RESTORATION AND MONITORING OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2010

REPORT TO THE

LUCKENBACH TRUSTEE COUNCIL

Lisa E. Eigner, Gerard J. McChesney, Sandra J. Rhoades, Mary W. Davis, Jonathan A. Shore, Crystal A. Bechaver, Corey S. Shake, Margaret M. Schaap, and Richard T. Golightly

U.S. Fish and Wildlife Service
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, CA 94555 USA

FINAL REPORT
November 2011

RESTORATION OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2010

REPORT TO THE

LUCKENBACH TRUSTEE COUNCIL

Lisa E. Eigner[1], Gerard J. McChesney[1], Sandra J. Rhoades[2,3], Mary W. Davis[2,3], Jonathan A. Shore[2,3], Crystal A. Bechaver[2,3], Corey S. Shake[2,3], Margaret M. Schaap[2,3], and Richard T. Golightly[2]

[1]U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, 1 Marshlands Road, Fremont, CA 94555 USA
[2]Humboldt State University, Department of Wildlife, Arcata, CA 95521 USA
[3]Mailing Address: U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, 1 Marshlands Road, Fremont, CA 94555 USA

U.S. Fish and Wildlife Service
San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, CA 94555 USA

FINAL REPORT
November 2011

Cover photo: Aerial photograph of Devil's Slide Rock, photographed by Gerard J. McChesney on 15 June 2010.

Suggested Citation: Eigner, L. E., G. J. McChesney, S. J. Rhoades, M. W. Davis, J. A. Shore, C. A. Bechaver, C. S. Shake, M. M. Schaap, and R. T. Golightly.2011. Restoration of Common Murre colonies in central California: annual report 2010. Unpublished report, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Newark, California. 86 pages.

PROJECT ADMINISTRATION

Project Staff

Co-Principal Investigator: Gerard J. McChesney
Co-Principal Investigator: Richard T. Golightly
Wildlife Biologist: Lisa E. Eigner
Wildlife Biologist (Point Reyes, Drakes Bay): Sandra J. Rhoades
Wildlife Biologist (Castle-Hurricane): Mary W. Davis
Wildlife Biologist (Devil's Slide-San Pedro): Jonathan A. Shore
Wildlife Technician (Devil's Slide-San Pedro): Crystal A. Bechaver
Wildlife Technician (Point Reyes, Drakes Bay): Corey S. Shake
Wildlife Technician (Point Reyes, Drakes Bay): Margaret M. Schaap

***Luckenbach* Trustee Council**

U.S. Fish and Wildlife Service/National Park Service

Representative: Janet Whitlock (Sacramento Field Office, Sacramento, CA)
Alternate: John DiGregoria (Point Reyes National Seashore)

California Department of Fish and Game

Representative: Steve Hampton (Office of Spill Prevention and Response, Sacramento, CA)
Alternate: Laird Henkel (Office of Spill Prevention and Response, Monterey, CA)

National Oceanic and Atmospheric Administration

Representative: Jennifer Boyce (NOAA Restoration Center, Long Beach, CA)

ABBREVIATIONS USED

CMRP = Common Murre Restoration Project

USFWS = U.S. Fish and Wildlife Service

NOAA = National Oceanic and Atmospheric Administration

CDFG = California Department of Fish and Game

GFNMS = Gulf of the Farallones National Marine Sanctuary

OSPR = Office of Spill Prevention and Response

SPN = Seabird Protection Network

PRH = Point Reyes Headlands

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

PRS = Point Resistance

MPR = Millers Point Rocks

DPR = Double Point Rocks

DSRM = Devil’s Slide Rock & Mainland

DSR = Devil’s Slide Rock

DSM = Devil’s Slide Mainland

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

SPR = San Pedro Rock

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

BM227X = Bench Mark-227X

CRM = Castle Rocks & Mainland

HPR = Hurricane Point Rocks

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

ACKNOWLEDGMENTS

In 2010, funding and oversight were provided primarily by the *Luckenbach* Trustee Council (consisting of the U.S. Fish and Wildlife Service [USFWS], National Park Service [NPS], National Oceanic and Atmospheric Administration [NOAA], and California Department of Fish and Game [CDFG]), with additional funds provided by SeaGrant for baseline studies of seabirds in the California Marine Life Protection Act's North Central Coast Study Area.

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

We are especially indebted to Harry R. Carter, Stephen W. Kress, and Michael W. Parker for their long-standing contributions to the restoration of Common Murres in central California. We are also indebted to the staff of the Gulf of the Farallones National Marine Sanctuary (GFNMS), especially Karen Reyna, Sage Tezak, Mai Maheigan, Angela Minnameyer, and Maria Brown, who lead the outreach and education component of the Seabird Protection Network. We would like to thank the law enforcement officials who supported the project's goals of following up on disturbance incidents including: Jared Klein (Law Enforcement Officer, USFWS–San Francisco Bay National Wildlife Refuge Complex), Alfred Colby and Phet Souphanya (Special Agents, USFWS), Robert Yerena (Enforcement Officer, NOAA), and Daniel F. Habig (Operations Supervisor, Point Reyes National Seashore). We owe special thanks to: Point Reyes National Seashore, especially Ben Becker and Sarah Allen, for assistance with field site housing, research permits, and access; Chris Bauman and Janice Pratt (Point Montara Lighthouse Hostel) for their continued support and assistance with outreach and education; Laird Henkel (CDFG-OSPR) and Phil Capitolo (University of California Santa Cruz) for support and assistance with aerial photographic surveys of seabird colonies; Wayne Burnett of CDFG-Air Services for his expert flying skills; Armand and Eliane Neukermans; Russell Bradley and Pete Warzybok (PRBO Conservation Science); and W. Breck Tyler (U.C. Santa Cruz). Jason Minton (Garcia and Associates), Raul Domingo, John Muench and several others at the California Department of Transportation (CalTrans) provided assistance with access during ongoing construction on Highway 1 at Devil's Slide.

We would also like to thank the committed volunteers who conducted surveys of Bird Island including Linda Schmid, Marjorie Siegel, and Peter White. Observations of the Devil's Slide area colonies were conducted from the mainland under Encroachment Permit No. 0407-NSV0318 from CalTrans. Research at Point Reyes National Seashore was conducted under Permit PORE-2007-SCI-0014. Low-level aerial photographic surveys of seabird colonies in the Gulf of the Farallones and Monterey Bay National Marine Sanctuaries were conducted under NOAA permit MULTI-2008-002.

EXECUTIVE SUMMARY

Efforts in 2010 represent the 15th year of restoration and associated monitoring of central California seabird colonies conducted by the Common Murre Restoration Project (CMRP). These efforts began in 1996 to restore breeding colonies of seabirds, especially Common Murres (*Uria aalge*), harmed by the 1986 *Apex Houston*, 1998 *Command*, and extended *Luckenbach* oil spills, gill net fishing, human disturbance, and other factors. From 1995 to 2005, the primary goal was to restore the previously extirpated Devil's Slide Rock colony using social attraction techniques and to assess restoration needs at other central California colonies. Since 2005, efforts have been directed to surveillance of human disturbance to central California murre colonies, assessing the impacts of that disturbance, and assessing other factors affecting growth of colonies; additionally, the outcome of initial restoration efforts at Devil's Slide Rock continue to be monitored. This information informs outreach and education efforts conducted by the Seabird Protection Network (coordinated by the Gulf of the Farallones National Marine Sanctuary) and monitors the success of those efforts. The goal of the Seabird Protection Network is to restore central California breeding colonies mainly through reduction of human disturbance.

Surveillance and monitoring were conducted almost daily from mid-April to late July at the following Common Murre colonies in central California: Point Reyes; Devil's Slide Rock & Mainland; and the Castle-Hurricane Colony Complex. Another four colonies were surveyed weekly or bi-weekly including three in the Drakes Bay area (Point Resistance, Millers Point Rocks, and Double Point Rocks) and at San Pedro Rock (near Devil's Slide). In addition to human disturbance, we measured seasonal attendance patterns and reproductive performance of Common Murres and five other seabird species as well as breeding population sizes for some species. At the Bird Island colony located near the Golden Gate, surveys were conducted three times per week (mainly by volunteers) to follow this recent murre colonization.

For aircraft, detection rates were measured as the number of fixed-wing planes and helicopters observed per hour that flew ≤ 305 m (1000 ft) above sea level (ASL) over colonies. Boat activity was measured as the number of vessels detected per observer hour (hereafter, per hour) that approached within 457 m (1500 ft) of colonies. Aircraft, boat and other anthropogenic disturbance rates were measured as the number of disturbance events per hour. At Point Reyes, combined aircraft and boat activity in 2010 was similar to previous years and the overall disturbance rate was lower than the baseline mean (average of 2005-2006, including aircraft, boats and other). In the Drakes Bay area, few aircraft or boats were observed at Point Resistance and Millers Point Rocks. At nearby Double Point Rocks, combined aircraft and boat detection rates were the highest of all monitored colonies. Although overall disturbance rates at Double Point Rocks were relatively high in 2010, they were 46% lower than the baseline mean. Disturbance rates continue to be the greatest of all colonies at Devil's Slide Rock & Mainland. However, the combined aircraft and boat detection rates were much lower than previous years and the overall disturbance rate was 32% lower than the baseline. This was the lowest disturbance rate recorded at Devil's Slide in the last six years. At the Castle-Hurricane Colony Complex, combined aircraft and boat detection rates were higher in 2010 than in previous years and the overall disturbance rate was considerably greater than the baseline mean, mostly due to an increase in disturbances caused by helicopters and boats.

Unmarked, other aircraft (e.g., private or charter) were the most commonly observed planes and helicopters and caused the most observed disturbances at all monitored colonies. The next most common sources of aircraft disturbance were from military helicopters (n =31) and military planes (n = 5), including 16 events where birds were flushed from the colony by aircraft. The majority of watercraft observed were recreational small private boats (71%) followed by commercial fishing vessels (14%). Seven recreational small private boats were responsible for the majority (64%) of disturbances. Eight recreational small private boats and one kayak were detected inside newly established Special Closure areas (Point Reyes Headlands, 1 kayak; Point Resistance, 2; Stormy Stack, 5; Devil's Slide Rock, 1); two of these events resulted in disturbances to seabirds.

In addition to disturbance monitoring, we also monitored attendance patterns and/or reproductive performance for six species of seabirds, with special focus on Common Murres. Common Murres and Brandt's Cormorants experienced delayed and prolonged breeding efforts in 2010. On Devil's Slide Rock, the high count of 824 murres was 18% less than the highest count of 1,003 birds recorded in 2009. The number of breeding pairs within monitored plots was 4% lower than 2009. Productivity (0.86 chicks/pair) was the highest recorded since restoration efforts began in 1996. Murres bred on the Devil's Slide Mainland (42 pairs) for the sixth consecutive year and productivity was 0.45 chicks per pair. In 2010, breeding murres were documented in a new area on the mainland cliffs beneath the South Bunker (subcolony DSR-04). Murre breeding success at Point Reyes (0.73 chicks/pair) and Castle Rocks & Mainland (0.65 chicks/pair) were above the long-term averages.

Brandt's Cormorant breeding success was much lower than the long-term averages at all three monitored colonies, though it was better than 2008 and 2009. Numbers of breeding Pelagic Cormorants were greater than in 2009 at Point Reyes and Devil's Slide Rock & Mainland but were fewer at the Castle-Hurricane Colony Complex; productivity of monitored nests was relatively high. In 2010, Western Gull nest counts were fewer than in 2009 at all colonies except for Devil's Slide Rock & Mainland; productivity was relatively low but was generally higher than over the previous three years.

High breeding success for most species reflected productive ocean conditions that were a result of slightly cooler than normal sea surface temperatures in late spring and summer after winter El Niño conditions diminished rapidly. Similar to 2009, many disturbances were caused by California sea lions (*Zalophus californianus*) at Point Reyes. However, impacts to the colony were not as severe since most disturbances occurred prior to peak egg laying. In contrast to many recent years, Brown Pelicans were responsible for very few disturbances to murres at monitored colonies. Chronic disturbance by Common Ravens at the Point Reyes and Drakes Bay murre colonies continued and may be contributing to the near extirpation of murres at the Millers Point Rocks colony.

Lower aircraft detection and disturbance rates than previous years at Devil's Slide is an improvement over previous years and further monitoring is necessary to see if rates continue to decline. Additional efforts are needed to address a recent increase in aircraft and boat activity at Castle-Hurricane. The Special Closures that became effective on 1 May 2010 may have reduced disturbance at Devil's Slide but a similar decrease at Stormy Stack (DPR-02) was not observed. Additional outreach on the locations and boundaries of closures may be needed as well as enforcement of the special closures. Additionally, monitoring is needed to determine the effectiveness of these closures.

INTRODUCTION

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

Since the early 1990s, the central California murre population has shown an increasing trend apparently due to restrictions on gill-net fishing, favorable prey conditions, and other factors (Carter et al. 2001; USFWS, unpublished. data). However, anthropogenic impacts to murres continue to occur and may continue to impact the population. Gill-net mortality continued (Forney et al. 2001) until the California Department of Fish and Game (CDFG) enacted an emergency closure of this gill-net fishery in September 2000 followed by a permanent closure in waters <110 meters (60 fathoms depth) from Point Reyes to Point Arguello in September 2002. Extensive oil pollution (e.g., 1998 *Command* Oil Spill and the series of oil releases from the sunken vessel *S.S. Jacob Luckenbach* from the early 1990s to the early 2000s) continued to kill thousands of murres in central California (Carter 2003; Carter and Golightly 2003; Hampton et al. 2003; Roletto et al. 2003). Disturbances from aircraft and boats have affected colonies as well (Rojek et al. 2007; USFWS, unpubl. data). Although several colonies have increased to levels observed in the early 1980s, others such as DSR and the Castle-Hurricane Colony Complex (CHCC) remain below historic numbers (McChesney et al. 2007; USFWS, unpubl. data). These colonies have been impacted in recent years by human disturbance, avian disturbance (from Brown Pelicans, *Pelecanus occidentalis*, and/or Common Ravens, *Corvus corax*), and poor prey conditions (from 2005 to 2009) that have contributed to reduced breeding success.

Beginning in 1995, restoration and associated monitoring of Common Murre colonies in central California have been funded largely through oil spill restoration plans and associated trustee councils, including the *Apex Houston* (1995-2009), T/V *Command* (2005-2009), and, beginning in 2010, the *Jacob Luckenbach*.

S.S. Jacob Luckenbach

On 14 July 1953, the *S.S. Jacob Luckenbach* collided with another vessel and sank in 55 meters of water approximately 27 kilometers southwest of San Francisco. The *S.S. Jacob Luckenbach*, which was loaded with 457,000 gallons of bunker fuel, leaked periodically during winter storms over the years. Using chemistry analysis, the 2002 oil that was associated with several mystery spills was linked to this vessel including the Point Reyes Tarball Incidents of winter 1997-1998 and the San Mateo Mystery Spill of 2001-2002. In summer 2002, the U.S. Coast Guard and the *Luckenbach* trustees removed much of the oil from the vessel and sealed the remaining oil inside the vessel (Hampton et al. 2003). An estimated 51,569 seabirds were killed between 1990 and 2003 from Bodega Bay to Monterey Bay, including 31,806 Common Murres (*Luckenbach* Trustee Council 2006).

The U. S. Coast Guard's National Pollution Funds Center (NPFC) awarded $22.7 million to implement 14 restoration projects. The award is a result of a claim filed by the *Luckenbach* trustees in 2006 for funding from the Oil Spill Liability Trust Fund. While the owners of the *Luckenbach* no longer exist, the Oil Spill Liability Trust Fund pays for oil spill cleanup and the restoration of impacted natural resources when there is no responsible party. The fund is sustained by fees from the oil industry and managed by the NPFC. The Seabird Colony Protection Project, now called the Seabird Protection Network (SPN), was first implemented by the *Command* Oil Spill Restoration Fund (Command Trustee Council 2004) in 2005 and was extended in 2010 with the *Luckenbach* funds. The GFNMS and the CMRP continue to work together to restore seabird colonies damaged by oil mainly by reducing human disturbance. The GFNMS focuses on the outreach and education component while the CMRP conducts the colony surveillance and monitoring component of the program. Surveillance and monitoring data from the colonies are utilized to guide education and outreach efforts and to assess the success of those efforts.

Colony surveillance and monitoring efforts have been focused at three colonies or colony complexes established as Common Murre restoration or reference sites in 1996: Point Reyes (PRH); Devil's Slide Rock & Mainland-San Pedro Rock Colony Complex (DSCC); and CHCC. Since 2005, less intensive surveys have been conducted at three additional colonies within Drakes Bay: Point Resistance (PRS); Millers Point Rocks (MPR); and Double Point Rocks (DPR). In 2010, surveys were also conducted three times per week at Bird Island (near Point Bonita) in Marin County. Common Murres were first recorded attending Bird Island during the 2007 breeding season among nesting Brandt's Cormorants and in 2008 murres were recorded breeding there for the first time. Surveys at these colonies in 2009 and 2010 were conducted mainly by trained volunteers and aimed to document potential murre attendance and breeding.

Here we summarize colony surveillance and monitoring efforts conducted at central California nearshore murre colonies in 2010. Similar to other years, data were gathered on aircraft, boat and other disturbances to seabirds, Common Murre seasonal attendance patterns, reproductive performance, and adult co-attendance and chick provisioning (at DSR only). Additionally we recorded Brandt's Cormorant (*Phalacrocorax penicillatus*) relative breeding population sizes and reproductive performance; and population sizes and/or productivity of Pelagic Cormorants (*P. pelagicus*), Black Oystercatchers (*Haematopus bachmani*), Western Gulls (*Larus occidentalis*), and Pigeon Guillemots (*Cepphus columba*). Common Raven surveys were also conducted near CHCC to track the recent invasion of this seabird nest predator in the area.

METHODS

Study Sites

We conducted colony surveillance and monitoring at five colonies or colony complexes in 2010 (Figure 1). PRH (Figure 2), PRS, MPR, and DPR (Figure 3) are in the Point Reyes National Seashore, Marin County; the latter three colonies are sometimes grouped into the Drakes Bay, Colony Complex (DBCC). Bird Island is located at the mouth of the Golden Gate within Golden Gate National Recreation Area, Marin County(Figure 4). The Devil's Slide Colony Complex (DSCC), San Mateo County, consists of DSRM and San Pedro Rock (Figure 5). The CHCC, Monterey County, consists of Bench Mark-227X (BM227X), Castle Rocks & Mainland (CRM), and Hurricane Point Rocks (HPR; Figure 6). The offshore rocks of DSCC and CHCC are within the California Coastal National Monument and the adjacent mainland areas are privately owned. At each colony, individual rocks and mainland cliffs with nesting seabirds were identified by their designated subcolony (SC) number, subcolony name, or subarea. In this report, colonies are ordered north to south within each section.

Disturbance

All observed anthropogenic disturbance events affecting murres and other seabirds at study colonies were recorded. Significant non-anthropogenic (e.g., avian) disturbances were also recorded. A disturbance event was defined as an event where adult birds were alarmed or agitated (e.g., head-bobbing in murres, raised head or wing flapping in cormorants), flushed (i.e., birds flew off) or otherwise displaced (i.e., birds moved from breeding or roosting site). The numbers of adults flushed or displaced and the numbers of eggs or chicks exposed, displaced, or depredated were recorded. For anthropogenic disturbances, numbers of disturbance events and numbers of disturbance events per observation hour during the breeding season (15 April until cessation of monitoring) are reported for comparisons between colonies and years. Monitoring effort was calculated for each colony and colony complex (Table 1). Data from 2010 were then compared to baseline means for PRH, DBCC, and CHCC. Baseline means were determined by averaging disturbance rates from 2005 and 2006. These years were prior to outreach and education efforts. The Seabird Protection Network (SPN) was initiated in November 2005 and began implementing outreach and education to address human disturbance to breeding seabird colonies along the central California coast. The 2005-2006 average is used as a baseline to evaluate if disturbance at monitored colonies has met the goal of reducing disturbance. Baseline means are reported as the mean plus or minus one standard error ($\bar{x} \pm 1$ SE). For non-anthropogenic disturbances, we report the species that caused disturbances and summarize major events.

In addition to events causing disturbance, all aircraft flying at or below about 1,000 ft (305 m) above sea level (ASL) and boats within about 1,500 ft (457 m) of the nearest seabird breeding or roosting area were recorded to examine use patterns of potential sources of anthropogenic disturbance. All watercraft entering new Special Closure areas that became effective on 1 May 2010 under the California Marine Life Protection Act (CDFG 2004) were also recorded. Special

Closure areas are no access zones in which all watercraft are restricted from entering designated areas. Four of the six new Special Closures surround CMRP monitored colonies; 1) Point Reyes Headlands (1000 ft/ 305 m closure off portion of headlands), 2) Point Resistance (300 ft/ 91 m closure), 3) Stormy Stack (300 ft/ 91 m closure), 4) Devil's Slide Rock (300 ft/ 91 m closure on west side and no access between the rock and mainland). Information recorded included: aircraft or boat type, direction of travel, activity, distance from the nearest seabird nesting or roosting area, and aircraft/boat identification number or name (when possible).

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 calculated, except for certain subcolonies at PRH (see below). Seasonal attendance data were collected at all active subcolonies periodically during the pre-breeding season (before 14 April) at DSRM and CHCC and regularly at all colonies throughout the breeding season (14 April until all chicks fledged and adult attendance ceased). Non-breeding season counts were conducted between 0700-1100 h when murres were more likely to be present. Breeding season counts were conducted during a standardized period between 1000-1400 h.

Point Reyes

Seasonal attendance patterns were determined for all murre subcolonies visible from mainland observation sites at least once per week from 14 April to 19 August. Attendance was recorded at established Type II index plots (see Birkhead and Nettleship 1980) on Lighthouse (Ledge, Edge, and Dugout plots), Boulder, Flattop, Middle, and Cone Rocks. Counts of index plots were conducted three times and the means reported. Each plot was counted once at Flattop and Middle Rocks. Other subcolonies were counted once per survey of entire visible areas.

Drakes Bay Colony Complex

Murre attendance was monitored about twice per week at PRS, MPR (15 April to 9 August), and DPR (23 April to13 August; Figure 14). Four index plots (Club, Grotto Ledge, Lower Ledge, and Cup Plots) were used at PRS and five plots (Lower Left, Lower Right, Crack Pot, Pond, and Cliff Plots) on Stormy Stack (DPR) because of the large numbers of murres attending these colonies.

Bird Island

Murres were first recorded attending Bird Island among nesting Brandt's Cormorants in 2007 (McChesney et al. 2008) and in 2008 breeding was documented for the first time (McChesney et al. 2009). In 2010, observations were conducted mainly by trained volunteers from 5 May to 18 August to continue following these colonization attempts. Counts were conducted during three time periods: early morning (0700-0900 h), late morning (1000-1200 h), and afternoon (after 1500h) to determine if murres were attending the rock throughout the day. One survey of each time period was conducted each week for a total of three surveys per week. Bird Island was observed from the same locations as in 2008 and 2009. The north and south sides of Bird Island were observed from separate locations (McChesney et al. 2009).

Devil's Slide Rock & Mainland, San Pedro Rock

Pre-breeding season attendance was monitored one day per month from 7 January to 7 April 2010. Breeding season (15 April to 15 August) counts were conducted every other day (weather permitting).

On Devil's Slide Mainland (DSM), attendance patterns were determined once per week for seven subareas (Figure 5): Mainland North (SC07), April's Finger (SC05), Upper Mainland South (SC05), Lower Mainland South (SC05), Mainland South Roost (SC05), Turtlehead (SC05), and South Bunker (SC04). At Turtlehead, murres attended the same subarea (Turtlehead Boulder) as in 2009, on top of a large boulder a few meters from the north base of Turtlehead proper. To avoid disturbance to breeding Peregrine Falcons (*Falco peregrinus*), Mainland South and Turtlehead subareas were viewed from Peregrine Falcon Point (or, PEFA Pt.) until after falcon breeding activities ceased for the season (20 May). After 20 May, observations also were conducted from the Turtlehead Cove overlook.

For SPR, bird counts were conducted once per week throughout the breeding season to document potential murre attendance at this historic colony.

Castle-Hurricane Colony Complex

Seasonal attendance patterns of murres were determined for all active subcolonies visible from mainland vantage points (Figure 6). Counts were conducted twice per week during the breeding season from 16 April to 16 August. At four subcolonies, separate subarea counts also were obtained: CRM-04 (productivity plot and entire rock); CRM-03East (south and east sides) CRM-06South (north and south sides); and HPR-02 (Ledge and Hump plots).

Common Murre Productivity

As in prior years, productivity of Common Murres was monitored at PRH, DSRM, and CRM at least every two to three days (weather permitting) from standardized mainland vantage points using either 65-130x or 15-60x spotting scopes. At PRH and CRM, locations of returning or new breeding and territorial sites were identified using maps and photographs updated from the 2009 breeding season. At DSR, all sites were mapped and numbered using aerial photographs from previous years. A breeding site was defined as a site where an egg was observed or inferred based on adult behaviors. A territorial site was defined as a location with attendance greater than or equal to 15% of monitored days but where an egg was not observed or inferred based on adult behaviors. Some territorial sites likely were breeding sites where eggs were lost at or shortly after laying without our detection. A sporadic site was defined as a location attended on at least two days but on less than 15% of monitored days. Many possible sporadic sites were not identified because of frequent movement by visiting birds. Chicks were considered to have fledged if they survived to at least 15 days of age and were not known to perish afterwards. Results from 2010 were compared to previous long-term weighted means: DSR and CRM 1996-2009; and PRH, 1996-2002 and 2005-2009. All long-term weighted means are reported as the mean plus or minus one standard error ($\bar{x}$ ± 1 SE).

Point Reyes
Murre productivity was monitored at PRH within two established Type I plots (see Birkhead and Nettleship 1980) on Lighthouse Rock (LHR). Ledge Plot and Edge Plot were located within the center and on the edge of the colony, respectively. All active sites in the plots were monitored beginning 14 April.

Devil's Slide Rock & Mainland
Due to widespread colony growth and increasing difficulty monitoring the entire colony, three Type I plots (A, B and C) were established on DSR in 2006 (McChesney et al. 2006; Figure 7). Boundary adjustments were made to plots A and C in 2007 and the same plots (A, B, and C) were utilized for monitoring in 2008-2010. At DSM, all visible sites were monitored within each of two active subareas: Lower Mainland South and Turtlehead Boulder. Newly established breeding sites on the cliffs beneath the South Bunker (DSR-04) could not be monitored due to poor viewing conditions. All active sites in plots and subareas were monitored beginning 19 April.

Castle - Hurricane Colony Complex
All active murre nesting sites were monitored within a productivity plot on CRM-04 (established in 1996) beginning 18 April. The ephemeral subcolony CRM-03East also hosted breeding murres in 2010. All active sites on that rock were also monitored beginning 18 April.

Common Murre Co-attendance and Chick Provisioning

Co-attendance and chick provisioning observations were conducted at DSR during the chick-rearing period. Observations were conducted from sunrise to sunset on 6 July, 11 July, and 18 July following standardized methods (see Parker 2005, McChesney et al. 2006). Fifteen to 18 breeding sites with chicks were monitored each day, resulting in a total of 50 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 survey to check for possible missed arrivals or departures. Results from 2010 were compared to the 1999-2008 long-term mean (reported as $\bar{x}$ ± 1 SE, no data available for 2008 because of total reproductive failure).

Nest Surveys

To assess relative breeding population sizes, nest and bird counts Brandt's Cormorant, Pelagic Cormorants, Black Oystercatchers, and Western Gulls were conducted weekly during the breeding season at all colonies except Bird Island. For Brandt's Cormorants, nests and territorial sites were counted and classified into five groups that roughly described nesting stages: 1) site with little or no nesting material; 2) poorly built nest; 3) fairly built nest; 4) well-built nest; and 5) nests with brooded chicks. In addition, large, wandering cormorant chicks were counted. See

McChesney et al. (2007) for more detailed descriptions of nest categories.

