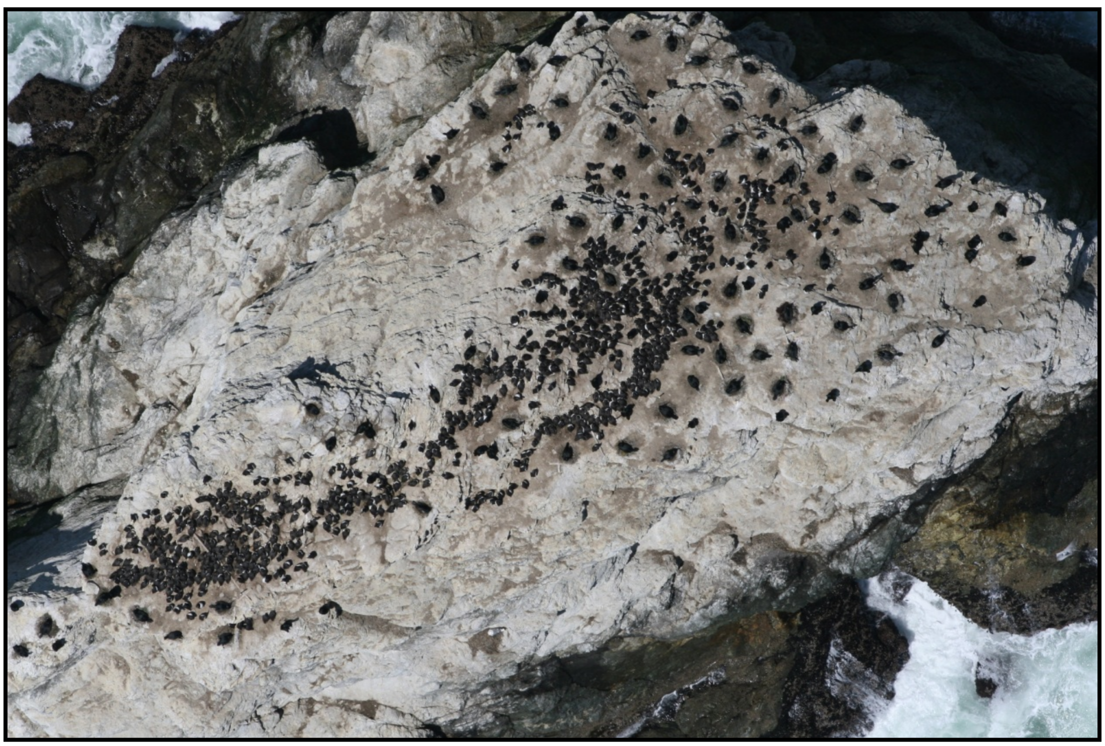
RESTORATION AND MONITORING OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2011

REPORT TO THE

LUCKENBACH TRUSTEE COUNCIL

Lisa E. Eigner, Sandra J. Rhoades, Gerard J. McChesney, Corey S. Shake, Seth D. Dallman, Jonathan A. Shore, Jason M. Brogan, Erika J. Taketa, Anna O. Mangan, Laura P. Hollander, and Richard T. Golightly



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San Francisco Bay National Wildlife Refuge Complex
1 Marshlands Road
Fremont, CA 94555 USA

FINAL REPORT
December 2012

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Lisa E. Eigner[1], Sandra J. Rhoades[2,3], Gerard J. McChesney[1], Corey S. Shake[2,3], Seth D. Dallman[2,3], Jonathan A. Shore[2,3], Jason M. Brogan[2,3], Erika J. Taketa[2,3], Anna O. Mangan[2,3], Laura P. Hollander[2,3], and Richard T. Golightly[2]

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Cover photo: Aerial photograph of Devil's Slide Rock on 1 June 2011, by Lisa Eigner.

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ABBREVIATIONS USED

CMRP = Common Murre Restoration Project

USFWS = U.S. Fish and Wildlife Service

NOAA = National Oceanic and Atmospheric Administration

CDFG = California Department of Fish and Game

GFNMS = Gulf of the Farallones National Marine Sanctuary

OSPR = Office of Spill Prevention and Response

SPN = Seabird Protection Network

PRH = Point Reyes Headlands

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

PRS = Point Resistance

MPR = Millers Point Rocks

DPR = Double Point Rocks

DSRM = Devil's Slide Rock & Mainland

DSR = Devil's Slide Rock

DSM = Devil's Slide Mainland

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

SPR = San Pedro Rock

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

BM227X = Bench Mark-227X

CRM = Castle Rocks & Mainland

HPR = Hurricane Point Rocks

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EXECUTIVE SUMMARY

Efforts in 2011 represented the 16th year of restoration and associated monitoring of central California seabird colonies conducted by the Common Murre Restoration Project (CMRP). These efforts began in 1996 to restore breeding colonies of seabirds, especially Common Murres (*Uria aalge*), harmed by the 1986 *Apex Houston*, 1998 *Command*, and extended *Luckenbach* oil spills, gill net fishing, human disturbance, and other factors. From 1995 to 2005, the primary goal was to restore the previously extirpated Devil's Slide Rock colony using social attraction techniques and to assess restoration needs at other central California colonies. Since 2005, efforts have been redirected to surveillance of human disturbance to central California murre colonies, assessing the impacts of that disturbance, and assessing other factors affecting growth of colonies. Additionally, the outcome of initial restoration efforts at Devil's Slide Rock continues to be monitored. This information informs outreach and education efforts conducted by the Seabird Protection Network (coordinated by the Gulf of the Farallones National Marine Sanctuary) and assesses the success of those efforts. The goal of the Seabird Protection Network is to restore central California breeding colonies primarily through reduction of human- caused disturbance.

Surveillance and monitoring were conducted almost daily from mid-April to late July at the following Common Murre colonies in central California: Point Reyes, Devil's Slide Rock & Mainland, and the Castle-Hurricane Colony Complex. Four additional colonies were surveyed weekly or bi-weekly including three in the Drakes Bay area (Point Resistance, Millers Point Rocks, and Double Point Rocks) and San Pedro Rock (near Devil's Slide). We measured detection and disturbance rates associated with planes, helicopters, and watercraft (or, boats). Seasonal attendance patterns, productivity, adult co-attendance patterns and reproductive success of Common Murres were also assessed. Additionally, population sizes and/or reproductive success of five other seabird species were assessed. At the Bird Island colony located near the Golden Gate, surveys were conducted three times per week, mainly by volunteers, to follow the recent murre colonization in 2008.

At Point Reyes, the combined aircraft and boat detection rate (number of aircraft or boats observed per observer hour) was the lowest of any year monitored, and the combined disturbance rate (disturbance events per observer hour) was the lowest since 2002. Detection and disturbance rates at Drakes Bay colonies were also well below the baseline mean (average of 2005-2006, including aircraft, boats, and other). Devil's Slide Rock & Mainland (DSRM) continued to have the highest combined aircraft and watercraft detection and disturbance rates of all colonies. At DSRM, combined aircraft and watercraft detection rates were lower than the baseline mean, but disturbance rates were higher. Most disturbances were agitation events (i.e., no flushing or displacement). At the Castle - Hurricane Colony Complex, the combined aircraft and boat detection rate was the lowest since 2007, but the disturbance rate was slightly higher than the baseline mean.

Unmarked aircraft (e.g., private or charter) were the most commonly observed planes and helicopters and caused the most observed disturbances at all monitored colonies. The next most common source of aircraft disturbance was from military aircraft. The majority of watercraft observed were small private recreational boats (46%) followed by charter boats (26%). Three small recreational private boats were responsible for the majority (50%) of disturbances. Seven vessels (12 events) were recorded inside state Special Closures at Devil's Slide Rock and Double Point Rocks/Stormy Stack, but only one resulted in agitation disturbance to seabirds.

The high count of 882 murres on Devil's Slide Rock was 7.0% higher than the 2010 high count, but still lower than the highest count of 1,003 murres recorded in 2009. Murre reproductive success, or productivity, was greater than average at Devil's Slide Rock and Castle Rocks & Mainland. Disturbances from Brown Pelicans (*Pelecanus occidentalis*) at Point Reyes resulted in very low murre productivity. Low co-attendance of murre breeding pairs during the chick-rearing period at Devil's Slide Rock indicated that murres needed to spend more time foraging to obtain enough prey to feed chicks.

Counts of Brandt's Cormorant (*Phalacrocorax pencillatus*) nests were greater than in 2010 at all colony complexes. However, productivity was lower than in both 2010 and the long-term means at Point Reyes and Devil's Slide Rock & Mainland. Productivity was only slightly higher at Castle-Hurricane than the long-term mean. Brandt's Cormorants had two peaks of nest initiation at Point Reyes and Devil's Slide Rock & Mainland. One occurred from April to May, and one in June, separated by a period of large-scale abandonment. Numbers of breeding Pelagic Cormorants (*Phalacrocorax pelagicus*) and Western Gulls (*Larus occidentalis*) varied among colonies compared to 2010, and productivity of monitored nests was relatively low.

INTRODUCTION

Breeding colonies of Common Murres (*Uria aalge*) in central California occur on nearshore rocks and adjacent mainland cliffs between Marin and Monterey counties as well as the North and South Farallon Islands, 20 to 40 km offshore of San Francisco (Carter et al. 1992, 2001). A steep decline in the central California population between 1980 and 1986 was attributed primarily to mortality in gill nets and oil spills, including the 1986 *Apex Houston* oil spill (Page et al. 1990; Takekawa et al. 1990; Carter et al. 2001, 2003). Between 1982 and 1986, a colony of about 3,000 breeding murres on Devil's Slide Rock in northern San Mateo County was extirpated. Since 1995, the Common Murre Restoration Project (CMRP) has sought to restore this and other central California colonies using social attraction and other techniques. Social attraction techniques were utilized at Devil's Slide Rock (DSR) beginning in 1996 (Parker et al. 2007). Murres quickly recolonized the rock and reached a 10-year restoration goal of 100 breeding pairs in five years. Social attraction was discontinued following the 2005 breeding season because the colony appeared to be well established (McChesney et al. 2006). Restoration efforts at other colonies in central California have focused on documenting 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 apparently due to restrictions on gill-net fishing, favorable prey conditions, and other factors (Carter et al. 2001; USFWS, unpublished. data). However, anthropogenic impacts to murres continue to occur and may continue to impact the population. Gill-net mortality continued (Forney et al. 2001) until the California Department of Fish and Game (CDFG) enacted an emergency closure of the gill-net fishery in September 2000, followed by a permanent closure in waters <110 meters (60 fathoms depth) from Point Reyes to Point Arguello in September 2002. Extensive oil pollution (e.g., 1998 *Command* Oil Spill and the series of oil releases from the sunken vessel *S.S. Jacob Luckenbach* from the early 1990s to the early 2000s) continued to kill thousands of murres in central California (Carter 2003; Carter and Golightly 2003; Hampton et al. 2003; Roletto et al. 2003). Disturbances from aircraft and boats have affected colonies as well (Rojek et al. 2007; USFWS, unpubl. data). Although several colonies have increased numbers similar to those in the early 1980s, others such as DSR and the Castle-Hurricane Colony Complex (CHCC) remain below historic numbers (McChesney et al. 2007; USFWS, unpubl. data). These colonies have been impacted in recent years by human disturbance, avian disturbance (from Brown Pelicans, *Pelecanus occidentalis*, and/or Common Ravens, *Corvus corax*), and poor prey conditions (from 2005 to 2009) that have contributed to reduced breeding success.

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

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* had been loaded with 457,000 gallons of bunker fuel which leaked periodically during winter storms over the years. 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 the remaining oil 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).

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

Colony surveillance and monitoring efforts have been focused at three colonies or colony complexes established as Common Murre restoration or reference sites in 1996: Point Reyes (PRH), Devil's Slide Rock & Mainland-San Pedro Rock Colony Complex (DSCC), and CHCC. Since 2005, less intensive surveys have also been conducted at three additional colonies within Drakes Bay: Point Resistance (PRS), Millers Point Rocks (MPR), and Double Point Rocks (DPR). In 2011, count surveys were also conducted three times per week at Bird Island (near Point Bonita) in Marin County. Common Murres were first recorded attending Bird Island during the 2007 breeding season among nesting Brandt's Cormorants, and in 2008 murres were recorded breeding there for the first time. Surveys at these colonies in 2009 and 2010 also were conducted mainly by trained volunteers, with the goal of documenting murre attendance and breeding.

Here we summarize colony surveillance and monitoring efforts conducted at central California nearshore murre colonies in 2011. Similar to other 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 and chick provisioning (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*). In addition, Common Raven surveys were conducted near CHCC to track the recent invasion of this seabird nest predator to the area.

METHODS

Study Sites

We conducted colony surveillance and monitoring at five colonies or colony complexes in 2011 (Figure 1). PRH (Figure 2), PRS, MPR, and DPR (Figure 3) are in the Point Reyes National Seashore, Marin County; the latter three colonies are sometimes grouped into the Point Resistance-Double, or Drakes Bay Colony Complex (DBCC). 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), San Mateo County, consists of DSRM and San Pedro Rock (Figure 4). The CHCC, 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 privately owned. At each colony, individual rocks and mainland cliffs with nesting seabirds were identified by their recognized subcolony (SC) number, subcolony name, or subarea. In this report, colonies are ordered north to south within each section.

Disturbance

All observed anthropogenic disturbance events affecting murres and other seabirds at study colonies were recorded. Major non-anthropogenic (e.g., avian) disturbances were also recorded. A disturbance event was defined as an event where adult birds were alarmed or agitated (e.g., head-bobbing in murres, raised head or wing flapping in cormorants), flushed (i.e., birds flew off of the rock) or otherwise displaced (i.e., birds moved from breeding or roosting site but did not flush). The numbers of adults flushed or displaced and the numbers of eggs or chicks exposed, displaced, or depredated were recorded. Numbers of anthropogenic disturbance events and numbers of anthropogenic disturbance events per observation hour during the "breeding season" (14 April until cessation of monitoring) were reported for comparisons between colonies and years. Monitoring effort was calculated for each colony and colony complex except for Bird Island (Table 1). Data from 2011 were then compared to baseline means for each colony or colony complex. Baseline means were calculated as the means of 2005 and 2006, the two years prior to outreach and education efforts by the SPN which aimed to reduce human disturbance to seabirds. Baseline means are reported as the mean plus or minus one standard error. For non-anthropogenic disturbances, we report the species that caused disturbances and summarized major events.

In addition to events causing disturbance, all aircraft flying at or below about 1,000 feet (305 m) above sea level (ASL) and boats within about 1,500 feet (457 m) of the nearest seabird breeding or roosting area were recorded as detections to examine use patterns of potential sources of anthropogenic disturbance. All watercraft entering new Special Closures which became effective on 1 May 2010 under the California Marine Life Protection Act (CDFG, 2004) were also recorded. Special Closures are no-access zones in which all watercraft are restricted from entering. Four of the six new Special Closures surround CMRP monitored colonies: 1) Point Reyes Headlands (1000 ft/ 305 m closure); 2) Point Resistance (300 ft/ 91 m closure); 3) Stormy

Stack/Double Point (300 ft/ 91 m closure); and 4) Egg Rock/Devil's Slide (300 ft/ 91 m closure on the west side and no passing on the east side between mainland and rock). Information recorded included: aircraft or watercraft type, direction of travel, activity (e.g. fishing, transiting, hovering), distance from the nearest seabird nesting or roosting area, and aircraft/boat identification number or name (when possible).

Common Murre Seasonal Attendance Patterns

At each colony, seasonal attendance patterns of Common Murres were monitored from standardized mainland vantage points using 65-130X or 15-60X spotting scopes. Attending murres were counted at each colony, subcolony, or index plot. For each survey, three consecutive counts were performed and a mean was calculated, except for certain subcolonies at PRH (see below). Seasonal attendance data were collected at all active subcolonies periodically during the pre-breeding season (before 14 April) at DSRM and regularly at all colonies throughout the breeding season (14 April until all chicks fledged and adult attendance ceased). Non-breeding season counts were conducted between 0700-1100 h when murres were more likely to be present. Breeding season counts were conducted during a standardized period between 1000-1400 h.

Point Reyes

Seasonal attendance patterns were determined for all murre subcolonies visible from mainland observation sites at least once per week from 20 April to 28 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 index plots were conducted three times and the means of these counts were reported. Plots on Flattop and Middle Rocks were counted once. 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 19 April to 25 August and at DPR from 21 April to 24 August (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 in 2008 breeding was documented (McChesney et al. 2009). In 2011, monitoring of these colonization attempts continued and observations were conducted by trained volunteers three times per week. From 13 May to 15 August 2011, counts were conducted during three time periods: 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
"Pre-breeding season" attendance was monitored twice per month from 7 January to 8 April 2011. Breeding season counts were conducted every other day (weather permitting).

On Devil's Slide Mainland (DSM), attendance patterns were monitored once per week for seven subareas (Figure 4): Mainland North (SC07), April's Finger (SC05), Upper Mainland South (SC05), Lower Mainland South (SC05), Mainland South Roost (SC05), Turtlehead (SC05), and South Bunker (SC04). At Turtlehead, murres attended the same subarea ("Turtlehead Boulder") as in 2010, on top of a large boulder a few meters from the north base of Turtlehead proper. In March 2011, Turtlehead Boulder shifted from what is thought to have been tsunami wave action originating from the massive earthquake off the coast of Japan in March 2011. This shift altered the orientation of the rock and thus the breeding habitat for murres (Figure 6), and made observations of the boulder impossible from Peregrine Falcon Point (or, "PEFA Pt."). Thus, all observations of Turtlehead Boulder in 2011 were made from Turtlehead Overlook (TRTH). Only two formal attendance counts were 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 patterns of murres were monitored for all active subcolonies visible from mainland vantage points (Figure 5). Counts were conducted twice per week during the breeding season from 18 April to 29 July. At four subcolonies, separate subarea counts were also obtained: CRM-04 (productivity plot and entire rock), CRM-03East (south and east sides), CRM-06South (north and south sides), and HPR-02 (Ledge and Hump plots).

Common Murre Productivity

As in 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 2010 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 and were not known to perish afterwards. Results from 2011 were compared to previous long-term means: DSR and CRM, 1996-2010 (n = 15 years); and PRH, 1996-2002 and 2005-2009 (n = 12 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, or full-scale, long-term monitoring 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 18 April.

Devil's Slide Rock and Mainland
Due to widespread colony growth and increasing difficulty monitoring the entire colony, three Type I plots (A, B and C) were established on DSR in 2006 (McChesney et al. 2006; Figure 7). Boundary adjustments were made to plots A and C in 2007 and the same plots (A, B, and C) were utilized for monitoring in 2008-2011. At DSM, all visible sites were monitored within each of three active subareas: Lower Mainland South, Turtlehead Boulder, and South of Turtlehead Cliffs (DSR-05-C). All active sites in plots and subareas were monitored beginning 18 April.

Castle-Hurricane Colony Complex
All active murre nesting sites were monitored within a plot on CRM-04 (established in 1996) beginning 18 April. The ephemeral subcolony CRM-03East also hosted breeding murres in 2011. All active sites on this rock were also monitored beginning 18 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 3 July, 8 July, and 14 July following standardized methods (see Parker 2005, McChesney et al. 2006). Observations were attempted on 12 July but ended early due to fog before the survey could be considered completed according to protocols. Eleven to 17 breeding sites with chicks were monitored each day, resulting in a total of 44 site-days. High-powered spotting scopes (65-130X) were used to conduct observations. Adult arrivals, departures, and food deliveries to chicks (including prey type, size, and fate) at each monitored site were recorded to the nearest minute. In addition, the number of birds at each site was recorded every 15 minutes throughout the entire survey to check for possible missed arrivals or departures. Results from 2011 were compared to the 1999-2010 long-term mean (reported as the mean plus or minus one standard error; no data available for 2009).

Nest Surveys

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

To provide more complete colony coverage, nest surveys from mainland vantage points were supplemented with boat surveys conducted at PRH and DBCC on 29 June, and DSCC (from SPR to Pillar Point) on 9 June. Boat surveys were not conducted at CHCC in 2011. Boat surveys were 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 high counts at each subcolony or subarea. Unlike previous years' reports, peak and seasonal high counts in 2011 included nests with brooded chicks. The boat nest count was the total number of nests counted during the boat survey, although boat counts often included only nests that could not be seen from mainland vantage points. Total counts reported are combined counts and include the highest count of the two survey methods for each subcolony/subarea, plus any nests visible only with one method. Comparisons to 2010 are made between total counts except at CHCC where comparisons are 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 Greentop (PRH-08B) and Ocho Ledge (PRH-08C). At Drakes Bay, nests were monitored at Point Resistance. At DSRM, monitoring was conducted at DSR (DSRM-01), Lower Mainland South (DSR-05-LOWER), Upper Mainland South (DSR-05-UPPER), and South of Turtlehead Cliffs (DSR-05C). At CHCC, monitoring was conducted at CRM-03East (east side), CRM-07 and CRM-09.

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 begin to wander from their nests and become impossible to associate with specific nests without marking (Carter and Hobson 1988, McChesney 1997). Results from 2011 were compared to prior long-term means for DSRM (1997-2007, 2010; n = 13 years), CHCC (1997-2001, 2006-2010; n = 10 years) and PRH (1997-2001, 2006-2010; n = 10 years). Means plus or minus one standard error are reported. Comparisons were made to 2010 if long term means were not available.

Pelagic Cormorant, Black Oystercatcher, and Western Gull Productivity

Productivity of Pelagic Cormorants, Western Gulls and Black Oystercatchers was determined at select nests that were easily visible from mainland vantage points at PRH, PRS, MPR, DPR, DSRM, and CHCC. Nests were checked at least once per week. Chicks were considered to have fledged if they survived at least 30 days and were not known to perish afterwards. Feathering status was used to determine nest success if chick age was not known (i.e., chicks that were greater than 75% feathered were considered to have fledged). Results were compared to 2010.

Pigeon Guillemot Surveys

To assess population status and seasonal attendance patterns, weekly standardized counts were conducted of birds rafting on the water and roosting on land (intertidal and nesting areas) at PRH, DSCC, and CHCC. Surveys were conducted twice per week from mid-April to 5 May, when numbers often peak, and approximately once per week thereafter, between one-half hour after sunrise and 0830 h. Due to the large size of the PRH colony area, weekly counts were conducted from just one location (Lighthouse). However, a single survey of the entire PRH colony was conducted on 8 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 (PRH and DSCC only).

Common Raven Surveys – Big Sur

Common Raven surveys were conducted to assess relative distribution and abundance near CHCC. Surveys were conducted while driving approximately 60 km/hr along a 26.4 km stretch of California State Highway 1 between Point Lobos and Point Sur. Two morning (before 0900 h) and two afternoon (after 1200 h) surveys were conducted weekly from 22 April to 25 July. Morning surveys were conducted south from Point Lobos, while afternoon surveys were conducted north from Point Sur. Each individual raven observed was considered a detection. Locations were recorded on a Garmin eTrex Personal Navigator unit and plotted on National Geographic Topo mapping software. For comparisons to previous years, the number of raven detections per km and number of raven detections per survey were calculated for the entire survey route and also for two sections of the survey area: 1) a 17.1 km segment from Point Lobos to Castle Pullout, and 2) a 9.3 km segment from Castle Pullout to Point Sur.

