RESTORATION AND MONITORING OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2012

REPORT TO THE
LUCKENBACH TRUSTEE COUNCIL

Allison R. Fuller, Gerard J. McChesney, Sandra J. Rhoades, Corey S. Shake,
Crystal A. Bechaver, Monika Parsons, Erika J. Taketa, Jason D. Tappa,
Emily Haber and Richard T. Golightly

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

and

Humboldt State University
Department of Wildlife
1 Harpst Street
Arcata, CA 95521

FINAL REPORT
10 February 2014

RESTORATION AND MONITORING OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2012

REPORT TO THE
LUCKENBACH TRUSTEE COUNCIL

Allison R. Fuller[2,3], Gerard J. McChesney[1], Sandra J. Rhoades[2,3], Corey S. Shake[2,3], Crystal A. Bechaver[2,3], Monika Parsons[2,3], Erika J. Taketa[2,3], Jason D. Tappa[2,3], Emily Haber[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

A Report By:

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

and

Humboldt State University
Department of Wildlife
1 Harpst Street
Arcata, California 95521

FINAL REPORT
10 February 2014

Cover photo: Aerial photograph of Devil's Slide Rock, 11 June 2012. By Michael W. Parker.

Suggested Citation: Fuller, A.R., G. J. McChesney, S. J. Rhoades, C. S. Shake, C. A. Bechaver, M. Parsons, E.J. Taketa, J.D. Tappa, E. Haber, and R.T. Golightly. 2013. Restoration of Common Murre colonies in central California: annual report 2012. Unpublished report, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Fremont, California and Humboldt State University, Department of Wildlife, Arcata, California. 71 pages.

PROJECT ADMINISTRATION

Project Staff

Co-Principal Investigator: Gerard J. McChesney
Co-Principal Investigator: Richard T. Golightly
Wildlife Biologist: Allison R. Fuller
Wildlife Biologist: Sandra J. Rhoades
Wildlife Biologist (Point Reyes, Drakes Bay): Corey S. Shake
Wildlife Biologist (Devil's Slide-San Pedro): Monika Parsons
Wildlife Biologist (Castle-Hurricane): Crystal A. Bechaver
Wildlife Technician (Point Reyes, Drakes Bay): Jason Tappa
Wildlife Technician (Devil's Slide-San Pedro): Erika J. Taketa
Wildlife Technician (Devil's Slide-San Pedro): Emily Haber

ABBREVIATIONS USED

CMRP = Common Murre Restoration Project

USFWS = U.S. Fish and Wildlife Service

NOAA = National Oceanic and Atmospheric Administration

CDFW = California Department of Fish and Wildlife

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, consisting 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, consisting of Devil's Slide Rock & Mainland and San Pedro Rock colonies

SPR = San Pedro Rock

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

BM227X = Bench Mark-227X

CRM = Castle Rocks and Mainland

HPR = Hurricane Point Rocks

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACKNOWLEDGMENTS

In 2012, funding and oversight were provided by the Luckenbach Oil Spills Trustee Council comprised of the California Department of Fish and Wildlife (CDFW), the National Oceanic and Atmospheric Administration (NOAA), and the Department of the Interior through the U.S. Fish and Wildlife Service (USFWS) and the National Park Service (NPS).

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 the Humboldt State University Sponsored Programs Foundation.

We are indebted to the staff of the Gulf of the Farallones National Marine Sanctuary (GFNMS), especially Sage Tezak, Mai Maheigan, Angela Minnameyer, Karen Reyna, and Maria Brown, for their efforts on the outreach and education component of the Seabird Protection Network. Jared Klein (Law Enforcement Officer, USFWS–San Francisco Bay National Wildlife Refuge Complex) supported the project's law enforcement goals. The staff at Point Reyes National Seashore, especially Ben Becker, provided assistance with field site housing and research permits. Laird Henkel (CDFW-OSPR), Phil Capitolo (University of California Santa Cruz), Wayne Burnett (CDFW-Air Services), and W. Breck Tyler (U.C. Santa Cruz) supported or assisted with aerial photographic surveys of seabird colonies. Armand and Eliane Neukermans provided property access. We owe special thanks to the committed volunteers who conducted surveys of Bird Island: Linda Schmid, Marjorie Siegel, and Peter White.

Observations of the Devil's Slide area colonies were conducted under Encroachment Permit No. 0412-NSV0005 from the California Department of Transportation. Research at Point Reyes National Seashore was conducted under Permit PORE-2012-SCI-0003. 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 2012 represented the 17th year of restoration and associated monitoring of central California seabird colonies by the Common Murre Restoration Project (CMRP). This project was initiated in 1996 in an effort to restore breeding colonies of seabirds, especially Common Murres (*Uria aalge*), harmed by the 1986 *Apex Houston*, 1998 *Command* and extended *Luckenbach* oil spills, as well as gill net fishing, human disturbance, and other factors. From 1995 to 2005, the primary goals were to restore the previously extirpated Devil's Slide Rock colony using social attraction techniques, and to assess restoration needs at additional central California colonies. Since 2005, efforts have been focused mainly on surveillance and assessment of human disturbance at central California Common Murre colonies. Additionally, the outcome of initial restoration efforts at Devil's Slide Rock continues to be monitored. These data inform outreach, education and regulatory efforts by the Seabird Protection Network (coordinated by the Gulf of the Farallones National Marine Sanctuary) and allows for assessment of the success of those efforts. The goal of the Seabird Protection Network is to restore central California breeding colonies, primarily through reduction of human disturbance, to compensate for losses during the Luckenbach and Command oil spills.

Surveillance and monitoring were conducted almost daily from mid-April to mid-August 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). Human disturbance rates associated with planes, helicopters, and watercraft were calculated. Seasonal attendance patterns, productivity, adult co-attendance patterns (the percentage of observation time that both parents are present at a nest site) and reproductive performance of Common Murres were also assessed. Additionally, population sizes and/or productivity of five other seabird species were assessed. Bird and nest counts were conducted three times per week at Bird Island and once per week at San Pedro Rock.

Detections of aircraft and watercraft (boats) and associated disturbances are reported as a rate per observation hour and compared to a baseline (average of 2005-2006 rates). At Point Reyes, the combined aircraft and boat detection rate was less than the baseline mean (including aircraft, boats, and other), but greater than in 2011. The combined disturbance rate was less than any year since 2002. Detection and disturbance rates at Drakes Bay colonies were also less than the baseline mean, with no observed disturbance events. Devil's Slide Rock & Mainland (DSRM) continued to have the greatest combined aircraft and boat detection and disturbance rates of all colonies. At DSRM, overall detection and disturbance rates were the greatest recorded to date, largely due to fixed-wing aircraft rates. Most disturbances were agitation events (i.e., no flushing or displacement) but several flushing events occurred, mostly from low helicopter overflights. At the Castle-Hurricane Colony Complex, the combined aircraft and boat detection rate was the least since 2007, but the disturbance rate was slightly greater than the baseline mean (but less than in 2011).

Unmarked planes and helicopters (e.g., private or charter), followed by military aircraft, were the most commonly observed aircraft and caused the majority of disturbances at all monitored colonies. The majority of watercraft observed were small private recreational boats (68%) followed by sailboats (11%). One small fishing boat at DSRM was responsible for the only boat-related disturbance. Four vessels were recorded inside state Special Closures at Devil's Slide Rock and Double Point Rocks/Stormy Stack, but only one resulted in disturbance to seabirds.

The peak count of 1,499 Common Murres on Devil's Slide Rock was 70% greater than the 2011 peak count, and greater than the previous record count of 1,003 murres recorded in 2009. Murre productivity, or reproductive success, was greater than average at Devil's Slide Rock and Castle Rocks & Mainland despite some Brown Pelican disturbance. Major and prolonged disturbances from Brown Pelicans (*Pelecanus occidentalis*) at Point Reyes Headlands, Point Resistance, and Double Point Rocks resulted in near total murre reproductive failure. Infrequent co-attendance of murre breeding pairs during the chick-rearing period at Devil's Slide Rock indicated that murres spent a substantial amount of time foraging to provision young.

There were fewer Brandt's Cormorant (*Phalacrocorax penicillatus*) nests counted in 2012 than in 2011 at all colony complexes but CHCC. Productivity in 2012 was also less than in both 2011 and the long-term means at all monitored colonies. Numbers of Pelagic Cormorant (*Phalacrocorax pelagicus*) appeared to be relatively great but productivity at Devil's Slide Rock and Mainland was the less than any other year on record. Productivity of Western Gulls (*Larus occidentalis*) was monitored only at DSRM and CHCC. Numbers of breeding Western Gulls were more variable among colonies than in 2011, and productivity of monitored nests was relatively low.

INTRODUCTION

In central California, Common Murre (*Uria aalge*) breeding colonies 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 additional 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 ten 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 the impacts of human disturbance, gill-net mortality, and other threats to murre colonies, as well as working with government agencies and the public to reduce these impacts.

Since the early 1990s, the central California murre population has shown an increasing trend 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 Wildlife (CDFW) implemented an emergency closure of the gill-net fishery in September 2000, followed by a permanent closure in September 2002 of waters less than 110 meters deep (60 fathoms), from Point Reyes to Point Arguello. Extensive oil pollution (e.g., 1998 *Command* oil spill and a 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 rebounded to numbers similar to those in the early 1980s, others such as DSR and the Castle-Hurricane Colony Complex (CHCC) were less than 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 (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*.

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* was loaded with 457,000 gallons of bunker fuel which subsequently leaked periodically during winter storms. Using chemical analysis, 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 the summer of 2002, the U.S. Coast Guard and the *Luckenbach* trustees removed much of the oil from the vessel and sealed that which remained inside (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).

To compensate for natural resources damaged from the series of *Luckenbach* oil spills, the U.S. Coast Guard's National Pollution Funds Center (NPFC) awarded $22.7 million to implement 14 restoration projects (Luckenbach Trustee Council 2006). The award was a result of a claim filed by the *Luckenbach* trustees in 2006 for funding from the Oil Spill Liability Trust Fund. While the company responsible for the *Luckenbach* no longer exists, the Oil Spill Liability Trust Fund pays for oil spill cleanup and 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 to restore Common Murres lost in these spills. The main means of restoring lost murres is by reducing human disturbance to breeding colonies within the spill zone. The SPN consists of a monitoring and disturbance surveillance component led by U.S. Fish and Wildlife Service and an outreach, education and regulatory component led by the Gulf of the Farallones National Marine Sanctuary. Surveillance and monitoring data 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 the Drakes Bay Colony Complex (DBCC): Point Resistance (PRS), Millers Point Rocks (MPR), and Double Point Rocks (DPR). In 2012, count surveys were also conducted three times per week at Bird Island (near Point Bonita) in Marin County with the goal of documenting murre attendance and breeding. 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.

Here we summarize colony surveillance and monitoring efforts conducted at central California nearshore murre colonies in 2012. Similar to past years, data were gathered on aircraft, watercraft and other disturbances to seabirds, Common Murre seasonal attendance patterns, productivity (or reproductive success), and adult co-attendance (the percentage of observation time that both parents are present at a nest site) and chick provisioning rates (at DSR only). We also recorded Brandt’s Cormorant (*Phalacrocorax penicillatus*) relative breeding population sizes and productivity; and population sizes and/or productivity of Pelagic Cormorants (*P.*

pelagicus), Black Oystercatchers (*Haematopus bachmani*), Western Gulls (*Larus occidentalis*), and Pigeon Guillemots (*Cepphus columba*).

METHODS

Study Sites

Five colonies or colony complexes were monitored in 2012 (Figure 1). Point Reyes (PRH; Figure 2), Point Resistance (PRS), Millers Point Rocks (MPR), and Double Point Rocks (DPR; Figure 3) are located within the Point Reyes National Seashore, Marin County; the latter three colonies often 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. The Devil's Slide Colony Complex (DSCC), located in San Mateo County, consists of DSRM and San Pedro Rock (Figure 4). The Castle-Hurricane Colony Complex (CHCC) in Monterey County consists of Bench Mark-227X (BM227X), Castle Rocks & Mainland (CRM), and Hurricane Point Rocks (HPR; Figure 5). The offshore rocks of DSCC and CHCC are within the California Coastal National Monument, while adjacent mainland areas are either privately or state-owned. At each colony, individual rocks and mainland cliffs with nesting seabirds were identified by their recognized subcolony number, subcolony name, or subarea. In this report, colonies are ordered north to south within each section.

Disturbance

Anthropogenic and non-anthropogenic (e.g., avian-caused) disturbance events affecting murres or other seabirds were recorded at each study colony. Disturbance events included any instances in which adult birds were alarmed or agitated (e.g., head-bobbing in murres, raised head or wing-flapping in cormorants), displaced (i.e., birds moved from breeding or roosting site but did not leave the rock) or flushed (i.e., birds left the rock). Numbers of disturbed seabirds within each disturbance category were recorded. Numbers of eggs or chicks exposed, displaced, or depredated were also recorded. When seabirds were displaced or flushed by a traceable human source (e.g., helicopter with recorded tail number), a wildlife disturbance report was filed with the Seabird Protection Network (SPN; NOAA) and applicable law enforcement authorities. These reports included photos and maps documenting the disturbance event, including: aircraft or watercraft type, direction of travel, activity (e.g., fishing, transiting, hovering, etc.), distance from the nearest seabird nesting or roosting area, and aircraft/boat identification number or name (when possible).

Monitoring effort was calculated for each colony and colony complex except for Bird Island (Table 1). In order to compare disturbance among colonies and among years, disturbance rates per observation hour were calculated. Anthropogenic disturbance rates during the breeding season (in 2012, 12 April until the end of monitoring) were calculated as the number of disturbance events per hour of observation, using the monitoring effort for each colony complex. Disturbance rates from 2012 were compared to baseline means (the average of disturbance rates from 2005 to 2006) for each colony or colony complex. Subsequent to 2006, an education and outreach program led by the SPN was implemented with the goal of reducing human-caused disturbance to seabird colonies in central California. Baseline means are reported as the mean plus or minus one standard error. For non-anthropogenic disturbances, we also reported the species that caused disturbance(s) and summarized major events.

In addition to disturbance events, all aircraft flying at or below 1,000 ft (305 m) above sea level and boats within about 1,500 ft (457 m) of the nearest seabird breeding or roosting area were recorded to highlight use patterns of potential sources of anthropogenic disturbance. Detection rates were calculated as the number of aircraft or boats observed within these given zones per observer hour, using monitoring effort for each colony complex. All watercraft entering Special Closure areas were recorded and reported to Cal-TIP ("Californians Turn in Poachers"; CDFW) and to the Seabird Protection Network. Special Closures are zones designated by CDFW under the California Marine Life Protection Act (MLPA), in which all unpermitted watercraft are restricted from entering. Four of six Special Closures in the North Central Coast Study Region (Point Arena to Pigeon Point) abut CMRP-monitored colonies: Point Reyes Headlands (1000 ft/ 305 m closure), Point Resistance (300 ft/ 91 m closure), Stormy Stack/Double Point (300 ft/ 91 m closure), and Egg Rock/Devil's Slide Rock (300 ft/ 91 m closure on the west side and complete closure on the east side of the rock; http://www.dfg.ca.gov/marine/mpa/nccmpas_list.asp).

Common Murre Seasonal Attendance Patterns

Seasonal attendance of Common Murres at each colony was 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. Three consecutive counts were taken and counts were averaged on most surveys, except for certain subcolonies at PRH (see below). Seasonal attendance data were collected regularly at all colonies throughout the breeding season (12 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 at PRH was recorded at all murre subcolonies visible from mainland observation sites once per week from 17 April to 16 August (Figures 1-2). Attendance was recorded at established Type II index plots (see Birkhead and Nettleship 1980) on Lighthouse (Ledge, Edge, and Dugout plots), Boulder, Flattop, Middle, and Cone Rocks. Counts of these index plots were conducted three times per survey and averaged. Plots on Flattop and Middle Rocks were counted only once per survey. All 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 and MPR from 24 April to 24 July and at DPR from 26 April to 20 July (Figure 3). Four index plots (Club, Grotto Ledge, Lower Ledge, and Cup Plots) were used at PRS, and five plots (Lower Left, Lower Right, Crack Pot, Pond, and Cliff Plots) on Stormy Stack (DPR) because of the large numbers of murres attending these colonies.

Bird Island

Murres were first recorded attending Bird Island among nesting Brandt's Cormorants in 2007 (McChesney et al. 2008), and breeding was first confirmed in 2008 (McChesney et al. 2009). In 2012, monitoring was conducted from 15 May to 24 July. Counts were conducted once per week during each of three time periods (for a total of three surveys per week): early morning (0700-0900 h), late morning (1000-1200 h), and late afternoon (after 1500 h). 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

Murres on Devil's Slide Rock (DSR) were counted every other day from the Traditional Pullout. On Devil's Slide Mainland (DSM), attendance patterns were monitored once per week for seven subareas (Figure 4): Mainland North (DSRM-07), April's Finger (DSRM-05), Upper Mainland South (DSRM-05), Lower Mainland South (DSRM-05), Mainland South Roost (DSRM-05), Turtlehead (DSRM-05), and South Bunker (DSRM-04). Turtlehead Boulder was not monitored in 2012. Only one standardized attendance count was conducted at TRTH in order to limit disturbance to nearby breeding Peregrine Falcons (*Falco peregrinus*). At SPR, bird counts were conducted once per week throughout the breeding season from Pipe Pullout.

Castle-Hurricane Colony Complex

Seasonal attendance of murres was monitored for all active subcolonies visible from mainland vantage points (Figure 5). Counts were conducted twice per week during the breeding season from 23 April to 26 July. At four subcolonies, separate subarea counts were also obtained: CRM-04 (productivity plot and entire rock), CRM-03B (south and east sides), CRM-06South (north and south sides), and HPR-02 (Ledge and Hump plots).

Common Murre Productivity

As in previous years, productivity (chicks fledged per pair) 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 2011 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 were likely breeding sites where eggs were lost at the time of laying, or shortly after without detection. A sporadic site was defined as a location attended for at least two days but for 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 at least 15 days. Results from 2012 were compared to previous long-term means: DSR and CRM, 1996-2011 (n = 16 years); and PRH, 1996-2002 and 2005-2011 (n = 14 years). All long-term means were reported as the mean plus or minus one standard error.

Point Reyes

Murre productivity was monitored at PRH within two established Type I plots on Lighthouse Rock (LHR). Ledge Plot and Edge Plot were located in the center and on the edge of the colony, respectively. All active sites in the plots were monitored beginning 17 April.

Devil's Slide Rock and Mainland

Due to widespread colony growth and the increasing difficulty of monitoring the entire colony, three Type I plots (A, B and C) were established on DSR in 2006 (McChesney et al. 2006; Figure 6). Boundary adjustments were made to plots A and C in 2007 and the same plots (A, B, and C) were utilized for monitoring in 2008-2012. On 14 June 2012, 41 sites were dropped from monitoring in plots B and C (25 and 17 sites, respectively), as following all sites had become too difficult due to crowding. At DSM, all visible sites were monitored at two active subareas: Lower Mainland South (DSRM-04A-LOWER) and Turtlehead (DSRM-05B). All active sites in plots and subareas were monitored beginning 12 April.

Castle-Hurricane Colony Complex

All active murre breeding sites were monitored within a plot on CRM-04 (established in 1996) beginning 23 April. The ephemeral subcolony CRM-03B also hosted breeding murres in 2012, where all active sites were monitored beginning 23 April.

Common Murre Co-attendance and Chick Provisioning

Murre co-attendance and chick provisioning observations were conducted at DSR only. Observations were conducted from sunrise to sunset on 22 June, 27 June, and 2 July following standardized methods (see Parker 2005, McChesney et al. 2006). Observations were attempted on 1 July but ended prematurely due to fog. Fourteen to 15 breeding sites with chicks were monitored each day, resulting in a total of 40 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) were recorded at each monitored site to the nearest minute. In addition, the number of birds at each site was recorded every 15 minutes throughout the survey to account for possible missed arrivals or departures. Results from 2012 were compared to the 1999-2011 long-term mean (reported as the mean plus or minus one standard error; no data available for 2009 because of breeding failure).

Nest Surveys

Nest and bird counts of non-murre seabirds were conducted weekly during the breeding season at all colonies in order to assess relative breeding population sizes. Brandt's Cormorant nests and territorial sites were classified into five groups that roughly described nesting stages: site with little or no nesting material, poorly built nest, fairly built nest, well-built nest, and nests with brooded chicks. In addition, large, wandering ("creching") 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 supplemented with boat surveys conducted at DSCC (from SPR to Pillar Point) on 11 June. Boat surveys were not conducted at PRH, DBCC, or CHCC in 2012. The boat survey at DSCC was conducted mainly to survey areas not visible from mainland vantage points. The peak single day count of Brandt's Cormorant well-built nests was reported. The land nest count reported was the sum of seasonal peak counts at each subcolony or subarea. Peak single day and seasonal peak counts in 2012 included nests with brooded chicks. The boat nest count typically included only nests that could not be seen from mainland vantage points. Total counts reported were combined counts and included the greater count of the two survey methods for each subcolony/subarea, plus any nests known to be visible only with one method. Comparisons to 2011 were made between total counts except at PRH and CHCC where comparisons were made only between total land 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 East Rock (PRH-10D), Border Rock (PRH-14C), and Miwok Rock (PRH-14D). At DSRM, monitoring was conducted at DSR (DSRM-01), April's Finger (DSRM-05-AF), Mainland Roost (DSRM-05A-ROOST), Upper Mainland South (DSRM-05A-UPPER), Turtlehead (DSRM-05B), and South of Turtlehead Cliffs (DSRM-05C). At CHCC, monitoring was conducted at CRM-09. Brandt's Cormorant productivity was not monitored at DBCC in 2012.

Monitored nests were checked every one to seven 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 typically begin to wander from their nests and become impossible to associate with specific nests without marking (Carter and Hobson 1988, McChesney 1997). Results from 2012 were compared to prior long-term means for DSRM (1997-2007, 2010-2011; n = 13 years), CHCC (1997-2001, 2006-2011; n = 11 years) and PRH (1997-2001, 2006-2011; n = 11 years). Means plus or minus one standard error are reported.

Pelagic Cormorant, Black Oystercatcher, and Western Gull Productivity

Productivity of Western Gulls and Black Oystercatchers was monitored at select nests that were easily visible from mainland vantage points at DSRM and CHCC. Productivity of Pelagic Cormorants was monitored only at DSRM. Nests were checked at least once per week. Chicks were considered to have fledged if they survived at least 30 days. 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 were compared to 2011.

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, DBCC, 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 0935-1510 h) for twice weekly colony surveys at PRS, MPR, and DPR. Additionally, Pigeon Guillemots were counted during boat surveys of colonies (DSCC only).

RESULTS

Anthropogenic Disturbance

During the 2012 field season, there were 498 aircraft detections, including 435 planes (88%), 59 helicopters (12%) and four blimps (0.8%) at PRH, DBCC, DSRM and CHCC combined. Overall, 48% (239) of these overflights resulted in disturbance (e.g. agitation, displacement or flushing). A total of 189 planes (43% of all planes), 46 helicopters (78%) and four blimps (100%) caused disturbance. Fifteen aircraft (one plane and 14 helicopters) caused displacement and/or flushing of murres, accounting for 3% of all overflights. Unmarked planes accounted for 81% of all aircraft detections, and 76% of disturbances. Unmarked helicopters accounted for 6.6% of aircraft detections and 13% of disturbances (Figure 7). Of 28 total boat detections throughout the study area, only one caused disturbance – a small recreational fishing vessel at DSR (Figure 8). This boat flushed 12 murres and one Brandt's Cormorant

Fourteen Wildlife Disturbance Reports were completed and submitted to the Seabird Protection Network in 2012 (all from DSR). One report was filed regarding the aforementioned boat, which caused the sole watercraft disturbance during the field season. Otherwise, reports were submitted for nine military helicopters, seven additional helicopters (of varying non-military categories) and one plane.