To provide more complete colony coverage, nest surveys from mainland vantage points were augmented with boat surveys conducted at PRH and DBCC on 8 July, DSCC (from SPR to Pillar Point) on 6 June, and CHCC on 13 June. Boat surveys were conducted mainly to survey areas not visible from mainland vantage points, and areas visible or not visible from the mainland were delineated. The land nest count reported is the sum of high seasonal counts (well-built nests and nests with brooded chicks) at each subcolony or subarea. The boat nest count was the total number of nests counted during the boat survey, although boat counts often included only nests that could not be seen from mainland vantage points. Total counts reported are combined counts and include the highest count of the two survey methods for each subcolony/subarea, plus any nests known to be visible only with one method. Comparisons to 2009 are made between total counts.

Brandt's Cormorant Productivity

Breeding phenology and reproductive success (clutch sizes, brood sizes and chicks fledged per pair) of Brandt's Cormorants were monitored at PRH, DSRM, and CHCC. At PRH, Brandt's Cormorants were monitored at Green Top (PRH-08-B) and Ocho Ledge (PRH-08-C). In Drakes Bay, nests were monitored at Point Resistance. At DSRM, monitoring was conducted at the cliffs beneath South Bunker (DSR-04). At CHCC, monitoring was conducted at CRM-03East (east side).

Monitored nests were checked every 1-7 days from mainland vantage points using binoculars and spotting scopes. Chicks were considered to have fledged if they survived to at least 30 days of age. After that age, chicks begin to wander from their nests and most become impossible to associate with specific nests without marking (Carter and Hobson 1988,McChesney 1997). Results from 2010 were compared to prior long-term weighted means for DSRM (1997-2007, 2009), CHCC(1997-2001, 2006-2009) and PRH (1997-2001,2006-2009).

Pelagic Cormorant, Black Oystercatcher, and Western Gull Productivity

Productivity (chicks fledged per pair) of Pelagic Cormorants, Western Gulls and Black Oystercatchers was determined at select nests that were easily visible from mainland vantage points at PRH, PRS, MPR, DPR, DSRM, and CHCC. Nests were checked at least once per week. Chicks were considered to have fledged if they survived to at least 30 days of age and were not known to perish afterwards. Feathering status was used to determine nest success if chick age was not known (i.e., chicks that were greater than 75% feathered were considered to have fledged). Results from 2010 were compared to prior long-term means for PRH, DBCC, DSRM, and CHCC (2006-2009; n = 4 years, reported as $\bar{x} \pm 1$ SE). Comparisons were made to 2009 if long term means were not available.

Pigeon Guillemot Surveys

To assess population status and seasonal attendance patterns, weekly standardized counts were conducted of birds rafting on the water and roosting on land (intertidal and nesting areas) at PRH, DSCC, and CHCC. Surveys were conducted twice per week from mid-April to 5 May, when numbers often peak, and approximately once per week thereafter, between one-half hour after sunrise and 0830 h. Due to the large size of the PRH colony area, weekly counts were conducted from just one location (Lighthouse). However, a single survey of the entire PRH colony was conducted on 28 May. At DSCC, the entire area from the south side of San Pedro Rock to the south end of the DSRM colony boundary was surveyed. At CHCC, the entire area from Rocky Point to the south end of the HPR colony boundary was surveyed. Guillemots were also counted upon arrival (range 0900-1410 h) for twice weekly colony surveys at PRS, MPR, and DPR. Additionally, Pigeon Guillemots were counted during boat surveys of colonies.

Common Raven Surveys – Big Sur

Common Raven surveys were conducted to assess relative distribution and abundance near CHCC. Surveys were conducted while driving approximately 60 km/hr along a 26.4 km stretch of California State Highway 1 between Point Lobos and Point Sur. Two morning (before 0900 h) and two afternoon (after 1200 h) surveys were conducted weekly from 18 April to 2 August. Morning surveys traveled south from Point Lobos, while afternoon surveys traveled north from Point Sur. Each individual raven observed was considered a detection. Locations were recorded on a DeLorme Earthmate PN-20 GPS unit and plotted on National Geographic Topo mapping software. For comparisons to previous years, the number of raven detections per km and number of raven detections per survey were calculated for the entire survey route and also for two sections of the survey area: 1) a 17.1 km segment from Point Lobos to Castle Pullout; and 2) a 9.3 km segment from Castle Pullout to Point Sur.

RESULTS

Anthropogenic Disturbance

A total of 288 aircraft overflights, including 172 (60%) planes and 116 (40%) helicopters, were recorded at PRH, DBCC, DSCC, and CHCC in 2010 (Table 2). Overall, 106 (37%) aircraft overflights caused some form of disturbance (i.e., agitation, displacement, and/or flushing). Twenty percent (n = 34) of all planes and 62% (n = 72) of all helicopters resulted in disturbance. Fifteen percent (n = 42) of all overflights caused birds to flush, including 3% (n = 5) of all planes and 32% (n = 37) of all helicopters. Unmarked, other aircraft (e.g., private or charter) were the most commonly observed planes and helicopters and also caused the most disturbances (Figure 8). The next most common source of aircraft disturbance was from military helicopters (n =31) and planes (n = 5), including 16 flushing events.

Eighty-five watercraft were observed at all colonies in 2010 (Table 3). The majority were recreational small private boats (71%) followed by commercial fishing vessels (14%; Figure 9). Eleven watercraft (13%) caused some form of seabird disturbance, including 9 (11%) that caused flushing. Seven (64%) recreational small private boats were responsible for the majority of disturbances.

Twenty-one Wildlife Disturbance Reporting Forms were filled out and submitted to the Seabird Protection Network. Disturbance Reports included photos and maps documenting disturbance to seabirds. Reports were submitted for 11 helicopters, two planes, seven boats, and one jet-ski. Five of these incidents (all commercial helicopters) were followed up with letters from USFWS Law Enforcement. Three additional private plane pilots were contacted by USFWS Law Enforcement following the Pacific Coast Dream Machines event. USFWS and NOAA Law Enforcement agents met with a commercial tour helicopter company following disturbance that occurred on 25 April during the Big Sur Marathon

Special Closure areas were implemented on 1 May 2010 at PRH, PRS, DPR (Stormy Stack), and DSR. Nine watercraft were observed inside special closure areas and two caused disturbance. Six recreational fishing boats, two charter fishing boats, and 1 kayak were recorded. All Special Closure violations were reported to CDFG (CalTips Hotline). One additional boat caused a disturbance but was outside of the Special Closure area around Stormy Stack (>300 ft/ 91 m from DPR-01).

Point Reyes

Fifteen aircraft overflights (0.029/hr; including 11 by planes and 4 by helicopters) and 13 boat detections (0.025/hr) were documented at PRH in 2010 (Tables 4, 5; Appendixes1, 2). Eight aircraft overflights (53%) resulted from the annual aerial photographic survey of the colony on 1 June.

Four (19%) overflights (0.008/hr) caused some level of disturbance including one by a plane (9% of planes) and three by helicopters (75% of helicopters). Two boat detections (15% of boats) caused agitation behavior in murres; none caused flushing or displacement. Most observations of watercraft detections were of small recreational boats fishing off the headlands. The peak boating period occurred in late July. One kayak was observed within the Special Closure along the headlands and did not cause any disturbance.

Three overflights (20%; including one plane and two helicopters) caused flushing of murres (range 20-200 birds; Table 5). On 30 April, a military helicopter flushed 80 murres when it flew 400 ft ASL and 500 m from Lighthouse Rock. A helicopter flying at 1800 ft ASL and within 100 m of the colony flushed 200 murres from Aalge Ledge on 14 July. This helicopter was likely involved in search and rescue efforts associated with a capsized boat just north of the lighthouse. In addition, one plane flying at 600 ft ASL and within 1000 m of Lighthouse Rock flushed 20 murres on 8 May.

The combined aircraft and boat detection rate (0.053/hr) was similar to previous years (Figure 10). The overall disturbance rate in 2010 (0.011/hr) was 69% lower than the baseline mean (baseline mean = 0.037 ± 0.019/hr). Compared to the baseline, disturbance rates (including all behaviors) were higher for helicopters (2010 = 0.006/hr and baseline mean = 0.001 ± 0.001/hr), but lower for planes (2010 = 0.002/hr and baseline mean = 0.02 ± 0.017) and lower for boats (2010 = 0.004/hr and baseline mean = 0.015 ± 0.002/hr). It should be noted that detection and disturbance rates overall were relatively low.

Drakes Bay Colony Complex
At DBCC, the combined aircraft and boat detection rate (0.089/hr) was similar to 2009 (Figure 12). The overall disturbance rate in 2010 (0.047/hr) was lower than the baseline mean (baseline mean = 0.088 ± 0.004/hr). Compared to the baseline, disturbance rates (including all behaviors) were higher for planes (2010 = 0.012/hr and baseline mean = 0.004 ± 0.004), but lower for helicopters (2010 = 0.003/hr and baseline mean = 0.023 ± 0.0001/hr), and lower for boats (2010 = 0.028/hr and baseline mean = 0.061 ± 0.007/hr).

Point Resistance – During standardized monitoring in 2010, there were three aircraft overflights (0.057/hr; Table 6, Appendix 3). Two were other planes, and one was a U.S. Coast Guard helicopter; none caused any noticeable disturbance. Two boats (0.038/hr) were observed; both were inside the Special Closure around Point Resistance, but neither caused any disturbance (Table 6, Appendix 4). Disturbance rates were the same as or lower than baseline means (plane = 0.0/hr; helicopter = 0.0/hr; boat = 0.018 ± 0.018/hr).

Millers Point Rocks - There were two aircraft overflights (planes; 0.025 /hr), and five boat detections (0.061/hr) recorded at MPR (Table 7, Appendix 5, 6). One overflight (50%) and one vessel detection (20%) caused murres to flush. On 13 June, a plane flushed two murres when it flew 100 ft ASL and 200 m from Miller's Point North Rock (MPR-01). On 21 June, three jet skis (conducting search and rescue training operations) flushed at least one murre from Blue Cheese (MPR-05) when they transited within 30 m of the rock. The overall disturbance rate (0.025/hr) in 2010 was lower than the baseline mean (baseline mean = 0.076 ± 0.009/hr), due to fewer disturbances from helicopters and boats.

Double Point Rocks – A total of thirteen aircraft overflights (0.109 /hr; 10 planes, 3 helicopter) and 31 boat detections were recorded at DPR (0.260/hr; Table 8; Appendixes 7, 8). Four aircraft overflights (31%) resulted from the annual aerial photographic survey of the colony. Four overflights (0.034/hr; one helicopter and three planes) caused some level of disturbance. Three overflights (23%) caused flushing of one or more seabirds. The most severe disturbance was caused by a U.S. Coast Guard helicopter flying at approximately 400 ft ASL on 22 May, which flushed 50 murres and 30 Brandt's Cormorants from DPR-01 (Stormy Stack). On 1 June, the aerial survey plane flushed two murres on one pass and five murres on another as it flew 900 ft ASL and 80 m from DPR-01. In addition, one military jet caused murres to head bob at 2000 ft ASL and 500 m from DPR-01.

Six boat detections (19%) caused flushing of one or more seabirds, mainly Brandt's Cormorants (range 3-20), Common Murres (range 10-23), and Brown Pelicans (range 2-4). All six disturbance events were caused by private recreational boats that were in close proximity (range = 25–100 m) to Stormy Stack (DPR-01; 3 events) and Double Point Rock North (DPR-03; 3events). Five boats were observed within the Special Closure around Stormy Stack; two of these caused disturbances within the Special Closure. The peak boating period occurred from mid-July through mid-August.

The overall disturbance rate (0.084/hr) in 2010 was 29% lower than the baseline mean (0.118 ± 0.003/hr). Disturbance rates were higher for planes (2010 = 0.025/hr and baseline=0.009 ± 0.009/hr), lower for helicopters (2010 = 0.008/hr and baseline=0.028 ± 0.011/hr) and lower for boats (2010 = 0.050/hr and baseline = 0.082 ± 0.005/hr).

Devil's Slide Rock & Mainland

At DSRM, 162 aircraft overflights (0.240/hr; including 102 planes and 60 helicopters) and 7 boat detections (0.010/hr) were documented in 2010 (Tables 9, 10; Appendixes 9, 10). Five aircraft overflights (3.0%) resulted from the annual aerial photographic survey of the colony. Twenty (12.3%) aircraft overflights were recorded on 25 April 2010 during the Pacific Coast Dream Machines event at the Half Moon Bay Airport.

A total of 69 (43%) aircraft overflights caused some form of disturbance, including 27 by planes (26% of planes) and 42 by helicopters (70% of helicopters). Seventeen (10%) overflights and one (14%) boat detection caused flushing or displacement of one or more seabirds, mainly Common Murres (range = 7-142) and Brandt's Cormorants (range = 1-30). Of the 17 aircraft disturbances, eight were caused by military aircraft (47%; 9 helicopters and 1 plane), three (18%) by U.S. Coast Guard helicopters, and six (35%) by other helicopters (private and commercial). Low-flying (range = 200-1000 ft ASL) helicopters accounted for 94% of aircraft flushing events. The most significant disturbance event occurred on 25 April when two military helicopters transiting south at 400 ft ASL and 500 m east of DSR caused 150 birds (142 murres and eight cormorants) to flush and displace. Additionally, on 7 April a U.S. Coast Guard helicopter, transiting south at 800 ft ASL, flushed 90 murres.

Two private recreational fishing boats observed multiple times resulted in the seven boat detections made during the 2010 season. On 28 July, one of these boats approached within 30 m of the mainland and caused 26 roosting Brandt's Cormorants to flush. This boat did not enter the Special Closure area that was implemented on 1 May 2010. One boat (recreational small, private) was observed inside the Special Closure area around DSR but it did not cause any discernable disturbance.

The combined aircraft and boat detection rate (0.251/hr) was the lowest since 2002. Lower detection rates resulted from lower plane and boat detections than previous years. However helicopter detection rates were similar to past years (Figure 10).

The overall disturbance rate in 2010 (0.105/hr) was 32% lower than the baseline mean (baseline mean = 0.154 ± 0.033/hr). Compared to the baseline, disturbance rates (including all behaviors) were lower for planes (2010 = 0.040/hr and baseline mean = 0.073 ± 0.023/hr), higher for helicopters (2010 = 0.062/hr and baseline mean = 0.040 ± 0.015/hr), and lower for boats (2010 = 0.001/hr and baseline mean = 0.030 ± 0.005/hr). The overall disturbance was the lowest rate recorded in six years. This is in contrast to the general trend of increased disturbance rates in recent years compared to the2001-2005 period (Figure 11).

Castle-Hurricane Colony Complex
A total of 75 aircraft overflights (0.169/hr; including 44 by planes and 31 by helicopters) and 23 boat detections (0.052/hr) were recorded at CHCC in 2010 (Tables 11, 12; Appendixes 11, 12). Thirteen (17%) aircraft overflights were recorded during the annual aerial seabird colony survey on 3 June.

Fourteen (19%) overflights (0.032/hr) caused some level of disturbance. All fourteen aircraft disturbance events involved low-flying (range = 200-850 ft) helicopters (45% of helicopters). One boat detection (4% of boats) caused disturbance. Thirteen (17%) overflights and one (4%) boat detection caused flushing or displacement of one or more seabirds, mainly Brandt's Cormorants (range 1-52) and Common Murres (range 2-65; Table 12).

During the Big Sur Marathon on 25 April, a single commercial tour helicopter caused four seabird disturbance events when the aircraft made four low-flying passes (range 600-650 ft) over the CRM colonies between 0816 and 0845 h. The four passes flushed a total of 18 Brandt's Cormorants and two Common Murres off CRM-03East and caused six Brandt's Cormorants to wing-flap.

Three events involving military helicopters caused disturbance to seabirds. In each event, two military helicopters were flying in tandem over the colonies. Two of the events occurred on 12 June when the helicopters flushed 42 Brandt's Cormorants off HPR-02 before continuing north and flushing 20 Common Murres and two Brandt's Cormorants off CRM-03East. One of the helicopters was flying below 500 ft ASL, while the other was above 1000 ft ASL.

The only boat disturbance in 2010 was caused by the commercial fishing vessel "Bonita" out of Monterey, CA. This vessel was a common visitor to the CHCC area and sightings of this boat accounted for ten (43%) of the vessel detection events in 2010. "Bonita" was often seen dropping and retrieving rockfish gear among the CRM and HPR colonies and on 29 July caused 52 Brandt's Cormorants and one Brown Pelican to flush while fishing between 20-100 m off of CRM-02.

The combined aircraft and boat detection rate of 0.22/hr was higher than 2009 and has been increasing since 2007 (Figure 10). The overall disturbance rate (0.034/hr) in 2010 was 438% higher than the baseline mean of 0.006 ± 0.006/hr. Compared to the baseline, disturbance rates (including all behaviors) were lower for planes (2010 = 0.00/hr and baseline mean = 0.003 ± 0.003/hr), higher for helicopters (2010 = 0.032/hr and baseline mean = 0.002 ± 0.002/hr), and higher for boats (2010 = 0.002/hr and baseline mean = 0.0/hr).

Non-Anthropogenic Disturbance

Point Reyes
Of 39 non-anthropogenic recorded disturbance events at PRH, most resulted in flushing (n = 37). Two disturbance events resulted in displacement. Most of the observed disturbances involved Common Ravens (56%) and California Sea Lions (31%). Additionally, two disturbances by Turkey Vultures (5%), two involving Peregrine Falcons (5%), and one by Western Gulls (3%) were observed. Additionally, a large wave caused 200 non-breeding murres to flush from Big Roost Rock (PRH-03A) on 29 June. Most disturbances impacted only murres, however three raven disturbances flushed and displaced Brandt's Cormorants (range = 1-6 birds) and murres (range = 7-28 birds) from Green Top (PRH-08B).

Unusually high numbers of Common Ravens in groups of 3-19 individuals were seen on the headlands in 2010, especially near the Elephant Seal Cove rocks (PRH-10). Ravens were observed causing 21 disturbances (affecting 1 to 2600 murres) at PRH throughout the season. Most (59%) raven disturbances were observed near the lighthouse on Lighthouse Rock, Big Roost Rock, and Aalge Ledge. Disturbances were also observed at Boulder Rock, Green Top, and Elephant Seal Cove rocks. On 8 July, a raven was seen flushing over 200 murres from Cone Rock (PRH-13) during our annual boat survey. Four murre eggs were seen taken by ravens: one at Lighthouse Rock (PRH-03B); one at Big Roost Rock (PRH-03A); one at Boulder Rock (PRH-05B); and one at Flattop Rock (PRH-10B).

California Sea Lions were seen causing 11 disturbance events (affecting 35 to 4500 murres) on Lighthouse Rock throughout the month of May. An additional disturbance occurred on 14 June when an immature sea lion flushed (40) and displaced (5) murres from Lighthouse Rock. Similar to 2009, sea lions (mainly immature) were seen climbing high up onto the rock, flushing and displacing murres. Many sea lion disturbance events attracted gulls and ravens, which usually caused more murres to be disturbed. Egg loss was observed during three (25%) of the disturbances; a total of 25 lost eggs were recorded. Typically these eggs were taken by Western Gulls or Common Ravens during or just after the sea lion disturbance.

Drakes Bay Colony Complex
Point Resistance – Thirty-six (95%) non-anthropogenic disturbances observed at PRS were caused by Common Ravens. A pair of ravens was observed harassing and flushing murres throughout the season. The pair would often work together and were seen pulling murres by wings or tails to obtain eggs. In at least one incident a raven picked up and then dropped an adult murre in order to obtain an egg. A total of 18 murre eggs were recorded taken by ravens. A pair of ravens (most likely the same pair causing disturbances) nested and fledged at least three chicks on the mainland cliffs in PRS-03. Late in the season, several unskilled ravens

(possibly young of the year) were seen unsuccessfully trying to find eggs on the rock and causing murres to flush and displace. Additionally, one disturbance by a Turkey Vulture and one by a Brown Pelican were also observed.

Millers Point Rocks – No non-anthropogenic disturbances were observed at MPR in 2010.

Double Point Rocks – A total of 14 non-anthropogenic disturbances were observed at DPR. Most of the disturbances were caused by Common Ravens (79%) flushing or displacing murres (range = 15-850). Two disturbances involving Turkey Vultures (14%) and one disturbance by a California Sea Lion (7%) were also observed. Common Ravens were observed taking four murre eggs. One of the vulture disturbances also resulted in 2 eggs being taken (one by a Western Gull and one broken during the disturbance event).

Devil's Slide Rock & Mainland
Of seven recorded disturbance events at DSRM, four resulted in flushing and three resulted in displacement. Three disturbance events were caused by Brown Pelicans, three events by Western Gulls, and one event by a Peregrine Falcon. Brown Pelicans flying over the rock caused 1 to 85 murres to flush or displace on two occasions. On 3 July, one roosting pelican caused two incubating murres to displace off their eggs. One of these eggs was depredated by a Western Gull.

Other Western Gull incidents involved a gull causing three murres to displace as it attempted to take a fish lying on the ground. Additionally, a gull fledgling flying low over DSR caused six murres to flush. On 18 June, a Peregrine Falcon caused one Brandt's Cormorant to flush off its nest (exposing one egg) on the mainland (DSR-04). Common Ravens were not observed causing disturbance to murres although there were two nesting pairs recorded on the Devil's Slide mainland.

Castle-Hurricane Colony Complex
One Brown Pelican flushing event was recorded in 2010. On 16 April, two Brown Pelicans flying over HPR-02 caused 15 Common Murres to flush. In addition to this documented disturbance event, pelicans were also recorded roosting within murre subcolonies on various dates from 28 April to 16 August. Roosting pelicans were alone or in mixed age groups (adults, subadults and immatures) ranging from 1-34 birds. Otherwise, transiting and roosting pelicans caused no visible disturbances to breeding murres in the CHCC colonies this year.

Brown pelican disturbance in 2010 was slightly lower than levels in 2009 and 2008, but much lower than in other recent previous years. Large-scale disturbance to murres caused by single juvenile pelicans resulted in near complete breeding failure at CRM in 2004-2007 and at HPR in 2007.

Turkey Vultures caused two murre flushing events late in the season. On 24 July, two Turkey Vultures landed near a Black Oystercatcher nest on CRM-03East to scavenge a dead Brandt's Cormorant chick. This caused two Black Oystercatchers, 120 Common Murres and four Brandt's Cormorants to flush off several subcolony rocks. On 5 August, one Turkey Vulture flying low over CRM-03East caused two oystercatchers, ten murres and one Brandt's Cormorant to flush and also displaced 100 crèching Brandt's Cormorant chicks.

Common Murre Seasonal Attendance Patterns

Point Reyes

All well-established nesting areas were active with confirmed breeding in 2010. Typical counts of murres were much higher than in 2009 at most subcolonies, with the largest increases occurring at Aalge ledge, Beach Rock, and Lighthouse Rock (Edge and Ledge plots). Peak numbers at most subcolonies were recorded during the incubation and chick periods. Attendance continued for an extended period until late August, reflecting the later onset of breeding. Counts of murres at Lighthouse and Boulder rocks were high in mid-April but then declined in early May just prior to egg laying. Numbers increased during incubation and then declined again during the chick period. However, Ledge plot had a high count of 479 murres recorded during the chick period on 13 July. Attendance declined steadily in late July as chicks fledged (Figure 13). Cone and Beach Rock attendance was variable prior to egg laying and less variable during incubation (May to late June; Figure 14). Peak counts occurred around chick hatch in mid-July and then declined steadily in early July until all birds departed in mid-August.

Murre attendance was high at ephemerally used subcolonies and clubbing areas (areas where non-breeding birds typically congregate) in 2010. Murres attended Slide (PRH-06B) from 8 June through 20 August, and Green Top (PRH-08B) from 18 May through 19 August, both locations in association with Brandt's Cormorants. Area B (PRH-14B) was attended 26 April through 11 August, but the rock was periodically empty throughout the season indicating that no successful breeding occurred. Breeding was confirmed at Aalge Ledge, which is often a clubbing area, and attendance was much higher than in 2009. Attendance increased steadily during the month of May and the peak of 632 birds was recorded on 1 June but then declined sharply thereafter (Figure 14). Big Roost Rock also had confirmed breeding in 2010, probably the first record for this clubbing area; one egg was seen taken by a Common Raven on 16 July. Murres were not seen attending Big Roost Rock until 1 June (8 murres); numbers increased sharply in late June until a peak count of 2,984 murres was counted on 29 June (Figure 14). Murres continued to attend Aalge Ledge and Big Roost Rock until early August when attendance declined at all subcolonies during the chick fledging period. Most birds had departed PRH subcolonies by 20 August, while the last few remaining birds on Lighthouse Rock (outside of plots) and Green Top departed by 27 August.

Drakes Bay Colony Complex

Point Resistance– Murres attended PRS regularly throughout the season in 2010. Numbers were much higher and less variable than in 2009. Regular attendance began later than is typical and was highly variable prior to egg laying but then became more stable during incubation and brooding. The peak count occurred on 14 July and was followed by a steady decline as chicks fledged (Figure 15).

Millers Point Rocks – Murres did not attend the East Plot of Millers Point North Rock (MPR-01) in 2010. The West Plot was only attended sporadically from 23 May to 13 June (Figure 15) suggesting that if breeding occurred, birds quickly lost or abandoned eggs.

As in 2009, successful breeding did not occur on Millers Point South Rock (MPR-02). Sporadic attendance occurred from 9 May to 9 June; the only other documented attendance was 42 murres on 7 July (Figure 15). However, murres regularly attended the small rock known as Blue Cheese (MPR-05) from mid-May through July in association with breeding Brandt's Cormorants, indicating likely successful breeding (Figure 15). .

Double Point Rocks – Attendance at Stormy Stack was not consistent until mid-May (Figure 15) suggesting a late onset of breeding. A high count of 2,234 birds (sum of five plots) was recorded on 7 May. Attendance was fairly stable from mid-May through July and declined in early August.

Bird Island

A total of 41 counts were conducted of Bird Island from 5 May to 18 August. Murres were first observed on 21 May and were present on all count days thereafter until 18 August. Brandt's Cormorants were infrequently observed attending Bird Island (27% of all counts) in low numbers ($\bar{x}$ = 1.2 ± 0.5 birds). Nesting Brandt's Cormorants were associated with murres when murres colonized the rock in 2007-08. The high counts of murres (496 birds) and Brandt's Cormorants (17 birds) both occurred on 10 June. The average number of murres counted was 36 ± 13 birds (range: 0 - 496, n =41). Approximately 311 murres were observed during the annual aerial seabird colony survey on 15 June.

Murres congregated around the wooden structural remains of an abandoned U.S. Navy compass station on the west side of the island. The only confirmed breeding was underneath a portion of the structural remains where views were largely obstructed. Eggs were never observed but one murre chick was seen on 25 July and several murres were observed landing with fish in their bills and appeared to be feeding chicks under the structural remains on 22 July and 25 July. The wooden debris appeared to provide protection from aerial predators such as gulls and ravens. Western gulls were observed harassing murres and trying to steal fish items. We were unable to estimate numbers of breeding birds due to difficult viewing conditions

Devil's Slide Rock & Mainland, San Pedro Rock

Devil's Slide Rock - Murres were observed on all count days between 7 January and 14 August 2010 (Figure 16). The greatest counts were recorded during the early egg-laying period. The maximum count of 824 murres was recorded on 12 May, one day after the first egg was observed. This count was 17.8% lower than the previous high count of 1,003 murres in 2009. Murre counts were extremely variable prior to the start of egg laying. From 26 April to 30 April, murres were observed early in the morning but all departed by 1000 h. Attendance became less variable during incubation after the mean egg lay date (3 June). Numbers of murres attending DSR increased slightly during hatching and remained fairly consistent until the last egg hatched on 26 July. There was a decreasing trend in August as chicks fledged until all breeding activity ceased. Nearly all attendance occurred in Plots A and B. Murres attended Plot C sporadically from April to May, but stopped attending after 29 May. Average murre counts in 2010 (447 ± 20 birds) were slightly lower than in 2009 (475 ± 37 birds), but murres attended the rock for a month longer and counts appeared to be less variable. The count from the annual aerial photographic survey of 565 murres was more than the near simultaneous count of 479 murres from land on 15 June 2010.

