RESTORATION AND MONITORING OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2014

REPORT TO THE
LUCKENBACH TRUSTEE COUNCIL

Allison R. Fuller, Gerard J. McChesney, Johanna C. Anderson, Ryan W. Berger, Jared A. Zimmerman, Ryan J. Potter, Bryan C. White, Justin A. Windsor, and Richard T. Golightly

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FINAL REPORT
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Cover photo: Aerial photograph of Devil's Slide Rock, 11 June 2014 by P.J. Capitolo.

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ABBREVIATIONS USED

BM227X = Bench Mark-227X

CDFW = California Department of Fish and Wildlife

CHCC = Castle-Hurricane Colony Complex (includes Bench Mark-227X, Castle Rocks and Mainland, and Hurricane Point Rocks)

CMRP = Common Murre Restoration Project

CRM = Castle Rocks and Mainland

DBCC = Drakes Bay Colony Complex (includes Point Resistance, Millers Point, and Double Point)

DPR = Double Point Rocks

DSCC = Devil's Slide Colony Complex (includes Devil's Slide Rock & Mainland, and San Pedro Rock)

DSM = Devil's Slide Mainland

DSR = Devil's Slide Rock

DSRM = Devil's Slide Rock and Mainland

GFNMS = Greater Farallones (formerly Gulf of the Farallones) National Marine Sanctuary

HPR = Hurricane Point Rocks

MPR = Millers Point Rocks

NOAA = National Oceanic and Atmospheric Administration

OSPR = Office of Spill Prevention and Response

PRH = Point Reyes Headlands

PRS = Point Resistance

SPN = Seabird Protection Network

SPR = San Pedro Rock

USFWS = U.S. Fish and Wildlife Service

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ACKNOWLEDGMENTS

In 2014, funding and oversight were provided by the *Luckenbach* Oil Spill Trustee Council comprised of California Department of Fish and Wildlife (CDFW), National Oceanic and Atmospheric Administration (NOAA), and Department of the Interior through the U.S. Fish and Wildlife Service (USFWS) and National Park Service (NPS).

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Observations of the Devil's Slide area colonies were conducted under a scientific collection permit from the County of San Mateo Parks Department and Encroachment Permit No. 0414-NSV0055 from the California Department of Transportation. Research at Point Reyes National Seashore was conducted under Permit PORE-2012-SCI-0003, and California Department of Fish and Wildlife Scientific Collecting Permit number SC-1769. Aerial photographic surveys of seabird colonies within overflight restricted areas of the Greater Farallones and Monterey Bay National Marine Sanctuaries were conducted under NOAA permit MULTI-2012-001 (issued to University of California Santa Cruz).

EXECUTIVE SUMMARY

Efforts in 2014 represented the 19th year of restoration and associated monitoring of central California seabird colonies by the Common Murre Restoration Project (CMRP). This project was initiated in 1996 in an effort to restore breeding colonies of seabirds, especially Common Murres (*Uria aalge*), harmed by the 1986 *Apex Houston* oil spill, as well as gill net fishing and human disturbance. Subsequently, the project was supported by the 1998 *Command* and extended *Luckenbach* oil spills. From 1995 to 2005, the primary goals were to restore the previously extirpated Devil's Slide Rock (DSR) colony using social attraction techniques, and to assess restoration needs at additional central California colonies. Since 2005, efforts have been directed towards surveillance and assessment of human disturbance at central California Common Murre colonies. Additionally, the outcome of initial recolonization efforts at DSR continues to be monitored. The human disturbance assessments inform outreach, education and regulatory efforts by the Seabird Protection Network (coordinated by the Greater Farallones National Marine Sanctuary) and allow for evaluation of those efforts. The goal of the Seabird Protection Network is to protect central California seabird breeding colonies primarily through reduction of human disturbance, which also adds to the restoration of previously damaged colonies.

Monitoring of human disturbance (mainly aircraft and watercraft), seabird productivity, seabird attendance patterns and relative population sizes were conducted at three Common Murre colony complexes (with less intensive monitoring at four additional colonies). In 2014, Devil's Slide Rock and Mainland (DSRM) continued to have the greatest combined aircraft and watercraft detection rate and disturbance rate of all monitored colonies. At DSRM, disturbance rates for planes and helicopters in 2014 were less than both the baseline mean and 2013 value. Disturbance rates for watercraft were less than the baseline mean, but greater than in 2013. Agitation and displacement/flushing events accounted for 60% and 40% of all seabird disturbances, respectively. The 16 flushing events at DSRM represented flushing/displacement rates greater than baseline means and greater than 2013 for both planes and helicopters. At both Point Reyes Headlands (PRH) and Drakes Bay Colony Complex (DBCC) sites, combined aircraft and watercraft disturbance rates in 2014 were less than both the baseline means and 2013 rates. At the Castle-Hurricane Colony Complex (CHCC), disturbance rates for planes and helicopters in 2014 were greater than baseline means.

The most commonly observed aircraft were general aviation (e.g., private or charter) planes and helicopters, followed by military helicopters, law enforcement helicopters and small commercial planes. Combined, these categories caused over 70% of disturbances at all monitored colonies. The most commonly observed watercraft were private recreational fishing boats, which caused 50% of disturbance events, followed by stand up paddle boards and kayaks with 25% each. Six vessels were recorded inside state Special Closures at DSR. These included four private fishing boats, a kayak, and a group of six stand-up paddlers: only the paddlers caused observed disturbance to seabirds. Additionally, one Special Closure violation was recorded at Stormy Stack/Double Point Rocks, but that vessel did not cause disturbance to seabirds.

On DSR, the maximum land-based count of 1,911 Common Murres in 2014 was 25% greater than the 2013 peak. The aerial photograph count of 1,971 Common Murres was nearly identical to the 2013 count, but the corrected population estimate of 3,213 breeding birds in 2014 was 9.2% greater than in 2013. Common Murre productivity, or reproductive success, was greater than long-term averages at both DSR and CHCC. In fact, Common Murre productivity at our standardized plot at CHCC (0.87 chicks per pair) was the greatest in the last 19 years of monitoring for that site. At PRH, Common Murre productivity was similar to the long-term average but considerably less than DSR and CHCC. The causes of poorer productivity at PRH are unclear, but may at least partly include raven predation on eggs and chicks. Raven predation on Common Murre eggs also was recorded at DSR, which hasn't been observed since 2009, and raises concern regarding future potential impacts.

There were more Brandt's Cormorant (*Phalacrocorax penicillatus*) nests counted from land-based observation points in 2014 than in 2013 at most colonies. Brandt's Cormorant productivity in 2014 was the greatest recorded to date at both PRH and CHCC but less than the long-term mean at DSRM, where birds abandoned nests then re-nested. The reasons for these differences among colonies were not clear but likely reflected local differences in prey availability. Pelagic Cormorants (*Phalacrocorax pelagicus*) at DSRM also had poor productivity; the number of chicks fledged per pair was 52% less than the long-term average. Productivity of Western Gulls (*Larus occidentalis*) and Black Oystercatchers (*Haematopus bachmani*) was monitored at DSRM and CHCC. Western Gull productivity has been poor at our monitored colonies over the last nine years, and in 2014 it was average or less than average at DSRM and CHCC. Only four Black Oystercatcher nests were monitored and of those, DSRM had no chicks fledged, and CHCC had 0.5 chicks fledged per pair.

Local ocean conditions in early 2014 were characterized by near average upwelling and sea surface temperatures (SST), followed by a reduction in upwelling and very warm SST in July and August (Leising et al. 2014). Seabird prey such as juvenile rockfish and euphausiids was abundant off central California (Leising et al. 2014). Piscivorous seabirds on the Farallon Islands fed their chicks mainly juvenile rockfish, with most species having near average to excellent breeding success (Warzybok et al. 2014). These same ocean conditions likely influenced the greater than average breeding success of Common Murres and Brandt's Cormorants at some of our monitored colonies, but less than average productivity of both Brandt's and Pelagic cormorants at DSRM may have reflected lack of prey near the colony.

INTRODUCTION

In central California, Common Murre (*Uria aalge*, hereafter referred to as murre) breeding colonies occur on nearshore rocks and adjacent mainland cliffs between Marin and Monterey counties as well as the North and South Farallon Islands, which are 20 to 40 km offshore of San Francisco (Carter et al. 1992, 2001). A steep decline in the central California population occurred between 1980 and 1986, and was attributed primarily to mortality associated with 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 (DSR) in northern San Mateo County was extirpated. Since 1995, the Common Murre Restoration Project (CMRP) has sought to restore DSR and other central California colonies using several techniques, including social attraction. Social attraction techniques were utilized at DSR between 1996 and 2005 (McChesney et al. 2006; Parker et al. 2007), and were discontinued after the colony appeared to be restored and self-sustaining. Restoration efforts at other murre colonies in central California have focused on documenting the impacts of human disturbance, gill-net mortality, and other threats to colonies, as well as working with government agencies and the public to reduce these impacts.

Since the early 1990s, the central California murre population has shown an increasing trend due to implementation of 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 until the California Department of Fish and Wildlife (CDFW) enacted an emergency closure of the gill-net fishery in September 2000 (Forney et al. 2001), followed by a permanent closure in September 2002 in waters less than 110 meters deep (60 fathoms) from Point Reyes to Point Arguello. Extensive oil pollution (e.g., 1998 *Command* oil spill and a series of oil releases from the sunken vessel *S.S. Jacob Luckenbach* from the early 1990s to the early 2000s) continued to kill thousands of murres in central California (Carter 2003; Carter and Golightly 2003; Hampton et al. 2003; Roletto et al. 2003). Disturbances from aircraft and watercraft have affected colonies as well (Rojek et al. 2007; USFWS, unpubl. data).

Beginning in 1995, restoration and associated monitoring of murre colonies in central California have been funded largely through oil spill restoration plans and associated trustee councils, including the *Apex Houston* (1995-2009), T/V *Command* (2005-2009), and, beginning in 2010, the *Jacob Luckenbach*. On 14 July 1953, the *S.S. Jacob Luckenbach* collided with another vessel and sank in 55 meters of water approximately 27 kilometers southwest of San Francisco. The *S.S. Jacob Luckenbach* was loaded with 457,000 gallons of bunker fuel which subsequently leaked periodically during winter storms. Using chemical analysis, oil that was associated with several mystery spills was linked to this vessel, including the Point Reyes tar ball 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 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 company responsible for the *Luckenbach* no longer exists, the Oil Spill Liability Trust Fund pays for oil spill cleanup and restoration of impacted natural resources when there is no responsible party. The fund is sustained by fees from the oil industry and managed by the NPFC. The Central California Seabird Colony Protection Project, now called the Seabird Protection Network (SPN), was initiated by the *Command* Oil Spill Restoration Fund (Command Trustee Council 2004) in 2005 and was extended in 2010 with *Luckenbach* funds. The SPN is implemented by the Greater Farallones National Marine Sanctuary (GFNMS) and CMRP to restore seabird colonies harmed by these oil spills mainly by reducing human disturbance. 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 murre restoration or reference sites in 1996: Point Reyes Headlands, Devil's Slide Colony Complex, and Castle-Hurricane Colony Complex. Since 2005, less intensive surveys have been conducted at three additional colonies in the Drakes Bay Colony Complex: Point Resistance (PRS), Millers Point Rocks (MPR), and Double Point Rocks (DPR). In 2014, colony count surveys were also conducted twice per week at Bird Island (near Point Bonita) in Marin County to document potential murre attendance and breeding at that site (recolonized in 2007).

Here we summarize colony surveillance and monitoring efforts conducted at central California nearshore murre colonies in 2014. Similar to past years, we also recorded and categorized aircraft, watercraft and other disturbances to seabirds; murre seasonal attendance patterns; and productivity (or, reproductive success). We also recorded Brandt's Cormorant (*Phalacrocorax penicillatus*) relative breeding population sizes and productivity, as well as population sizes and/or productivity of Pelagic Cormorants (*P. pelagicus*), Black Oystercatchers (*Haematopus bachmani*), Western Gulls (*Larus occidentalis*), and Pigeon Guillemots (*Cepphus columba*).

METHODS

Study Sites

Five colonies or colony complexes were monitored in 2014 (Figure 1). Point Reyes Headlands (PRH; Figure 2), Point Resistance (PRS), Millers Point Rocks (MPR), and Double Point Rocks (DPR; Figure 3) are located within the Point Reyes National Seashore, Marin County; the latter three colonies are often grouped into the Drakes Bay Colony Complex (DBCC). Bird Island is located near the mouth of the Golden Gate within Golden Gate National Recreation Area, Marin County. The Devil's Slide Colony Complex (DSCC), located in San Mateo County, consists of the colonies Devil's Slide Rock and Mainland (DSRM) and San Pedro Rock (Figure 4). The Castle-Hurricane Colony Complex (CHCC) in Monterey County consists of the colonies Bench

Mark-227X (BM227X), Castle Rocks & Mainland (CRM), and Hurricane Point Rocks (HPR; Figure 5). The offshore rocks of DSCC and CHCC are within the California Coastal National Monument, while adjacent mainland areas are either privately, state or county-owned. At each colony, individual rocks and mainland cliffs with nesting seabirds were identified by their recognized subcolony number, subcolony name, or subarea. In this report, colonies are ordered north to south within each section. All means are reported as the mean plus or minus one standard error, unless otherwise noted.

In March of 2014, the Devil's Slide Trail – a 1.3 mile (2.1 km) pedestrian trail along what was formerly Highway 1 – officially opened to the public as part of the new Devil's Slide Trail County Park. Most of the seabird nesting areas on Devil's Slide Mainland, as well as all observation points for monitoring DSRM, are within the park. The closing of the highway in 2013 and opening of the trail in 2014 changed the access to observation points but otherwise did not affect data collection protocols or observations.

Disturbance

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

Monitoring effort was calculated for each colony and colony complex except for Bird Island (Table 1). In order to compare disturbance among colonies and among years, disturbance rates were calculated. Anthropogenic disturbance rates were calculated during the breeding season (in 2014, 14 April until the end of monitoring, Table 1) as the number of disturbance events per hour of observation (monitoring effort) at each colony complex. Disturbance rates from 2014 were compared to baseline means for each colony or colony complex. Baseline means were the average disturbance rates from 2005 to 2006 combined; which represented the beginning of focused disturbance monitoring just prior to the initiation of the SPN outreach and education program directed at reducing human-caused disturbance to seabird colonies in central California. For non-anthropogenic disturbances, we reported the species that caused disturbance(s) and summarized major events.

In addition to disturbance events, all aircraft flying at or below 1,000 ft above sea level and watercraft within about 1,500 ft of the nearest seabird breeding or roosting area were recorded to highlight use patterns of potential sources of anthropogenic disturbance. Detection rates were calculated as the number of aircraft or watercraft observed within these given zones per observation hour, using monitoring effort for each colony complex. All watercraft entering Special Closure areas were recorded and reported to Cal-TIP ("Californians Turn in Poachers;" CDFW) and SPN. Special Closures are no-entry zones designated by CDFW under the California Marine Life Protection Act (MLPA) to protect important seabird and marine mammal colonies from disturbance. Four of six Special Closures in the North Central Coast Study Region (Point Arena to Pigeon Point) are adjacent to CMRP-monitored colonies: Point Reyes Headlands (1000 ft closure), Point Resistance (300 ft closure), Stormy Stack/Double Point (300 ft closure), and Egg Rock/Devil's Slide Rock (300 ft closure on the west side and complete closure from the east side of the rock to the mainland) (http://www.dfg.ca.gov/marine/mpa/nccmpas_list.asp).

Common Murre Seasonal Attendance Patterns

Seasonal attendance of murres at each colony was monitored from standardized mainland observation points using 65-130X or 15-60X spotting scopes. Attending murres were counted at each colony, subcolony, or index plot. Three consecutive counts were made and counts were averaged for most surveys, except for certain subcolonies at PRH (see below). Seasonal attendance data were collected regularly at all colonies throughout the field season until all chicks fledged and adult attendance ceased. Breeding season counts were conducted during a standardized period between 1000-1400 h.

Point Reyes Headlands

Seasonal attendance at PRH was recorded at all murre subcolonies visible from mainland observation points once per week from 14 April to 15 August (Figure 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, Beach, and Cone Rocks. Counts of most index plots were conducted three times per survey and averaged. Plots on Flattop and Middle Rocks were only counted once per survey. All other subcolonies were counted once per survey of entire visible areas.

Drakes Bay Colony Complex

Murre attendance was monitored twice per week at DPR, PRS and MPR from 16 April to 4 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 (within DPR) because of the large numbers of murres attending these colonies.

Bird Island

Murres were first recorded attending Bird Island among nesting Brandt's Cormorants in 2007 (McChesney et al. 2008), and breeding was first confirmed in 2008 (McChesney et al. 2009). In 2014, monitoring of this recent colonization continued and observations were conducted by trained volunteers twice per week. From 16 April to 30 July, counts were conducted during two time periods, with early morning (0700-0900 h) and late afternoon (after 1500 h) surveys alternated between count days. Because of recent murre attendance patterns, surveys were only conducted of the north side of the rock, from the blufftop above the north end of Rodeo Beach.

Devil's Slide Rock & Mainland, San Pedro Rock

Murres on DSR were counted every other day from 15 April to 21 August from the Traditional Pullout. On Devil's Slide Mainland (DSM), attendance patterns were monitored once per week wherever murres could be viewed (Figure 4). Access to the best observation point for viewing Turtlehead (DSR-05) and Turtlehead Boulder was restricted prior to 15 May in order to minimize disturbance to nesting Peregrine Falcons (*Falco peregrinus*). At SPR, bird counts were conducted once per week throughout the breeding season from Pipe Pullout.

Castle-Hurricane Colony Complex

Seasonal attendance of murres was monitored for all active subcolonies visible from accessible, standard mainland observation points (Figure 5). Counts were conducted twice per week during the breeding season from 14 April to 25 July. At four subcolonies, separate subarea counts were also conducted: CRM-04 (productivity plot and entire rock), CRM-03B (south and east sides), CRM-06South (north and south sides), and HPR-02 (Ledge and Hump plots). In 2014, counts were not conducted from the Woodrat Bluff observation point because road construction in 2013 resulted in the removal of the turnout previously used for access. Area CRM-06-A-N was observed from the Castle Pullout instead of Woodrat Bluff in 2014.

Common Murre Productivity

As in previous years, productivity (chicks fledged per pair) of murres was monitored at PRH, DSRM, and CRM daily (at least every two to three days; weather permitting) from standardized mainland observation points using either 65-130x or 15-60x spotting scopes. At PRH and CRM-04B, locations of returning or new breeding and territorial sites were identified using maps and photographs updated from the 2013 breeding season. At CRM-03B, a subset of potential breeding sites was followed, at the discretion of the field biologist. At DSR, all sites were mapped and numbered using digiscoped photographs of the colony, as well as 2014 aerial photographs. 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 but without detection. A sporadic site was defined as a location attended for at least two days but for less than 15% of monitored days. Many possible sporadic sites were not identified because of frequent movement by visiting birds. Chicks were considered to have fledged if they survived at least 15 days. Results from 2014 were compared to previous long-term means: DSR and CRM, 1996-2013 (n = 18 years); and PRH, 1996-2002 and 2005-2013 (n = 16 years).

Point Reyes Headlands

Murre productivity was monitored at PRH within two established Type I plots on Lighthouse Rock (LHR). Ledge Plot and Edge Plot were located in the interior and edge of the colony, respectively. All active, visible sites in the plots were monitored beginning 15 May.

Devil's Slide Rock and Mainland

Due to widespread colony growth and the increasing difficulty of monitoring the entire colony, three Type I plots (A, B and C) were established on DSR in 2006 (McChesney et al. 2006; Figure 6). Boundary adjustments were made to plots A and C in 2007, and difficult sites were dropped from plots B and C in 2012. These adjusted plots (A, B, and C) were utilized for monitoring in 2008-2013. Prior to the 2014 field season, difficult to observe sites were dropped from plots A and B, and more suitable sites were added. This resulted in 47 and 21 fewer sites followed compared to 2013 in plots A and B, respectively. Plot C was eliminated from monitoring entirely for the 2014 field season because of difficult viewing conditions (compared to 13 sites followed in 2013). At DSM, visible sites were monitored at one active subarea: Lower Mainland South (DSR-05A-Lower). All active sites in plots and subareas were monitored beginning 16 April.