There were two Special Closure violations reported in 2012, one from PRH and one from DSR. One PRH violation involving a large sailboat was reported to Cal-TIP (CDFW) and to the National Park Service. Only one Special Closure violation, the small fishing vessel at DSR, resulted in disturbance to seabirds, and accounted for the only boat-related disturbance event of the season.

Point Reyes

At PRH, 12 aircraft overflights (0.029 aircraft/hr; all planes) and 11 boat detections (0.027 boats/hr; all small recreational fishing vessels) were recorded (Table 2, Appendices 1, 2). Nine of the 12 overflights involved the permitted aerial seabird colony survey plane. Two overflights (16%) resulted in disturbance of murres (0.007 disturbances/hr), including one unmarked plane and one USCG plane. The USCG plane caused agitation of murres, while the unmarked plane, a small, experimental rear-propeller plane, flushed murres from Lighthouse Rock (Table 3). There were no boat disturbances at PRH in 2012.

The 2012 combined detection rate (aircrafts and boats) of 0.056 detections/hr was 60% less than the baseline mean, but 115% greater than in 2011 (Table 2, Figure 9). Detection rates for planes (0.03 planes/hr), helicopters (0 helicopters/hr), and boats (0.03 boats/hr) were all less than baseline means. The combined disturbance rate of 0.005 disturbances/hr was 87% less than the baseline mean, and 29% less than in 2011 (Table 2, Figure 10). Disturbance rates for planes (0.005 planes/hr), helicopters (0 helicopters/hr), and boats (0 boats/hr) were all less than baseline means.

Drakes Bay Colony Complex

When considered together, the combined (boat and aircraft) detection rate at all DBCC colonies of 0.085 detections/hr was 68% less than the baseline mean. Detection rates for planes (0.014 planes/hr), helicopters (0.014 helicopters/hr), and boats (0.056 boats/hr) were all less than the baseline means (Figure 11). There were no disturbance events in 2012 at DBCC, which is 100% less than both the baseline mean and from 2011 (Figure 11). However, reduced detections and disturbances may have been partly related to our reduced effort at these colonies in 2012 compared to 2010 and 2011.

Point Resistance

At PRS, one helicopter overflight was recorded (0.101 helicopters/hr) (Table 4, Appendix 1). There were no additional plane or boat detections. There were no disturbance events at Point Resistance.

Millers Point Rocks

There were no aircraft or boat detections and no disturbances recorded at MPR in 2012 (Table 5).

Double Point Rocks

At DPR, there was one plane detection (0.023 planes/hr), and four boat detections (0.090 boats/hr) (Table 6, Appendices 1,2). The total combined detection rate of 0.113 detections/hr was the greatest of all DBCC sites, but was still 67% less than the baseline mean. However, the plane detection rate was 161% greater than the baseline mean, but 62% less than 2011. There were no disturbance events at Double Point Rocks.

Devil's Slide Rock and Mainland

In 2012, 412 plane (0.779 planes/hr), 51 helicopter (0.099 helicopters/hr), four blimp (0.007 blimps/hr) and 11 boat detections (0.021 boats/hr) were recorded (Table 7, Appendices 1, 2). The combined (boat and aircraft) detection rate of 0.899 detections/hr was 96% greater than the baseline mean and 128% greater than the 2011 rate (Figure 9, Table 7). This was largely due to a nearly two-fold increase in the plane detection rate from 2011. Fifty-seven percent (235) of all overflights resulted in disturbance to seabirds. Disturbances were caused by 45% of planes (187), 86% of helicopters (44), 100% of blimps (four) and 9% of boats (one). The combined disturbance rate of 0.453 disturbances/hr was 194% greater than the baseline mean, and 141% greater than 2011. Disturbances from planes and helicopters increased from the baseline mean (390%, 113% and 100%, respectively) while disturbance from boats decreased 94% (Figure 10, Table 7). These were the first recorded disturbances from blimps in project history.

The rate of disturbance events involving displacement and/or flushing of seabirds (0.030 displacement and/or flushing/hr) was 2.7% less than the baseline mean. However, this rate increased 235% from 2011, with 14 flushing events involving helicopters driving this large increase. Five of the 14 total helicopter-caused flushing events involved military helicopters. The largest numbers of birds affected by one event (31 May) involved three military helicopters that flushed 200 murres and nine Brandt's Cormorants (Table 8).

The annual Half Moon Bay Dream Machines event took place over two days in 2012 (28-29 April), and accounted for 35 overflights (7.5% of total overflights in 2012). Although the event lasted a day longer than previous years, there were 3% fewer overflights in 2012 than in 2011. Foggy conditions on the morning of the second day of the event likely contributed to fewer overflights. Twenty-eight total disturbance events were recorded over the course of the two-day event, with one flushing event caused by a helicopter. The other 27 agitation events were caused by a total of 27 planes and two helicopters.

Castle-Hurricane Colony Complex

At CHCC, 11 plane overflights (0.039 planes/hr), eight helicopter overflights (0.028 helicopters/hr) and five boat detections (0.018 boats/hr) were recorded in 2012 (Table 9, Appendix 1,2). There were only two disturbance events (agitation only) at CHCC (11% of total overflights); both were caused by helicopters (one unmarked helicopter, one USCG). The combined detection rate of 0.085 detections/hr was 29% greater than the baseline mean, but 25% less than the 2011 rate. The 2012 detection rate for planes was less than the baseline mean, but rates for helicopters and boats were much greater (856% and 956% respectively) (Figure 9, Table 9). The combined disturbance rate of 0.007 disturbances/hr was 19% greater than the baseline mean, but 46% less than the disturbance rate in 2011. Disturbance attributed to helicopters was 258% greater in 2012 than the baseline mean, but 30% less than in 2011 (Figure 10, Table 9). However, these large percent differences should be viewed with caution because they are comparing very small values.

Non-Anthropogenic Disturbance

Point Reyes

In 2012, PRH was plagued by disturbances caused predominately by immature Brown Pelicans. Of 48 recorded flushing events and one displacement event, pelicans were responsible for 65% (n = 32), Common Ravens were responsible for 33% (n = 16), and one disturbance event was of unknown origin. A total of 134 eggs and 81 chicks were observed to be depredated or scavenged over the course of the season, but monitoring results suggested that actual numbers were much greater. Thousands or tens of thousands of murre breeding sites were abandoned as a result.

In the pre-breeding season and early portion of the breeding season between late April and mid-June, ravens often flushed murres from PRH subcolonies, with an average of 21 murres flushed per event Pelican disturbance occurred almost consistently throughout the Headlands from 13 June until mid-July with catastrophic results, including subcolonies PRH-03B, PRH-05B, PRH-10B, PRH-10E, and PRH-13. The first large-scale pelican disturbance on 13 June involved four to five juvenile pelicans that flushed and displaced at least 1,115 murres from Lighthouse Rock

(PRH-03B) throughout the day, resulting in at least 165 murre eggs exposed or displaced and at least 31 eggs taken by Western Gulls and Common Ravens. Following this initial event, disturbances by immature pelicans continued regularly, with thousands of murres flushed and upwards of thousands of eggs and chicks lost. Pelicans were observed consuming five murre chicks, and were also seen picking up and dropping murre chicks (live and dead) (Figure 12). The greatest loss in a single disturbance event occurred on Lighthouse Rock on 2 July, when eight immature pelicans flushed or displaced at least 4,000 murres, and 35 eggs and 32 chicks were observed to be scavenged by Western Gulls and Common Ravens (Figure 13). On 18 July, a single immature pelican flushed at least 5,000 murres from Lighthouse Rock. In our productivity plots on Lighthouse Rock, by the end of July all eggs and all but one chick (in Ledge Plot) were lost.

Drakes Bay Colony Complex

Point Resistance

A large-scale disturbance caused by five immature Brown Pelicans occurred on 3 July, during which at least 800 murres were flushed and 200 were displaced. The disturbance lasted throughout the 90-minute observation period, with pelicans flushing the colony repeatedly about every five minutes. National Parks Service employees reported two instances of pelicans consuming live murre chicks there earlier in the day.

Double Point Rocks

Disturbances from immature Brown Pelicans were observed on Stormy Stack on 28 June, 6 July and 12 July (four total flushing events). The largest-scale disturbance occurred on 28 June, when six pelicans flushed or displaced at least 2,500 murres, resulting in the loss of at least 24 eggs and nine chicks. Three of these chicks were consumed by pelicans. The only other disturbance event recorded was by a Common Raven that that flushed or displaced 42 murres on 14 June.

Devil’s Slide Rock and Mainland

Forty non-anthropogenic disturbance events were observed at DSRM in 2012; 37 on DSR, and three on the mainland. Pelicans caused 56% (n = 23) of disturbances, Western Gulls caused 20% (n = 8), Common Raven and unknown sources each caused 10% (n = 4 each), and Heermann’s Gulls were responsible for 3% (n = 1). Eight eggs and eight chicks were observed to be lost over the course of the season as a result.

There were two major non-anthropogenic disturbance events at DSRM in 2012. The first, on 5 July, involved a single immature Brown Pelican. Over the course of the day, at least 1,050 murres were flushed, four eggs were lost and three chicks were taken. A second immature pelican with an injured, drooped wing spent the period of 9 to 12 July on DSR. At least 800-1,000 murres were flushed or displaced per day. Three eggs and five chicks were observed to be scavenged by Western and Heermann’s Gulls over the four day period, though it is likely that there were numerous other unobserved losses. The apparently starving pelican repeatedly attempted to kleptoparasitize murres on DSR, and was successful at least ten times. This bird was observed flying from the rock to the water nearby on 12 July, and washed up dead on the beach the same day.

Castle-Hurricane Colony Complex

Five non-anthropogenic disturbance events were recorded in 2012: four were caused by Brown Pelicans and one was caused by a Peregrine Falcon. One disturbance was caused by a single pelican on 29 June that resulted in 700 murres flushed, 300 displaced and two murre eggs scavenged by Western Gulls. In the other four disturbance events, an average of ten (range = 3-20) murres were flushed or displaced and no egg or chick loss was observed.

Common Murre Seasonal Attendance Patterns

Point Reyes

All well-established nesting areas were active with confirmed breeding in 2012. For most subcolonies, peak numbers were recorded prior to the first egg lay date (8 May) in productivity plots on Lighthouse Rock; however, Lower Cone Rock (PRH-13LC), Flattop Rock (PRH-10B) and Face Rock (PRH-11B) all had peak counts after the mean egg-laying date (Figure 14 – 20). Nearly every subcolony was impacted by Brown Pelican disturbances beginning in late June, as indicated by major declines in in attendance. Most subcolonies were no longer attended by murres by 25 July. Face Rock was the only large subcolony that did not appear to be affected by the widespread Brown Pelican, as no disturbance was observed, and early decrease in attendance was not evident. Attendance actually peaked at Face Rock on 18 July, when nearly all other subcolonies were in decline (Figure 19). Thus, attendance at Face Rock may be indicative of attendance patterns for a successful colony in 2012.

Murres attended several infrequently used subcolonies and non-breeding clubs in 2012, but no breeding was confirmed. These included Subcolony Big Roost Rock (PRH-03A), Aalge Ledge (PRH-03D), Area B (PRH-14B), Border Rock (PRH-14C), and Miwok Rock (PRH-14D).

Drakes Bay Colony Complex

Point Resistance

Murre attendance was somewhat variable at this colony during the incubation period (mid-May to late-June; Figure 21), partly due to variable numbers of non-breeding clubbing birds. An early decline in attendance that began in early July indicated many birds were abandoning breeding sites and it appears the colony likely experienced near total reproductive failure. Given similar attendance patterns at PRH and DPR, this colony was likely impacted by Brown Pelican disturbance but our infrequent observations failed to record it.

Millers Point Rocks

Common Murres attended MPR in relatively small numbers in 2012. Few birds attended Blue Cheese (MPR-05), but attendance was fairly consistent, suggesting that there may have been successful breeding (Figure 21). At Millers South Rock (MPR-02), little attendance occurred during the egg-laying period but attendance increased in late June and July (peak of 488 on 10 July; Figure 21), probably from non-breeding, prospecting birds. In 2011, South Rock was only attended by single birds occasionally, and had been all but abandoned in other recent years. This subcolony and MPR-01 were formerly established breeding sites.

Double Point Rocks
Attendance at Stormy Stack (DPR-01) was affected by observed disturbance events by Common Ravens (14 June) and Brown Pelicans (28 June, 6 July, 12 July). Attendance was relatively stable from mid-May to mid-June, with dips in attendance corresponding with Brown Pelican and Common Raven disturbances (also see Non-Anthropogenic Disturbance, above; Figure 21). Attendance steadily declined after mid-June, suggesting that breeders were abandoning breeding sites and departing the colony. Two plots, Crackpot and LRP, were abandoned following a pelican disturbance event on 12 July. Based on attendance patterns, it appears that murre productivity was very poor on Stormy Stack.

Bird Island
Surveys were conducted at Bird Island from 15 May to 29 July 2012. Murres were last seen on 24 July 2012. The average count was 6 ± 7 murres (range = 0-35); the peak count occurred on 9 July. While no eggs were seen, three chicks were observed in July, including one that was depredated by a Common Raven (17 July 2012), and one observed departing the colony ("fledging;" 24 July 2012).

Devil's Slide Rock and Mainland, San Pedro Rock
Devil's Slide Rock
Murres were observed on all count days between 23 April and 6 August 2012 (Figure 22). The greatest counts were recorded during the pre-egg laying and chick periods. The maximum count of 1,499 murres was recorded on 26 April shortly before the start of egg-laying. This count was 70% greater than the 2011 peak count of 882 murres, and 49% greater than the previous peak count of 1,003 murres recorded in 2009. Attendance patterns were relatively consistent from early May to early July through the egg-laying, incubation and early chick periods. This period was followed by a characteristic rapid decline as adults and chicks departed the colony. Reduced attendance on 5 July and 9-12 July was caused largely by Brown Pelican disturbance. During the annual aerial survey on 11 June, 1,294 murres were counted compared to 1,075 and 1,033 murres on 10 and 12 June, respectively (Figure 6). The greater aerial survey count likely reflects the more complete colony coverage provided by this method. To derive an approximate estimate of the DSR breeding population size, we applied the correction factor of 1.56 calculated for murres at Southeast Farallon Island in 2012 (Warzybok et al. 2012). The correction factor accounts for breeding birds not present at the colony as well as non-breeding birds present at the colony. Applying this correction factor, the aerial survey count of 1,294 birds yields an estimate of 2,019 breeding birds, or about 1,009 breeding pairs. This estimate is 47% greater than the estimate of 1,079 breeding birds in 2011 (USFWS, unpubl. data) and is the greatest since DSR was recolonized in 1996.

Devil's Slide Mainland
In 2012, murres attended and attempted breeding on Lower Mainland South (DSRM-05A-LOWER) and Turtlehead (DSRM-05B). Six breeding sites were confirmed but no eggs hatched. Murres attended Turtlehead from 3 May to 21 June, with a peak count of 31 birds on 17 May (Figure 23). Murres attended Lower Mainland South from 3 May to 7 June with a peak count of 21 murres on 10 May (Figure 23). Three other subareas had very sparse attendance: April's Finger (DSRM-05AF), Mainland South Roost (DSRM-05A-ROOST), and Upper Mainland

South (DSRM-05A-UPPER). Each was attended for only one or two days, with a peak count of six murres at Upper Mainland South.

San Pedro Rock
Murres were not observed on San Pedro Rock in 2012.

Castle/Hurricane Colony Complex
Similarities in attendance suggested synchronous breeding at most at CHCC subcolonies, with relatively stable attendance from late April to mid-July. Rapid declines in mid-July signified colony departure as chicks fledged (Figure 24 – 27). Some subcolonies showed a typical pattern of brief increases in attendance during the chick period in early July. Abandonment of CRM-03B (East side) in late June was consistent with failed breeding (see Common Murre Productivity, below). Murres were absent from CHCC by 26 July.
Away from established subcolonies, murres attended Esselen Rock (BM227X-02) and CRM-09 among nesting Brandt's Cormorants. Regular attendance at Esselen Rock through mid-July suggested successful breeding by small numbers of birds. Attendance at CRM-03B (Southside) through May suggested attempted but failed breeding by small numbers of birds.

Common Murre Productivity

Point Reyes
A total of 175 sites were monitored between Ledge (n = 98; 56%) and Edge (n = 77; 44%) plots on Lighthouse Rock. In Ledge Plot, 78 sites were breeding and 20 were territorial. There was a 6.8% increase in the number of breeding sites from 2011. The mean egg lay date for first eggs in Ledge Plot was 25 May ± 0.9 days (range = 8 May-11 June; n = 58; Table 10), five days later than the long-term average of 26 May ± 2.9 days. Three replacement eggs were laid in Ledge. Productivity was 0.01 chicks fledged per pair (a single chick fledged), 98.2% less than the long-term mean of 0.56 ± 0.07 (Figure 28).

In Edge Plot, 67 sites were breeding and 9 sites were territorial. The mean egg lay date for first eggs in Edge Plot was 25 May ± 0.9 days (range = 12 May-11 June; n = 44; Table 10), one day earlier than the long-term mean of 26 May ± 2.9 days. Six replacement eggs were laid. All breeding sites failed by 3 July. Long-term mean productivity at Edge Plot was 0.45 ± SE 0.09 (Figure 28).

When Edge and Ledge plots were combined, the mean egg-laying date was 25 May ± 0.6 days, (range = 8 May-11 June; n = 102; Table 10), two days earlier than the long-term mean (27 May ± 2.7 days). Overall productivity was 0.01 chicks fledged per pair, 98.2% less than the long-term average (0.53 ± 0.08), with both poor hatching (22.1%) and fledging success (2.9%). The single fledged chick stayed on the rock for 30 days. This chick was last observed on 30 July. Poor breeding success was mostly caused by large-scale disturbance by Brown Pelicans during the period 13 June to 18 July (see Non-anthropogenic Disturbance, above).

Devil's Slide Rock and Mainland

Of 247 sites documented within DSR plots, 226 (91.5%) were breeding, 19 (7.7%) were territorial, and two (0.8%) were sporadic. There was a 20% increase in the number of breeding sites in plots from 2011. At all sites combined, the mean egg-laying date of first eggs was 22 May ± 0.5 days (range = 8 May-19 July, n = 186; Table 10), which is four days earlier than the long-term average (26 May ± 2.2 days). In Plot C, there were 28 breeding sites compared to 12 in 2011. A total of 237 eggs were laid, including 11 replacement eggs. Overall productivity of 0.71 chicks fledged per pair was 20% greater than the long-term average (0.59 ± 0.06; Figure 28). Above average productivity was influenced by both above average hatching and fledging success (81.0% and 83.3%, respectively). Chicks that fledged remained on the rock for an average of 23.7 ± 0.3 days after hatching and the last chick was seen on 28 July.

Recorded breeding sites on DSM decreased 89% from 2011. Of seven total sites monitored in two subareas, six (86%) were breeding and one (14%) was territorial. The mean egg-laying date was 30 May ± 1.9 days (range = 26 May-7 June, N = 6; Table 10). The breeding attempt (N = 1) on Lower Mainland South (DSRM-05A LOWER) failed during incubation by 1 June. There were five breeding sites observed on Turtlehead (DSRM-05B), and all failed by 21 June. No breeding occurred on Turtlehead Boulder, where murres bred from 2008 to 2011.

Castle-Hurricane Colony Complex

Of 109 total monitored sites in the CRM-04 plot in 2012, 87 (80%) were breeding, 20 (18%) were territorial and two (2%) were sporadic (Table 10). The number of breeding sites decreased 3% from 2011. The mean egg-laying date was 8 May ± 0.8 days (range = 27 April-31 May; n = 83; Table 10), nine days earlier than the long-term average of 17 May ± 2.4 days. Seven replacement eggs were observed. Overall productivity at CRM-04 was 0.56 chicks per pair, 17% greater than the long-term mean (0.48 ± 0.05 chicks per pair; Figure 28). Chicks that fledged remained on the rock for an average of 23.1 ± 0.4 days (n = 53) after hatching, and the last chick was seen on 9 July.

For the fifth consecutive year, murres were observed breeding and were monitored on the east side of CRM-03B. Of 68 sites monitored, 49 (72%) were breeding, 16 (24%) were territorial and three (4%) were sporadic. The mean egg-laying date was 18 May ± 1.1 days (range = 2 May-6 June; n = 43; Table 10). Eight replacement clutches were laid. Productivity at CRM-03B was 0.0 in 2012; the long-term average for this subcolony is 0.44 ± 0.15 chicks per pair (1999-2003, 2005, 2008-2011; n = 10 years). The cause(s) for the failed breeding effort is unclear.

Common Murre Co-attendance and Chick Provisioning

At DSR, the mean percent of sampling period that pairs with chicks spent in co-attendance was 7.9% ± 0.008 (range = 3.6 - 13.3%; n = 16), which is 42% less than the long-term average of 13.6% ± 0.02. During co-attendance observations, 230 mate arrivals were recorded. On average, mates arrived 0.39 ± 0.02 times per site per hour (range = 0.3-0.6; n = 16). Of all mate arrivals seen, 66% were observed with prey, 3% had no prey, and 29% were inconclusive. Of the confirmed prey deliveries, 96.0% were consumed by chicks, 0.7% were consumed by adults, and 3.3% were undetermined. The mean chick provisioning rate was 0.26 ± 0.02 feedings per hour (range: 0.1-0.4; n = 16), the same as the long-term average.

Brandt's Cormorant Nest Surveys and Productivity

Point Reyes

Nest surveys – Brandt's Cormorant nest surveys were conducted from 27 April to 25 July. Well-built nests were recorded at Northwest Rock (PRH-10A), East Rock (PRH-10D), Beach Rock (PRH-10E), Little Rock (PRH-10G), Tim Tam (PRH-10H), Area B (PRH-14B), Border Rock (PRH-14C), and Miwok Rock (PRH-14D). The first well-built nest was observed on 27 April. The peak single-day count for all subcolonies combined was 146 nests on 13 June. The sum of the seasonal peak counts for each subcolony was 158 nests (Table 11). No boat survey was conducted to supplement land-based surveys in 2012.

Productivity - A total of 111 nests were monitored at PRH and 108 were egg-laying sites (Table 12). Monitoring of nests on Miwok Rock and Border Rock began on 23 April and on East Rock on 15 May. A notable nest abandonment event occurred between 1 July and 15 July, during which 16 of 43 nests (37%) on East Rock (PRH-10D) were abandoned, and eight nests failed on Miwok and Border Rocks.

The average clutch initiation date of 17 May ± 0.9 days (range = 27 April to 5 June) for first clutches (Table 12) was two days earlier than the long-term mean of 19 May ± 4.7 days. The first chick was observed on 31 May. Overall productivity of 0.95 chicks fledged per pair (subarea range = 0.74-1.35) was 47% less than the long-term average of 1.78 ± 0.2 (Figure 29). Breeding success per nest was 0.58 (subarea range = 0.44 - 0.77).

Drakes Bay Colony Complex

Nest surveys – Brandt's Cormorant nest surveys were conducted from 24 April to 26 July. Peak counts of Brandt's Cormorant nests at each colony are summarized in Table 11.
Brandt's Cormorant nesting effort on PRS was decreased in 2012 from 2011. The first well-built nests were observed on 22 May, the same day as the peak nest count (two nests). It is worth noting that the formerly mainland colony PRS-03 separated from the mainland in 2012, and is now an island. The first nests were observed on MPR-01 and MPR-02 on 24 April, the first check of the season. The peak count for MPR-01 was 16 nests on 29 May, and the peak for MPR-02 was 69 nests on 6 June. Nests were first observed on MPR-03 on 22 May, the same day as the peak nest count (two nests).

The first well-built nests on Stormy Stack (DPR-01) were observed on 26 April. The peak count of 51 nests occurred on 8 June.

