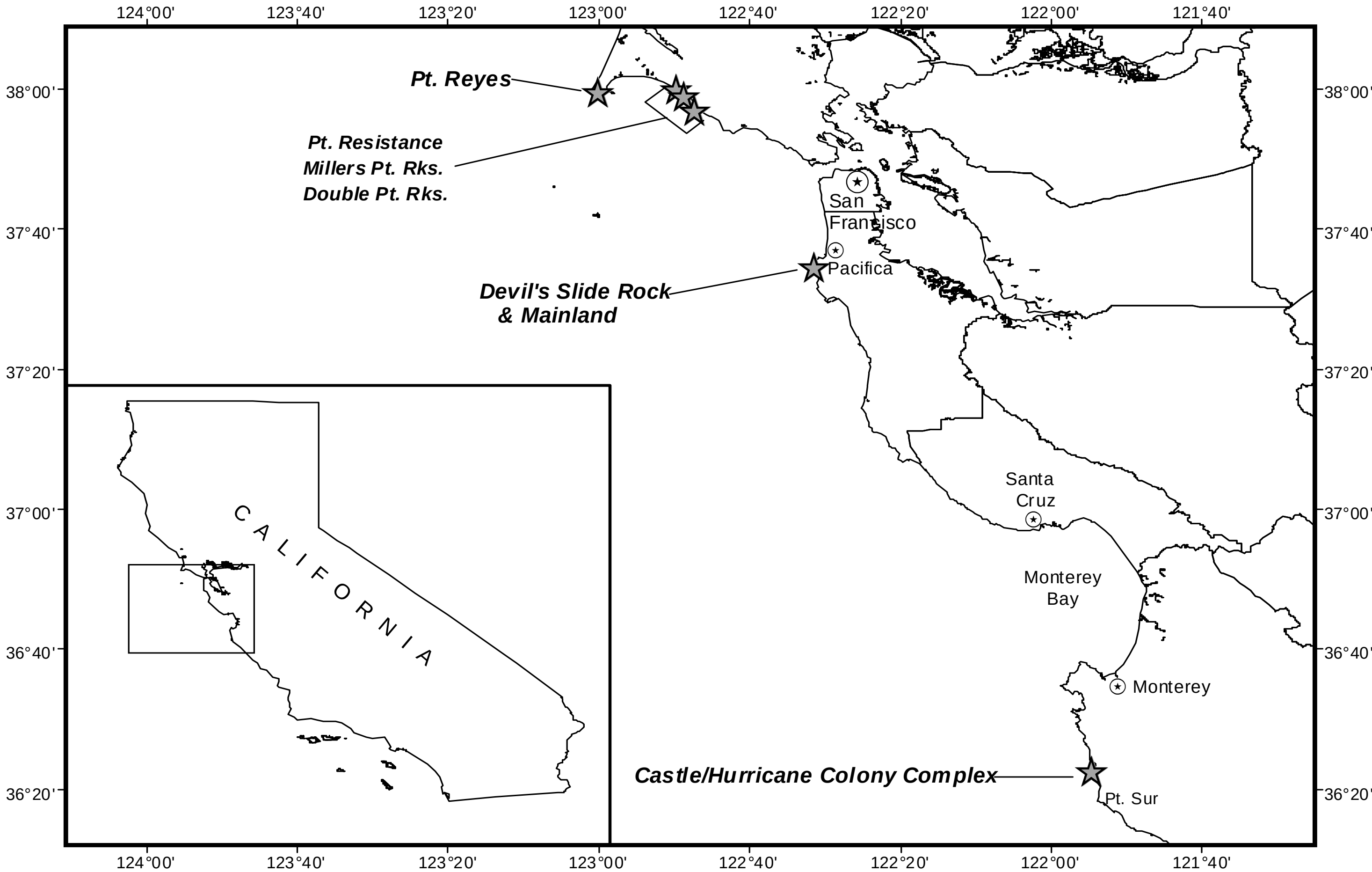

Figure 1. Map of the study area showing locations of study colonies. Point Resistance, Millers Point Rocks, and Double Point Rocks are within the Drakes Bay Colony Complex.

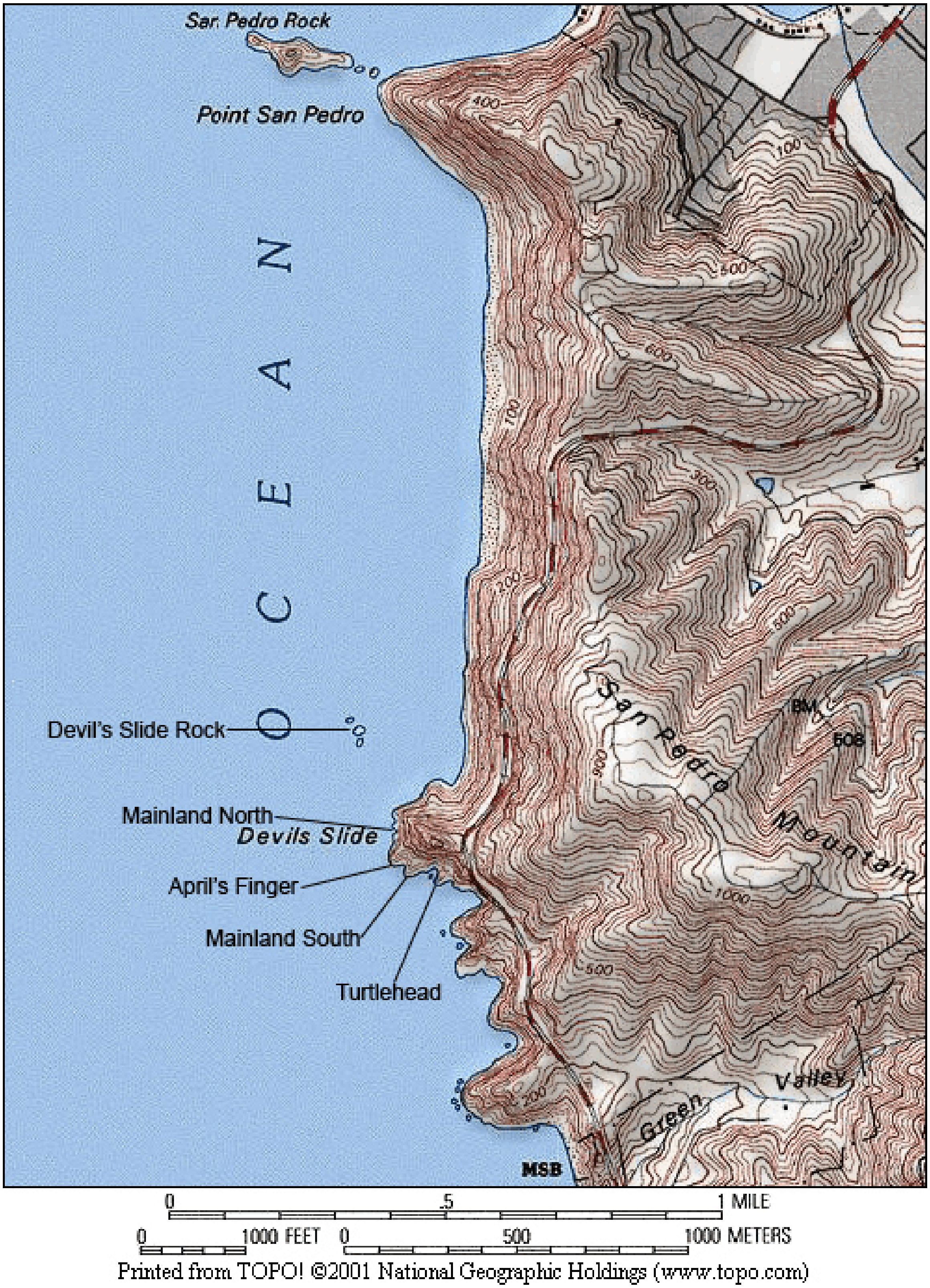

Figure 2. Map showing locations of San Pedro Rock and Devil's Slide Rock and Mainland subareas monitored.