Castle-Hurricane Colony Complex

All active murre breeding and territorial sites were monitored within a standardized plot on CRM-04 (established in 1996) beginning 15 April. Murres were present at the ephemeral subcolony CRM-03B in 2014, for the seventh year in a row. A subset of active sites was monitored beginning 15 April. In 2013, the observation point for monitoring CRM-04 was moved about 100 m south because of road construction. However, we found this new observation point provided improved views of the productivity plot and continued using it in 2014.

Common Murre Co-attendance and Chick Provisioning

Time budget surveys were not completed at DSR in 2014. Several surveys were attempted, but a combination of fog, and logistical problems resulted in their cancellation.

Nest Surveys

Nest and bird counts of non-murre seabirds were conducted weekly during the breeding season at all colonies in order to assess relative breeding population sizes. Brandt's Cormorant nests and territorial sites were classified into five groups that described nesting stages: site with little or no nesting material, poorly built nest, fairly built nest, well-built nest, and nests with brooded chicks. In addition, large, wandering ("creching") cormorant chicks were counted. See McChesney et al. (2007) for more detailed descriptions of nest categories. Nest counts for each colony were reported as the sums of seasonal peak counts at each subcolony or subarea. Peak counts in 2014 included nests with brooded chicks (this was inconsistent in past years). In addition, a boat survey was conducted at DSRM to survey nesting areas not visible from mainland observation points and all Pigeon Guillemots. These counts were reported separately. For comparisons to 2013, only land-based counts were used because boat surveys were not conducted in 2013.

Brandt's Cormorant Productivity

Breeding phenology and reproductive success of Brandt's Cormorants were monitored at PRH, DSRM, and CHCC wherever observation points provided sufficient views. At PRH, Brandt's Cormorants were monitored at Sea Lion Cove (PRH-06C; Top, East and Cliff), Spine Point (PRH-11E-SPINE), Sloppy Joe (PRH-12A), Border Rock (PRH-14C) and Miwok Rock (PRH-14D). At DSRM, monitoring was conducted at DSR (DSR-01), Mainland South (DSR-05A), April's Finger (DSR-05-AF), and South of Turtlehead Cliffs (DSR-05C). At CHCC, monitoring was conducted at CRM-03B and CRM-09.

Monitored nests were checked every one to seven days from mainland observation points using binoculars and spotting scopes. Chicks were considered to have fledged if they survived to at least 30 days of age. After that age, chicks typically begin to wander from their nests and become impossible to associate with specific nests without marking (Carter and Hobson 1988, McChesney 1997). Results from 2014 were compared to prior long-term means for DSRM (1997-2007, 2010-2013; n = 15 years), CHCC (1997-2001, 2006-2013; n = 13 years) and PRH (1997-2001, 2006-2013; n = 13 years).

Pelagic Cormorant, Black Oystercatcher, and Western Gull Productivity

Productivity of Western Gulls and Black Oystercatchers was monitored at select nests that were easily visible from mainland observation points at DSRM and CHCC. Productivity of Pelagic Cormorants was monitored only at DSRM. Nests were checked at least once per week. Chicks were considered to have fledged if they survived at least 30 days. Feathering status was used as a proxy for chick age if precise age was not known (i.e., chicks that were greater than 75% feathered were considered to have fledged). Results were compared to 2013, and to long-term means when available for comparison.

Pigeon Guillemot Surveys

To assess relative population size and seasonal attendance patterns, weekly standardized counts were conducted of birds rafting on the water and roosting on land (intertidal and nesting areas) at PRH, DBCC, DSCC and CHCC. Surveys at all colonies except DBCC were conducted between one-half hour after sunrise and 0830 h. From mid-April to 5 May, when numbers often peak, surveys were conducted twice per week (weather permitting) and about once per week thereafter. Due to the large size of the PRH colony area, weekly counts were only conducted of areas easily visible from the lighthouse. While a single survey of the entire PRH colony has been conducted in the past, the "all headlands" survey was not conducted in 2014. At DSCC, the entire area from the south side of San Pedro Rock to the South Bunker (DSRM Subcolony 04; Figure 4) was surveyed. Access to the Turtlehead Overlook (DSR-05) was restricted prior to 2 May in order to reduce disturbance to nesting Peregrine Falcons (*Falco peregrinus*). After 2 May, access was granted for brief Pigeon Guillemot surveys. At CHCC, the Woodrat Bluff and Rocky Point survey areas were dropped in 2014 due to access issues. At DBCC colonies, guillemots were counted upon arrival (range 0850–1401 h) for twice weekly colony surveys at PRS, MPR, and DPR.

RESULTS

Anthropogenic Disturbance

During the 2014 field season, there were 75 aircraft detections within our monitoring zones at PRH, DBCC, DSRM and CHCC combined, including 49 planes (65%) 25 helicopters (33%) and one kit plane (amateur-built; 1%). Overall, 45 (60%) of these overflights resulted in disturbance to seabirds (e.g. agitation, displacement or flushing), which were categorized as 23 planes (47% of planes detected), 21 helicopters (84% of helicopters detected) and the single kit plane. Thirteen helicopters (accounting for 17% of all detected aircraft), and five planes (accounting for 7% of all detected aircraft) caused displacement and/or flushing of murres. The most frequently detected aircraft categories were general aviation planes (49% of all aircraft detections, and causing 35% of disturbances) and general aviation helicopters (20% of aircraft detections and causing 24% of disturbances; Figure 7). There were 12 total watercraft detections within 1,500 feet of monitored colonies, including seven recreational fishing boats, two charter fishing boats, two kayaks, and a group of six stand-up paddle boards. Four of these events resulted in disturbance: two from recreational fishing boats, one from a kayak, and one from the paddle boards (Figure 8).

A total of 35 Wildlife Disturbance Reports were completed and submitted to the SPN in 2014 (two from PRH, 29 from DSRM and four from CHCC). Agitation events were reported immediately to SPN for the first time in 2014. This included 15 reports of agitation and 20 reports of flushing. Thirty-one of the reports involved aircraft disturbance, three involved watercraft disturbance, and one involved a land-based disturbance involving gunshots.

There were seven Special Closure violations recorded in 2014, including one at DPR, and six at DSR. Only one violation, involving stand-up paddle boards at DSR, resulted in disturbance. All Special Closure violations were reported to the SPN and CalTIP, while three of the violations at DSR were also reported directly to a CDFW warden.

Point Reyes Headlands

At PRH in 2014, two aircraft overflights (0.007 aircraft/hr; one plane, one helicopter) were recorded, and three watercraft were detected (0.011 watercraft/hr) (Table 2, Appendices 1, 2). One U.S. Coast Guard helicopter overflight (50% of total aircraft detected) resulted in disturbance (agitation) to murres (0.004 disturbances/hr), and one small recreational fishing boat flushed Pelagic Cormorants, Western Gulls and Pigeon Guillemots (0.004 disturbances/hour).

The 2014 combined detection rate (aircrafts and watercraft) of 0.018 detections/hr was 87% less than the baseline mean, and 17% less than in 2013 (Table 2, Figure 9). Detection rates for planes (0.004 planes/hr) and watercraft (0.011 watercraft/hr) were less than baseline means, but the rate for helicopters (0.004 helicopters/hr) was 174% greater than the baseline mean. The combined disturbance rate of 0.004 disturbances/hr was 81% less than the baseline mean, and 47% less than 2013 (Table 2, Figure 10). Disturbance rates for planes (0 planes/hr) and watercraft (0.004 watercraft/hr) were less than baseline means, but the disturbance rate for helicopters (0.004 helicopters/hr) was 174% greater than the baseline mean. Disturbance rates for watercraft and helicopters were also greater than 2013. It should be noted that despite certain increases in detection and disturbance rates in 2014, detection and disturbance rates at PRH were much less than at other colonies.

Drakes Bay Colony Complex

When considered together, the combined (watercraft and aircraft) detection rate at all DBCC colonies of 0.012 detections/hr was 95% less than the baseline mean. Detection rates for planes (0 planes/hr), helicopters (0 helicopters/hr), and watercraft (0.012 watercraft/hr) were all less than the baseline means (Figure 11). The overall disturbance rate also was less than the baseline mean (Figure 11), with one unusual disturbance at MPR (see below).

Point Resistance
At PRS, there were no aircraft or watercraft detections (Table 4) and thus no disturbance events.

Millers Point Rocks
At MPR, there were no aircraft or watercraft detections or disturbances (Table 5, Appendix 2). However, gunshots fired by hikers on the beach below Millers Point on 17 May resulted in the flushing and/or displacement of 300 murres, 20 Brandt's Cormorants, 20 Pelagic Cormorants, 15 Pigeon Guillemots and five Western Gulls (Tables 5, 3). Point Reyes National Seashore law enforcement officers were notified of the incident and the suspects were apprehended.

Double Point Rocks
At DPR, there were no aircraft detections, and a single watercraft detection (0.024 watercraft/hr) with no recorded disturbance (Table 6).

Devil's Slide Rock and Mainland

In 2014, 41 plane (0.069 planes/hr), 20 helicopter (0.034 helicopters/hr), and 11 watercraft detections (0.019 boats/hr) were recorded (Table 7, Appendices 1, 2). The combined watercraft and aircraft detection rate of 0.122 detections/hr was 73% less than the baseline mean and 43% less than the 2013 rate (Figure 9, Table 7). Sixty-two percent (n = 38) of all overflights resulted in disturbances to seabirds. Disturbances were caused by 51% of planes (n = 21) and 85% of helicopters detected (n = 17). The single watercraft-related disturbance event was caused by a group of six stand-up paddle boarders. The combined disturbance rate of 0.068 disturbances/hr was 56% less than the baseline mean, and 13% less than in 2013. Disturbance rates were less than the baseline means for planes and helicopters by 23% and 10%, respectively (Figure 10,

Table 7). The watercraft disturbance rate for 2014 was less than the baseline mean (by 83%), but greater than in 2013 (by 100%).

The rate of disturbance events involving displacement and/or flushing of seabirds (0.027 disturbances/hr) was 12% less than the baseline mean, but 239% greater than in 2013. There were 16 total flushing events, including: three general aviation planes, two commercial planes, three military helicopters, seven general aviation helicopters and a group of stand-up paddle boarders. The largest numbers of birds affected by one aircraft occurred during the Pacific Coast Dream Machines event. The flushing event was caused by a general aviation helicopter that flushed 412 murres on a southbound pass, about 700 feet above DSR (Tables 7, 8).

The annual Pacific Coast Dream Machines event on 27 April, returned to a one-day format following its move to a two-day event in 2013. This event includes an aircraft fly-in, which can attract dozens or more aircraft. In some years, aircraft disturbances associated with the event at DSRM have been quite frequent. The SPN has been working with event organizers and airport managers to decrease aircraft overflights at DSRM. Fog was not a major factor in 2014 unlike past years. Just six aircraft detections (9.8% of total detections in 2014) were recorded during the event day in 2014, comparable to detections during 2013's event. Four disturbance events were recorded over the course of the day: three agitation events and one flushing event. The three agitation events were caused by general aviation planes. The disturbance rate during the 2014 event was greater than in 2013, but still less than previous years. Using real-time information provided by field observers, SPN staff made contact with pilots of observed aircraft if it subsequently landed at the Half Moon Bay airport.

Castle-Hurricane Colony Complex

At CHCC, six plane overflights (0.020 planes/hr), four helicopter overflights (0.014 helicopters/hr) and three watercraft detections (0.010 watercraft/hr) were recorded in 2014 (Table 9, Appendices 1, 2). Three planes, three helicopters and two watercraft caused disturbances (0.27 disturbances/hr). The combined detection rate of 0.044 detections/hr was 36% less than the baseline mean, but 59% greater than the 2013 rate (Figure 9, Table 9). The combined disturbance rate of 0.027 was 358% greater than the baseline mean, and 100% greater than in 2013 (Figure 10, Table 9).

Non-Anthropogenic Disturbance

Point Reyes Headlands

In 2014, 41 flushing events and seven displacement events were recorded from non-anthropogenic sources. Common Ravens were responsible for 79% (n = 38), Western Gulls for 13% (n = 6), Turkey Vultures for 4% (n = 2), and Brown Pelicans and California Sea Lions for 2% each (n = 1). A total of 26 eggs were observed to be taken from Lighthouse Rock (PRH-03B), including one egg taken from a monitored site during these events by Common Ravens and Western Gulls. The largest disturbance event was caused by one juvenile Brown Pelican that was attempting to steal fish from murres for about 30 minutes duration, and resulted in 2,000 murres being displaced or flushed from Cone Rock (PRH-13). While no eggs were observed to be taken during the event, 50 eggs were displaced, and likely lost. Ravens flushed and/or displaced an average of 172 (range = 10 – 500) murres per disturbance event.

Drakes Bay Colony Complex

Point Resistance
Three non-anthropogenic disturbance events were observed at PRS in 2014, including two involving Brown Pelicans, and one caused by Turkey Vultures. No eggs or chicks were observed to have been lost during any of these events. The maximum number of murres flushed or displaced in a given disturbance event was 60, in an event caused by three Turkey Vultures.

Millers Point Rocks
A single non-anthropogenic disturbance event was observed at MPR in 2014, caused by one Western Gull. While 160 murres were flushed, no eggs or chicks were observed to have been lost during this event.

Double Point Rocks
Seven flushing and one displacement event were observed at DPR in 2014, including four events caused by Common Ravens, and four caused by Brown Pelicans. Six murre eggs and one murre chick were observed to be lost as a result of these events. The maximum number of murres flushed or displaced in a given disturbance event was 2,000, in an event caused by a pair of ravens.

Devil's Slide Rock and Mainland

In 2014, 29 flushing events and four displacement events were recorded at DSRM from non-anthropogenic sources. Common Ravens were responsible for 70% (n = 23), Brown Pelicans for 23% (n = 9), and Western Gulls for 3% (n = 1). A total of nine murre eggs were observed to be taken from DSR by ravens, as well as two Pelagic Cormorant eggs from a nest on DSM. Though raven events were more numerous, more birds were flushed on average during Brown Pelican events. The largest disturbance event was caused by a fly-by of one Brown Pelican, resulting in 130 murres being displaced or flushed from DSR. Ravens flushed and/or displaced an average of 19 (range = 1 – 100) murres per disturbance event.

Castle-Hurricane Colony Complex

Four non-anthropogenic disturbance events were recorded in 2014 at CHCC, including one displacement event and three flushing events. Two of the events were caused by Brown Pelicans, one by a Western Gull, and one by a Peregrine Falcon. The greatest number of murres flushed in a given event at CHCC was 30, by a Brown Pelican that flew over the rock. While the Western Gull did not flush any adult murres, it did take an egg from a monitored site.

Common Murre Seasonal Attendance Patterns

Point Reyes Headlands

All well-established nesting areas were active with confirmed breeding in 2014. The dates of peak counts were variable, ranging from 14 April to 3 July among subcolonies. For most subcolonies, peak numbers were recorded before the first egg lay date at monitored sites (16 May); however Northwest Rock (PRH-10A) and Flattop Rock (PRH-10B) had peak counts after the mean egg-lay date (Figure 12-17). Half of the subcolonies were no longer attended by murres by 30 July, and plots on Lighthouse Rock (PRH-03B) were vacant by 15 August (Figure 12). These attendance patterns were consistent with previous years. In 2012 and 2013, murres attended PRH subcolonies until late July or early August.

Murres attended several infrequently used subcolonies and non-breeding "clubs" in 2014, including Big Roost Rock (PRH-03A), Aalge Ledge (PRH-03D), Wishbone Point (PRH-11EWISH), and Area B (PRH-14B). Breeding was not confirmed at any of these subcolonies, but attendance at Wishbone Point (PRH-11EWISH) was consistent throughout the breeding season, suggesting that breeding may have taken place there.

Drakes Bay Colony Complex

Point Resistance

Murre attendance at PRS was variable into early June, with a peak count by 9 June (Figure 18). Counts were relatively stable through June, and then decreased by approximately half by 18 July. Attendance ceased entirely by 26 July. Consistent attendance suggests that there was likely successful breeding at PRS.

Millers Point Rocks

Murre attendance at MPR South Rock (MPR-02) was variable, and may have been impacted by unobserved disturbance (Figure 18). Attendance peaked on 8 May, but was not consistent, suggesting that successful breeding did not take place at MPR in 2014. Murres were not observed at MPR North Rock (MPR-01) until 6 June, but not in substantial numbers (maximum of 35 on 7 July). Murres did not attend MPR-03 or Blue Cheese (MPR-04), and only attended MPR-02 in small numbers after 19 June.

Double Point Rocks

Attendance at Stormy Stack (DPR-01) was consistent through early July, with a peak count on 17 April (Figure 18). Attendance steadily declined through mid-July, suggesting that there was successful breeding at DPR. Attendance ceased at all plots by 4 August.

Bird Island

Surveys were conducted at Bird Island from 16 April to 30 July 2014. Murres were observed on 33% of observation days, but in small numbers. The average number of murres observed on days when they were present was seven (range = 3-35, n = 10 days). Infrequent, variable attendance suggests that murres did not successfully breed at Bird Island in 2014. Murres continued to use the small area underneath the remains of a former U.S. Navy Compass House, on the far western end of the rock. Brown Pelican disturbance was observed through July, but it is unclear whether it had any impact on murre attendance.

Devil's Slide Rock and Mainland, San Pedro Rock

Devil's Slide Rock

Murres were observed on all count days between 15 April and 15 August 2014, and were completely absent from the rock by 21 August, following the end of breeding activity (Figure 19). The greatest counts were recorded during the pre-egg-laying period (April to early May). The maximum count of 1,911 murres on 7 May was 25% greater than the 2013 peak count of 1,527 murres. Attendance patterns were relatively consistent from mid-May to early July through the egg-laying, incubation and early chick periods, followed by a slight increase in early to mid-July, and then by a rapid decline as adults and chicks departed the colony. From photographs obtained during the annual aerial survey on 11 June, 1,971 murres were counted, similar to the 2013 aerial survey count of 2,001 murres. This aerial count was greater than the count of 976 murres counted on 11 June from the standardized land-based observation point (Figure 19). The greater aerial survey count reflects the more complete colony coverage provided by this method. To derive an approximate estimate of the DSR breeding population size, we applied the correction factor of 1.63 calculated for murres at Southeast Farallon Island in 2014 (Warzybok et al. 2014). The correction factor accounts for breeding birds not present, as well as non-breeding birds present at the colony at the time of the survey. Applying this correction factor to the aerial survey count of 1,971 birds yields an estimate of 3,213 breeding birds, or about 1,607 breeding pairs. This estimate is 9.2% greater than the estimate of 2,942 breeding birds in 2013 (USFWS, unpubl. data), the greatest since DSR was recolonized in 1996, and similar to estimates of 2,300-2,923 breeding birds in 1979-1982 prior to colony extirpation (Sowls et al. 1980, Briggs et al. 1983, Carter et al. 2001).

Devil's Slide Mainland

Murres attended Lower Mainland South (DSR-05A-Lower) in overall larger numbers than 2013 (mean = 25, range = 2-44, Figure 20). This was the only mainland subarea with consistent attendance in 2014. Nine breeding sites were confirmed from which one chick hatched, but none successfully fledged.

San Pedro Rock

Murres were not observed on San Pedro Rock in 2014.

Castle/Hurricane Colony Complex

Monitoring at all CHCC subcolonies began on 14 April. Similarities in attendance suggested relatively synchronous breeding at most active CHCC subcolonies, with stable attendance from late April to early July. Rapid declines in early to mid-July signified colony departure as chicks fledged (Figure 21-24). Murres were absent from CHCC by 22 July.

Common Murre Productivity

Point Reyes Headlands

A total of 177 sites were monitored between Ledge (n = 100; 58%) and Edge (n = 77; 42%) plots on Lighthouse Rock. The first murre egg on Lighthouse Rock was observed on 10 May, outside of the productivity plots. In Ledge Plot, 88 sites were breeding and 12 were territorial. The mean egg lay date (exclusive of replacement eggs) was 30 May ± 0.5 days (range = 21 May – 13 June; n = 50; Table 11), four days later than the long-term average of 26 May ± 2.4 days. Six replacement eggs were laid in Ledge. Productivity was 0.51 chicks fledged per pair, 2% less than the long-term mean of 0.52 ± 0.07 (Figure 25).