Productivity – Productivity data was not collected for Brandt's Cormorants at DBCC this year.

Bird Island

Surveys were conducted between 15 May and 24 July. Although roosting Brandt's Cormorants were observed on the rock, no nesting occurred on Bird Island in 2012.

Devil's Slide Rock and Mainland

Nest surveys – Nests and territorial sites were counted at nesting areas on DSR and DSM between 26 April and 10 August. The first well-built nests were observed on 10 May. The peak count on DSR was 32 nests. On the mainland, nesting occurred predominately on Turtlehead (DSRM-05B; peak count of 48 nests), with fewer nests on April's Finger (DSRM-05AF; peak count of seven nests), Upper Mainland South (DSRM-05A-UPPER; peak count of 11 nests), and DSRM-05C (peak count of three nests).

The peak single day count for all areas combined was 74 nests on 7 June, 40% fewer than the 2011 peak count (124 nests). The sum of the seasonal peak counts, including the boat survey, was 85 nests (Table 11), 41% less than the 2011 seasonal peak count sum of 145 nests.

Productivity – A total of 129 sites were monitored on all of DSRM in 2012, and 111 of those were breeding sites. Brandt's Cormorant nests were monitored on DSR (DSRM-01), April's Finger (DSRM-05AF), Roost (DSRM-05A-ROOST), Upper Mainland South (DSRM-05A-UPPER), Turtlehead (DSRM-05B), and South of Turtlehead Cliffs (DSRM-05C) (Table 12). The first egg was observed on Turtlehead on 20 April. For all subareas combined, the mean clutch initiation date of 17 May ± 1.03 days was seven days later than the long-term mean of 10 May ± 3.2 days. Overall productivity of 0.42 chicks fledged per pair (subarea range = 0.00-0.73; n = 111) was 75% less than the long-term average of 1.71 ± 0.2 (Figure 29). Breeding success per nest of 0.27 indicates that there may have been some nest abandonment. There were three replacement clutches observed in 2012.

Castle-Hurricane Colony Complex

Nest surveys - Brandt's Cormorant nest surveys were conducted from 24 April to 26 July. Subcolonies with confirmed breeding in 2012 were BM227X-02, BM227X-03, CRM-03A, and CRM-09. The first well-built nests were observed on all four subcolonies on 24 April. At all CRM subcolonies combined, the peak single survey nest count of 127 nests was recorded on both 4 June and 12 June, and the sum of the peak subcolony counts was also 127 nests (Table 11). At BM227X subcolonies combined, the peak count of 123 nests was recorded on 31 May, and the sum of the peak subcolony counts was 126 (Table 11).

For all CHCC colonies combined, the peak single-day count of 248 nests on 31 May was 8.1% greater than the 2011 peak count. The sum of the peak subcolony counts was 253 nests, 6.3% greater than in 2011.

Productivity – Brandt's Cormorant productivity was monitored on CRM-09 (Table 12). The mean clutch initiation date of 26 April ± 2.1, ten days earlier than the long-term mean of 6 May ± 4.6 days. The first chicks were observed on 14 May. Overall productivity of 1.55 chicks fledged per pair (subcolony range = 0-3.00; n = 44) was 3.1% less than the long-term average of 1.60 ± 0.2 (Figure 29). Breeding success per nest of 0.82 reflects relatively little nest abandonment.

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

Nest and bird surveys

Peak weekly counts of nests (cormorant, gull, and oystercatcher) or birds (guillemot) from land, single boat counts, and combined land/boat counts are summarized in Tables 13 and 14. Boat counts were not conducted at PRH, DBCC and CHCC colonies in 2012; therefore nest survey results are compared only to land counts from 2011 except for Pelagic Cormorant.

Pelagic Cormorant – Pelagic Cormorant nests were first observed at PRH on 27 April, at DBCC on 24 April, at DSRM on 26 April, and at CHCC on 24 April. An egg was first recorded at DSR on 2 May. Nest counts at DSRM were 41% greater than in 2011. Because a large percentage of nests are often detected only from boat surveys, comparisons to prior data were not made at other colonies because no boat surveys were conducted. However, results from ground-based surveys suggested that numbers at PRH, PRS, MPR, and CHCC were greater than in 2011.

Western Gull – Compared to 2011, there were fewer nests at PRH (0.8%), DPR (0.4%), DSR (8.3%) and CHCC (18%). The nest count at MPR (eight) was the same as the count in 2011. No nests were counted at PRS in either year.

Pigeon Guillemot – At PRH, the peak standardized count from the lighthouse of 104 birds on 27 May was 45% less than in 2011. The land-based survey of the entire headlands on 28 May resulted in a count of 346 birds, 27% less than the count of 471 birds in 2011. There was no boat survey of PRH in 2012. Although surveys of Drakes Bay colonies were not done at standardized times, peak counts were slightly greater than 2011 counts at both PRS and MPR (4% and 16% respectively) and slightly less at DPR (9%). There was no boat survey of DBCC in 2012.

At the Devil's Slide Colony Complex, the peak land-based count of 206 guillemots on 27 May was 8% greater than in 2011, and the boat count of 145 guillemots was 30% greater than in 2011. At CHCC, the peak land count of 45 birds on 19 July was 31% less than in 2011.

Productivity

Productivity results of Pelagic Cormorants, Western Gulls, and Black Oystercatchers are summarized in Table 15. Productivity monitoring was not conducted for these species at PRH or DBCC in 2012, and Pelagic Cormorants were monitored on DSRM only.

Pelagic Cormorant –At DSRM, Pelagic Cormorant productivity was monitored on April's Finger (DSRM-05AF), Lower Mainland South (DSRM-05A-Lower), Mainland South Roost (DSRM-05A-Roost), Turtlehead (DSRM-05B) and South of Turtlehead Cliffs (DSRM-05C). Productivity at DSRM (1.03 chicks fledged per pair) was 16% less than in 2011. Raven egg-predation may have played a role in this depressed productivity, as seven eggs were observed taken by ravens between17 and 26 May.

Western Gull – Nests were monitored at DSRM and CHCC. Productivity was 13% less at DSRM and 82% less at CHCC than in 2011.

Black Oystercatcher – One nest was monitored at DSRM, and four were monitored at CHCC. Productivity was 0.0 chicks fledged per pair at DSRM and 0.50 chicks fledged per pair at CHCC. Productivity was no different at DSRM than in 2011 and 25% less at CHCC.

DISCUSSION

Anthropogenic Disturbance

Continuing the trends of previous years, DSRM had the greatest combined aircraft and watercraft detection and disturbance rates of all monitored colonies. In 2012, aircraft detection and (especially) disturbance rates were the greatest recorded to date. Particularly notable were much greater rates of fixed-wing aircraft detections and disturbances, which were 150% and 390% greater than the respective baseline means. Similar to past years, most fixed wing disturbances only caused agitation behaviors in seabirds, with only one observed flushing event. However, helicopters caused a fairly large number (n = 14) of flushing events. These frequent disturbance events may cause chronic stress problems for the colony. The Half Moon Bay Dream Machines event, held annually at Half Moon Bay Airport the last weekend of April, sometimes has resulted in large numbers of low aircraft overflights and disturbances at DSRM. While numbers of low overflights in 2012 were similar to 2011, the increase from a one day to a two day event in 2012 may lead to increases in low overflights in future years. Also of concern at DSRM were four blimp detections, the first that we have observed, including one that caused agitation. These extremely large aircraft could have more profound effects on seabirds if overflights become more frequent in the future.

At other monitored colonies, aircraft and watercraft detections and disturbance rates remained relatively low, especially when compared to DSRM. Despite sizeable percent differences from baseline means for helicopter detections, helicopter disturbances, and boat detections at CHCC, rates were still much less than rates at DSRM, and only two seabird agitation events were recorded.

Watercraft detections were few overall, although there was one fairly minor flushing event at DSRM. Fewer watercraft detections may be related to the Special Closures and marine reserves established in 2010 under the California Marine Life Protection Act. Special closures, which prohibit boat entry, were established off the colonies at PRH, PRS, DPR (Storm Stack), and DSRM. In addition, a no take marine reserve occurs off PRH. These measures may be having a positive effect towards reducing potential boat disturbances at these important seabird colonies. However, two special closure violations were still observed in 2012

Non-Anthropogenic Disturbance

In 2012, Brown Pelicans again caused major impacts to several Common Murre colonies in central California. Pelicans mainly impacted murres when they landed in colonies, chased birds off of breeding sites en masse, and left eggs and chicks exposed to scavengers. Pelicans frequently attempted (sometimes successfully) to kleptoparasitize murres that were attempting to feed chicks. At Point Reyes colonies, several chicks were observed to be eaten by pelicans.

Major disturbances by pelicans have been occurring nearly every year since about 2004, although colonies impacted have varied. Like past years, most, if not all, pelican disturbances in 2012 were caused by immature birds. Colonies most affected in 2012 were at PRH, DPR, and likely PRS, where near complete breeding failure resulted from large scale and frequent pelican disturbances in late June and July. Unlike most other years when disturbances were mainly caused by single individual pelicans, disturbances at PRH in 2012 often involved multiple pelicans. At least a few individuals eventually died on the rocks. This was the second consecutive year that murres at PRH experienced greatly reduced breeding success resulting from large-scale pelican disturbance. Murre colonies at Yaquina Head in Oregon also experienced large scale chick mortality resulting from pelican disturbance in 2012 (Suryan et al. 2012).

Murres at DSR also were impacted by disturbances from two separate pelicans in early to mid-July, one of which remained for four days before departing the rock and perishing on a nearby beach. While the overall impact on productivity appeared to be fairly minor, the similarity in the timing of the most significant disturbance event at DSR and the onset of chick fledging may have led to an underestimate of the effects of the disturbance. Some chicks that were considered fledged at 15 days of age may have actually been casualties of pelican disturbance. In that case, productivity estimates may have been inflated. During the four-day disturbance event alone, there were ten “probable failures” and 45 “probable fledges” recorded – hinting at the uncertainty of data collection during that period

The increasing frequency and severity of pelican disturbances to murre colonies is a growing cause of concern. While causes are not entirely clear, hunger is at least one likely cause. In addition to dying and dead pelicans observed on the colonies, seabird rehabilitation centers along the coast of California experienced a large influx of pelicans in the summer of 2012, most of them starving juveniles (International Bird Rescue and Research Center, unpubl. data). Pelicans also experienced very poor breeding success on the California Channel Islands (Laurie Harvey, CIES, Pers. Com.). Local availability of Northern Anchovy (*Engraulis mordax*) and Pacific Sardine (*Sardinops sagax*) – both important prey sources for pelicans – has been anomalously dismal over the last several years, and this reduction in prey availability has been cited as the cause of recent wrecks in the pelican population (Bjorkstedt et al. 2011, 2012, Nevins et al. 2011).

Aside from frequent scavenging by gulls and ravens of eggs and chicks exposed by pelican disturbances, Common Ravens were the next most frequent cause of disturbance overall.

Raven disturbance tends to be most frequent in the Point Reyes area where several breeding pairs nest near colonies. At PRH, raven disturbance was less frequent in 2012 than in 2011. At DSRM, there was more raven disturbance in 2012, with disturbances to mainland colonies, including depredation of Pelagic Cormorant nests. Raven disturbances have been rare at DSRM despite a nesting pair on the mainland cliffs

Attendance and Reproductive Success

Among colony differences in Common Murre attendance patterns and reproductive success in 2012 were associated with differing impacts from Brown Pelican disturbance. As discussed above, large-scale pelican disturbance resulted in near total reproductive failure and early colony departure at most PRH and DBCC colonies. For the second consecutive year, murres at PRH study plots experienced very poor productivity largely as a result of pelican disturbance. Despite some pelican disturbances at DSR and CHCC, standardized plots at these colonies experienced their third consecutive year of above average productivity. However, impacts of pelican disturbance at DSR may have been underestimated as some chicks considered “fledged” may have actually succumbed as a result. Also, murres continued to decline on the Devil’s Slide Mainland, and breeding there and in the non-standardized plot on CRM-03B completely failed for unknown reasons. At CRM-03B, attendance was reduced from 2011and egg loss occurred over the course of the incubation stage.

At DSR, murre attendance continued the long-term trend of colony growth. This was evident both in increases in densities and distribution on the rock, as more birds spread to the east and north ends of the rock. Increases were reflected in the seasonal peak count of 1,499 murres (49% greater than the previous peak count in 2009) and the aerial photographic count of 1,294 murres and resulting corrected estimate 2,019 breeding birds (47% greater than in 2011). Both of these counts were the greatest recorded since DSR was recolonized in 1996. Within monitored productivity plots, colony expansion was especially evident in Plot C near the eastern edge of the rock, with 28 breeding sites in 2012 and successful breeding (0.50 chicks fledged per pair) for the second straight year. Following several years of consistent but small numbers of breeders in the mid-2000s, this portion of the colony went into decline and was completely abandoned in 2010 then recolonized in 2011.

Subcolonies within DSM experienced complete breeding failure for the second year in a row. Murres first colonized DSM in 2005, and in the first few years, most murres bred on the cliffs of Lower Mainland South (DSRM-05). After an initial increase, numbers began to decline in the late 2000’s in association with declining numbers of nesting Brandt’s Cormorants. As numbers declined on Lower Mainland South, murres have continued colonizing other areas of the mainland but in reduced numbers. Only six breeding pairs were documented on DSM in 2012 (on Lower Mainland South and Turtlehead), and all failed during the incubation period. Another subarea, Turtlehead Boulder, was colonized by murres in 2008. This large rock was reoriented following the fall 2010 tsunami. While murres still bred (unsuccessfully) on Turtlehead Boulder in 2011, they abandoned the site in 2012.

Murre breeding failed completely at CRM-03B, and about half as many birds nested at the subcolony as in 2011. Murre eggs were frequently lost at this subcolony, though no disturbance was observed. It is unclear what may have caused the egg losses and subsequent breeding failure.

In 2012, there were fewer Brandt's Cormorant nests compared to 2011 at all colony complexes. Productivity rates in 2012 were less than rates in 2011 and the long-term means at each monitored colony. This species has experienced very poor breeding success in nearly every year since 2008, when numbers of nesting pairs also declined dramatically. Numbers of nesting pairs had increased somewhat in 2010 and 2011. However, earlier breeding at most colonies compared to 2011 and other recent years, when nesting was extremely delayed, was a potential sign of some "normalcy". Brandt's Cormorants at the nearby Southeast Farallon Island also experienced almost complete breeding failure in 2012 (Warzybok et al. 2012).

In contrast to Brandt's Cormorants, Pelagic Cormorant nest counts in 2012 were greater than 2011 counts at all colony complexes. However, productivity was more similar to Brandt's; at DSRM, Pelagic Cormorant productivity was the less than any recorded year since monitoring began there in 2006. Similarly, Pelagic Cormorant breeding failed completely at Southeast Farallon Island in 2012 (Warzybok et al. 2012). Western Gull nest counts were similar to 2011 counts at PRH and DBCC, and less than 2011 at DSR and CHCC. Productivity declined from 2011 at both DSR and CHCC. Numbers of Black Oystercatchers were too low, and Pigeon Guillemot numbers too variable, to make any meaningful assessment.

Murre Time Budgets and Ocean Conditions

Co-attendance rates of murre breeding pair members are regarded as a proxy to prey availability. The less time pair members spend together at the colony, the more time it takes them to find food for their chick. The average murre co-attendance rate at DSR in 2012 was 114% greater than in 2011, but 42% less than the long-term mean. Mean chick provisioning rates were greater than the long-term mean, but less than in 2011. Ocean conditions leading up to the 2012 breeding season were characterized by La Niña conditions, with cooler sea surface temperatures (SSTs) during the winter of 2011-2012 (Bjorkstedt et al. 2012). Sea surface temperatures continued to be cool throughout the spring and summer, and in combination with strong northwest winds in the spring, resulted in productive ocean conditions (Warzybok et al. 2012).

Northern anchovy (*Engraulis mordax*), an important prey item for murres and certain other seabirds, continued to be sparse in central California waters in 2012. In contrast, other forage fish such as juvenile rockfish (*Sebastes* spp.) were abundant early in the season, and krill (*Euphausiid* spp.) continued to be anomalously abundant into 2012 (Bjorkstedt et al. 2012, Warzybok et al. 2012).

The abundance of forage fish, such as juvenile rockfish, in central California waters in 2012 likely influenced above average breeding success of Common Murres at DSR. However, less than average co-attendance rates of murres at DSR suggest that murre foraging effort was greater than average in 2012. This, combined with poor Brandt's Cormorant productivity, suggests that preferred prey were not locally abundant near DSR and that birds had to spend more time foraging to provision chicks. Above average provisioning rates and breeding success shows that murres were still able to provide adequate nutrition to their developing young, but that available prey may have been of lower caloric value (thus, more prey items needed to be delivered to chicks). It is suspected that Brandt's Cormorants have relied heavily on Northern anchovies in past breeding seasons, and the loss of anchovies as an abundant food source appears to have affected this species (Point Blue Conservation Science, unpubl. data) Anchovies have also been a historically important prey species for murre chicks in central California, including DSR specifically (Eigner 2009).

Recommendations for Future Management, Monitoring and Research

Continued outreach, education, and enforcement are needed to reduce aircraft disturbance at DSR. Additional investigation on causes of increased airplane overflights at DSR are also needed. Because helicopters caused the most flushing events, outreach directed specifically towards helicopter pilots is necessary to reduce future Working with the organizers of the Half Moon Bay Dream Machines event must be continued in efforts to minimize aircraft disturbance at DSR from this event. Continued directed outreach to boaters on the locations and regulations of special closures and marine reserves will be necessary to keep boat disturbance incidences low.

In 2013, a new tunnel through Montara Mountain near Pacifica will be completed, re-routing Highway 1 away from the dangerous Devil's Slide. Plans are to convert the former highway to a public trail for pedestrians and bikers. This change in use could have dramatic effects on breeding birds of the Devil's Slide mainland, as breeding colonies will be close to potential vantage points. If not planned properly, human disturbance could increase dramatically in this area with potential harmful impacts to these important seabird colonies. Working with San Mateo County Parks, the California Coastal Commission, and others will be important to better ascertain that trail plans include measures to protect breeding seabirds.

Annual aerial surveys of central and northern California Common Murre, Brandt's Cormorant and Double-crested Cormorant colonies continued in 2012 in cooperation with California Department of Fish and Wildlife and U.C. Santa Cruz. However, no sustained funding is currently available to count nests and birds from the photographs. Analysis of aerial survey photographs has provided the baseline for assessing population trends of these species since the early 1980s and must be continued to properly track murre recovery efforts as well as murre and cormorant population changes caused by natural and anthropogenic sources.

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

The increasingly common and now widespread occurrence of Brown Pelican disturbance and resultant large-scale breeding failures of murres is a major cause of concern. This phenomenon must continue to be monitored and investigations of possible causes (prey availability, disease, etc.) conducted.

Evaluation of the efficacy of monitoring murre productivity at DSR will need to continue. As numbers and densities of breeding sites increase on the rock, it is becoming increasingly difficult to view individual breeding sites. In the future, it may be necessary to further adjust plot boundaries or eventually discontinue productivity monitoring.

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, R. Brodeur, T. Auth, J. Fisher, C. Morgan, J. Peterson, J. Largier, S. Bograd, R. Durazo, G. Gaxiola-Castro, B. Lavaniegos, F. Chavez, C. Collins, B. Hannah, J. Field, K. Sakuma, W. Satterthwaite, M. O'Farrell, S. Hayes, J. Harding, W. Sydeman, S.A. Thompson, P. Warzybok, R. Bradley, J. Jahncke, R. Golightly, S. Schneider, R. Suryan, A. Gladics, C. Horton, S.Y. Kim, S. Melin, R. Delong, and J. Abell. 2012. State of the California Current 2011-2012: Ecosystems respond to local forcing as La Niña wavers and wanes. CalCOFI Report Volume 53.

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.

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

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.

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.

Suryan, R., C. Horton, S. Wheeler and E. Nelson. 2012. Yaquina Head Seabird Colony Monitoring 2012 Season Summary. Unpublished report.

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. 2012. Status of Seabirds on Southeast Farallon Island During the 2012 Breeding Season. Unpublished report to the U.S. Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California.

Table 1. Monitoring effort of study colonies or colony complexes in days and hours, April 2012 to August 2012.

Colony/Colony Complex	Start date	End date	Number of observation days	Total hours[1]
Point Reyes	17-Apr-12	16-Aug-12	92	414.20
Point Resistance	24-Apr-12	24-July-12	13	9.93
Millers Point Rocks	24-Apr-12	24-July-12	14	16.65
Double Point Rocks	26-Apr-12	20-July-12	12	44.27
San Pedro Rock	24-Apr-12	10-Aug-12	29	11.27
Devil's Slide Rock & Mainland	12-Apr-12	12-Aug-12	108	533.93
Castle-Hurricane Colony Complex	23-Apr-12	26-July-12	78	281.18

[1] Total hours by all observers together and not total person hours.

Table 2. Total detected boats and aircraft, and resulting disturbances to all seabirds (Common Murres, Brandt's Cormorants, and Brown Pelicans) at Point Reyes in 2012, baseline means (2005-2006), and percent difference between baseline mean and 2012. Detection and disturbance rates are reported as numbers per observer hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane		0.031	1	0	1	0.005	0.003	0.040 (± 0.009)	0.020 (± 0.017)	-27.8%	-75.5%
Helicopter 12	0	0	0	0	0	0	0	0.001 (± 0.001)	0.001 (± 0.001)	-100%	-100%
Boat	11	0.028	0	0	0	0	0	0.097 (± 0.030)	0.015 (± 0.002)	-72.5%	-100%
Total	23	0.058	1	0	1	0.005	0.003	0.138 (± 0.022)	0.037 (± 0.019)	-59.7%	-87.1%

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

Table 3. Number of disturbance events and mean 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, 2012.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean Number Seabirds Flushed/ Displaced	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds
Plane	20	1	20	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	20	1	20	0	0	0	0	0	0	0	0	0	0	0	0

Table 4. Total detected boats and aircraft, and resulting disturbances to all seabirds, (Common Murres, Brandt's Cormorants, and Brown Pelicans) at Point Resistance, 2012. Detection and disturbance rates reported as numbers per observer hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	0	0	0	0	0	0	0	0.018	0.0	-100%	-
Helicopter	1	0.101	0	0	0	0	0	0.0	0.0	-	-100%
Boat	0	0	0	0	0	0	0	0.018 (± 0.018)	0.018 (± 0.018)	-100%	-
Total	1	0.101	0	0	0	0	0	0.036 (± 0.036)	0.018 (± 0.018)	182. 2%	-100%

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

Table 5. Total detected boats and aircraft, and resulting disturbances to all seabirds, (Common Murres, Brandt's Cormorants, and Brown Pelicans) at Millers Point Rocks, 2012. Detection and disturbance rates reported as numbers per observer hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	0	0	0	0	0	0	0	0.044	0.0	-100%	-
Helicopter	0	0	0	0	0	0	0	0.022 (± 0.022)	0.022 (± 0.022)	-100%	-100%
Boat	0	0	0	0	0	0	0	0.185 (± 0.015)	0.054 (± 0.031)	-100%	-100%
Total	0	0	0	0	0	0	0	0.252 (± 0.082)	0.076 (± 0.009)	-100%	-100%

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

Table 6. Total detected boats and aircraft, and resulting disturbances to all seabirds, (Common Murres, Brandt's Cormorants, and Brown Pelicans) at Double Point Rocks, 2012. Detection and disturbance rates reported as numbers per observer hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	1	0.023	0	0	0	0	0	0.009	0.009	160.9%	-100%
Helicopter	0	0	0	0	0	0	0	0.047 (± 0.030)	0.028 (± 0.011)	-100%	-100%
Boat	4	0.090	0	0	0	0	0	0.289 (± 0.057)	0.082 (± 0.005)	-68.7%	-100%
Total	5	0.113	0	0	0	0	0	0.345 (± 0.036)	0.118 (± 0.003)	-67.2%	-100%

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

Table 7. Total detected boats and aircraft, and resulting disturbances to all seabirds (Common Murres, Brandt's Cormorants, and Brown Pelicans) at Devil's Slide Rock & Mainland, 2012. Detection and disturbance rates reported as numbers per observer hour.