RESULTS

Anthropogenic Disturbance

A total of 338 aircraft overflights, including 271 (80%) planes and 67 (20%) helicopters, were recorded at PRH, DBCC, DSRM, and CHCC in 2011. Overall, 152 (42%) overflights caused some form of disturbance (e.g. agitation, displacement, and/or flushing), including 41% (112) of planes and 60% (40) of helicopters. Two percent of aircraft (two planes and six helicopters) caused flushing and/or displacement of birds. Unmarked, other aircraft made up 69% of all observed aircraft and caused the most (66%) disturbances (Figures 8-9). The next highest cause of disturbance was unmarked, "other" helicopters, which caused 18% of all disturbances and accounted for 14% of aircraft observations. Six Wildlife Disturbance Reports were completed (all from DSR) and submitted to the Seabird Protection Network in 2011. These reports included photos and maps documenting disturbance to seabirds.

Special Closures were implemented by the California Department of Fish and Game on 1 May 2010 at PRH, PRS, DPR (Stormy Stack), and DSR. A total of eight Special Closure violations were recorded in 2011 and three of these caused disturbance to seabirds. Seven recreational fishing boats, and one commercial fishing boat were recorded. Disturbances (all agitation) were caused by three of the recreational fishing boats. All Special Closure violations were reported to the California Department of Fish and Game (CalTips Hotline). Two additional disturbances (agitation) were caused by watercraft outside Special Closures, including one charter boat at DPR and one kayak at DSR.

Point Reyes

Nine aircraft overflights (0.021/hr; all planes) and two boat observations (0.005/hr) were documented at PRH in 2011 (Tables 2-3; Appendices 1-2). Six of these were from the annual aerial survey plane on 2 June, which resulted in no disturbances. Three plane overflights (33% of all overflights; 0.008/hr) caused disturbance including two agitation events (22% of plane observations) and a military jet that flushed 45 Common Murres from Lighthouse Rock (PRH-03B) on 12 April. Neither of the two small recreational fishing boats observed entered the Special Closure or caused any noticeable disturbance.

The 2011 combined aircraft and boat detection rate of 0.026/hr was 81% below the baseline mean (Table 2, Figure 10). Detection rates for planes (0.04/hr), helicopters (0.000/hr), and boats (0.005/hr) were all below baseline means. The overall (combined aircraft and boat) disturbance rate of 0.007/hr in 2011 was 81% below the baseline mean (Table 1, Figure 11). Disturbance rates (including all behaviors) for planes (0.007/hr), helicopters (0.000/hr), and boats (0.000/hr) were all below baseline means.

Drakes Bay Colony Complex

At all DBCC colonies combined, the combined aircraft and boat detection rate (0.110/hr) was 66% lower than the baseline mean of 0.263 ± 0.035/hr (Figure 12). Observation rates for planes (0.025/hr) were 63% lower than the baseline mean (0.023 ± 0.023/hr). Rates for helicopters (0.000/hr) and boats (0.081/hr) were 100% and 61% lower than the baseline means, respectively (helicopter = 0.034 ± 0.011/hr; boat = 0.206 ± 0.024hr). Disturbance rates were 11% higher for planes (0.004/hr) but 100% lower for helicopters (0.000/hr.) and 72% lower for boats (0.017/hr) compared to the baseline means (plane = 0.004 ± 0.004; helicopter = 0.023 ± 0.00; boat = 0.061 ± 0.007). The overall disturbance rate of 0.021/hr was 72% lower than the baseline mean of 0.061 ± 0.007/hr (Figure 12).

Point Resistance – During standardized monitoring in 2011, there was one plane overflight (0.041/hr; Table 4, Appendix 3) that did not cause any disturbance. No helicopters or boats were observed.

Millers Point Rocks - There were no aircraft overflights and three boat detections (0.027/hr, Table 5, Appendices 4-5) but no disturbances. The combined aircraft and boat detection rate of 0.027/hr was 89% below the baseline mean. The detection rate for boats (0.027/hr) was 86% below the baseline mean.

Double Point Rocks **–** Six aircraft overflights (all planes; 0.061/hr) and 16 boat detections (0.163/hr) were recorded at DPR (Table 6; Appendices 6-7). Five of the aircraft overflights were during our annual aerial survey of seabird colonies on 2 June, which resulted in no disturbances. The other aircraft was a small unmarked (other) plane that caused agitation but no flushing or displacement. Two separate boats caused Common Murre agitation (head bobbing) on Stormy Stack (DPR-01), including one private recreational fishing boat that entered the special closure. . One additional boat (private recreational fishing boat) was recorded inside the Stormy Stack Special Closure but did not cause noticeable disturbance.

The combined aircraft and boat detection rate of 0.223/hr was 35% below the baseline mean. The detection rate for planes was 604% above baseline, mainly because of our observer's presence during the annual aerial seabird colony survey. The detection rate for boats was 44% below the baseline mean. The overall disturbance rate of 0.051/hr in 2011 was 57% below the baseline mean. Disturbance rates were 17% higher for planes (0.010/hr) and 50% lower for boats (0.041/hr).

Devil's Slide Rock and Mainland

At DSRM, 296 aircraft (0.378/hr; including 235 plane, 59 helicopter, and two overflights of unknown origin) and 15 boat (0.019/hr) detections were recorded in 2011 (Tables 7-8; Appendices 9-10). Six aircraft overflights (2.0%) resulted from the annual aerial survey of the colony. Thirty-six aircraft overflights (12.2% of 2011 overflights) were recorded on 1 May 2011 during the Pacific Coast Dream Machines event, an 80% increase from the 2010 Dream Machines event.

A total of 49.3% (146) of aircraft overflights caused some form of disturbance. Disturbances were caused by 46% (107) of planes and 63% (37) of helicopters. Agitation with no flushing or displacement of seabirds was observed in 47.3% of overflights. Two percent (six) of overflights caused flushing of one or more seabirds, including five events that flushed Common Murres (range = 3-70 birds) and one event where a single Brandt's Cormorant was flushed. Of the six overflight disturbances, two were caused by military helicopters, one by a U.S. Coast Guard helicopter, two by unmarked (other) helicopters and one by an unmarked (other) plane. Low-flying (range = 400-500 ft) helicopters accounted for 83% of aircraft flushing events. The greatest number of birds disturbed occurred on 22 April when a commercially owned helicopter transiting south at 500 ft ASL passed directly over DSR and flushed 70 murres.

A total of 15 vessel detections were recorded at DSRM in 2011. Two vessels caused seabird agitation, including a permitted charter boat hired to place special closure buoys and a recreational kayak but no vessels caused flushing or displacement. Three detections were of vessels involved in special closure buoy launching and maintenance. Five vessels entered the Egg Rock/Devil's Slide Special Closure. Only one, the aforementioned charter boat, caused disturbance (agitation) in the Special Closure area. Our small research boat entered the Special Closure by permit to conduct seabird colony surveys. The other three Special Closure violations involved a private fishing vessel (two entries by the same vessel) and a small commercial fishing vessel.

One land-based disturbance at DSRM occurred on 7 May as loud exhaust noise from a Volkswagen automobile, driving past Turtlehead Overlook (TRTH) on Highway 1, caused 15 Pigeon Guillemots to flush from Turtlehead Boulder.

In 2011, the overall aircraft and watercraft detection rate decreased but the disturbance rate increased compared to baseline means. The overall detection rate of 0.395/hr was 14% lower than the baseline mean (Figure 10). Overflight detection rates were slightly lower than baseline for both planes (4%) and helicopters (1%). The watercraft detection rate was 73% lower than the baseline mean.

The overall disturbance rate of 0.188/hr was 22% above the baseline mean and 81% higher than in 2010 (0.105/hr), but was more consistent with rates observed in 2006-2009 (Figure 11). Disturbance rates from planes (87%) and helicopters were 87% and 17% above the baseline means, respectively. The boat disturbance rate was 92% below baseline. If only flushing and displacement were included, the overall disturbance rate for 2011 (0.009/hr) was actually 68.3% lower than 2010 (0.028/hr).

Castle-Hurricane Colony Complex

A total of 33 aircraft (0.109/hr; 25 planes and eight helicopters) and three boat (0.010/hr) detections were recorded at CHCC in 2011 (Tables 9-10; Appendices 11-12). Ten (30%) aircraft overflights were recorded during the annual aerial seabird colony survey on 1 June.

Four (12%) aircraft overflights (0.013/hr) caused some level of disturbance. Three of four disturbances caused agitation of murres, two of which were caused by low flying (range = 500-700 ft) helicopters (38% of helicopters). The one plane disturbance (4% of planes) caused agitation of murres and occurred during the annual aerial seabird colony survey. None of the three boat detections caused any form of obvious disturbance. Only one (3%) aircraft overflight, a low flying helicopter (13% of helicopters), caused flushing of 50 Common Murres and two Western Gulls (Table 10). There were two aircraft overflights by the same plane during the Big Sur Marathon on 1 May; neither caused visible disturbance.

Compared to baseline means, both detection and disturbance rates increased in 2011. The combined aircraft and boat detection rate of 0.119/hr was 72% greater than the baseline mean (Figure 10). Plane, helicopter, and boat detection rates were 29%, 786%, and 390% above baseline means, respectively (Table 9). The overall disturbance rate (0.013/hr) was 122% above the baseline mean (Figure 11). Compared to the baseline means, disturbance rates were also higher for planes (11%) and helicopters (399%). Despite higher than baseline values, detection and disturbance rates were relatively low.

Non-Anthropogenic Disturbance

Point Reyes

Sixty-two flushing and displacement events were recorded at PRH, all affecting Common Murres. The majority (54%) of disturbance events were caused by Common Ravens. Immature Brown Pelicans were responsible for at least 18 disturbance events (28.6%), and five of six disturbance events with unseen causes were suspected to have been caused by Brown Pelicans.

Turkey Vultures were responsible for one disturbance, and Western Gulls were responsible for four additional disturbances. Seventy-one percent of all disturbances were observed on Lighthouse Rock, where we spent considerably more time.

Similar to other recent years, pelican disturbance resulted in major impacts to murre breeding in 2011. Thousands of birds were flushed on multiple occasions between 19 June and 25 July, and 94 eggs and 23 chicks were seen taken by Western Gulls and Common Ravens as a result of pelican disturbances. Multiple pelican disturbances occurred on our two murre productivity plots (27 June and 1, 3, 4, and 13 July) and resulted in complete breeding failure on Edge Plot and several egg and chick losses on Ledge Plot (also see Common Murre Productivity, below).

On 25 July on Middle Rock, a young pelican was observed swallowing a murre chick; it was unclear whether the chick was dead or alive when the pelican found it. On 13 July at Lighthouse Rock, one pelican ate five small fish dropped by adult Common Murres on various parts of the colony. Two of these fish were kleptoparasitized just as the adults were passing them to their chicks.

Disturbances solely by ravens occurred throughout the breeding season and resulted in hundreds of murres flushed and displaced; 10 eggs and one chick were depredated during these events.

Drakes Bay Colony Complex

Point Resistance **–** Four of six non-anthropogenic disturbances observed at PRS were caused by Brown Pelicans and the two others were caused by Turkey Vultures. One Turkey Vulture disturbance displaced 20 murres and the other five disturbances flushed between five and 120 Common murres. During a pelican disturbance on 25 June, one murre chick was eaten by a Western Gull.

Millers Point Rocks **–** Two non-anthropogenic disturbances were observed at MPR; both occurred at Millers Point North Rock (MPR-01). Each of these disturbances, one caused by a Common Raven and the other by a Turkey Vulture, flushed a small number of Common Murres. No eggs or chicks were exposed or taken.

Double Point Rocks **–** A total of 20 non-anthropogenic disturbances were observed at DPR. Half (ten) were caused by Brown Pelicans, eight were caused by Common Ravens, and one Turkey Vulture and one Brandt's Cormorant each caused an additional disturbance. All but one pelican disturbance involved one or two immature birds walking through the colony, and several of these resulted in hundreds to thousands of murres flushed or displaced. During pelican disturbances, we observed 276 murre eggs and 48 chicks exposed or displaced, and 14 eggs and nine chicks taken by predators. The most significant disturbance was on 16 June. Ravens generally disturbed smaller groups of murres; the largest group flushed or displaced in one event was 500. Seven murre eggs were observed lost during raven disturbances.

Devil's Slide Rock and Mainland

Ten murre flushing events were recorded at DSRM, all on DSR. Seven events were caused by Brown Pelicans (four events caused by juveniles), one event by a Western Gull, and two events of unknown origin, possibly caused by a Heermann's Gull.

Brown Pelicans flying over or landing on DSR caused 12 to 60 murres to flush or displace on seven occasions. On 1 July, two juvenile pelicans caused two separate events which resulted in a total of three murre eggs exposed. All three eggs were re-incubated within seven minutes of being exposed. The disturbance event that impacted the most birds occurred on 26 July when a juvenile pelican landed on the west side of DSR and displaced 40 adult murres and four murre chicks, and flushed 20 more adult murres. Murres resumed normal behavior following the event and no eggs or chicks were lost.

On 8 May, two Western Gulls flying over DSR caused 30 murres to flush (all returned to the rock). On 23 July an unknown source, suspected to be a Heermann's Gull, flushed a total of 30 murres (two events) and one Brandt's Cormorant. Common Ravens were not observed causing disturbance to murres in 2011 although there was one nesting pair recorded on the mainland.

Castle-Hurricane Colony Complex

Major disturbances to murres were infrequent and were caused by either Brown Pelicans (two events) or Western Gulls (one event). Two Brown Pelican flushing events were recorded in 2011. On 27 June, six pelicans flying over CRM-04 flushed ten murres and displaced 50 murres from their sites; no eggs or chicks were exposed and all disturbed murres returned to their sites. On 3 July, a single juvenile pelican on HPR-02-Ledge flushed 350 murres, displaced 30 murres, exposed 15 eggs, and displaced 45 chicks. The event occurred during a colony count and resulted in decreased attendance on that day. Murre attendance appeared normal the following day. On 6 June, a Western Gull displaced three adult murres and depredated one egg from a monitored site on CRM-03East.

Common Murre Seasonal Attendance Patterns

Point Reyes

All well-established nesting areas were active with confirmed breeding in 2011. Attendance patterns were fairly typical at most subcolonies. For most subcolonies, peak numbers were recorded in the few weeks prior to first egg lay dates and then numbers remained relatively consistent throughout the incubation and chick periods (Figures 13-14). These consistent patterns generally began in mid- to late May and numbers began to decline in late July, corresponding with egg-laying and chick-fledging dates recorded at Lighthouse Rock. A major disturbance caused by an immature Brown Pelican cleared almost all breeding murres from Edge Plot on Lighthouse Rock, resulting in a very low count on 1 July. Additionally, immature pelicans were seen flushing murres from Boulder and Beach Rocks in mid- and late July, which might explain a slightly earlier decline in numbers at those subcolonies.

Murres attended many ephemerally used subcolonies in 2011, but successful breeding at most of these was most likely limited because attendance periods were too short for successful fledging of chicks. Murres attended Trinity Point (PRH-08A), Cliff Colony West (PRH-09B), Wishbone Point (PRH-11E), and Sloppy Joe (PRH-12A) in association with nesting Brandt's Cormorants. Greentop (PRH-08B) had sporadic murre attendance. Tim Tam (PRH-10H) had low attendance throughout the season; counts dropped to two birds on 23 June, indicating that successful breeding was limited. Subcolony PRH-14B had regular murre attendance from mid-May through late July with a high count of 744 murres on 20 July; this is very high attendance for this subcolony.

Drakes Bay Colony Complex

Point Resistance – Murre attendance was regular but variable (Figure 15). A decline in numbers in mid-July, followed by a moderate increase through 25 July when the last count was conducted, may have reflected a disturbance event in mid-July.

Millers Point Rocks – Regular attendance patterns through the breeding season suggested successful breeding on the North Rock (MPR-01) and the relatively small rock known as Blue Cheese (MPR-05; Figure 15). On Blue Cheese, up to 52 birds (14 May) were recorded between 24 May and 25 July; a low count of four birds on 17 June suggested that numbers of successful breeders were low. On the large South Rock (MPR-02), only single birds were observed on three occasions: 25 June, 11 July, and 15 July (Figure 15). This rock has been all but abandoned in recent years.

Double Point Rocks – Attendance at Stormy Stack was fairly stable for much of the breeding season despite some major disturbances by Brown Pelicans (see Anthropogenic Disturbance, above; Figure 15). However, a decline in attendance in early July was earlier than most other colonies and likely reflected pelican disturbances and resultant failed breeding. A high count of 1,984 birds at all plots combined was recorded on 1 May.

Bird Island

Surveys were conducted from 13 May through 15 August, when the last murre was observed. The first murres were observed on 23 May. Most birds were observed in a small area on the northwest portion of the rock, under and around the last remains of a former U.S. Navy compass house. The average count was 11 ± 1 SE murres, with a high count of 32 murres on 27 July. No eggs were seen, but at least two chicks were observed fledging (10 and 14 August), and one other fledging-aged chick was seen on the rock on 14 August.

Devil's Slide Rock and Mainland, San Pedro Rock

Devil's Slide Rock - Murres were observed on all count days between 7 January and 12 August 2011 (Figure 16). The greatest counts were recorded during the pair formation/site prospecting period and the chick period. The maximum count of 882 murres was recorded on 28 April during the late pre-egg-laying period. This count was 7.0% higher than the 2010 high count of 824 murres, but lower than the highest count of 1,003 murres recorded in 2009. Attendance patterns were fairly typical of a successful colony, with highly variable attendance until egg-laying began in mid-May, less variable attendance during the incubation and early chick stages (mid-May to early July), increased attendance during the peak chick period (early to mid-July), followed by rapid decline as adults and chicks departed the colony. During the annual aerial surveys on 1 June, 771 murres were counted compared to 576 murres counted the same day from the standardized land-based vantage point (Figure 17).

Devil's Slide Mainland – As in other recent years, murres were observed attending and breeding on Lower Mainland South (DSR-05A) and Turtlehead Boulder (DSR-05B). In June 2011, murres started attending a new area on South Turtlehead Cliffs (DSR-05C; Figure 18). Although the high count was only five birds (19 July), one breeding site was confirmed (Figure 17). Murres were observed attending Turtlehead Boulder from 21 January to 21 June, when attendance ceased. The high count was 74 birds on 27 April. Most breeding attempts failed in early June when many broken egg shells were observed.

On Lower Mainland South, murre attendance (Figure 17) reflected Brandt's Cormorant breeding attendance. Murre attendance was highest during periods of Brandt's Cormorant nest building (around 10 May and 23 June). As cormorants abandoned nesting efforts, murre breeding efforts failed and murre attendance declined. In areas where Brandt's Cormorants did not re-establish nests, murres ceased attendance. The high count of 37 murres on 18 May occurred one week prior to murre egg-laying on Lower Mainland South.

Murres again were observed on the western point of South Bunker Cliffs (DSR-04; Figure 19). Attendance was only seen until 1 June (9 birds) and no murres were observed breeding. On Mainland North (DSR-02), single non-breeding murres were observed on two occasions in early May. The greatest combined single day count for all mainland subareas was 71 birds on 3 May.

San Pedro Rock -Murres were not observed on San Pedro Rock in 2011.

Castle/Hurricane Colony Complex
The majority of CHCC subcolonies displayed a similar attendance pattern: peaks in mid-April, a decline in early May, relative stability from mid-May to early July, and a rapid decline in mid- to late July (Figures 20-22). Murres were absent from CHCC by 29 July.

Murres were observed attending CRM-03East (Southside) as viewed from the FUNT overlook for the second year in a row. Unlike in 2010, there were no Brandt's Cormorants nesting in this area. Murres began attending this subarea at the beginning of the breeding season and attendance remained consistent until it ceased on 14 July. No breeding was observed or suspected at CRM-05 where attendance was slightly lower than in the previous three years, although murres were recorded on every count from 16 May until 8 July.

Deviations from typical patterns included highly variable counts on CRM-06South (Southside), as was observed in the previous two years. These seemingly erratic attendance patterns may have been attributed to poor observation conditions due to the distance from the overlook, often exacerbated by either poor lighting conditions or heat waves. At HPR-02 Ledge, a pelican disturbance on 3 July resulted in an especially low count that day (also see Non-anthropogenic Disturbance section, above). At BM227X-02, attendance by small numbers of murres did not begin until about 30 May. At CRM-04, three juvenile Brown Pelicans roosting within ten feet of the plot on 18 July may have affected the number of murres (20) counted that day, since 91 murres were counted the previous day. However, this decline in attendance also may have reflected chick fledging (also see Common Murre Productivity, below).

Common Murre Productivity

Point Reyes

A total of 166 sites were monitored between Ledge (n = 93; 56%) and Edge (n = 73; 44%) plots on Lighthouse Rock. In Ledge Plot, 73 sites were breeding and 20 were territorial. There was a 1.4% increase in the number of breeding sites from 2010. The mean egg lay date for first eggs in Ledge Plot was 29 May ± 1.2 days (range = 14 May-21 June; n = 52; Table 11), five days later than the long-term average (24 May ± 2.9 days). Seven replacement eggs were laid in Ledge. The number of chicks fledged per breeding pair was 0.26, 57.4% lower than the long-term mean (0.61 ± 0.07; Figure 23).

In Edge Plot, 57 sites were breeding and 14 sites were territorial. The number of breeding sites decreased 6.6% from 2010. Two sites (considered territorial) were seen in incubating posture but without confirmed eggs for several days (four to eight days) before a major disturbance from Brown Pelicans on 27 June. As a result of this disturbance, it is possible that these sites lost eggs before breeding could be confirmed. The mean egg lay date for first eggs in Edge Plot was 26 May ± 1.1 days (range = 15 May-9 June; n = 32; Table 11) - two days earlier than the long-term mean of 28 May ± 3.5 days. Three replacement eggs were laid. Disturbances by immature pelicans on 27 June and 1 July were observed that cleared almost all murres from the plot and resulted in major losses of eggs and chicks (also see Non-anthropogenic Disturbance, above). It is suspected that other pelican disturbances occurred that were not observed. All breeding sites failed by 1 July. Long-term mean productivity at Edge Plot was 0.53 ± 0.06 (Figure 23).

When Edge and Ledge plots were combined, the mean egg-laying date was 28 May ± 0.9 days, (range = 14 May-21 June; n = 84; Table 11), three days later than the long-term mean (25 May ± 2.8 days). Overall productivity was 0.15 chicks fledged per pair, 76% lower than the long-term average (0.59 ± 0.06), with both low hatching (29.3%) and fledging success (46.3%). Fledged chicks remained on the rock for an average of 20 days. The last chick observed in Ledge Plot was on 26 July.

Devil's Slide Rock and Mainland

Of 222 sites documented within DSR plots, 189 (85.1%) were breeding, 31 (14.0%) were territorial, and 2 (0.9%) were sporadic. There was a 29% increase in the number of breeding sites from 2010. At all sites combined, the mean egg-laying date of first eggs was 27 May ± 0.6 days (range = 13 May-13 July, n = 164; Table 11), which is similar to the long-term average (26 May ± 2.2 days). In Plot C, there were 12 breeding sites compared to none in 2010 and egg-laying occurred one week later than in Plots A and B. A total of 194 eggs were laid, including five replacement eggs. Overall productivity of 0.72 chicks fledged per pair was 32.9% higher than the long-term average (0.54 ± 0.06; Figure 23). Above average productivity was influenced by both high hatching and fledging success (80.4% and 86.8%, respectively). Chicks that fledged remained on the rock for an average of 25.4 ± 0.3 days after hatching and the last chick was seen on 12 August.