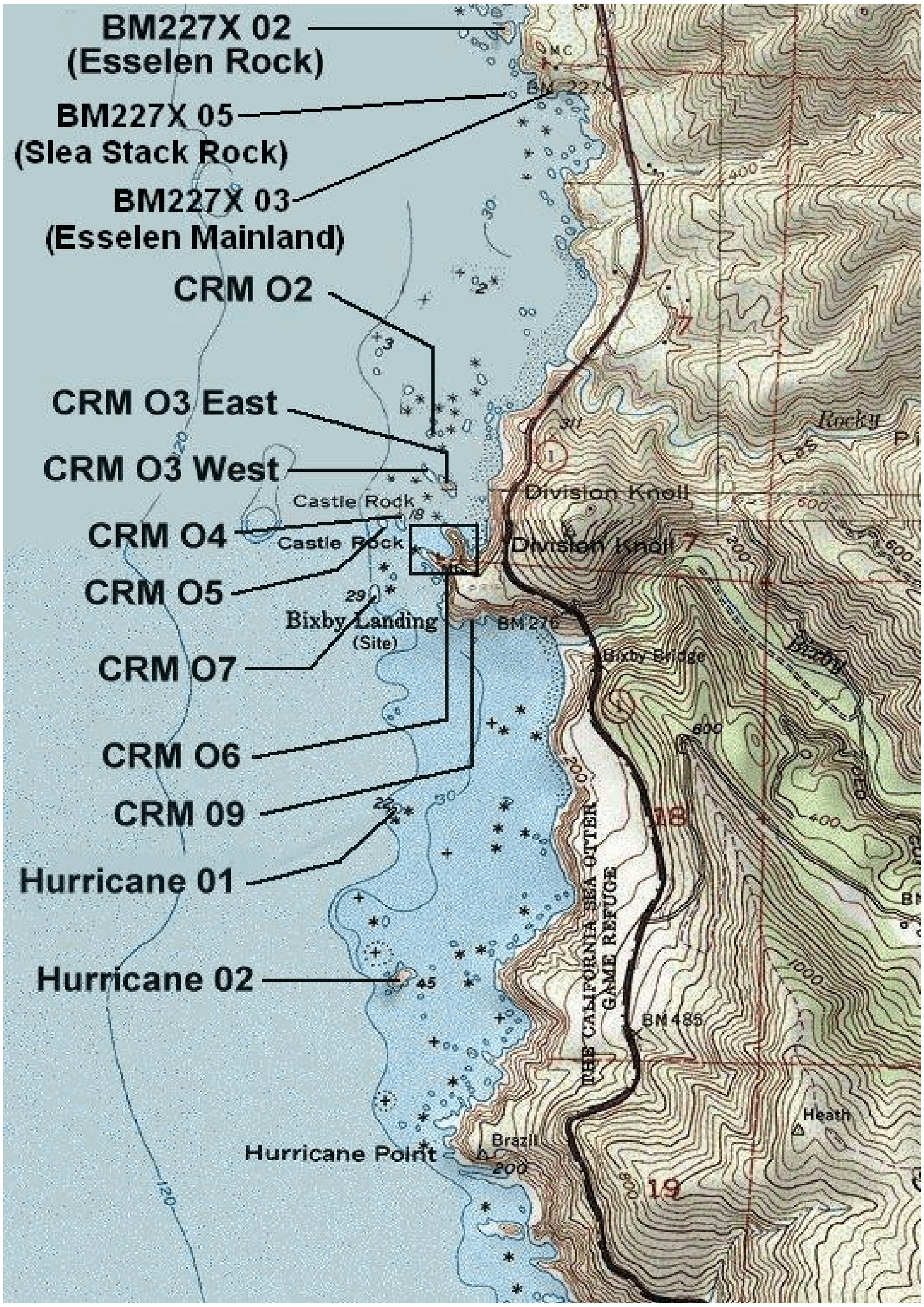

Figure 3. Castle/Hurricane Colony Complex, including Bench Mark-227X (BM227X), Castle Rocks and Mainland (CRM), and Hurricane Point Rocks (Hurricane). Labels indicate subcolonies mentioned in the text.

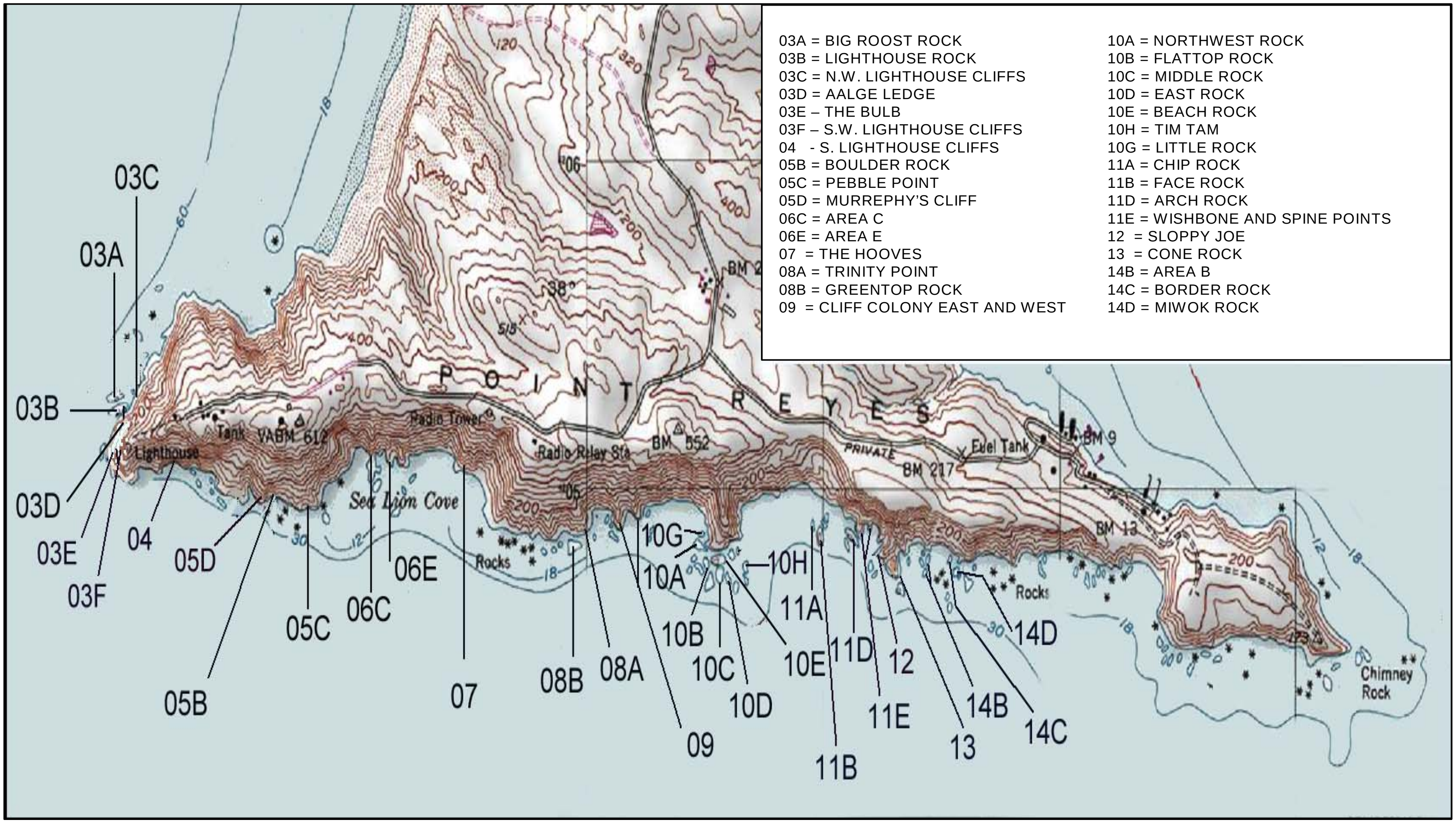

Figure 4. Point Reyes, including subcolonies mentioned in this report.

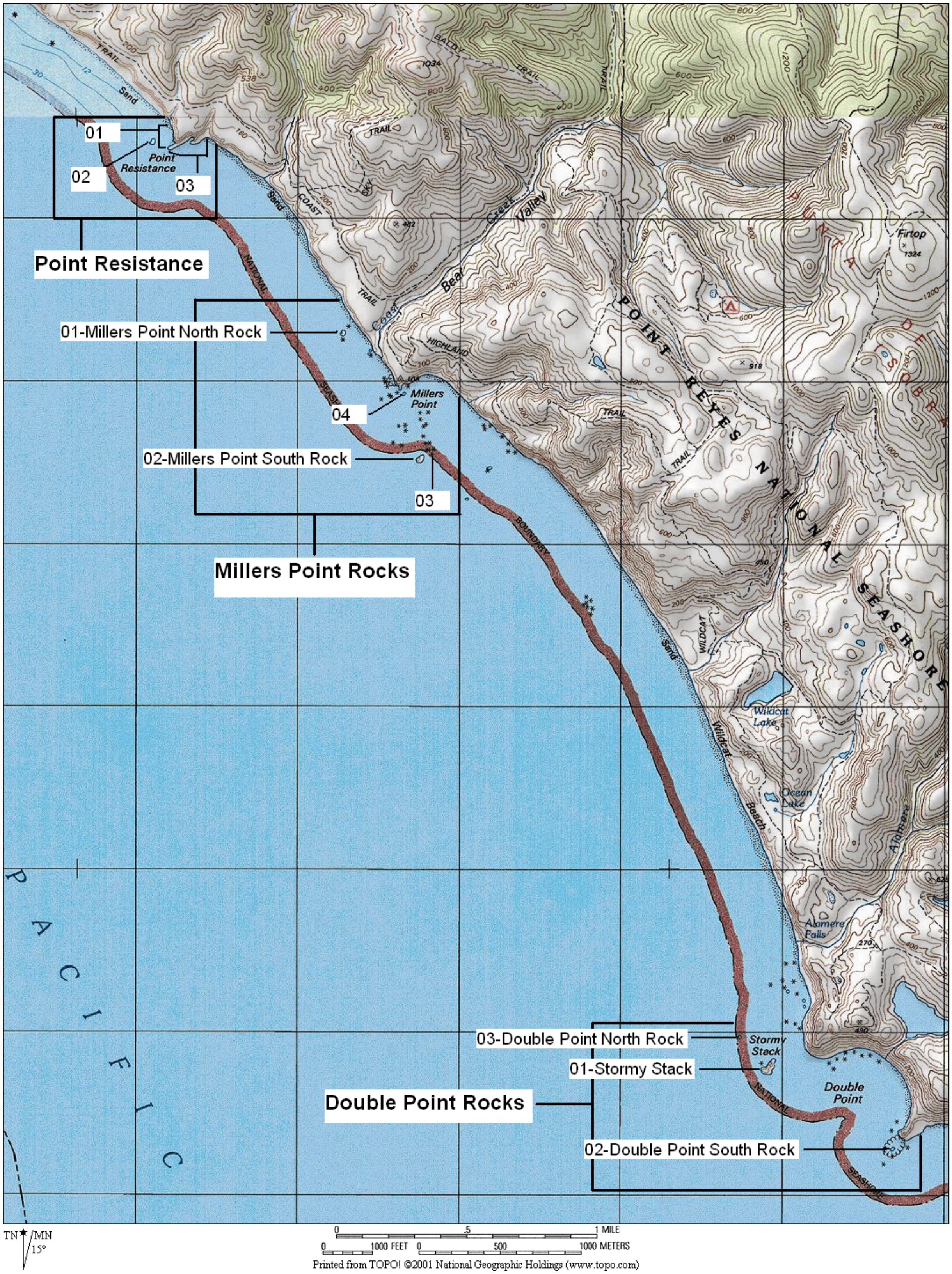

Figure 5. Drakes Bay Colony Complex, including colonies and subcolonies.