Source	Total Detections	Number Detections/hr	Number of Disturbance Events: A	D	F	Number of Disturbance Events/hr: Total/hr[1]	Flush or Displace/ hr	Baseline mean ± SE: Number Detections/hr	Number Disturbances/hr	% Difference: Number Detections/hr	Number Disturbances/hr
Plane	412	0.772	185	0	1	0.348	0.002	0.311 (± 0.081)	0.073 (± 0.023)	150.2%	389.5%
Helicopter	51	0.096	30	0	14	0.082	0.026	0.076 (± 0.004)	0.040 (± 0.015)	29.9%	113.4%
Blimp	4	0.007	4	0	0	0.007	0.0	-	-	-	-
Boat	9	0.017	0	0	1	0.002	0.002	0.071 (± 0.008)	0.030 (± .005)	-71.0%	-93.8%
Total	476	0.892	219	0	16	0.440	0.030	0.459 (± 0.077)	0.154 (± 0.033)	95.9%	188.8%

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

Table 8. Number of disturbance events and mean numbers (range) 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, 2012.

Source	Mean Number Seabirds Flushed/ Displaced	COMU Disturbance: Number Events	Mean Number birds	BRCO Disturbance: Number Events	Mean Number birds	PECO Disturbance: Number Events	Mean Number birds	BRPE Disturbance: Number Events	Mean Number birds	WEGU/UNGU Disturbance: Number Events	Mean Number birds	BLOY Disturbance: Number Events	Mean Number birds	PIGU Disturbance: Number Events	Mean Number birds
Plane	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	66 (6-209)	14	64 (6-200)	6	5 (1-13)	0	0	0	0	0	0	0	0	1	1
Boat	13	1	12	1	1	0	0	0	0	0	0	0	0	0	0
Total	59	16	57	7	4	0	0	0	0	0	0	0	0	1	1

Table 9. Total detected boats and aircraft, and resulting disturbances to all seabirds (Common Murres, Brandt's Cormorants, and Brown Pelicans) at Castle-Hurricane Colony Complex, 2012. Detection and disturbance rates reported as numbers per observer hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	11	0.039	0	0	0	0.000	0.000	0.064 (±0.013)	0.003 (±0.003)	-38.8%	-100.0%
Helicopter	8	0.028	2	0	0	0.007	0.003	0.003 (± 0.003)	0.002 (±0.002)	855.8%	258.4%
Boat	5	0.018	0	0	0	0.000	0.000	0.002 (± 0.002)	0.000	956.1%	-
Total	24	0.085	2	0	0	0.007	0.003	0.069 (± 0.014)	0.006 (±0.006)	28.9%	19.5%

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

Table 10. Common Murre breeding phenology and reproductive success at Point Reyes (two plots and combined), Devil's Slide Rock & Mainland (DSR, three plots; DSM; and combined), and Castle Rocks & Mainland (two plots), 2012. Means (range; n) are reported.

Colony/Plot	Number of Sites Monitored	Number of Egg Laying Sites	Mean Lay Date[1]	Number of Eggs Laid	Mean Hatch Date	Hatching Success[2]	Mean Fledge Date	Fledging Success[3]	Chicks Fledged per Pair (Productivity)
Point Reyes (PRH)									
PRH-Ledge	98	78	25 May	81	24 June	30.9%	30 July	4.0%	0.01
			(5/8-6/10; 58)		(6/17-6/30; 24)	(81)	(7/30; 1)	(25)	(78)
PRH-Edge	77	67	26 May	73	25 June	12.3%	-	0.0%	0.00
			(5/12-6/11; 44)		(6/21-6/28; 8)	(73)		(9)	(67)
PRH-(combined)	175	145	25 May	154	24 June	22.1%	30 July	2.9%	0.01
			(5/8-6/11; 102)		(6/17-6/30; 32)	(154)	(7/30; 1)	(34)	(145)
Devil's Slide Rock and Mainland (DSRM)									
DSRM-A	132	123	22 May	131	23 June	83.2%	15 July	80.7%	0.72
			(5/8-6/4;109)		(6/14-7/6;103)	(131)	(7/6-7/26;79)	(109)	(123)
DSRM-B	84	75	21 May	76	21 June	85.5%	15 July	89.2%	0.77
			(5/12-6/19;60)		(6/11-7/8;55)	(76)	(7/6-7/27;54)	(65)	(75)
DSRM-C	31	28	24 May	30	27 June	60.0%	22 July	77.8%	0.50
			(5/14-6/12;17)		(6/18-7/5;15)	(30)	(7/12-7/28;14)	(18)	(28)
DSR (combined)	247	226	22 May	237	23 June	81.0%	16 July	83.3%	0.71
			(5/8-6/19;186)		(6/11-7/8;173)	(237)	(7/6-7/28;147)	(192)	(226)
DSM	**7**	**6**	**30 May**	**6**	**-**	**0.0%**	**-**	**0.0%**	**0.0**
			(5/26-6/7;6)			**(6)**		**(0)**	**(6)**
Castle Rocks and Mainland (CRM)									
CRM-04	109	87	8 May	91	10 June	70.2%	30 June	80.3%	0.56
			(4/27-5/31;83)		(5/30-6/27; 65)	(94)	(6/19-7/9; 53)	(66)	(94)
CRM-03B	68	49	18 May	57	18 June	7.0%	-	0	0
			(5/2-6/6;43)		(6/14-6/21;4)	(57)		(4)	(57)

Table 10 (continued).

[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 11. Peak counts of nests for Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO) from land, boat, and combined land/boat counts (Total), 2012. ND = No Data.

Species	Colony	Land[1]	Boat[3]	Total Count[2]
Brandt's Cormorant	Point Reyes	158	ND	158
	Point Resistance	2	ND	2
	Millers Point Rocks	87	ND	87
	Double Point Rocks	61	ND	61
	Bird Island (Point Bonita)	0	ND	0
	Devil's Slide Rock & Mainland	74	11	85
	San Pedro Rock	0	6	6
	Bench Mark-227X	126	ND	126
	Castle Rocks & Mainland	127	ND	127
	Hurricane Point Rocks	0	ND	0
Pelagic Cormorant	Point Reyes	28	ND	ND
	Point Resistance	12	ND	ND
	Millers Point Rocks	17	ND	ND
	Double Point Rocks	0	ND	ND
	Devil's Slide Rock & Mainland	46	52	98
	San Pedro Rock	0	9	9
	Bench Mark-227X	1	ND	1
	Castle Rocks & Mainland	10	ND	10
	Hurricane Point Rocks	11	ND	11

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

Table 12. Brandt's Cormorant breeding phenology and reproductive success at Point Reyes, Devil's Slide Rock & Mainland, and Castle Rocks & Mainland, 2012. Means (range; n) are reported.

Colony/ Subcolony	Number of Breeding Sites	Clutch Initiation Date[1]	Clutch Size[1]	Number of Chicks Hatched/Pair[2]	Hatching Success[2]	Fledging Success[2]	Breeding Success[2]	Number of Chicks Fledged/Pair[2] (Productivity)	Breeding Success/ Nest[3]
Point Reyes									
East Rock (PRH-10-D)	61	24 May (5/11-6/5; 54)	3.0 (1-4; 43)	0.65 (0-3; 23)	24.4% (131)	40.0% (15)	19.8% (131)	0.74 (1-3; 61)	0.44 (61)
Border Rock (PRH-14-C)	21	12 May (5/3-5/17; 20)	3.4 (2-4; 16)	1.83 (0-3; 6)	90.0% (54)	54.5% (11)	35.2% (54)	1.10 (1-3; 21)	0.75 (21)
Miwok Rock (PRH-14-D)	26	8 May (4/27-5/15; 26)	3.2 (2-4; 26)	3.00 (3-3; 12)	97.3% (83)	50.0% (36)	42.2% (83)	1.35 (1-2; 26)	0.77 (26)
Total - Point Reyes	108	17 May (4/27-6/5; 100)	3.1 (1-4; 85)	1.51 (0-3; 41)	62.5% (268)	48.4% (62)	29.9% (268)	0.95 (1-3; 107)	0.58 (107)
Devil's Slide Rock & Mainland									
Devil's Slide Rock (DSRM-01)	35	5/25/2012 (5/7-6/14; 30)	2.8 (1-4; 18)	0.77 (0-3; 22)	29.4% (18)	41.2% (17)	19.2% (18)	0.73 (0-3; 33)	0.55 (0-1; 33)
Mainland South (DSRM-05)	79	5/14/2012 (4/30-6/22; 75)	2.7 (1-5; 67)	0.8 (0-4; 77)	33.9% (67)	37.1% (62)	12.6% (67)	0.29 (0-3; 78)	0.15 (0-1; 78)
Total – Devil's Slide	114	5/17/2012 (4/30-6/22; 105)	2.7 (1-5; 85)	0.8 (0-4; 99)	33.2% (85)	38.0% (79)	14.0% (85)	0.42 (0-3; 111)	0.27 (0-1; 111)
Castle-Hurricane Colony Complex									
CRM-09	44	26 April (4/13-5/15; 40)	3.2 (1-4; 42)	2.48 (0-4; 44)	77.3% (141)	58.7% (109)	45.4% (141)	1.55 (0-3; 44)	0.82 (44)

[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 13. Peak counts of nests (Black Oystercatcher and Western Gull) and of birds (Pigeon Guillemot), from land, boat, and combined land/boat counts (Total), in 2012. ND = No Data.

Species	Colony	Land[1]	Boat[2]	Total Count[3]
Black Oystercatcher	Point Reyes	3	ND	3
	Point Resistance	0	ND	0
	Millers Point Rocks	1	ND	1
	Double Point Rocks	1	ND	1
	Devil's Slide Rock & Mainland	1	0	1
	Bench Mark-227X	0	ND	0
	Castle Rocks & Mainland	3	ND	3
	Hurricane Point Rocks	1	ND	1
Western Gull	Point Reyes	122	ND	122
	Point Resistance	0	ND	0
	Millers Point Rocks	8	ND	8
	Double Point Rocks	5	ND	5
	San Pedro Rock	4	3	7
	Devil's Slide Rock & Mainland	8	6	14
	Gray Whale Cove South	ND	0	0
	Bench Mark-227X	2	ND	2
	Castle Rocks & Mainland	10	ND	10
	Hurricane Point Rocks	6	ND	6
Pigeon Guillemot	Point Reyes	346[4]	ND	-
	Point Resistance	28	ND	-
	Millers Point Rocks	42	ND	-
	Double Point Rocks	51	ND	-
	Devil's Slide Colony Complex	206	165	-
	Gray Whale Cove South	ND	8	-
	Castle-Hurricane Colony Complex	45	ND	-

[1] Sum of peak seasonal counts at each subcolony.
[2] In several cases, Black Oystercatcher and Western Gull nests were counted only if they could not be seen from mainland vantage points.
[3] Black Oystercatcher and Western 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 14. Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls at Devil's Slide Rock and Mainland (DSRM) and Castle Rocks & Mainland (CRM, 2012. Means (range; n) or (n) are reported. A dash indicated no data.

	Pelagic Cormorant				Black Oystercatcher				Western Gull			
	Number of Breeding Sites	Number of Chicks Fledged	Number of Chicks Fledged/ Pair (Productivity)	Breeding Success/ Nest[1]	Number of Breeding Sites	Number of Chicks Fledged	Number of Chicks Fledged/ Pair (Productivity)	Breeding Success/ Nest[1]	Number of Breeding Sites	Number of Chicks Fledged	Number of Chicks Fledged/ Pair (Productivity)	Breeding Success/ Nest[1]
DSRM		41	1.03	0.45	1	0	0.0	0.0	8	2	0.33	0.17
			(0-3; 40)	(40)			(0; 1)	(1)			(0-2; 6)	(6)
41												
CRM	-	-	-	-	4	2	0.5	0.5	9	1	0.11	0.11
							(0-1; 4)	(4)			(0-1; 9)	(9)

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

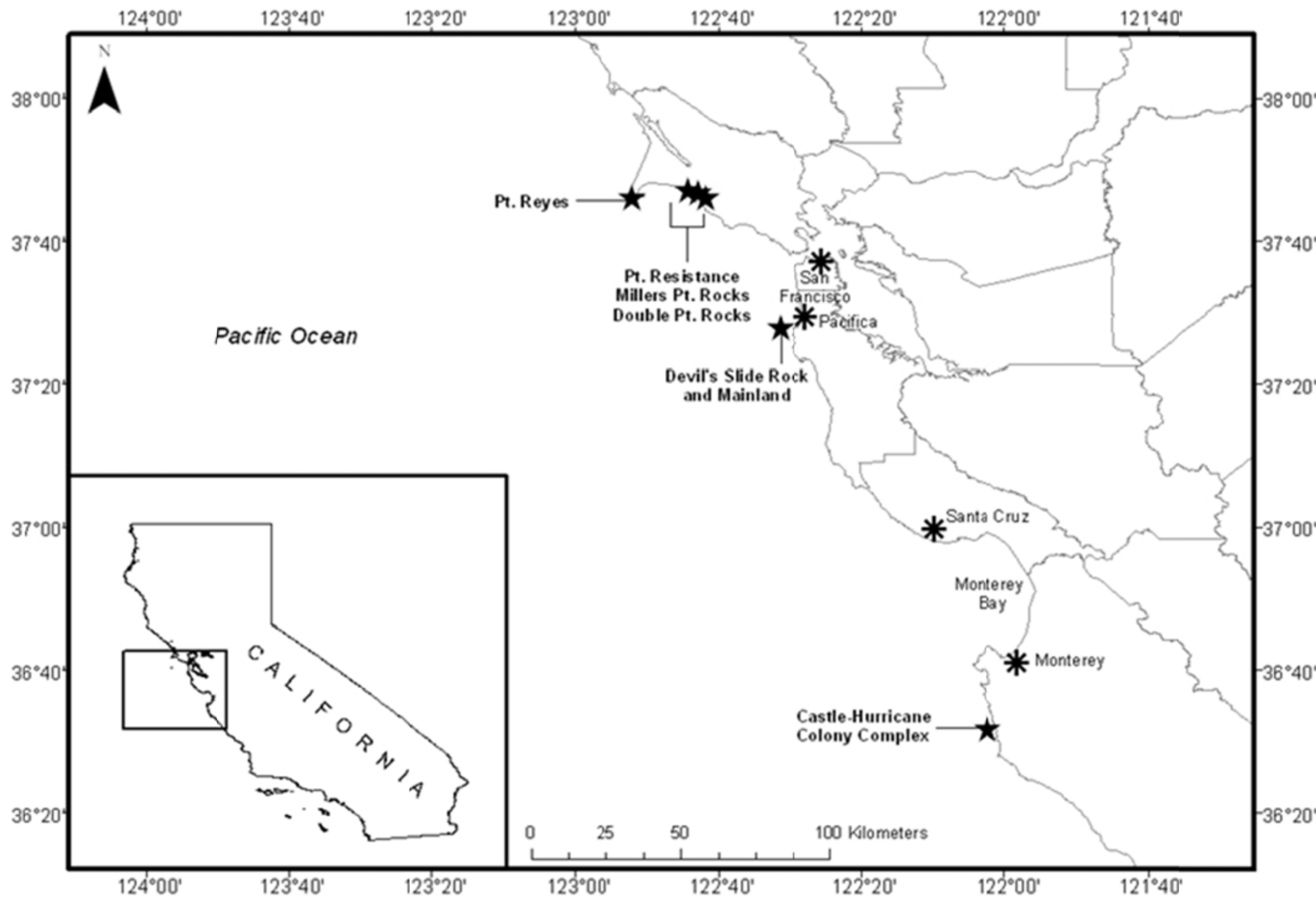


Figure 1. Map of the study area showing locations of study colonies or colony complexes along the Central California coast where seabird disturbance, attendance and breeding biology are monitored.

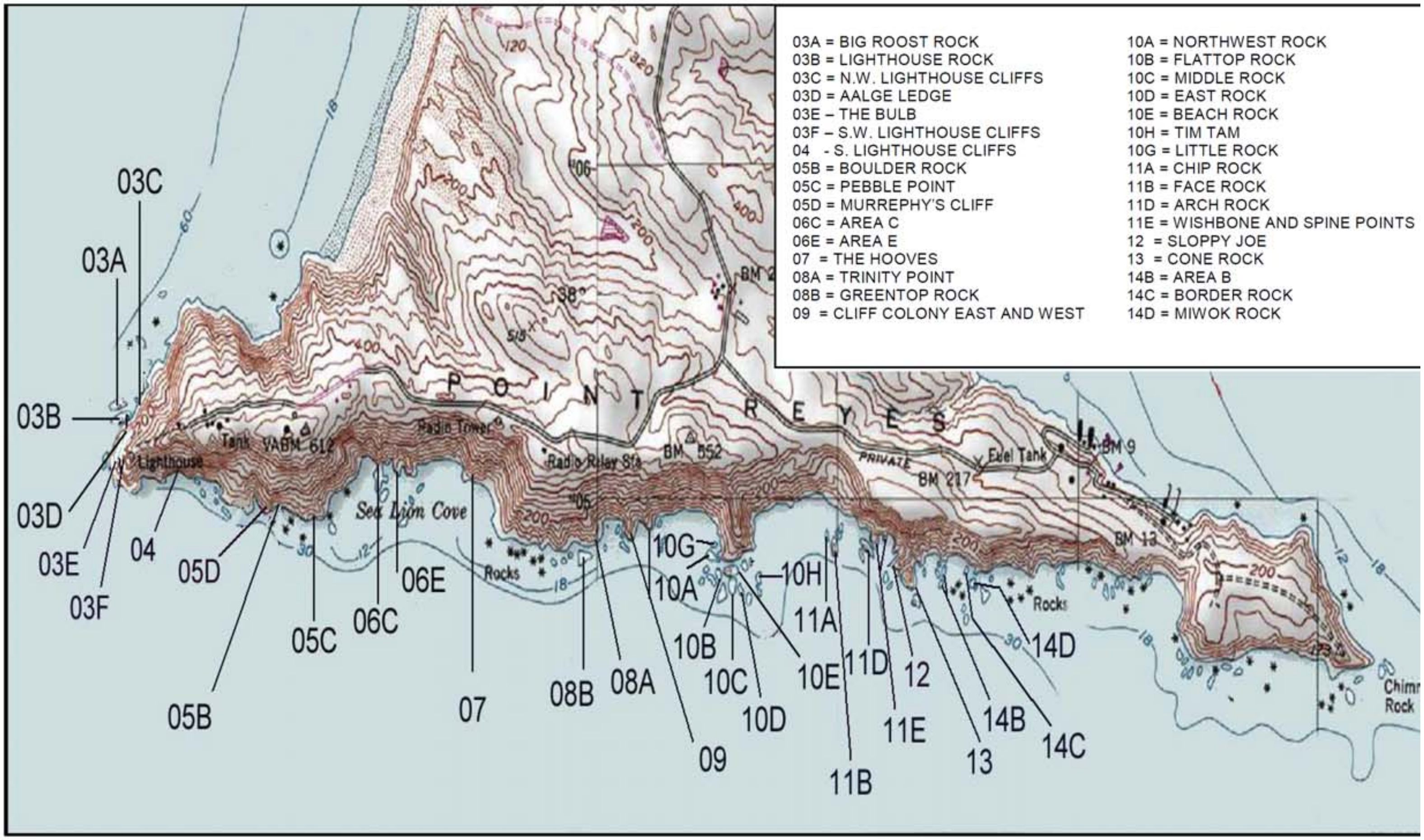


Figure 2. Map of Point Reyes, including subcolonies 03A through 14D.

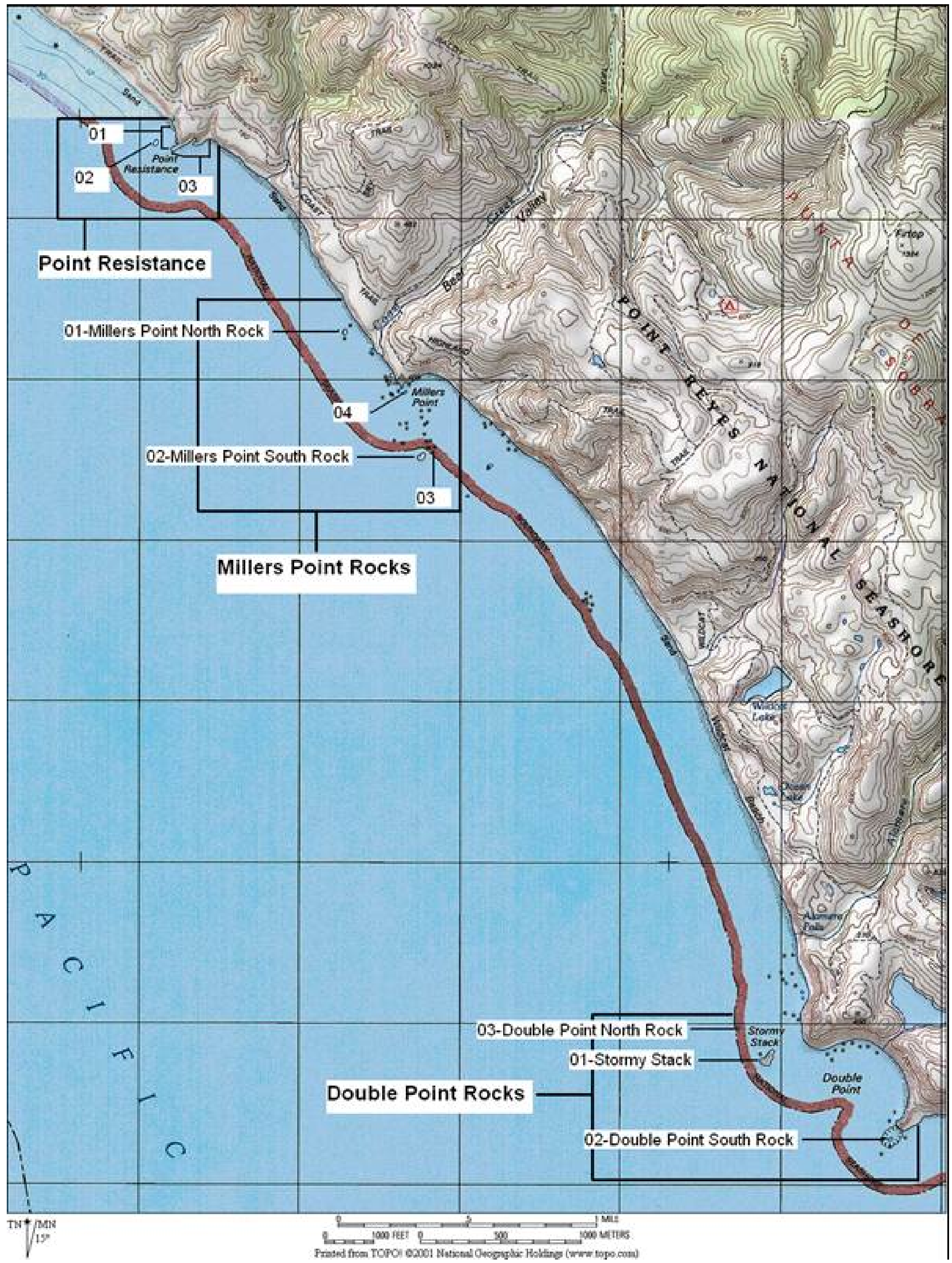


Figure 3. Map of the Drakes Bay Colony Complex, including Point Resistance, Millers Point Rocks and Double Point Rocks colonies and subcolonies.