In Edge Plot, 57 sites were breeding and 20 sites were territorial. The mean egg lay date for first eggs (exclusive of replacement eggs) was 28 May ± 0.6 days (range = 16 May – 13 June; n = 35; Table 11), two days earlier than the long-term mean of 30 May ± 3.1 days. Three replacement eggs were laid. Productivity was 0.51 chicks fledged per pair, 19% greater than the long-term mean of 0.43 ± 0.09 (Figure 25).

When Edge and Ledge plots were combined, the mean egg-laying date was 30 May ± 0.5 days, (range = 17 May – 13 June; n = 85; Table 11), four days later than the long-term mean (26 May ± 2.3 days). Overall productivity was 0.51 chicks fledged per pair, 2% greater than the long-term average (0.50 ± 0.08), with 72.2% hatching success and 71.2% fledging success. Chicks that fledged remained on the rock for an average of 24 ± 0.6 days (n = 39), and the last chick was last observed on 11 August.

Devil's Slide Rock and Mainland

Of 175 sites documented within DSR plots, 159 (91%) were breeding, and 16 (8%) were territorial. The first murre egg on DSR was observed on 11 May, outside of the productivity plots. At all sites combined, the mean egg-laying date (exclusive of replacement eggs) was 28 May ± 0.5 days (range = 14 May – 15 June, n = 136; Table 11), which is three days later than the long-term average (25 May ± 2.0 days). A total of 162 eggs were laid, including three replacement eggs. Overall productivity of 0.82 chicks fledged per pair was 32% greater than the long-term average (0.62 ± 0.06; Figure 25). Greater than average productivity was influenced by hatching success of 84.0% and fledging success of 97.8% Chicks that fledged remained on the rock for an average of 24 ± 0.3 days (n = 125), and the last chick was seen on 12 August.

Ten sites were followed on Lower Mainland South (DSR-05A-LOWER), including nine breeding sites (90%) and one territorial site (10%). Mean egg-lay date was 21 May ± 6.9 days (range = 11 May – 10 July, n = 8; Table 11). A total of 10 eggs were laid, including one replacement egg, but only one egg hatched. The single chick was last seen on 28 July when it was too young to fledge.

Castle-Hurricane Colony Complex

Of 111 total monitored sites in the CRM-04 plot in 2014, 94 (85%) were breeding, 14 (13%) were territorial and two (2%) were sporadic (Table 11). The mean egg-laying date (exclusive of replacement eggs) was 4 May ± 0.8 days (range = 23 April – 2 June; n = 93), 12 days earlier than the long-term average of 16 May ± 2.4 days. Two replacement eggs were observed. Overall productivity at CRM-04 was 0.87 chicks per pair, 74% greater than the long-term mean (0.50 ± 0.05 chicks per pair), and the greatest on record (Figure 25). Chicks that fledged remained on the rock for an average of 23 ± 0.3 days (n = 88) after hatching, and the last chick was seen on 12 July.

For the seventh consecutive year, murres were monitored and bred on the east side of CRM-03B. Of 74 sites monitored, 62 (84%) were breeding and 12 (16%) were territorial. The first CHCC murre egg was observed on CRM-03B on 21 April. The mean egg-laying date was 10 May ± 1.3 days (range = 21 April – 6 June; n = 62; Table 11), nine days earlier than the long-term average of 19 May ± 2.2 days. Eleven replacement eggs were laid. Productivity at CRM-03B was 0.24 chicks per pair in 2014, 43% less than the long-term average of 0.42 ± 0.13 chicks per pair (1999-2003, 2005, 2008-2013; n = 12 years) for this subcolony.

Common Murre Co-attendance and Chick Provisioning

Time budget surveys were not completed at DSR in 2014.

Brandt's Cormorant Nest Surveys and Productivity

Seasonal peak nest counts of Brandt's Cormorants obtained from land, and combined land and boat counts (DSRM only) are provided. Because Brandt's Cormorant nesting areas typically vary from year to year, some nests may not be visible from our observation points, and nest counts should be considered a minimum estimate. Comparisons to previous years should also be considered with caution. Analyses of aerial photographic surveys are needed to provide more complete nest counts and more meaningful comparisons.

Point Reyes Headlands

Nest surveys

Brandt's Cormorant nest surveys were conducted from 14 April to 4 August. Well-built nests were recorded at Pebble Point (PRH-05C), Slide (PRH-06B), Area C (PRH-06C), PRH-10 (Other), Rock 37 (PRH-10F), Tim Tam (PRH-10H), PRH-11 (Other), Spine Point (PRH-11E-SPINE), Wishbone Point (PRH-11E-WISHBONE), PRH-12 (Other), Sloppy Joe (PRH-12A), Cone Shoulder (PRH-13CS), Border Rock (PRH-14C) and Miwok Rock (PRH-14D). The first well-built nest was observed on 14 April. The peak single-day count for all subcolonies combined was 230 nests on 24 June, 2.6% greater than in 2014 (n = 224). The sum of the seasonal peak counts for each subcolony was 242 nests, 13% less than in 2014 (n = 277; Table 12). No boat survey was conducted to supplement land-based surveys in 2014.

Productivity
A total of 129 nests were monitored at five subareas, and 126 were egg-laying sites (Table 13). Monitoring of nests on Spine Point (PRH-11E), Border Rock (PRH-14C) and Miwok Rock (PRH-14D) began on 15 April; at Sea Lion Cove Area (PRH-06C) on 18 April; and on Sloppy Joe (PRH-12A) on 14 May.

The average clutch initiation date of 5 May ± 1.1 days (range = 6 April – 5 June, n = 116) for first clutches (Table 13) was 12 days earlier than the long-term mean of 17 May ± 4.1 days. The first chick was observed on 9 May. Five replacement clutches were observed. Overall productivity of 2.60 chicks fledged per pair (subarea range = 2.36 – 2.86) was 47% greater than the long-term average of 1.77 ± 0.2 (Figure 26). Breeding success was 0.97 per nest (subarea range = 0.90 – 1.00).

Drakes Bay Colony Complex

The first well-built nests were observed at PRS and MPR (both MPR-01 and MPR-02) on 16 April and at DPR on 17 April, the first checks of the season at each. The peak count for PRS was 38 nests on 6 June; none nested in 2013. The peak count for MPR-01 was 102 nests on 31 May, and for MPR-02, 11 nests on 22 May. The combined peak total count of 113 nests was 77% greater than in 2013. At DPR, the peak count of 53 nests on 21 June was 47% greater than in 2013.

Bird Island

Surveys were conducted from 16 April to 30 July. Although Brandt's Cormorants were observed roosting on Bird Island, often in large numbers, no nesting occurred in 2014.

Devil's Slide Rock and Mainland

Nest surveys
Nests and territorial sites were counted between 17 April and 7 August. The first well-built nests were observed on 17 April, the first day of monitoring. The peak count of nests on DSR was 25 nests. On the mainland, nesting occurred on South of Turtlehead Cliffs (DSR-05C; peak count of three nests), Mainland South Roost (DSR-05A-ROOST; peak count of one nest), Upper Mainland South (DSR-05A-UPPER; peak count of seven nests) and Lower Mainland South (DSR-05A-LOWER; peak count of 69 nests). Several Brandt's Cormorant nest abandonment events were observed, followed by unsuccessful re-nesting attempts. Details can be found below in the Brandt's Cormorant productivity section.

The peak single day count for DSRM was 103 nests on 19 June, 98% more than the 2013 peak count (n = 52). The sum of the seasonal peak counts was 105 nests (Table 12), 11% more than the 2013 seasonal peak count sum of 95 nests.

Productivity
In 2014, several Brandt's Cormorant nest abandonment events were observed at DSRM, starting in April, when half of monitored nests (52 on DSM, and 19 on DSR) were abandoned. Some of these nests had already reached well-built status and had eggs. In May, there was a second mass abandonment event on DSM. Re-nesting was quickly initiated following the event in May, but many of the birds that rebuilt their nests lost their eggs soon after laying them. Through May, June, and July, cormorants continued to re-lay, lose their eggs, and then apparently re-nest within different subcolonies, only to lose their eggs again. Several nests on DSM and DSR incubated eggs for long periods of time, suggesting that they were inviable.

A total of 104 breeding sites were monitored at DSRM in 2014, including DSR (DSRM-01), April's Finger (DSRM-05-AF), Mainland South Roost (DSRM-05A-ROOST), Upper Mainland South (DSRM-05A-UPPER), Lower Mainland South (DSRM-05A-LOWER) and South of Turtlehead Cliffs (DSRM-05C) (Table 13). The first egg was observed on DSR on 21 April. For all subareas combined, the mean clutch initiation date of 7 May ± 1.6 days (range = 14 April to 13 July) was five days earlier than the long-term mean of 12 May ± 2.9 days. Overall productivity of 1.27 chicks fledged per pair (subarea range = 0 – 1.50; n = 116) was 23% less than the long-term average of 1.64 ± 0.2 (Figure 26). Breeding success of 0.62 per nest reflects the noted nest abandonment. There were 13 replacement clutches observed in 2014, including an apparent third and fourth clutch for one pair on Lower Mainland South (DSR-05A-LOWER). Third and fourth clutches have never been observed previously by the CMRP.

Castle-Hurricane Colony Complex

Nest surveys
Brandt's Cormorant nest surveys were conducted from 15 April to 22 July. Subcolonies or subareas with confirmed breeding in 2014 were BM227X-02, BM227X-05, CRM-03B, CRM-06-A-N, CRM-06BSS, CRM-07, CRM-09 and HPR-02. The first well-built nests were observed on 15 April at all subcolonies except for BM227X-05 (8 July) and CRM-06BSS (18 April). At all CHCC subcolonies combined, the peak single survey nest count of 234 nests was recorded on 23 June. The sum of the peak subcolony counts was 255 nests (Table 12). Because 2013 counts did not include BM227X, no comparisons to 2013 were made.

Productivity
Brandt's Cormorant productivity was monitored on CRM-03B and CRM-09 (Table 13). The mean clutch initiation date for both subcolonies combined was 24 April ± 1.3 days, 11 days earlier than the long-term mean of 5 May ± 4.0 days. The first chick was observed on 5 May. Overall productivity of 2.66 chicks fledged per pair (subcolony range = 2.29 – 2.94; n = 64) was 60% greater than the long-term average of 1.66 ± 0.2 (Figure 26). Breeding success per nest was 0.92.

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

Nest and bird surveys

Peak counts of nests (Pelagic Cormorant, Western Gull, and Oystercatcher) or birds (Pigeon Guillemot) from weekly land-based observations and boat counts are summarized in Tables 12 and 14. Boat counts were conducted only at DSRM in 2014; and because no boat surveys were conducted in 2013, nest survey results are compared to 2013 land counts only.

Pelagic Cormorant
Pelagic Cormorant well-built nests were first observed at PRH on 23 April, at DBCC on 16 April, at DSRM on 17 April, and at CHCC on 15 April. The first observed egg of the year was at DSRM on 30 April. Nest counts are summarized in Table 12. Pelagic Cormorant nesting areas typically vary from year to year and some nests may not be visible from land-based observation points. Because of this, nest counts should be considered a minimum estimate and comparisons to previous years should be considered with caution. Because of incomplete coverage in either 2013 or 2014, no between years comparisons were made. However, the combined land and boat count of 99 nests at DSRM was among the greatest recorded at that colony.

Western Gull
Compared to 2013, there were fewer nests observed at PRH (14%) and DBCC (35%). A comparison to 2013 was not made for DSRM because boat surveys were not conducted in 2013. Also, comparisons to 2013 were not made for CHCC because the BM227X colony was not surveyed in 2013 due to road construction. In addition, a count of the largest nesting area for Western Gulls on the southwest side of HPR-02 was not conducted in 2014. Although counts at PRH and DBCC also were incomplete in both 2013 and 2014 as boat surveys were not conducted either year, previous surveys showed that most nests at those colonies were counted on land-based surveys.

Black Oystercatcher
Nest counts for Black Oystercatchers were comparable to 2013, except for PRH, where 10 nests were observed, compared to three in 2013. Three total nests were observed at DBCC (PRS, MPR and DPR, combined), one at DSRM and four at CHCC.

Pigeon Guillemot
At PRH, the peak standardized count from the lighthouse of 141 birds on 3 June (PRH-02, PRH-03 and PRH-04) was 18% less than in 2013. Although surveys of Drakes Bay colonies were not done at standardized times, peak counts were greater than 2013 peak counts at PRS (61%), MPR (21%), and DPR (53%).

At DSCC, the peak land-based count of 255 guillemots on 1 May was 150% greater than in 2013. As no boat surveys were conducted in 2013, no comparison could be made to the 158 guillemots counted on the 2014 boat survey. At CHCC, the peak count was 14 guillemots on 12

May. Guillemot surveys were not conducted at CHCC in 2013 due to road construction, so comparisons were not made.

Productivity

Productivity results for Pelagic Cormorants, Western Gulls, and Black Oystercatchers are summarized in Table 15. Productivity monitoring for Western Gulls and Black Oystercatchers was conducted at DSRM and CHCC, and Pelagic Cormorants were monitored at DSRM only.

Pelagic Cormorant
At DSRM, Pelagic Cormorant productivity was monitored on Mainland North (DSR-02), DSR-03, Turtlehead (DSR-05B) and Lower Mainland South (DSR-05A-LOWER). Productivity of 0.85 chicks fledged per pair was 52% less than the long-term average (1.67 ± 0.2, 2006 – 2013).

Western Gull
Nests were monitored at DSRM and CHCC. Gull productivity was 0.67 chicks fledged per pair at DSRM and 0.50 chicks fledged per pair at CHCC; both values were less than the long-term means.

Black Oystercatcher
One breeding site was followed at DSRM, but no chicks fledged. Productivity at CHCC was 0.50 chicks fledged per pair.

DISCUSSION

Anthropogenic Disturbance

In 2014, DSRM had the greatest rates of aircraft and watercraft activity among our monitored colonies, consistent with the long-term pattern. Also like past years, aircraft (especially planes) far outnumbered watercraft for both detections and disturbances. Overall, detection and disturbance rates at DSR were less than baseline means, and were similar to 2013. Despite relatively reduced rates of detection and disturbance, flushing rates at DSR were greater than baseline means for both helicopters and planes (33.3% and 785.3% greater than baseline means, respectively). In other words, birds flushed more when disturbed, instead of exhibiting only behaviors such as head-bobbing. As was observed in past years, PRH and DBCC colonies had fewer aircraft and watercraft detections than the other colonies. One unusual, major flushing event was caused by gunshots at MPR. In contrast, the overall disturbance rate at CHCC was the greatest since 2010 and resulted from a combination of aircraft and watercraft activity. Disturbance rates for planes, helicopters and watercraft at CHCC were all greater than baseline means.

In past years, the annual Pacific Coast Dream Machines event resulted in elevated levels of aircraft activity and disturbance at DSR. Monitoring efforts were coordinated with pilot outreach efforts conducted by GFNMS staff. In 2014, the event returned to a one-day format after a trial run of a two-day event in 2013. Although aircraft overflights were relatively infrequent (despite clear skies), four overflights resulted in disturbance, including the greatest number of birds disturbed in any single event of the year. While the disturbance rate during the event was greater in 2014 than in 2013, it was less than all other previous years. The persistent presence of GFNMS outreach staff at this event may have decreased low overflights at DSR.

In 2014, six watercraft were detected inside the state Special Closure at DSR, and one at Stormy Stack (DPR). Only two Special Closure violations were recorded in 2013; both at DSR. The single watercraft disturbance event at DSR in 2014 involved a group of six stand-up paddle boarders, the first record of paddle boarders. This increasingly popular form of water recreation may continue to be a disturbance threat in the future (The Outdoor Foundation 2015). However, the use of stand-up paddle boards is limited mostly to calm sea conditions, which are infrequent around DSR and the other colonies, and may limit opportunities for this kind of disturbance in the future.

Non-Anthropogenic Disturbance

At all colonies combined in 2014, Common Ravens were the most common source of non-anthropogenic disturbances (67% of events), with occurrences at PRH, DPR, and DSRM. Ravens were observed at DPR and DSR pulling adult murres by their wings until they fled from their nests, and then taking their eggs. Raven disturbance and predation have not been major problems at DSRM in the past but incidents on both the rock and mainland were more frequent in 2014 than any previous year. This is a concern for the DSR murre colony, especially given its relatively small size. If raven disturbance of the colony should become more frequent, there is potential for impact to murre productivity and colony size.

Brown Pelicans (mainly juveniles) have caused large-scale disturbances at monitored murre colonies in the past, sometimes resulting in near to total breeding failure at affected colonies (Fuller et al. 2013). In 2014, only one major pelican disturbance was recorded, at Cone Rock (PRH-13LC) in PRH. Many murre eggs were likely lost, but the impact was not as great as in some previous years. Catastrophic pelican breeding failure at colonies in Mexico and southern California in 2014 resulted in few juvenile birds on the central California coast (D. W. Anderson, pers. comm.).

Attendance and Reproductive Success

At DSR, the murre colony continued the long-term trend of colony growth, though it appears the colony size is beginning to plateau. While the standardized land-based maximum count in 2014 was the greatest on record, and 25% greater than in 2013, this was only a single day count early in the season prior to egg-laying. The 2014 aerial photograph count was very similar to 2013, yet population estimates based on those counts suggested a nearly 10% increase. Additional years will be necessary to determine the actual current trend. Whether or not murre numbers are still increasing, the colony appears to be similar in numbers to the early 1980s, prior to extirpation in the mid-1980s.

Seasonal attendance patterns at monitored colonies reflected differences in breeding phenology between colonies. In particular, CHCC subcolonies exhibited earlier colony departure than the other colonies, and most previous years, reflecting earlier breeding. Colony departure at PRH and DSR appeared later than normal, reflecting late breeding at those colonies. Consistent attendance at typically non-breeding subcolonies, or "clubs" at PRH suggested a healthy population of subadults. These "clubs" were vacant for many years following the declines in the mid-1980s.

At MPR, murre attendance continues to be very sporadic both within and between years. In some years, birds mainly attend the South Rock (MPR-02) while in other years birds attend the North Rock (MPR-01) or even the very small rock known as Blue Cheese (in MPR-04). While productivity is not monitored at MPR, the sporadic within-season attendance indicates that most birds did not breed in 2014. The reasons for this erratic attendance and poor productivity are unclear. In past years, raven disturbance and egg predation has been observed and was thought to impact the colony. Raven disturbance has not been observed at MPR in recent years, so it is uncertain if ravens continue to disrupt colony activity or if other factors are involved.

Murre attendance at Bird Island also continues to be sporadic. Following initial prospecting in 2007 and the first confirmed breeding in 2008, murre attendance has generally declined on this rock with only occasional observations of chicks in 2010 and 2012. Observations in 2014 showed that only small numbers of birds occasionally visited the rock and that breeding most likely did not occur. However, murre attendance warrants continued monitoring of Bird Island in case of future successful breeding and colony establishment.

Murre breeding was earlier than average at CRM in 2014 but average to slightly late at PRH and DSR. This difference in timing warrants further investigation but was likely related to local ocean conditions and/or prey availability. Murre productivity was greater than long-term means at DSR and CRM-04, but was near average at PRH. Productivity at CRM-04 was the greatest since monitoring began in 1996. While greater than average breeding success at DSR and CRM-04 indicated availability of local prey, the cause(s) of poor breeding success at PRH is not clear. Raven nest predation may be at least partly to blame, but the infrequent nature of observed raven predation in the LHR colony suggests additional causal factors.

Murres once again bred in small numbers on DSM but failed to produce any fledglings. While breeding on DSM has occurred nearly every year since 2005, murre breeding locations within this area continuously change and breeding success has been poor. Also, like past years, murre productivity was poor at CRM-03B compared to neighboring CRM-04. Compared to our monitored nearshore colonies, murre breeding success at the long-term Farallon Islands plot was near to slightly below average, mainly due to low hatching success (Warzybok et al. 2014).