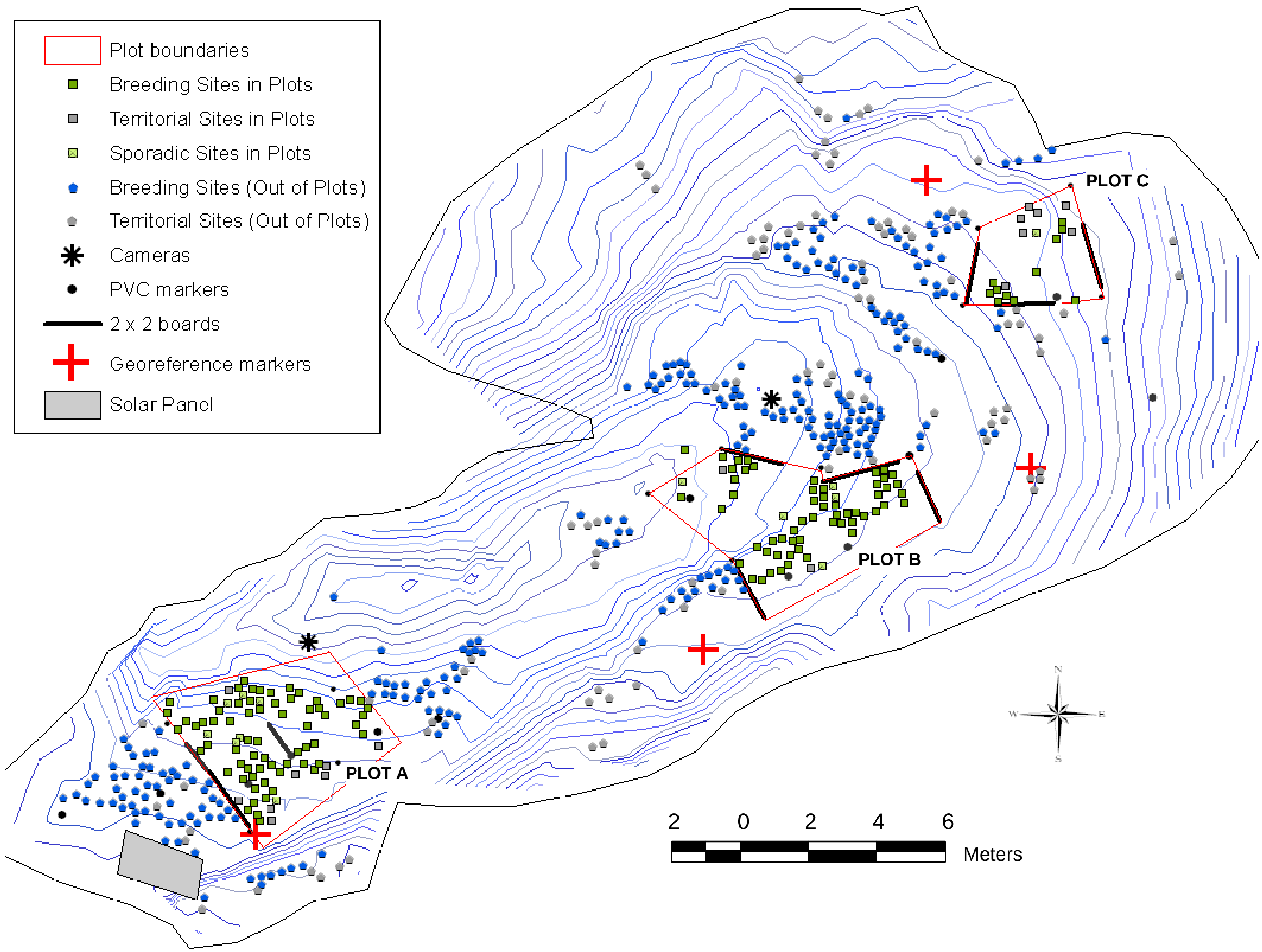

Figure 6. GIS map of Devil's Slide Rock, 2007. Shown are Common Murre breeding, territorial, and sporadic sites, plot boundaries, markers and other features.

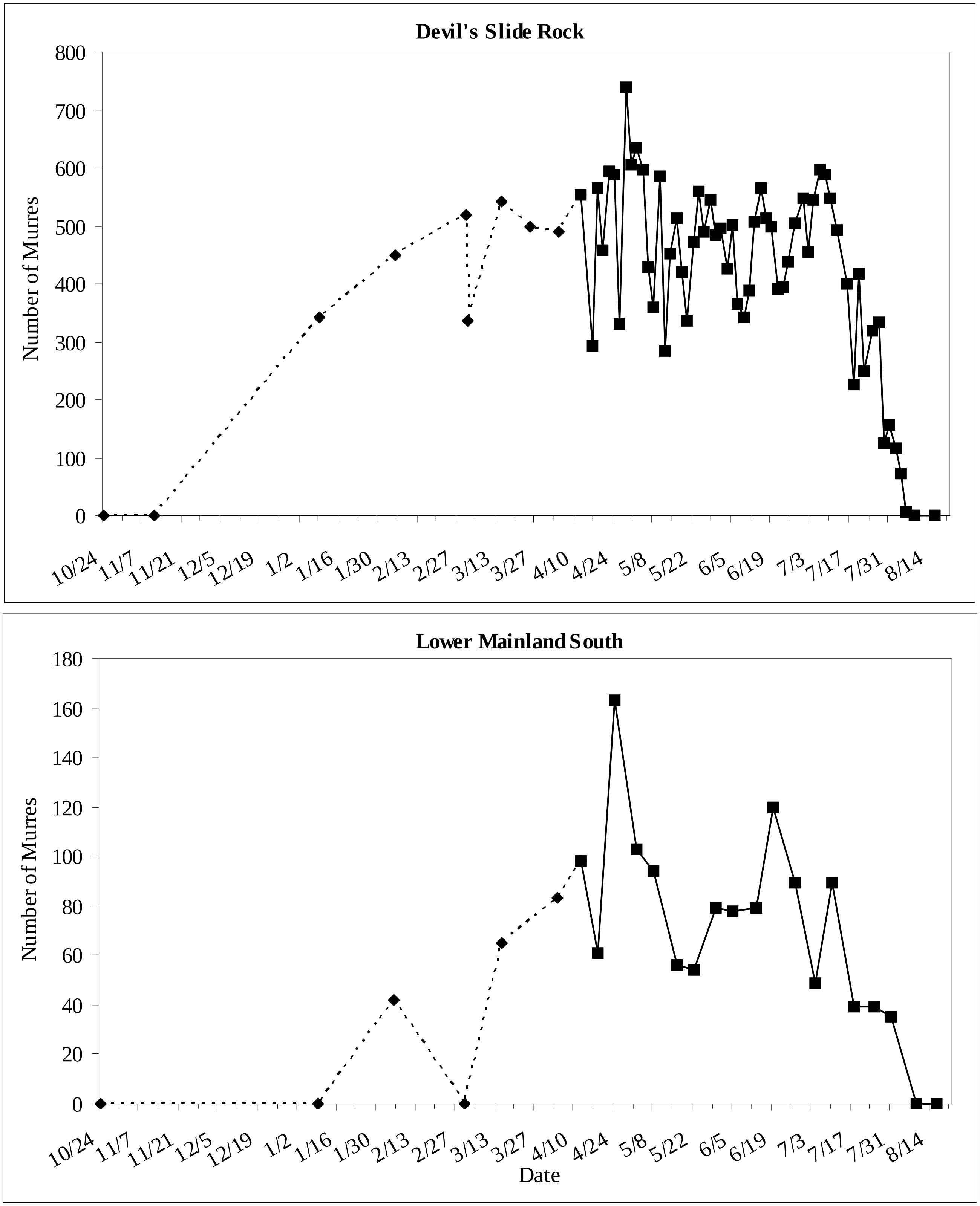

Figure 7. Seasonal attendance of Common Murres at Devil's Slide Rock and Lower Mainland South subarea, 24 October 2006 to 16 August 2007. Dashed lines indicate pre-breeding season counts and solid lines indicate breeding season counts.

Figure 8. Aerial photograph of Devil's Slide Rock, 29 May 2007, showing the distribution of the Common Murre and Brandt's Cormorant breeding colony.

Figure 9. Aerial photograph of Lower Mainland South on Devil's Slide Mainland, showing Common Murre breeding sites among nesting Brandt's Cormorants, 29 May 2007.