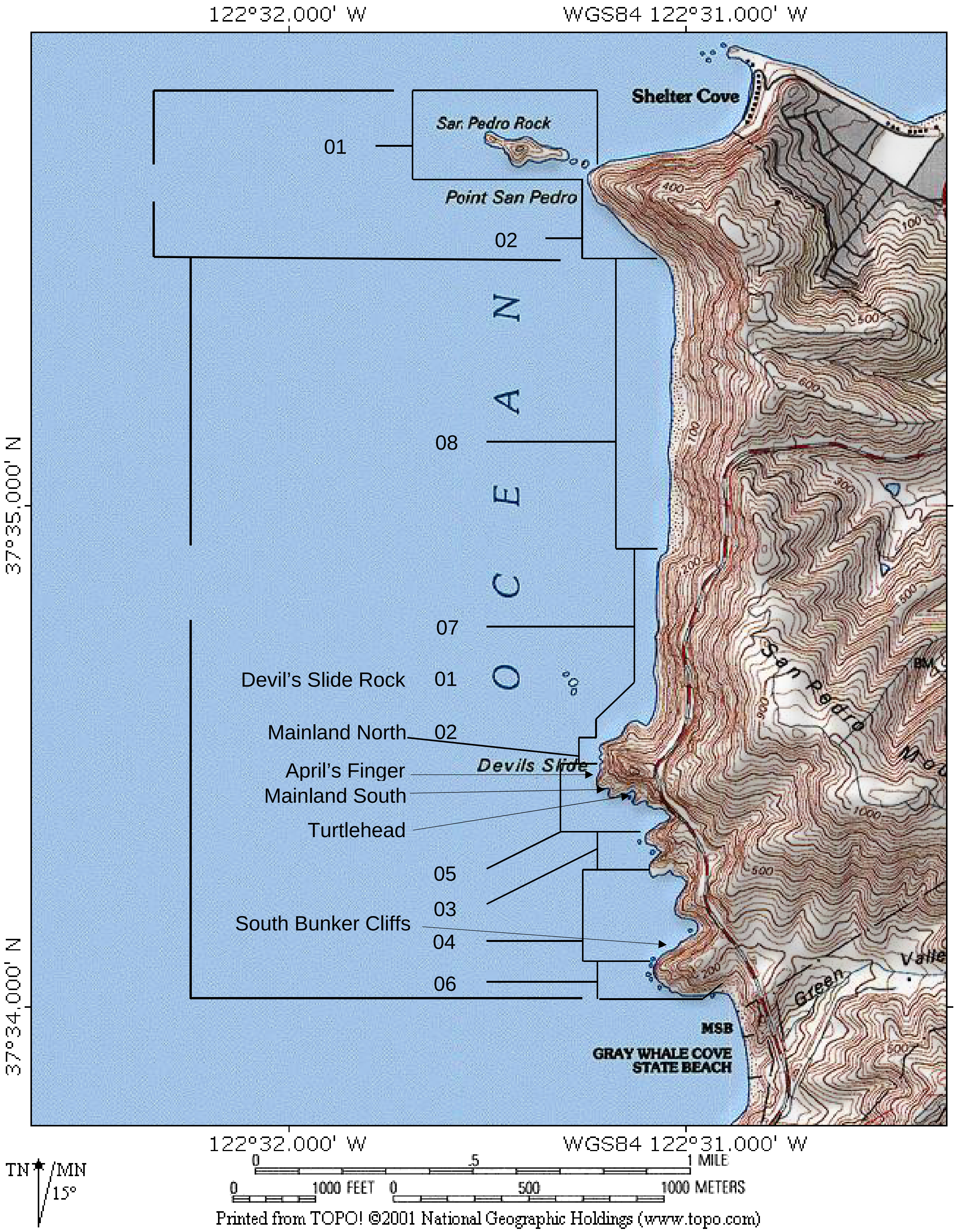


Figure 4. Map of the Devil's Slide Colony Complex, including San Pedro Rock and Devil's Slide Rock & Mainland colonies and subcolonies.

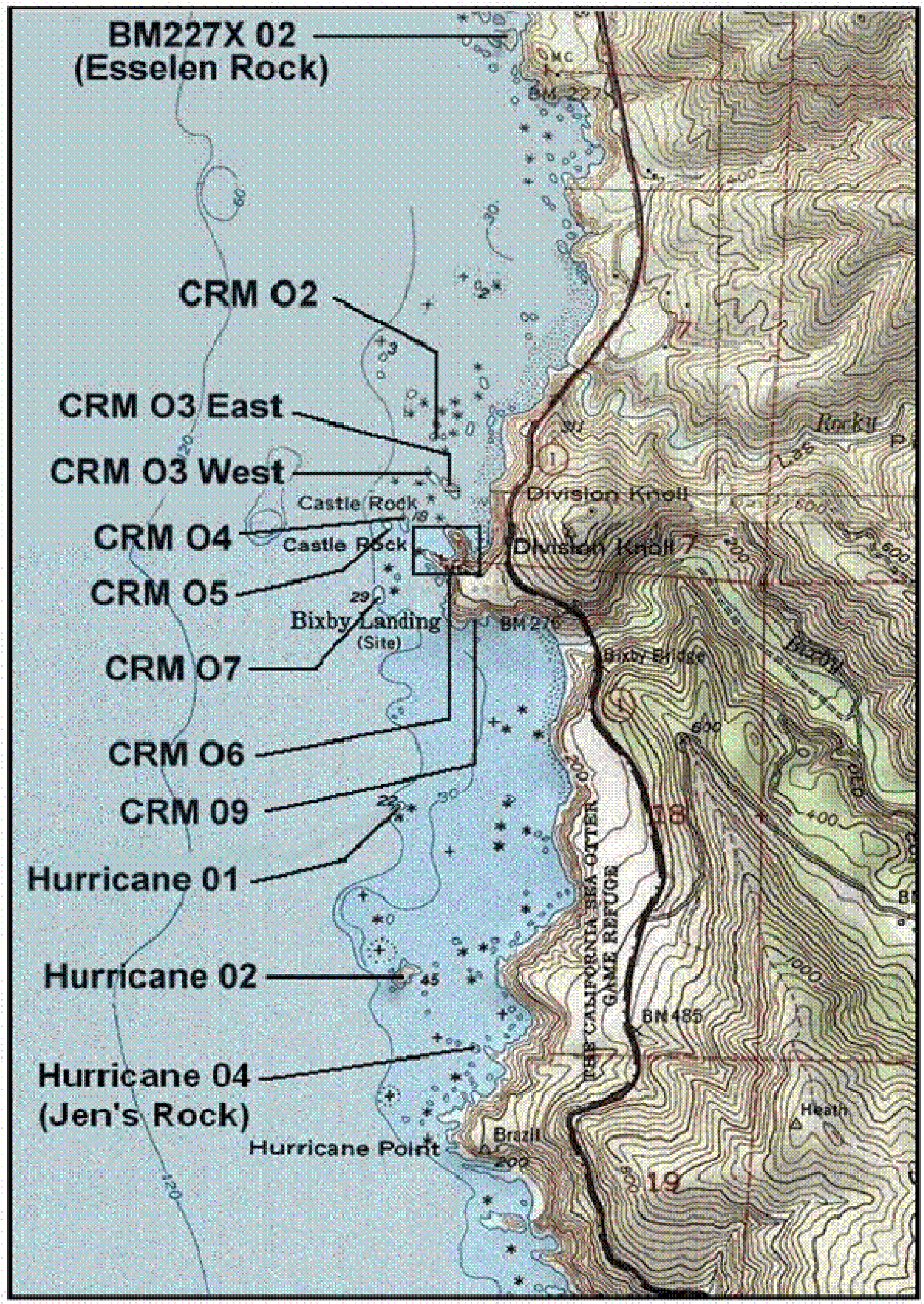


Figure 5. Map of the Castle-Hurricane Colony Complex, including Bench Mark-227X (BM227X), Castle Rocks and Mainland (CRM), and Hurricane Point Rocks (Hurricane) colonies and subcolonies.

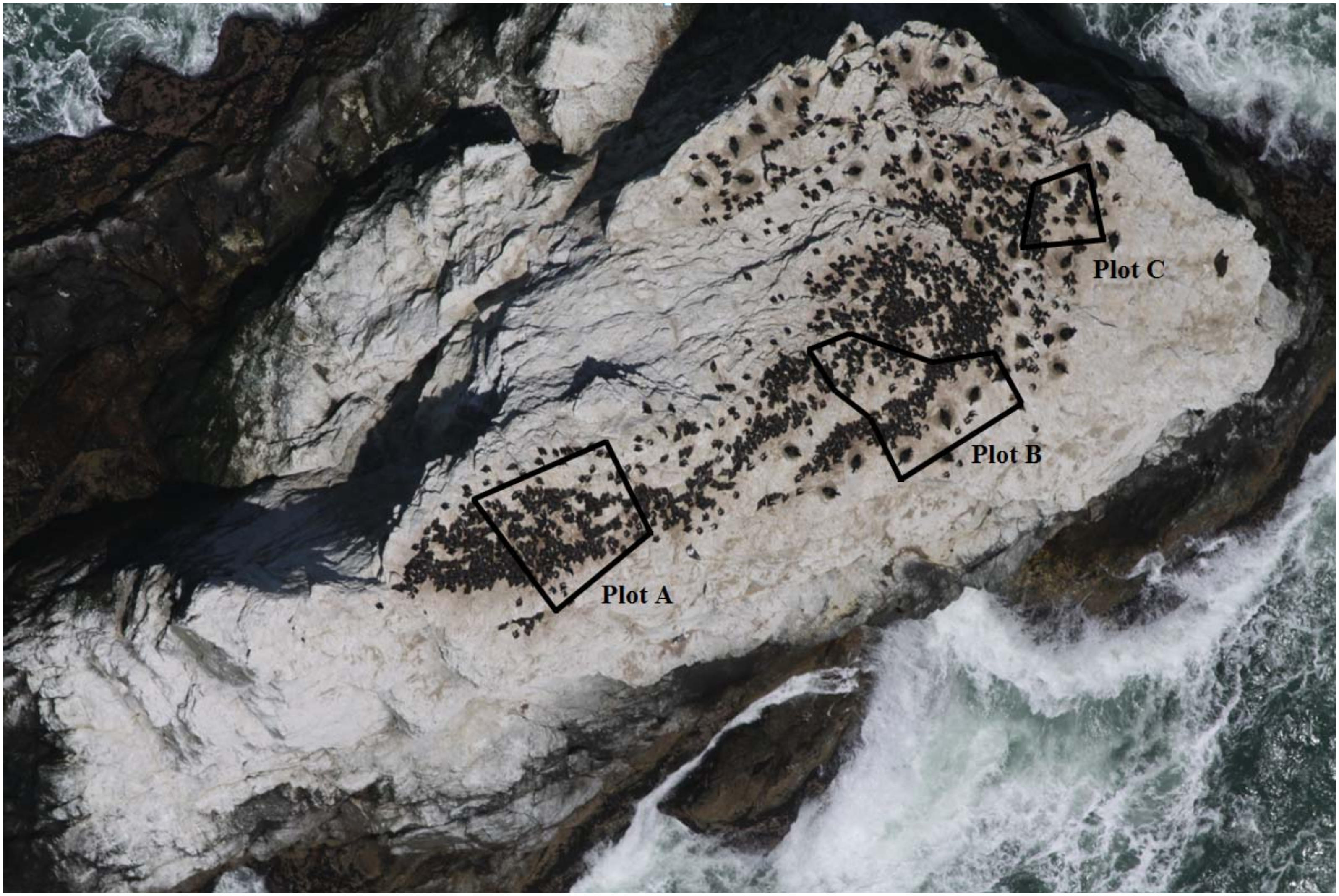
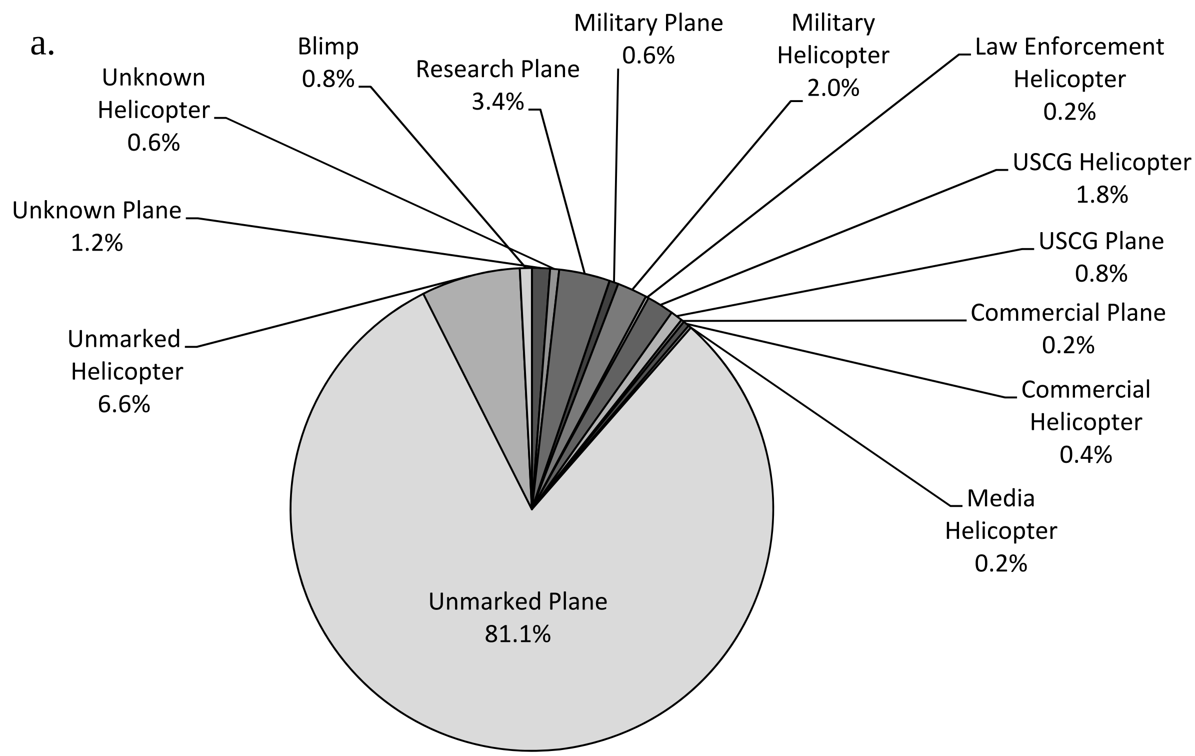


Figure 6. Aerial photograph of Devil's Slide Rock, 11 June 2012, showing the distribution of the Common Murre and Brandt's Cormorant breeding colony and boundaries of murre productivity plots.



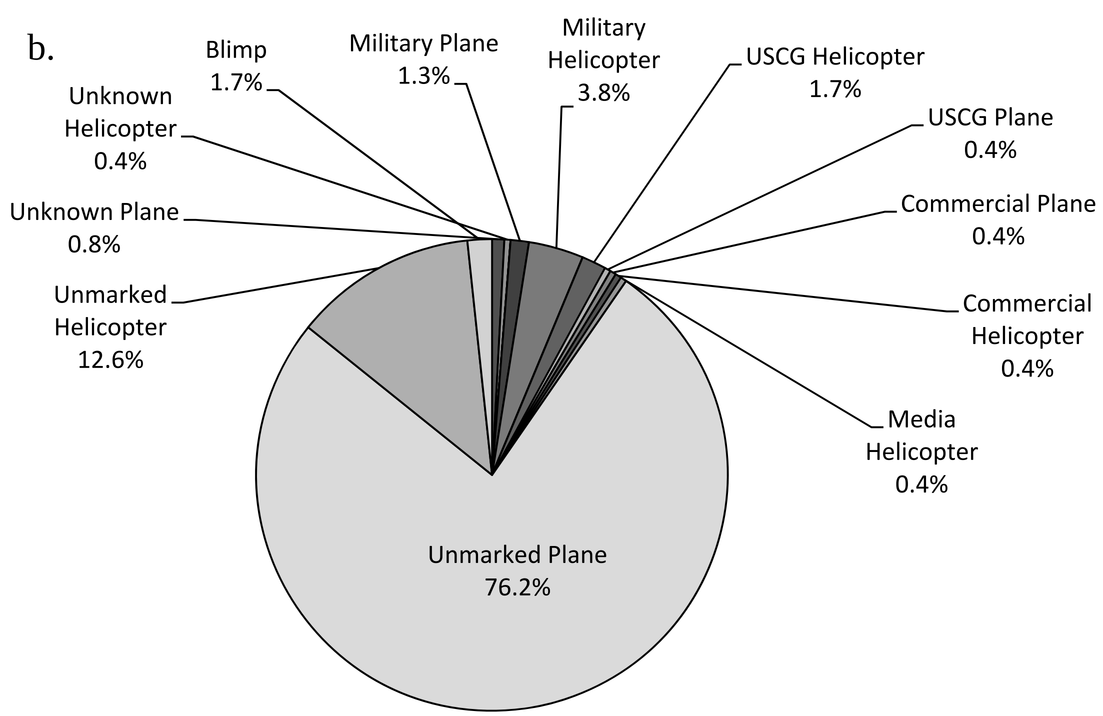


Figure 7. a) Aircraft detections (n = 498) and b) aircraft disturbances (n = 239) at Point Reyes, Drakes Bay, Devil's Slide Rock and Mainland and Castle-Hurricane Colony Complex combined, in 2012, categorized by type.

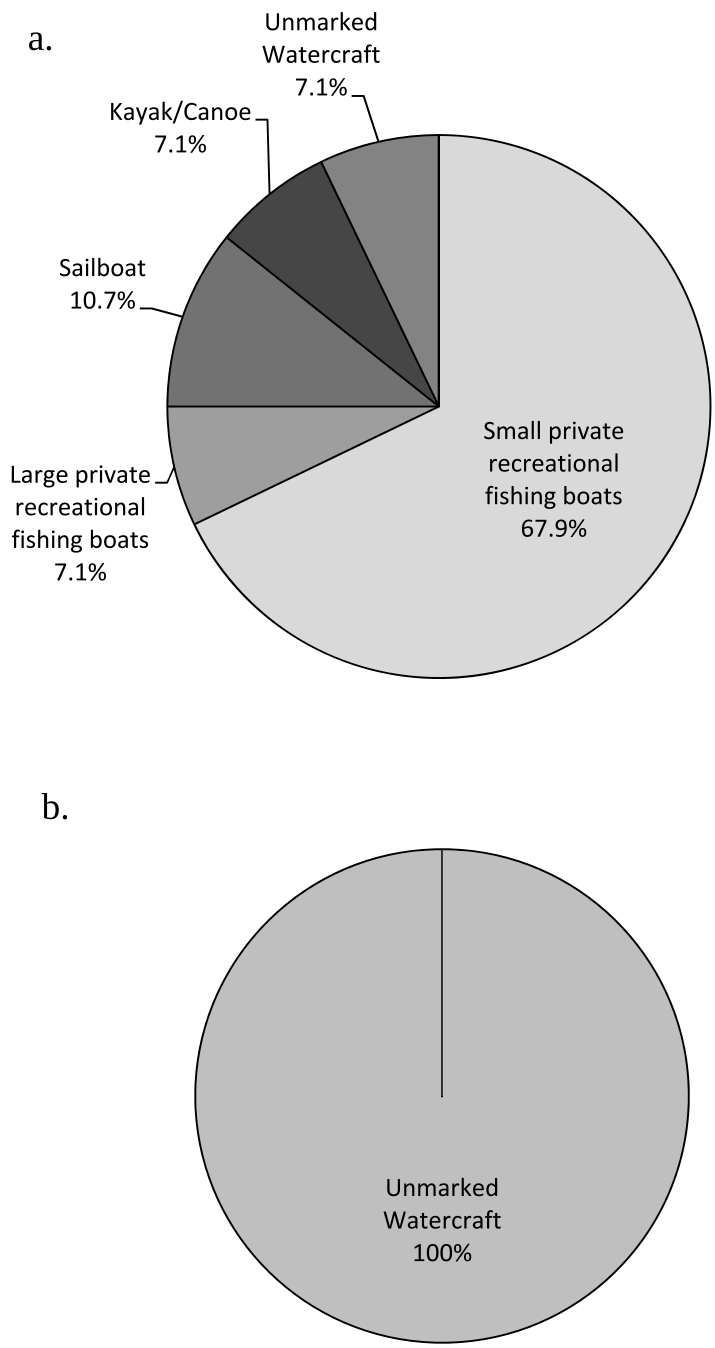


Figure 8. a) Watercraft detections (n = 28), and b) watercraft disturbances (n = 1) at Point Reyes, Drakes Bay, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex combined, in 2012, categorized by type.

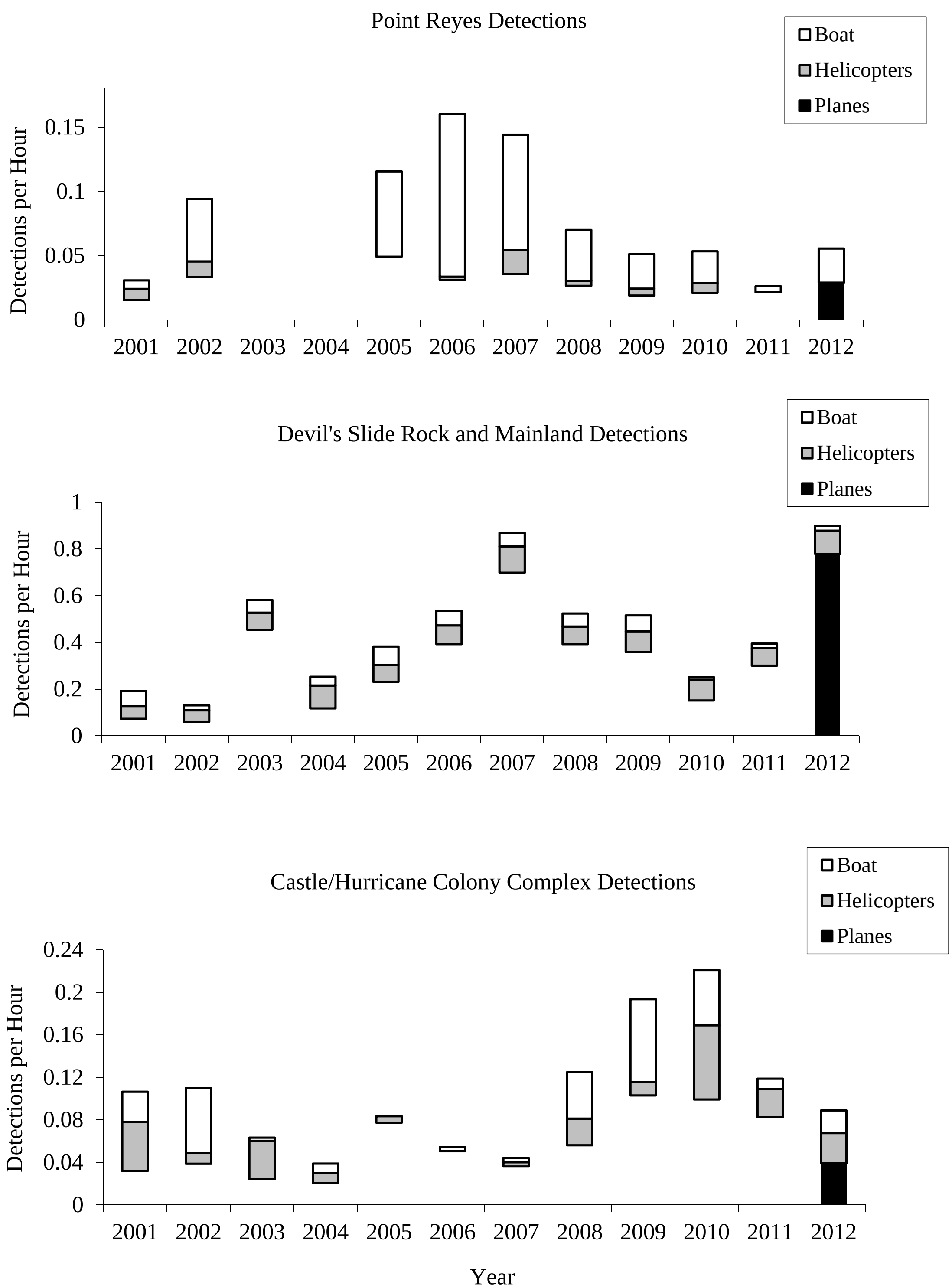


Figure 9. Detection rates (number of detections per observer hour) of boats, helicopters and planes at Point Reyes, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex, 2001 to 2012.