Brandt's Cormorants nest numbers in 2014 appeared to be similar to or greater than 2013 at nearly all colonies, although confirmation from aerial photographic surveys is needed. Breeding was earlier than average at all monitored colonies. Productivity was greater than long-term means at PRH and CHCC, with numbers being among some of the greatest on record. However, productivity at DSRM was poor compared to the other colonies and was less than the long-term mean. The unusual behavior at DSRM of entire subcolonies abandoning nests and then re-nesting was also observed at the nearby Farallon Islands; however, at the Farallones, cormorants still managed to achieve greater than average productivity (Warzybok et al. 2014).

Pelagic Cormorants experienced similar nest abandonment to Brandt's Cormorants at DSRM, with below average productivity. In contrast, Pelagic Cormorant productivity at the Farallon Islands was greater than average in 2014 (Warzybok et al. 2014). Western Gulls, similar to the past several years, had poor productivity at both DSRM and CHCC.

There are some inherent limitations to our data, especially regarding Brandt's and Pelagic Cormorant nest data. Cormorants typically do not nest on the same subcolonies from year to year, and it is likely that some nests each year are not visible, thus not counted, from our land observation locations. Because of this limitation, nest counts for these species should be considered minimum counts, and comparisons to previous years and between sites should be considered with caution. Complementary boat and/or aerial surveys can provide more complete coverage.

Much of the North Pacific experienced warmer than average sea surface temperatures (SST) in the first half of 2014 (Leising et al. 2014). However, coastal upwelling was still near average for most of the first half of the year, which kept water along the central California coast relatively cool (Leising et al. 2014). At the Farallon Islands, monthly mean SST was near average for most of the period of January to June (except April). However, cessation of upwelling-favorable winds resulted in Farallon SST much greater than average in July and August (Warzybok et al. 2014). SST near DSR followed the same general pattern, with sustained high temperature peaks in July and August and a smaller peak in late-April (NOAA CoastWatch, unpubl. data). Central California fisheries data indicated an abundance of juvenile rockfish, juvenile sanddabs, euphausiids, and market squid, but a shortage of northern anchovies and Pacific sardines (Leising et al. 2014). Piscivorous seabirds at the Farallon Islands fed on the more abundant prey, primarily feeding juvenile rockfish to their chicks (Warzybok et al. 2014). We assume that seabirds at our nearshore monitored colonies fed on similar prey. Lesser productivity of murres at PRH, and of Brandt's and Pelagic cormorants at DSRM, suggested there may have been a shortage of local prey near those colonies compared to the Farallon Islands or CHCC, unless other factors such as raven predation were the main causes.

Recommendations for Future Management, Monitoring and Research

- Outreach and education efforts targeting aircraft and watercraft user groups should be continued and adapted to changing sources and characteristics of disturbance.

- The Devil's Slide pedestrian trail was completed in March of 2014, and for the first time, pedestrians traversed the span of road above DSM. While no pedestrian-related disturbances were recorded, monitoring should be continued so as to record any new or different types of potential disturbance. The presence of thousands of visitors throughout the seabird season can also provide a great opportunity for outreach. Increased outreach efforts should be pursued, including better coordination with San Mateo County Parks trail ambassadors.

- Annual aerial surveys of central California murre and Brandt's Cormorant colonies continued in 2014 in cooperation with CDFW and University of California, Santa Cruz. However, no sustained funding is currently available to count nests and birds from the photographs. As murre numbers have increased, land-based counts have become more difficult and even less accurate. Additionally, Brandt's Cormorant nests are often only visible from aerial photographs. This enhances the importance of counting of these aerial photographs for accurate tracking of central California seabird numbers.

- As the numbers and densities of murres on monitored breeding colonies increases, it will be necessary to continually evaluate productivity monitoring methods (especially at DSR). This will include adjustments to plot boundaries and elimination of sites that are difficult to view.

- With ever-growing data sets, it is our intention to implement more meaningful comparisons to past years and analyzing trends in the long-term dataset for a variety of parameters including anthropogenic disturbance rates, colony sizes, attendance patterns, and productivity. These changes will be implemented in the 2015 annual report.

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Table 1. Monitoring effort of study colonies or colony complexes, April 2014 to August 2014.

Colony/Colony Complex	Start Date	End Date	Number of observation days	Total Hours[1]
Point Reyes Headlands	14 April 2014	15 August 2014	82	283
Point Resistance	16 April 2014	26 July 2014	20	18
Millers Point Rocks	16 April 2014	26 July 2014	20	24
Double Point Rocks	17 April 2014	4 August 2014	21	42
San Pedro Rock	15 April 2014	7 August 2014	27	13
Devil's Slide Rock & Mainland	15 April 2014	21 August 2014	122	578
Castle-Hurricane Colony Complex	14 April 2014	25 July 2014	80	293

[1]Number of hours with staff on site, not person-hours.

Table 2. Total detected watercraft and aircraft, and resulting disturbances to all seabirds at Point Reyes Headlands in 2014. Detection and disturbance rates reported as numbers per observation hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	1	0.004	0	0	0	0.000	0.000	0.040 (± 0.009)	0.020 (± 0.017)	- 91.18%	- 100%
Helicopter	1	0.004	1	0	0	0.004	0.000	0.001 (± 0.001)	0.001 (± 0.001)	173.6%	173.6%
Watercraft	3	0.011	0	0	1	0.004	0.004	0.097 (± 0.030)	0.015 (± 0.002)	- 89.01%	- 76.54%
Total	5	0.018	1	0	1	0.007	0.004	0.138 (± 0.022)	0.037 (± 0.019)	- 87.18%	- 81.06%

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

Table 3. Number of disturbance events and mean numbers (range) of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Point Reyes Headlands and Drakes Bay Colony Complexes, 2014.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean Number Seabirds Flushed/ Displaced	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds
Watercraft[1]	9	0	0	0	0	1	2	0	0	1	3	0	0	1	4
Other[2]	360	1	300	1	20	1	20	0	0	1	5	0	0	1	15

[1] Point Reyes Headlands
[2] Drakes Bay Colony Complex (Millers Point Rocks)

Table 4. Total detected watercraft and aircraft, and resulting disturbances to all seabirds at Point Resistance in 2014. Detection and disturbance rates reported as numbers per observation hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	0	0.000	0	0	0	0.000	0.000	0.018 (± 0.018)	0.0	- 100%	-
Helicopter	0	0.000	0	0	0	0.000	0.000	0.0	0.0	-	-
Watercraft	0	0.000	0	0	0	0.000	0.000	0.018 (± 0.018)	0.018 (± 0.018)	- 100%	- 100%
Total	0	0.000	0	0	0	0.000	0.000	0.036 (± 0.036)	0.018 (± 0.018)	- 100%	- 100 %

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

Table 5. Total detected watercraft and aircraft, and resulting disturbances to all seabirds at Millers Point Rocks in 2014. Detection and disturbance rates reported as numbers per observation hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	0	0.000	0	0	0	0.000	0.000	0.044 (± 0.044)	0.0	- 100%	-
Helicopter	0	0.000	0	0	0	0.000	0.000	0.022 (± 0.022)	0.022 (± 0.022)	- 100%	- 100%
Watercraft	0	0.000	0	0	0	0.000	0.000	0.185 (± 0.015)	0.054 (± 0.031)	- 100 %	- 100%
Other[2]	1	0.042	0	0	1	0.042	0.042	0.0	0.0	100%	100%
Total	1	0.042	0	0	1	0.042	0.042	0.252 (± 0.082)	0.076 (± 0.009)	- 83.32%	- 44.68%

[1] Events during which birds exhibited agitation or alert behaviors (A), flushing (F), or displacement (D).
[2] Event involved gunshots attributed to hikers at Millers Point.

Table 6. Total detected watercraft and aircraft, and resulting disturbances to all seabirds at Double Point Rocks in 2014. Detection and disturbance rates reported as numbers per observation hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/ hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	0	0.000	0	0	0	0.000	0.000	0.009 (± 0.009)	0.009 (± 0.009)	- 100%	- 100%
Helicopter	0	0.000	0	0	0	0.000	0.000	0.047 (± 0.030)	0.028 (± 0.011)	- 100%	- 100%
Watercraft	1	0.024	0	0	0	0.000	0.000	0.289 (± 0.057)	0.082 (± 0.005)	- 91.66%	- 100 %
Total	1	0.024	0	0	0	0.000	0.000	0.345 (± 0.036)	0.118 (± 0.003)	- 93.01%	- 100%

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

Table 7. Total detected watercraft and aircraft, and resulting disturbances to all seabirds at Devil's Slide Rock & Mainland in 2014. Detection and disturbance rates reported as numbers per observation hour.

Source	Total Detections	Number Detections/hr	Number of Disturbance Events: A	D	F	Number of Disturbance Events/hr: Total/hr[1]	Flush or Displace/ hr	Baseline mean ± SE: Number Detections/hr	Number Disturbances/hr	% Difference: Number Detections/hr	Number Disturbances/hr
Plane	41	0.069	16	0	5	0.036	0.008	0.311 (± 0.081)	0.073 (± 0.023)	- 77.70%	- 51.33%
Helicopter	20	0.034	7	0	10	0.029	0.017	0.076 (± 0.004)	0.040 (± 0.015)	- 55.64%	- 28.67%
Watercraft	11	0.019	0	0	1	0.002	0.002	0.071 (± 0.008)	0.030 (± 0.005)	- 73.81%	- 94.37%
Total	72	0.122	23	0	16	0.067	0.027	0.459 (± 0.077)	0.154 (± 0.033)	- 73.43%	- 56.11%

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

Table 8. Number of disturbance events and mean numbers (range) of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Devil's Slide Rock & Mainland, 2014.

Source	Mean Number Seabirds Flushed/ Displaced	COMU Disturbance: Number Events	Mean Number birds	BRCO Disturbance: Number Events	Mean Number birds	PECO Disturbance: Number Events	Mean Number birds	BRPE Disturbance: Number Events	Mean Number birds	WEGU/UNGU Disturbance: Number Events	Mean Number birds	BLOY Disturbance: Number Events	Mean Number birds	PIGU Disturbance: Number Events	Mean Number birds
Plane	16 (2-50)	5	16 (2-50)	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	138 (15-412)	15	138 (15-412)	0	0	0	0	0	0	0	0	0	0	0	0
Watercraft	16	1	16	1	16	0	0	0	0	0	0	0	0	0	0
Total	103	21	108	1	16	0	0	0	0	0	0	0	0	0	0

Table 9. Total detected watercraft and aircraft, and resulting disturbances to all seabirds at Castle-Hurricane Colony Complex in 2014. Detection and disturbance rates reported as numbers per observation hour.

			Number of Disturbance Events			Number of Disturbance Events/hr		Baseline mean ± SE		% Difference	
Source	Total Detections	Number Detections/hr	A	D	F	Total/hr[1]	Flush or Displace/hr	Number Detections/hr	Number Disturbances/hr	Number Detections/hr	Number Disturbances/hr
Plane	6	0.020	3	0	0	0.010	0.000	0.064 (±0.013)	0.003 (±0.003)	- 68.01%	243.7%
Helicopter	4	0.014	0	0	3	0.010	0.010	0.003 (± 0.003)	0.002 (±0.002)	358.2%	415.5%
Watercraft	3	0.010	1	0	1	0.007	0.003	0.002 (± 0.002)	0.000	406.3%	100%
Total	13	0.044	4	0	6	0.270	0.014	0.069 (±0.014)	0.006 (±0.006)	- 35.71%	129.1%

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

Table 10. Number of disturbance events and mean numbers (range) of Common Murres (COMU), Brandt's Cormorants (BRCO), Pelagic Cormorants (PECO), Brown Pelicans (BRPE), Western or Unknown Gulls (WEGU/UNGU), Black Oystercatchers (BLOY), and Pigeon Guillemots (PIGU) flushed or displaced at Castle-Hurricane Colony Complex, 2014.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU		BLOY Disturbance		PIGU Disturbance	
Source	Mean Number Seabirds Flushed/ Displaced	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds
Plane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopter	53 (10-200)	3	82 (15-200)	1	10	1	10	0	0	0	0	0	0	0	0
Watercraft	20 (15-25)	1	15	1	25	0	0	0	0	0	0	0	0	0	0
Total	44	4	65	2	18	1	10	0	0	0	0	0	0	0	0

Table 11. Common Murre breeding phenology and reproductive success at Point Reyes Headlands (2 plots and combined), Devil's Slide Rock & Mainland (DSR, 2 plots and combined; and DSM), and Castle Rocks & Mainland (2 plots), 2014. Means (range; n) are reported.

Colony/Plot	Number of Sites Monitored	Number of Egg Laying Sites	Mean Lay Date[1]	Number of Eggs Laid	Mean Hatch Date	Hatching Success[2]	Mean Fledge Date	Fledging Success[3]	Chicks Fledged per Pair
Point Reyes Headlands (PRH)									
PRH-Ledge	100	88	30 May (5/21 - 6/13; 50)	88	1 July (6/24 - 7/15; 25)	75.0% (88)	27 July (7/16 - 8/11; 45)	68.2% (66)	0.51 (88)
PRH-Edge	77	57	28 May (5/16 - 6/13; 35)	56	29 June (6/17 - 7/9; 19)	67.9% (56)	22 July (7/12 - 8/5; 27)	76.3% (38)	0.51 (57)
PRH- (combined)	177	145	30 May (5/16 - 6/13; 85)	144	30 June (6/17 - 7/15; 44)	72.2% (144)	25 July (7/12 - 8/11; 72)	71.2% (104)	0.51 (144)
Devil's Slide Rock and Mainland (DSRM)									
DSR-A	105	95	29 May (5/21-6/15; 81)	95	1 July (6/23 - 7/12; 79)	88.4% (95)	24 July (7/13 - 8/8; 82)	97.6% (84)	0.86 (95)
DSR-B	70	64	27 May (5/14 - 6/14; 55)	67	29 June (6/18 - 7/7; 49)	77.6% (67)	24 July (7/14 - 8/8; 51)	98.1% (52)	0.76 (67)
DSR (combined)	175	159	28 May (5/14 - 6/15; 136)	162	30 June (6/18 - 7/12; 128)	84.0% (162)	24 July (7/13 - 8/8; 133)	97.8% (136)	0.82 (162)
DSM	10	9	21 May (5/11 - 7/10; 8)	10	17 July (1)	10.0% (10)	-	0.0% (1)	0.00 (10)
Castle Rocks and Mainland (CRM)									
CRM-04	111	94	4 May (4/23 - 6/2; 93)	96	5 June (5/26 - 7/6; 89)	92.7% (96)	28 June (6/19 - 7/14; 82)	91.1% (90)	0.87 (94)
CRM-03B	74	62	10 May (4/21 - 6/6; 62)	73	7 June (5/29 - 6/20; 25)	34.2% (73)	29 June (6/19 - 7/2; 15)	60.0% (25)	0.24 (62)

Table 11 (continued)

[1] Calculated using first eggs only; i.e., does not include replacement eggs.

[2] Hatching success is defined as the number of eggs hatched per eggs laid (includes both first and replacement eggs).

[3] Fledging success is defined as the number of chicks fledged per eggs hatched (includes both first and replacement eggs).

Table 12. Peak counts of nests for Brandt's Cormorants (BRCO) and Pelagic Cormorants (PECO) obtained during land, boat, and combined land/boat counts (total) in 2014.

Species	Colony	Land[1]	Boat[3]	Total Count[2]
Brandt's Cormorant	Point Reyes Headlands	242	-	242
	Point Resistance	38	-	38
	Millers Point Rocks	113	-	113
	Double Point Rocks	53	-	53
	Bird Island (Point Bonita)	0	-	0
	Devil's Slide Rock & Mainland	105	7	112
	San Pedro Rock	4	0	4
	Bench Mark-227X	143	-	143
	Castle Rocks & Mainland	101	-	101
	Hurricane Point Rocks	11	-	11
Pelagic Cormorant	Point Reyes Headlands	40	-	40
	Point Resistance	18	-	18
	Millers Point Rocks	24	-	24
	Double Point Rocks	0	-	0
	Devil's Slide Rock & Mainland	16	83	99
	San Pedro Rock	0	0	0
	Gray Whale Cove South[4]	11	-	11
	Bench Mark-227X	0	-	0
	Castle Rocks & Mainland	19	-	19
	Hurricane Point Rocks	12	-	12

[1] Sum of peak seasonal counts at each subcolony or subarea.
[2] Nests that may have been counted on both surveys were included only once towards the total nest count. A dash indicates that a boat survey was not conducted.
[3] Brandt's Cormorants: only nests that could not be seen from mainland observation points were counted.
[4] Gray Whale Cove South surveyed on 13 June.

Table 13. Brandt's Cormorant breeding phenology and reproductive success at Point Reyes Headlands, Devil's Slide Rock & Mainland, and Castle Rocks & Mainland, 2014. Means are reported (range; n).

Colony/ Subcolony	Number of Breeding Sites	Clutch Initiation Date[1]	Clutch Size[1]	Breeding Success[2]	Number of Chicks Fledged/Pair[2]	Breeding Success/ Nest[3]
Point Reyes Headlands						
Sea Lion Cove Area (PRH-06-C)	31	2 May (4/20-5/18; 25)	3.06 (1-4; 31)	78.8% (99)	2.79 (0-4; 31)	0.97 (30)
Spine Point (PRH-11-E)	30	4 May (4/18-5/16; 30)	3.23 (1-4; 30)	72.8% (103)	2.50 (0-4; 30)	0.90 (30)
Sloppy Joe (PRH-12-A)	36	20 May (5/12-6/5; 35)	3.44 (3-4; 36)	68.4% (114)	2.36 (1-3; 36)	1.00 (33)
Border Rock (PRH-14-C)	21	19 Apr (4/6-5/6; 18)	3.29 (3-4; 21)	87.0% (69)	2.86 (1-4; 21)	1.00 (21)
Miwok Rock (PRH-14-D)	8	28 Apr (4/20-5/6; 8)	3.38 (3-4; 8)	78.3% (23)	2.57 (2-3; 8)	1.00 (7)
Total - Point Reyes	126	5 May (4/6-6/5; 116)	3.27 (1-4; 126)	75.7% (408)	2.60 (0-4; 126)	0.97 (121)
Devil's Slide Rock and Mainland						
Devil's Slide Rock (DSR-01)	17	13 May (4/21-7/13; 18)	2.8 (1-4; 17)	40.4% (52)	1.17 (0-3; 18)	0.72 (13)
South of Turtlehead Cliffs (DSR-05C)	2	24 April (4/20-4/27; 2)	3.0 (3-3; 2)	50.0% (6)	1.50 (0-3; 2)	0.50 (1)
Mainland South (Lower, Upper and Roost) (DSR-05A)	82	6 May (4/15-6/25; 78)	2.9 (1-5; 82)	47.5% (259)	1.31 (0-4; 94)	0.62 (58)
April's Finger (DSR-05-AF)	3	21 May (5/16-5/27; 2)	1.7 (1-2; 3)	0.0% (3)	0.00 (0; 2)	0.00 (0)
Total – Devil's Slide	104	7 May (4/15-7/13; 100)	2.9 (1-5; 104)	45.9% (320)	1.27 (0-4; 116)	0.62 (72)
Castle Rocks & Mainland						
CRM-09	28	25 Apr (4/12-5/5; 26)	3.2 (1-4; 90)	71.1% (90)	2.29 (0-4; 28)	0.89 (28)
CRM-03B	38	24 Apr (4/3-5/31; 35)	3.4 (3-5; 124)	83.5% (127)	2.94 (0-4; 36)	0.95 (38)
Total – Castle Rocks & Mainland	66	24 Apr (4/3-5/31; 61)	3.3 (1-5; 214)	78.3% (217)	2.66 (0-4; 64)	0.92 (66)

Table 13 (continued)
[1] Includes first clutches only.
[2] Includes replacement clutches. See text for details.
[3] Breeding success per nest is defined as the proportion of egg-laying nests that fledged at least one chick [3]

Table 14. Peak counts of nests (Black Oystercatcher and Western Gull) and of birds (Pigeon Guillemot), from land, boat, and combined land/boat counts (Total), in 2014.