On DSM, breeding murres were documented for the seventh consecutive year at Lower Mainland South and for the fourth straight year at Turtlehead Boulder. Although small numbers of birds attended Upper Mainland South, South Bunker Cliffs, and the north facing cliffs of

DSR-05C (see Common Murre Attendance Patterns, above), no breeding was observed. On 17 June, an abandoned murre egg was observed on the South Turtlehead Cliffs (DSR-05C) amongst three attending murres surrounded by nesting Brandt's Cormorants.

Recorded breeding sites on DSM decreased 29% from 2010. Of 65 total sites monitored in three subareas, 30 (46.2%) were breeding, 30 (46.2%) were territorial, and five (7.7%) were sporadically attended. The mean egg-laying date was 30 May ± 1.3 days (range = 21 May-17 June, N = 29; Table 11). There were two replacement eggs recorded, both on Turtlehead Boulder. All breeding attempts (n = 6) on Lower Mainland South failed during incubation by 16 June. There were 23 breeding sites observed on Turtlehead Boulder and all failed by 18 June. The many broken egg shells observed on Turtlehead Boulder suggested that predation may have caused the failure of this subcolony, but eggs may have been scavenged following abandonment. Changes to the habitat may have also been a factor (see Common Murre Attendance Patterns, above).

Castle-Hurricane Colony Complex

Of 112 monitored sites in the CRM-04 plot in 2011, 80 (71.4%) were breeding, 24 (21.4%) were territorial and seven (6.3%) were sporadic (Table 11). The number of breeding sites decreased by 3.6% from 2010. Eggs were first observed on 12 May, and the mean egg-laying date was 20 May ± 0.7 days (range = 11 May-4 June; n = 42), 4 days later than the long-term average of 16 May ± 2.4 days. No replacement eggs were observed. Overall productivity was 0.56 chicks per pair, 19% higher than the long-term average (0.47 ± 0.06 chicks per pair; Figure 23). Sample sizes for hatching success, fledging success, and overall productivity were lower than usual because egg and chick fate data for several sites were inconclusive. Chicks that fledged remained on the rock for an average of 24.3 ± 0.8 days (n = 23) after hatching and the last chick was seen on 19 July.

For the fourth consecutive year, murres bred and were monitored on the east side of CRM-03East. Of 143 sites monitored, 110 (76.9%) were breeding, 24 (16.8%) were territorial and nine (6.3%) were sporadic. The number of breeding sites increased 62% from 2010. The first egg was observed on 22 May and the mean egg lay date was 26 May ± 0.4 days (range = 19 May-3 June; n = 38; Table 11). Three replacement clutches were laid. The very low productivity of 0.27 chicks per pair on CRM-03East was 47% lower than the long-term average of 0.51 ± 0.10 chicks per pair (1999-2003, 2005, 2008-2010; n = 9 years) for this subcolony.

Common Murre Co-attendance and Chick Provisioning

At DSR, the mean percent of sampling period that pairs with chicks spent in co-attendance was 3.7% ± 0.004 (range 1.3-7.7%; n = 16), which is 74.6% lower than the long-term average of 14.5% ± 0.01. Data from four breeding pairs was omitted from calculations since we were not able to monitor co-attendance for more than one survey day. During co-attendance observations, 173 mate arrivals were recorded. On average, mates arrived 0.32 ± 0.03 times per site per hour (range = 0.14-0.51; n = 16). Of all mate arrivals seen, 84.4% were observed with prey, 8.1% had no prey, and 7.5% were inconclusive. Of the prey deliveries, 95.2% were consumed by chicks and 2.9% were undetermined. The mean chick provisioning rate was 0.26 ± 0.03 feedings per hour (range: 0.03-0.43; n =16), 9.8% higher than the long-term average of 0.23 ± 0.02. On 8 July, one chick was observed unattended for 29 minutes until an adult returned with prey.

Brandt's Cormorant Nest Surveys and Productivity

Point Reyes

Nest surveys – Brandt's Cormorant nest surveys were conducted from 22 April to 28 August (Table 12). Well-built nests were recorded at Trinity Point (PRH-08A), Cliff Colony East (PRH-09A), Cliff Colony West (PRH-09B), Arch Rock (PRH-11D), Spine and Wishbone Points (PRH-11E), Sloppy Joe (PRH-12A), and Cone Rock (PRH-13). The first well-built nest was observed on 22 April. The peak single-day count for all subcolonies combined was 247 nests during the week of 4 July. The sum of the seasonal high counts for all subcolonies visible from land was 311 nests. Inclusion of 12 additional nests recorded during the boat survey raised the total count to 323 nests, 21% higher than the 2010 total nest count (254 nests).

Productivity - A total of 129 nests were monitored at PRH and 125 were egg-laying sites (Table 13). Monitoring of nests on Spine and Wishbone Points began on 4 May. Monitoring of nests on Sloppy Joe began on 5 June. At the beginning of these monitoring periods, there were 18 nests that had or may have had complete clutches (seven at Spine/Wishbone and 11 on Sloppy Joe). A clutch initiation date could be confidently backdated from hatch dates for only one of these nests, so it is likely that estimates of average clutch initiation presented here are biased slightly late. A notable nest abandonment event occurred on Spine and Wishbone points between 16 and 27 May, when 28 of 78 nests (36%) were abandoned. However, by mid-June, all but three of these abandoned nests had relayed eggs and many pairs initiated nesting in areas including Sloppy Joe, Trinity Point, and Cliff Colony West. Nests with a relay clutch were assumed to consist of the same pairs of birds as the first clutch.

The average clutch initiation date of 17 May ± 1.7 days for first clutches (Table 13) was two days earlier than the long-term mean of 19 May ± 5.1 days. First chicks were observed on 27 May. Overall productivity of 1.36 chicks fledged per pair (subarea range = 1.03-1.81) was 23.3% lower than the long-term average of 1.77 ± 0.2 (Figure 24). Breeding success per nest was 0.67 chicks per pair (subarea range = 0.53-0.78), indicating fairly high rates of nest abandonment.

Drakes Bay Colony Complex

Nest surveys – High counts of Brandt's Cormorant nests from land, single boat counts, and combined land/boat counts for the Drakes Bay colonies are summarized in Table 12.

Brandt's Cormorants had a higher nesting effort on PRS than in 2010. The first well-built nests were observed on 29 April and the peak number of nests was 28 on 17 June. The first nests were observed on MPR-01 on 19 April, the first check of the season. The peak count was 50 nests on 20 May.

The first well-built nests on Stormy Stack were observed on 21 April. The peak count of 67 nests occurred on 13 May. Brandt's Cormorants also nested on DPR-02 in 2011 for the first time since land-based monitoring began in 2005. The first well-built nests were recorded on 12 June.

The peak count of 20 nests was observed on 24 July.

At all Drakes Bay colonies combined, 199 nests were counted from land and boat surveys combined (Table12), 424% higher than in 2010 (38 nests).

Productivity – A total of 52 egg-laying nests were monitored on Miller's Point North Rock (MPR-01; Table 13). Monitoring of nests began on 29 April. At this time there were 23 nests that already had or may have had complete clutches, and clutch initiation dates could not be determined for almost all of these nests. Because of this, it is likely that estimates of average clutch initiation date presented here are biased slightly late. Ten of 50 active nests (20%) were abandoned between 16 and 26 May, although seven of these nests relayed eggs by mid-June.

The average clutch initiation date was 5 May ± 1.2 days. Chicks were first observed on 24 May. Productivity was 1.10 chicks per pair (n = 52), and breeding success per nest was 0.69 (n = 52).

Bird Island

Surveys were conducted between 13 May and 31 July. Although cormorants were observed regularly on the rock, no nests were recorded on Bird Island in 2011.

Devil's Slide Rock and Mainland, San Pedro Rock

Nest surveys – Nest and territorial sites were counted at all nesting areas between 19 April and 10 August. Territorial sites on Devil's Slide Rock (DSR-01) were observed as early as 1 April during pre-season counts of murres. The first nest survey with well-built nests was on 26 April. This was the largest nesting effort by Brandt's Cormorants on DSR since 2007. On the mainland, the nesting occurred predominantly on Mainland South and South Turtlehead Cliffs, with small numbers of nests (high count of 11 nests) on Mainland North (DSR-02). There was an early nest building effort that peaked on 11 May, then numbers of nests declined until about 1 June when nest initiation resumed and increased until the peak. The peak count was 130 nests on 28-29 June. The sum of the seasonal high counts, including the boat survey, was 145 nests (Table 12), 179% higher than in 2010 (52 nests).

Productivity – Brandt's Cormorant nests were monitored on DSR, Lower Mainland South, Upper Mainland South, and South Turtlehead Cliffs (Table 13). The first egg was observed on DSR on 20 April. For all subareas combined, the mean clutch initiation date of 27 May ± 1.5 days was 17 days later than the long-term mean of 10 May ± 3.2 days. Overall productivity of 0.89 chicks fledged per pair (subarea range = 0.75-1.67; n = 178) was 55.9% lower than the long-term average of 2.01 ± 0.2 (Figure 24). Breeding success per nest of 0.54 chicks indicates relatively high nest abandonment. There were thirty-four replacement clutches, an unusually high value.

Castle-Hurricane Colony Complex

Nest surveys - Brandt's Cormorant nest surveys were conducted from 18 April to 29 July. Subcolonies with confirmed breeding in 2011 were BM227X-02, BM227X-03, CRM-03East, CRM-07, and CRM-09. The first well-built nests were observed on CRM-03East on 20 April. At all CRM subcolonies combined, the peak single survey nest count of 88 nests was recorded on 8-9 July and the sum of the peak subcolony counts was 91 nests (Table 12). At BM227X subcolonies combined, the peak count of 146 nests was recorded on 29 June.

For all CHCC colonies combined, the peak single-day count of 228 nests on 8-9 July was 75% higher than the 2010 peak count. The sum of the peak subcolony counts was 237 nests, 81% higher than in 2010.

Productivity – Brandt's Cormorant productivity was monitored on three CRM subcolonies: CRM-03East, CRM-07 and CRM-09 (Table 12). For all subcolonies combined, the mean clutch initiation date of 9 May ± 2.1 was the same as the long-term mean of 9 May ± 5.1. The first chicks were observed on 23 May. Overall productivity of 1.67 chicks fledged per pair (subcolony range = 1.20-2.00; n = 49) was 7% higher than the long term average of 1.56 ± 0.3 (Figure 24). Breeding success per nest of 0.82 chicks reflects a relatively low rate of nest abandonment.

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

Nest and bird surveys

High 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 12 and 14. Boat counts were not conducted at CHCC in 2011; therefore nest survey results are compared only to land counts from 2010.

Pelagic Cormorant – Pelagic Cormorant nests were first observed at CRM on 15 March, at DSRM on 19 April, at DBCC on 19 April, and at PRH on 22 April. Eggs were first recorded at CHCC on 23 April, at DSRM on 3 May, at DBCC on 5 May, and at PRH on 20 July. Nest counts were higher at DBCC colonies (45%) but were lower at PRH (29%) and DSRM (40%) than in 2010. Nest counts at CHCC (seven) were the same as in 2010, although the count in 2010 included a boat survey.

Western Gull – Compared to 2010, nest counts were higher at PRH (21%), MPR (20%), DPR (67%), and SPR (33%). While nest counts were 24% lower at DSRM than in 2010, nest counts for the entire Devil's Slide Colony Complex (DSRM and SPR combined) in 2010 and 2011 were the same. Compared to 2010, nest counts from land were lower at CHCC (29%). No nests were counted at PRS in either year.

Pigeon Guillemot – At PRH, the peak standardized count from the lighthouse of 188 birds on 8 May was 37.2% higher than in 2010. Single land-based (471 birds) and boat (469 birds) surveys of the entire headlands were 78% and 19% higher than counts in 2010, respectively. Although surveys of Drake's Bay colonies were not done at standardized times, land counts were slightly lower than 2010 at both PRS and MPR (18.2% and 28.5% respectively) and higher than 2010 at DPR (12%). Boat counts at DBCC were much higher at MPR (400%) and PRS (143%) and lower at DPR (42%) than in 2010.

At the Devil's Slide Colony Complex, the high land-based count of 190 guillemots on 29 April was 28% higher than in 2010, and the boat count of 101 guillemots was 45% lower. On 30 June, a large guillemot chick was seen outside a nest crevice on April's Finger (DSR-05AF).

At CHCC, the high land counts of 31 birds on both 9 and 23 July were 42% lower than in 2010. At least one guillemot was observed flying with a prey item to the rocks at BM227X-02.

Productivity
Productivity results of Pelagic Cormorants, Western Gulls, and Black Oystercatchers are summarized in Table 15.

Pelagic Cormorant – Nests were monitored at PRH, MPR, DPR, DSRM, and CHCC. At DSRM, Pelagic Cormorant productivity was monitored on South of Turtlehead Cliffs (DSR-05C). Productivity was 34% higher at PRH and 8% higher at CHCC than in 2010. Productivity was 48% lower at DSRM and 50% lower at DBCC than in 2010.

Western Gull – Nests were monitored at PRH, MPR, DPR, DSRM, and CHCC. Productivity was 1.7% lower at DSRM, 6% lower at PRH, and 40% lower at CHCC than in 2010. Productivity increased from zero in 2010 to 0.33 at DBCC.

Black Oystercatcher – Nests were monitored at DBCC, DSRM, and CHCC. Three nests were monitored at DBCC (two at MPR and one at DPR). One nest successfully hatched chicks, but the fate of the chicks could not be determined. Productivity was 0.0 chicks/pair (n = 2) at DSRM and 0.67 chicks/pair (n = 3) at CHCC. Productivity was similar to 2010 at DSRM and CHCC.

Common Raven Surveys – Big Sur

In 2011, 42 Common Raven surveys were conducted along Highway 1 between Point Lobos and Point Sur. A total of 18 raven detections were recorded (Figure 25), corresponding to 0.43 ± 0.9 SD detections/survey (range = 0-4) and 0.016 detections/km. On a per kilometer basis, ravens were detected at a higher rate in the southern portion (Point Sur to Castle Pullout; 0.028/km, or 0.26 detections/survey; n = 11 detections) than in the northern portion (Point Lobos to Castle Pullout; 0.010/km. or 0.17 detections/survey; n = 7 detections).

The overall detection rate in 2011 was 40% lower than in 2010 (0.71 ± 1.1 detections/survey and 0.027 detections/km). The detection rate in the northern portion was lower compared to 2010 (0.033/km) while the detection rate in the southern portion was higher compared to 2010 (0.017/km).

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

DISCUSSION

Anthropogenic Disturbance

As in previous years, PRH had the lowest combined aircraft and boat detection and disturbance rates of all colonies in 2011. PRH also had the lowest combined aircraft/boat detection rate of any year monitored and the lowest disturbance rate since 2002. All disturbances in 2011 were caused by planes, and the only flushing event was caused by a military jet. DBCC also had detection and disturbance rates well below the baseline mean for that area.

DSRM continued to have the highest detection and disturbance rates of all colony complexes. Low-flying helicopters continued to account for the majority of seabird flushing events. Overall detection rates for aircraft and watercraft were lower than the baseline mean, but disturbance rates were higher. Disturbance rates increased 78% from 2010 but were 19% lower than in 2009. When only flushing and displacement disturbance events were included, the rate of overall disturbance for 2011 was 68% lower than 2010. Agitation only (i.e., no flushing or displacement) of seabirds was observed in almost half (47%) of all aircraft overflights. The high rate at which aircraft caused agitation is a cause for concern. Overflights during the Dream Machines event increased greatly this year. Although no displacement or flushing was observed during the Dream Machines event, 69% of the overflights caused agitation in murres. Overflights causing agitation were spread throughout the day, with 80% before 1300 h causing agitation and 74% after 1300 h causing agitation.

Boat detection and disturbance rates at DSR were well below the baseline means in 2011. Because of other factors such as weather conditions and fishing regulations that affect vessel occurrence in the area, it is unclear what affect the Special Closure surrounding DSR (enacted in May 2010) or the buoys (placed in spring 2011) had on vessel occurrence. All vessels observed in the Special Closure at DSR (excluding research and buoy deployment/maintenance vessels) in 2011 entered from the west boundary. This boundary was missing a marker buoy, as the west buoy had become submerged and later was observed missing. Two of the three buoys placed to demarcate the Special Closure broke free of their tethering cables during the 2011 summer season.

The combined aircraft and boat detection rate at CHCC was the lowest since 2007, but the disturbance rate continued to be above the baseline mean. As at DSR, helicopters continued to be the main source of disturbance.

Non-Anthropogenic Disturbance

In 2011, most non-anthropogenic disturbances occurred at PRH and DBCC, and most were caused by Common Ravens and Brown Pelicans. Raven disturbances only occurred at colonies within Point Reyes National Seashore where raven numbers were artificially inflated by anthropogenic food sources, mainly dairies (Kelly et al. 2002). Ravens that nest near colonies at PRH and DBCC frequently fly over and flush birds, and occasionally depredate murre eggs or chicks. As part of a raven management program initiated by Point Reyes National Seashore in 2011, a pair of ravens that nested at PRS in 2010 was removed. This removal was reflected in no raven disturbances observed at PRS in 2011, compared to regular raven disturbances in other recent years.

Similar to most recent years, non-breeding Brown Pelicans caused major impacts to nesting murres at certain colonies in 2011 when juvenile pelicans roamed through breeding colonies, flushed murres off eggs, preyed on at least one murre chick, kleptoparisitized adults and chicks, and generally prevented chicks from being fed. While disturbances occurred at nearly all monitored colonies, disturbances were most frequent and severe at PRH and DBCC colonies. Impacts included the complete breeding failure of Edge Plot at PRH. Rapid colony departure at CRM-04 and CRM-03East following the presence of three young pelicans roosting on CRM-04 on 18 July could have been related, although departure may have been more related to chick fledging. Fortunately, none of seven pelican disturbances on DSR resulted in observed egg or chick loss. Pelicans also caused large disturbances at Yaquina Head, Oregon in 2011 where pelicans were observed pursuing and consuming murre chicks (Suryan et al. 2011).

Attendance Patterns and Reproductive Success

Murre attendance patterns at most colonies in 2011 were relatively typical, with peaks in attendance just prior to the egg-laying period, relatively stable attendance during the incubation and early chick periods, an increase during the chick period, then a rapid decline to zero during the chick fledging period. Deviations from typical attendance patterns were apparent at subcolonies that experienced substantial pelican disturbance, including PRH Edge Plot, PRS, and Stormy Stack. At PRH Ledge Plot, attendance patterns appeared fairly normal despite substantial pelican disturbance in early July.

At DSR, murre numbers increased somewhat from 2010 but were lower than in 2009. Increased murre attendance in 2011 may have been influenced by greater numbers of nesting Brandt's Cormorants on the rock, which were the highest since 2007. Increased numbers of murres included re-expansion of the murre colony back into Plot C where murres last bred in 2009 and last bred successfully in 2007. An increase (28.6%) in the number of breeding sites in plots suggest that increasing numbers largely reflected increasing numbers of breeders, as opposed to increasing numbers of non-breeders.

Murre productivity was above long-term means at DSR and CRM-04 but very low at PRH and CRM-03B. Low productivity at PRH largely resulted from major disturbances by Brown Pelicans, including complete breeding failure in Edge Plot and substantial egg and chick loss in Ledge Plot. At CRM-03East, data quality may have partly affected productivity estimates but high rates of both egg and chick losses were clear.

Murres at DSM continued a trend of low productivity, subcolony abandonment, and formation of new subcolonies. In certain subareas, attendance patterns reflected patterns of nesting Brandt's Cormorants: when cormorants were on or building nests, murre attendance was generally greater. When cormorants abandoned nesting efforts, murres also departed. Low productivity and early abandonment of Turtlehead Boulder was apparently affected by the rock's re-orientation, a likely result of a series of tsunami waves that struck the California coast in March 2011. Despite this major habitat change, murres still attempted breeding.

Brandt's Cormorant nest numbers increased from 2009-2010 at all colony complexes in 2011, but productivity was lower than both 2010 and the long-term mean at PRH and DSRM, and only slightly higher at CHCC. Cormorants initiated nesting earlier than average at PRH, about average at CHCC, and continued a recent trend by nesting later than average at DSRM. PRH and DSRM had two waves of Brandt's Cormorant nesting: one in late April to early May followed by high rates of abandonment; and one in June that included relatively high numbers of replacement clutches as well as many new nests. Nesting efforts appeared to have been impacted by unusually high May precipitation. The second wave of nesting attempts at PRH and DSRM included a large number of replacement clutches, and preliminary assessments indicated that birds that initiated clutches in June were more successful than those that nested earlier. Peak single-day nest counts occurred during the last week of June or first week of July at all three colony complexes. These unusually late dates were almost a month after the annual aerial colony surveys. Brandt's Cormorants are still recovering locally from a major decline experienced in 2008-2009.

Annual trends in Pelagic Cormorant nest numbers varied, with an increase from 2010 at DBCC, declines at PRH and DSRM, and no apparent change at CHCC. Productivity was generally low to mid-range, but only DSRM had a sample size (N = 22) adequate for meaningful comparisons. At DSRM, productivity was 48% lower than in 2010. Western Gull nest numbers increased at most colonies, but a recent trend of low productivity continued. Numbers of Black Oystercatchers were too low, and Pigeon Guillemot numbers too variable, to make meaningful assessments without more data or analyses.

Murre Time Budgets and Ocean Conditions

Murre co-attendance rates at DSR in 2011 were the lowest since 1999. Mates spent 73% less time in co-attendance than in 2010. Although co-attendance was very low, mean chick provisioning rates were higher than the long-term mean, but lower than in 2010. This suggests that murres were spending considerably more time than usual looking for prey in 2011 but still managed to provision chicks adequately, consistent with the findings of Parker (2005).

Ocean conditions leading up to the 2011 breeding season were characterized by a weak La Niña, with cooler sea surface temperatures (SSTs) during the winter of 2010-2011 (Bjorkstedt et al. 2011). By March, SSTs had returned to average and remained near the long-term mean through the breeding season. While SSTs were near average, they were higher than in 2010 at the nearby South Farallon Islands (Warzybok and Bradley 2011). Northern anchovy (*Engraulis mordax*) and Pacific sardine (*Sardinops sagax*) populations continued to remain low in central California waters in 2011. In contrast, forage fish such as juvenile rockfish (*Sebastes* spp.), market squid (*Loligo opalescens*), Pacific hake (*Merluccius productus*), and Pacific sanddabs (*Cytharichthys sordidus*) were recorded at some of the highest levels since the early 2000s. Krill (*Euphausiid* sp.) continued to be abundant, but at lower levels than in 2008-2010 (Bjorkstedt et al. 2011).

The apparent abundance of forage fish in central California waters in 2011 likely influenced above average breeding success of Common Murres at DSR as well as the partial recovery of Brandt's Cormorant nest numbers. However, low co-attendance rates of murres at DSR suggests that murres had to spend considerably more time than usual looking for prey in 2011. This, combined with low productivity of Brandt's Cormorants, suggests that preferred prey were not overly abundant or available near study colonies. It is suspected that Brandt's Cormorants relied heavily on Northern anchovies during the breeding season in the early 2000s, and the loss of anchovies as an abundant food source appears to continue to afflict this species. Murres also fed chicks a high proportion of anchovies at DSR in the mid-2000s (Eigner 2009). Atypical weather patterns, including several days of rain in May and some heavy rain in June, also appear to have affected seabird breeding success in 2011, especially that of Brandt's Cormorants.