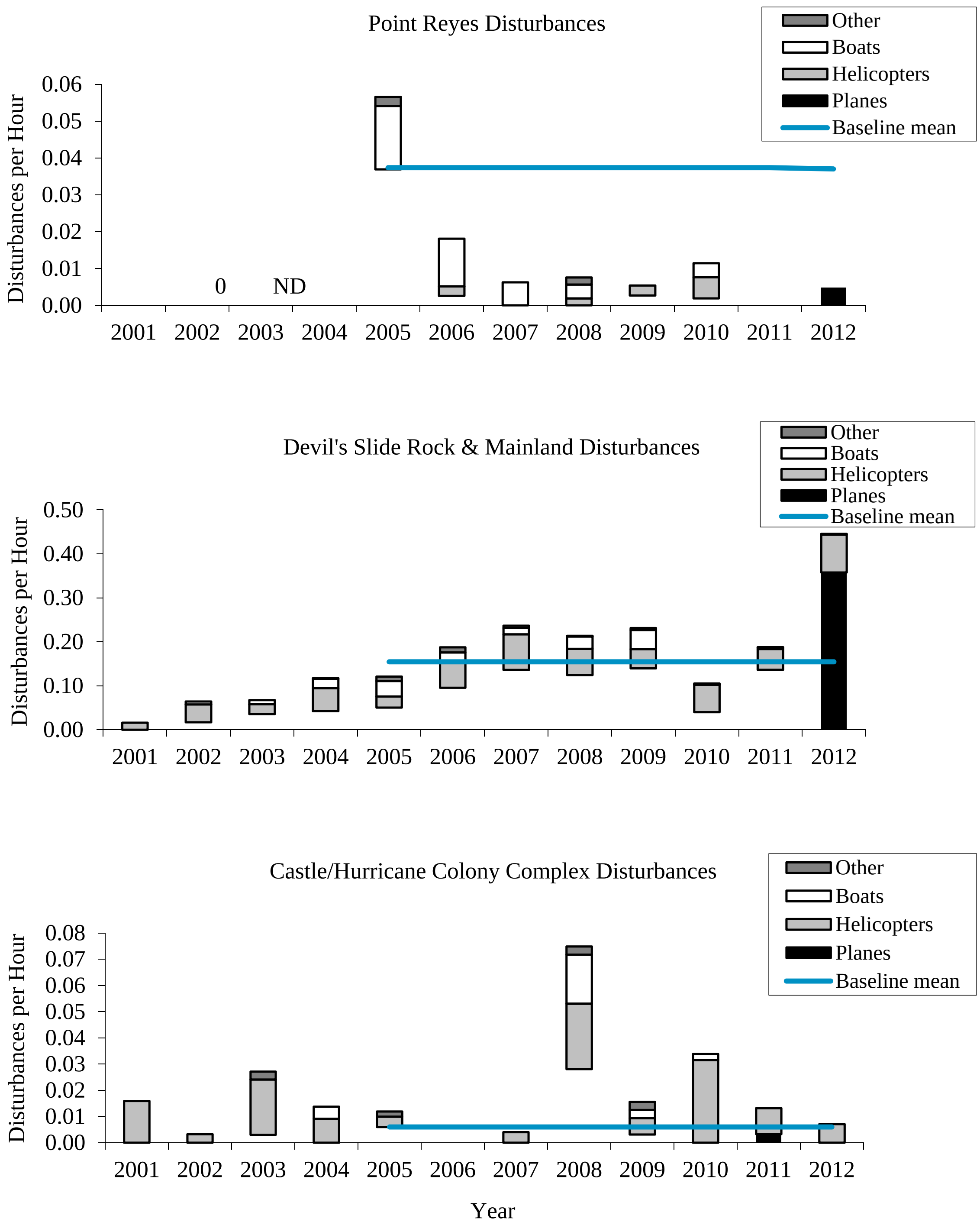


Figure 10. Disturbance rates (number of seabird disturbances per observer hour) from boats, helicopters, planes, and other anthropogenic sources at Point Reyes, Devil's Slide Rock and Mainland and Castle-Hurricane Colony Complex from 2001 to 2012. The horizontal line indicates the baseline mean disturbance rate from 2005 to 2006.

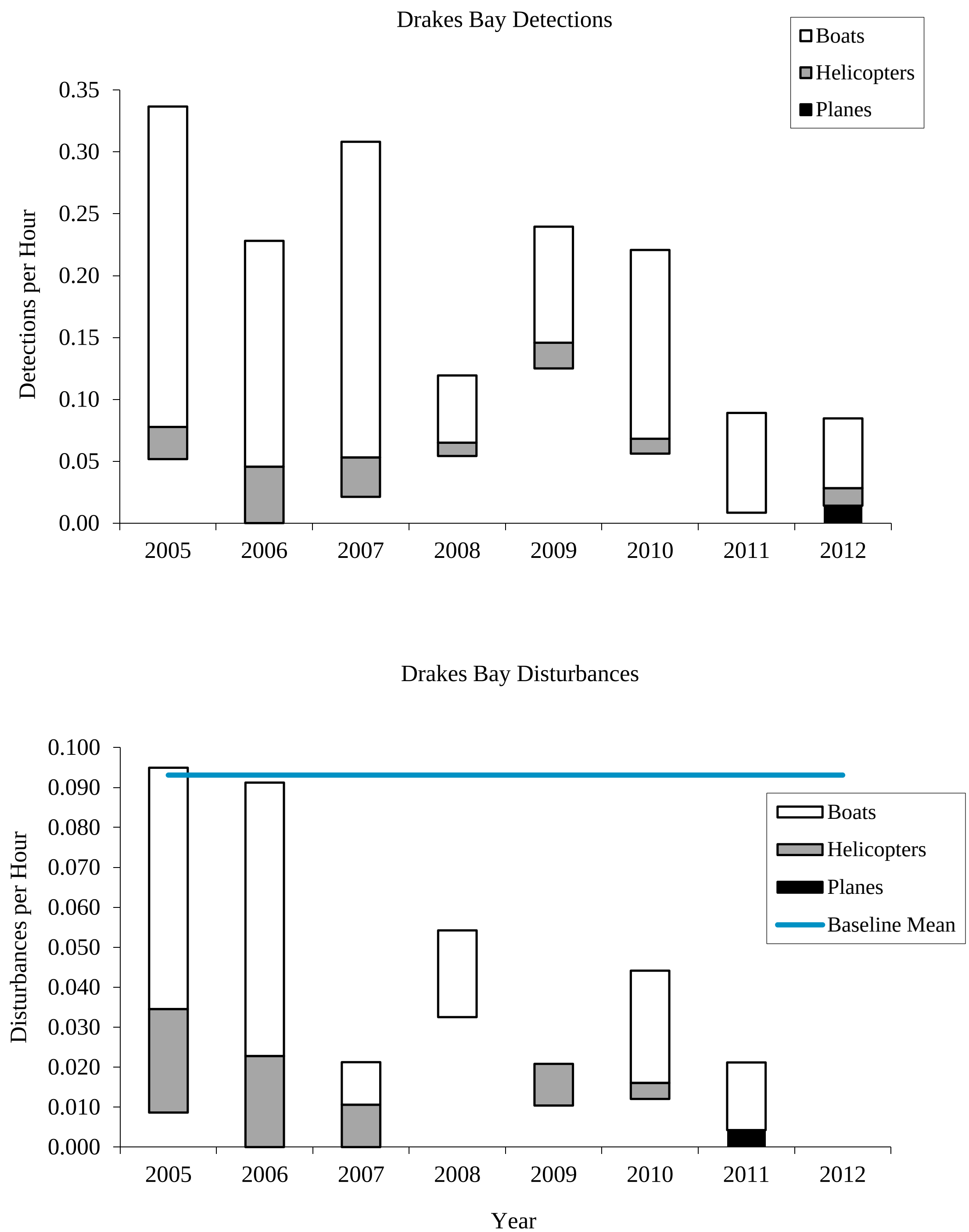


Figure 11. Detection and disturbance rates of boats, helicopters, and planes at Drakes Bay Colony Complex from 2005 to 2012. The horizontal line indicates the baseline mean disturbance rate from 2005 to 2006.

Figure 12. A Brown Pelican consuming a Common Murre chick at Point Reyes on 2 July 2012. This predatory behavior is unusual, but has become more common over the past two years. Photo by C. Shake.

Figure 13. Displaced adults, displaced and exposed chicks, and abandoned eggs of Common Murres resulting from a Brown Pelican disturbance at Lighthouse Rock, Point Reyes Headlands on 2 July 2012. Photo by J. Tappa.

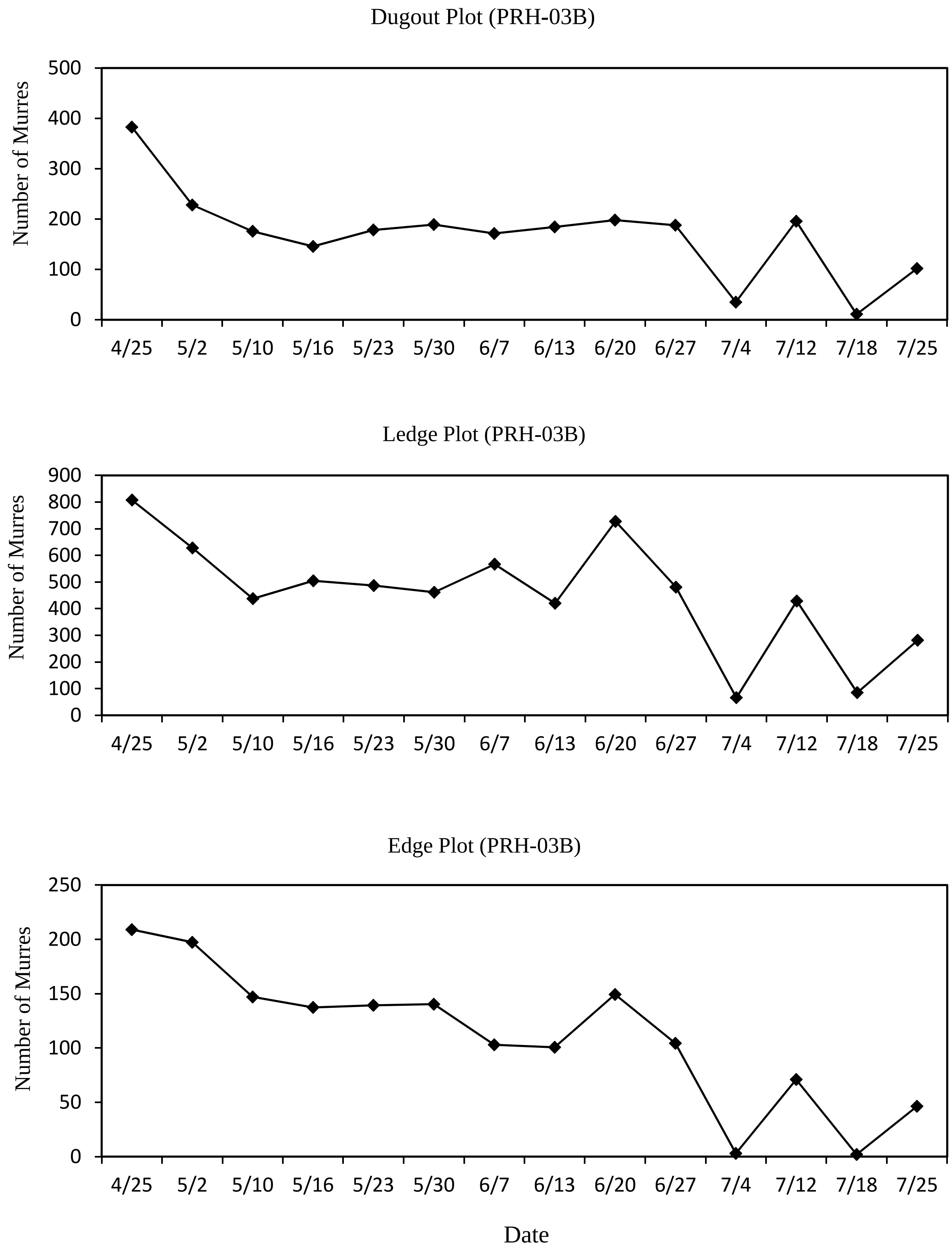


Figure 14. Seasonal attendance of Common Murres at Dugout, Edge and Ledge plots, Point Reyes, 25 April to 25 July 2012.

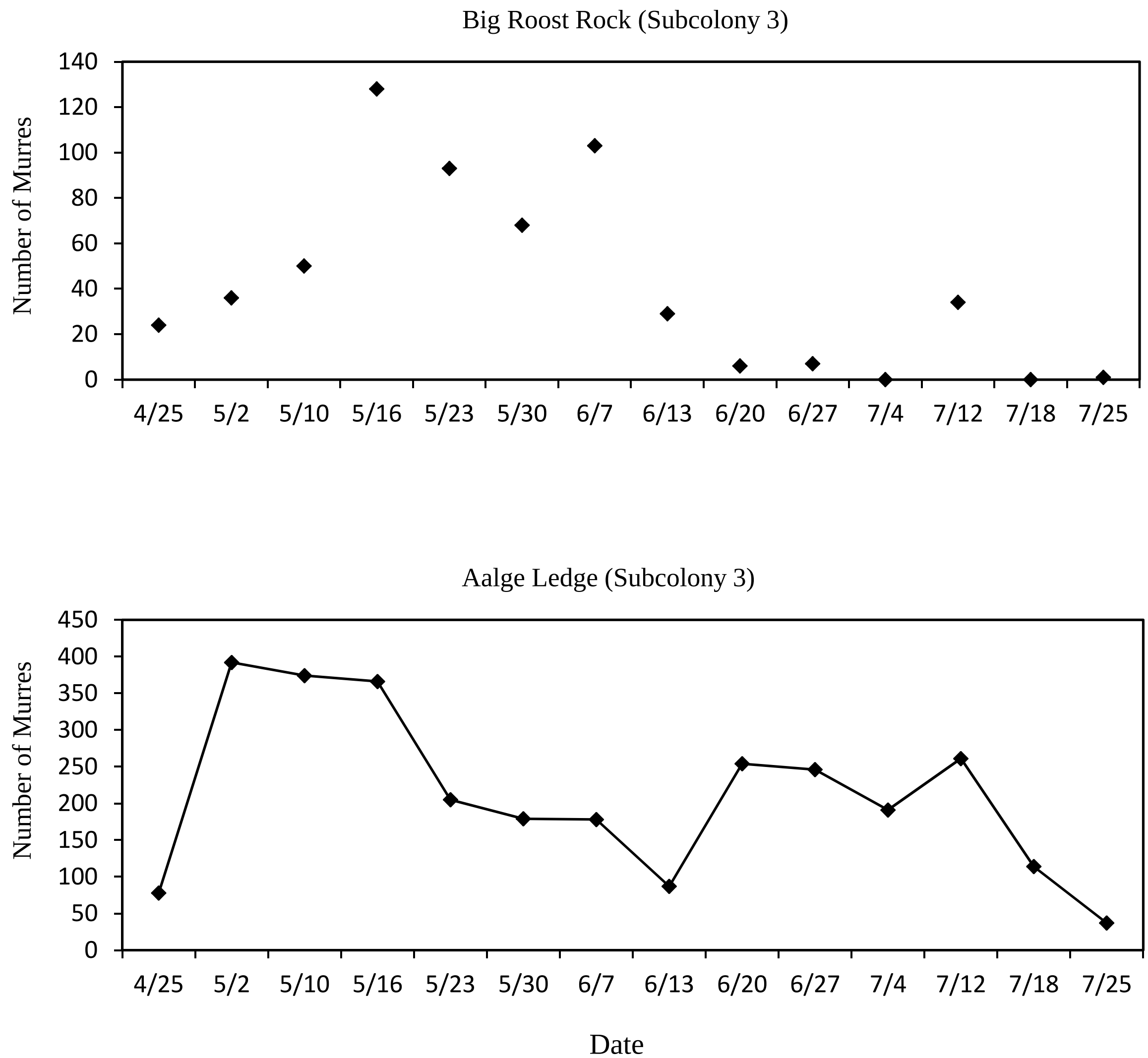


Figure 15. Seasonal attendance of Common Murres at Big Roost Rock (PRH-03X) and Aalge Ledge (PRH-03X), Point Reyes, 25 April to 25 July 2012.

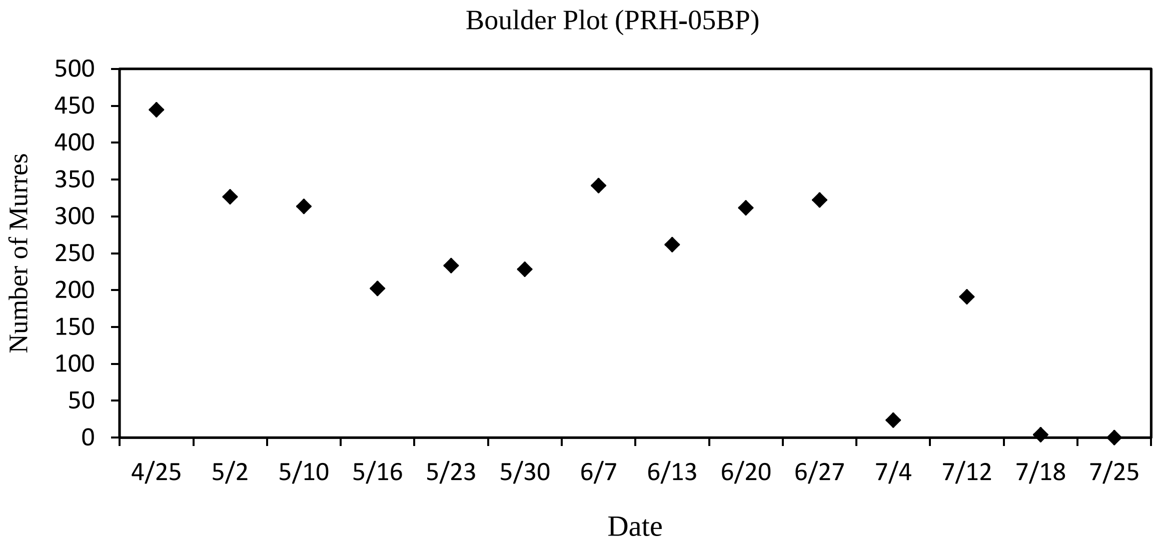


Figure 16. Seasonal attendance of Common Murres at the Boulder Rock plot, Point Reyes, 25 April to 25 July 2012.

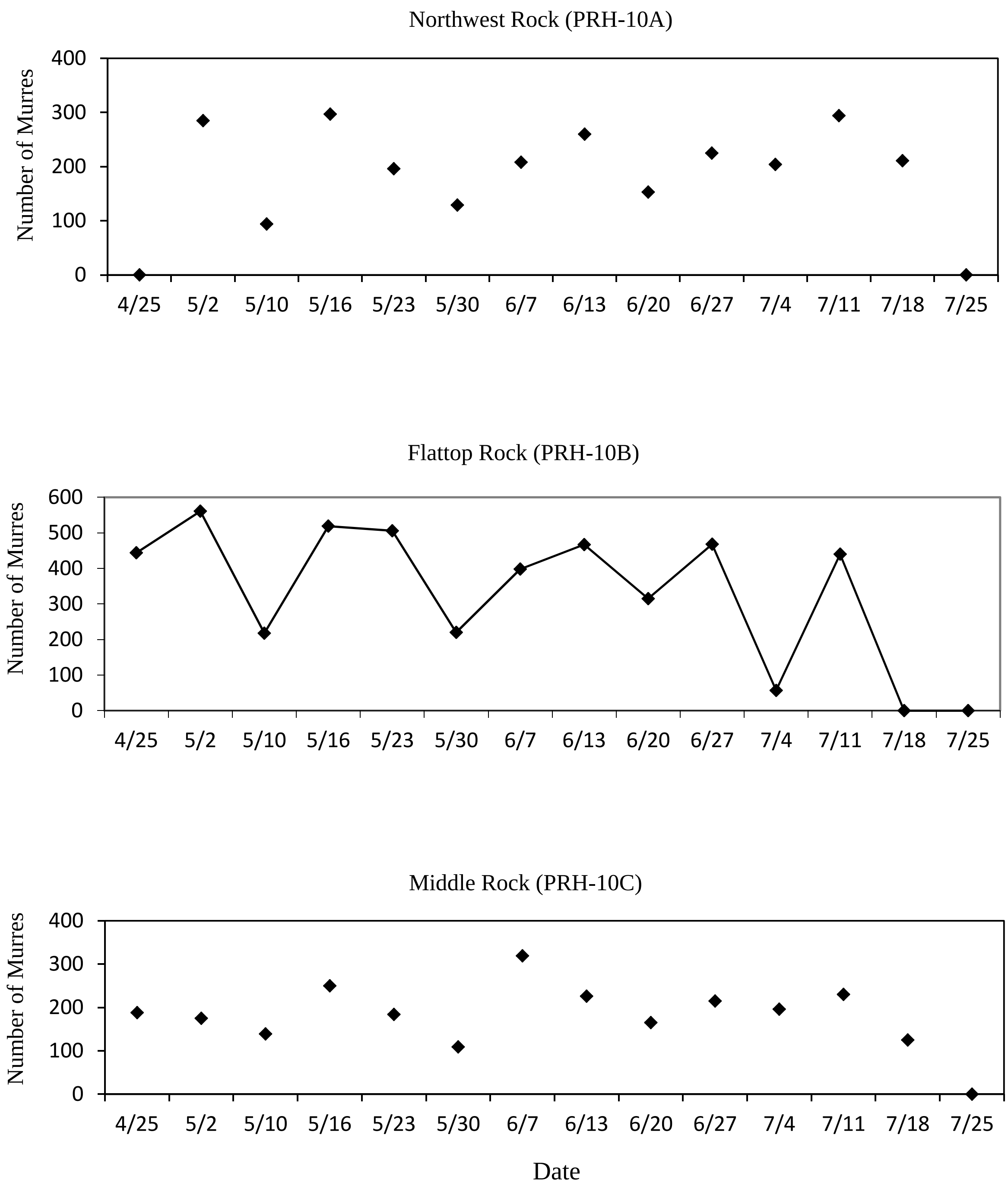


Figure 17. Seasonal attendance of Common Murres within subcolony 10 (Northwest Rock, Flattop Rock, Middle Rock), Point Reyes, 25 April to 25 July 2012.