Devil's Slide Mainland – Murres were observed attending mainland areas on Lower Mainland South (DSR-05A) and Turtlehead Boulder(DSR-05B; Figure 5). However, murres did not attend the Upper Mainland South area and were observed at a new location on the cliffs beneath the South Bunker (DSR-04). Murres were observed among nesting Brandt's Cormorants at three separate locations on the South Bunker cliffs: 1) on the western point (Point Area), 2) Area E, and 3) Area N (Figure 17). Breeding was observed at the Point Area on the South Bunker cliffs (see Common Murre Productivity below). Murre attendance at Lower Mainland South began to decline on 26 May; concomitantly, the number of murres on the South Bunker cliffs increased (Figure 18). On 17 June, five murres were observed flying from Lower Mainland South to the South Bunker area, indicating that the South Bunker Cliffs were colonized at least partially from Lower Mainland South birds. Attendance was the most consistent on Turtlehead Boulder, where the majority of breeding sites occurred. High counts were: Lower Mainland South, 108 murres (12 May); Turtlehead Boulder, 18 murres (22 and 28 July); and the South Bunker cliffs, 90 (30 June). The greatest combined single day count for all subareas was 120 birds on 12 May. Overall attendance on the mainland was lower than in 2009.

San Pedro Rock -Murres were not observed on San Pedro Rock in 2010.

Castle-Hurricane Colony Complex
Most CHCC subcolonies displayed similar attendance pattern: peaks in attendance between mid-April and early May, relatively consistent attendance from early May to mid-July, and rapid decline in late July to early August (Figures 19-21). However, counts of CRM-06South (Southside) were highly variable, even though murres attended the cliffs regularly throughout the breeding season and breeding was confirmed. These counts were at least partially affected by unfavorable viewing conditions caused by a large viewing distance, shadows, and frequent heat waves. At CRM-03East, attendance appeared to be highly influenced by the presence of nesting Brandt's Cormorants. The north side of CRM-03East had relatively steady murre attendance from early April to early June (mean = 118 birds between 16 April and 3 June), then increased dramatically during the peak egg-laying period for Brandt's Cormorants in mid- to late May. Attendance more than doubled at this area from 8 June to 6 August (mean = 248 between 8 June and 6 August). Similarly, murre attendance on the south side of CRM-03East did not begin until 19 May and attendance increased gradually until a peak of 64 birds in late July.

Cessation of attendance was less variable than in 2009, though attendance by small numbers of birds continued until mid-August. All subcolonies were empty by 16 August.

Breeding was observed at all regularly attended subcolonies. In addition, murres were recorded on the cliff ledges of Funt Cove (CRM-06North) on the boat and aerial surveys. The only observed attendance in the Bench Mark-227X colony was of two birds among roosting Brandt's Cormorants on 28 May.

Common Murre Productivity

Point Reyes

A total of 161 sites were monitored between Ledge (n = 89; 55.3%) and Edge (n = 72; 44.7%) plots on Lighthouse Rock. In Ledge Plot, 72 (80.9%) sites were egg-laying, 16 (18.0%) were territorial, and one (1.1%) was sporadic. There was a 2.9% increase in the number of breeding sites from 2009. The mean egg lay date for first eggs in Ledge Plot was 2 June ± 0.5 days (Table 13), ten days later than the long-term average (23 May ± 3.1 days). Three replacement eggs were laid in Ledge. The number of chicks fledged per breeding pair was 0.72, 20.4% higher than the long-term mean (0.60 ± 0.08; Figure 22).

In Edge Plot, 61 (84.7%) sites were breeding and 11 (15.3%) sites were territorial. The number of breeding sites increased 27.1% from 2009. The mean egg lay date for first eggs in Edge Plot was 30 May ± 0.4 days (Table 13), three days later than the long-term mean. No replacement eggs were laid in Edge. The number of chicks fledged per breeding pair was 0.74, 47.5% higher than the long-term mean (0.50 ± 0.06; Figure 22).

When Edge and Ledge plots are combined, the mean egg-laying date was 1 June ± 0.5 days, eight days later than the long-term mean (24 May ± 3.0 days). Overall productivity of 0.73 chicks fledged per pair, 28.0% higher than the long-term average (0.57 ± 0.07), was influenced by high hatching (74.6%) and fledging (97.0%) success. Fledged chicks remained on the rock for an average of 24.4 ± 0.5 days in Ledge Plot and 23.3 ± 0.4 days in Edge Plot, respectively. The last chicks observed in Edge and Ledge plots were seen on 10 and 19 August, respectively.

Devil's Slide Rock & Mainland

Of 176 sites documented within DSR plots, 147 (83.5%) were breeding, 18 (10.2%) were territorial, and 11 (6.3%) were sporadic. There was a 4% decrease in the number of breeding sites from 2009. There were no breeding sites observed in Plot C. At all sites combined, the mean egg-laying date of first eggs was 3 June ± 0.7 days (Table 13), nine days later than the long-term average (25 May ± 2.3 days). A total of 154 eggs were laid, including seven replacement eggs. Overall productivity of 0.86 chicks fledged per pair was 65.4% higher than the long-term average (0.52 ± 0.06; Figure 22). Above average productivity was influenced by both high hatching (85.1%) and fledging success (96.2%). Chicks that fledged remained on the rock for an average of 24.6 ± 0.3 days after hatching and the last chick was seen on 14 August.

On DSM, breeding murres were documented for the sixth consecutive year on the Lower Mainland South subarea (DSR-05). This was the third year breeding was confirmed on Turtlehead Boulder, a large boulder near the base of Turtlehead (DSR-05B). Breeding has been documented on Turtlehead or Turtlehead Boulder in 2005, 2006, 2008, and 2009). Unlike the previous two years, there was no breeding observed at Upper Mainland South in 2010. However, breeding murres were documented for the first time on the mainland cliffs beneath the South Bunker (DSR-04). One egg and one chick were observed on the western point of DSR-04 (Figure 17). The egg was observed on 10 June, but was abandoned within a few days. On 16 August, a fledging age murre chick was seen with 6 adult murres, and therefore it is likely that breeding was successful. Productivity monitoring of this new area was not possible due to difficult viewing conditions and it is likely that successful breeding occurred at other locations on the South Bunker cliffs.

Breeding sites on DSM increased 31% from 2009. Of 108 total sites monitored in two subareas, 42 (38.9%) were breeding, 53 (49.1%) were territorial, and 13 (12.0%) were sporadically attended. The mean egg-laying date was 6 June ± 1.8 days (Table 13). There were no replacement eggs recorded. All breeding attempts (n=12) on Lower Mainland South failed during incubation. However, murres on Turtlehead Boulder had high hatching (70%) and high fledging success (91%), and fledged 0.63 chicks per pair. The combined productivity on DSM was 0.45 chicks fledged per pair, which is 80% higher than the long-term mean (0.25 ± 0.08). Chicks fledged at an average age of 23.1 ± 0.5 days and the last chick was seen on 3 August.

Combining DSR plots and DSM, breeding success was 0.77 chicks fledged per pair (n = 189) which is 57.1% higher than the long-term average (0.49 ± 0.06).

Castle-Hurricane Colony Complex

Of 125 monitored sites in the CRM-04 plot in 2010, 83 (66.4%) were egg-laying, 39 (31.2%) were territorial and 3 were sporadic (2.4%) (Table 13). The number of breeding sites increased by 6% from 2009. The first eggs in the plot were observed on 6 May. The mean egg-laying date of 17 May ± 0.9 days (Table 13) was 1 day later than the long-term average (16 May ± 2.6 days). There were five replacement eggs laid. Overall productivity of 0.54 chicks per pair was 17% higher than the long-term average (0.46± 0.06 chicks per pair; Figure 22). Chicks that fledged remained on the rock for an average of 23.1 ± 0.4 days after hatching and the last chick was seen on 23 July.

For the third consecutive year, murres bred on the east side of CRM-03East. Breeding effort and productivity have been erratic at this sub-colony since monitoring began in 1996, but perhaps due to the presence of a large Brandt's Cormorant breeding colony, murres successfully bred here in 2010 for only the second time since 2003. Of 187 sites, 68 (36%) were breeding, 101 (54%) were territorial and 18 (10%) were sporadic. The number of breeding sites increased 172% from 2009. The first egg was observed on 7 May and the mean egg lay date was 23 May ± 1.7 days (Table 13). Three replacement clutches were laid. Hatching success (85.7%, highest on record for this colony) and fledging success (88.3%, 2nd highest on record for this colony) were dramatically higher than in previous years. Overall productivity of 0.78 chicks per pair was 70% higher than the long-term average (0.46 ± 0.10 chicks per pair; n = 8 years). This is the highest murre productivity recorded at either breeding plot at CHCC since monitoring began in 1996.). Chicks that fledged remained on the rock for an average of 24.0 ± 0.3 days after hatching and the last chick was seen on 5August.

Common Murre Co-attendance and Chick Provisioning

At DSR, mean percent of sampling period that pairs with chicks spent in co-attendance was 11.7% ± 0.01 (range = 7.7-20.2%; n = 18), which is 20.9% lower than the long-term average of 14.8% ± 0.01. During co-attendance observations, 325 mate arrivals were recorded. On average, mates arrived 0.45 ± 0.03 times per site per hour (range = 0.30-0.71; n = 18). Of all mate arrivals seen, 86.5% were observed with prey, 9.5% had no prey, and 4.0% were undetermined whether or not they carried prey. Of prey deliveries, 92.2% were consumed by chicks and 7.1% were undetermined. The mean chick provisioning rate was 0.36 ± 0.02 feedings per hour (range= 0.23 - 0.50; n =18), 60.9% higher than the long-term average of 0.22 ± 0.02.

Brandt's Cormorant Nest Surveys and Productivity

Point Reyes

Nest surveys - Brandt's Cormorant nest surveys were conducted from 14 April to 19 August (Figure 23). As in 2008 and 2009, cormorants had a delayed and prolonged egg laying period. Well-built nests were recorded at Slide (PRH-06B), Green Top (PRH-08B), Ocho Ledge (PRH-08-C), Cliff Colony East (PRH-09-A), Beach Rock (PRH-10-E), and Area B (PRH-14-B; Figure 2). Nest building in 2010 began much later than in previous years. Nest building was observed as early as 4 May, but the first well-built nest was not observed until 18 May. The peak single-day count for all subcolonies combined was 159 nests (54 well-built nests and 105 nests with brooded chicks) on 13 July. The sum of the seasonal high counts (well–built nests and nests with brooded chicks) for all subcolonies obtained from land was 174. Inclusion of 80 additional nests recorded during the boat survey (not visible from land) raised the total 2010 nest count at PRH to 254 nests (Table 15), 11% higher than the 2009 total nest count (228 nests).

Productivity - A total of 79 nests were monitored at PRH. All clearly visible egg laying sites were monitored on Green Top (PRH-08B) and Ocho Ledge (PRH-08C). Monitoring did not begin until 21 May, when many nests already had full clutches. For nests already containing complete clutches at this time, clutch initiation dates were estimated by backdating from confident hatch dates (n = 16 nests).

For all nests combined, the average clutch initiation date of 16 June ± 2.1 days (Table 14) was 29 days later than the long-term mean (18 May ± 4.5 days) and the latest in ten years of monitoring. Clutch sizes averaged 2.9 eggs and no replacement clutches were recorded. First chicks were observed on 27 June and the average brood size was 2.19 chicks. Overall productivity of 1.70 chicks fledged per pair (subarea range = 1.06-1.91) was 7.6% lower than the long-term average of 1.84 ± 0.2 (Figure 24). Breeding success per nest was 0.86 (subarea range= 0.50-0.98). Breeding success per nest was much lower on Ocho Ledge, where many nests were abandoned after chicks hatched.

Drakes Bay Colony Complex

Nest surveys **–** Brandt's Cormorants had a small and delayed nesting effort on PRS in 2010. The first poorly-built nest was not seen until 16 May. A peak of five nests (5 well-built nests and 0 nests with brooded chicks) was seen at PRS on 27 June (Table 15; Figure 25). Only 1 nest was present in 2009.

Very little Brandt's Cormorant nesting occurred at MPR in 2010. One poorly-built nest was seen on MPR-01 (on 29 April and 2 May), where cormorants nested in 2009. Cormorants also nested on Blue Cheese (MPR-05) where the first fairly-built nest was observed on 13 May, and a peak of four well-built nests (4 well-built nests and 0 nests with brooded chicks) was recorded on 20

June (Table 15; Figure 25). The total MPR nest count of four nests was 90% lower than the 2009 total nest count (40 nests).

Brandt's Cormorants on Stormy Stack had a reduced and delayed nesting effort compared to 2008 and 2009. Although the first poorly-built nests were seen on 23 April, the first well-built nests were not observed until 20 May (25 days later than in 2009). The peak count and total count occurred on the same day on 22 June. The count was 29 nests (26 well-built nests and 3 nests with brooded chicks; Table 15), which was 57% lower than the 2009 total nest count (68 nests).

Productivity - Three confirmed egg-laying sites at Point Resistance (PRS-02) were initially monitored for productivity (Table 14). The average clutch initiation date was 23 June ± 1.5 days (range: 22 June-25 June; n=2). Productivity was 1.00 chicks per pair (n=2), and breeding success per nest was 0.50 (n=2). At the third nest, productivity was uncertain.

Bird Island
Brandt's Cormorant nest surveys were conducted from 5 May to 18 August. No nests were recorded at Bird Island in 2010.

Devil's Slide Rock & Mainland, San Pedro Rock
Nest surveys–Nest and territorial sites were counted at all nesting areas between 15 April and 4 August (Figure 26). Similar to 2008 and 2009, Brandt's Cormorants had a reduced nesting effort. Although nest building began earlier than in 2009, nesting efforts were delayed and extended late into August. Nesting occurred on the cliffs beneath the South Bunker (DSR-04; Figures5, 17). Displaying birds were observed on Devil's Slide Rock (DSR-01) in mid-April, and the first well-built nests were recorded on 6 May, but no eggs were laid. The peak single-day count for all subcolonies was 50 nests (32 well–built nests and 18 nests with brooded chicks) on 30 June. The sum of the seasonal high counts was also 50 nests, since breeding only occurred at one subcolony (DSR-04). Productivity monitoring of DSR-04 documented a higher nest count (63 breeding sites). This difference of 13 nests is a result of nest failures and an extended nesting effort. Inclusion of 2 additional nests recorded during the boat survey (not visible from land) raised the total 2010 nest count from standardized boat and ground counts at DSRM to 52 nests (Table 15), 300% higher than the very low 2009 total nest count (13 nests).

Productivity– All visible Brandt's Cormorant nests on the South Bunker Cliffs (DSR-04) were monitored. This was added as a new monitoring location in 2010 since cormorants did not nest in the monitored areas (DSR-01 or DSR-05) used in previous years. A total of 84 nests were monitored on the South Bunker cliffs, 63 of which were recorded with eggs. The mean clutch initiation date of 2 June ± 2.6 days (Table 14) was over three weeks later than the long-term mean (8 May ± 2.8 days). Average clutch size was 2.3 eggs and 7 replacement clutches were recorded. First chicks were observed on 9 June and the average brood size was 2.2 chicks. Low hatching success (55%) and average fledging success (79%) led to an overall productivity of 1.13 chicks per pair. Productivity was much higher than in 2009 (0.25 chicks per pair) but was 44.7% lower than the long-term average (2.04 ± 0.2; Figure 24). Breeding success per nest of 0.61 chicks indicates relatively high nest abandonment.

Castle-Hurricane Colony Complex
Nest surveys - Brandt's Cormorant nest surveys were conducted from 22 April to 16 August (Figure 27). Subcolonies with confirmed breeding in 2010 were CRM-03East (east and south sides) and CRM-06A (North side). Poor to fairly-built nests were also recorded on the mainland cliffs below the CRM auto pullout (Woodrat Bluff Area) but no eggs were observed and nest building was abandoned by 29 May. The first well-built nests on CRM-03East were observed on 1 May (east side) and 24 May (south side). The peak single-day count for all subcolonies was 130 nests (63 well–built nests and 67 nests with brooded chicks) on 4 July. The sum of the seasonal high counts (well–built nests and nests with brooded chicks) for all subcolonies obtained from land was 131 nests (Table 15). No additional Brandt's Cormorant nests were detected during the boat survey. The total 2010 nest count for CHCC was 19% higher than in 2009 (110 nests).

Productivity - Brandt's Cormorant productivity was monitored at 97 nests on CRM-03East (east side). The mean clutch initiation date of 24 May ± 1.6 days (Table 14) was 20 days later than the long-term mean (4 May ± 5.3 days). Average clutch size was 2.7 eggs and eight replacement clutches were recorded. First chicks were observed on 5 June and the average brood size was 2.4. Hatching success (76%) and fledging success (77%) were close to average and led to an overall productivity of 1.45 chicks per pair, 9% lower than the long-term mean (1.59 ± 0.3 chicks per pair; Figure 24). Breeding success per nest of 0.74 chicks reflects a relatively moderate rate of nest abandonment.

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

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

Pelagic Cormorant – Compared to 2009, nest counts were higher at PRH (+59%), MPR (+40%), DPR (+150%), and DSRM (+59%). The count of 10 nests at PRS was similar to 2009 (11 nests), and counts were 33% lower at CHCC (BM227X, CRM, and HPR combined; Table 15). Nests were first observed at CRM on 16 April, at PRH on 19 April, at DSRM on 28 April and at DBCC on 5 May. Eggs were first recorded at CHCC on 3 May, at DSRM on 5 May, at DBCC on 23 May, and at PRH on 22 June.

Western Gull – Compared to 2009, total nest counts were lower at PRH (-26.0%), PRS (-100%), MPR (-28.6%), DPR (-47.1%) and CHCC (-18%), and higher at DSRM (+70%; Table 15). However, total counts at PRH and DBCC colonies were affected by the late survey date of 8 July. By this time, many gull nests had either failed or their chicks had wandered away from nests and were hidden from view. Land-based counts at these colonies were similar to 2009, which may be a better indication of actual change between years. At CHCC, lower numbers were mainly affected by a lower boat count at HPR, where it is difficult to view all nests. Thus, overall numbers of nests appeared similar to 2009.

Pigeon Guillemot–At PRH, the high standardized count from the lighthouse of 137 birds on 28

April was 12.2% lower than in 2009. Surveys of the entire headlands resulted in higher counts compared to 2009: +4.3% from the land-based count and +11.9% from the boat-based count (Table 16). Although surveys of Drake's Bay colonies were not done at a standardized time of day, seasonal high counts were slightly greater than in 2009 at PRS (13.8%), MPR (11.4%), and DPR (4.2%).

At DSCC (SPR and DSRM), the high land count of 149 guillemots on 26 April and the high boat count of 184 guillemots on 6 June were both similar to 2009 (142 and 172). No birds were seen carrying fish during the surveys but were often observed with fish incidentally while monitoring other species. During instances while monitoring murre productivity on Turtlehead Boulder, there were guillemots observed with fish entering and leaving crevice sites. On 22 July, two guillemots were seen feeding chicks in rock crevices on the South Bunker cliffs.

At CHCC, the high land count of 53 birds on 27 July was 6% higher while the boat count was 19% lower than in 2009 (Table 16). Guillemots were observed entering and leaving crevice sites at BM227X-02 throughout the breeding season and were seen carrying fish and entering at least two sites on the North face of HPR-02 during the 13 June boat survey.

Productivity

Pelagic Cormorant–Nests were monitored at PRH, DSRM, and CHCC (Table 17). Sample sizes were small (<10 nests) at all colonies except DSRM, where there was a large subcolony of visible nests on the South Bunker Cliffs (DSR-04). Unfortunately, almost none of the large colony at PRH can be viewed adequately for productivity. At DSRM, Pelagic Cormorant productivity of 2.35 chicks per pair was 30.6% higher than the long-term mean of 1.8 ± 0.1 chicks/pair. Sample sizes at other colonies were too small to make meaningful comparisons.

Black Oystercatcher – This species breeds at very low densities and locating nests is challenging. Productivity was determined in 2010 at PRH (0.0 chicks/pair; n = 1), DBCC (0.00 chicks/pair; n=2), DSRM (0.0 chicks/pair; n = 1), and CHCC (0.5 chicks/pair; n = 4, Table 17).

Western Gull – Although sample sizes were relatively small (range = 1-13 nests), fairly large portions of the colonies at DSRM and CHCC were monitored for productivity. As is typical at PRH, nests with sufficient views for monitoring were largely limited to scattered pairs on seastacks and certain mainland cliffs, resulting in a lower sample size relative to colony size. Only one nest could be monitored at DBCC colonies.

Productivity was 42.9% higher than the long-term mean (0.70 ± 0.2 chicks/pair) at DSRM and 59% higher than the long-term mean of 0.63 ± 0.3 chicks/pair at CHCC. Productivity was 21.4% lower than the long-term mean of 0.98 ± 0.3 chicks/pair at PRH. Low fledging success appeared to contribute to lower than average productivity at PRH.

Common Raven Surveys – Big Sur

In 2010, 52 Common Raven surveys were conducted along Highway 1 between Point Lobos and Point Sur. A total of 37 raven detections were recorded (Figure 28), corresponding to 0.71 ± 1.1 SD detections/survey (range = 0-5) and 0.027 detections/km. On a per kilometer basis, ravens were detected at a higher rate in the northern portion (Point Lobos to Castle Pullout; 0.033/km, or 0.56 detections/survey; n = 29 detections) than in the southern portion (Point Sur to Castle Pullout; 0.017/km, or 0.15 detections/survey; n = 8 detections). This differs from 2009, when detection rates were higher in the southern portion (0.035/km) than in the northern portion (0.020/km). As in 2009, ravens were most concentrated between Soberanes Point and Joshua Creek in the north, especially at parking pullouts for Garrapata State Park.

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

DISCUSSION

Anthropogenic Disturbance

As is typical, Point Reyes had the lowest combined aircraft and boat detection and disturbance rates of the monitored colony complexes. Although disturbance rates at DBCC were lower than baseline means, the detection rates at DPR were the highest of all monitored colonies. Most detections and disturbances at DPR were caused by small recreational fishing boats. There was an increase in boat disturbances at DPR from 2009 even though there was a new special closure area around Stormy Stack (DPR-01) in 2010. Higher boat traffic at DPR than at other Drakes Bay colonies likely reflects the closer proximity to the harbor at Bolinas Lagoon.

Aircraft and boat detection rates at DSRM declined dramatically from recent years. The overall disturbance rate at DSRM was lower than the mean and was the lowest rate recorded in six years. This is in contrast to the general trend of increased disturbance rates in recent years. Reduced detection and disturbance rates were a result of a decrease in rates for planes and boats, but with an increase in helicopter detection and disturbance rates. The new special closure area around DSR may have contributed to the observed lower rate of boat detections and disturbances. Although the Pacific Coast Dream Machines event at the Half Moon Bay Airport continued to be a substantial contributor to aircraft activity at DSRM, (12% of all overflights), the number of aircraft overflights and disturbances caused during this event was lower than 2009. Outreach and enforcement personnel from USFWS and NOAA were able to communicate with event pilots and air traffic control staff at the event, which appears to have helped reduce disturbance to the colony.

At CHCC, detection rates were the highest ever recorded and disturbance rates were higher than baseline means. Detection and disturbance rates were relatively low from 2001 to 2007, but in the past three years these rates have increased. Most disturbance events at CHCC were caused by helicopters flying at low altitudes (below 650 ft).

Of particular note in 2010, were the high rates of helicopter detections and disturbances.at all colonies.

Non-Anthropogenic Disturbance

In 2010, most non-anthropogenic disturbances occurred at PRH and DBCC and most were caused by Common Ravens and California sea lions. Raven disturbances in 2010 only occurred at colonies within Point Reyes National Seashore, where raven numbers are artificially inflated by anthropogenic food sources, mainly from dairies (Kelly et al. 2002). Disturbance and predation by Common Ravens continues to impact colonies at PRH and DBCC. Ravens caused many flushing events and were recording depredating eggs at PRH, PRS, and DPR. Unlike previous years, there were no disturbances from ravens recorded at MPR. Observations from past years (2005, 2007, 2008) suggest that near abandonment of the two major murre subcolonies (North and South Rocks) at MPR has likely resulted from chronic raven disturbance and nest predation and may have contributed to the lower attendance in 2010. While ravens were not seen at MPR in 2010, there appeared to be an increase in the amount of raven disturbances at PRS, where a resident breeding pair was frequently observed working cooperatively to steal murre eggs. Additionally, young of the year ravens were observed learning this specialized behavior and causing birds to flush. A local resident pair of ravens has been observed causing disturbances at PRS in most years since monitoring began in 2005. More raven disturbances at PRS could also be a result of increased and more frequent monitoring this year.

California sea lions caused many disturbances at PRH. Similar to 2009, sea lions (mostly immature) climbed high onto rocks, causing murres to flush and eggs to be exposed and subsequently depredated by gulls or ravens. However, unlike 2009, most sea lion disturbances occurred before the peak egg-laying period for murres, fewer eggs were lost, and sea lion impacts to productivity were minor.

Few avian disturbances were observed in 2010 at DSR and CHCC. Brown Pelicans caused a limited amount of disturbance at DSR (three events) and at CHCC (one event). Roosting pelicans were observed within murre subcolonies at CHCC but they did not cause any disturbance. In recent years Brown Pelicans have been responsible for major disturbances to murres involving breeding failure at most monitored colonies. Minor disturbances were also caused by Western Gulls, Turkey Vultures, and Peregrine Falcons.

Attendance Patterns and Reproductive Performance

Attendance and breeding success were high for most species and colonies in 2010. Most species had protracted attendance patterns that lasted into August for all colonies. For Common Murres, delayed breeding resulted in peak counts occurring later in the season than normal and numbers of murres attending most colonies were similar or slightly less than 2009. Murre breeding phenology was later than average at both PRH and DSR but similar to average at the more southern CRM.

At PRH, murres started attending colonies later than usual and counts of murres were much higher than in 2009 at most subcolonies. Peak numbers (for most subcolonies) were recorded during the incubation and chick periods and attendance continued for an extended period until late August, reflecting the later onset of breeding. Murres attended and likely bred at all subcolonies with nesting Brandt’s Cormorants present; none of these subcolonies are well-established (i.e., with annual breeding) murre breeding areas. Of particular note was a new Brandt's Cormorant and murre breeding subcolony on the South Bunker Cliffs on the Devil's Slide mainland (DSR-04). Murres were observed flying from cliff sites at DSR-05 to this new subcolony, suggesting that murres colonizing this new area were made up at least in part by birds abandoning DSR-05. All monitored murre colonies experienced high breeding success, and DSR had the highest recorded productivity since restoration efforts began in 1996. This was in marked contrast to very low murre productivity that has been typical since 2005, including complete reproductive failure at DSR and certain other colonies in 2009.

At DSR, the high count and the number of breeding pairs within monitored plots both declined from 2009. This may be a result of lower recruitment to DSR caused by five years of poor reproductive success in murres (2005-2009) at this colony. No breeding sites were recorded in Plot C and murres stopped attending this plot in May. The number of breeding pairs and attendance in plot C has been declining since the removal of decoys in 2005. Repeated disturbance from Brown Pelicans and the lack of Brandt’s Cormorants nesting on Devil’s Slide in past years likely contributed to the lower attendance in Plot C.

For the third consecutive year, Brandt's Cormorants had delayed arrival at colonies, delayed breeding, and below average productivity at all three monitored colonies; however, productivity was higher than in 2008 and 2009. This population experienced a severe starvation event in 2009. Numbers of Pelagic Cormorant nests were higher than in 2009 at most colonies and productivity at DSRM was the highest recorded since monitoring began in 2006. Western Gull nest counts declined at all colonies except for DSRM. Productivity for Western Gulls was higher than 2006-2009 averages but low compared to other previous studies (e.g., Penniman et al. 1990).

Ocean conditions leading up to the 2010 breeding season were characterized by a short-lived El Niño event, with intense downwelling and higher than average sea surface temperatures (SSTs) during winter2009-10. El Niño conditions diminished rapidly and strong upwelling-favorable winds led to a return to slightly cooler than normal SSTs by April (Bjorkstedt et al. 2010). However, the warm El Niño conditions appeared to have delayed the timing of the spring transition to upwelling. In 2010 the spring transition occurred in late April to early May, which is approximately one month later than the spring transition in 2009 (Bjorkstedt et al. 2010). This later timing in upwelling likely influenced the delayed breeding observed for murres and Brandt's Cormorants at all monitored colonies. Ocean, and likely foraging, conditions improved as the season progressed; apparently permitting higher than average breeding success for most species.