Recommendations for Future Management, Monitoring, and Research

Continued outreach, education, and enforcement are needed to reduce aircraft disturbance at DSR. Because helicopters continue to cause the most flushing events, more targeted outreach to helicopter pilots, including the U.S. Coast Guard and military, may be necessary. Increased aircraft detections during the annual Half Moon Bay Dream Machines event is also a cause for concern, especially as the event has a planned duration of two days in 2012, instead of the historical one day.

The Special Closures that became effective on 1 May 2010 under the California Marine Life Protection Act (CDFG 2004) at PRH, PRS, Stormy Stack, and DSR appear to be having some success, but violations still occur. Directed outreach and enforcement to boaters is needed to educate them on the closures.

Annual aerial surveys of central and northern California Common Murre, Brandt's Cormorant and Double-crested Cormorant colonies continued in 2011 in cooperation with California Department of Fish and Game and U.C. Santa Cruz. However, no sustained funding is currently available to count nests and birds from the photographs. These aerial surveys have provided the baseline for assessing population trends of these species since the early 1980s and must be continued to 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 are needed. Comparative studies on the foraging ecology of Brandt's Cormorants, Pelagic Cormorants, and murres may provide insight on the varying response to ocean and prey conditions that have been documented over the past few years.

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

Monitoring of breeding sites on the Devil's Slide mainland (DSM) should be re-evaluated. Murres have been changing breeding areas from year to year and nests are often difficult to view. Monitoring of Turtlehead Boulder, which now holds much of the DSM subpopulation, should be discontinued. The new orientation of the rock and the murre colony has compromisedeffective viewing of breeding sites.

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Table 1. Monitoring effort of study colonies or colony complexes for calculations of aircraft and watercraft detection and disturbance rates, January 2011 to August 2011.

Colony/Colony Complex	Start date	End date	No. of obs. days	Total hours
Point Reyes	12 April	19 August	99	419.93
Point Resistance	19 April	19 August	26	24.23
Millers Point Rocks	19 April	19 August	41	113.18
Double Point Rocks	21 April	24 July	23	98.45
Devil's Slide Rock & Mainland				
Pre-breeding season	7 January	8 April	8	16.83
Breeding season	14 April	6 September	122	783.02
Castle-Hurricane Colony Complex				
Pre-breeding season	15 March	15 March	1	2.00
Breeding season	18 April	31 July	104	303.24

[1] Does not include Common Raven survey hours (21.08 h).

Table 2. Numbers of observed (detected) boats and aircraft and resulting disturbances to all seabirds at Point Reyes in 2011 (including total number observed and number per observer hour), 2005-2006 baseline means for number observed and number of disturbances per hour, and percent difference between 2011 values and baseline means.

			No. Disturbance Events			No. Disturbance Events/hr.		Baseline mean ± SE		% Difference	
Source	Total Obs.	No. Obs./hr.	A	D	F	Total/hr[1]	Flush or Displace/hr.	No. Obs./hr.	Total Dist./hr.	No. Obs./hr.	Total Dist./hr.
Plane	9	0.021	2	0	1	0.007	0.002	0.040 ± 0.009	0.020 ± 0.017	-47%	-64%
Helicopter	0	0	0	0	0	0	0	0.001 ± 0.001	0.001 ± 0.001	-100%	-100%
Boat	2	0.005	0	0	0	0	0	0.097 ± 0.030	0.015 ± 0.002	-95%	-100%
Total	11	0.026	2	0	1	0.007	0.002	0.138 ± 0.022	0.037 ± 0.019	-81%	-81%

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

Table 3. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Point Reyes in 2011.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean No. Seabirds Flushed/ Displaced	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	45	1	45	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	45	1	45	0	0	0	0	0	0	0	0	0	0	0	0

Table 4. Numbers of observed (detected) boats and aircraft and resulting disturbances to all seabirds at Point Resistance in 2011 (including total number observed and number per observer hour), 2005-2006 baseline means for number observed and number of disturbances per hour, and percent difference between 2011 values and baseline means.

			No. Disturbance Events			No. Disturbance Events/hr.		Baseline mean ± SE		% Difference	
Source	Total Obs.	No. Obs./hr.	A	D	F	Total/hr[1]	Flush or Displace/hr.	No. Obs./hr.	Total Dist./hr.	No. Obs./hr.	Total Dist./hr.
Plane	1	0.041	0	0	0	0	0	0.018 ± 0.018	0.0	131%	0%
Helicopter	0	0	0	0	0	0	0	0.0	0.0	0%	0%
Boat	0	0	0	0	0	0	0	0.018 ± 0.018	0.018 ± 0.018	-100%	-100%
Total	1	0.041	0	0	0	0	0	0.036 ± 0.036	0.018 ± 0.018	16%	-100%

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

Table 5. Numbers of observed (detected) boats and aircraft and resulting disturbances to all seabirds at Miller's Point Rocks in 2011 (including total number observed and number per observer hour), 2005-2006 baseline means for number observed and number of disturbances per hour, and percent difference between 2011 values and baseline means.

			No. Disturbance Events			No. Disturbance Events/hr.		Baseline mean ± SE		% Difference	
Source	Total Obs.	No. Obs./hr.	A	D	F	Total/hr[1]	Flush or Displace/hr.	No. Obs./hr.	Total Dist./hr.	No. Obs./hr.	Total Dist./hr.
Plane	0	0	0	0	0	0	0	0.044 ± 0.044	0.0	-100%	0%
Helicopter	0	0	0	0	0	0	0	0.022 ± 0.022	0.022 ± 0.022	-100%	-100%
Boat	3	0.027	0	0	0	0	0	0.185 ± 0.015	0.054 ± 0.031	-86%	-100%
Total	3	0.027	0	0	0	0	0	0.252 ± 0.082	0.076 ± 0.009	-89%	-100%

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

Table 6. Numbers of observed (detected) boats and aircraft and resulting disturbances to all seabirds at Double Point Rocks in 2011 (including total number observed and number per observer hour), 2005-2006 baseline means for number observed and number of disturbances per hour, and percent difference between 2011 values and baseline means.

			No. Disturbance Events			No. Disturbance Events/hr.		Baseline mean ± SE		% Difference	
Source	Total Obs.	No. Obs./hr.	A	D	F	Total/hr[1]	Flush or Displace/hr.	No. Obs./hr.	Total Dist./hr.	No. Obs./hr.	Total Dist./hr.
Plane	6	0.061	1	0	0	0.010	0	0.009 ± 0.009	0.009 ± 0.009	604%	17%
Helicopter	0	0	0	0	0	0	0	0.047 ± 0.030	0.028 ± 0.011	-100%	-100%
Boat	16	0.163	4	0	0	0.041	0	0.289 ± 0.057	0.082 ± 0.005	-44%	-50%
Total	22	0.223	5	0	0	0.051	0	0.345 ± 0.036	0.118 ± 0.003	-35%	-57%

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

Table 7. Numbers of observed (detected) boats and aircraft and resulting disturbances to all seabirds at Devil's Slide Rock & Mainland in 2011 (including total number observed and number per observer hour), 2005-2006 baseline means for number observed and number of disturbances per hour, and percent difference between 2011 values and baseline means. ND = No Data.

Source	Total Obs.	No. Obs./hr.	No. Disturbance Events: A	No. Disturbance Events: D	No. Disturbance Events: F	No. Disturbance Events/hr.: Total/hr[1]	No. Disturbance Events/hr.: Flush or Displace/hr.	Baseline mean ± SE: No. Obs./hr.	Baseline mean ± SE: Total Dist./hr.	% Difference: No. Obs./hr.	% Difference: Total Dist./hr.
Plane	235	0.300	106	0	1	0.137	0.001	0.311 ± 0.081	0.073 ± 0.023	-4%	87%
Helicopter	59	0.075	32	0	5	0.047	0.006	0.076 ± 0.004	0.040 ± 0.015	-1%	17%
Unknown aircraft	2	ND	2	0	0	0.003	0.000	ND	ND	ND	ND
Boat	15	0.019	2	0	0	0.003	0.000	0.071 ± 0.008	0.030 ± .005	-73%	-92%
Other (car)	1	ND	0	0	1	0.001	0.001	ND	ND	ND	ND
Total	312	0.394	142	0	7	0.190	0.009	0.459 ± 0.077	0.154 ± 0.033	-14%	22%

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

Table 8. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Devil's Slide Rock & Mainland in 2011.

Source	Mean No. Seabirds Flushed/ Displaced	COMU Disturbance: No. Events	COMU Disturbance: Mean No. birds	BRCO Disturbance: No. Events	BRCO Disturbance: Mean No. birds	PECO Disturbance: No. Events	PECO Disturbance: Mean No. birds	BRPE Disturbance: No. Events	BRPE Disturbance: Mean No. birds	WEGU/UNGU Disturbance: No. Events	WEGU/UNGU Disturbance: Mean No. birds	BLOY Disturbance: No. Events	BLOY Disturbance: Mean No. birds	PIGU Disturbance: No. Events	PIGU Disturbance: Mean No. birds
Plane	5	1	5	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	20 (1-70)	4	25(3-70)	1	1	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-car	15	0	0	0	0	0	0	0	0	0	0	0	0	1	15
Total	17(1-70)	5	21(3-70)	1	1	0	0	0	0	0	0	0	0	1	15

Table 9. Numbers of observed (detected) boats and aircraft and resulting disturbances to all seabirds at the Castle-Hurricane Colony Complex in 2011 (including total number observed and number per observer hour), 2005-2006 baseline means for number observed and number of disturbances per hour, and percent difference between 2011 values and baseline means.

			No. Disturbance Events			No. Disturbance Events/hr.		Baseline mean ± SE		% Difference	
Source	Total Obs.	No. Obs./hr.	A	D	F	Total/hr[1]	Flush or Displace/Hr.	No. Obs./hr.	Total Dist./hr.	No. Obs./hr.	Total Dist./hr.
Plane	25	0.082	1	0	0	0.003	0.000	0.064 ± 0.013	0.003 ± 0.003	29%	11%
Helicopter	8	0.026	2	0	1	0.010	0.003	0.003 ± 0.003	0.002 ± 0.002	786%	399%
Boat	3	0.010	0	0	0	0.000	0.000	0.002 ± 0.002	0.000	390%	-100%
Total	36	0.119	3	0	1	0.013	0.003	0.069 ± 0.014	0.006 ±0.006	72%	-100%

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

Table 10. Numbers of events and mean (range) numbers of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at the Castle-Hurricane Colony Complex, 2011.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/HEEG Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean No. Seabirds Flushed/ Displaced	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds	No. Events	Mean No. birds
Plane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	52	1	50	0	0	0	0	0	0	1	2	0	0	0	0
Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	52	1	50	0	0	0	0	0	0	1	2	0	0	0	0

Table 11. Common Murre breeding phenology and reproductive success at Point Reyes (two plots and combined), Devil's Slide Rock & Mainland (DSR, three plots; DSM), and Castle Rocks & Mainland (twp plots), 2011. Means (range and/or sample size) are reported.

Colony/Plot	No. Sites Monitored	No. Egg Laying Sites	Mean Lay Date[1]	No. Eggs Laid	Mean Hatch Date	Hatching Success[2]	Mean Fledge Date	Fledging Success[3]	Chicks Fledged per Pair
Point Reyes (PRH)									
PRH-Ledge	93	73	29 May (5/14-6/21;52)	80	27 June (6/15-7/10;18)	37.5% (80)	17 July (7/9-7/26;20)	63.3% (30)	0.26 (73)
PRH-Edge	73	57	26 May (5/15-6/9; 32)	60	23 June (6/16-6/26;11)	18.3% (60)	-----	0%	0.00 (57)
PRH (combined)	166	130	28 May (5/14-6/21;84)	140	25 June (6/15-7/10;29)	29.3% (140)	17 July (7/9-7/26;32)	46.3% (41)	0.15 (130)
Devil's Slide Rock and Mainland (DSRM)									
DSR-A	109	96	27 May (5/13-6/18;83)	97	28 June (6/14-7/23;72)	84.5% (97)	23 July (7/10-8/5;64)	76.8% (82)	0.66 (95)
DSR-B	90	81	26 May (5/16-6/17;73)	85	26 June (6/16-7/21;60)	75.3% (85)	21 July (7/11-8/14;58)	98.3% (60)	0.77 (77)
DSR-C	23	12	2 June (5/22-7/13;8)	12	28 June (6/23-7/7;7)	83.3% (12)	26 July (7/18-8/6;9)	100.0% (10)	0.83 (12)
DSR (combined)	222	189	27 May (5/13-7/13;164)	194	27 June (6/14-7/23;139)	80.4% (194)	22 July (7/10-8/14;131)	86.8% (152)	0.72 (184)
DSM	65	30	30 May (5/21-6/17;29)	32	-	0.0% (32)	-	0.0% (0)	0.0 (30)
Castle Rocks and Mainland (CRM)									
CRM-04	112	80	20 May (5/11-6/4;42)	80	20 June (6/12-6/26;31)	79.7% (79)	14 July (7/7-7/19;35)	72.2% (54)	0.56 (70)
CRM-03B	143	110	26 May (5/19-6/3;38)	113	27 June (6/15-7/11;29)	54.9% (113)	13 July (7/9-7/15;14)	50.0% (56)	0.27 (104)

[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 12. High annual counts of nests for Brandt's Cormorants (BRCO), Pelagic Cormorant (PECO), obtained during land, boat, and combined land/boat counts (total), 2011.

Species	Colony	Land[1]	Boat[2]	Total Count[3]
Brandt's Cormorant	Point Reyes	311	12	323
	Point Resistance	28	2	30
	Miller's Point Rocks	50	0	50
	Double Point Rocks	87	32	119
	Bird Island (Point Bonita)	0	0	0
	Devil's Slide Rock & Mainland	139	6	145
	San Pedro Rock	0	0	0
	Bench Mark-227X	146	-	146
	Castle Rocks & Mainland	91	-	91
	Hurricane Point Rocks	0	-	0
Pelagic Cormorant	Point Reyes	21	114	135
	Point Resistance	1	8	9
	Miller's Point Rocks	9	13	25
	Double Point Rocks	2	6	8
	Devil's Slide Rock & Mainland	46	9	55
	San Pedro Rock	0	0	0
	Bench Mark-227X	0	-	0
	Castle Rocks & Mainland	7	-	7
	Hurricane Point Rocks	0	-	0

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

Table 13. Brandt's Cormorant breeding phenology and reproductive success at Point Reyes, Devil's Slide Rock & Mainland, and Castle Rocks & Mainland, 2011. Reported are means (range and/or sample size).

Colony/ Subcolony	No. Breeding Sites	Clutch Initiation Date[1]	Clutch Size[1]	No. Chicks Hatched/Pair[2]	Hatching Success[2]	Fledging Success[2]	Breeding Success[2]	No. Chicks Fledged/Pair[2]	Breeding Success/ Nest[3]
Point Reyes (PRH)									
Spine Point (PRH-11E)	31	6 May (4/25-5/16; 19)	3.5 (2-4; 22)	1.13 (0-4; 15)	56.7% (30)	88.2% (17)	60.3% (73)	1.81 (0-4; 27)	0.78 (27)
Wishbone Point (PRH-11E)	50	10 May (4/30-6/13; 32)	3.0 (1-4; 34)	0.78 (0-3; 40)	36.0% (86)	92.6% (27)	37.9% (140)	1.38 (0-3; 47)	0.72 (47)
Sloppy Joe (PRH-12A)	44	5 June (6/3-6/11; 20)	3.0 (2-4; 23)	2.00[4] (1-3; 4)	100.0%[4] (7)	40.0%[4] (5)	34.4% (64)	1.03 (0-3; 40)	0.53 (40)
PRH (combined)	125	17 May (4/25-6/13; 71)	3.1 (1-4; 79)	0.95 (0-4; 59)	44.7% (123)	85.7% (49)	43.0% (277)	1.36 (0-4; 114)	0.67 (114)
Miller's Point Rocks									
North Rk. (MPR-01)	52	5 May (5/1-5/14; 15)	2.9 (1-4; 14)	0.71 (0-3; 24)	45.8% (24)	66.7% (15)	32.5% (40)	1.10 (0-3; 52)	0.69 (52)
Devil's Slide Rock & Mainland (DSRM)									
Devil's Slide Rock (DSRM-01)	108	25 May (4/20-6/25;76)	3.3 (2-4;46)	0.13 (0-3;61)	5.8% (86)	75.0% (8)	25.9% (189)	0.81 (0-3;108)	0.50 (108)
Lower Mainland S. (DSRM-05A)	36	24 May (4/21-6/21;34)	3.2 (2-4;16)	0.39 (0-3;28)	55.5% (20)	45.5% (11)	36.8% (68)	0.75 (0-3;36)	0.44 (36)
Upper Mainland S. (DSRM-05A)	3	26 May (5/10-6/11;2)	3.0 (3;1)	1.00 (0-2;2)	66.7% (3)	100.0% (2)	66.7% (6)	1.67 (1-2;3)	1.00 (3)
South of Turtlehead Cliffs (DSRM-05C)	33	7 June (5/11-7/15;27)	3.0 (1-4;28)	1.86 (0-3;14)	72.2% (36)	65.4% (26)	38.9% (90)	1.23 (0-3;31)	0.74 (31)
DSRM (combined)	180	27 May (4/20-7/15; 139)	3.2 (1-4;91)	0.45 (0-3;105)	30.3% (145)	63.8% (47)	32.0% (353)	0.89 (0-3;178)	0.54 (178)
Castle Rocks & Mainland (CRM)									
CRM-03East	4	30 April (4/20-5/16;4)	3.3 (3-4;3)	3.00 (2-4;4)	90.0% (10)	66.7% (12)	70.0% (10)	2.00 (1-3;4)	1.00 (4)
CRM-07	5	26 April (4/24-6/13;26)	2.7 (2-3;3)	1.80 (0-3;5)	87.5% (8)	66.7% (9)	50.0% (8)	1.20 (0-2;5)	0.60 (5)
CRM-09	42	12 May (4/24-6/13;26	3.1 (2-4;38)	2.10 (0-3;31)	66.3% (86)	82.3% (62)	51.8% (114)	1.70 (0-3;40)	0.83 (40)
CRM (combined)	51	9 May (4/20-6/13; 32)	3.1 (2-4;44)	2.15 (0-4;40)	70.2% (104)	78.3% (83)	53.0% (83)	1.67 (0-3;49)	0.82 (49)

Table 13 (con't).

[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
[4] Low sample sizes because of poor views into nests.

Table 14. High annual counts of nests for Black Oystercatcher (BLOY), Western Gull (WEGU), and of birds for Pigeon Guillemot (PIGU), obtained during land, boat, and combined land/boat counts (total count), in 2011. Dash (-) = No Data.

Species	Colony	Land[1]	Boat[2]	Total Count[3]
Black Oystercatcher	Point Reyes	0	0	0
	Point Resistance	0	0	0
	Miller's Point Rocks	2	0	2
	Double Point Rocks	1	0	1
	Devil's Slide Rock & Mainland	1	0	1
	Bench Mark-227X	0	-	0
	Castle Rocks & Mainland	3	-	3
	Hurricane Point Rocks	2	-	2
Western Gull	Point Reyes	132	58[4]	183[4]
	Point Resistance	0	0	0
	Miller's Point Rocks	8	4	12
	Double Point Rocks	8	7	15
	San Pedro Rock	5	3	8
	Devil's Slide Rock & Mainland	8	5	13
	Bench Mark-227X	3	-	-
	Castle Rocks & Mainland	13	-	-
	Hurricane Point Rocks	6	-	-
Pigeon Guillemot	Point Reyes	471[5]	469	-
	Point Resistance	27	12	-
	Miller's Point Rocks	35	15	-
	Double Point Rocks	56	7	-
	Devil's Slide Colony Complex[6]	190	102	-
	Castle/Hurricane Colony Complex	31	-	-

[1] Sum of high seasonal counts at each subcolony.
[2] In several cases, oystercatcher and gull nests were counted only if they could not be seen from mainland vantage points.
[3] Oystercatcher and gull nests that may have been counted on both land and boat surveys were included only once towards the total count.
[4] Includes 7 territorial sites because of late survey date, when many nests had already failed or chicks were wandering from nests.
[5] Single day survey of entire Point Reyes colony.
[6] Includes San Pedro Rock.

Table 15. Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls at Castle Rocks & Mainland, Devil's Slide Rock & Mainland, and Point Reyes in 2011. Reported are means (range; n) or (n).

	Pelagic Cormorant				Black Oystercatcher				Western Gull			
	No. of Breeding Sites	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	No. of Breeding Sites	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]	No. of Breeding Sites	No. of Chicks Fledged	Chicks Fledged/ Pair	Breeding Success/ Nest[1]
Point Reyes	6	4	0.67 (0-2;6)	0.33 (6)	0	0	0.0 (0;0)	0.0 (0)	11	8	0.73 (0-2;11)	0.45 (11)
Drakes Bay	6	6	1.00 (0-2;6)	0.80 (5)	3	0[2]	0.0[2] (0;2)	0.0[2] (2)	6	2	0.33 (0-1; 6)	0.33 (6)
Devil's Slide Rk & Mainland	22	27	1.23 (0-2;22)	0.73 (22)	2	0	0.0 (0;2)	0.0 (2)	8	3	0.38 (0-2;8)	0.25 (8)
Castle Rocks and Mainland	6	7	1.4 (0-3;5)	0.67 (5)	4	2	0.67 (0-2;3)	0.33 (3)	23	12	0.6 (0-2;20)	0.35 (20)

[1] Breeding success per nest is defined as the proportion of egg-laying nests that fledged at least one chick.
[2] Fate of chicks at one nest were unknown, so sample size for number of chicks fledged and breeding success/nest was two nests.