Species	Colony	Land[1]	Boat[2]	Total Count[3]
Black Oystercatcher	Point Reyes Headlands	10	-	10
	Point Resistance	0	-	0
	Millers Point Rocks	1	-	1
	Double Point Rocks	2	-	2
	Devil's Slide Rock & Mainland	1	0	1
	Bench Mark-227X	0	-	0
	Castle Rocks & Mainland	2	-	2
	Hurricane Point Rocks	2	-	2
Western Gull	Point Reyes Headlands	117	-	117
	Point Resistance	1	-	1
	Millers Point Rocks	7	-	7
	Double Point Rocks	5	-	5
	San Pedro Rock	4	2	6
	Devil's Slide Rock & Mainland	6	3	9
	Gray Whale Cove South	0	-	0
	Bench Mark-227X	7	-	7
	Castle Rocks & Mainland	13	-	13
	Hurricane Point Rocks	8	-	8
Pigeon Guillemot	Point Reyes Headlands[4]	141	-	141
	Point Resistance	45	-	45
	Millers Point Rocks	51	-	51
	Double Point Rocks	55	-	55
	Devil's Slide Colony Complex	255	158	N/A
	Gray Whale Cove South[6]	3	-	3
	Castle-Hurricane Colony Complex[5]	14	-	14

[1] Sum of peak seasonal counts at each subcolony.
[2] In several cases, Black Oystercatcher and Western Gull nests were counted only if they could not be seen from mainland observation points. A dash indicates that boat surveys were not conducted at a given colony.
[3] Black Oystercatcher and Western Gull nests that may have been counted on both surveys were included only once towards the total count.
[4] Only includes subareas counted from the lighthouse (see Methods).
[5] Does not include the subareas between Rocky Point and Esselen Rock (BM227X-02), which were included in most past years.
[6] Gray Whale Cove South surveyed on 13 June.

Table 15. Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls at Devil's Slide Rock and Mainland, and Castle Rocks & Mainland, 2014. Means (range; n) or (n) are reported.

	Pelagic Cormorant				Black Oystercatcher				Western Gull			
	Number of Breeding Sites	Number of Chicks Fledged	Number of Chicks Fledged/ Pair (Productivity)	Breeding Success/ Nest[1]	Number of Breeding Sites	Number of Chicks Fledged	Number of Chicks Fledged/ Pair (Productivity)	Breeding Success/ Nest[1]	Number of Breeding Sites	Number of Chicks Fledged	Number of Chicks Fledged/ Pair (Productivity)	Breeding Success/ Nest[1]
Devil's Slide Rock and Mainland	26	22	0.85 (0-2; 26)	0.50 (26)	1	0	0	0	6	4	0.67 (0-2; 6)	0.33 (6)
Castle Hurricane Colony Complex	-	-	-	-	2	1	0.50 (0-1;2)	0.50 (2)	24	12	0.50 (0-3;24)	0.25 (24)

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

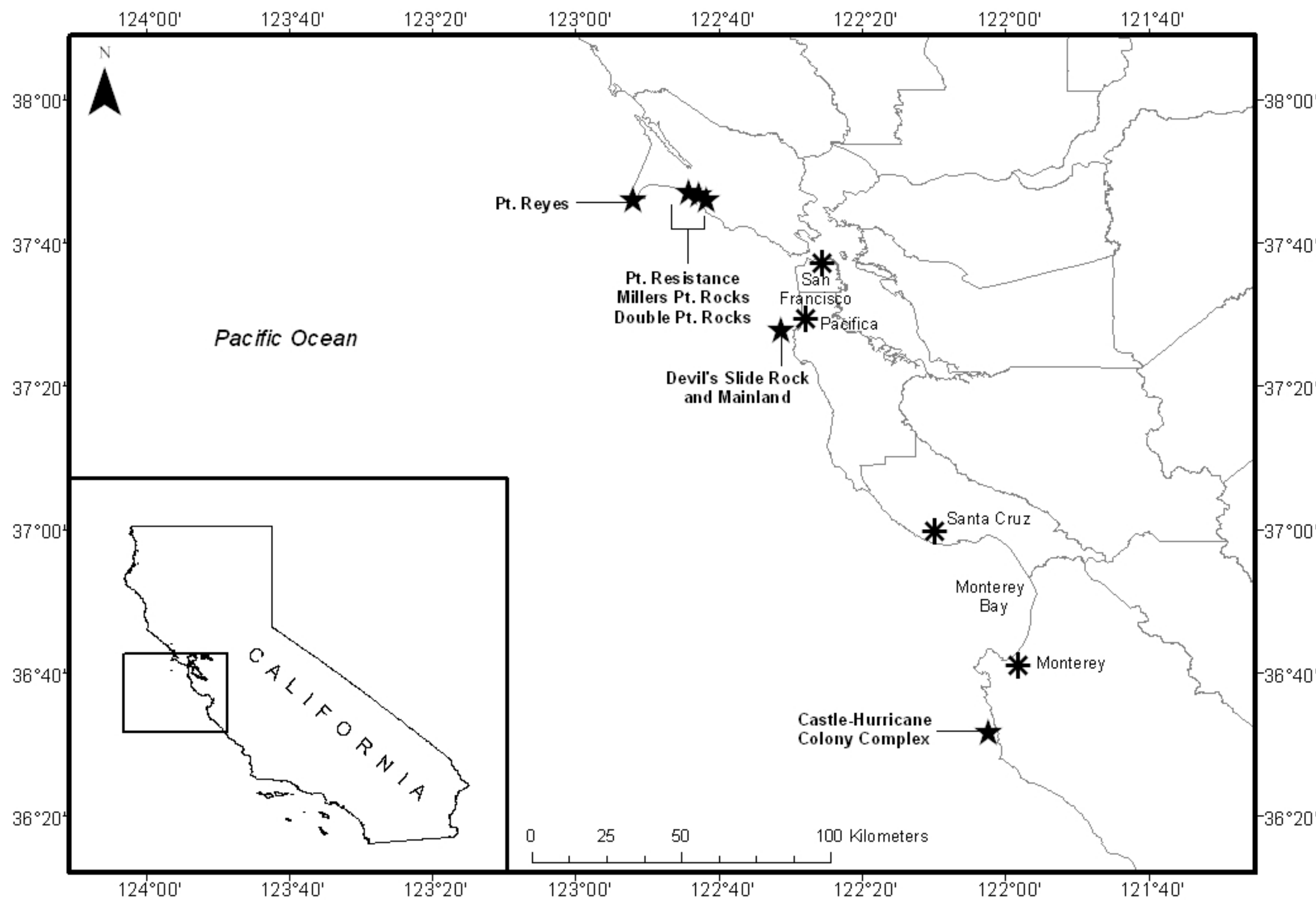


Figure 1. Study area showing locations of study colonies or colony complexes along the Central California coast where seabird disturbance, attendance and breeding biology are monitored.

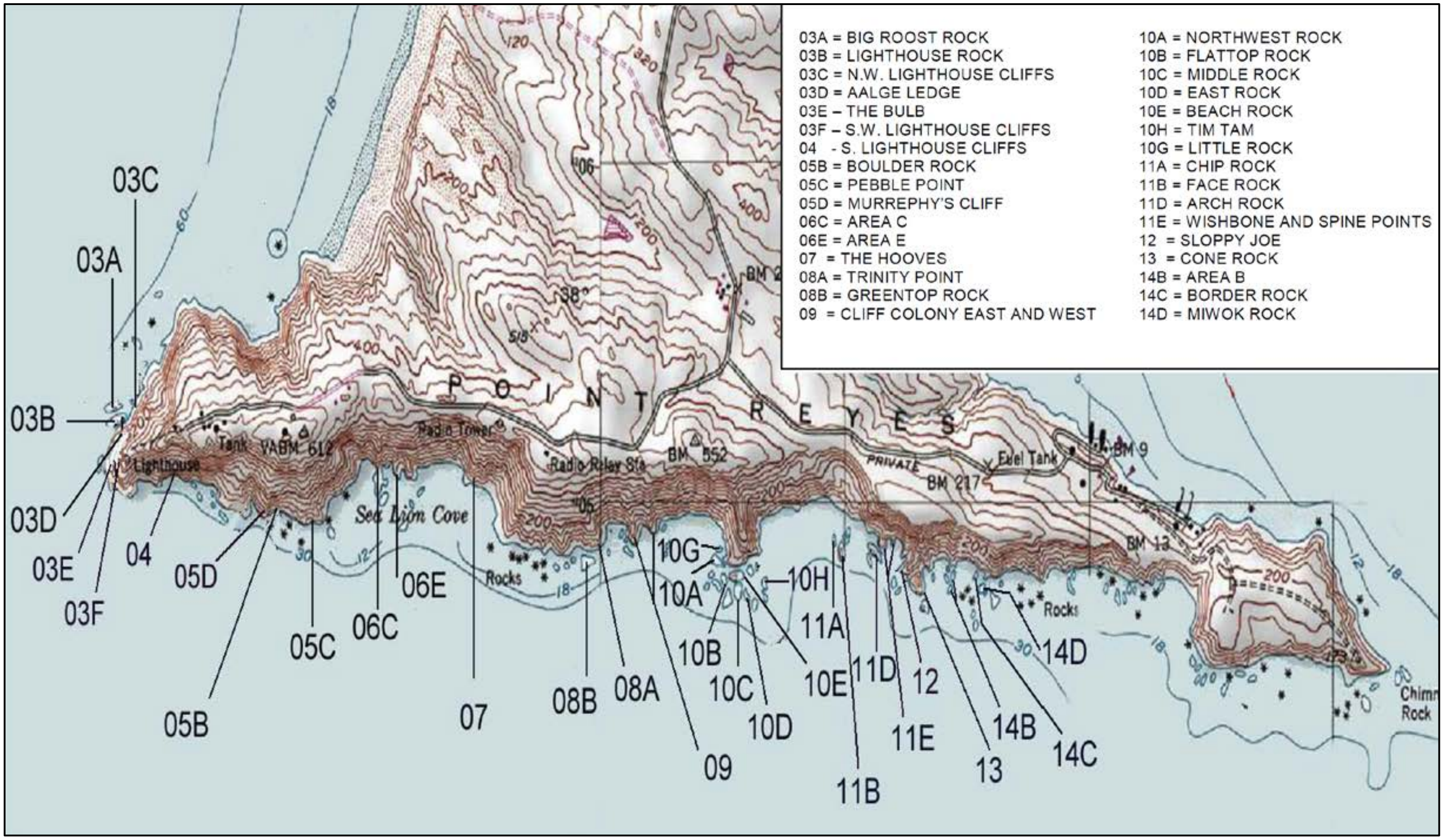


Figure 2. Point Reyes Headlands, including subcolonies 03A through 14D.

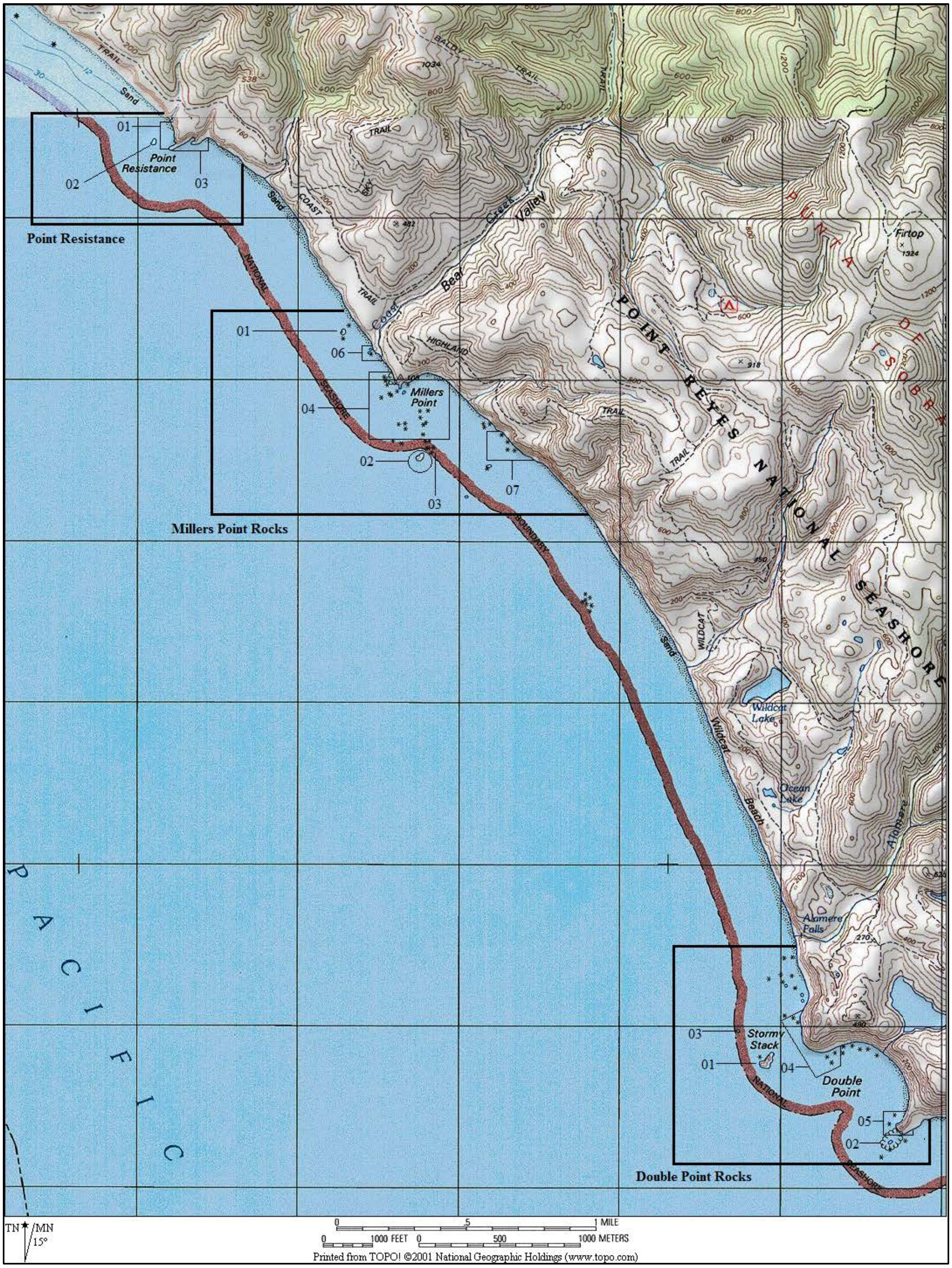


Figure 3. Drakes Bay Colony Complex, including Point Resistance, Millers Point Rocks and Double Point Rocks colonies and subcolonies.

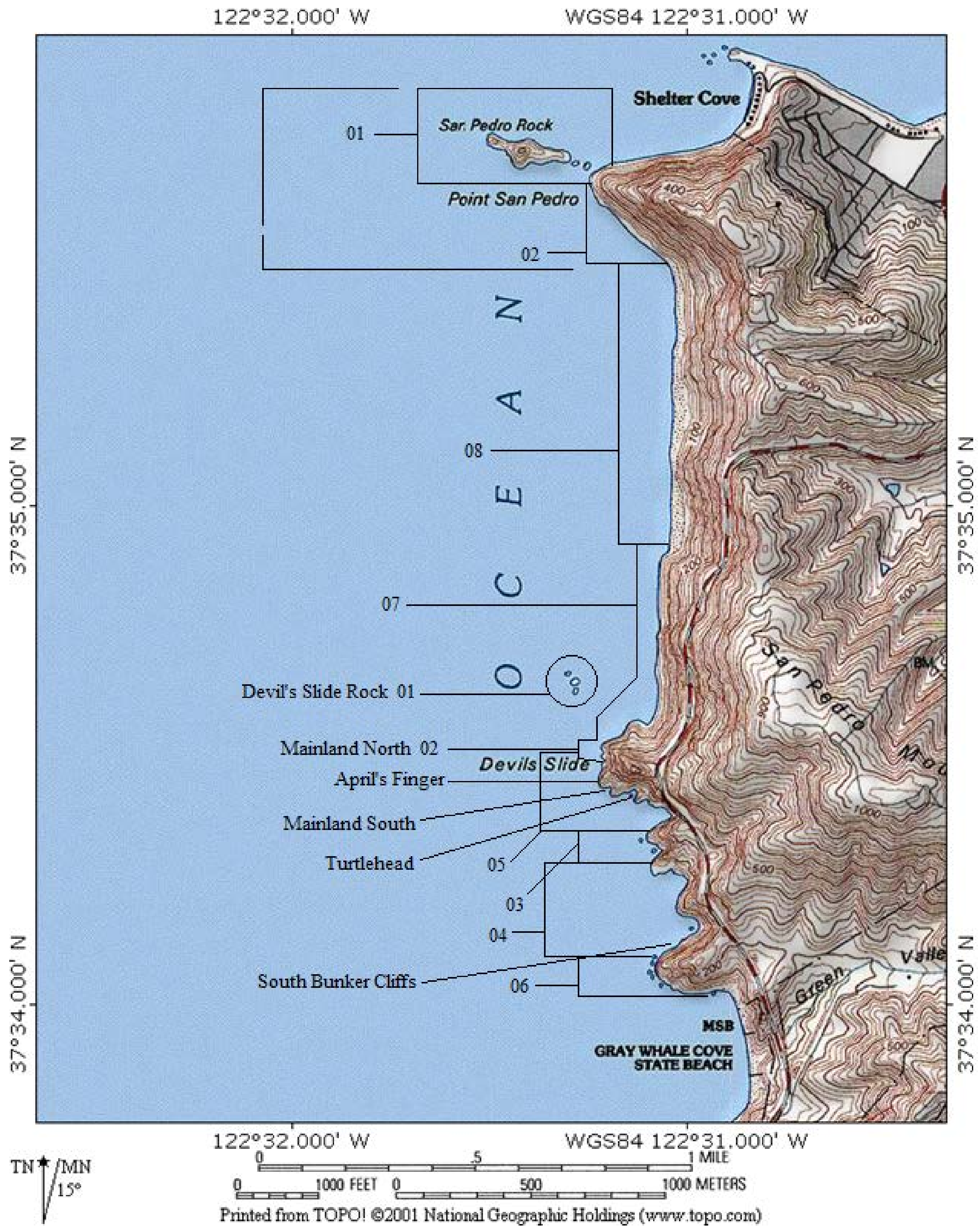


Figure 4. Devil's Slide Colony Complex, including San Pedro Rock and Devil's Slide Rock & Mainland colonies and subcolonies.