Anchovy (*Engraulis mordax*) and sardine (*Sardinops sagax*) populations were recorded at very low levels in 2010 while juvenile rockfish (Sebastes spp.), juvenile hake (*Merluccius productus*), market squid (*Loligo opalescens*) and krill (Euphausid spp.) were abundant in central California waters (Bjorkstedt et al. 2010). Brandt's Cormorants appear to be more affected than other species by the recent low abundance of Northern anchovy (Warzybok and Bradley 2009, 2010), resulting in continued low productivity for this species. On the contrary, Common Murres and Pelagic Cormorants likely preyed on the more abundant species.

Murre co-attendance patterns at DSR also may have reflected the prey fed to chicks. The amount of time murres spent in co-attendance was lower than average, suggesting that these birds spent a considerable amount of time away from the colony foraging while rearing chicks. Although co-attendance was relatively low, chick provisioning rates were high, possibly reflecting the lesser energetic value of the prey compared to that of anchovy, which were more abundant in central California murre chick diet in the late 1990s and early 2000s (Miller and Sydeman 2004, Eigner 2009; PRBO Conservation Science, unpubl. data). Northern anchovy is a lipid-rich fish with higher caloric value than most prey items (Spear 1993).

Recommendations for future management, monitoring and research

Additional outreach, education, and enforcement are needed to reduce aircraft disturbance at all colonies. Lower aircraft detections and disturbance at DSRM in 2010 is an encouraging sign that outreach efforts may have a positive impact. However, the increased aircraft activity and disturbance at CHCC in the past three years is notable. More focused effort for this southern-most colony is needed. Additionally, helicopters continue to cause the most frequent and most severe (e.g., flushing) disturbances. Therefore, directed outreach to helicopter pilots, especially tour operators and military pilots, is recommended. It is often difficult to locate and contact military pilots after a disturbance has occurred. Trying to contact pilots before they approach seabird colonies would be more effective. In one case in 2010, military helicopters transiting past colonies (first observed at CHCC and then at DSRM) were on their way to an air show in the San Francisco Bay Area. Working with air show organizers and contacting pilots before they come to the area may be a more effective approach to avoid overflights of colonies.

The Special Closures that became effective on 1 May 2010 under the California Marine Life Protection Act (CDFG 2004) at PRH, PRS, Stormy Stack (DPR-01), and DSR had varying effects. Boat disturbance at DSR was reduced substantially, while boat disturbances at Stormy Stack increased. Directed outreach and enforcement to boaters is needed to inform them on the closures.

Annual aerial surveys of central and northern California murre, Brandt's Cormorant and Double-crested Cormorant colonies continued in 2010 (in cooperation with California Department of Fish and Game and U.C. Santa Cruz). However, no sustained funding is currently available to count nests and birds from the photographs. These aerial surveys have provided the baseline for assessing population trends of these species since the early 1980s and must be continued to track the success of murre recovery efforts as well as murre and cormorant population changes caused by natural and anthropogenic sources. From 1996-2006, these counts were funded by the *Apex Houston* Trustee Council.

Efforts may be needed to restore the murre colony at MPR. This colony has been nearly extirpated, with very little successful breeding, in recent years. We suspect chronic disturbance and egg predation by Common Ravens to be the main cause for this. Fairly large-scale raven disturbance and murre nest predation has also occurred at nearby PRS. Targeted management of resident, specialist ravens in this area may assist recovery and productivity of these colonies.

Additional research on factors affecting murre, Brandt's Cormorant, and other seabird breeding efforts and success are needed. Comparative studies on the foraging ecology of Brandt's Cormorants, Pelagic Cormorants, and murres may provide insight on the variable response to ocean and prey conditions that have been documented over the past few years.

LITERATURE CITED

Birkhead, T. R., and D. N. Nettleship. 1980. Census methods for murres, Uria species: a unified approach. Canadian Wildlife Service Occasional Paper Number 43.

Bjorkstedt E.P., R. Goericke, S. McClatchie, E. Weber, W. Watson, N. Lo, B. Peterson, B. Emmett, J. Peterson, R. Durazo, G. Gaxiola-Castro, F. Chavez, J.T. Pennington, C.A. Collins, J. Field, S. Ralston, K. Sakuma, S J.. Bograd, F. B. Schwing, Y. Xue, W. J. Sydeman, S. A.Thompson, J. A. Santora, J. Largier, C. Halle, S. Morgan, S. Y. Kim, K. Merkens, J. Hildebrand, L. Munger. 2010. State of the California Current 2009–2010: Regional variation persists through transition from La Niña to El Niño (and back?).CalCOFI Report Volume 51.

Carter, H. R. 2003. Oil and California's seabirds: an overview. Marine Ornithology 31:1-7.

Carter, H. R., and R. T. Golightly (eds.). 2003. Seabird injuries from the 1997-1998 Point Reyes Tarball Incidents. Unpublished Report, Humboldt State University, Department of Wildlife, Arcata, California.

Carter, H. R. and K. A. Hobson. 1988. Creching behavior of Brandt's Cormorant chicks. Condor 90:395-400.

Carter, H. R., G. J. McChesney, D. L. Jaques, C. S. Strong, M. W. Parker, J. E. Takekawa, D. L. Jory, and D. L. Whitworth. 1992. Breeding populations of seabirds in California, 1989-1991. Vols. 1 and 2. Unpublished draft report, U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Dixon, California.

Carter, H. R., U. W. Wilson, R. W. Lowe, D. A. Manuwal, M. S. Rodway, J. E. Takekawa, and J. L. Yee. 2001. Population trends of the Common Murre (*Uria aalge californica*). pp. 33-133 in Manuwal, D.A., H.R. Carter, T.S. Zimmerman, and D.L. Orthmeyer (eds.), Biology and conservation of the Common Murre in California, Oregon, Washington, and British Columbia. Volume 1: Natural History and population trends. U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR-2000-0012, Washington, D.C.

Carter, H. R., V. A. Lee, G. W. Page, M. W. Parker, R. G. Ford, G. Swartzman, S. W. Kress, B. R. Siskin, S. W. Singer, and D. M. Fry. 2003. The 1986 Apex Houston oil spill in central California: seabird injury assessments and litigation process. Marine Ornithology 31:9-19.

CDFG. 2004. Marine Life Protection Act: sections 2850-2863. Sacramento, CA: California Department of Fish and Game, Marine Region.

Command Trustee Council. 2004. Command Oil Spill Final Restoration Plan and Environmental Assessment. U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, California Department of Fish and Game, California Department of Parks and Recreation, and California State Lands Commission.

Eigner, L. E. 2009. Spatial and temporal variation in prey use of Common Murres (Uria aalge) at two disjunct colonies in the California Current System. Unpublished M.S. Thesis, Humboldt State University, Arcata, California.

Forney, K. A., S. R. Benson, and G. A. Cameron. 2001. Central California gillnet effort and bycatch of sensitive species, 1990-98. in E. F. Melvin and J. K. Parrish, (eds.), Seabird bycatch: trends, roadblocks, and solutions. University of Alaska Sea Grant, Fairbanks, Alaska.

Hampton, S., R. G. Ford, H. R. Carter, C. Abraham and D. Humple. 2003. Chronic oiling and seabird mortality from the sunken vessel S.S. Jacob Luckenbach in central California. Marine Ornithology 31:35-41.

Kelly, J. P, K. L. Etienne, and J. E. Roth. 2002. Abundance and distribution of the Common Raven and American Crow in the San Francisco Bay Area, California. Western Birds 33:202-217.

Luckenbach Trustee Council.2006. S.S. *Jacob Luckenbach* and Associated Mystery Oil Spills Final Damage Assessment and Restoration Plan/Environmental Assessment. Prepared by California Department of Fish and Game, National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service, and National Park Service.

McChesney, G. J. 1997. Breeding biology of the Brandt's Cormorants on San Nicolas Island, California. Unpublished M.S. thesis, California State University, Sacramento, California.

McChesney, G. J., L. E. Eigner, T. B. Poitras, P. J. Kappes, D. Le Fer, L. Nason, P. J. Capitolo, H. Beeler, C. Fitzpatrick, R. T. Golightly, K. S. Bixler, H. R. Carter, S. W. Kress, and M. W. Parker. 2006. Restoration of Common Murre colonies in central California: annual report 2005. Unpublished report, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Newark, California

McChesney, G. J., L. E. Eigner, T. B. Poitras, P. J. Kappes, N. M. Jones, D. N. Lontoh, P. J. Capitolo, R. T. Golightly, D. Le Fer, H. R. Carter, S. W. Kress, and M. W. Parker. 2007. Restoration of Common Murre colonies in central California: annual report 2006. Unpublished report, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Newark, California.

McChesney, G. J., L. E. Eigner, P. J. Kappes, T. B. Poitras, D. N. Lontoh, S. J. Rhoades, N. J. Metheny, R. T. Golightly, P. J. Capitolo, H. R. Carter, S. W. Kress, and M. W. Parker. 2008. Restoration of Common Murre colonies in central California: annual report 2007. Unpublished report, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Newark, California

McChesney, G. J., D. N. Lontoh, S. J. Rhoades, K. A. Borg, E. L. Donnelly, M. E. Gilmour, P. J. Kappes, L. E. Eigner, and R. T. Golightly. 2009. Restoration of Common Murre colonies in central California: annual report 2008. Unpublished report, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Newark, California

Miller, A. K., and W. J. Sydeman. 2004. Rockfish response to low-frequency ocean climate change as revealed by the diet of a marine bird over multiple time scales. Marine Ecology - Progress Series 281:207-216.

Page, G. W., H. R. Carter, and R. G. Ford. 1990. Numbers of seabirds killed or debilitated in the 1986 Apex Houston oil spill in central California. pp. 164-174. in Sealy, S.G. (ed.), Auks at sea. Studies in Avian Biology 14.

Parker, M. W. 2005. Comparison of breeding performance, co-attendance, and chick provisioning rates of breeding Common Murres (*Uria aalge*) as early indicators for ecological monitoring. Unpublished M.S. Thesis, Humboldt State University, Arcata, California.

Parker, M. W., S. W. Kress, R. T. Golightly, H. R. Carter, E. B. Parsons, S. E. Schubel, J. A. Boyce, G. J. McChesney, and S. M. Wisely. 2007. Assessment of social attraction techniques used to restore a Common Murre colony in central California. Waterbirds 30:17-28.

Penniman, T.M., M. C. Coulter, L. B. Spear, and R. J. Boekelheide. 1990. Western Gull. Pages 218-244 *in* (Ainley, D.G. and R. J. Boekelheide, eds.), Seabirds of the Farallon Islands: ecology, dynamics, and structure in an upwelling-system community. Stanford University Press, Stanford, California.

Rojek, N. A., M. W. Parker, H. R. Carter, and G. J. McChesney. 2007. Aircraft and vessel disturbances to Common Murres at breeding colonies in central California, 1997-1999. Marine Ornithology 35:67-75.

Roletto, J., J. Mortenson, I. Harrald, J. Hall, and L. Grella. 2003. Beached bird surveys and chronic oil pollution in central California. Marine Ornithology 31:21-28.

Spear, L. B. 1993. Dynamics and effect of Western gulls feeding in a colony of guillemots and Brandt's cormorants. Journal of Animal Ecology 62:399-414.

Takekawa, J. E., H. R. Carter, and T. E. Harvey. 1990. Decline of the Common Murre in Central California 1980-1986. Pp. 149-163. In Sealy, S.G. (ed.), Auks at sea. Studies in Avian Biology 14.

Warzybok, P.M. and R.W. Bradley. 2009. Population Size and Reproductive Performance of Seabirds on Southeast Farallon Island, 2009. Unpublished report to the US Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California. PRBO Contribution Number 1700.

Warzybok, P.M and R.W. Bradley. 2010. Status of Seabirds on Southeast Farallon Island During the 2010 Breeding Season. Unpublished report to the US Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California. PRBO Contribution Number 1769.

Table 1. Monitoring effort of study colonies or colony complexes, January to September 2010.

Colony/Colony Complex	Start date	End date	No. of obs. days	Total hours
Point Reyes	13 Apr 10	16 Sept 10	112	524.30
Point Resistance	15 Apr 10	25 Aug 10	31	52.25
Millers Point Rocks	15 Apr 10	9 Aug 10	33	81.43
Double Point Rocks	23 Apr 10	19 Aug 10	30	119.05
San Pedro Rock	15 Apr 10	4 Aug 10	34	17.77
Devil's Slide Rock & Mainland				
Pre-breeding season	7 Jan 10	7 Apr 10	4	3.67
Breeding season	15 Apr 10	15 Sep 10	127	674.12
Castle-Hurricane Colony Complex				
Pre-breeding season	25 Mar 10	25 Mar 10	1	1.25
Breeding season	16 Apr 10	01 Sept 10	99	443.57[1]

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

Table 2. Numbers of observed aircraft overflights categorized by type and resulting disturbance events recorded at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex, 2010.

Aircraft Type	Total Observations		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	4	0	0	0	0	0	4	0	4
Media	0	1	0	1	0	0	0	0	0	1
Research	32	0	1	0	0	0	2	0	3	0
U.S. Coast Guard	1	16	0	5	0	0	0	5	0	10
Military	10	43	4	13	0	2	1	16	5	31
Law Enforcement	0	2	0	1	0	0	0	0	0	1
Other[1]	129	49	24	13	0	0	2	11	26	24
Unknown[2]	0	1	0	0	0	0	0	1	0	1
Total	172	116	29	33	0	2	5	37	34	72

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

Table 3. Numbers of observed watercraft and resulting disturbance events recorded at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex, 2010.

Watercraft Type	Total Observations	#No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	12	0	0	1	1
Recreational (<25')Small Private	60	1	0	6	7
Recreational (>25')Large Private	3	0	0	1	1
Charter	4	0	0	0	0
Research	1	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	2	0	0	1	1
Kayak/Canoe	1	0	0	0	0
Law Enforcement	0	0	0	0	0
USCG	0	0	0	0	0
Other	1	1	0	0	1
Unknown	1	0	0	0	0
Total	85	2	0	9	11

Table 4. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) during breeding season observations at Point Reyes, 2010. Total number observed and number per observer hour are reported.

			No. Disturbance Events			No. Disturbance Events/hr	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/hr[1]	Flush or Displace/hr
Plane	11	0.021	0	0	1	0.002	0.002
Helicopter	4	0.008	1	0	2	0.006	0.004
Boat	13	0.025	2	0	0	0.004	0
Total	28	0.053	3	0	3	0.011	0.006

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

Table 5. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Point Reyes, 2010.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean No. Seabirds Flushed/ Displaced	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	20	1	20	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	140 (80-200)	2	140 (80-200)	0	0	0	0	0	0	0	0	0	0	0	0
Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	100 (20-200)	3	100 (20-200)	0	0	0	0	0	0	0	0	0	0	0	0

Table 6. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) during breeding season observations at Point Resistance, 2010. Total number observed and number per observer hour are reported.

			No. Disturbance Events			No. Disturbance Events/hr			COMU Disturbance		BRCO Disturbance		BRPE Disturbance	
Source	Total Obser-vations	No.Ob/hr	A	D	F	Total/hr[1]	Flush or Displace/hr	Mean No. Seabirds Flushed/Displaced	No Events	Mean No.birds	No Events	Mean No.birds	No. Events	Mean No.birds
Plane	2	0.038	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	1	0.019	0	0	0	0	0	0	0	0	0	0	0	0
Boat	2	0.038	0	0	0	0	0	0	0	0	0	0	0	0
Total	5	0.096	0	0	0	0	0	0	0	0	0	0	0	0

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

Table 7. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) during breeding season observations at Miller's Point Rocks, 2010. Total number observed and number per observer hour are reported.

			No. Disturbance Events			No. Disturbance Events/hr			COMU Disturbance		BRCO Disturbance		BRPE Disturbance	
Source	Total Obser-vations	No.Obs/hr	A	D	F	Total/hr[1]	Flush or Displace/hr	Mean No. Seabirds Flushed/Displaced	No Events	Mean No.birds	No Events	Mean No.birds	No. Events	Mean No.birds
Plane	2	0.025	0	0	1	0.012	0.012	2	1	2	0	0	0	0
Helicopter	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boat	5	0.061	0	0	1	0.012	0.012	1	1	1	0	0	0	0
Total	7	0.086	0	0	2	0.025	0.025	1.5 (1-2)	2	1.5 (1-2)	0	0	0	0

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

Table 8. Numbers of observed boats and aircraft and resulting disturbances to all seabirds, Common Murres (COMU), Brandt's Cormorants (BRCO), and Brown Pelicans (BRPE) during breeding season observations at Double Point Rocks, 2010. Total number observed and number per observer hour are reported.

			No. Disturbance Events			No. Disturbance Events/hr			COMU Disturbance		BRCO Disturbance		BRPE Disturbance	
Source	Total Obser-vations	No.Obs/hr	A	D	F	Total/hr[1]	Flush or Displace/hr	Mean No. Seabirds Flushed/Displaced	No Events	Mean No.birds	No Events	Mean No.birds	No. Events	Mean No.birds
Plane	10	0.084	1	0	2	0.025	0.017	3.5 (2-5)	2	3.5 (2-5)	0	0	0	0
Helicopter	3	0.025	0	0	1	0.009	0.008	80 (80)	1	50	1	30	0	0
Boat	31	0.260	0	0	6	0.050	0.050	15 (5-24)	2	16.5 (10-23)	5	10.2 (3-20)	2	3 (2-4)
Total	44	0.370	1	0	9	0.084	0.076	19.7 (2-80)	5	18 (2-50)	6	13.5 (3-30)	2	3

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

Table 9. Numbers and hourly rates of observed boats, aircraft overflights, and resulting disturbances to all seabirds during breeding season observations at Devil's Slide Rock & Mainland, 2010.

Source	Total Obser-vations	No. Obs/hr	No. Disturbance Events			No. Disturbance Events/hr	
			A	D	F	Total/hr[1]	Flush or Displace/hr
Plane	102	0.151	26	0	1	0.040	0.001
Helicopter	60	0.089	25	1	16	0.062	0.025
Boat	7	0.010	0	0	1	0.001	0.001
Other (truck)	1	-	1	0	0	0.001	0.0
Total	170	0.251	52	1	18	0.105	0.028

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

Table 10. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Devil's Slide Rock & Mainland, 2010.

Source	Mean No. Seabirds Flushed/ Displaced	COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
		No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	40	1	40	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	38 (6-150)	14	38 (7-142)	12	9 (1-30)	0	0	0	0	0	0	0	0	0	0
Boat	26	0	0	1	26	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	39 (6-150)	15	38 (7-142)	13	11 (1-30)	0	0	0	0	0	0	0	0	0	0

Table 11. Numbers and hourly rates of observed boats, aircraft overflights, and resulting disturbances to all seabirds during breeding season observations at the Castle-Hurricane Colony Complex, 2010.

			No. Disturbance Events			No. Disturbance Events/hr	
Source	Total Obser-vations	No. Obs/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr
Plane	44	0.099	0	0	0	0.000	0.000
Helicopter	31	0.070	1	0	13	0.032	0.029
Boat	23	0.052	0	0	1	0.002	0.002
Total	98	0.221	1	0	14	0.034	0.032

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

Table 12. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at the Castle-Hurricane Colony Complex, 2010.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/HEEG Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean No. Seabirds Flushed/ Displaced	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	19 (2-67)	8	18 (2-65)	7	9 (1-42)	0	0	0	0	2	20	0	0	0	0
Boat	53	0	0	1	52	0	0	1	1	0	0	0	0	0	0
Total	22 (2-67)	8	18 (2-65)	8	15 (1-52)	0	0	1	1	2	20	0	0	0	0

Table 13. Common Murre breeding phenology and reproductive success at Point Reyes (2 plots and combined), Devil's Slide Rock & Mainland (DSR, 3 plots; DSM; and combined), and Castle Rocks & Mainland (2 plots), 2010. Means (range; n) are reported.

Colony/Plot	No.Sites Monitored	No. Egg Laying Sites	Mean Lay Date[1]	No. Eggs Laid	Mean Hatch Date	Hatching Success[2]	Mean Fledge Date	Fledging Success[3]	Chicks Fledged per Pair
Point Reyes (PRH)									
PRH-Ledge	89	72	2 June	75	4 July	72.0%	29 July	96.3%	0.72
			(5/22-6/25;63)		(6/22-7/26; 50)	(75)	(7/17-8/20; 51)	(54)	(72)
PRH-Edge	72	61	30 May	61	1 July	78.0%	25 July	97.8%	0.74
			(5/19-6/14;49)		(6/20-7/18; 42)	(59)	(7/13-8/11; 45)	(46)	(61)
PRH-(combined)	161	133	1 June	136	3July	74.6%	27 July	97.0%	0.73
			(5/19-6/25;112)		(6/20-7/26; 92)	(134)	(7/13-8/20; 96)	(100)	(133)
Devil's Slide Rock & Mainland (DSRM)									
DSR-A	87	81	4 June	86	7 July	82.6%	31 July	98.6%	0.86
			(5/11-6/25;70)		(6/26-7/26;61)	(86)	(7/17-8/15;70)	(71)	(81)
DSR-B	79	66	1 June	68	3 July	88.2%	28 July	93.3%	0.85
			(5/22-6/20;59)		(6/26-7/22;59)	(68)	(7/17-8/14;56)	(60)	(66)
DSR-C	10	0	-	0	-	0.0%	-	0.0%	0.0
						(0)		(0)	(0)
DSR (combined)	176	147	3 June	154	5 July	85.1%	30 July	96.2%	0.86
			(5/11-6/25;129)		(6/26-7/26;120)	(154)	(7/17-8/15;126)	(131)	(147)
DSM	108	42	6 June	42	8 July	50.0%	31 July	90.5%	0.45
			(5/26-7/7;33)		(6/30-7/13;21)	(42)	(7/23-8/4;19)	(21)	(42)
DSR, DSM (combined)	284	189	3 June	196	5 July	77.6%	30 July	95.4%	0.77
			(5/11-7/7;162)		(6/26-7/26;141)	(196)	(7/17-8/15;145)	(152)	(189)
Castle Rocks & Mainland (CRM)									
CRM-04	125	83	17 May	88	18 June	68.3%	July 12	81.8%	0.54
			(5/5-6/14;74)		(6/5-7/8;54)	(82)	(7/4-7/24;45)	(55)	(83)
CRM-03B	187	68	23 May	71	24 June	85.7%	July 15	88.3%	0.78
			(5/5-7/2;65)		(6/4-8/1;58)	(70)	(7/1-8/4;53)	(60)	(68)

Table 13 (con't).

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

Table 14. Brandt's Cormorant breeding phenology and reproductive success at Point Reyes, Devil's Slide Rock & Mainland, and Castle Rocks & Mainland, 2010. Reported are means (range; n).

Colony/ Subcolony	No. Breeding Sites	Clutch Initiation Date[1]	Clutch Size[1]	No. Chicks Hatched/Pair[2]	Hatching Success[2]	Fledging Success[2]	Breeding Success[2]	No. Chicks Fledged/Pair[2]	Breeding Success/ Nest[3]
Point Reyes									
Green Top (PRH-08B)	57	12 June (5/25-7/9; 28)	2.9 (2-4; 28)	2.17 (0-3; 54)	75.5% (0-100; 155)	87.5% (0-100; 120)	65.1% (0-100; 149)	1.91 (0-3; 55)	0.98 (55)
Ocho Ledge (PRH-08C)	22	28 June (6/11-7/9; 8)	2.6 (2-3;8)	1.86 (0-3; 22)	73.2% (0-100; 56)	57.6% (0-100; 33)	41.3% (0-100; 46)	1.06 (0-3; 18)	0.50 (18)
Total - Point Reyes	79	16 June (5/25-7/9; 36)	2.9 (2-4; 36)	2.08 (0-3; 76)	74.9% (0-100; 211)	81.0% (0-100; 153)	59.5% (0-100; 195)	1.70 (0-3; 73)	0.86 (73)
Point Resistance (PRS-02)	3	23 June (6/22-6/25; 2)	3.0 (3; 1)	2 (2; 1)	66.7% (67; 3)	100% (100; 2)	ND	1.00 (0-2; 2)	0.50 (2)
Devil's Slide Rock & Mainland									
South Bunker Cliffs (DSR-04)	63	2 June (5/10-7/17;60)	2.3 (1-4;61)	1.3 (0-3;68)	55.3% (0-100;161)	78.7% (0-100;89)	43.5% (0-100;161)	1.13 (0-3;62)	0.61 (62)
Castle Rocks & Mainland (CRM-03B)	97	24 May (5/6-7/7; 96)	2.7 (1-4; 83)	1.77 (0-3; 103)	76.2% (0-100; 239)	76.9% (0-100; 182)	57.6% (0-100; 245)	1.45 (0-3; 97)	0.74 (97)

[1] Includes first clutches only.
[2] Includes replacement clutches. See text for details
[3] Breeding success per nest is defined as the proportion of egg-laying nests that fledged at least one chick

Table 15. High counts of nests for Brandt's Cormorants (BRCO), Pelagic Cormorant (PECO), obtained during land, boat, and combined land/boat counts (total count), 2010.

Species	Colony	Land[1]	Boat	Total Count[2]
Brandt's Cormorant	Point Reyes	174	100	254
	Point Resistance	5	0	5
	Miller's Point Rocks	4	3	4
	Double Point Rocks	29	0	29
	Bird Island (Point Bonita)	0	-	0
	San Pedro Rock	0	0	0
	Devil's Slide Rock & Mainland	50	19	52
	Bench Mark-227X	0	0	0
	Castle Rocks & Mainland	131	0	131
	Hurricane Point Rocks	0	0	0
Pelagic Cormorant	Point Reyes	20	173	189
	Point Resistance	10	9	10
	Miller's Point Rocks	7	7	14
	Double Point Rocks	0	5	5
	San Pedro Rock	0	0	0
	Devil's Slide Rock & Mainland	73	45	81
	Bench Mark-227X	0	2	2
	Castle Rocks & Mainland	0	7	7
	Hurricane Point Rocks	0	1	1

[1] Sum of high seasonal counts at each subcolony or subarea.
[2] Nests that may have been counted on both surveys were included only once towards the total nest count.

Table 16. High counts of nests for Black Oystercatcher (BLOY), Western Gull (WEGU), and of birds for Pigeon Guillemot (PIGU), obtained during land, boat, and combined land/boat counts (total count), 2010.

Species	Colony	Land[1]	Boat[2]	Total Count[3]
Black Oystercatcher	Point Reyes	2	1	3
	Point Resistance	1	0	1
	Miller's Point Rocks	1	0	1
	Double Point Rocks	0	1	1
	Devil's Slide Rock & Mainland	1	0	1
	Bench Mark-227X	0	0	0
	Castle Rocks & Mainland	3	0	3
	Hurricane Point Rocks	1	0	1
Western Gull	Point Reyes	131	20	151
	Point Resistance	0	0	0
	Miller's Point Rocks	9	1	10
	Double Point Rocks	7	2	9
	San Pedro Rock	3	6	6
	Devil's Slide Rock & Mainland	10	11	17
	Gray Whale Cove South	0	1	1
	Bench Mark-227X	9	3	10
	Castle Rocks & Mainland	17	8	18
	Hurricane Point Rocks	5	28	31
Pigeon Guillemot	Point Reyes	264[4]	394	-
	Point Resistance	33	7	-
	Miller's Point Rocks	49	3	-
	Double Point Rocks	50	12	-
	Devil's Slide Colony Complex	149	184	-
	Gray Whale Cove South	0	0	-
	Castle-Hurricane Colony Complex	53	25	-

[1] Sum of high seasonal counts at each subcolony.
[2] In several cases, oystercatcher and gull nests were counted only if they could not be seen from mainland vantage points.
[3] Oystercatcher and gull nests that may have been counted on both surveys were included only once towards the total count.
[4] Single day survey of entire Point Reyes colony

Table 17. Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls at Point Reyes, Devil's Slide Rock & Mainland, and Castle Rocks & Mainland in 2010. Reported are means (range; n) or (n).