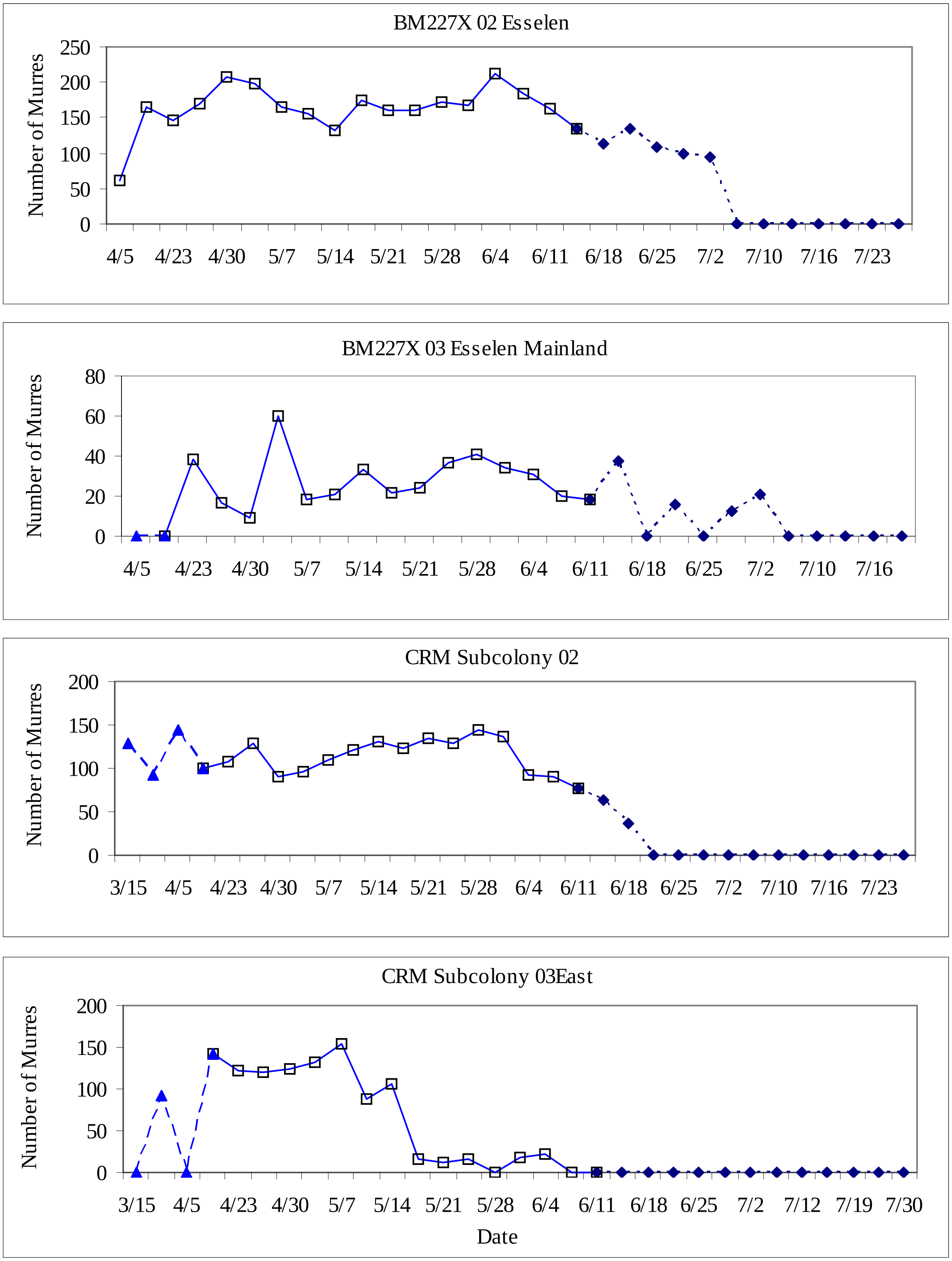

Figure 10. Seasonal attendance patterns of Common Murres at BM227X subcolonies 02 and 03 and Castle Rocks and Mainland subcolonies 02 and 03 East, 15 March to 30 July 2007. Dashed lines indicate pre-breeding season, solid lines indicate breeding season, and dotted lines indicate breeding season attendance after arrival of a juvenile Brown Pelican on 12 June.

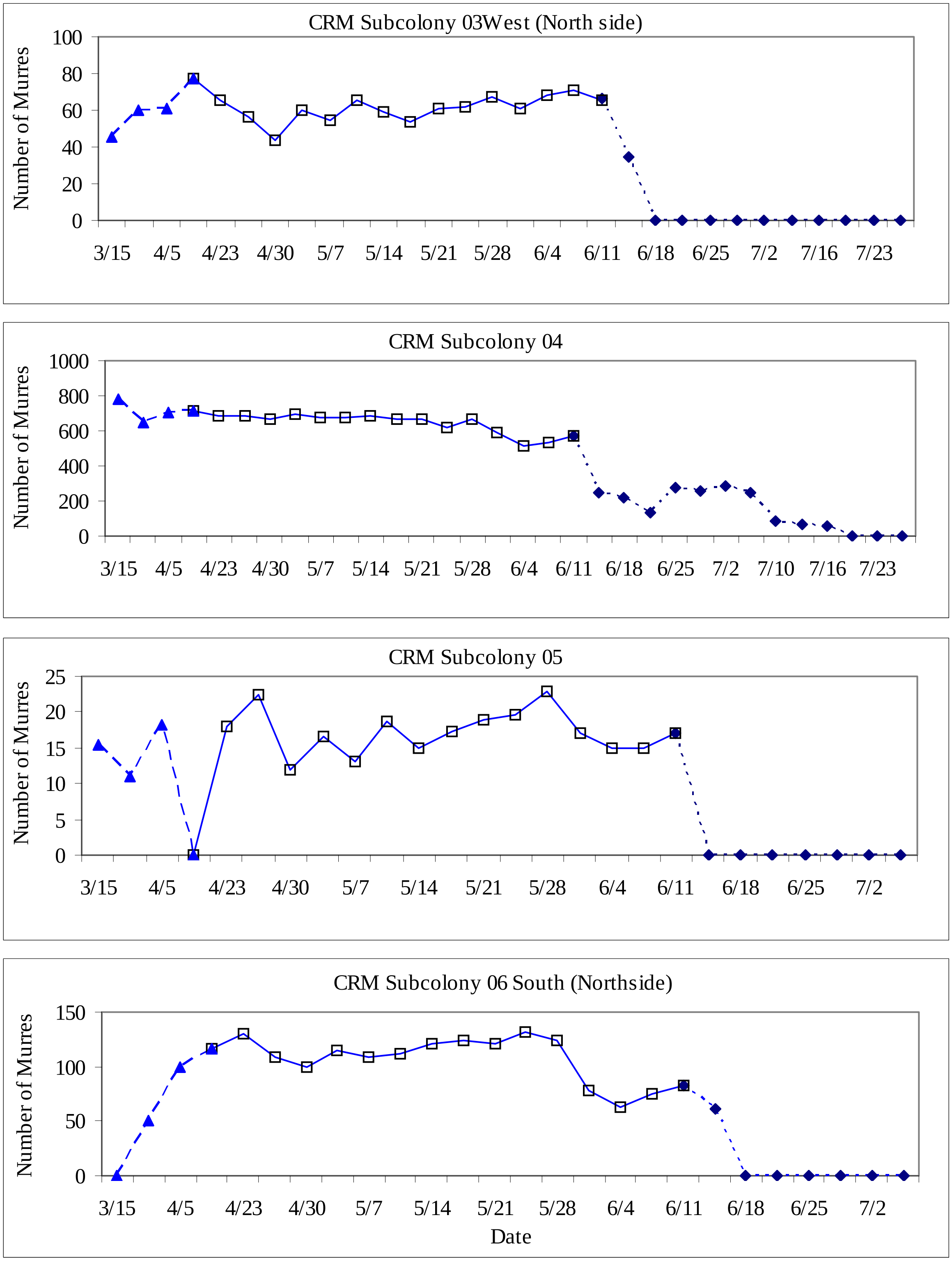

Figure 11. Seasonal attendance patterns of Common Murres at Castle Rocks and Mainland subcolonies 03 West, 04, 05 and 06 South, 15 March to 30 July 2007. Dashed lines indicate pre-breeding season, solid lines indicate breeding season, and dotted lines indicate breeding season attendance after arrival of a juvenile Brown Pelican on 12 June.

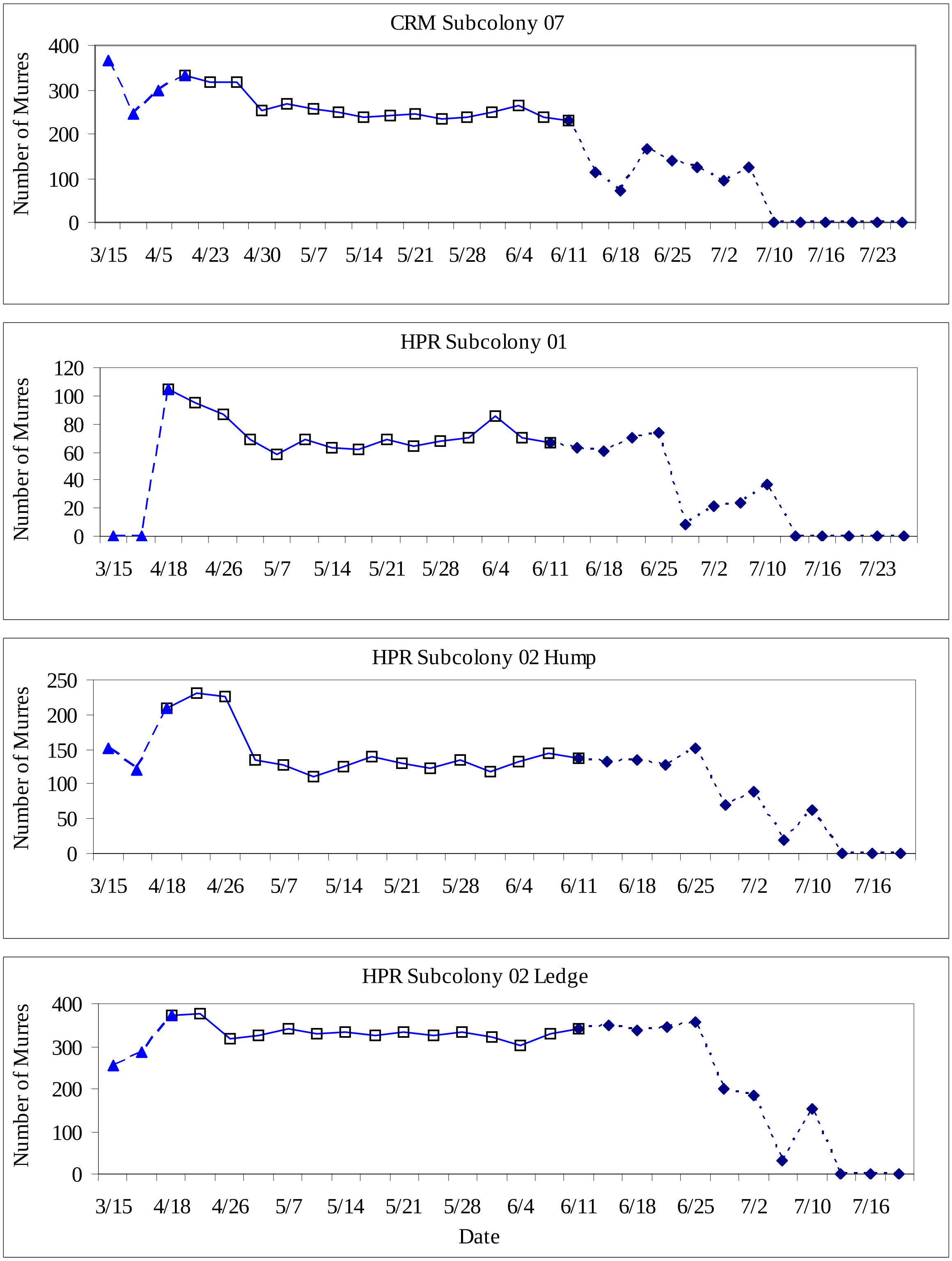

Figure 12. Seasonal attendance patterns of Common Murres at Castle Rocks and Mainland sub-colony 07 and Hurricane Point Rocks subcolonies 01 and 02 (Hump and Ledge areas), 15 March to 30 July 2007. Dashed lines indicate pre-breeding season, solid lines indicate breeding season, and dotted lines indicate breeding season attendance after arrival of a juvenile Brown Pelican on 12 June.