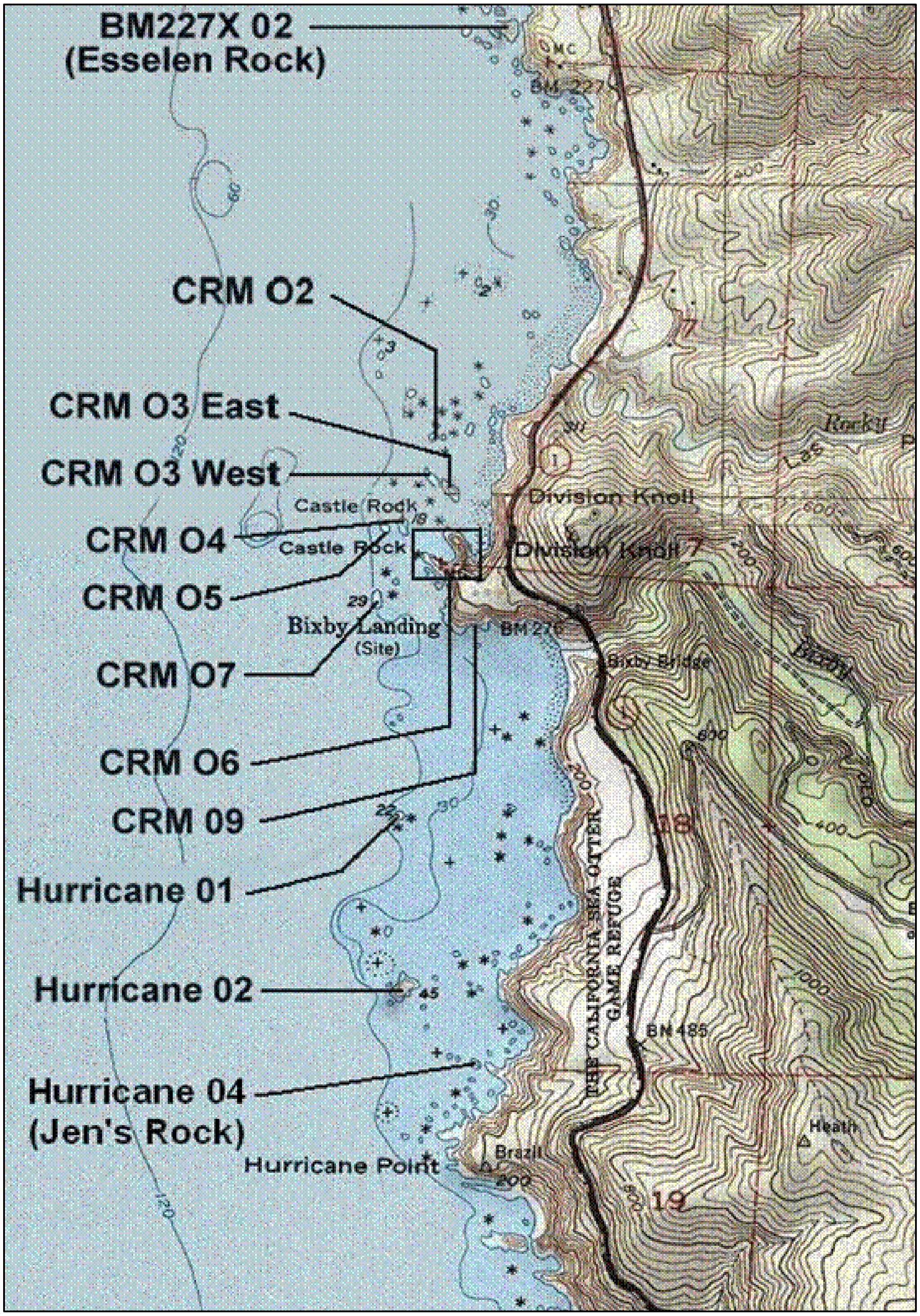


Figure 5. Castle-Hurricane Colony Complex, including Bench Mark-227X (BM227X), Castle Rocks and Mainland (CRM), and Hurricane Point Rocks (Hurricane) colonies and subcolonies.

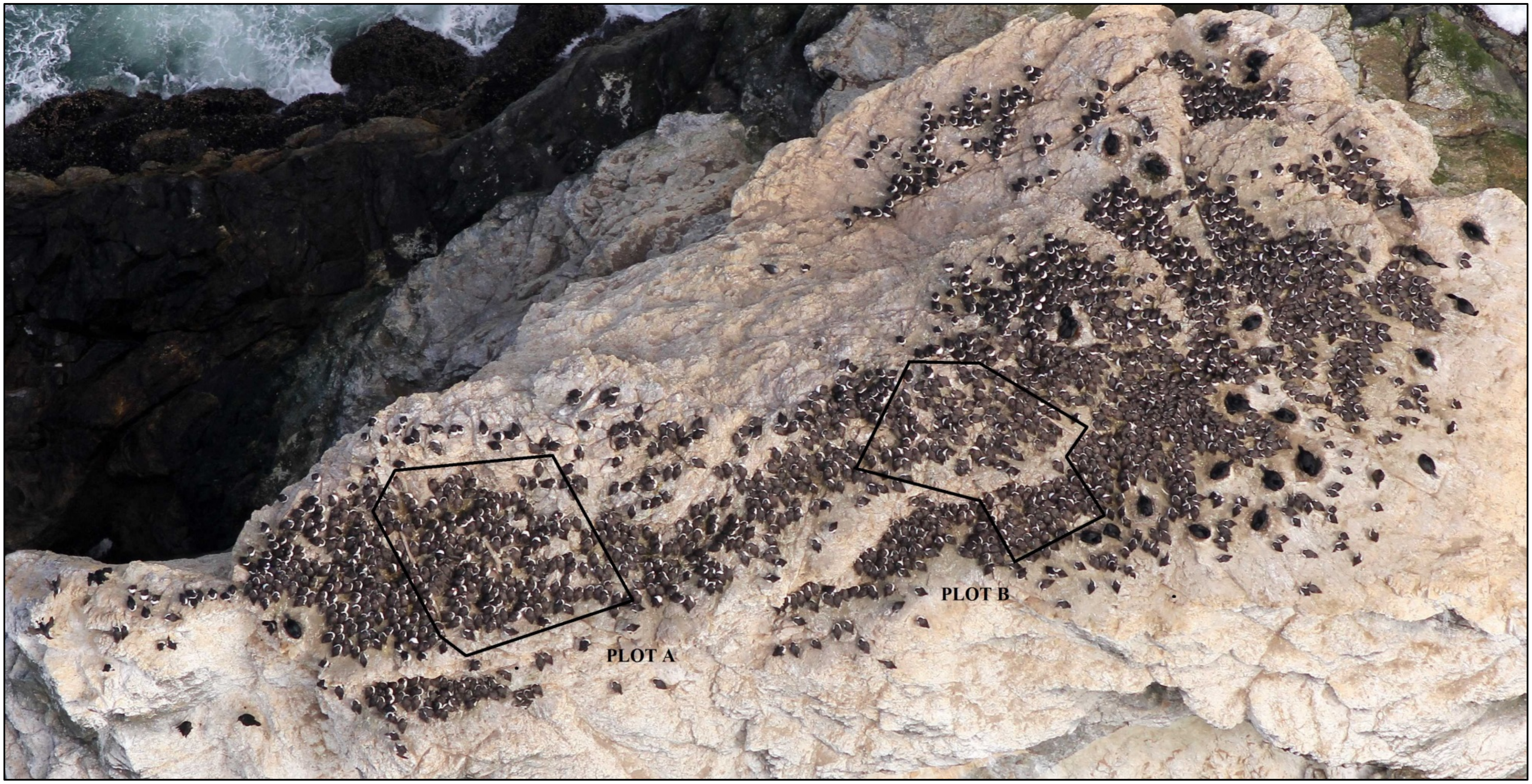


Figure 6. Aerial photograph of Devil's Slide Rock, 11 June 2014, showing the distribution of the Common Murre and Brandt's Cormorant breeding colony and boundaries of murre productivity plots.

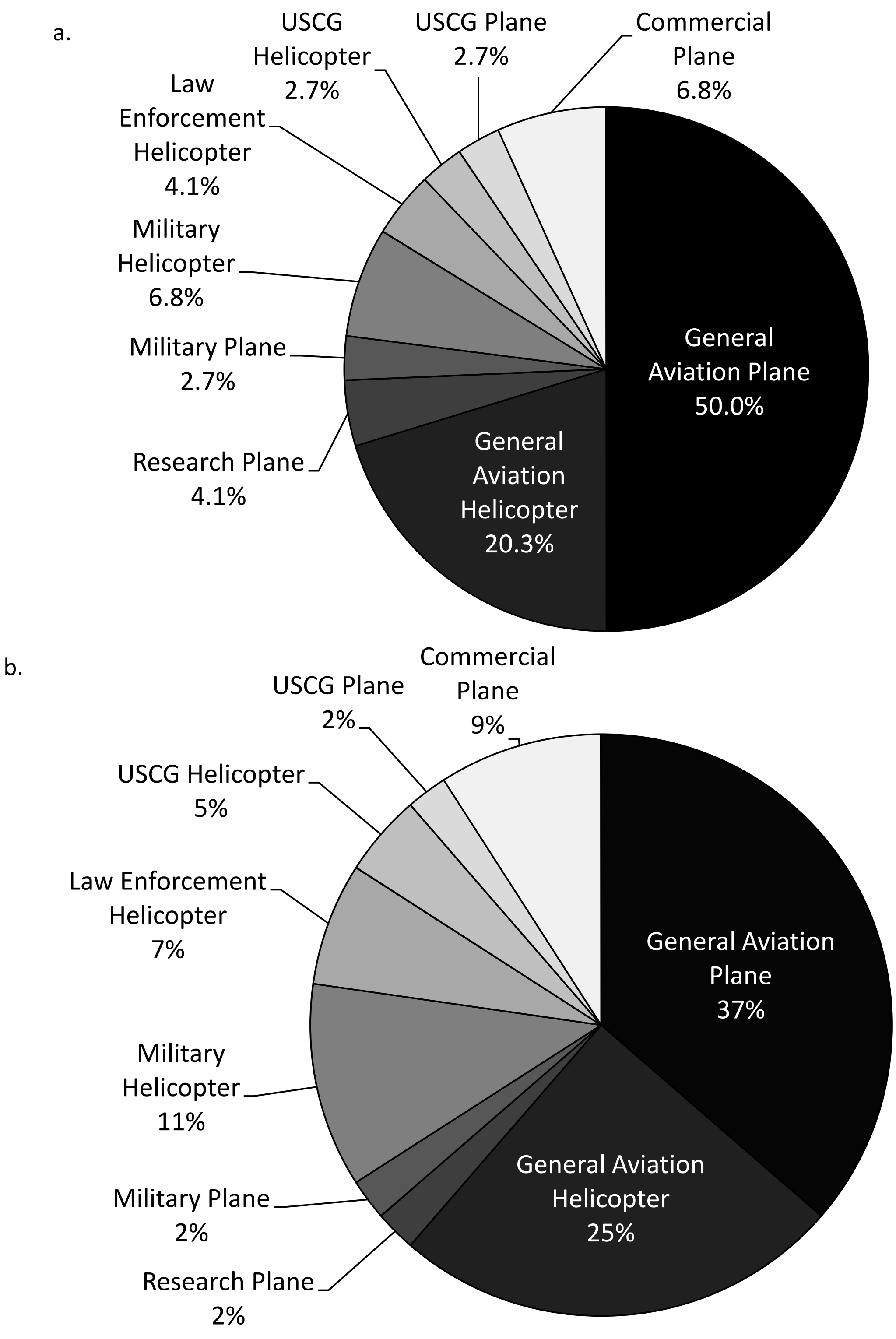


Figure 7. a. Aircraft overflight detections (n = 75) and b. aircraft disturbances (n = 45) at Point Reyes Headlands, Drakes Bay, Devil's Slide Rock and Mainland and Castle-Hurricane Colony Complex combined, in 2014, categorized by type.

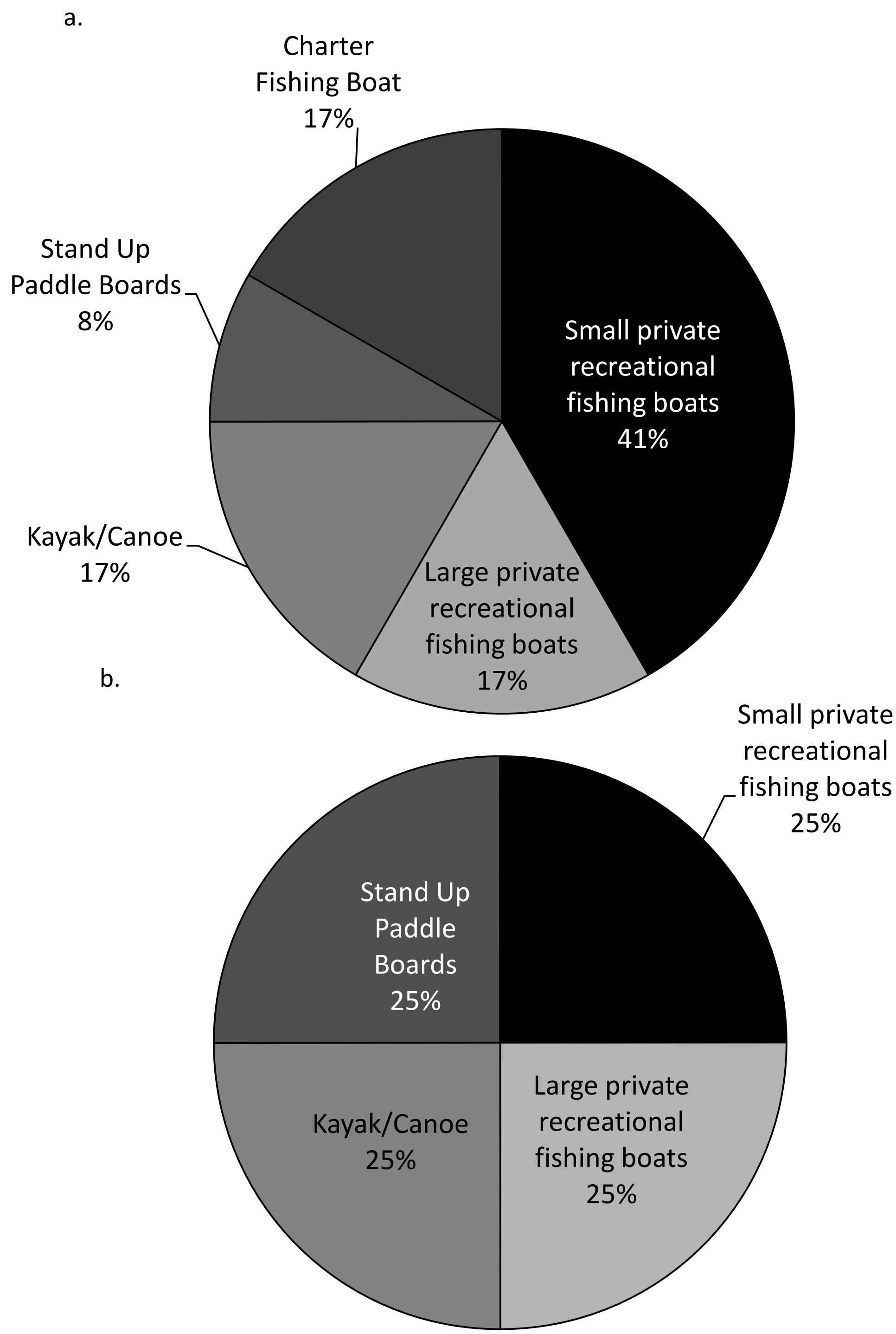


Figure 8. a. Watercraft detections (n = 17), and b. Watercraft disturbances (n = 4) at Point Reyes Headlands, Drakes Bay, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex combined, in 2014, categorized by type.

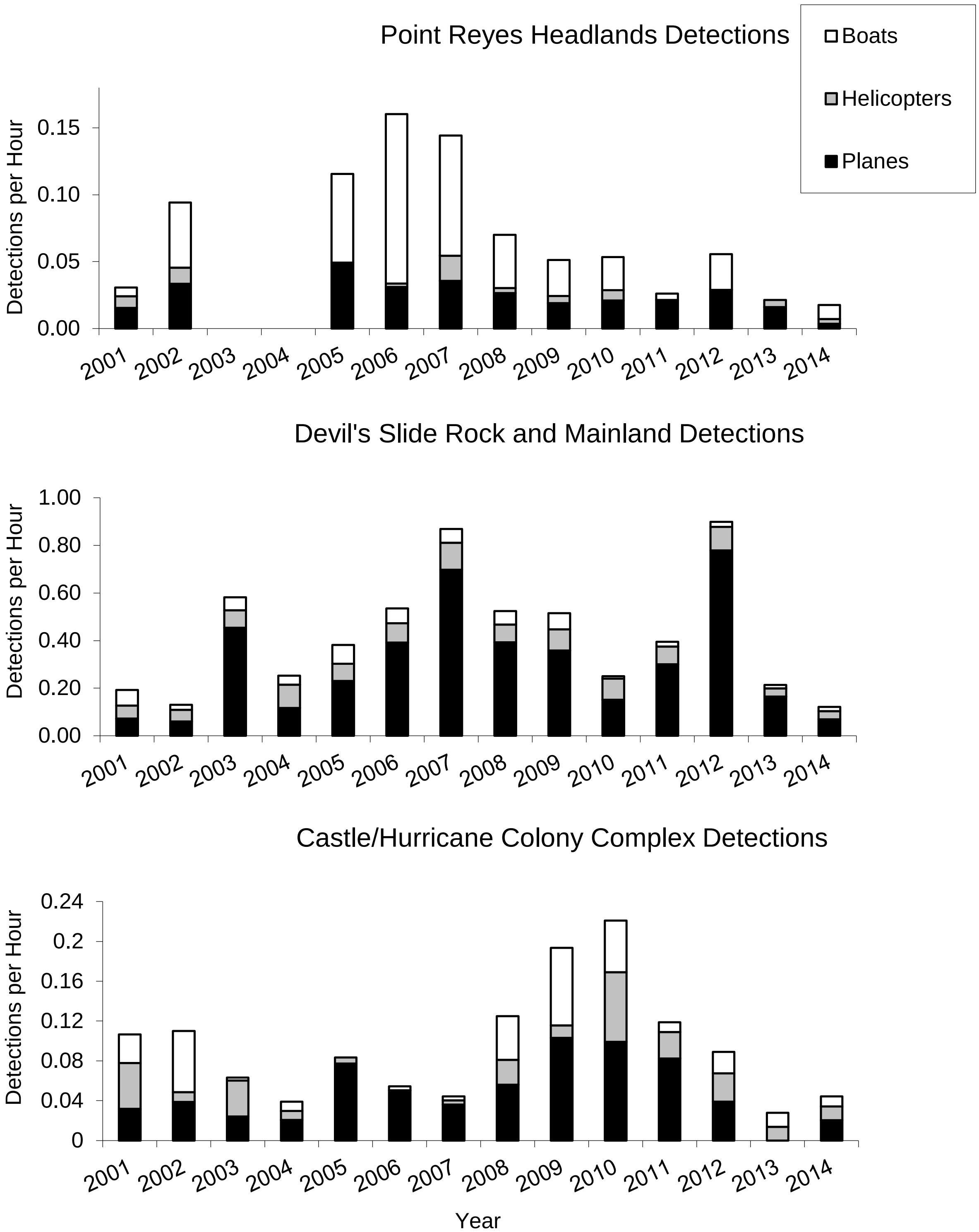


Figure 9. Detection rates (number of detections per observation hour) of boats, helicopters and planes at Point Reyes Headlands, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex, 2001 to 2014.

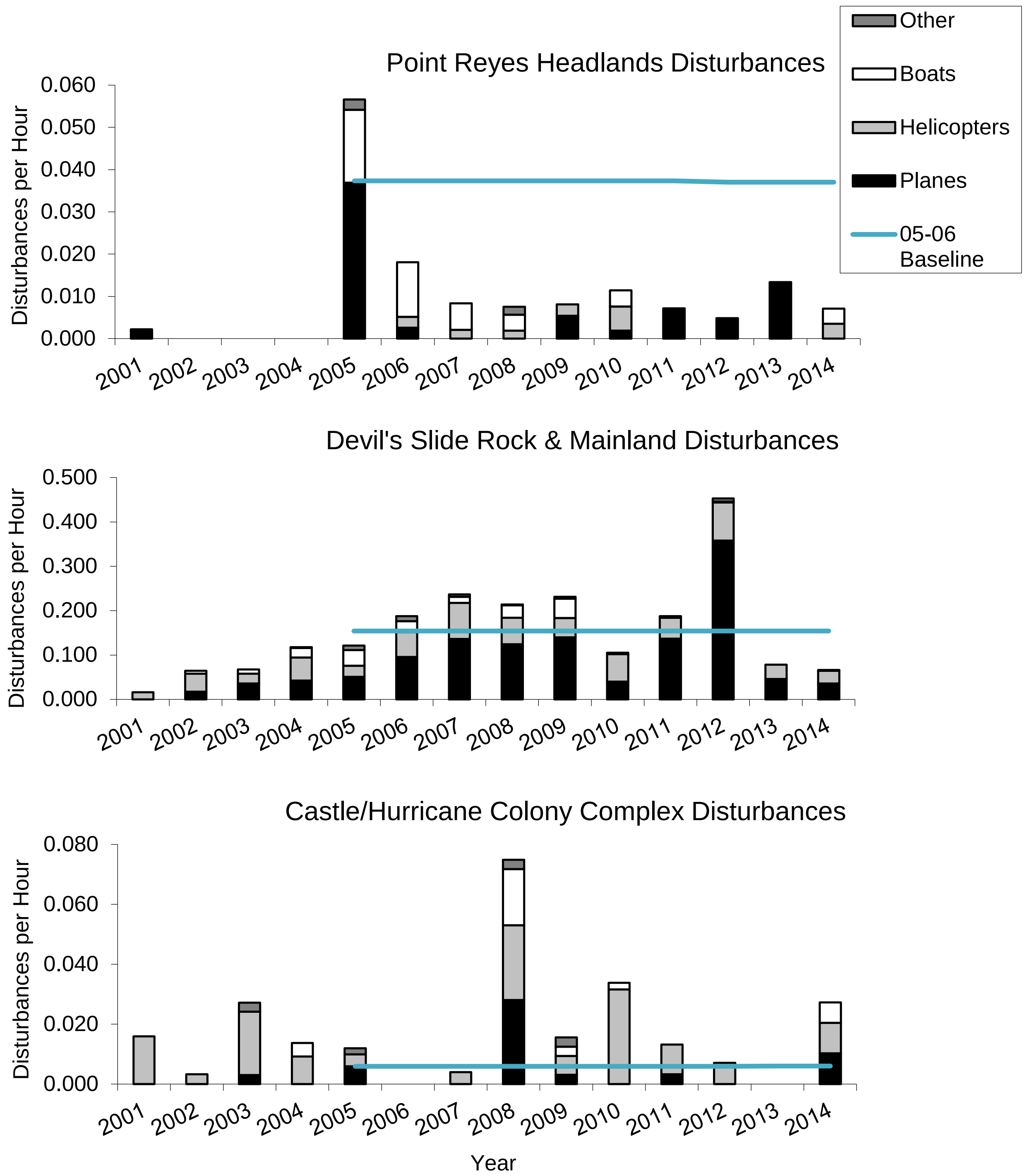


Figure 10. Disturbance rates (number of seabird disturbances per observation hour) from boats, helicopters, planes, and other anthropogenic sources at Point Reyes Headlands, Devil's Slide Rock and Mainland and Castle-Hurricane Colony Complex from 2001 to 2014. The horizontal line indicates the baseline mean disturbance rate from 2005 to 2006.