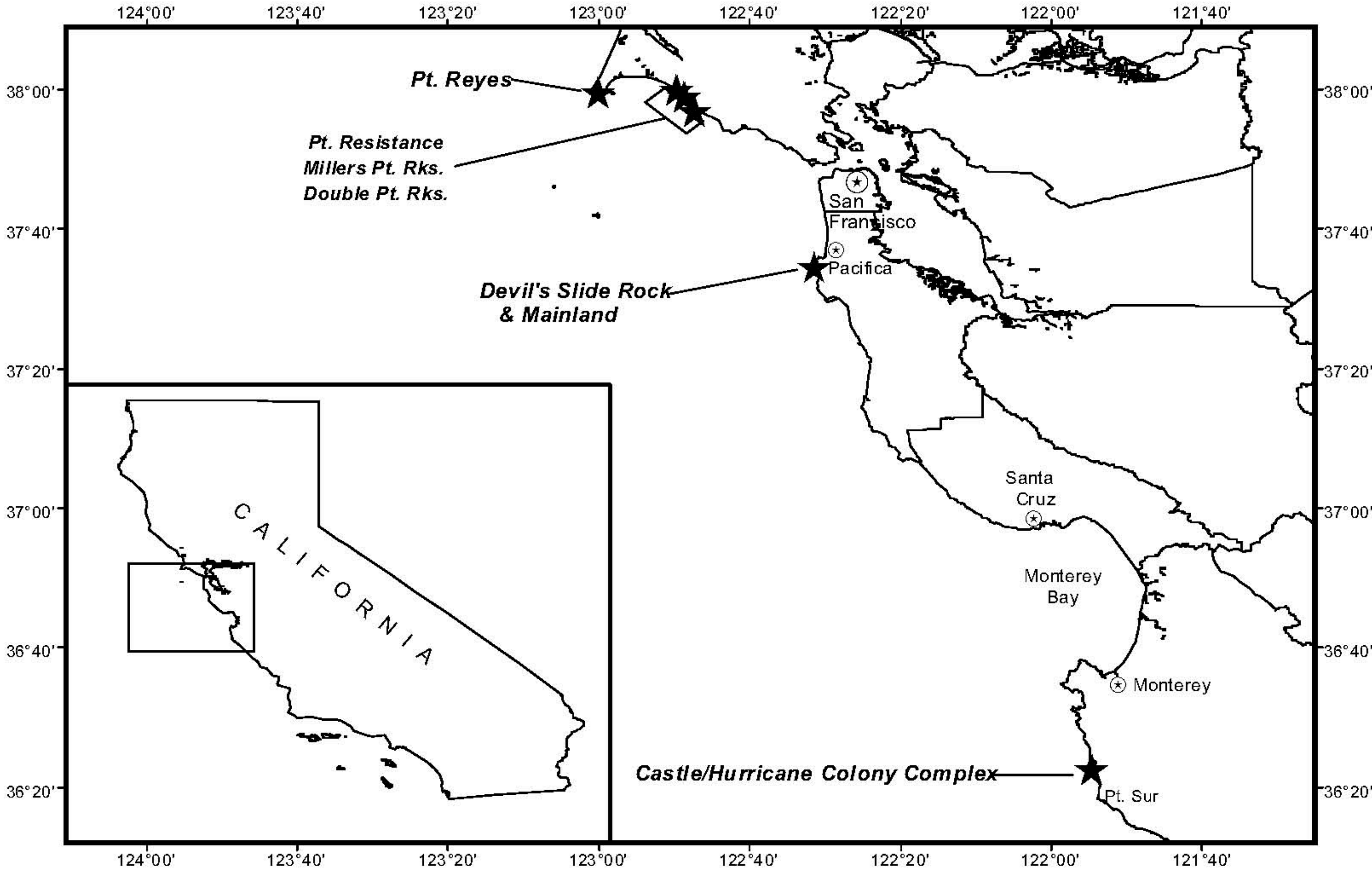


Figure 1. Map of the study area showing locations of study colonies or colony complexes along the Central California coast where seabird disturbance, attendance and breeding biology are monitored.

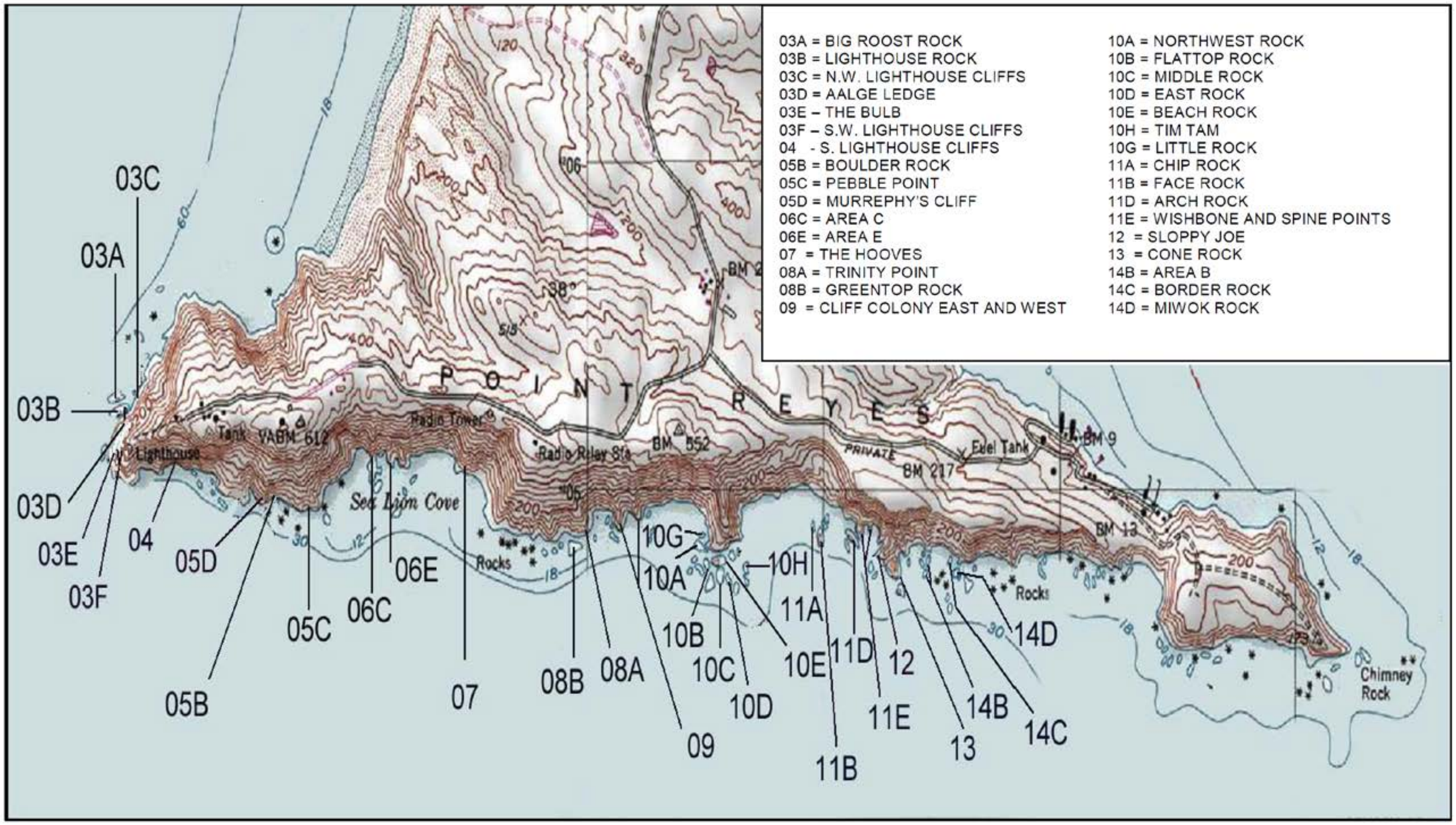


Figure 2. Map of Point Reyes, including subcolonies 03A through 14D.

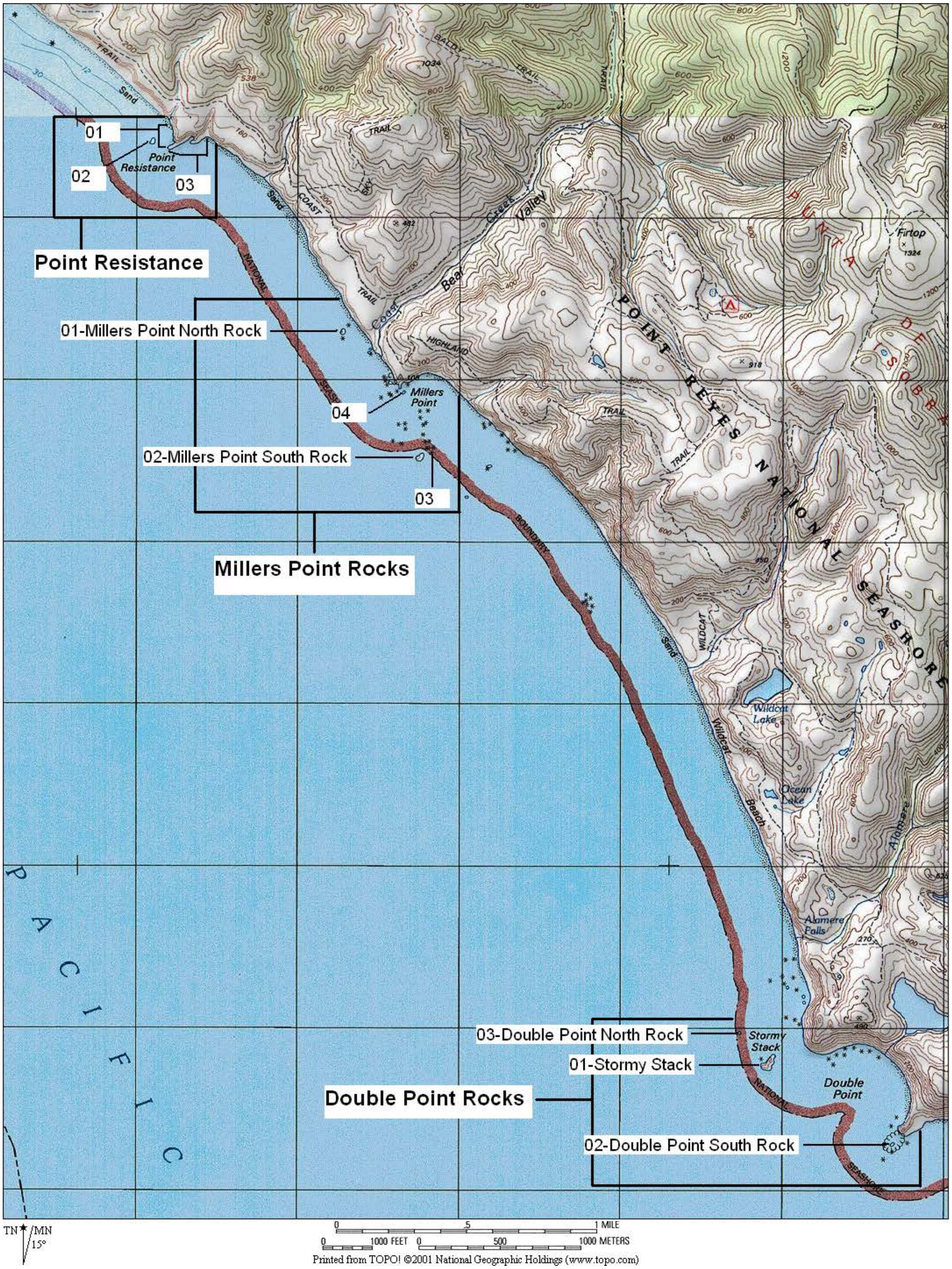


Figure 3. Map of the Drakes Bay Colony Complex, including Point Resistance, Millers Point Rocks and Double Point Rocks colonies and subcolonies.

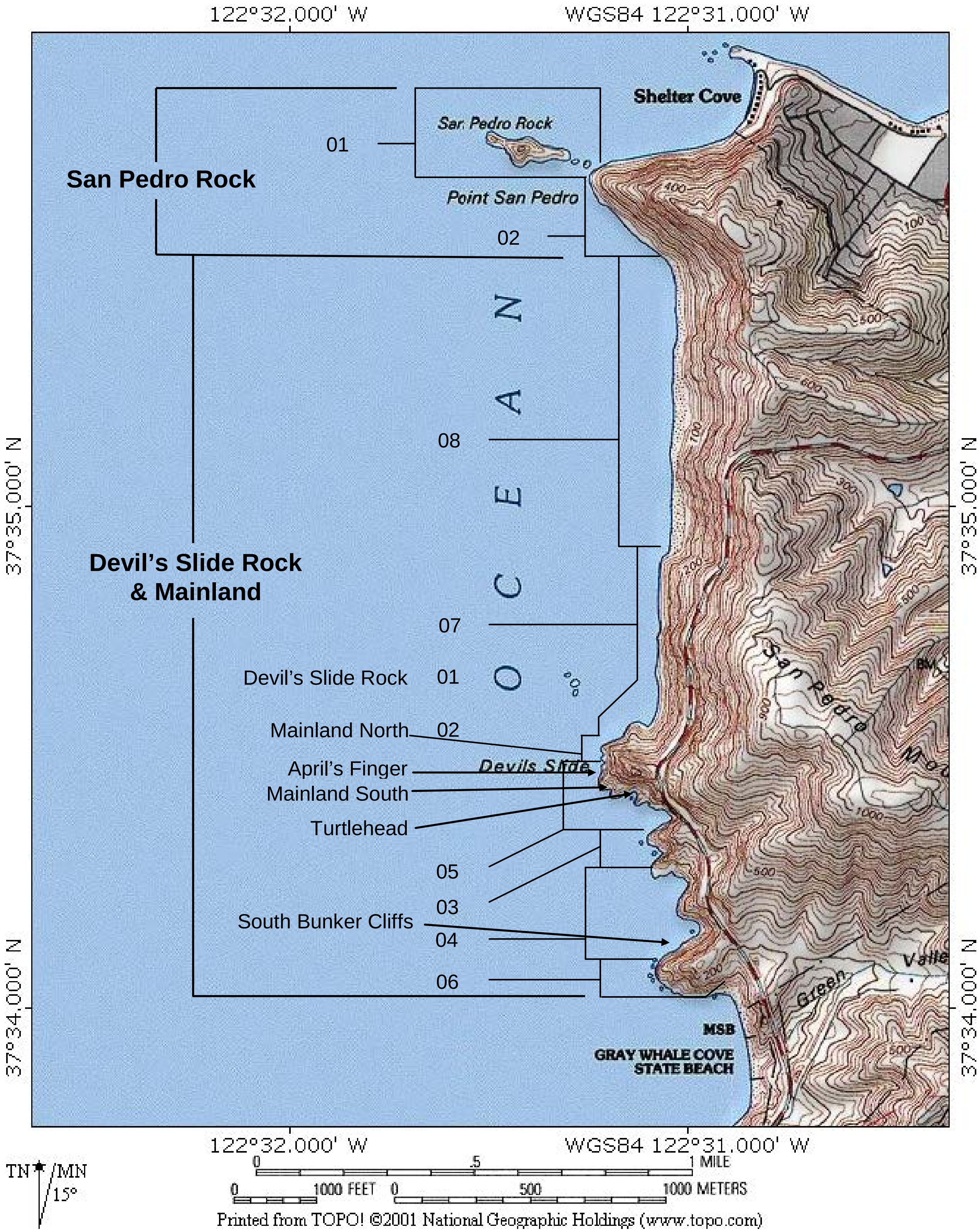


Figure 4. Map of the Devil's Slide Colony Complex, including San Pedro Rock and Devil's Slide Rock & Mainland colonies and subcolonies.

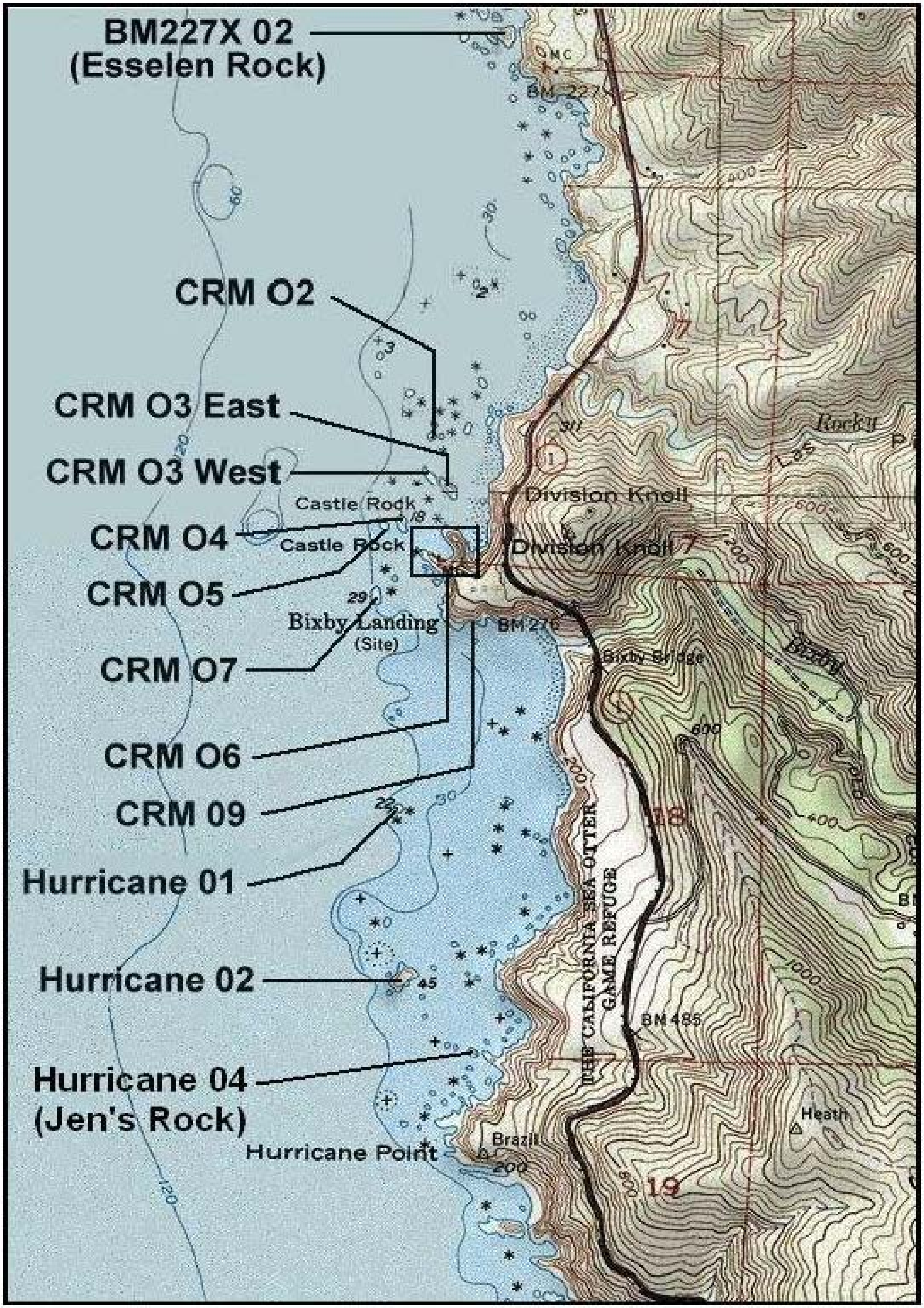


Figure 5. Map of the Castle-Hurricane Colony Complex, including Bench Mark-227X (BM227X), Castle Rocks and Mainland (CRM), and Hurricane Point Rocks (Hurricane) colonies and subcolonies.

Figure 6. Aerial photographs comparing the orientation of Turtlehead Boulder (DSR-05B) and location of breeding Common Murres in 2010 and 2011.

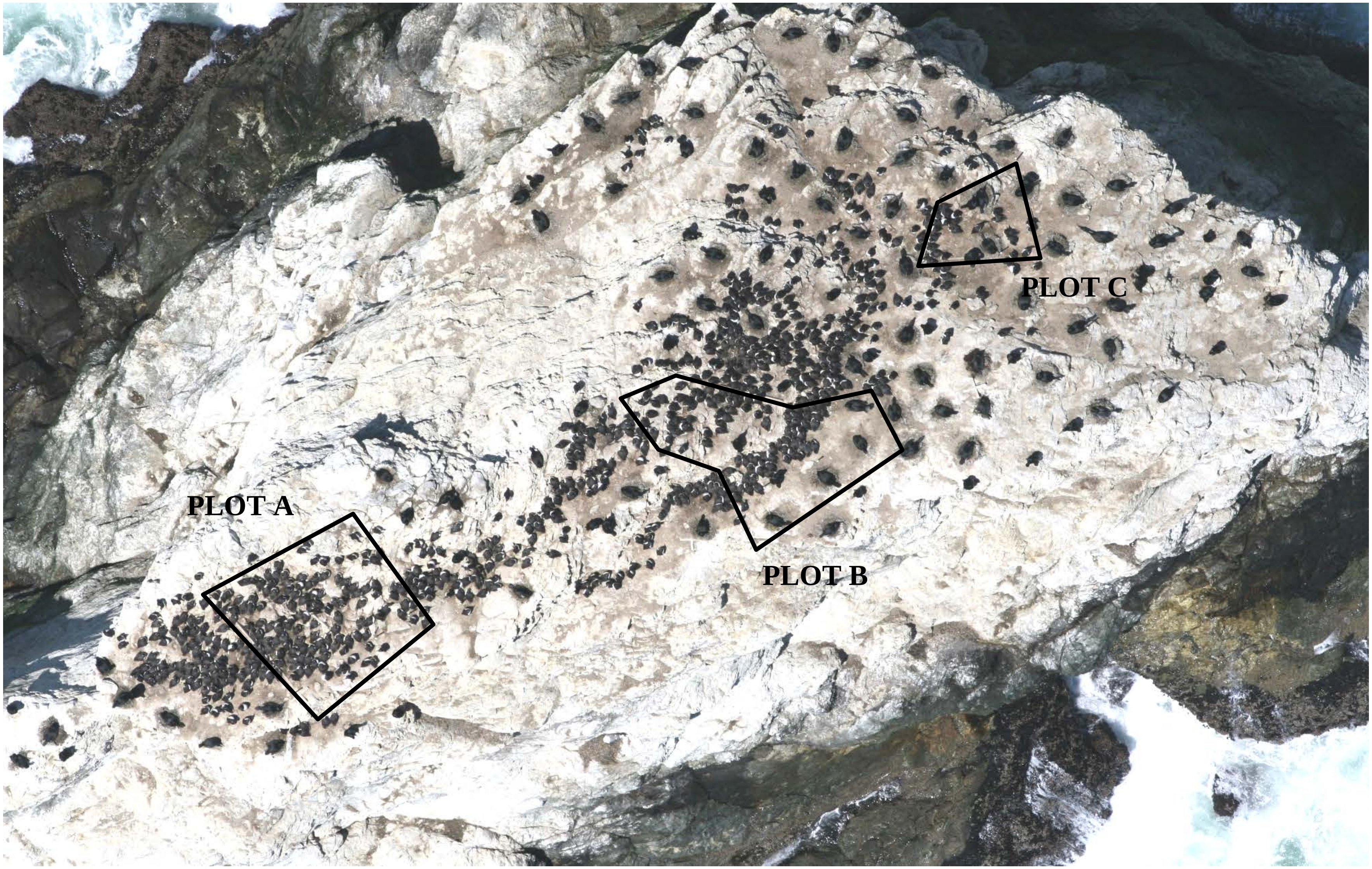
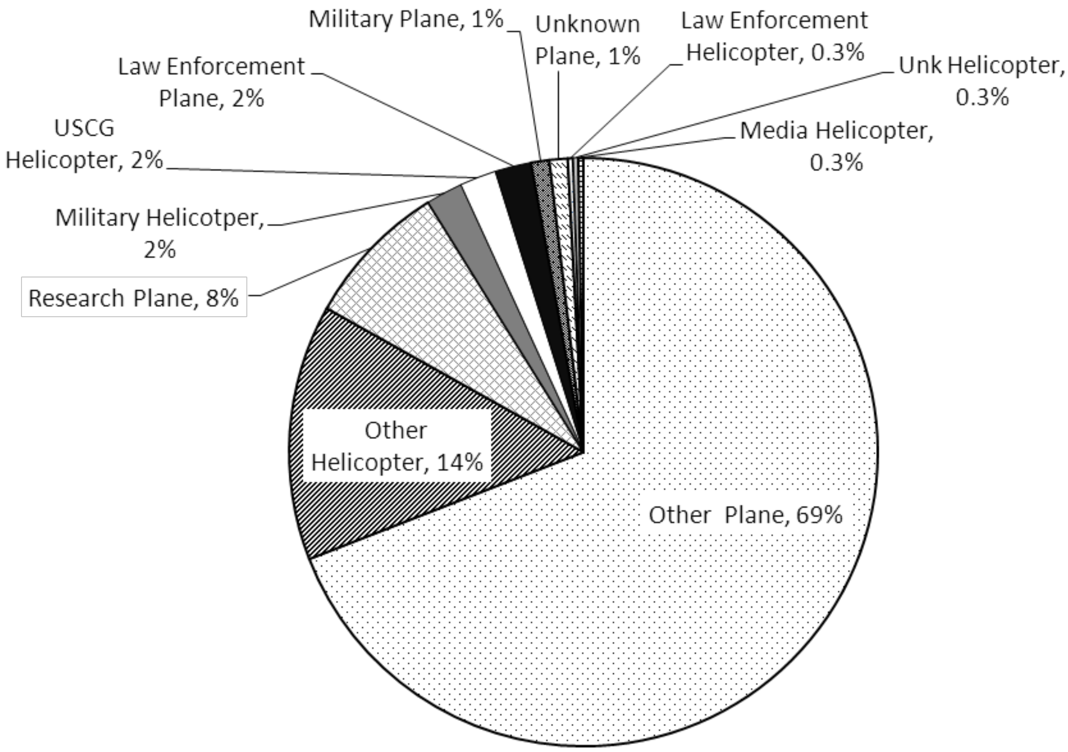


Figure 7. Aerial photograph of Devil's Slide Rock, 1 June 2011, showing the distribution of the Common Murre and Brandt's Cormorant breeding colony and boundaries of murre productivity plots.

a.



b.