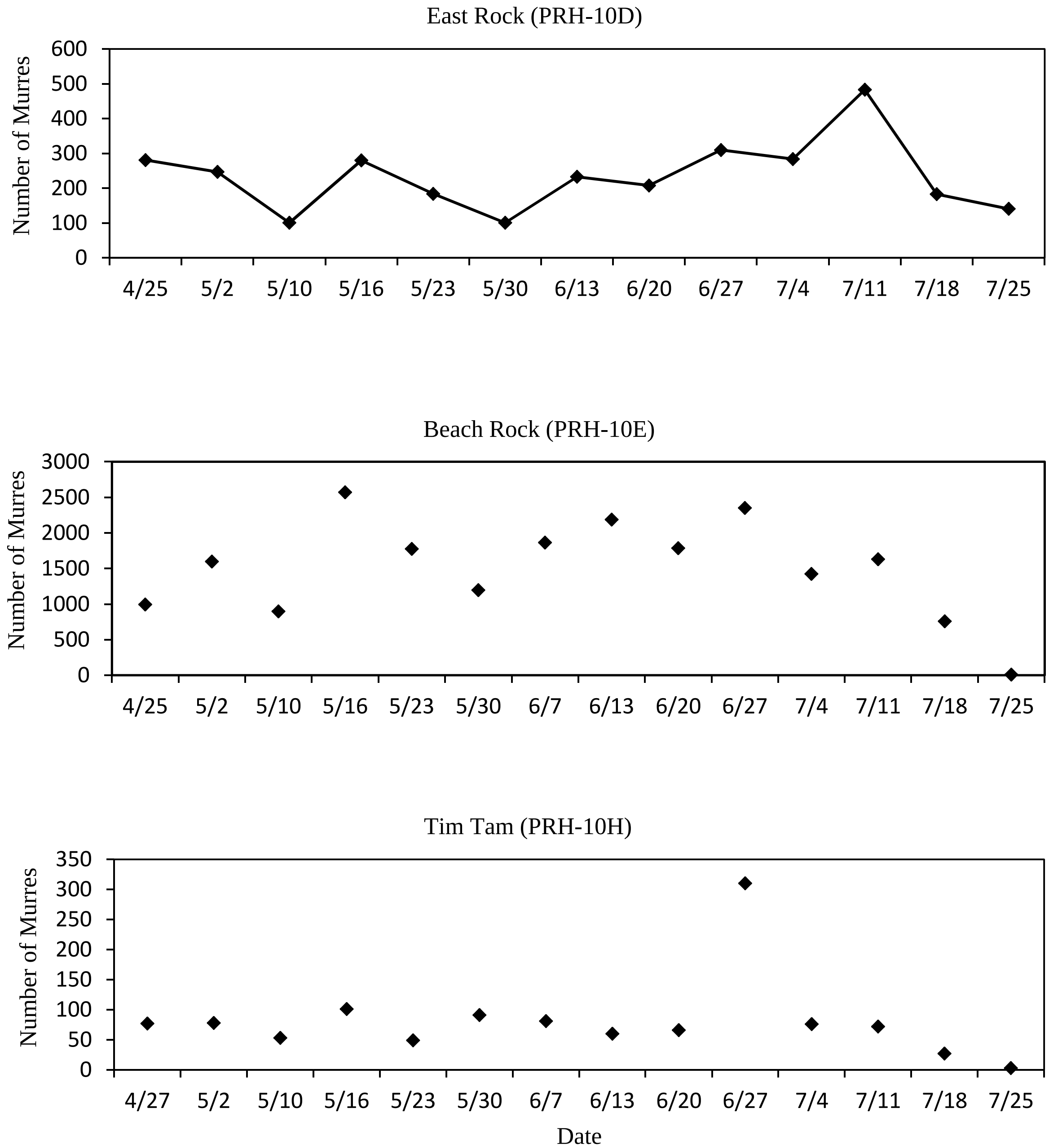


Figure 18. Seasonal attendance of Common Murres within subcolony 10 (East Rock, Beach Rock and Tim Tam), Point Reyes, 25 April to 25 July 2012.

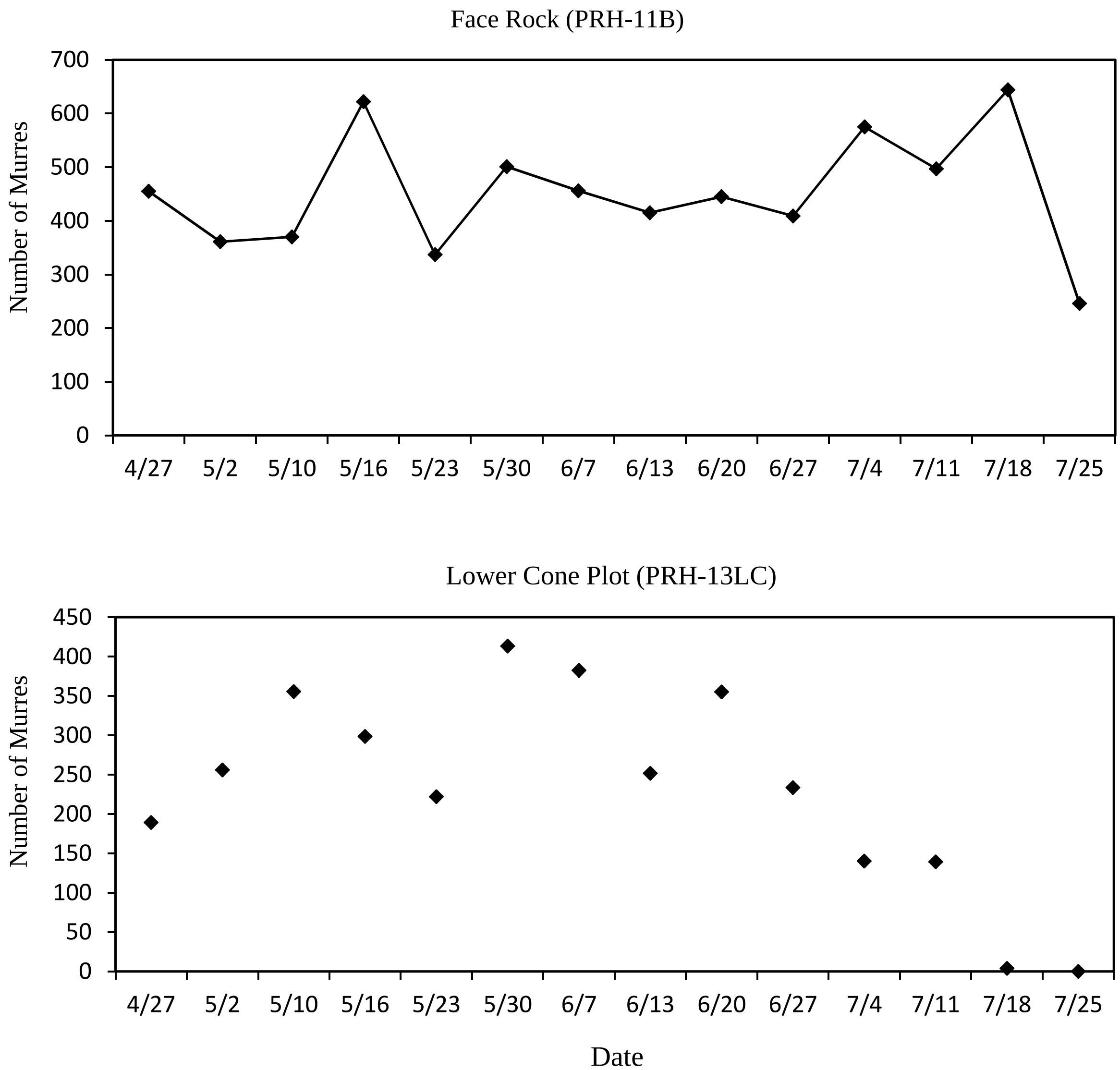


Figure 19. Seasonal attendance of Common Murres on Face Rock and Lower Cone Plot, Point Reyes, 27 April to 25 July 2012.

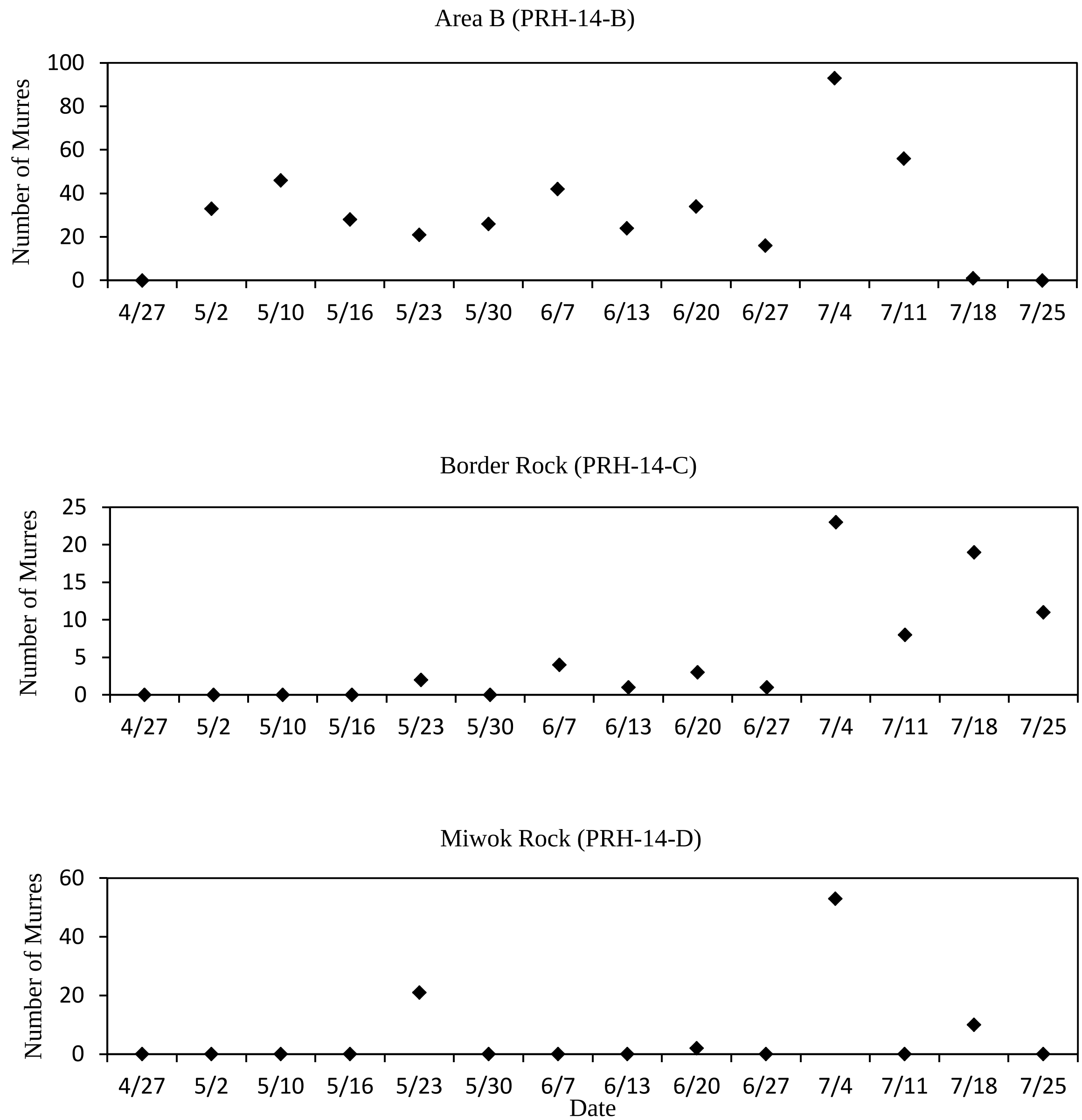


Figure 20. Seasonal attendance of Common Murres at Area B, Border Rock and Miwok Rock, Point Reyes, 27 April to 25 July 2012.

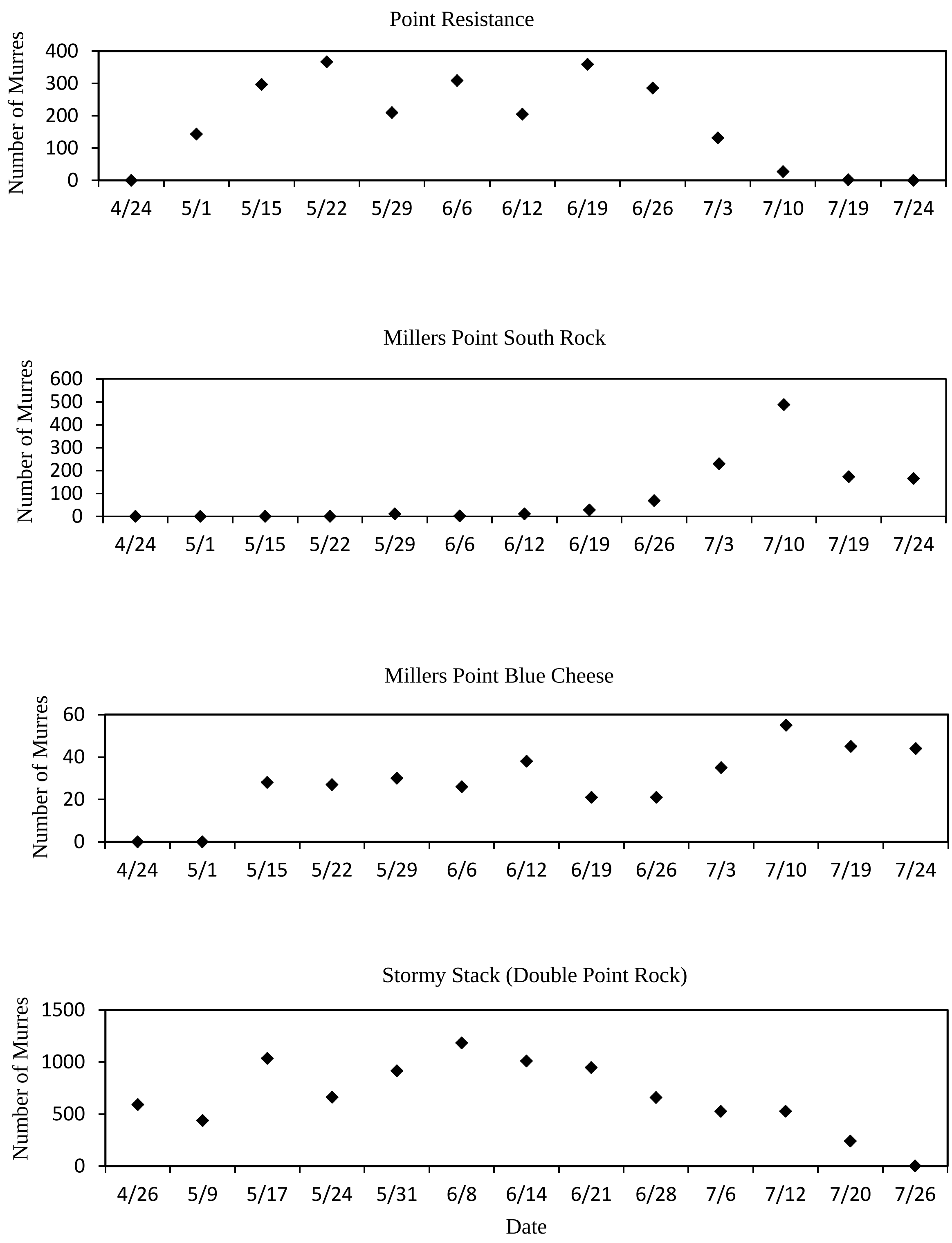


Figure 21. Seasonal attendance of Common Murres at Point Resistance, Millers Point South Rock, Millers Point "Blue Cheese" and Double Point Rocks, 26 April to 26 July 2012.

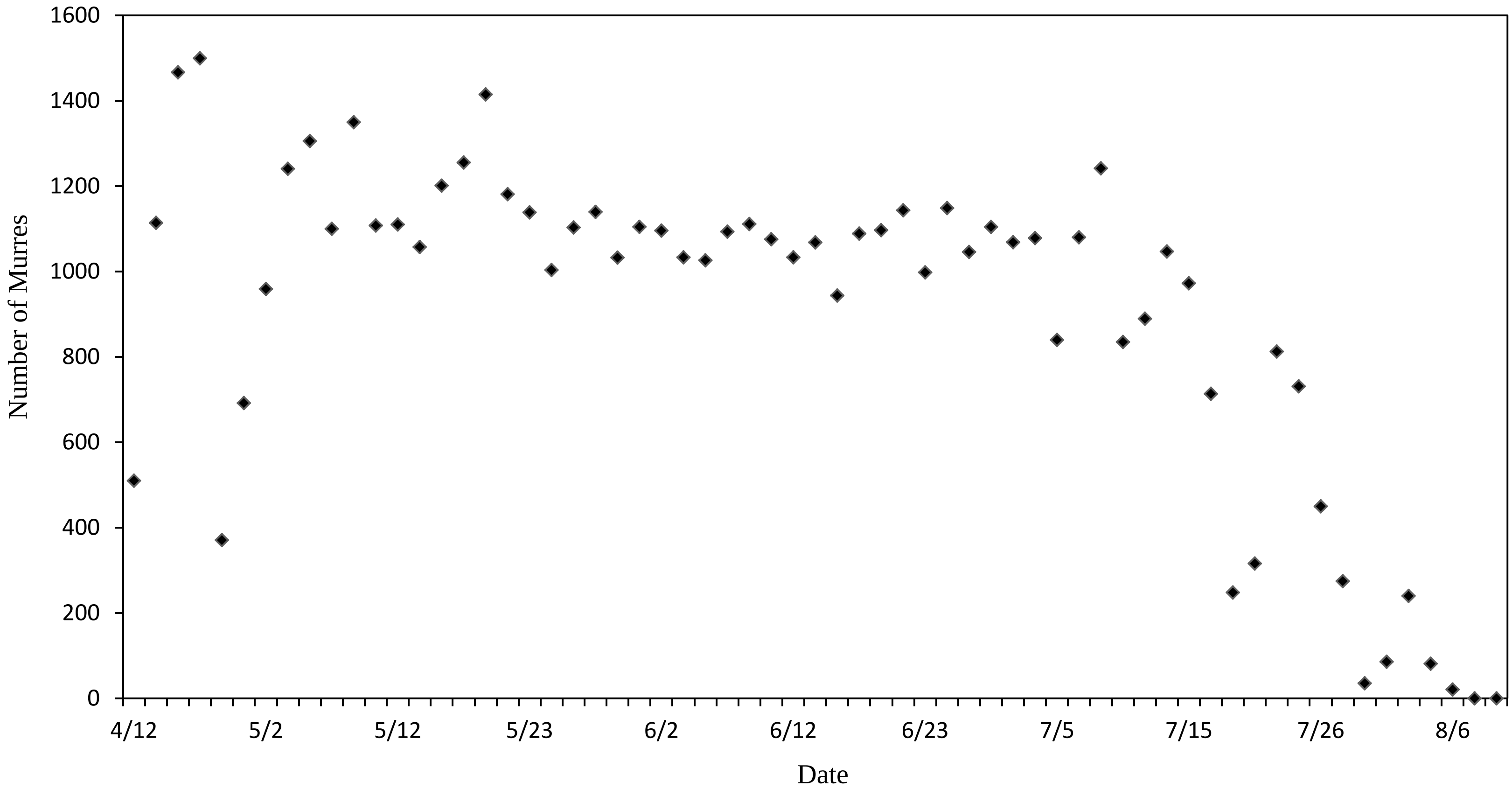


Figure 22. Seasonal attendance of Common Murres at Devil's Slide Rock, 12 April to 6 August 2012.

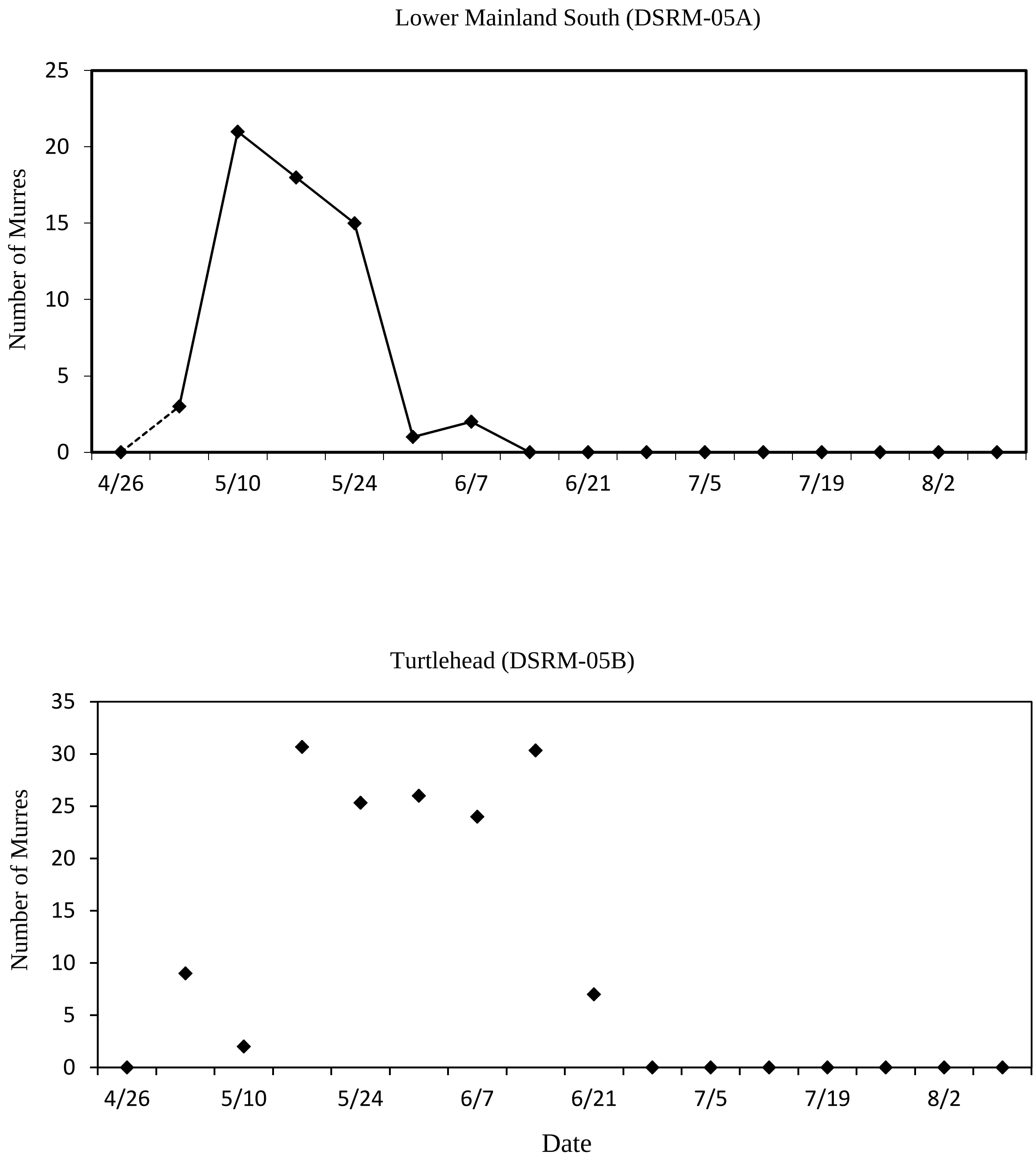


Figure 23. Seasonal attendance of Common Murres at Lower Mainland South, and Turtlehead, Devil's Slide Rock and Mainland, 26 April to 2 August.