	Pelagic Cormorant				Black Oystercatcher				Western Gull			
	N	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	N	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	N	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]
Point Reyes	2	1	0.50 (0-1;2)	0.50 (2)	1	0	0.0 (0;1)	0.0 (1)	13	10	0.77 (0-3;13)	0.46 (13)
Drakes Bay Colony Complex[2]	10	20	2.00 (0-3;10)	0.90 (10)	2	0	0.0 (0; 2)	0.0 (2)	1	0	0.00 (0; 1)	0.00 (1)
Devil's Slide Rock & Mainland	75	176	2.35 (0-4;75)	0.88 (75)	1	0	0.0 (0;1)	0.0 (1)	8	8	1.00 (0-3;8)	0.63 (8)
Castle Rocks & Mainland	4	5	1.30 (0-2;4)	0.75 (4)	4	2	0.5 (0-1;4)	0.5 (4)	10	10	1.00 (0-3;10)	0.60 (10)

[1] Breeding success per nest is defined as the proportion of egg-laying nests that fledged at least one chick.
[2] Because of small sample sizes, Drakes Bay colonies were combined

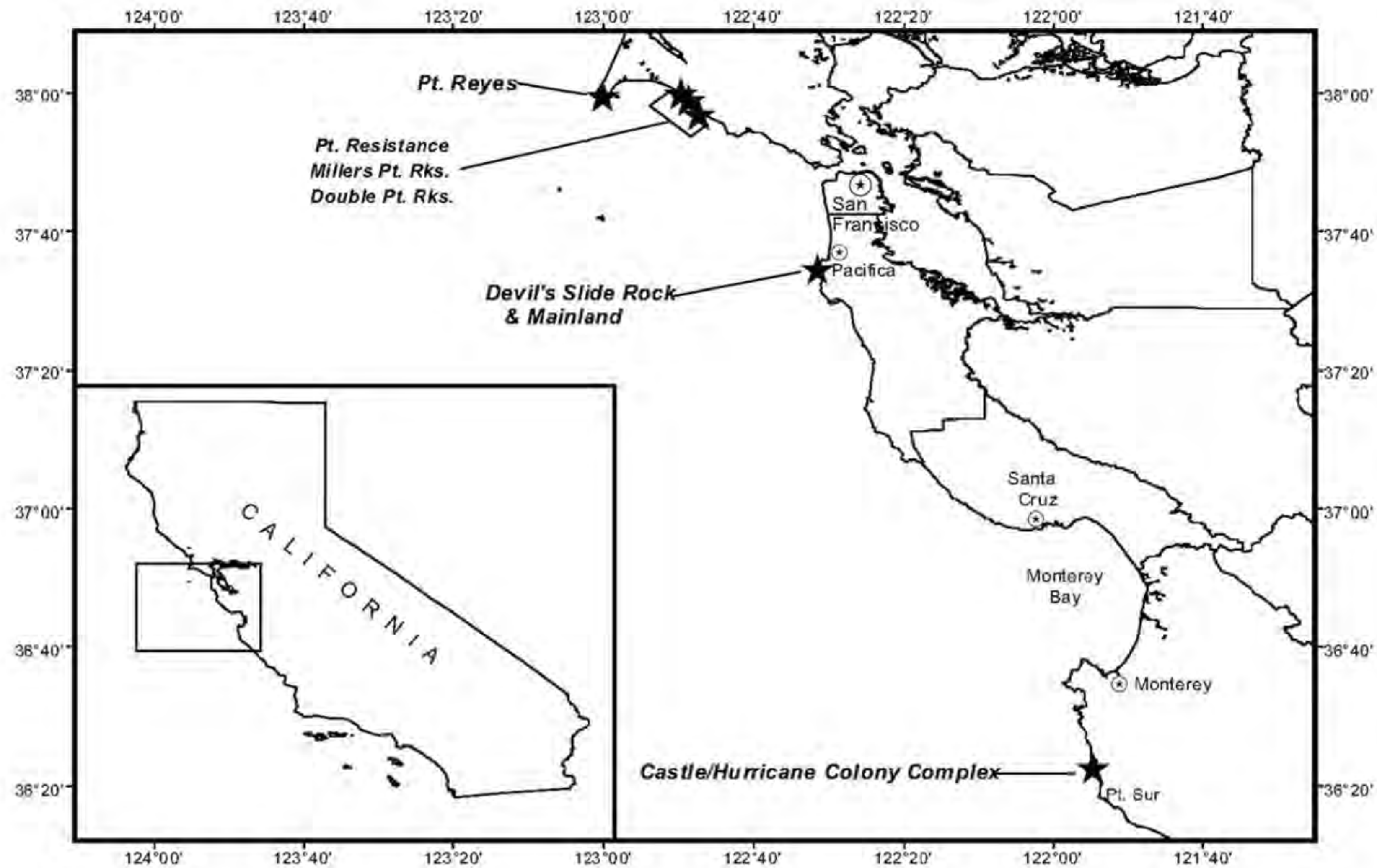


Figure 1. Map of the study area showing locations of study colonies or colony complexes.

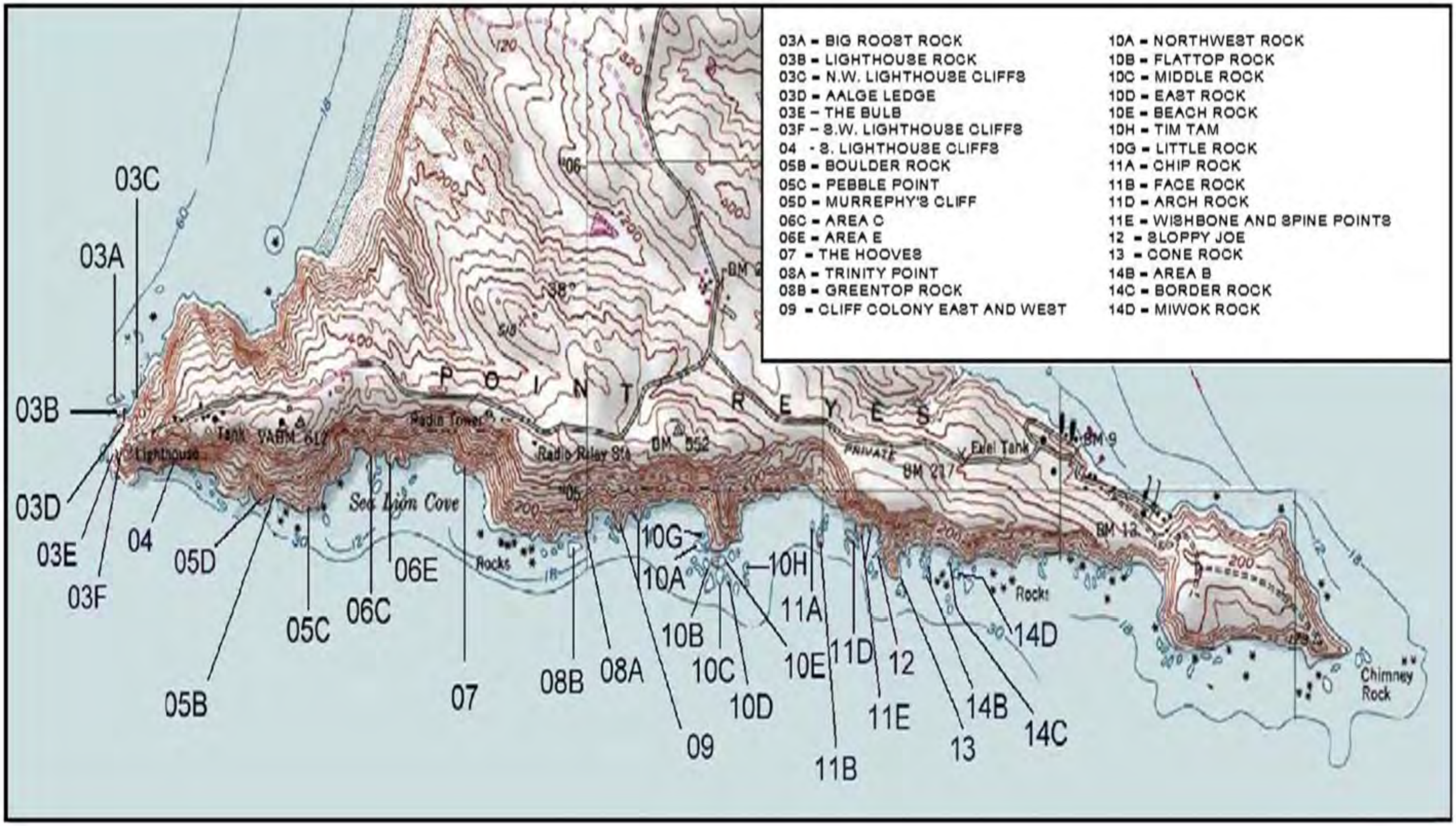


Figure 2. Point Reyes Headlands, including most of the subcolonies mentioned in this report.

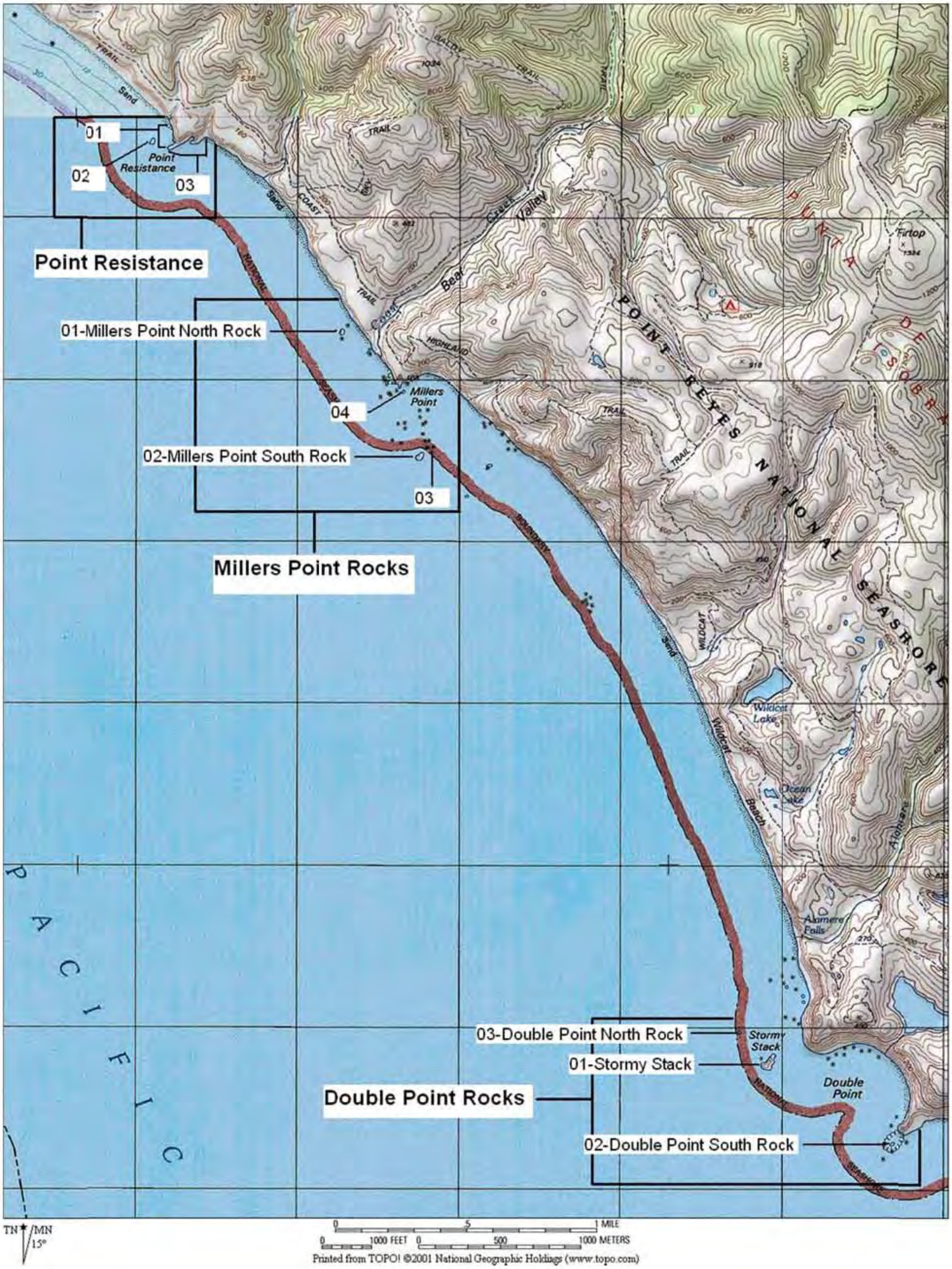


Figure 3. Map of the Drakes Bay Colony Complex, including Point Resistance, Millers Point Rocks and Double Point Rocks colonies and subcolonies.

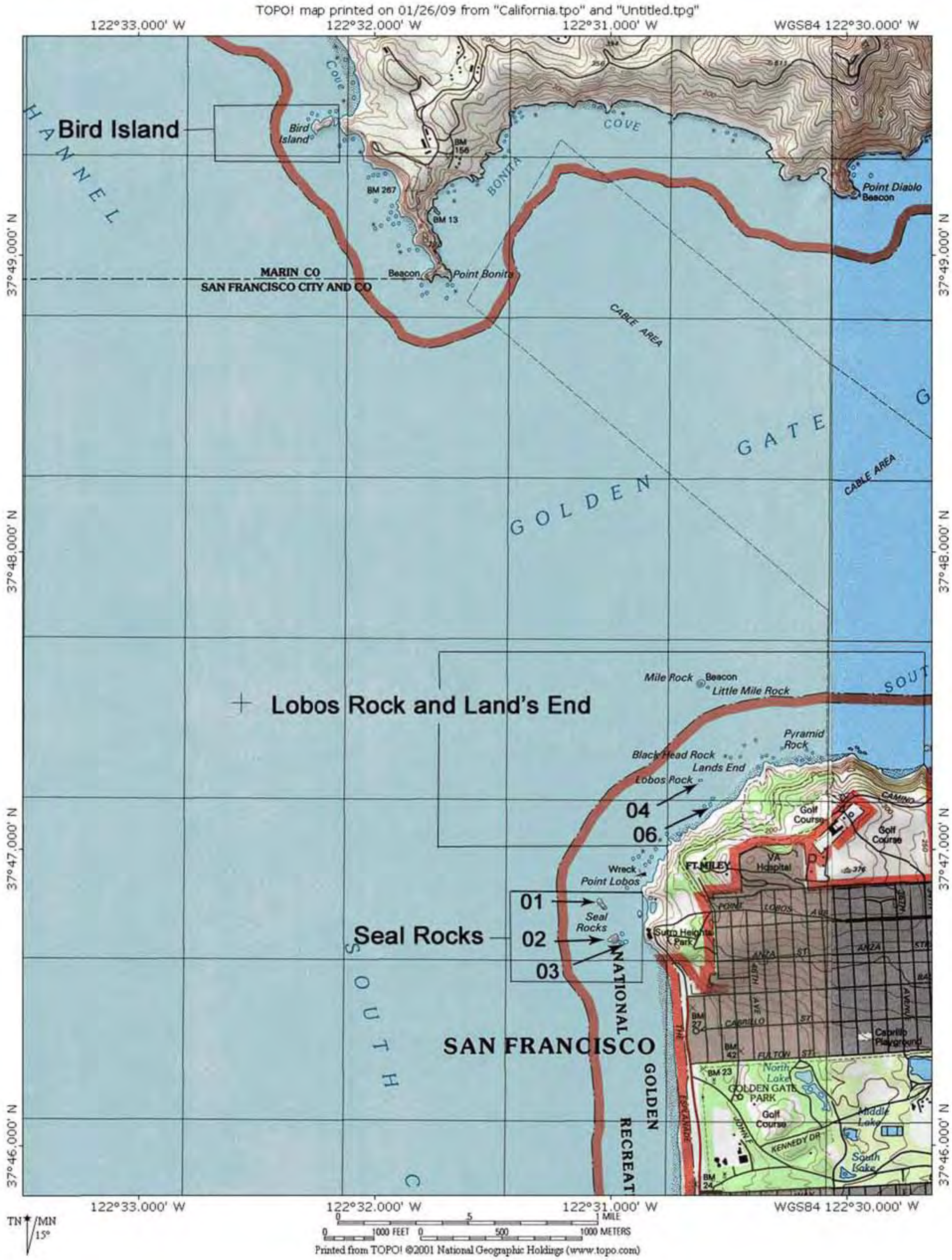


Figure 4. Map of the Bird Island colony monitored at the mouth of the Golden Gate.

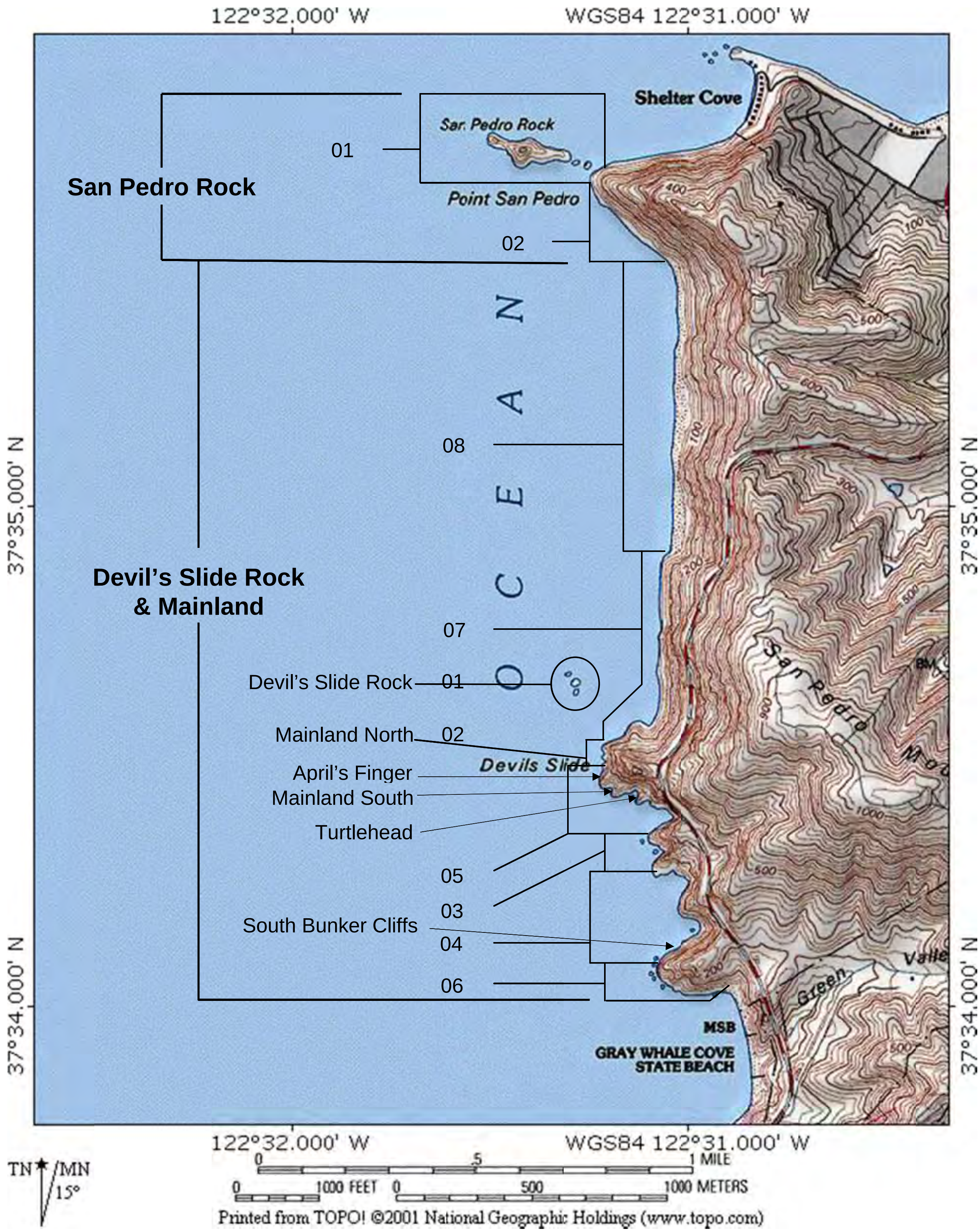


Figure 5. Map of the Devil's Slide Colony Complex, including San Pedro Rock and Devil's Slide Rock & Mainland colonies and subcolonies.

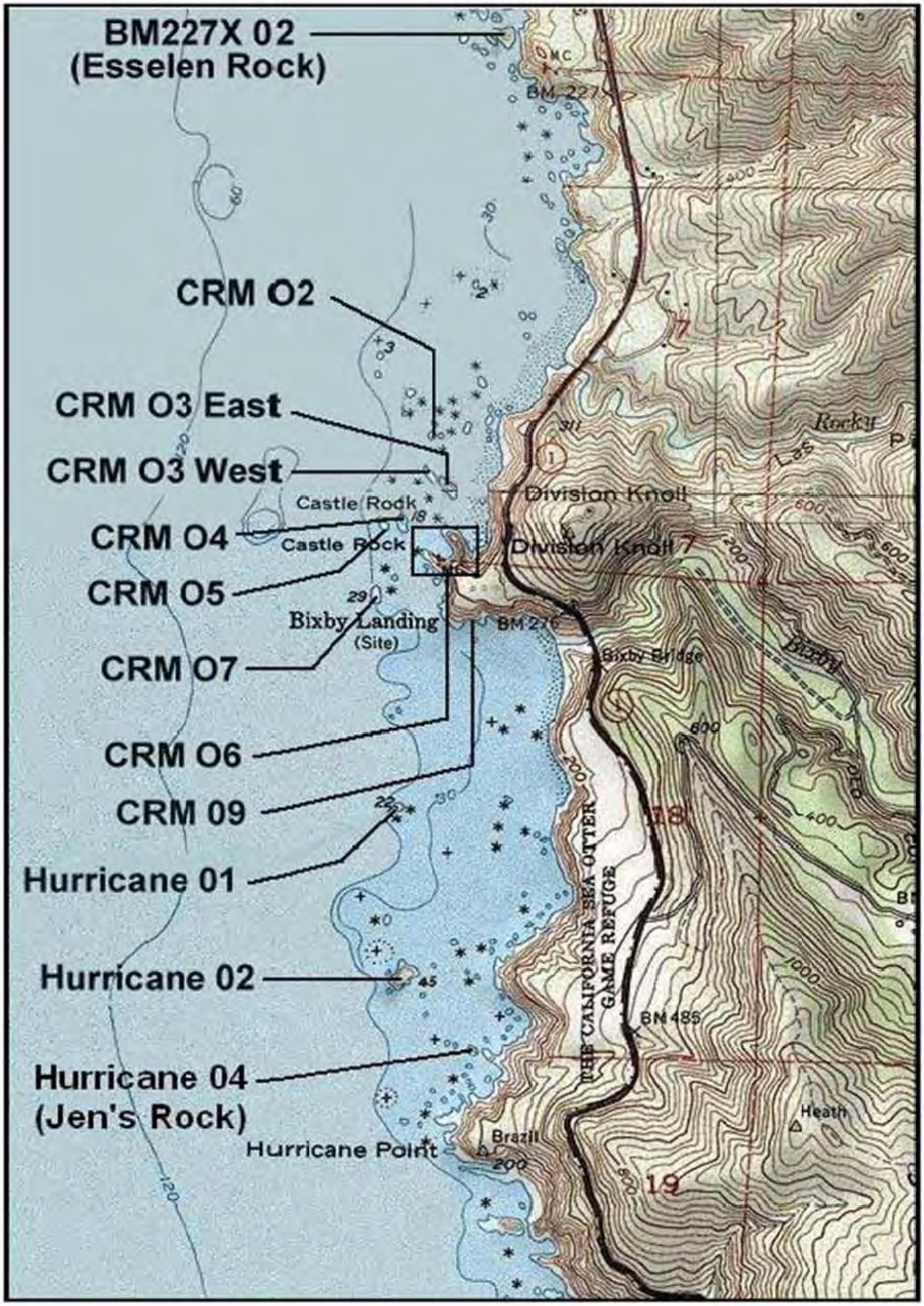


Figure 6. Map of Castle-Hurricane Colony Complex, including Bench Mark-227X (BM227X), Castle Rocks & Mainland (CRM), and Hurricane Point Rocks (Hurricane) colonies and subcolonies.

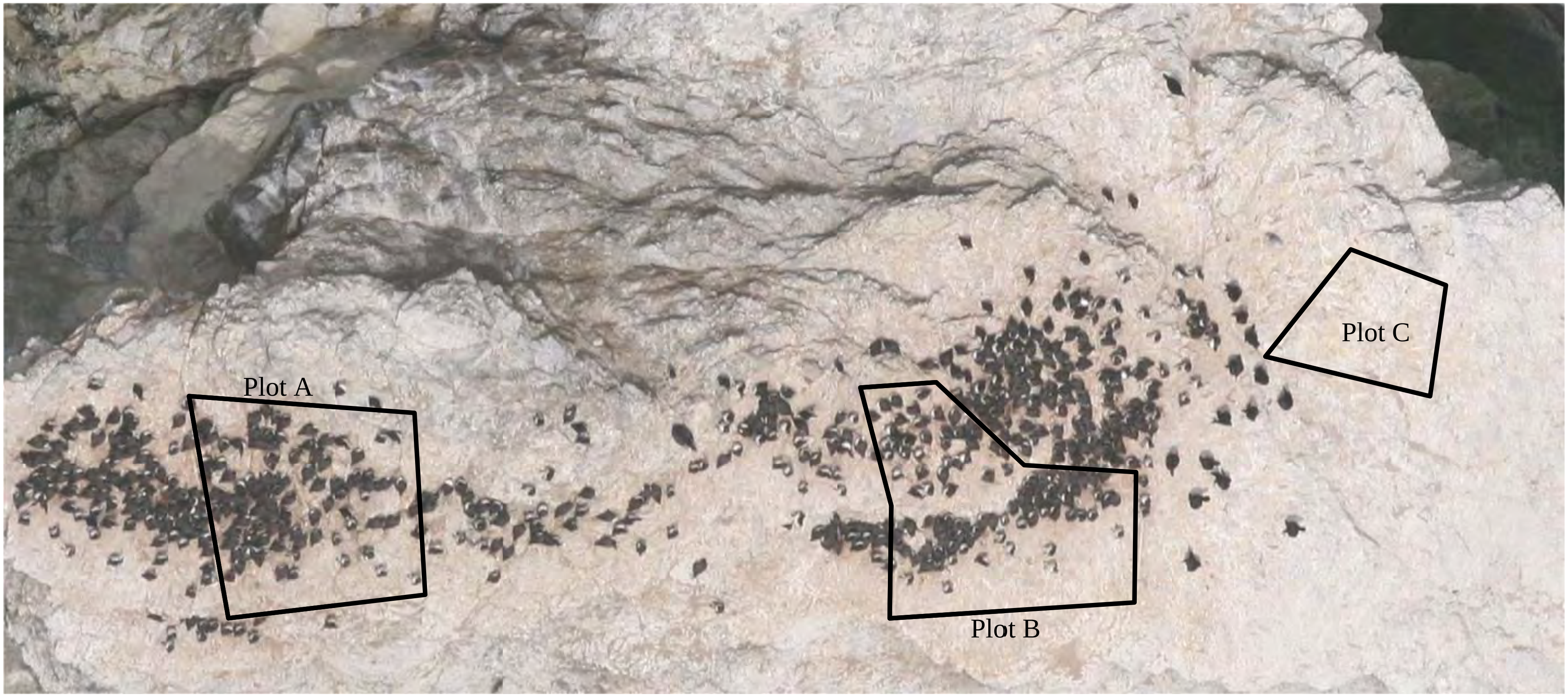


Figure 7. Aerial photograph of Devil's Slide Rock, 15 June 2010, showing the distribution of the Common Murre breeding colony, and locations of Plots A, B and C. Note lack of nesting murres in Plot C and lack of nesting Brandt's Cormorants on rock.