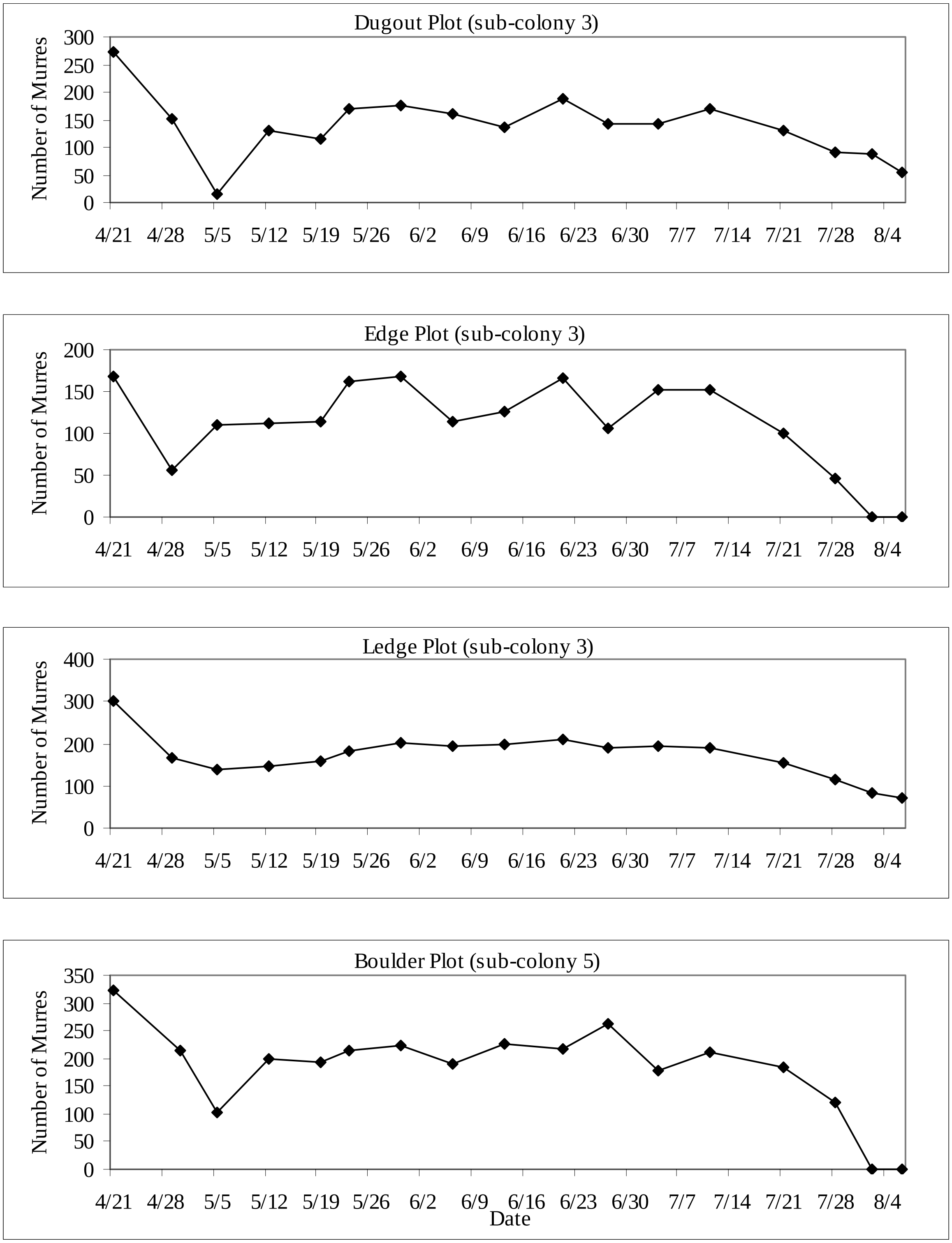

Figure 13. Seasonal attendance of Common Murres at four index plots (3 on Lighthouse Rock: Dugout, Edge and Ledge plots, and one on Boulder Rock), Point Reyes, 21 April to 6 August, 2007.

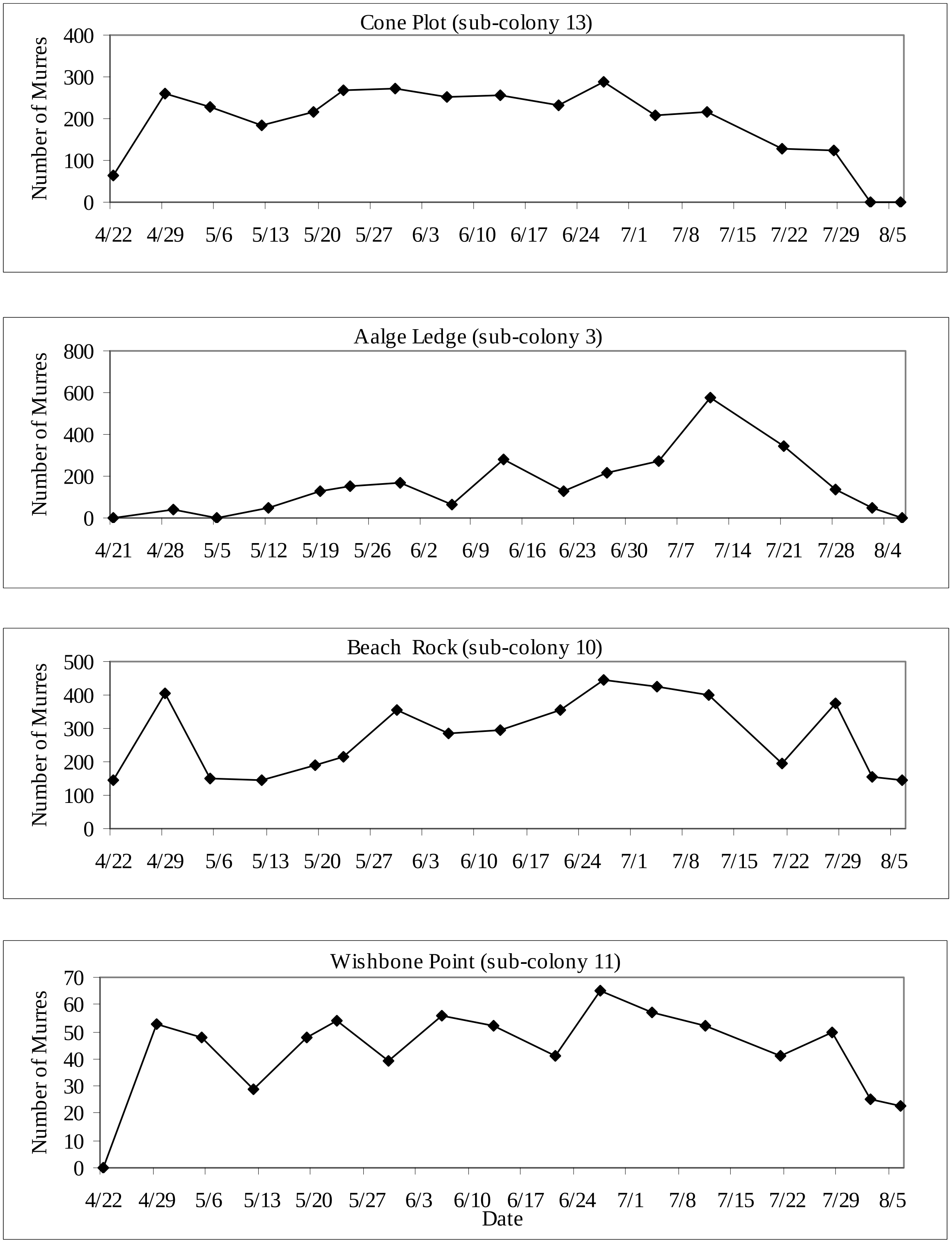

Figure 14. Seasonal attendance of Common Murres at Cone Rock (one index plot), Aalge Ledge, Beach Rock, and Wishbone Point, Point Reyes, 21 April to 6 August, 2007.