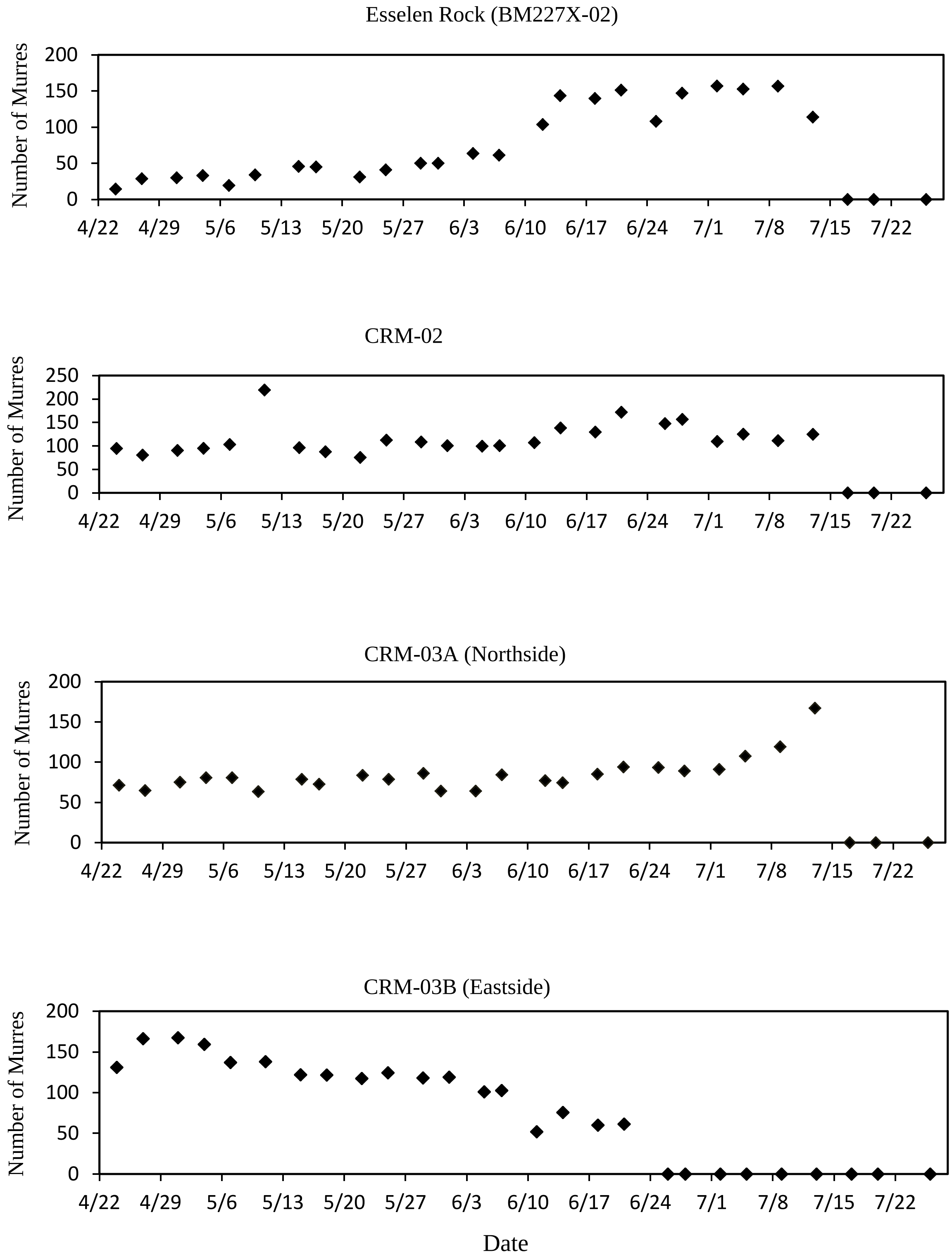


Figure 24. Seasonal attendance of Common Murres at BM227X subcolony 02 (Esselen Rock); and subcolonies 02, 03West (Northside), and 03East (Eastside), Castle-Hurricane Colony Complex, 22 April to 28 July 2012.

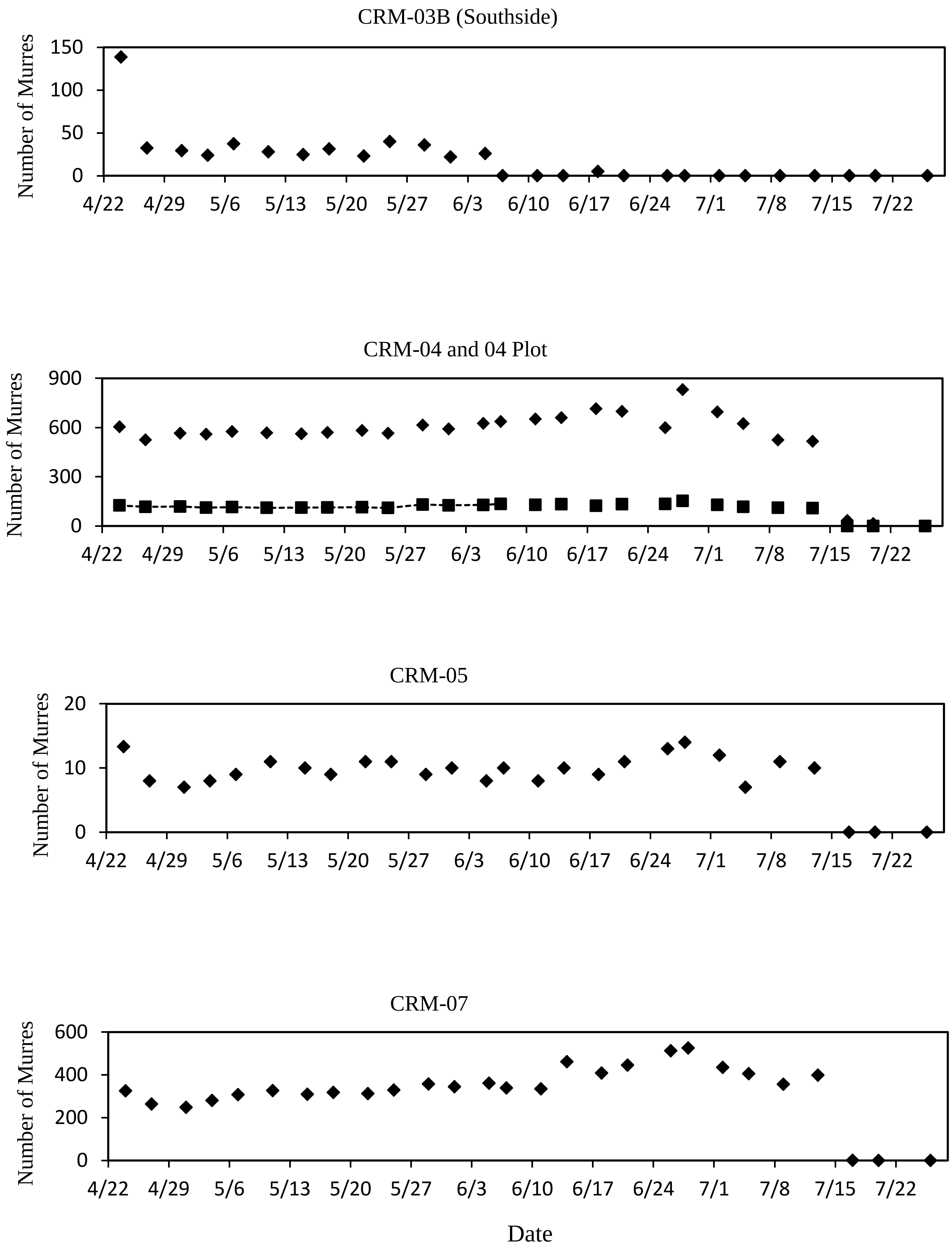


Figure 25. Seasonal attendance of Common Murres at subcolonies 03East (Southside), 04 and 04 Plot, 05, and 07, Castle-Hurricane Colony Complex, 22 April to 28 July 2012.

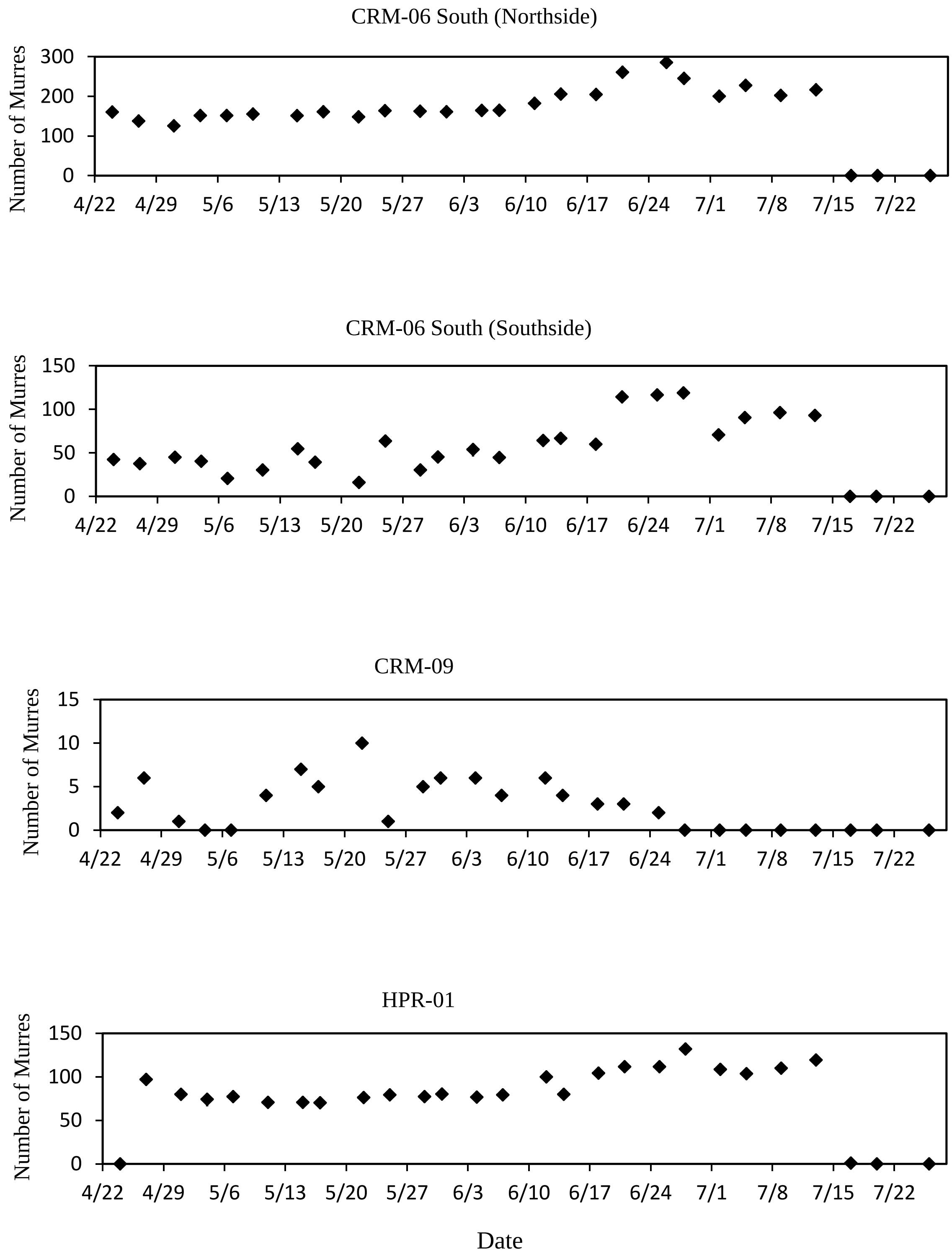
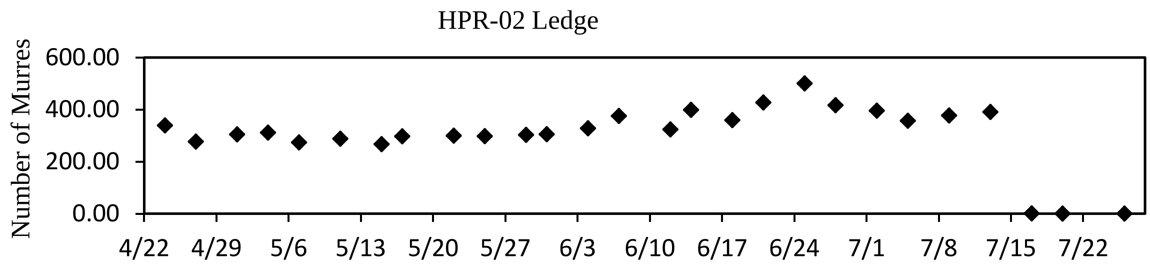


Figure 26. Seasonal attendance of Common Murres at subcolonies 06South (Northside), 06South (Southside), 09, and Hurricane Point Rocks subcolony 01, Castle Hurricane Colony Complex, 22 April to 28 July 2012.



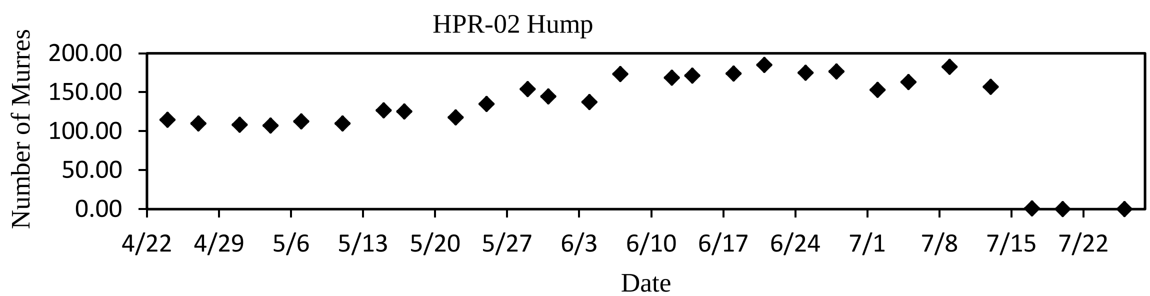


Figure 27. Seasonal attendance of Common Murres at Hurricane Point Rocks subcolony 02 (Hump and Ledge subareas), Castle-Hurricane Colony Complex, 22 April to 28 July 2012.

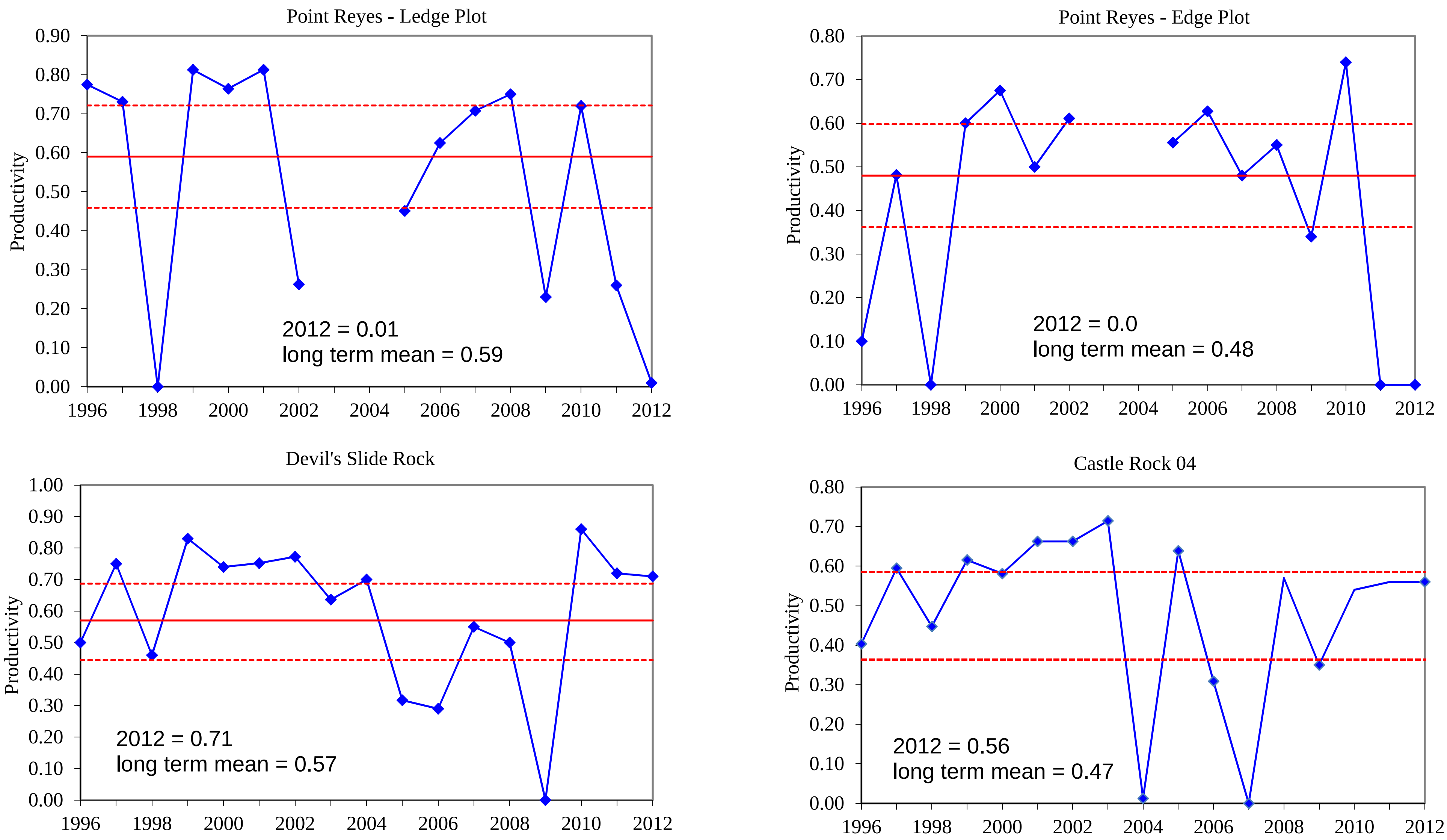


Figure 28. Productivity (chicks fledged per pair) of Common Murres at Point Reyes (Ledge and Edge plots), Devil's Slide Rock, and Castle Rock 04 plot, 1996-2012. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence interval.

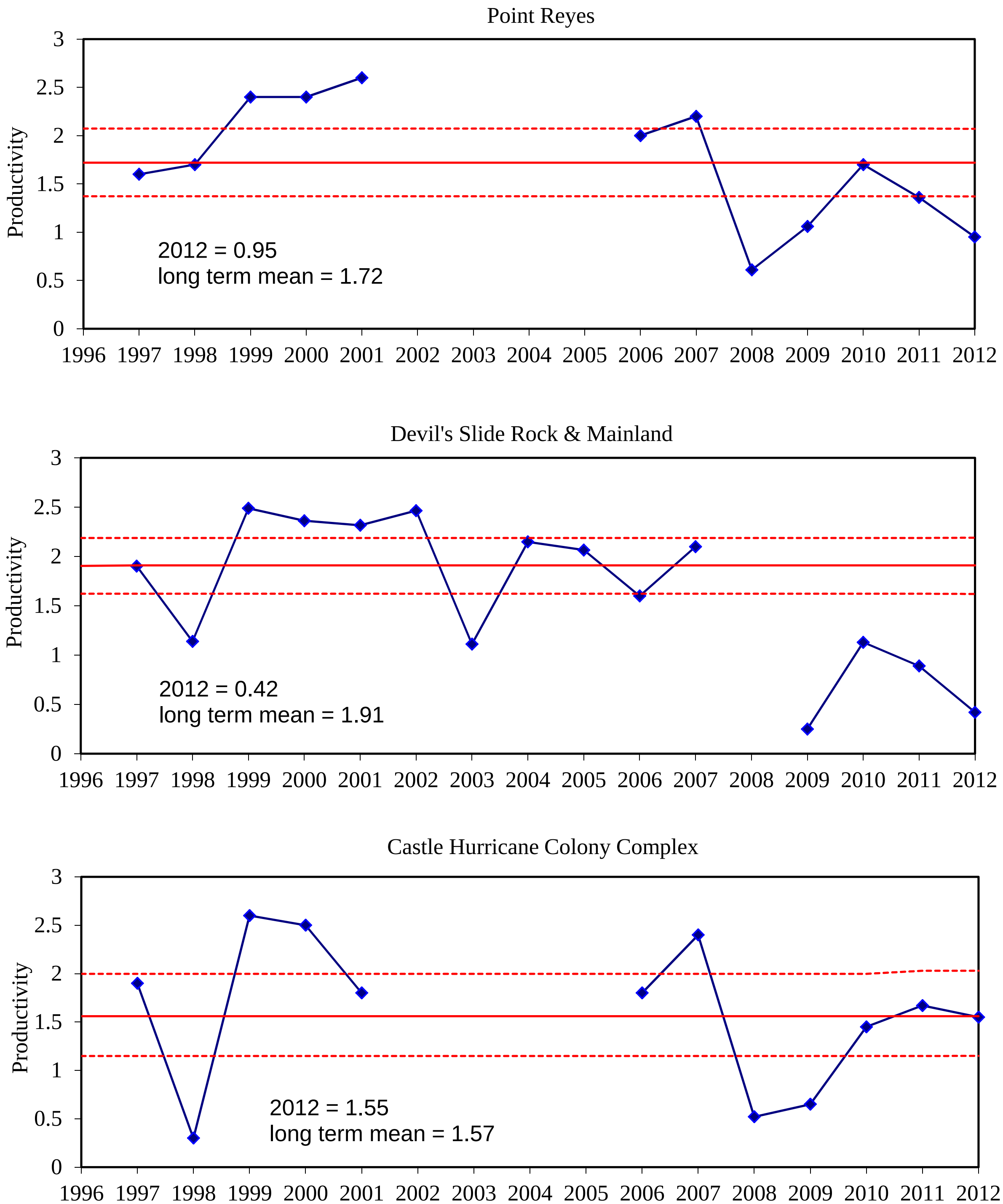


Figure 29. Productivity (chicks fledged per pair) of Brandt's Cormorants at Point Reyes, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex, 1996-2012. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence interval.

Appendix 1. Number of aircraft overflights detected categorized by type and resulting disturbance events recorded at Point Reyes, Point Resistance, Double Point Rocks, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex in 2012.

Aircraft Type	Total Detections		Number of Agitation Events		Number of Displacement Events		Number of Flushing Events		Total Disturbance Events	
	Plane	Helicopter	Plane	Helicopter	Plane	Helicopter	Plane	Helicopter	Plane	Helicopter
Point Reyes										
Research	9	0	0	0	0	0	0	0	0	0
USCG	2	0	1	0	0	0	0	0	1	0
Unmarked	1	0	0	0	0	0	1	0	1	0
Point Resistance										
Unmarked	0	1	0	0	0	0	0	0	0	0
Double Point Rocks										
Unmarked	1	0	0	0	0	0	0	0	0	0
Devil's Slide Rock and Mainland										
Commercial	1	2	1	0	0	0	0	1	1	1
Media	0	1	0	0	0	0	0	1	0	1
USCG	2	6	0	3	0	0	0	0	0	3
Military	4	10	3	5	0	0	0	5	3	10
Unmarked	407	34	185	24	0	0	1	7	186	31
Unknown	2	0	1	0	0	0	0	0	1	0
Castle-Hurricane Colony Complex										
Research	8	0	0	0	0	0	0	0	0	0
USCG	0	3	0	1	0	0	0	0	0	1
Military	0	1	0	0	0	0	0	0	0	0
Law	0	1	0	0	0	0	0	0	0	0
Unmarked	3	3	0	1	0	0	0	0	0	1

Appendix 2. Number of watercraft detected categorized by type and resulting disturbance events recorded at Point Reyes, Double Point Rocks, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex, 2012.

Watercraft Type	Total Observations	Number of Agitation Events	Number of Displacement Events	Number of Flushing Events	Total Disturbance Events
Point Reyes					
Recreational (<25') Small Private	8	0	0	0	0
Recreational (>25') Large Private	1	0	0	0	0
Sailboat	2	0	0	0	0
Double Point Rocks					
Commercial Fishing	1	0	0	0	0
Recreational (<25') Small Private	2	0	0	0	0
Kayak/Canoe	1	0	0	0	0
Devil's Slide Rock and Mainland					
Recreational (<25') Small Private	6	0	0	0	0
Sailboat	1	0	0	0	0
Kayak/Canoe	2	0	0	0	0
Unmarked	2	0	0	1	1
Castle-Hurricane Colony					
Recreational (<25') Small Private	5*	0	0	0	0

*Includes one event with two boats. One boat was <25' and one boat was >25'