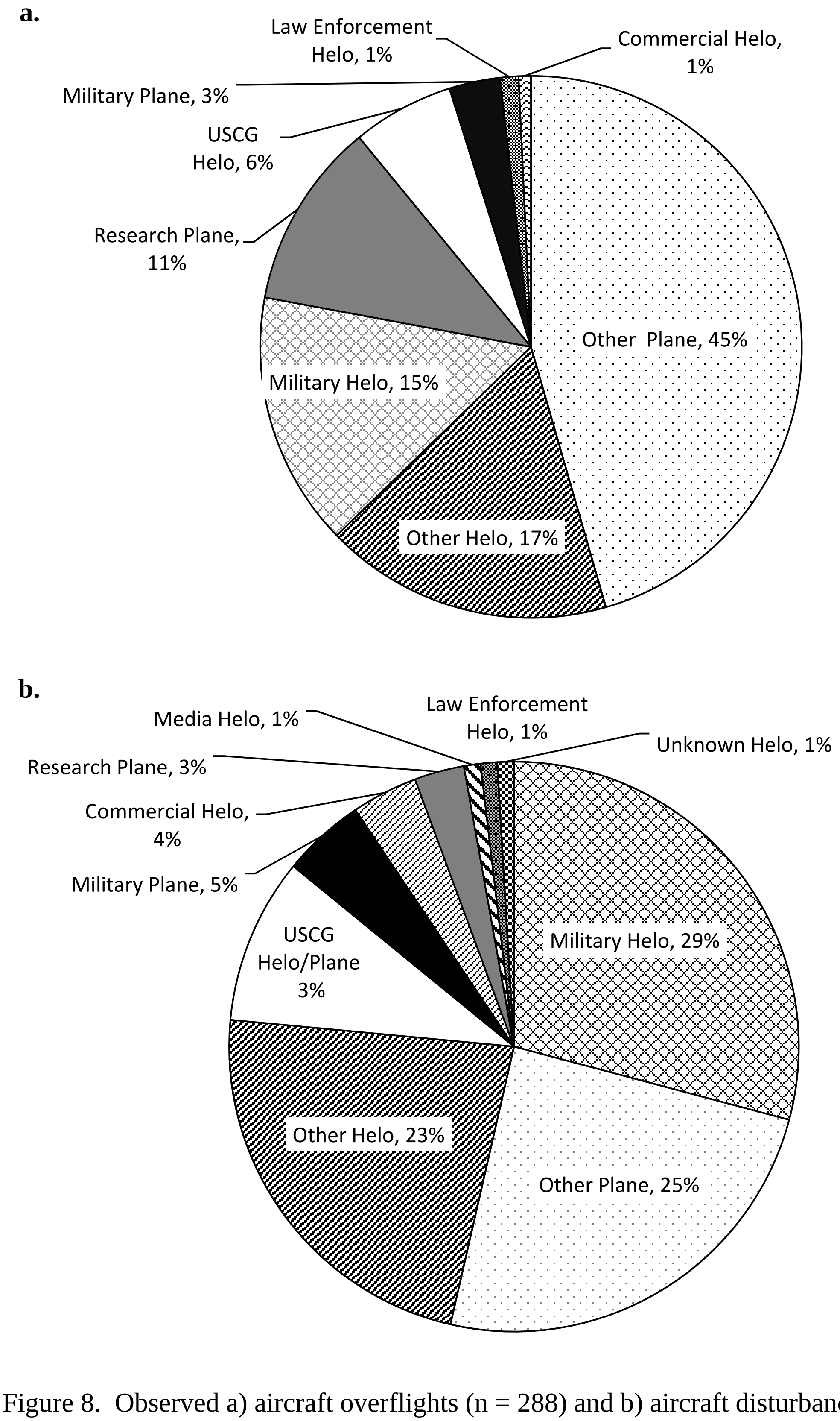
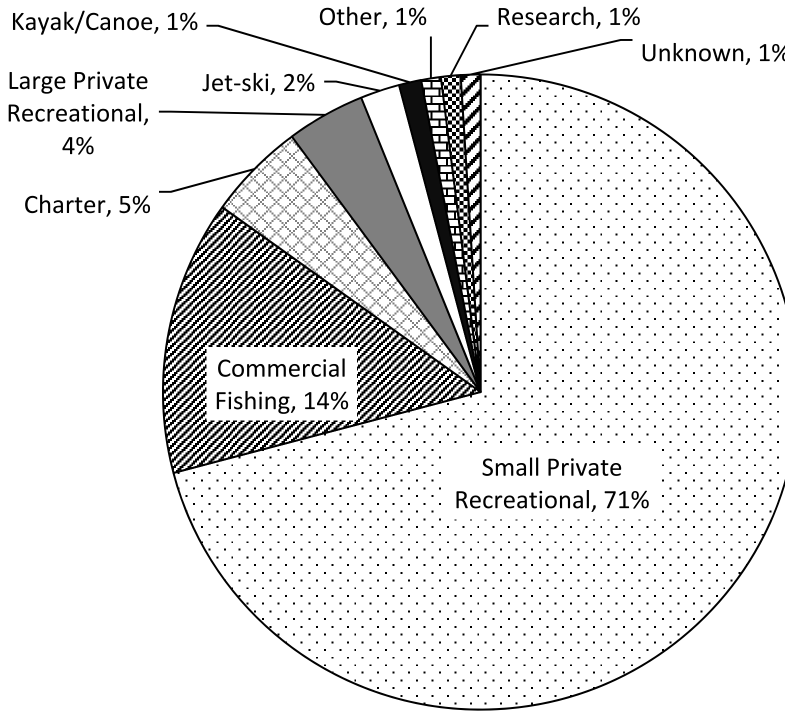


Figure 8. Observed a) aircraft overflights (n = 288) and b) aircraft disturbances (n=106) at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex 2010, categorized by type.

a.



b.

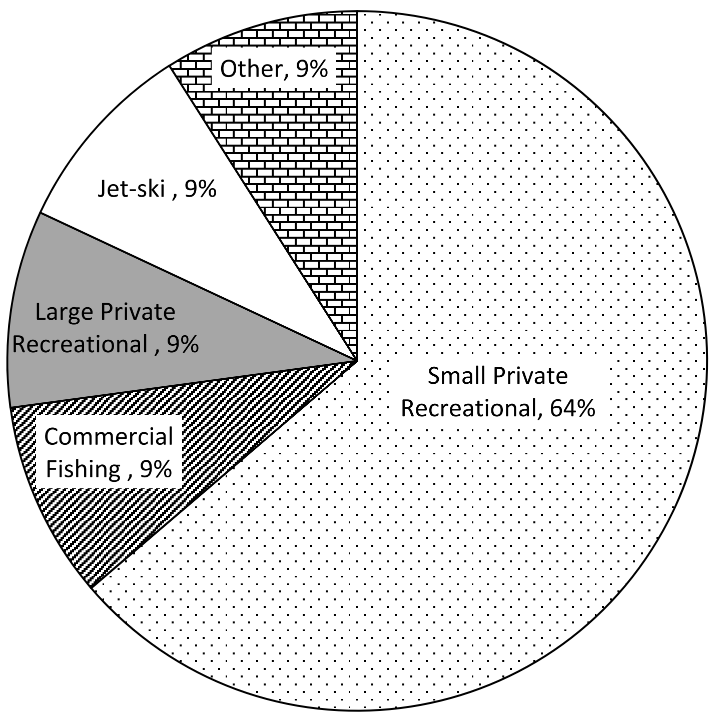


Figure 9. Observed a) watercraft (n=85) and b) watercraft disturbances (n = 11) at Point Reyes, Drakes Bay, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex 2010, categorized by type.

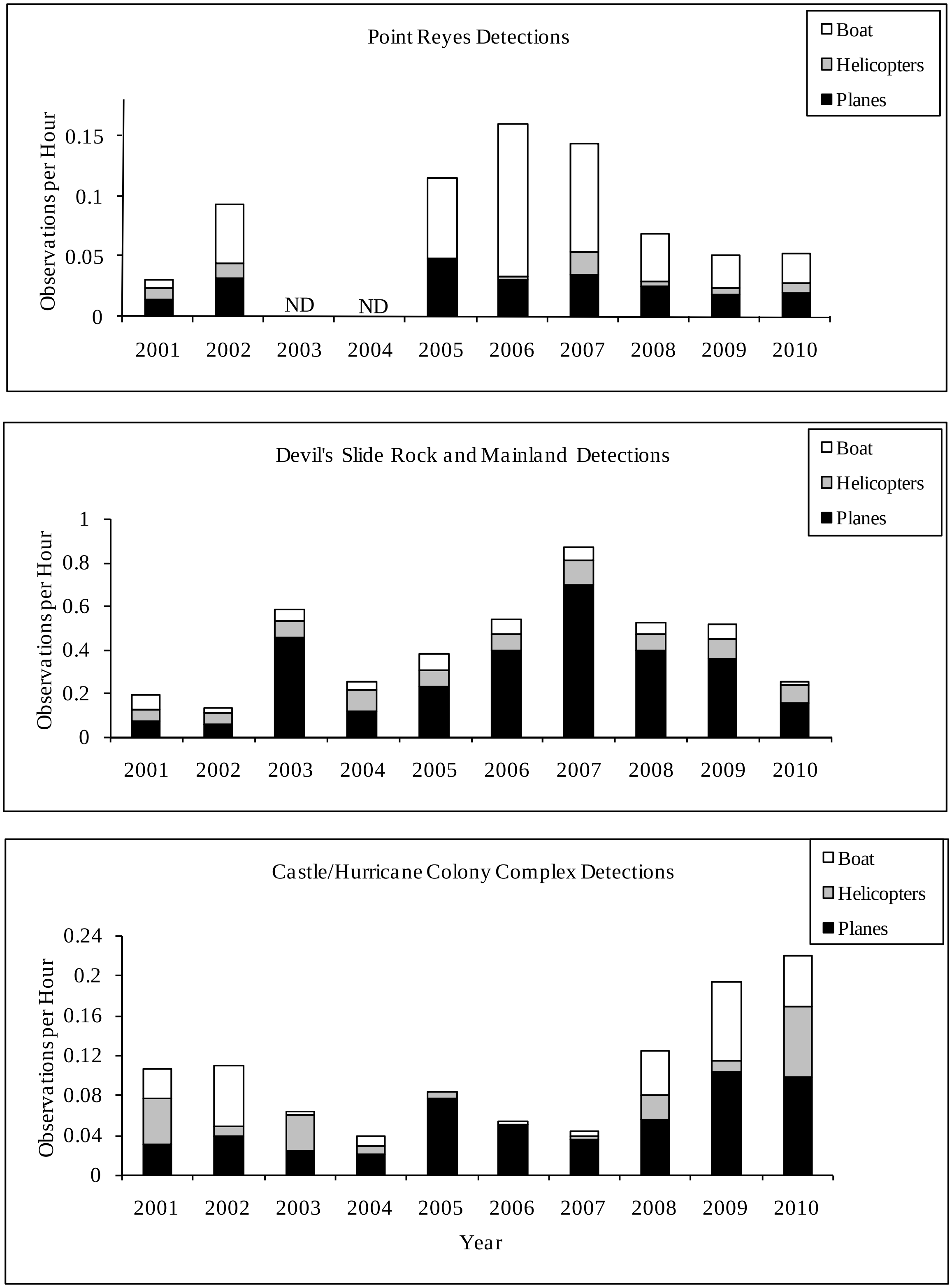


Figure 10. Detection rates (detections per observation hour) of boats, helicopters, and planes at Point Reyes, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex, 2001 to 2010.

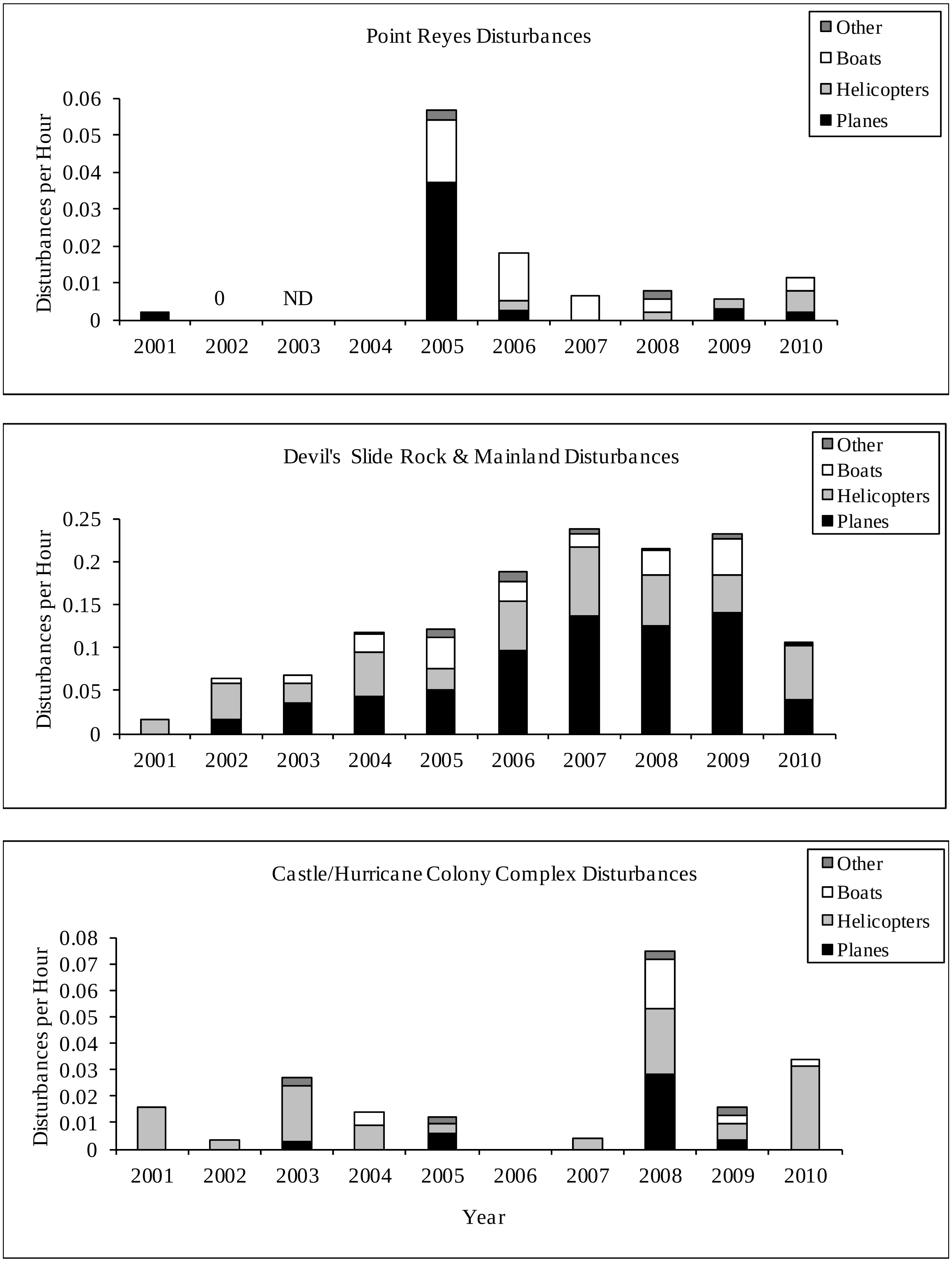
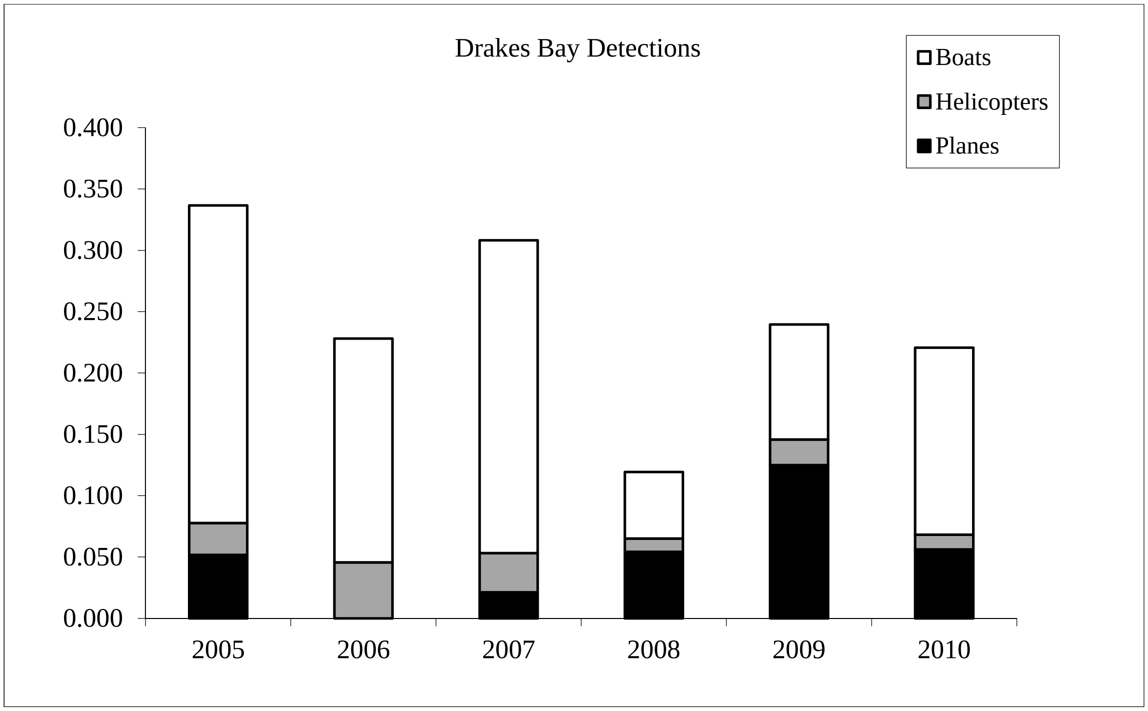


Figure 11. Disturbance rates (numbers per observation hour) of seabirds from boats, helicopters, planes, and other human sources at Point Reyes, Devil's Slide Rock & Mainland, and the Castle-Hurricane Colony Complex, 2001-2010.



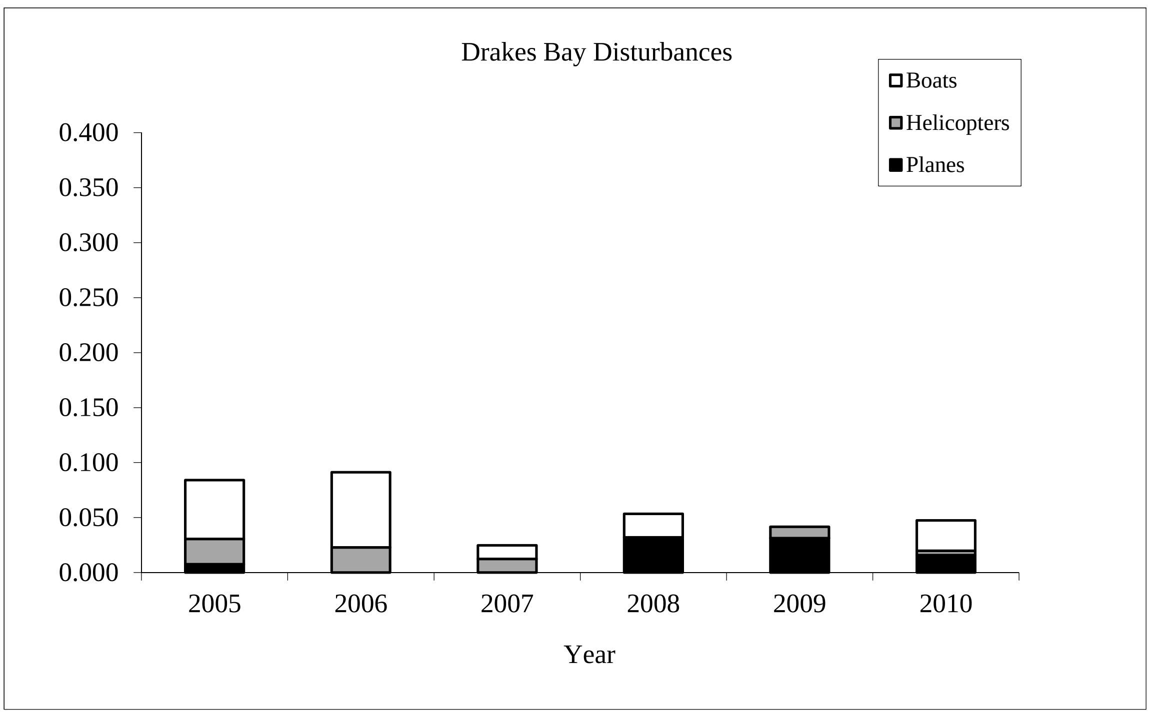


Figure 12. Detection and disturbance rates (numbers per observation hour) of boats, helicopters, and planes at Drakes Bay Colonies, 2005 to 2010.

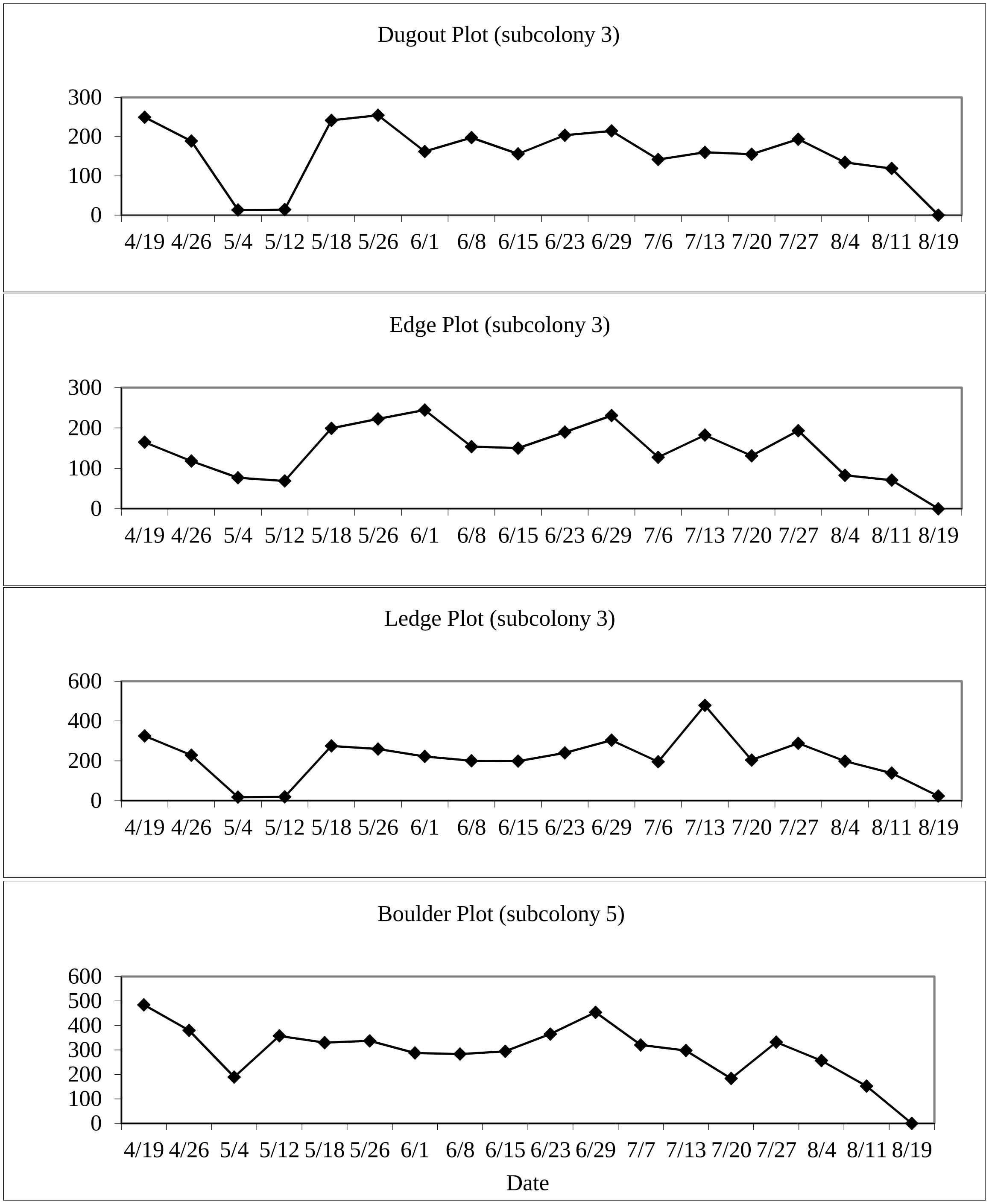


Figure 13. Seasonal attendance patterns of Common Murres at Dugout, Edge, Ledge and Boulder Plots 19 April to 19 August 2010.

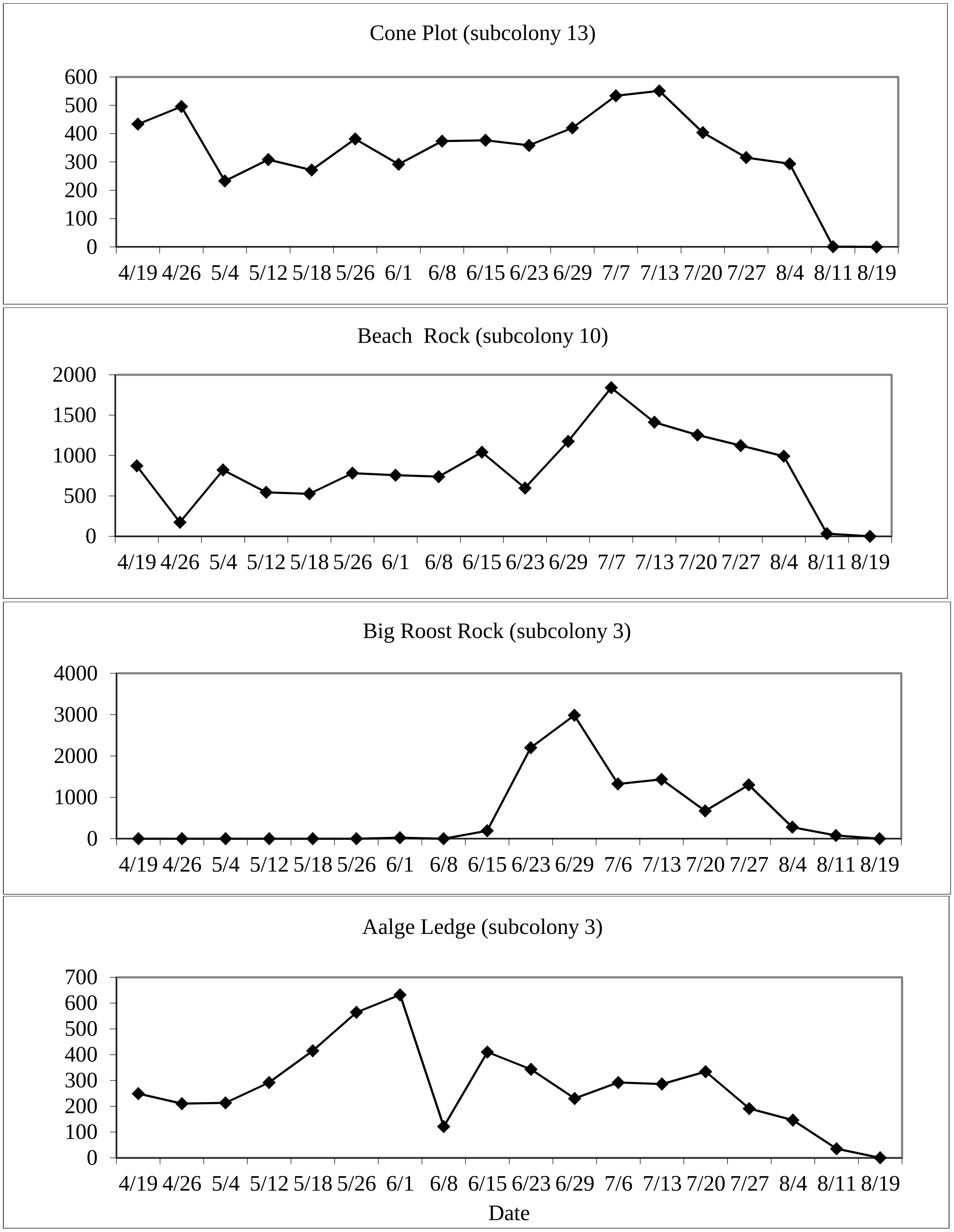


Figure 14. Seasonal attendance patterns of Common Murres at Cone Plot, Beach Rock, Big Roost Rock, and Aalge Ledge 19 April to 19 August 2010.