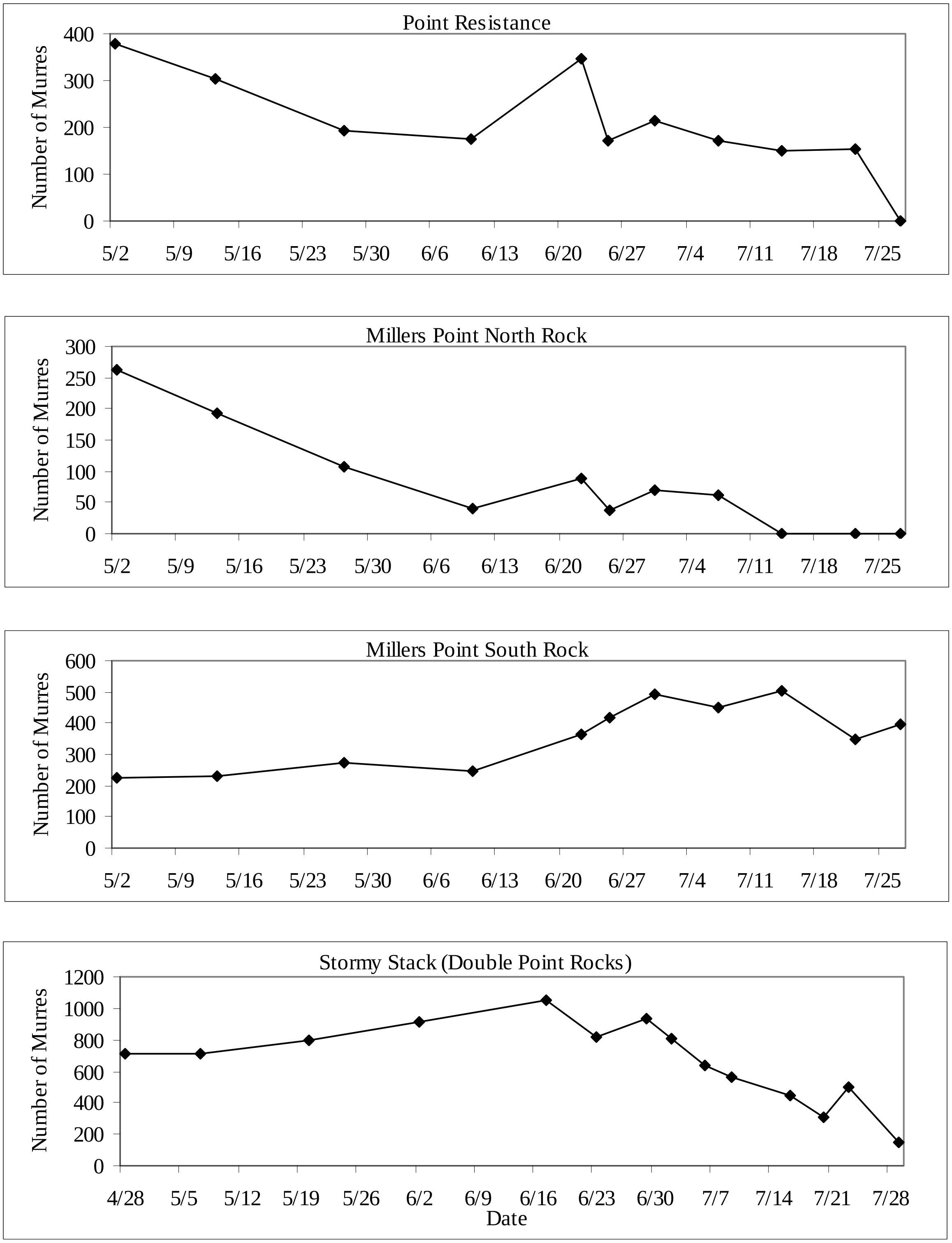

Figure 15. Seasonal attendance of Common Murres at Point Resistance (four index plots), Millers Point Rocks (North and South Rocks), and Double Point Rocks (five index plots on Stormy Stack), 28 April to 29 July, 2007.

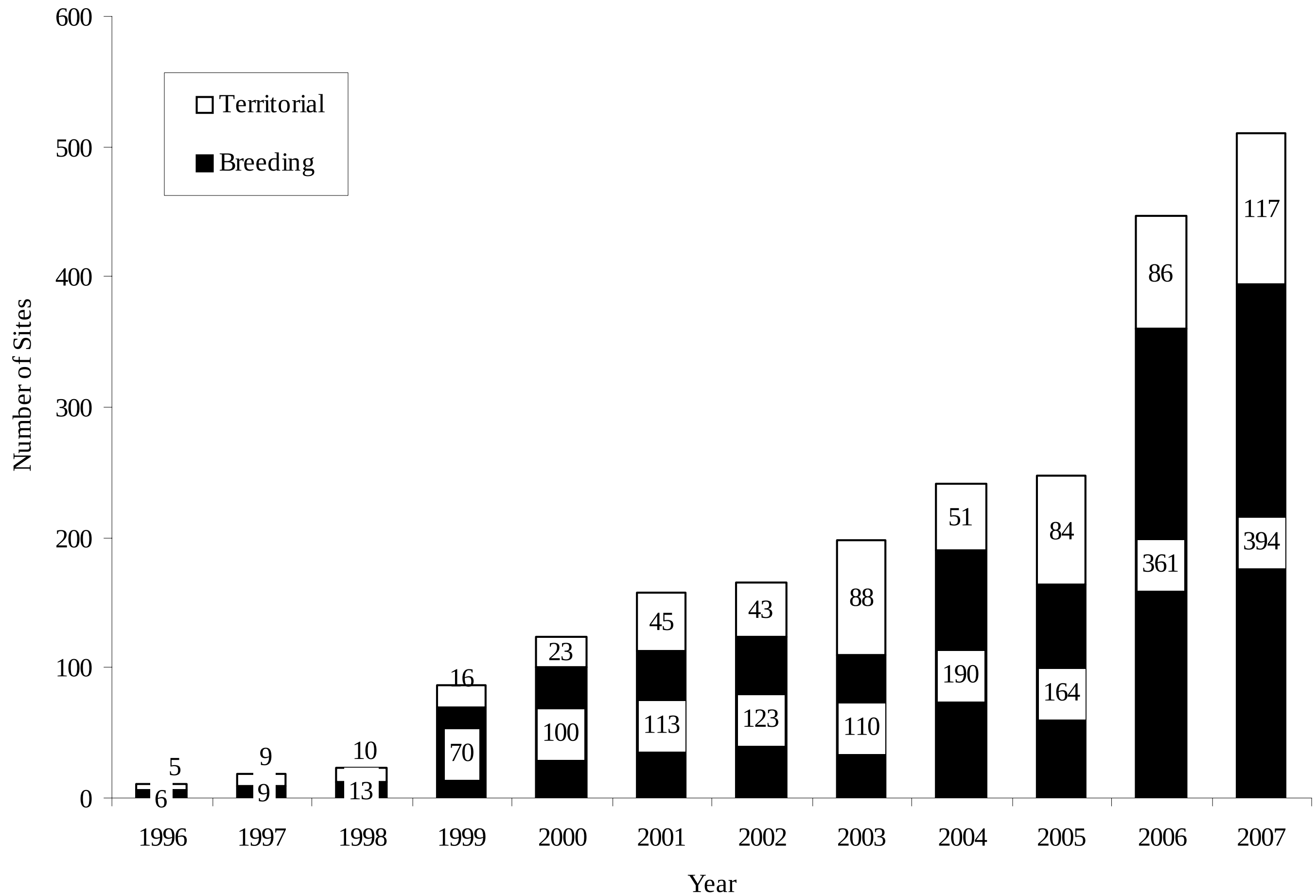

Figure 16. Numbers of Common Murre breeding and territorial sites at Devil's Slide Rock, 1996-2007.

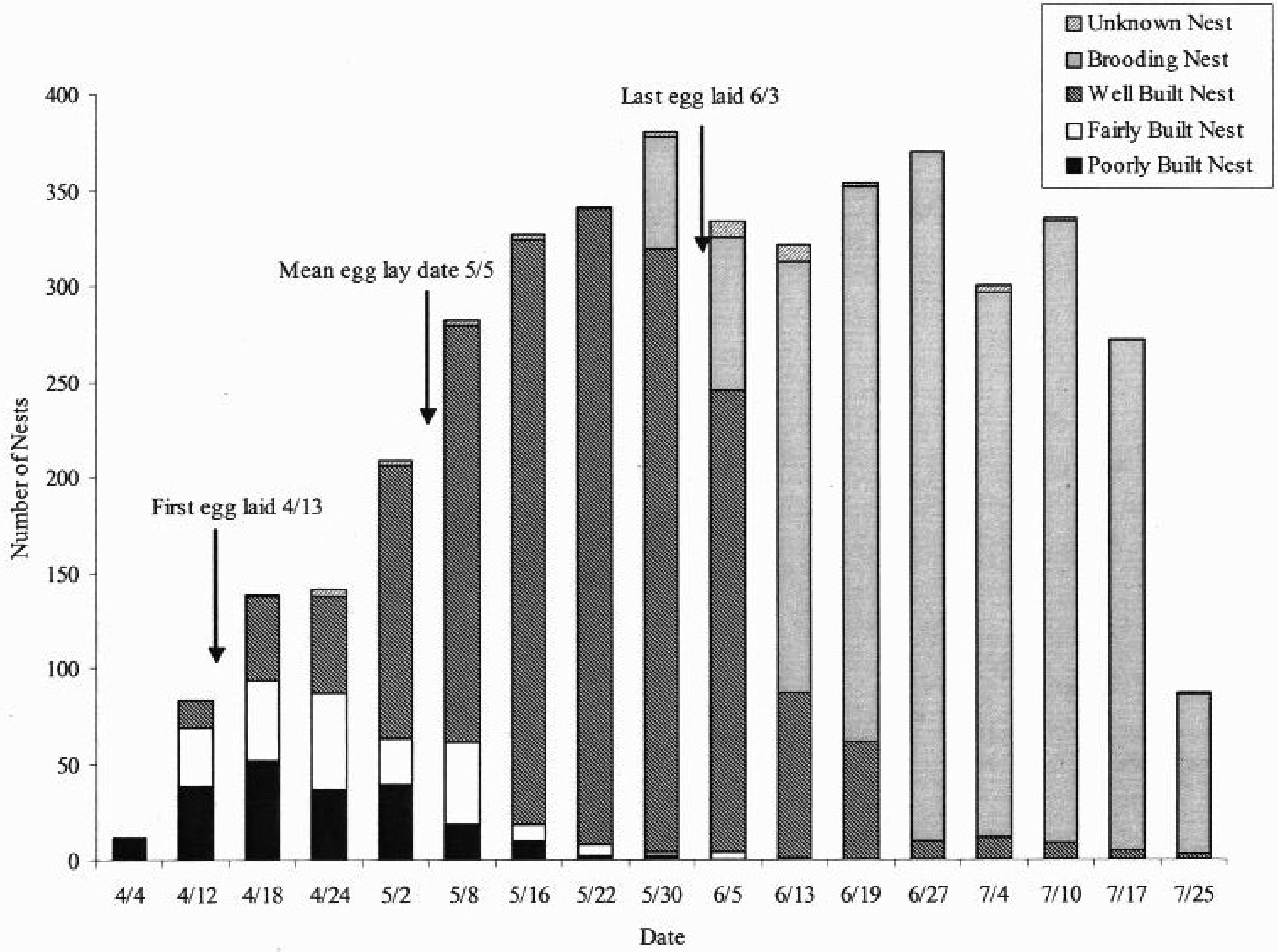

Figure 17. Numbers of Brandt's Cormorant nests counted weekly at Devil's Slide Rock and Mainland, 4 April to 25 July 2007, in relation to breeding phenology at monitored nests.