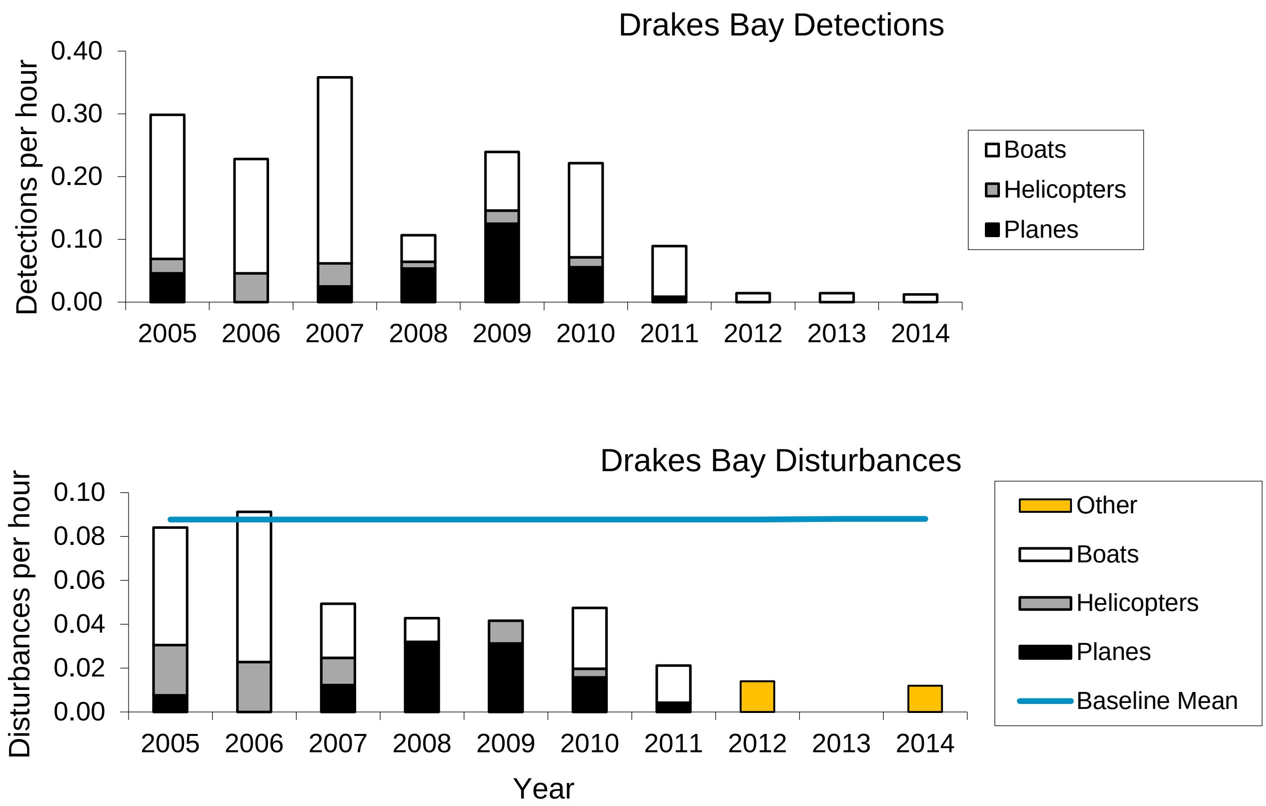


Figure 11. Detection and disturbance rates of boats, helicopters, planes and other anthropogenic sources (disturbances only) at Drakes Bay Colony Complex from 2005 to 2014. The horizontal line indicates the baseline mean disturbance rate from 2005 to 2006.

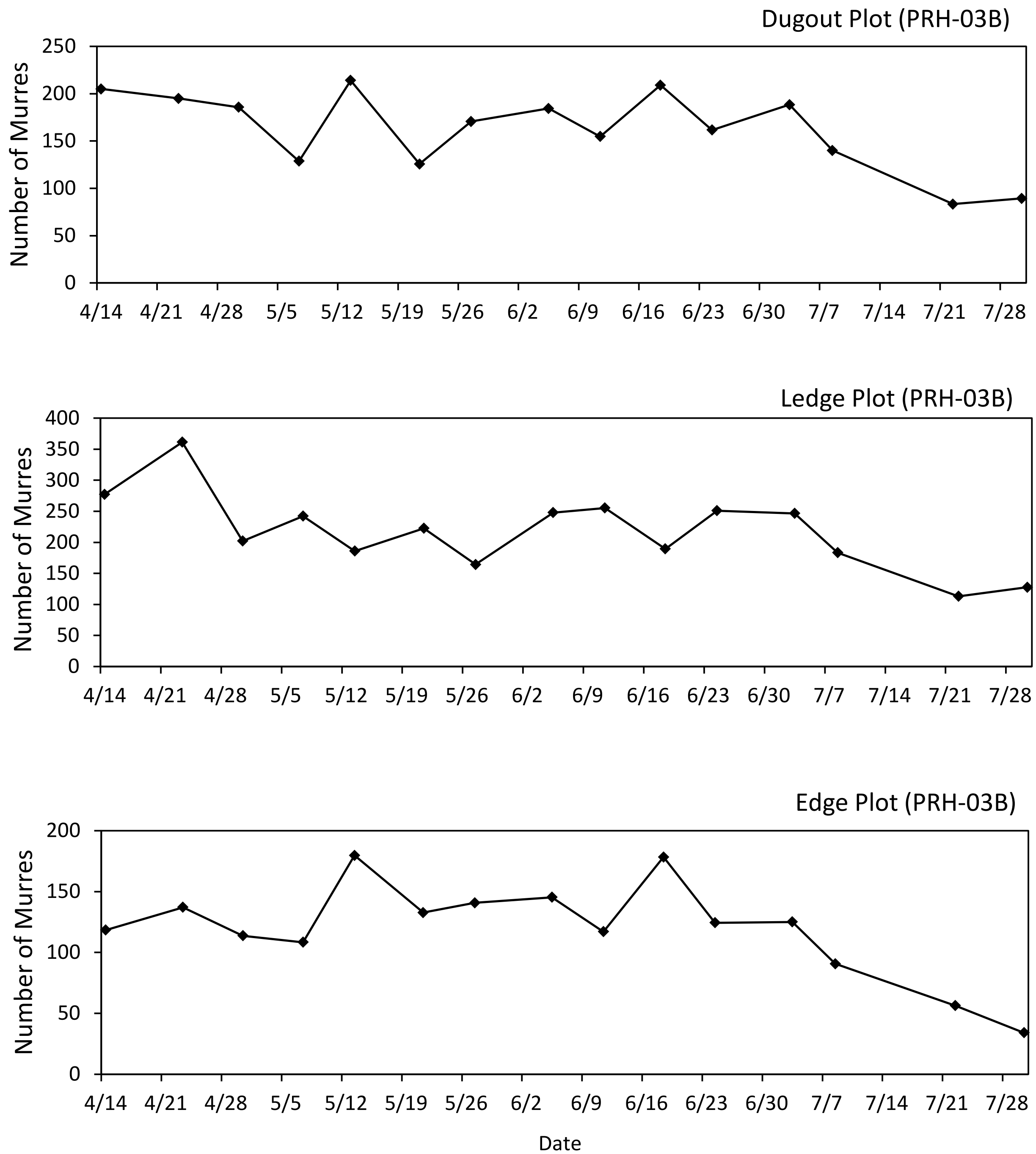


Figure 12. Seasonal attendance of Common Murres at Dugout, Ledge and Edge plots, Point Reyes Headlands, 14 April to 30 July, 2014.

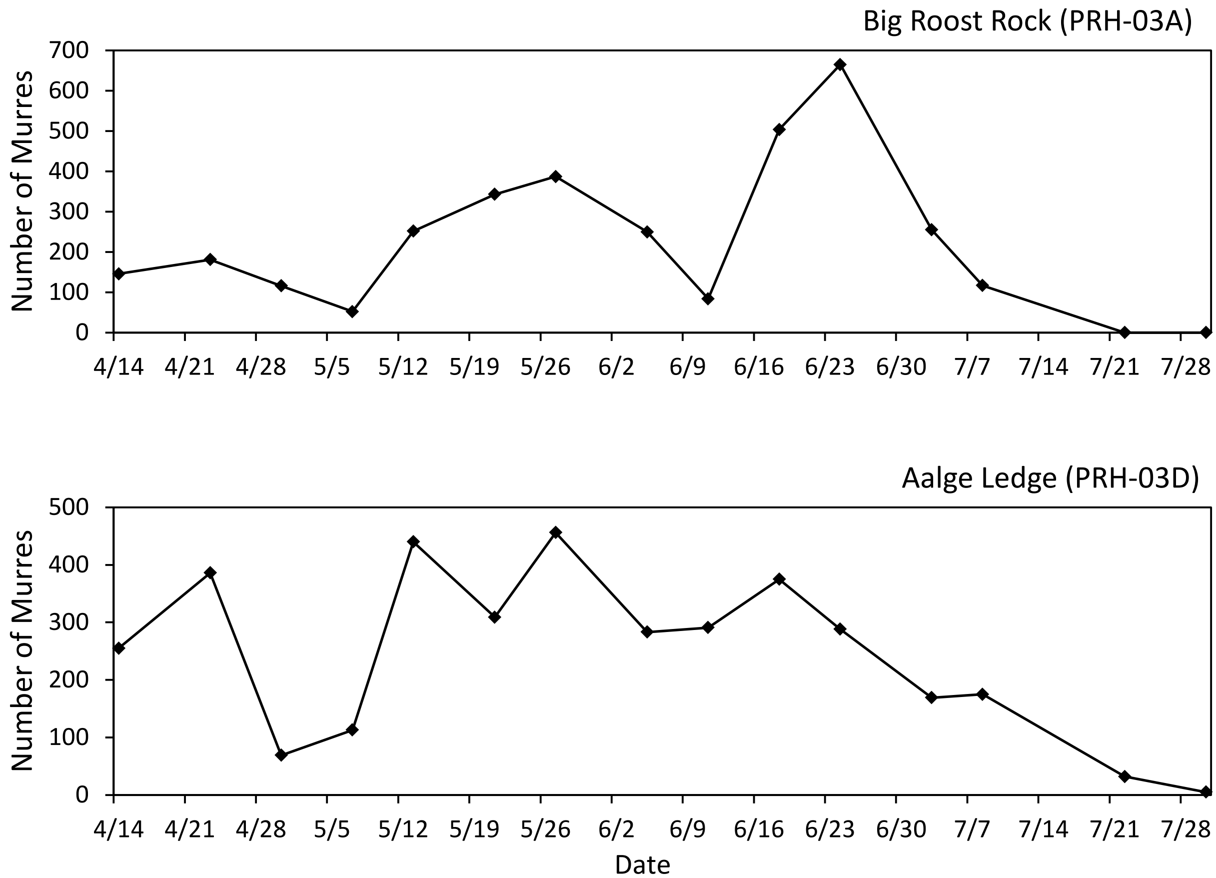


Figure 13. Seasonal attendance of Common Murres at Big Roost Rock and Aalge Ledge, Point Reyes Headlands, 14 April to 30 July, 2014.

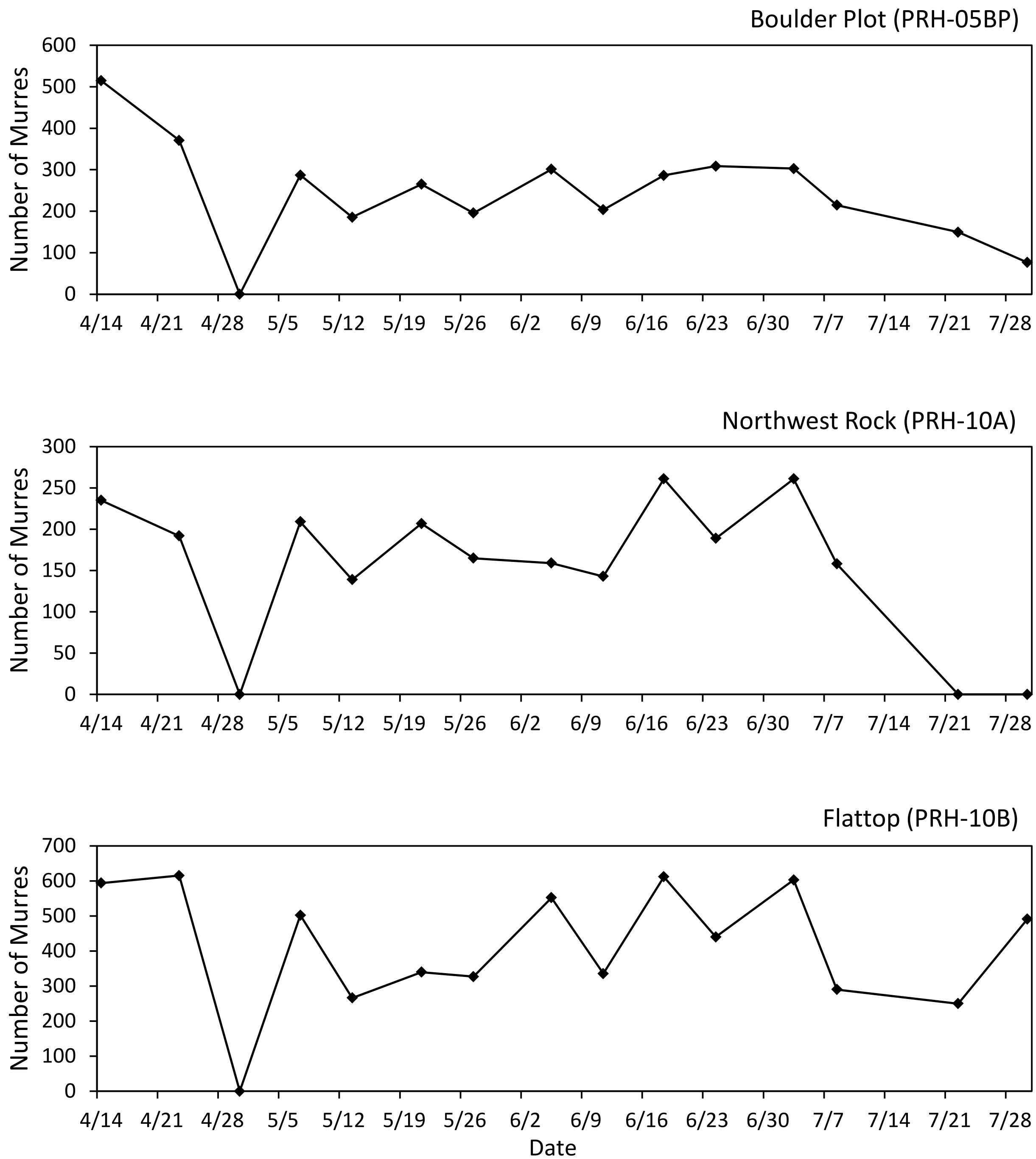


Figure 14. Seasonal attendance of Common Murres at Boulder Plot, Northwest Rock and Flattop, Point Reyes Headlands, 14 April to 30 July, 2014.

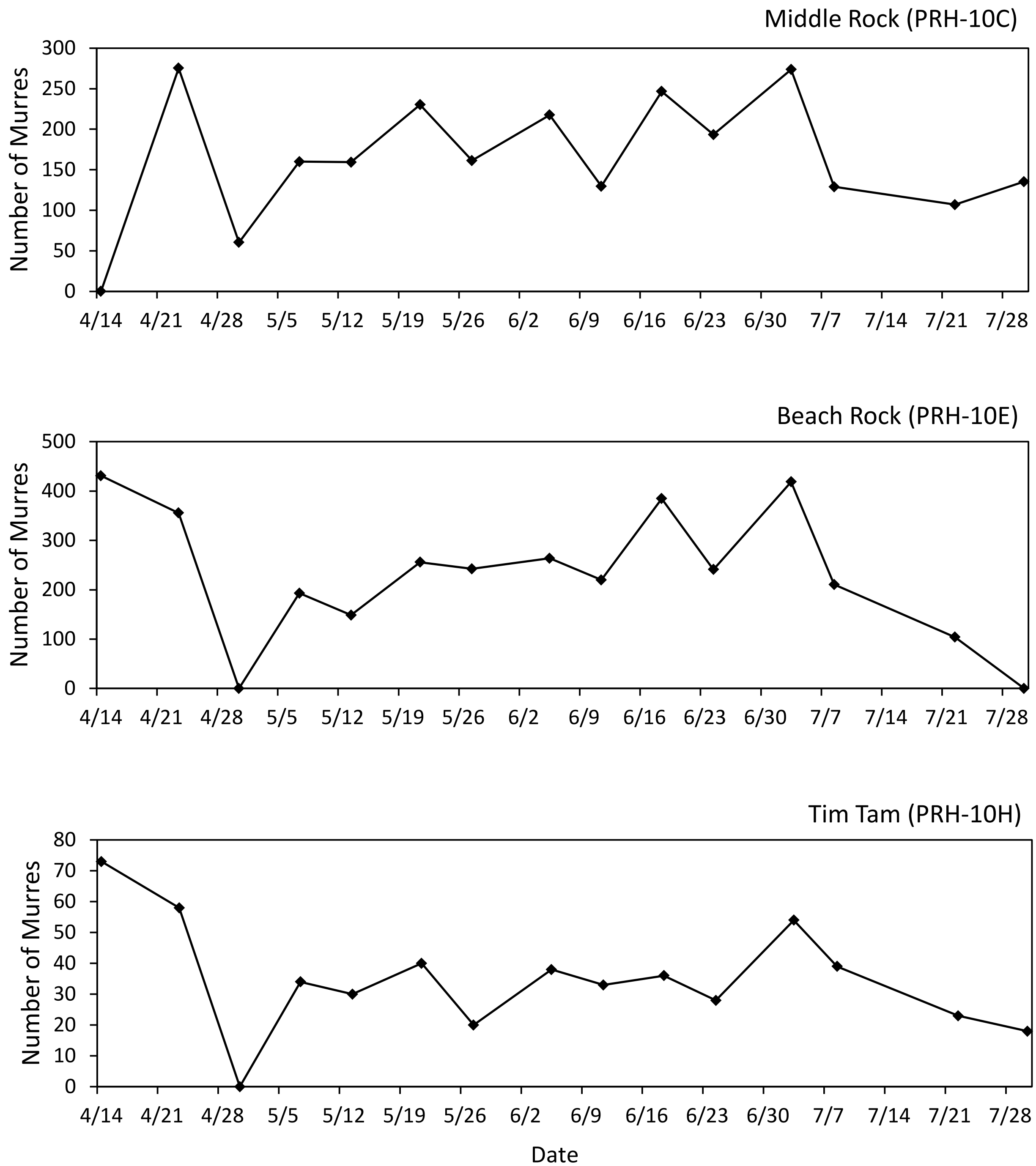


Figure 15. Seasonal attendance of Common Murres at Middle Rock, Beach Rock and Tim Tam, Point Reyes Headlands, 14 April to 30 July, 2014.