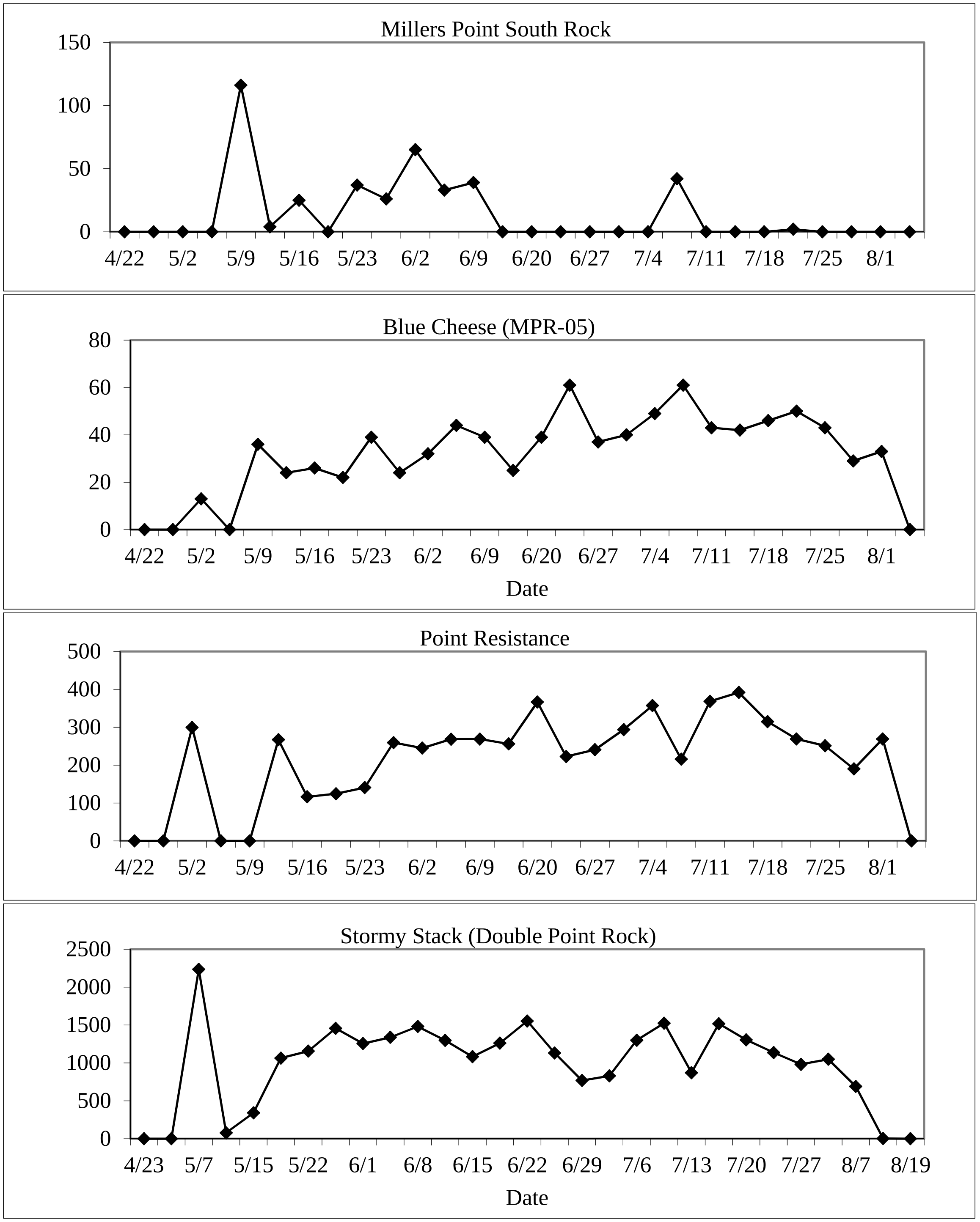


Figure 15. Seasonal attendance patterns of Common Murres at Drakes Bay: Point Resistance, Millers Point Rocks, and Stormy Stack 22 April to 19 August 2010.

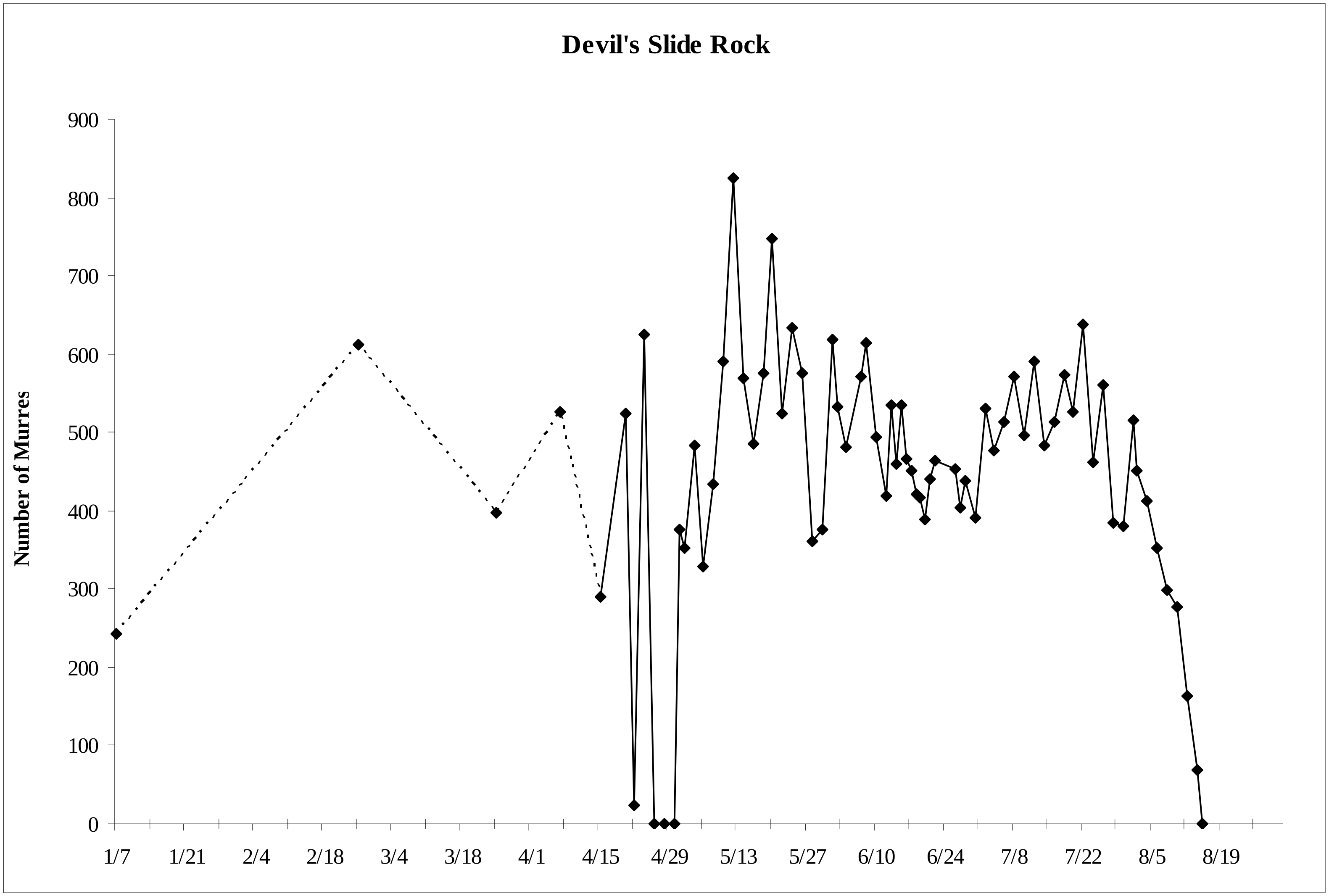
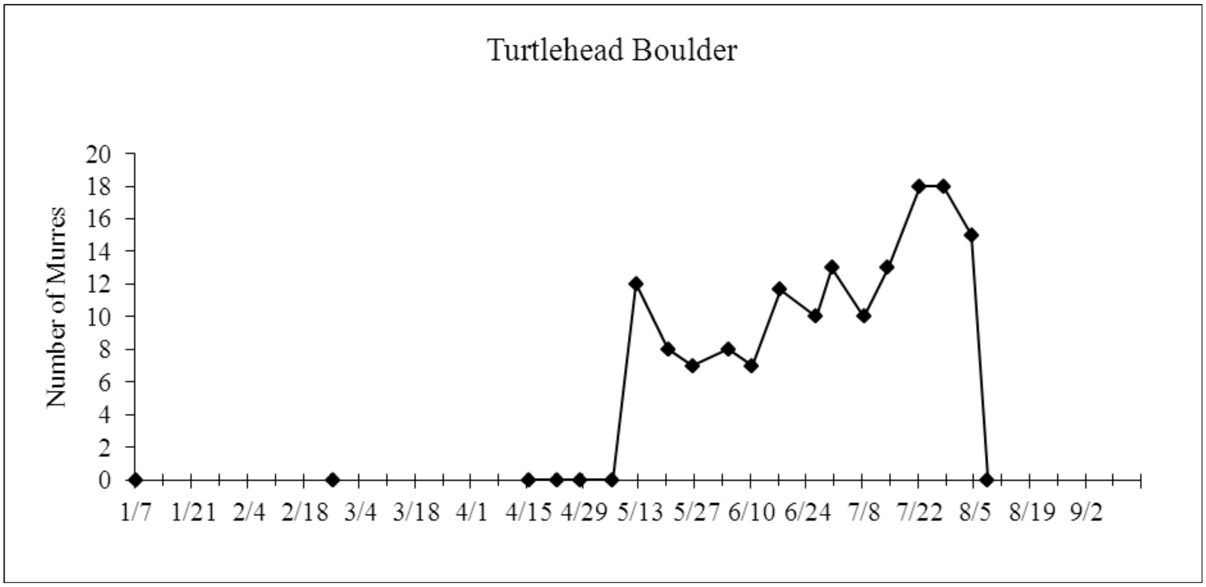


Figure 16. Seasonal attendance of Common Murres at Devil's Slide Rock, 7 January 2010 to 15 August 2010. Dashed line indicates pre-breeding season counts and solid line indicates breeding season counts.

Figure 17. Location of Common Murre attendance at South Bunker Cliffs (DSR-04), photographed by Crystal Bechaver on 30 June 2010.



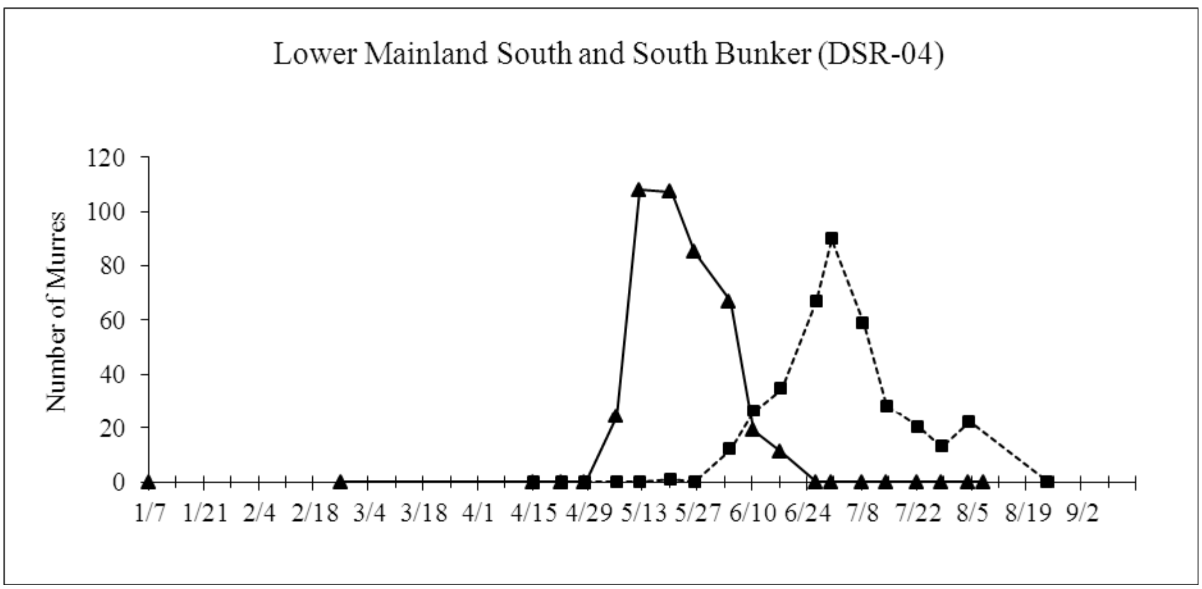


Figure 18. Seasonal attendance of Common Murres at Turtlehead Boulder, Lower Mainland South and South Bunker Cliffs (DSR-04), 7 January 2010 to 24 August 2010. The solid line and triangles indicate counts of Lower Mainland South as compared to the dashed line and squares which indicate counts of the South Bunker Cliffs (DSR-04).

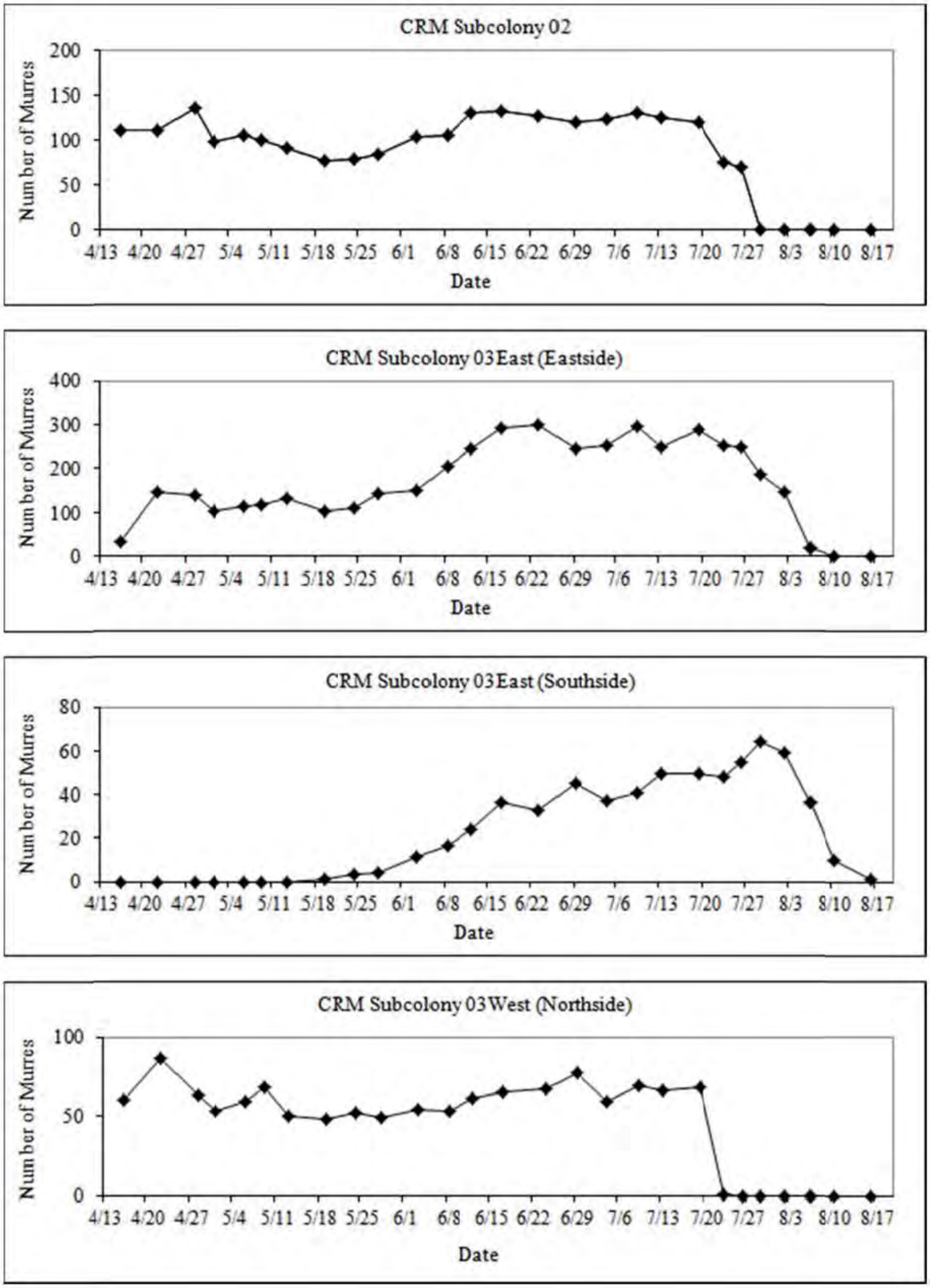


Figure 19. Seasonal attendance patterns of Common Murres at Castle Rocks & Mainland subcolonies 02, 03East (Eastside), 03East (Southside) and 03West (Northside), 16 April to 16 August 2010.

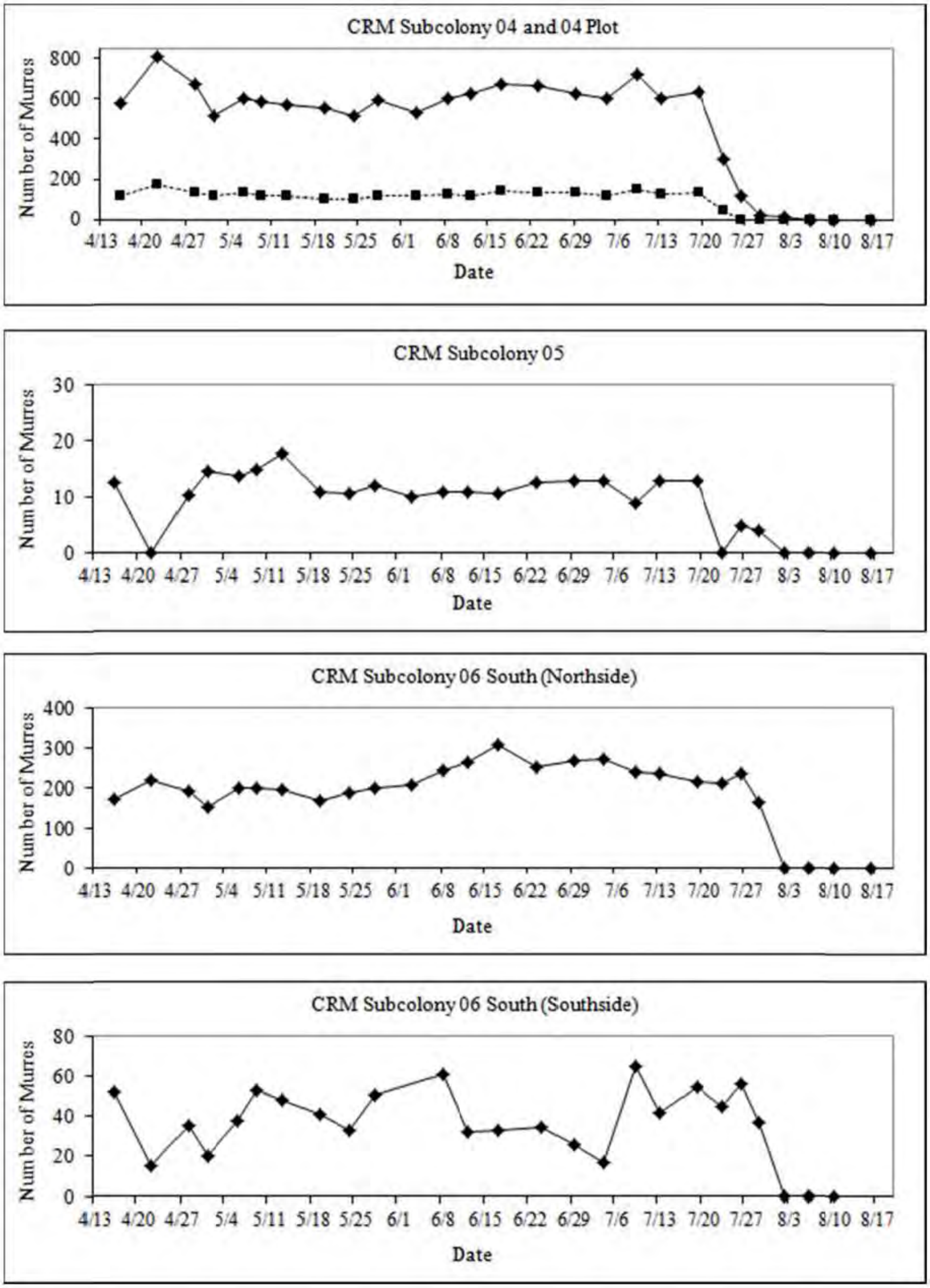


Figure 20. Seasonal attendance patterns of Common Murres at Castle Rocks & Mainland subcolonies 04 and 04 Plot, 05, 06South (Northside) and 06South (Southside), 16 April to 16 August 2010.

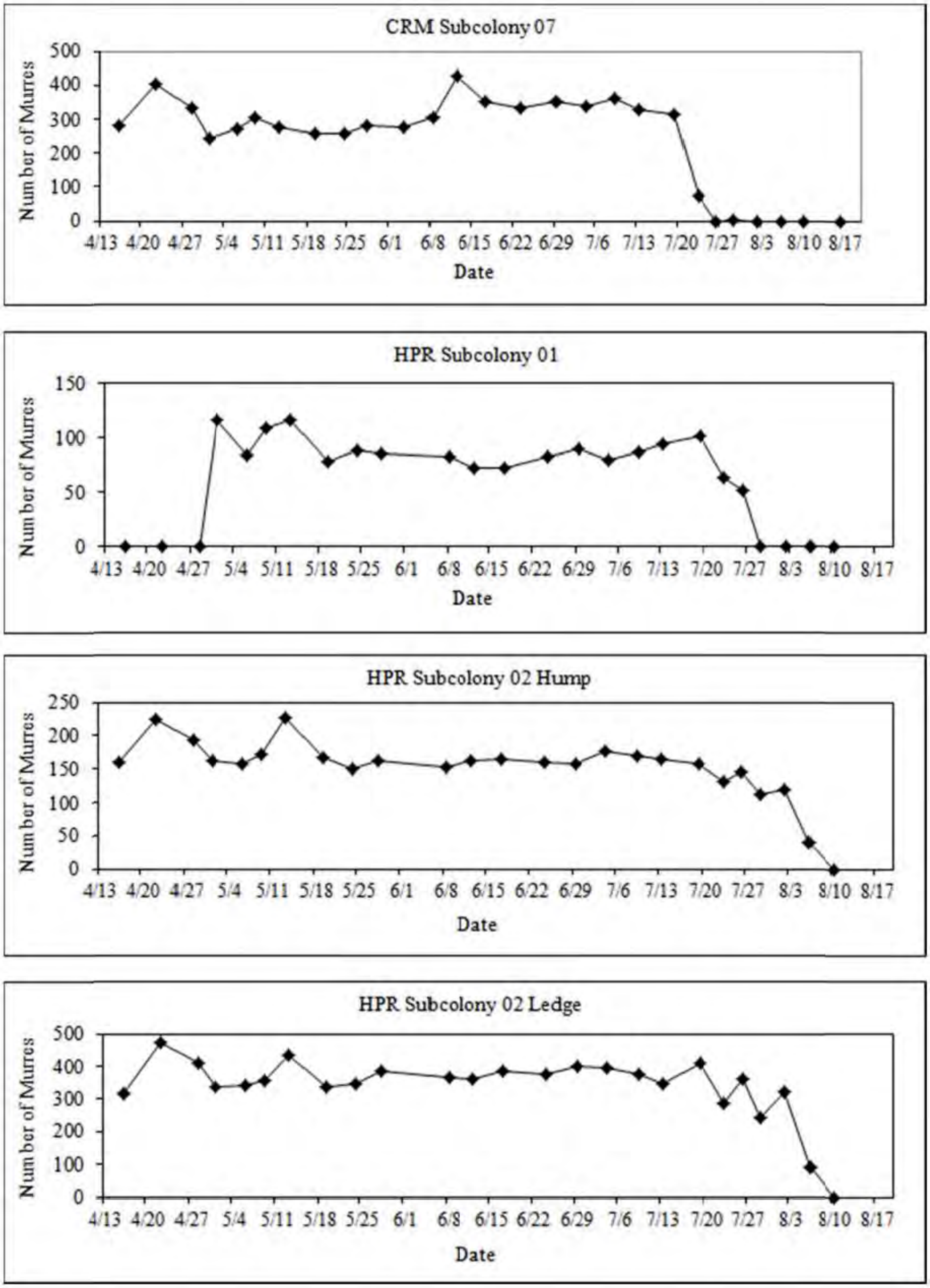


Figure 21. Seasonal attendance patterns of Common Murres at Castle Rocks & Mainland subcolony 07 and Hurricane Point Rocks subcolonies 01 and 02 (Hump and Ledge subareas), 16 April to 16 August 2010.

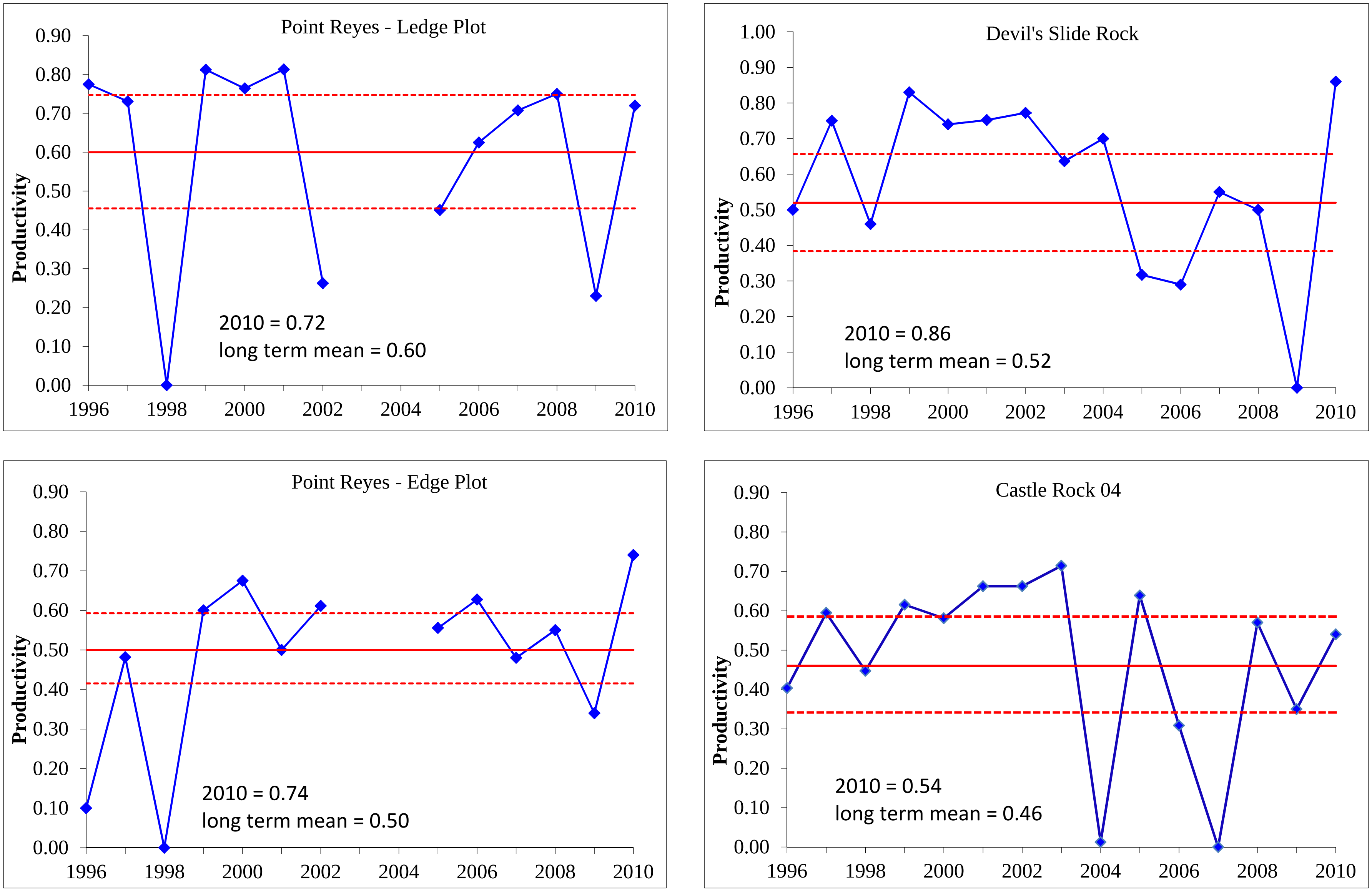


Figure 22. Productivity of Common Murres at Point Reyes (Ledge and Edge plots), Devil's Slide Rock, and Castle Rock 04 plot, 1996-2010. The solid horizontal line indicates the long term weighted mean and dashed lines represent the 95% confidence interval.