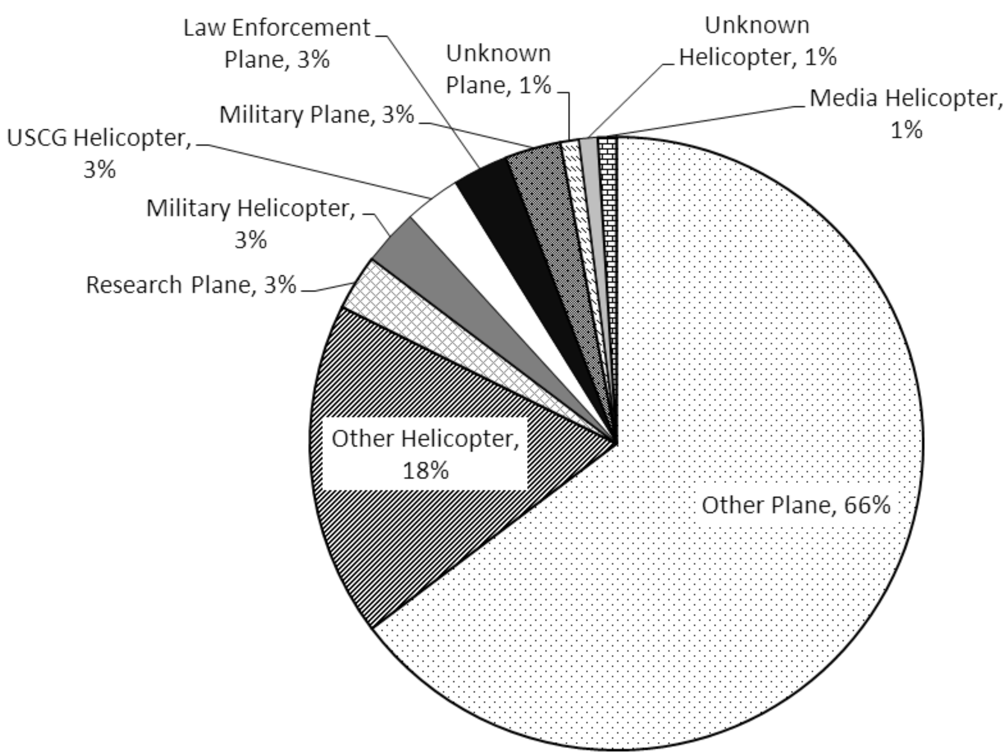
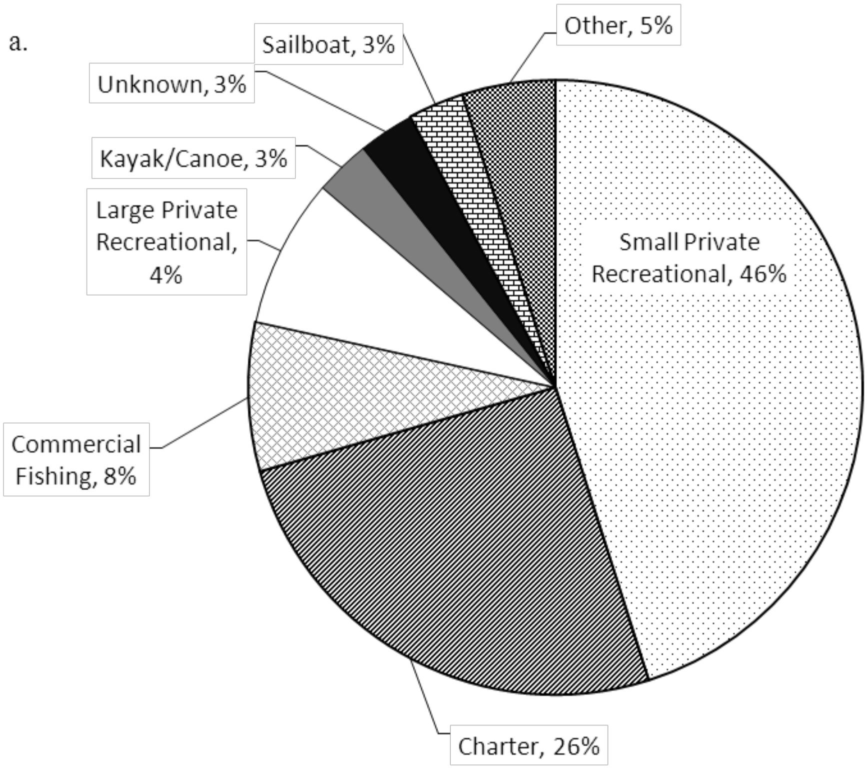


Figure 8. Pie charts of observed a) aircraft overflights (n = 350) and b) aircraft disturbances (n= 158) at Point Reyes, Drakes Bay, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex in 2011, categorized by type.

a.



b.

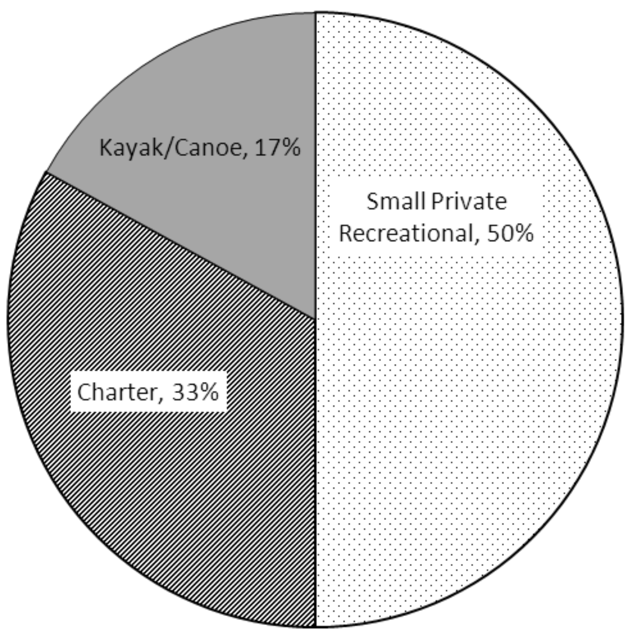


Figure 9. Pie charts of observed a) boat (n= 39) and b) boat disturbances (n = 6) at Point Reyes, Drakes Bay, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex in 2011, categorized by type.

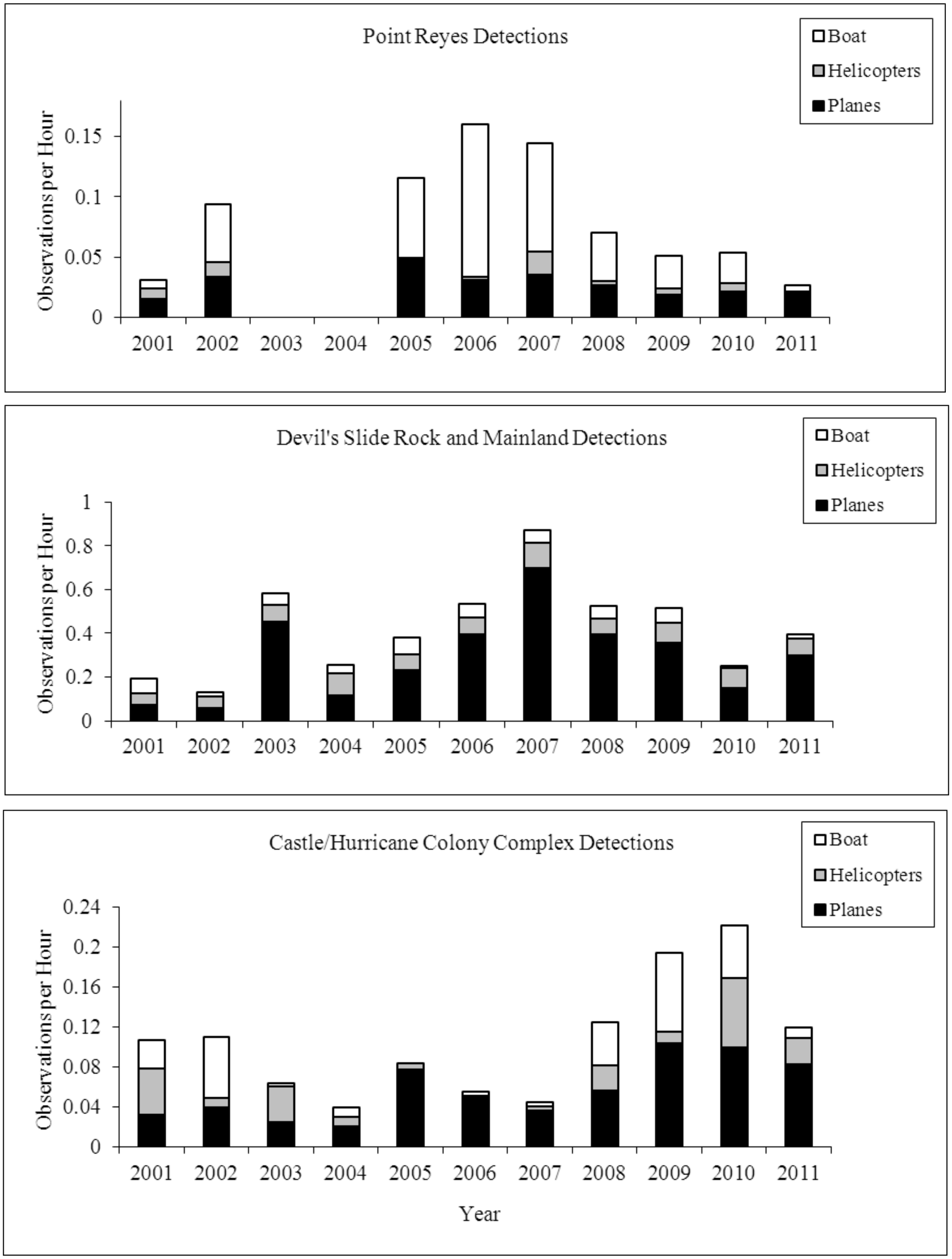


Figure 10. Detection (observation) rates per observation hour of boats, helicopters, and planes at Point Reyes, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex, 2001 to 2011.

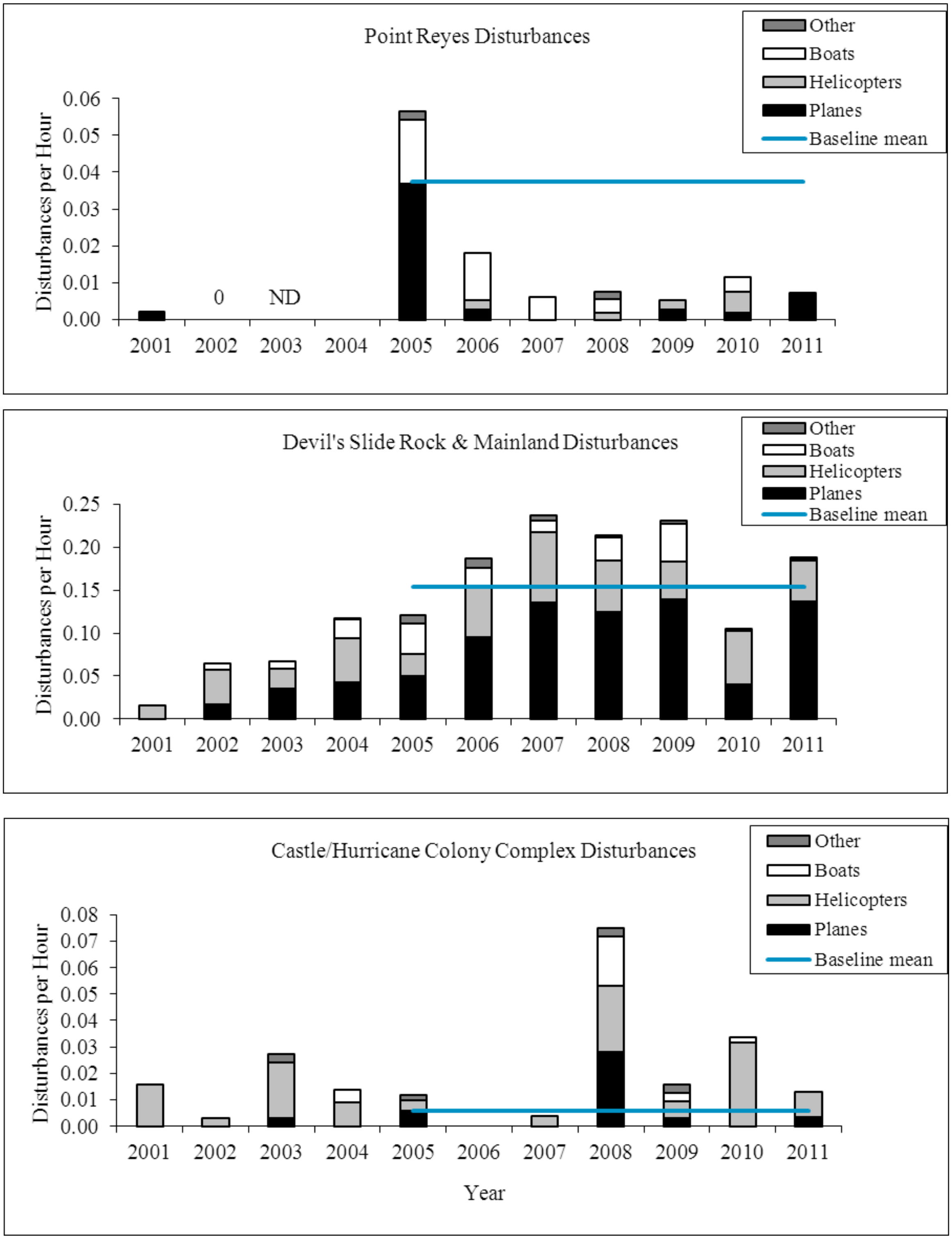


Figure 11. Disturbance rates (numbers per observation hour) of seabirds from boats, helicopters, planes, and other human sources at Point Reyes, Devil's Slide Rock & Mainland, and the Castle-Hurricane Colony Complex, 2001- 2011. Horizontal lines indicate the baseline 2005-2006 means.

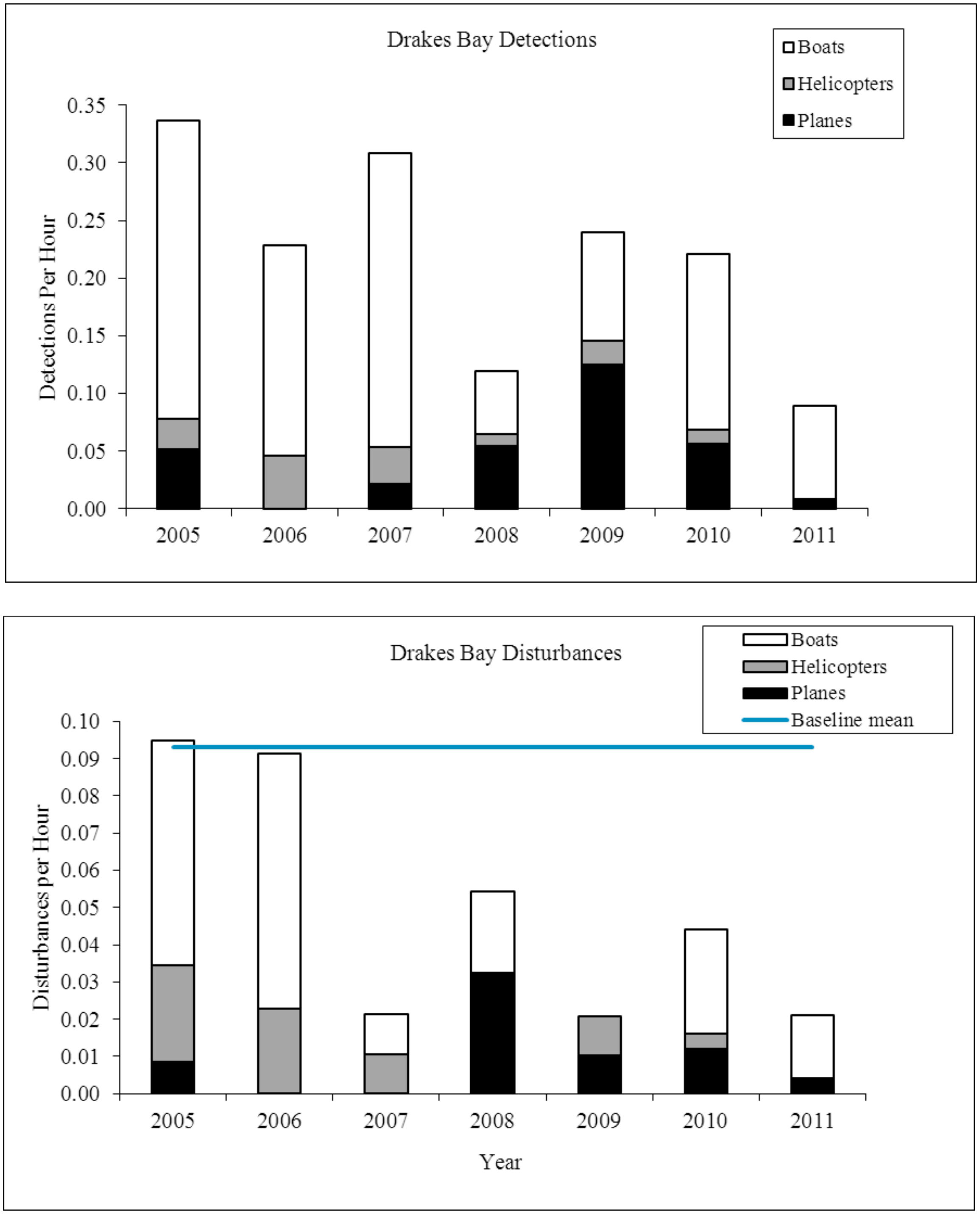


Figure 12. Detection and disturbance rates (numbers per observation hour) of boats, helicopters, and planes at all Drakes Bay colonies combined, 2005-2011. The horizontal line in the disturbance graph indicates the 2005-2006 baseline mean.

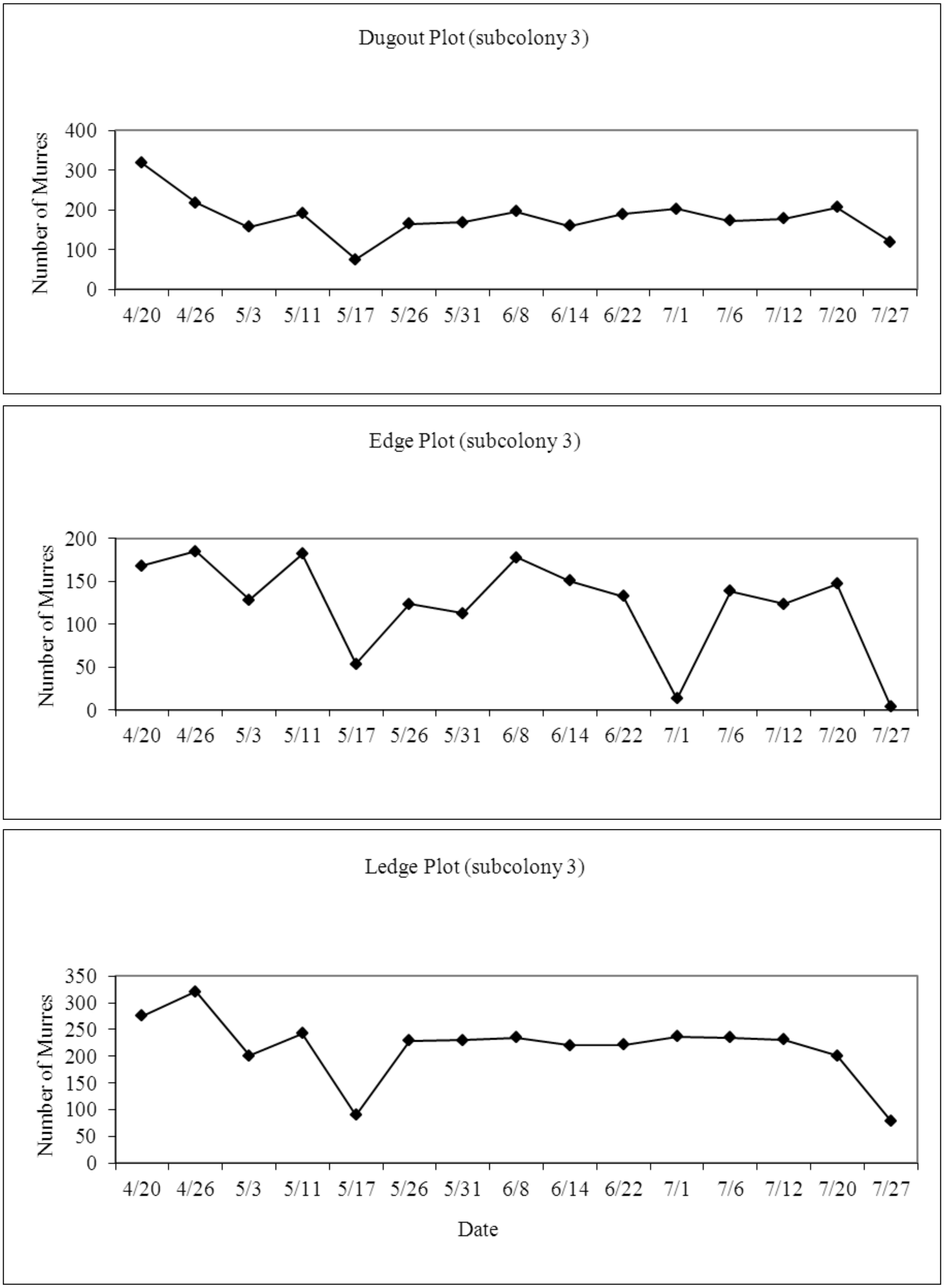


Figure 13. Seasonal attendance patterns of Common Murres at Dugout, Edge, and Ledge Plots, Point Reyes, 20 April to 27 August 2011.