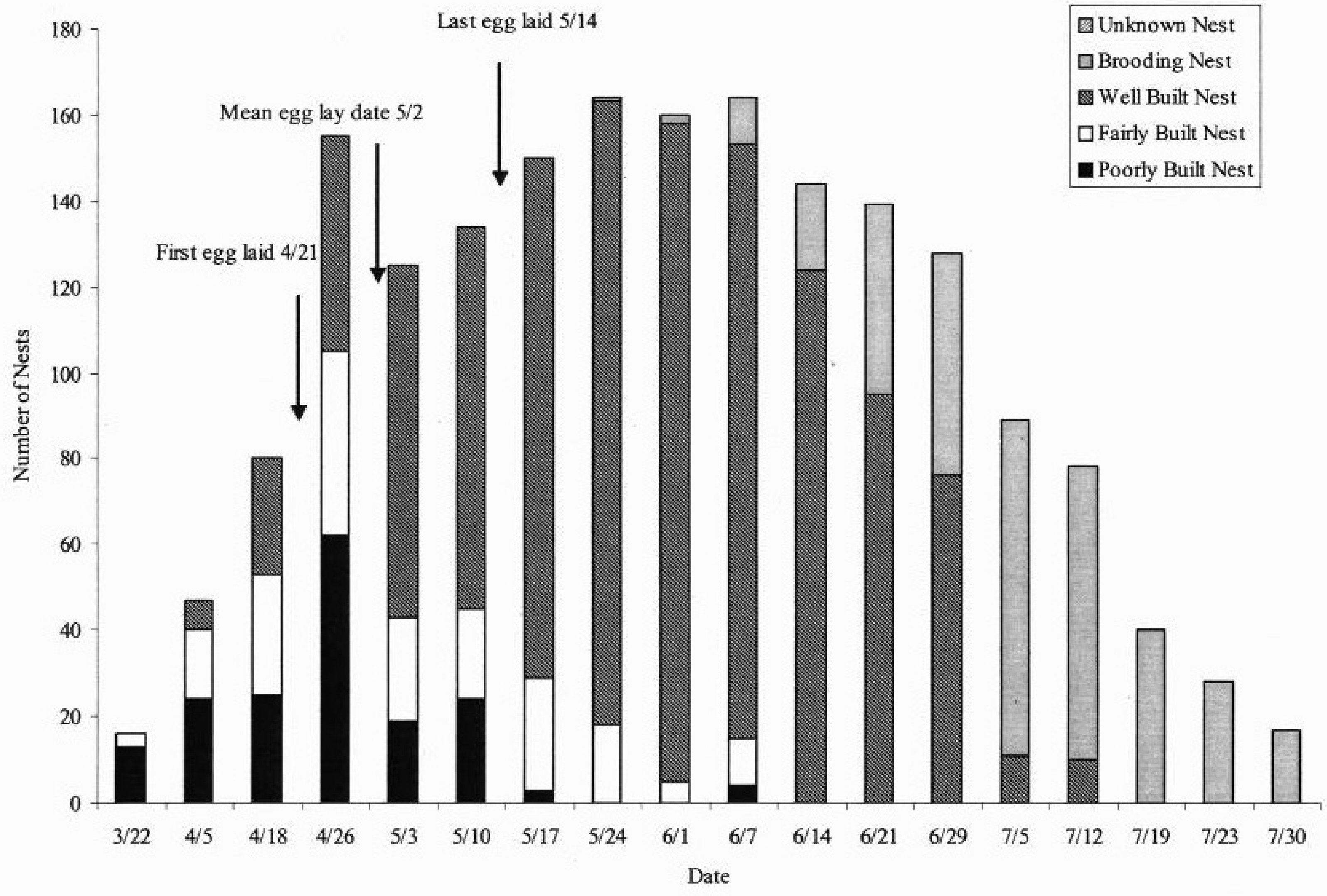

Figure 18. Numbers of Brandt's Cormorant nests counted weekly at Castle/Hurricane Colony Complex, 22 March to 30 July 2007, in relation to breeding phenology at monitored nests.

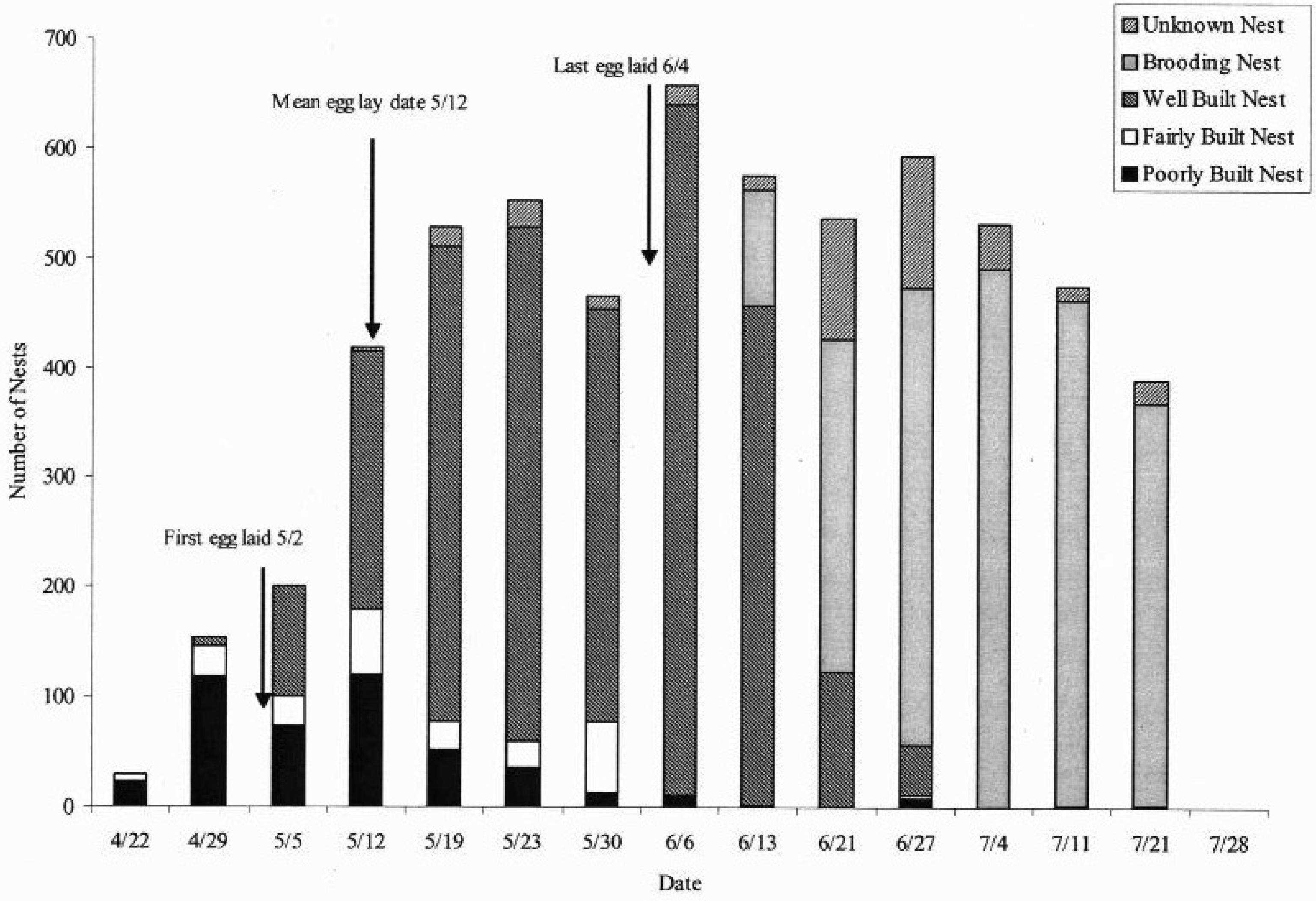

Figure 19. Numbers of Brandt's Cormorant nests counted weekly at Point Reyes, 22 April to 28 July, 2007, in relation to breeding phenology at monitored nests.

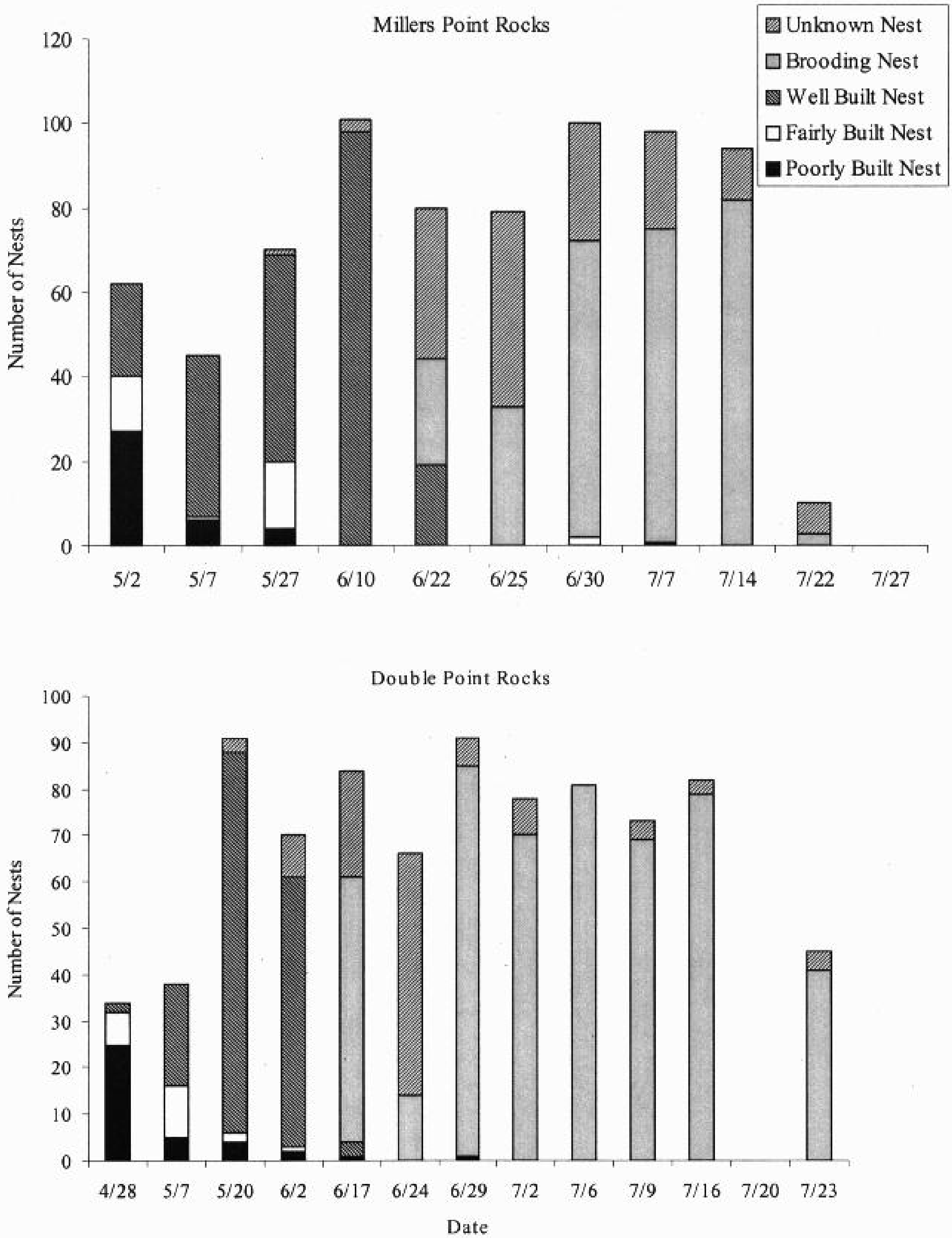

Figure 20. Numbers of Brandt's Cormorant nests counted weekly at Millers Point Rocks and Double Point Rocks, 28 April to 27 July, 2007, in relation to breeding phenology at monitored nests.