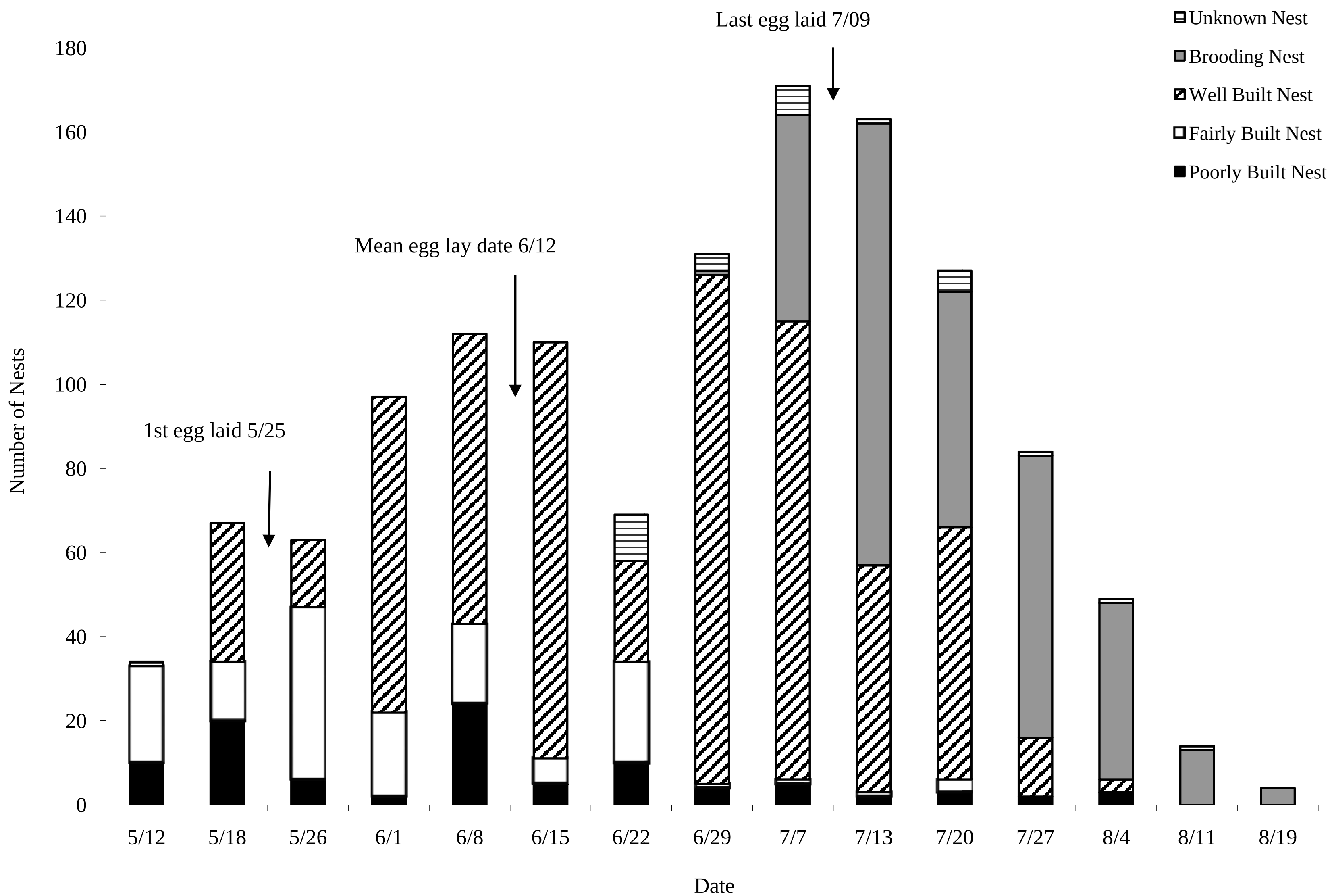
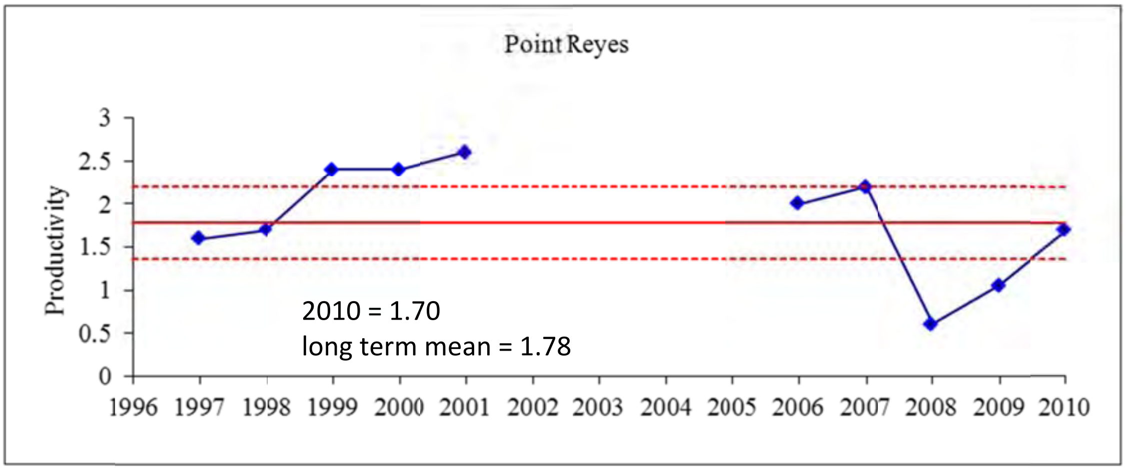
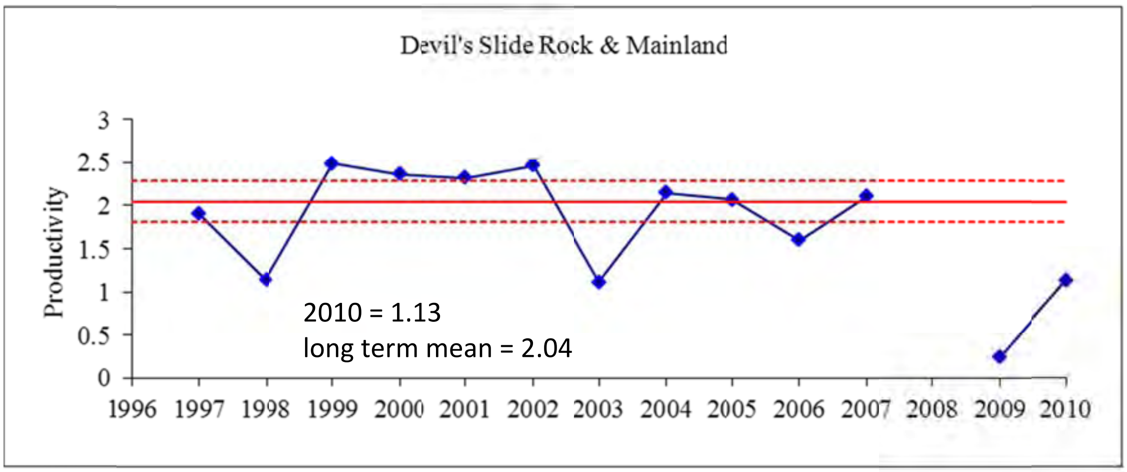


Figure 23. Numbers of Brandt's Cormorant nests counted weekly at Point Reyes Headlands, 12 May to 19 August 2010, in relation to breeding phenology at monitored nests. Data from 5/18 includes portions of nest surveys conducted on 5/19 as weather did not allow the full nest survey to be completed in one day.





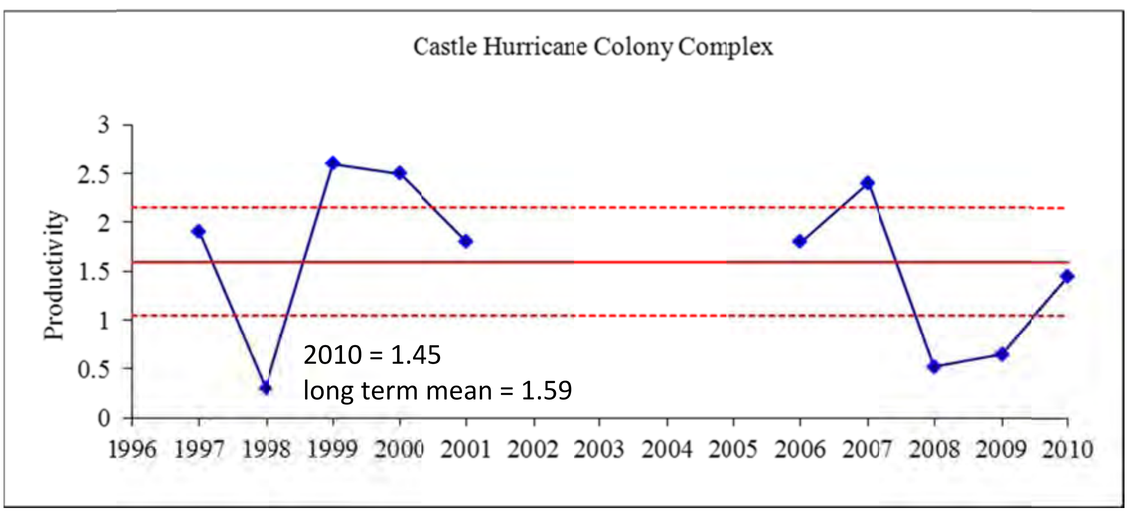


Figure 24. Long term Brandt's Cormorant productivity at Point Reyes, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex. The solid horizontal line indicates the long term weighted mean and dashed lines represent the 95% confidence interval.

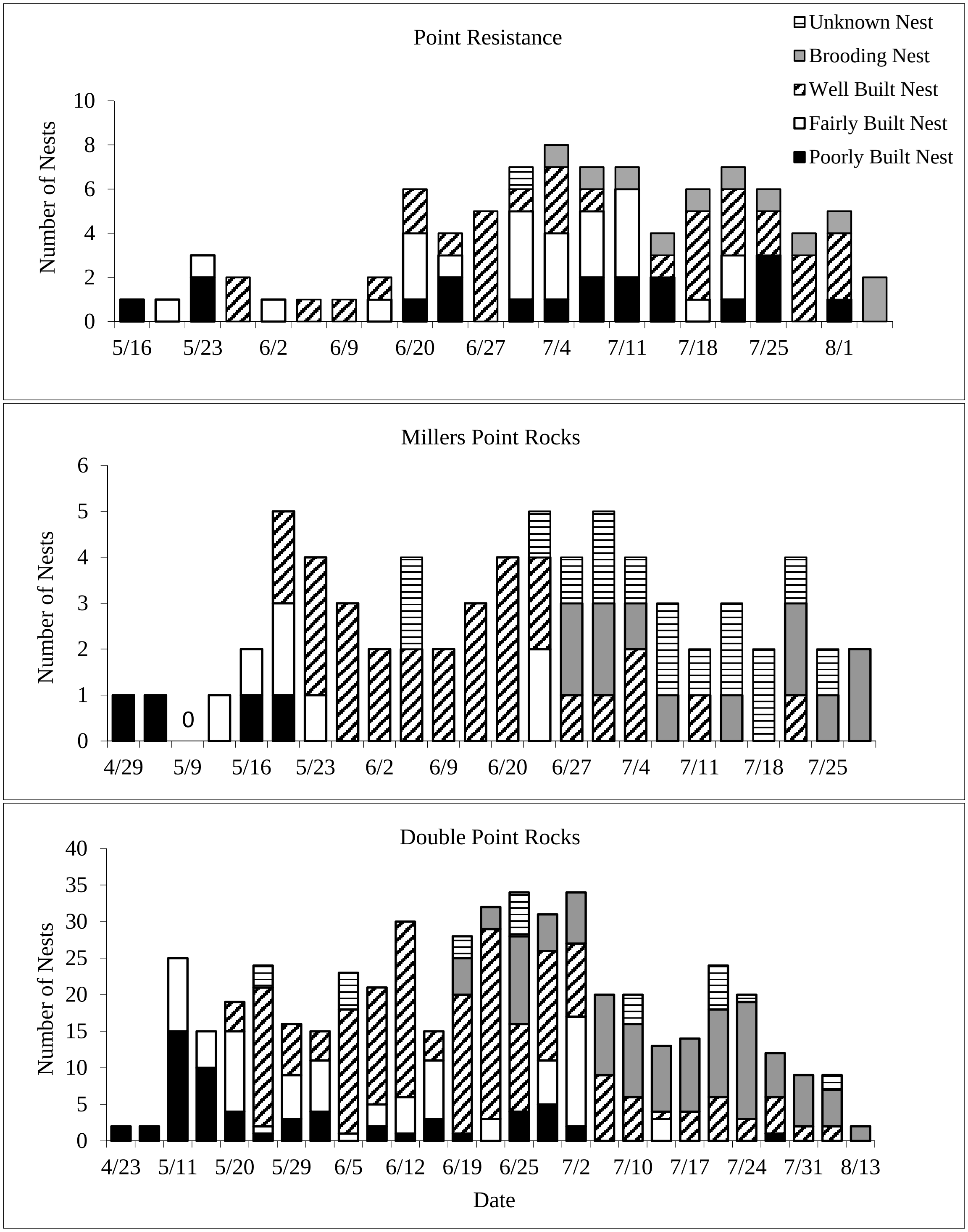


Figure 25. Numbers of Brandt's Cormorant nests counted twice weekly at Drakes Bay, 23 April to 13 August 2010.

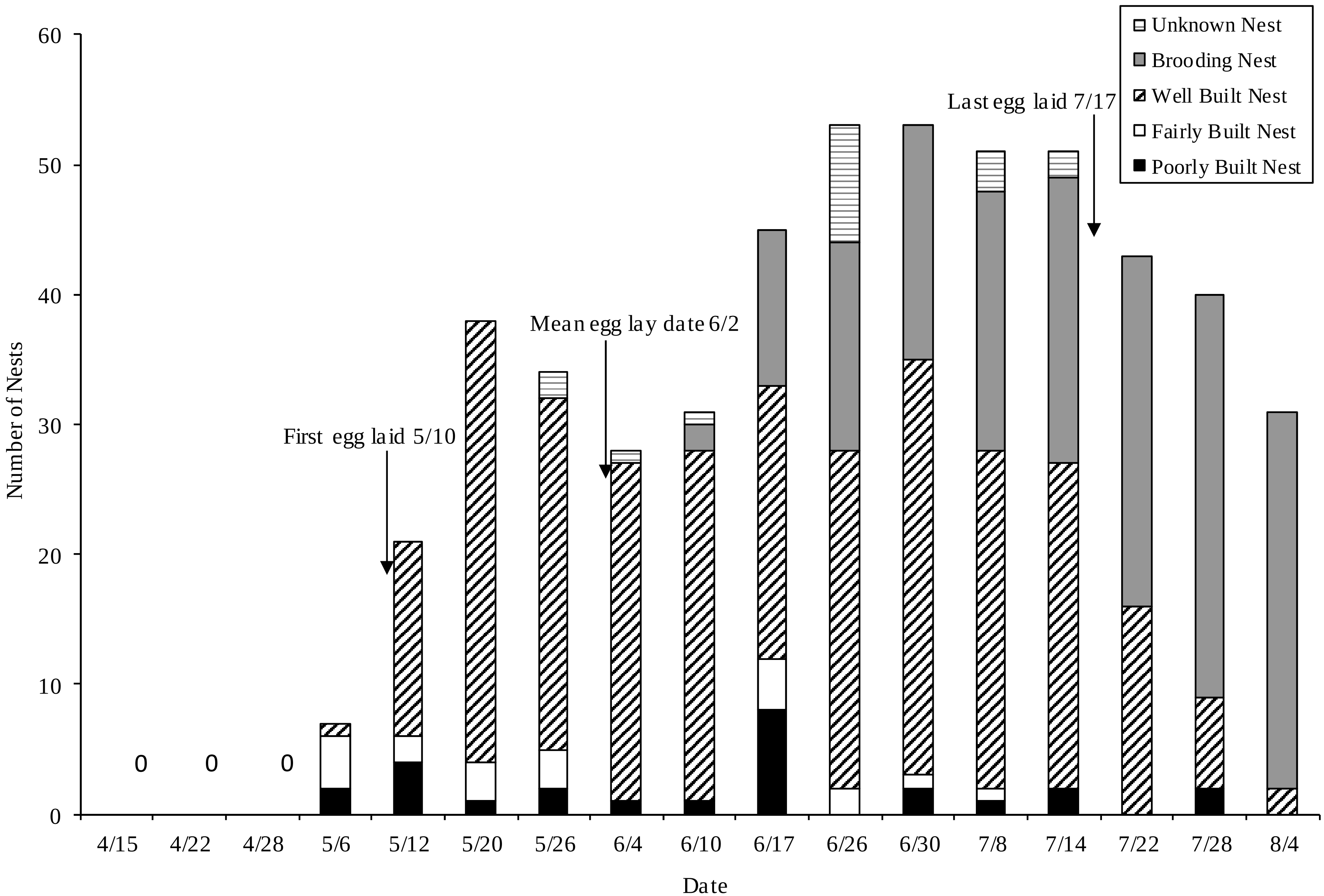


Figure 26. Numbers of Brandt's Cormorant nests counted weekly at Devil's Slide Rock & Mainland, 15 April to 4 August 2010, in relation to breeding phenology at monitored nests.

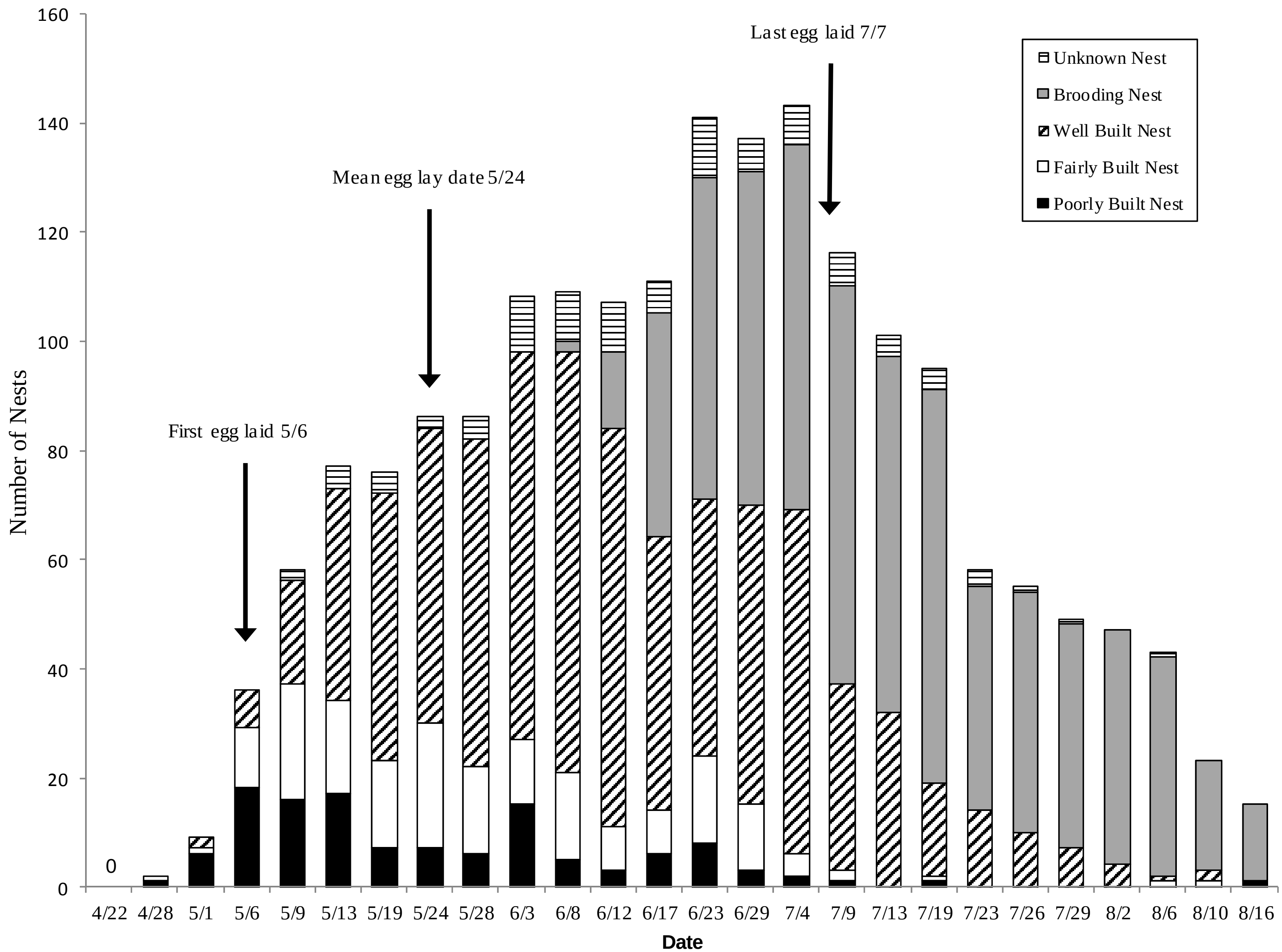


Figure 27. Numbers of Brandt's Cormorant nests counted bi-weekly at Castle-Hurricane Colony Complex, 22 April to 16 August 2010, in relation to breeding phenology at monitored nests. Surveys on 3 June and 16 August were incomplete.

Figure 28. Locations of Common Raven detections along Highway 1 between Point Lobos and Point Sur, California, 2010.

Appendix 1. Numbers of observed aircraft overflights categorized by type and resulting agitation, displacement, and flushing recorded at Point Reyes, 2010.

Aircraft Type	Total Detections		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	8	0	0	0	0	0	0	0	0	0
United States Coast Guard	1	1	0	1	0	0	0	0	0	1
Military	0	1	0	0	0	0	0	1	0	1
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	2	1	0	0	0	0	1	0	1	0
Unknown	0	1	0	0	0	0	0	1	0	1

Appendix 2. Numbers of observed watercraft categorized by type and resulting agitation, displacement, and flushing recorded at Point Reyes, 2010.

Watercraft Type	Total Detections	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	0	0	0	0	0
Recreational (<25')Small Private	9*	1	0	0	1
Recreational (>25')Large Private	1	0	0	0	0
Charter	0	0	0	0	0
Research	1	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	1	0	0	0	0
Law Enforcement	0	0	0	0	0
United States Coast Guard	0	0	0	0	0
Other	1	1	0	0	1
Unknown	0	0	0	0	0

*Includes 2 boats with no length category recorded

Appendix 3. Numbers of observed aircraft overflights categorized by type and resulting agitation, displacement, and flushing recorded at Point Resistance, 2010.

Aircraft Type	Total Detections		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	0	0	0	0	0	0	0	0	0	0
United States Coast Guard	0	1	0	0	0	0	0	0	0	0
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	2	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Appendix 4. Numbers of observed watercraft categorized by type and resulting agitation, displacement, and flushing recorded at Point Resistance, 2010.

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

Appendix 5. Numbers of observed aircraft overflights categorized by type and resulting agitation, displacement, and flushing recorded at Miller's Point Rocks, 2010.

Aircraft Type	Total Detections		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	0	0	0	0	0	0	0	0	0	0
United States Coast Guard	0	0	0	0	0	0	0	0	0	0
Military	0	0	0	0	0	0	0	0	0	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	2	0	0	0	0	0	1	0	1	0
Unknown	0	0	0	0	0	0	0	0	0	0

Appendix 6. Numbers of observed watercraft categorized by type and resulting agitation, displacement, and flushing recorded at Millers Point Rocks, 2010.

Watercraft Type	Total Detections	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	0	0	0	0	0
Recreational (<25')Small Private	3	0	0	0	0
Recreational (>25')Large Private	0	0	0	0	0
Charter	0	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	2	0	0	1	1
Kayak/Canoe	0	0	0	0	0
Law Enforcement	0	0	0	0	0
United States Coast Guard	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0

Appendix 7. Numbers of observed aircraft overflights categorized by type and resulting agitation, displacement, and flushing recorded at Double Point Rocks, 2010.

Aircraft Type	Total Detections		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0
Research	4	0	0	0	0	0	2	0	2	0
United States Coast Guard	0	1	0	0	0	0	0	1	0	1
Military	1	0	1	0	0	0	0	0	1	0
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	4	2	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0

Appendix 8. Numbers of observed watercraft categorized by type and resulting disturbance events recorded at Double Point Rocks, 2010.

Watercraft Type	Total Detections	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	0	0	0	0	0
Recreational (<25')Small Private	25	0	0	5	5
Recreational (>25')Large Private	2	0	0	1	1
Charter	3	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	0	0	0	0	0
Law Enforcement	0	0	0	0	0
United States Coast Guard	0	0	0	0	0
Other	0	0	0	0	0
Unknown	1	0	0	0	0

Appendix 9. Numbers of observed aircraft overflights categorized by type and resulting agitation, displacement and flushing recorded at Devil's Slide Rock & Mainland, 2010.

Aircraft Type	Total Detections		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	0	0	0	0	0	0	0	0	0
Media	0	1	0	1	0	0	0	0	0	1
Research	5	0	1	0	0	0	0	0	1	0
United States Coast Guard	0	9	0	4	0	0	0	3	0	7
Military	4	30	3	13	0	2	1	9	4	24
Law Enforcement	0	2	0	1	0	0	0	0	0	1
Other	95	29	24	12	0	0	0	6	24	18
Unknown	0	0	0	0	0	0	0	0	0	0

Appendix 10. Numbers of observed watercraft categorized by type and resulting agitation, displacement and flushing recorded at Devil's Slide Rock & Mainland, 2010.

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

Appendix 11. Numbers of observed aircraft overflights categorized by type and resulting agitation, displacement and flushing recorded at the Castle-Hurricane Colony Complex, 2010.

Aircraft Type	Total Detections		No. Agitation Events		No. Displacement Events		No. Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Commercial	0	4	0	0	0	0	0	4	0	4
Media	0	0	0	0	0	0	0	0	0	0
Research	15	0	0	0	0	0	0	0	0	0
United States Coast Guard	0	4	0	0	0	0	0	1	0	1
Military	5	12	0	0	0	0	0	6[1]	0	6[1]
Law Enforcement	0	0	0	0	0	0	0	0	0	0
Other	24	17	0	1	0	0	0	5	0	6
Unknown	0	0	0	0	0	0	0	0	0	0

[1]Includes 3 disturbance events in which 2 helicopters were flying at the same time (Total= 6 military helos)

Appendix 12. Numbers of observed watercraft categorized by type and resulting agitation, displacement and flushing recorded at the Castle-Hurricane Colony Complex, 2010.

Watercraft Type	Total Detections	No. Agitation Events	No. Displacement Events	No. Flushing Events	Total Disturbance Events
Commercial Fishing	12	0	0	1	1
Recreational (<25') Small Private	15	0	0	0	0
Recreational (>25') Large Private	0	0	0	0	0
Charter	0	0	0	0	0
Research	0	0	0	0	0
Sailboat	0	0	0	0	0
Yacht/Cruiser	0	0	0	0	0
Speed Boat	0	0	0	0	0
Jet-ski	0	0	0	0	0
Kayak/Canoe	0	0	0	0	0
Law Enforcement	0	0	0	0	0
United States Coast Guard	0	0	0	0	0
Other	0	0	0	0	0
Unknown	0	0	0	0	0