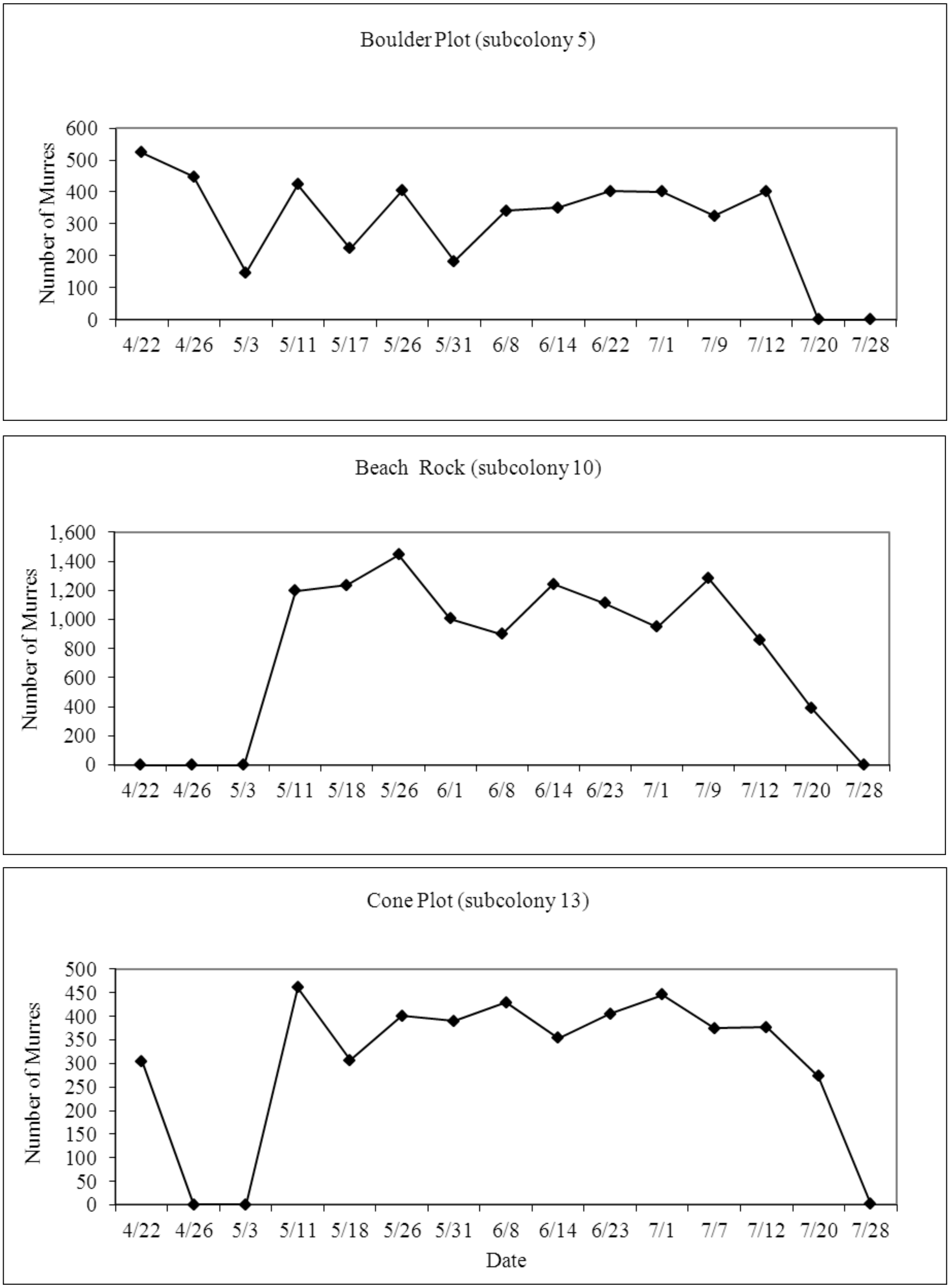


Figure 14. Seasonal attendance patterns of Common Murres at Boulder Plot, Cone Plot, and Beach Rock, Point Reyes, 22 April to 28 August 20.

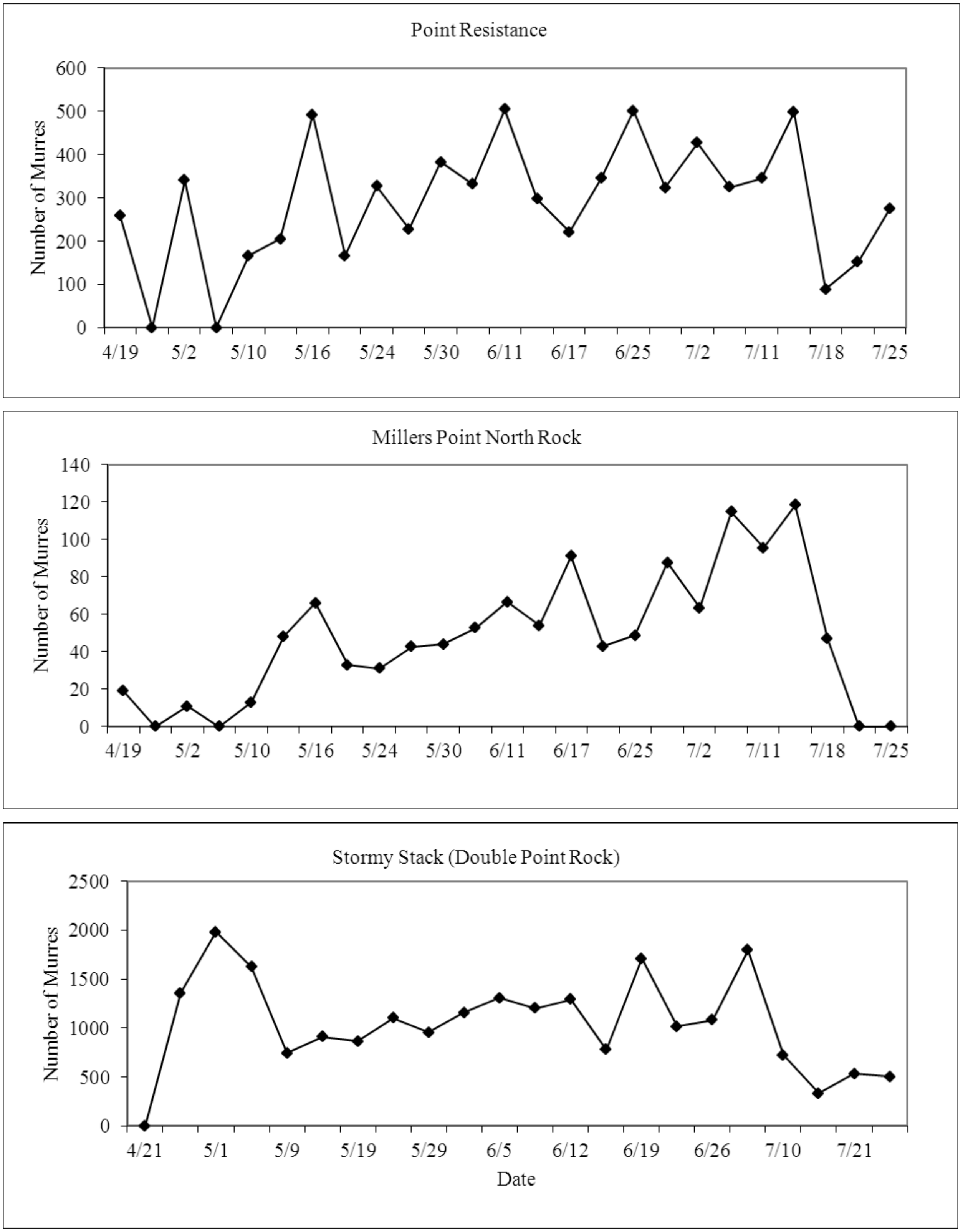


Figure 15. Seasonal attendance patterns of Common Murres at Point Resistance, Millers Point Rocks- North Rock (MPR-01), and Stormy Stack (Double Point Rocks), 19 April to 25 July 2011.

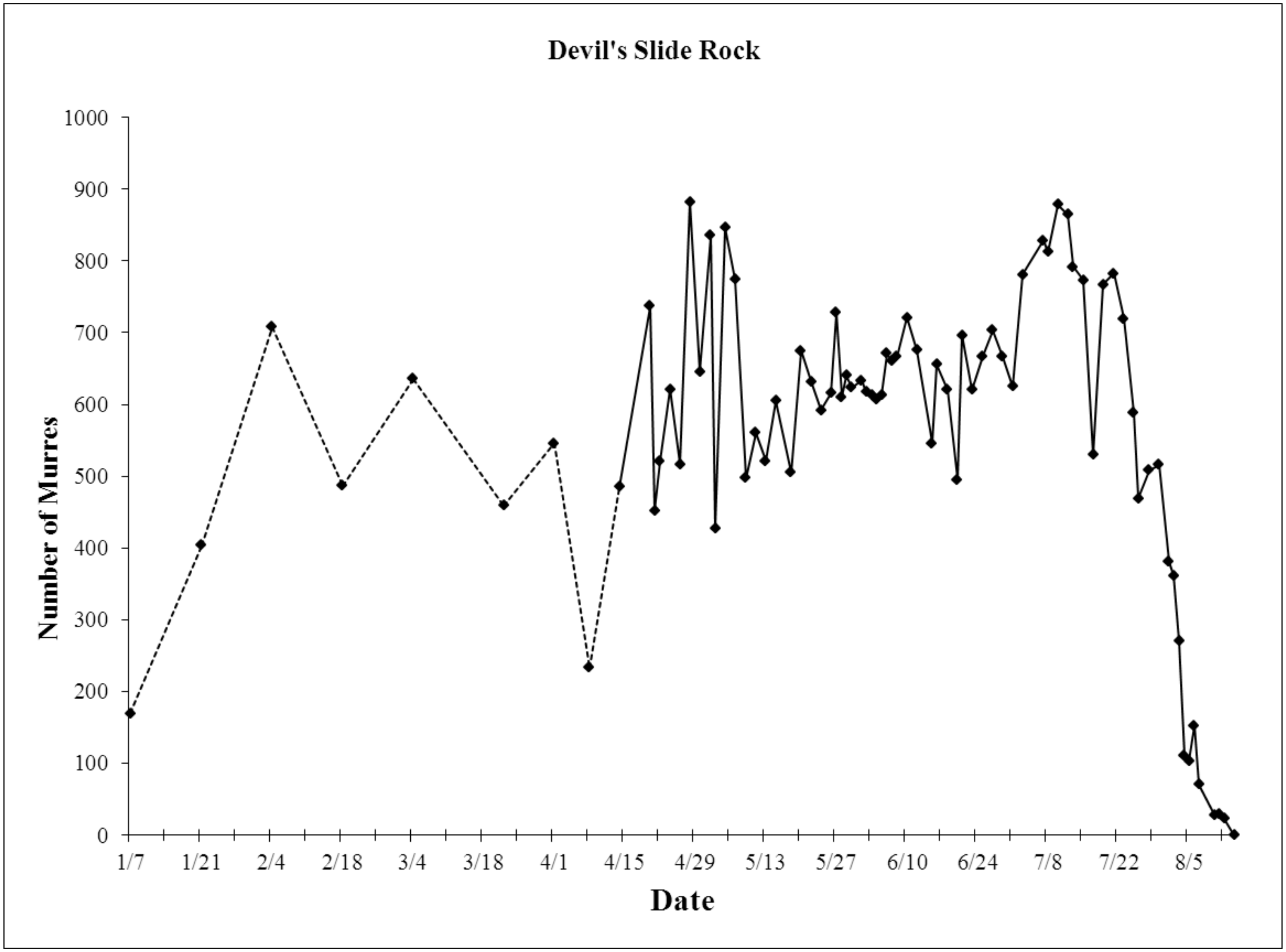
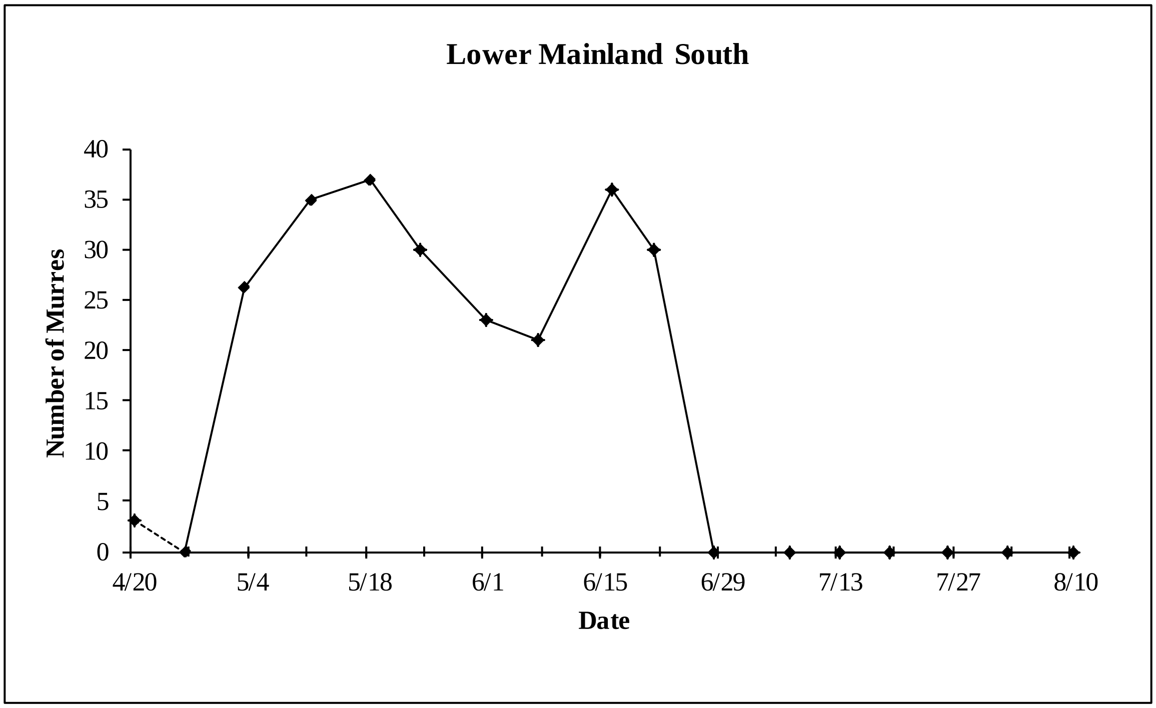


Figure 16. Seasonal attendance of Common Murres at Devil's Slide Rock, 7 January 2011 to 14 August 2011. Dashed line indicates pre-breeding season counts and solid line indicates breeding season counts.



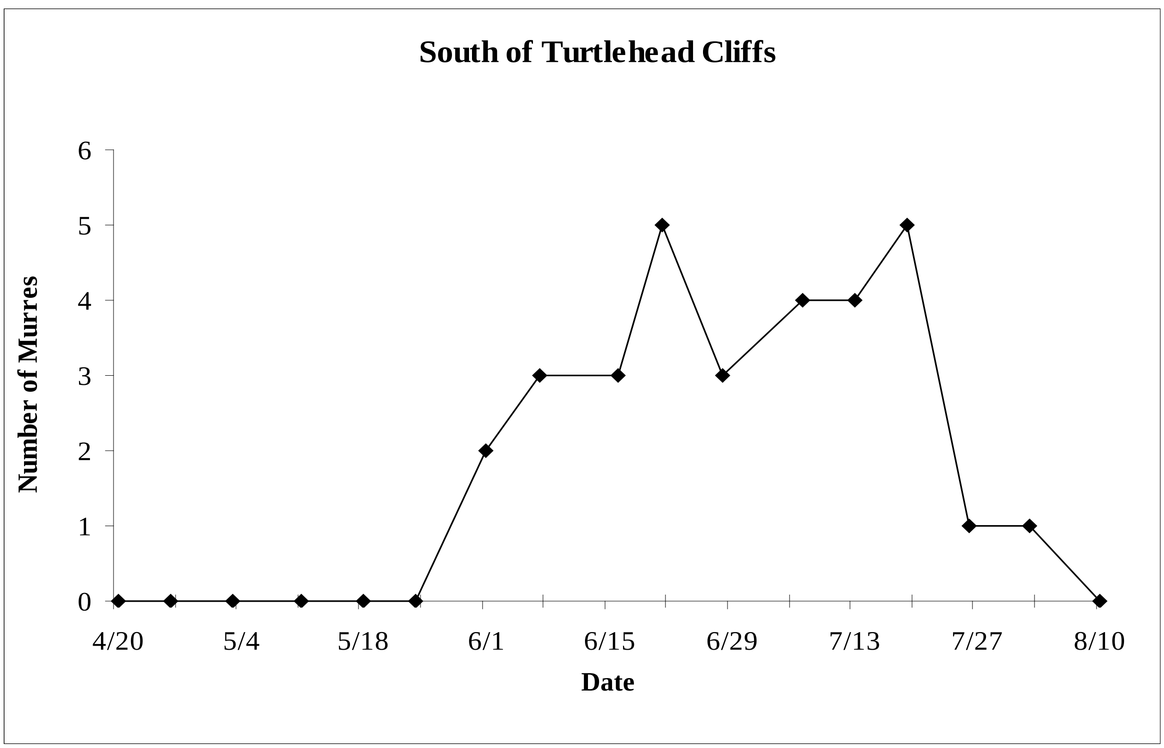


Figure 17. Seasonal Attendance of Common Murres at Lower Mainland South and South of Turtlehead Cliffs areas, 20 April 2011 to 10 August 2011.

Figure 18. Photograph showing location of Common Murres on South of Turtlehead Cliffs (DSRM-05C), 28 May 2011.

Figure 19. Photograph of Common Murres on South Bunker Cliffs (DSRM-04) on 23 April 2011.

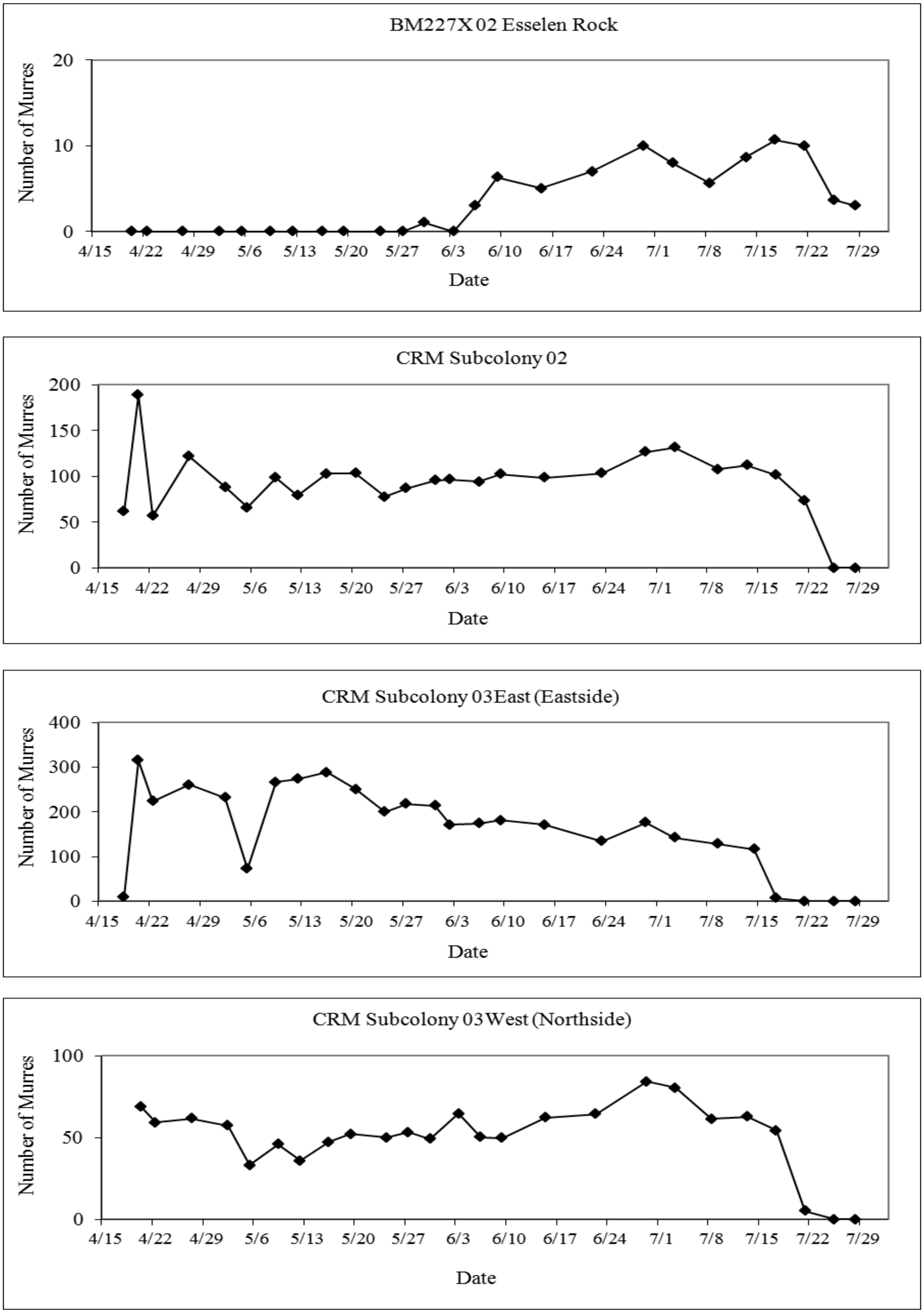
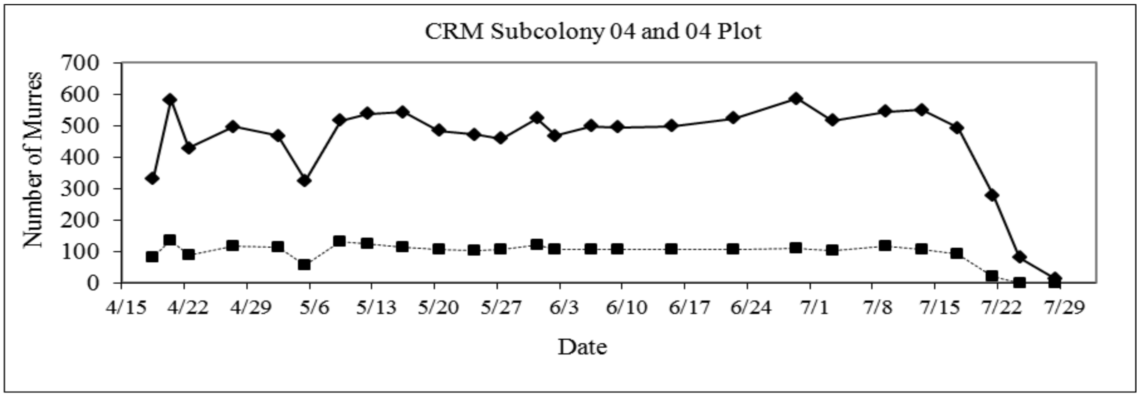
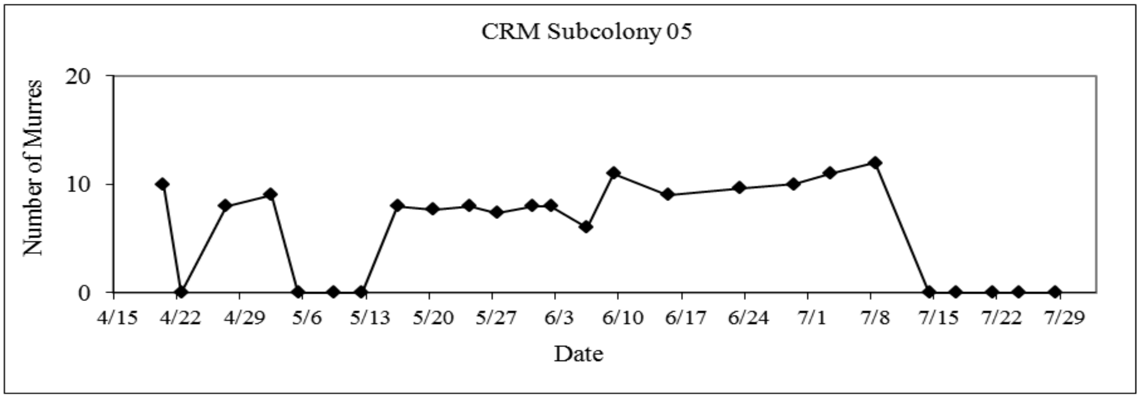
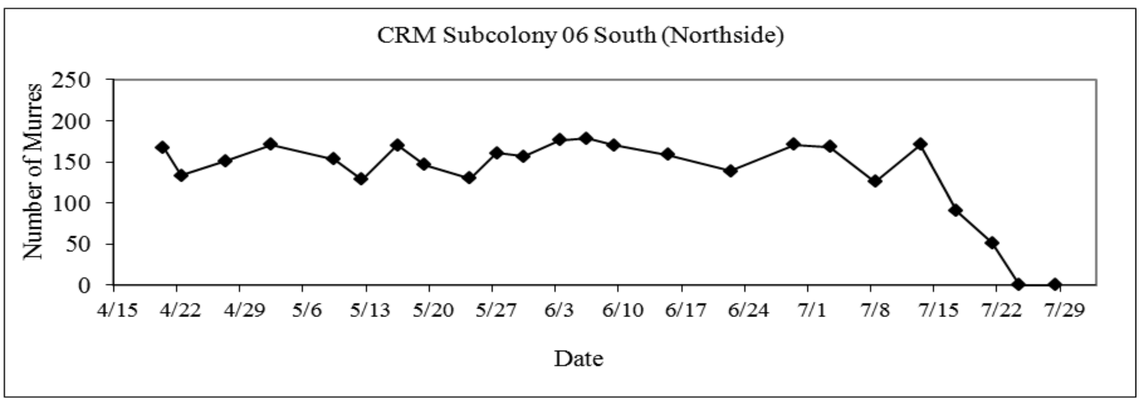


Figure 20. Seasonal attendance patterns of Common Murres at Bench Mark-227X subcolony 02 and Castle Rocks and Mainland subcolonies 02, 03East (east side) and 03West (north side), 18 April to 28 July 2011.