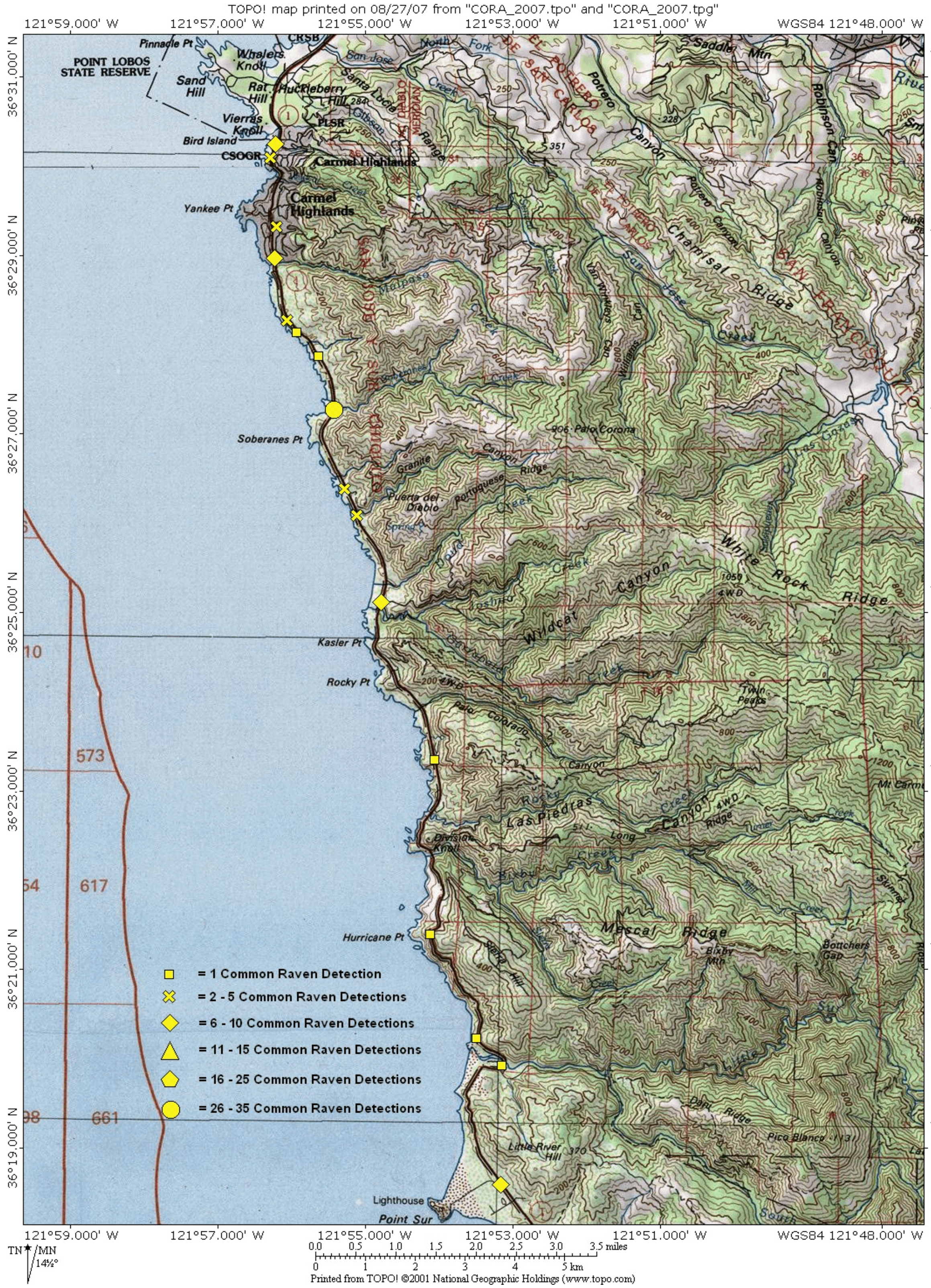

Figure 21. Locations of Common Raven detections between Point Lobos and Point Sur, California, 2007.

Appendix 1. Numbers and types of observed aircraft and watercraft and resulting disturbance events recorded at Devil's Slide Rock and Mainland, 2007.

Aircraft Type	Total Observations		# Agitation Events		# Displacement Events		# Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	14	12	9	1	0	0	2	8	11	9
Military	5	7	3	3	0	0	0	3	3	6
Law Enforcement	4	0	2	0	0	0	0	0	2	0
USCG	0	19	0	10	0	0	0	2	0	12
Ultra-light	0	-	0	-	0	-	0	-	0	-
Other[1]	370	26	59	8	0	0	4	11	63	19
Unknown	2	1	2	0	0	0	0	1	2	1

Watercraft Type	Total Observations	# Agitation Events	# Displacement Events	# Flushing Events	Total Disturbance Events
Small Private	22	4	2	0	6
Large Private	4	0	0	0	0
Charter	2	1	0	0	1
Commercial	0	0	0	0	0
Law Enforcement	1	0	0	0	0
Kayak	4	1	0	0	1
Other	0	0	0	0	0
Unknown	0	0	0	0	0

[1]These numbers include all aircraft not identified under other categories, including private aircraft.

Appendix 2. Numbers and types of observed aircraft and watercraft and resulting disturbance events recorded at Castle/Hurricane Colony Complex, 2007.

Aircraft Type	Total Observations		# Agitation Events		# Displacement Events		# Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	1	0	0	0	0	0	0	0	0	0
Military	0	2	0	0	0	0	0	2	0	2
Law Enforcement	0	0	0	0	0	0	0	0	0	0
USCG	0	0	0	0	0	0	0	0	0	0
Ultra-light	0	-	0	-	0	-	0	-	0	-
Other[1]	17	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Watercraft Type	Total Observations	# Agitation Events	# Displacement Events	# Flushing Events	Total Disturbance Events
Small Private	0	0	0	0	0
Large Private	0	0	0	0	0
Charter	0	0	0	0	0
Commercial	2	0	0	0	0
Law Enforcement	0	0	0	0	0
Kayak	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

[1]These numbers include all aircraft not identified under other categories, including private aircraft.

Appendix 3. Numbers and types of observed aircraft and watercraft and resulting disturbance events recorded at Point Reyes, 2007.

Aircraft Type	Total Observations		# Agitation Events		# Displacement Events		# Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	2	0	0	0	0	0	0	0	0	0
Military	1	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
USCG	0	6	0	0	0	0	0	0	0	0
Ultra-light	0	-	0	-	0	-	0	-	0	-
Other[1]	6	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Watercraft Type	Total Observations	# Agitation Events	# Displacement Events	# Flushing Events	Total Disturbance Events
Small Private	33	0	0	2	2
Large Private	0	0	0	0	0
Charter	7	0	0	1	1
Commercial	3	0	0	0	0
Law Enforcement	0	0	0	0	0
Kayak	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

[1]These numbers include all aircraft not identified under other categories, including private aircraft.

Appendix 4. Numbers and types of observed aircraft and watercraft and resulting disturbance events recorded at Point Resistance, 2007.

Aircraft Type	Total Observations		# Agitation Events		# Displacement Events		# 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
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
USCG	0	2	0	0	0	0	0	1	0	1
Ultra-light	0	-	0	-	0	-	0	-	0	-
Other[1]	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Watercraft Type	Total Observations	# Agitation Events	# Displacement Events	# Flushing Events	Total Disturbance Events
Small Private	0	0	0	0	0
Large Private	0	0	0	0	0
Charter	2	0	0	0	0
Commercial	0	0	0	0	0
Law Enforcement	0	0	0	0	0
Kayak	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

[1]These numbers include all aircraft not identified under other categories, including private aircraft.

Appendix 5. Numbers and types of observed aircraft and watercraft and resulting disturbance events recorded at Millers Point Rocks, 2007.

Aircraft Type	Total Observations		# Agitation Events		# Displacement Events		# 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
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
USCG	0	1	0	0	0	0	0	0	0	0
Ultra-light	0	-	0	-	0	-	0	-	0	-
Other[1]	1	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Watercraft Type	Total Observations	# Agitation Events	# Displacement Events	# Flushing Events	Total Disturbance Events
Small Private	7	0	0	0	0
Large Private	0	0	0	0	0
Charter	2	0	0	0	0
Commercial	0	0	0	0	0
Law Enforcement	0	0	0	0	0
Kayak	1	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

[1]These numbers include all aircraft not identified under other categories, including private aircraft.

Appendix 6. Numbers and types of observed aircraft and watercraft and resulting disturbance events recorded at Double Point Rocks, 2007.

Aircraft Type	Total Observations		# Agitation Events		# Displacement Events		# 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
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
USCG	0	0	0	0	0	0	0	0	0	0
Ultra-light	0	-	0	-	0	-	0	-	0	-
Other[1]	1	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Watercraft Type	Total Observations	# Agitation Events	# Displacement Events	# Flushing Events	Total Disturbance Events
Small Private	12	0	1	0	1
Large Private	0	0	0	0	0
Charter	0	0	0	0	0
Commercial	0	0	0	0	0
Law Enforcement	0	0	0	0	0
Kayak	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

[1]These numbers include all aircraft not identified under other categories, including private aircraft.