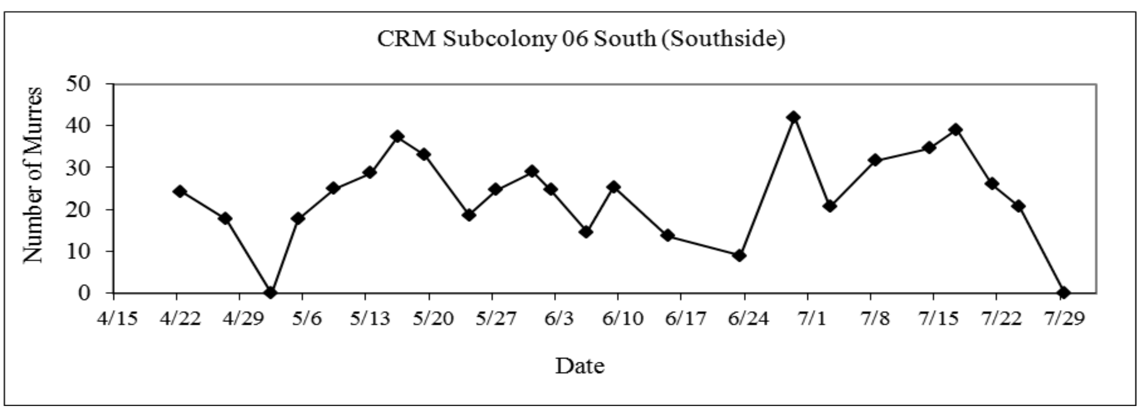


Figure 21. Seasonal attendance patterns of Common Murres at Castle Rocks and Mainland subcolonies 04 (total) and 04 (Plot only), 05, 06South (North side) and 06South (South side), 20 April to 29 July 2011.

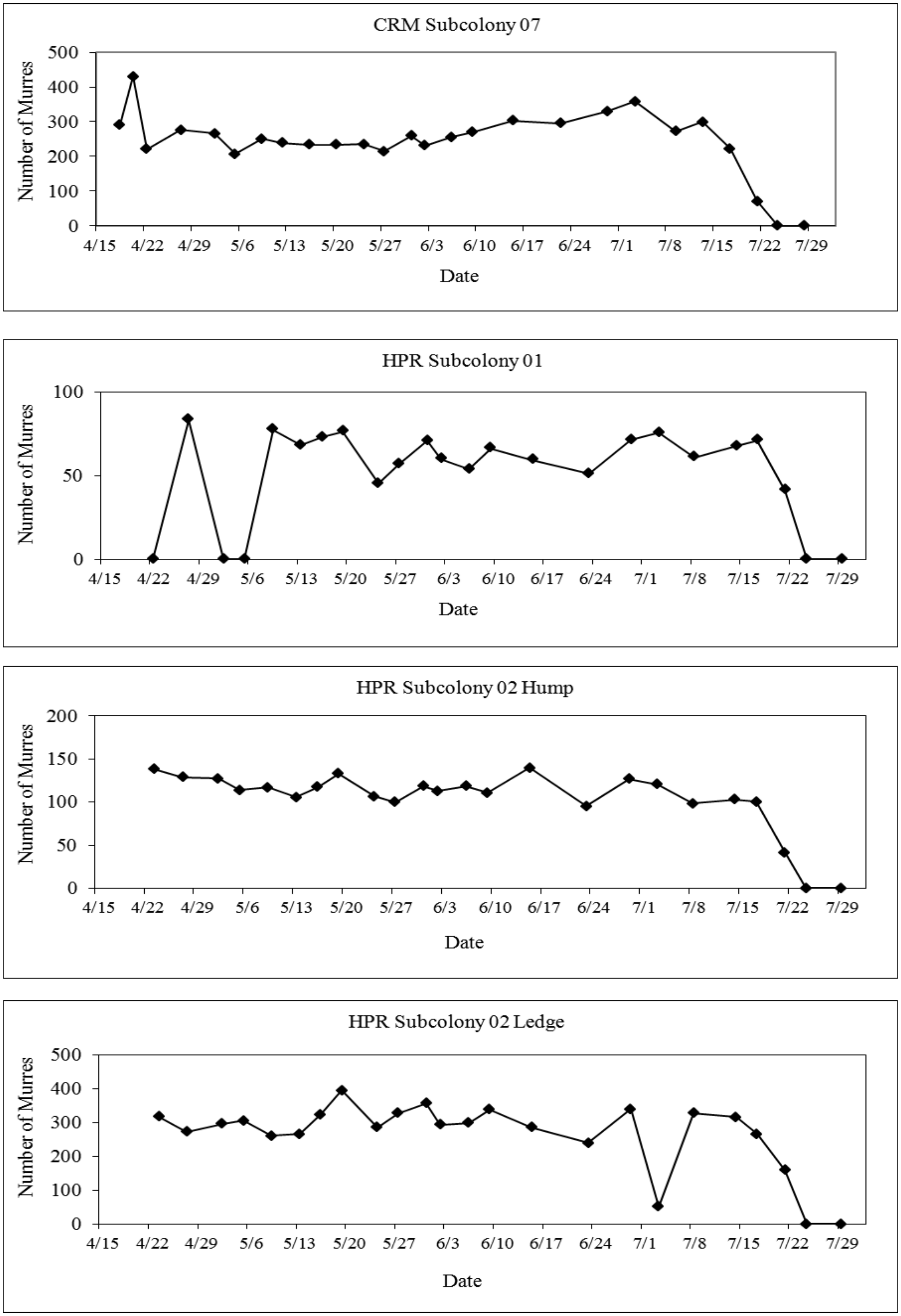


Figure 22. Seasonal attendance patterns of Common Murres at Castle Rocks and Mainland subcolony 07 and Hurricane Point Rocks subcolonies 01 and 02 (Hump and Ledge subareas), 18 April to 29 July 2012.

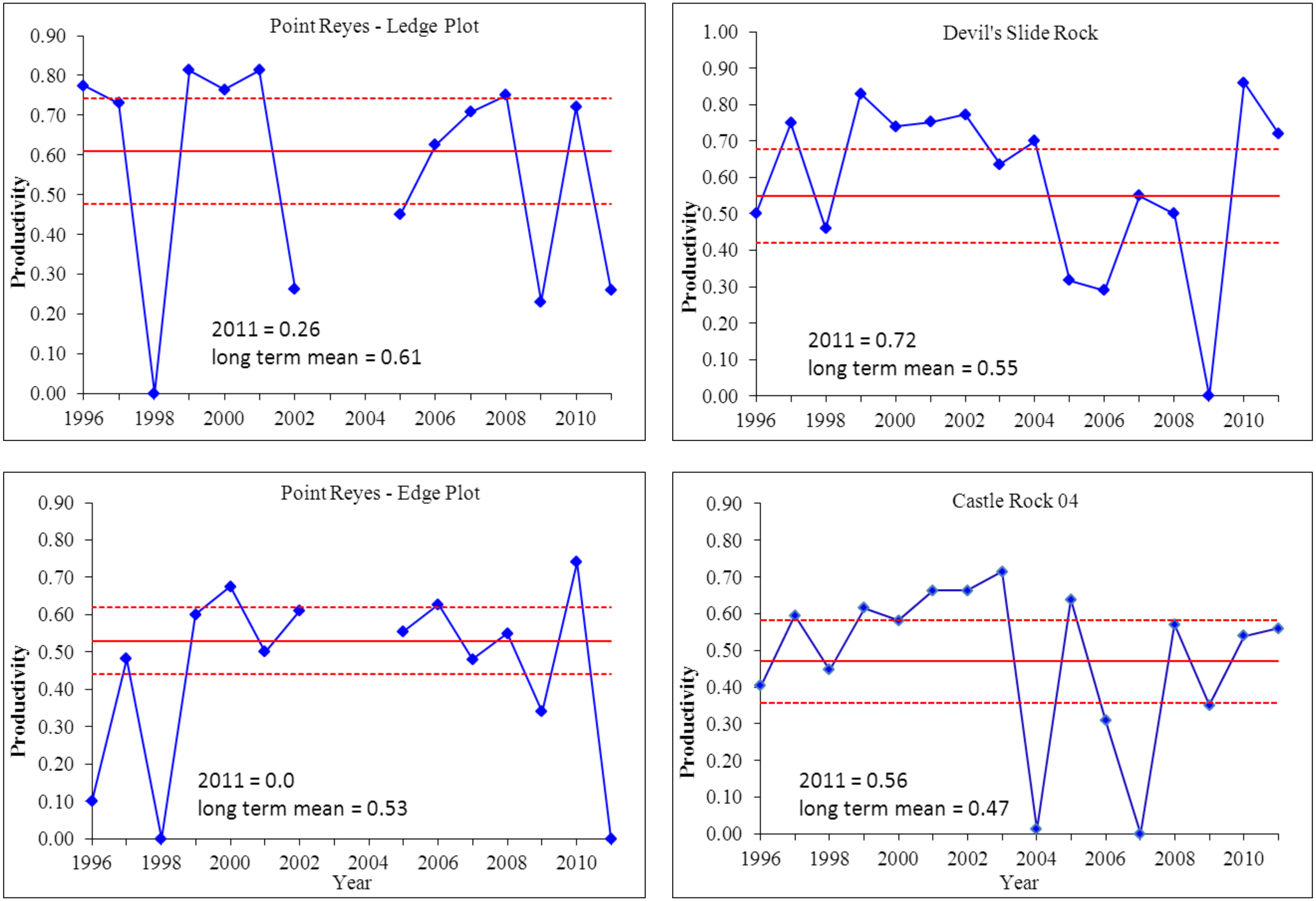


Figure 23. Productivity (number of chicks fledged/pair) of Common Murres at Point Reyes (Ledge and Edge plots), Devil's Slide Rock, and Castle Rocks and Mainland 04 Plot, 1996-2011. Solid horizontal lines indicate the long-term means and dashed lines represent the 95% confidence interval.

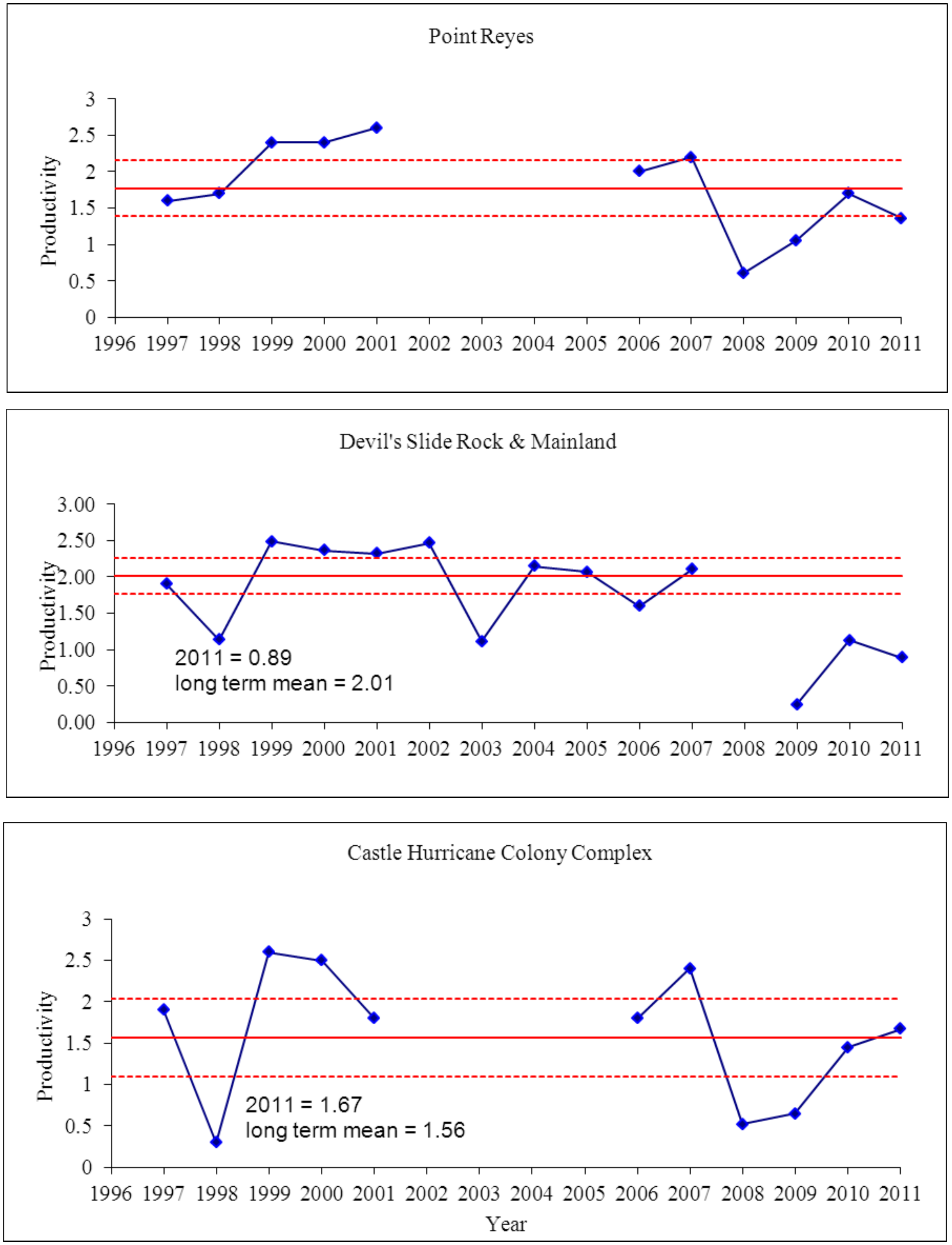


Figure 24. Productivity (number of chicks fledged/pair) of Brandt's Cormorants at Point Reyes, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex, 1997-2011. Solid horizontal lines indicate the long-term means and dashed lines represent the 95% confidence intervals.

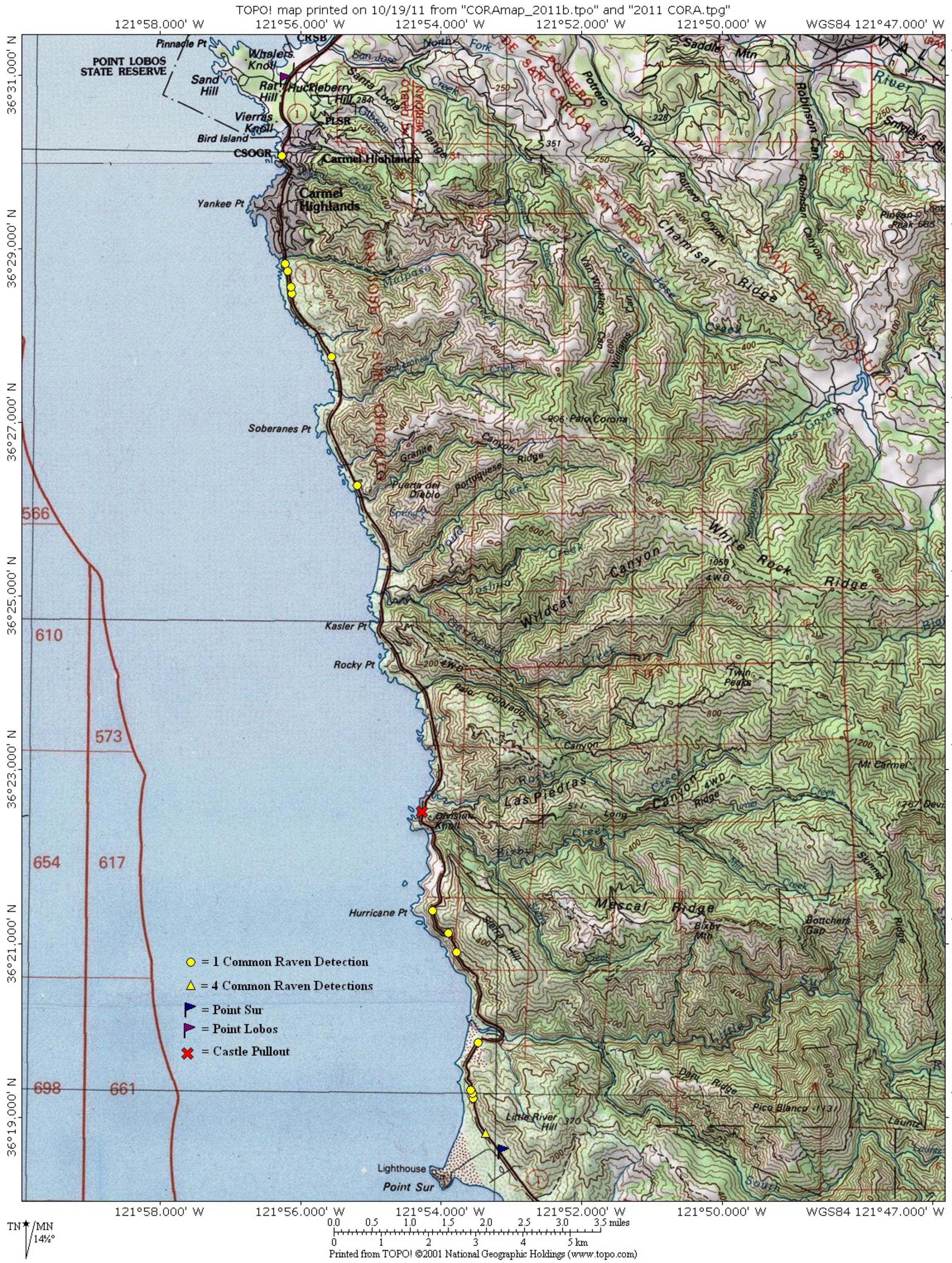


Figure 25. Locations of Common Raven detections along Highway 1 between Point Lobos and Point Sur, California, in 2011.

Appendix 1. Numbers of observed aircraft overflights 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 2011.

Aircraft Type	Total Detections		Number Agitation		Number Displacement Events		Number Flushing Events		Total Disturbance Events	
	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo	Plane	Helo
Point Reyes										
Research	6	0	0	0	0	0	0	0	0	0
Military	1	0	0	0	0	0	1	0	1	0
Unmarked	2	0	2	0	0	0	0	0	2	0
Point Resistance										
Unmarked	1	0	0	0	0	0	0	0	0	0
Double Point Rocks										
Research	5	0	0	0	0	0	0	0	0	0
Unmarked	1	0	1	0	0	0	0	0	1	0
Devil's Slide Rock and Mainland										
Media	0	1	0	1	0	0	0	0	0	1
Research	6	0	3	0	0	0	0	0	3	0
USCG	0	8	0	3	0	0	0	1	0	4
Military	4	6	3	3	0	0	0	2	3	5
Law Enforcement	4	1	4	0	0	0	0	0	4	0
Unmarked	225	42	100	24	0	0	1	2	101	26
Unknown	3	1	2	1	0	0	0	0	2	1
Castle-Hurricane Colony Complex										
Research	10	0	1	0	0	0	0	0	1	0
Law Enforcement	2	0	0	0	0	0	0	0	0	0
Unmarked	13	8	0	2	0	0	0	1	0	3

Appendix 2. Numbers of observed watercraft categorized by type and resulting disturbance events recorded at Point Reyes, Miller's Point Rocks, Double Point Rocks, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex, 2011.

Watercraft Type	Total Detections	Number. Agitation Events	Number. Displacement Events	Number. Flushing Events	Total Disturbance Events
Point Reyes					
Recreational (<25') Small Private	2	0	0	0	0
Miller's Point Rocks					
Charter	3	0	0	0	0
Double Point Rocks					
Recreational (<25') Small Private	7	3	0	0	3
Charter	5	1	0	0	1
Sailboat	1	0	0	0	0
Unmarked	2	0	0	0	0
Unknown	1	0	0	0	0
Devil's Slide Rock and Mainland					
Commercial Fishing	2	0	0	0	0
Recreational Small (<25') Private	7	0	0	0	0
Charter	2	1	0	0	1
Research	3	0	0	0	0
Kayak/Canoe	1	1	0	0	1
Castle-Hurricane Colony Complex					
Commercial Fishing	1	0	0	0	0
Recreational (<25') Small Private	2	0	0	0	0