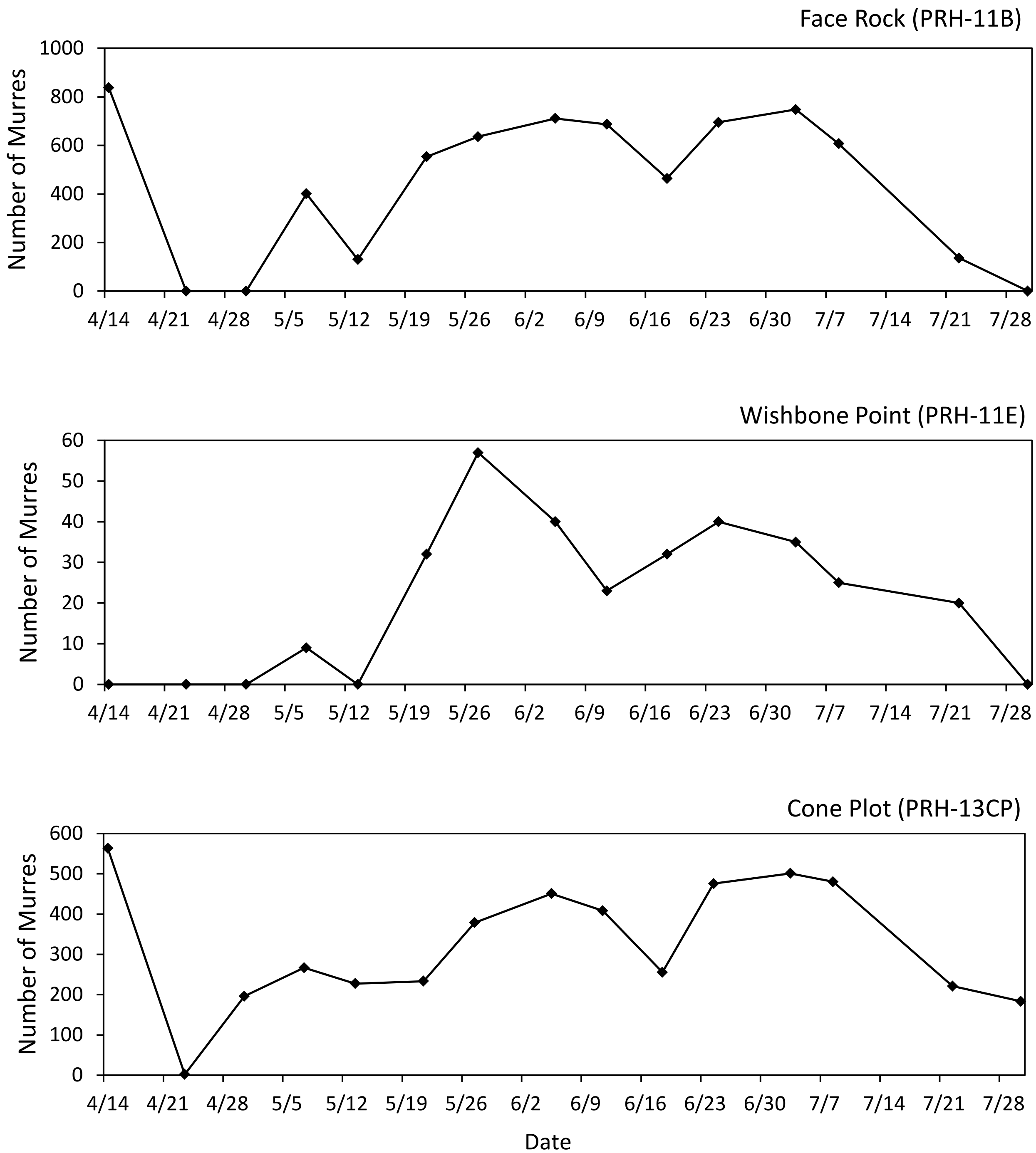


Figure 16. Seasonal attendance of Common Murres at Face Rock, Wishbone Point and Cone Plot, Point Reyes Headlands, 14 April to 30 July, 2014.

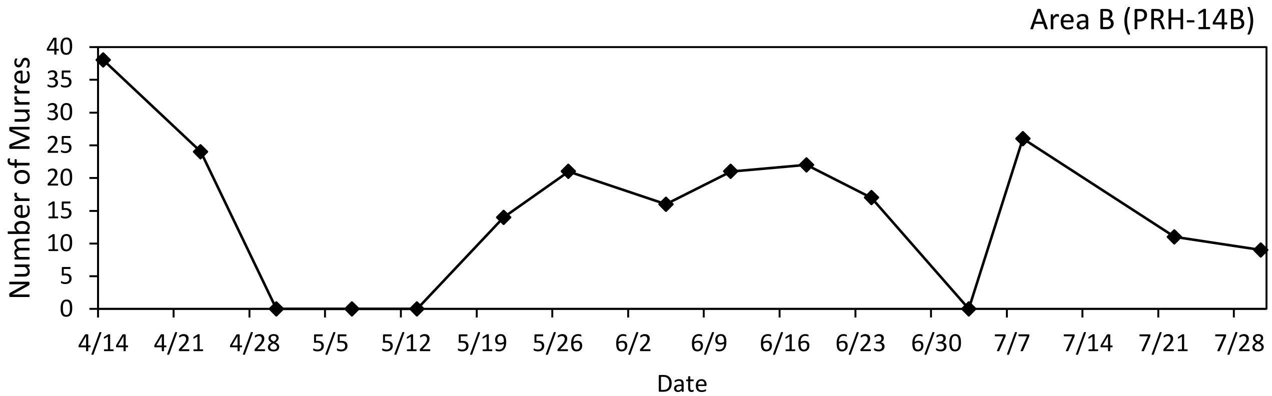


Figure 17. Seasonal attendance of Common Murres at Area B, Point Reyes Headlands, 14 April to 30 July, 2014.

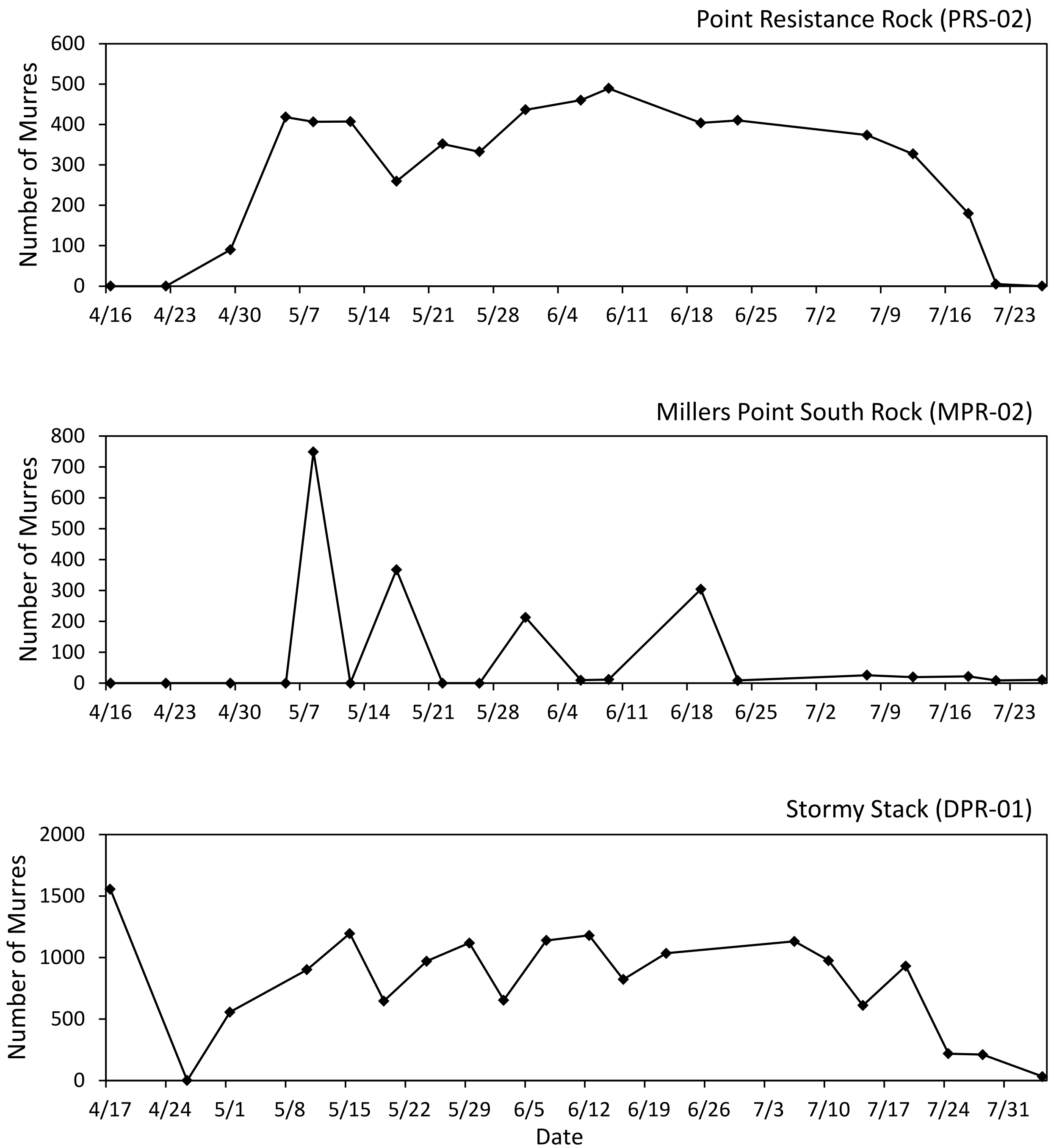


Figure 18. Seasonal attendance of Common Murres at Point Resistance Rock, Millers Point South Rock and Stormy Stack, Drakes Bay Colony Complex, 16 April to 4 August, 2014.

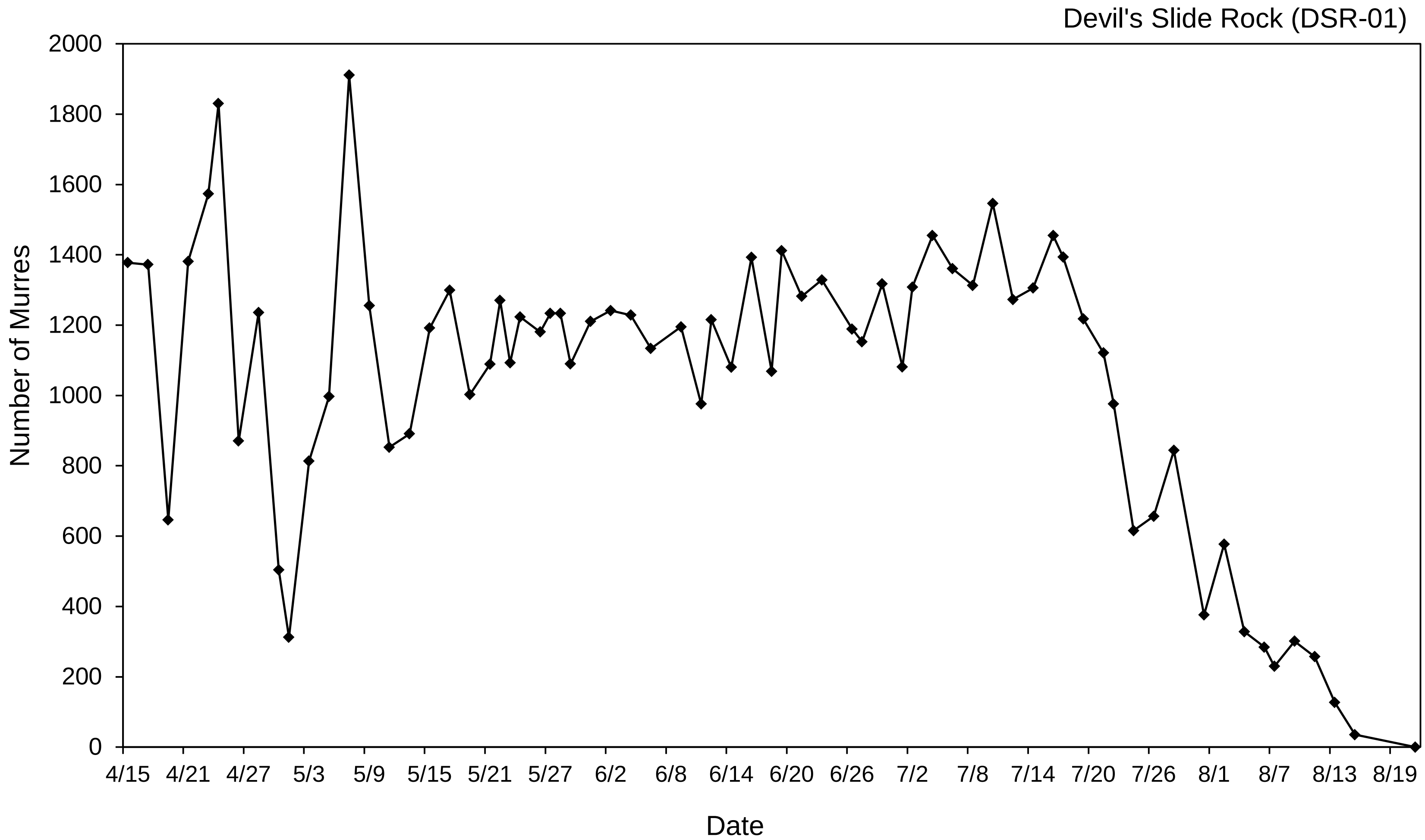


Figure 19. Seasonal attendance of Common Murres at Devil's Slide Rock, 15 April to 21 August, 2014.

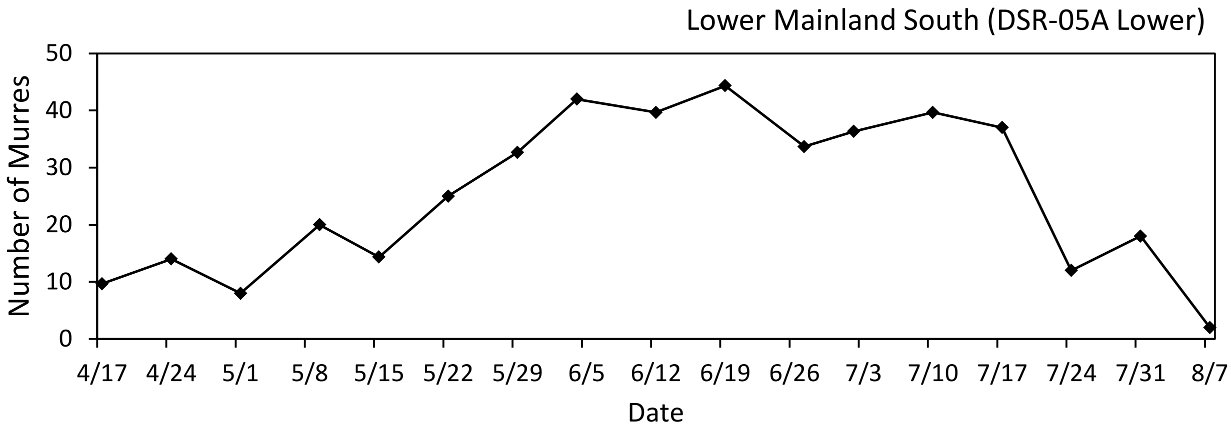


Figure 20. Seasonal attendance of Common Murres at Lower Mainland South, Devil's Slide Rock Mainland, 17 April to 7 August, 2014.

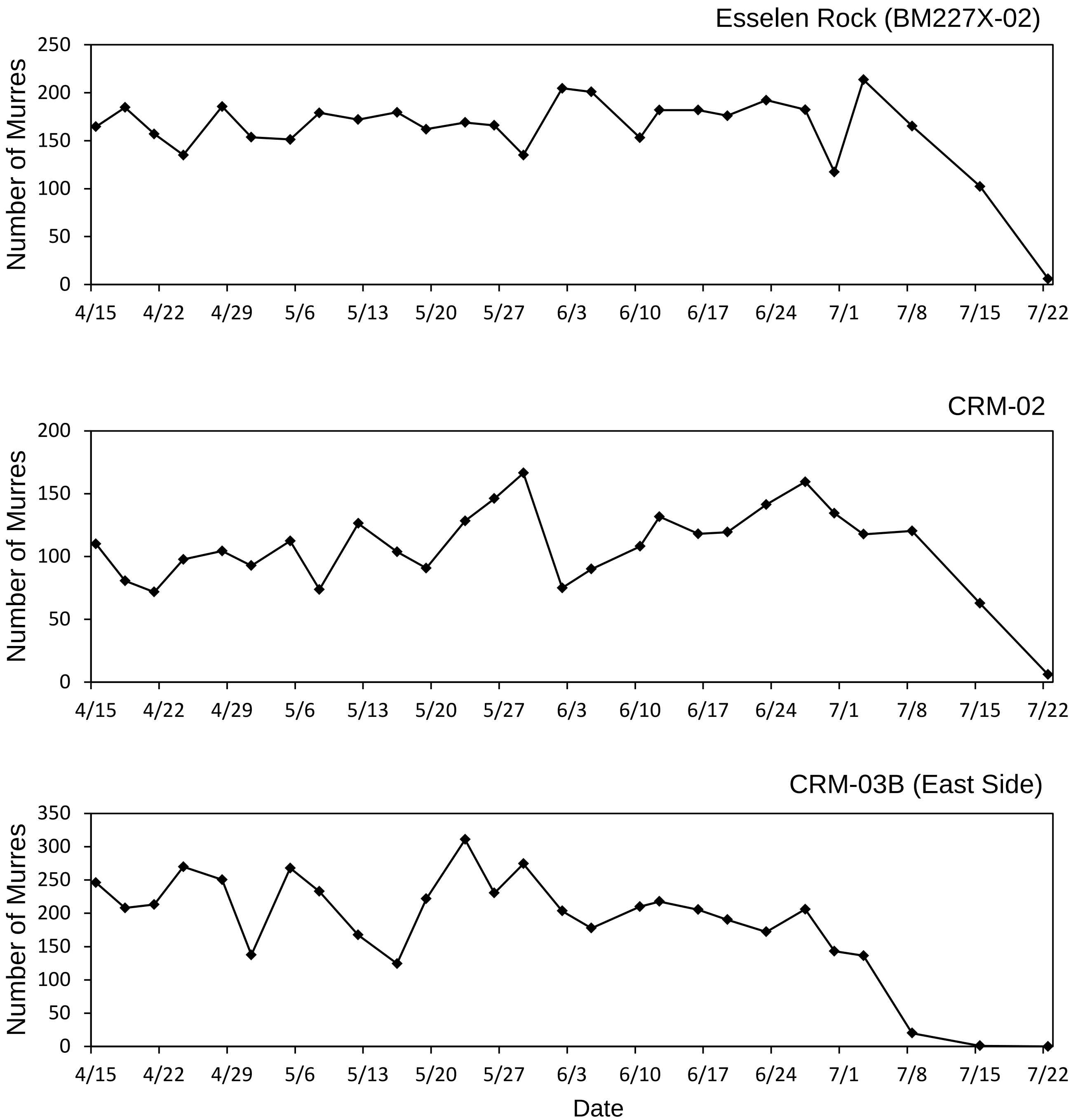


Figure 21. Seasonal attendance of Common Murres at Esselen Rock, CRM-02 and CRM-03B, Castle-Hurricane Colony Complex, 15 April to 22 July, 2014.

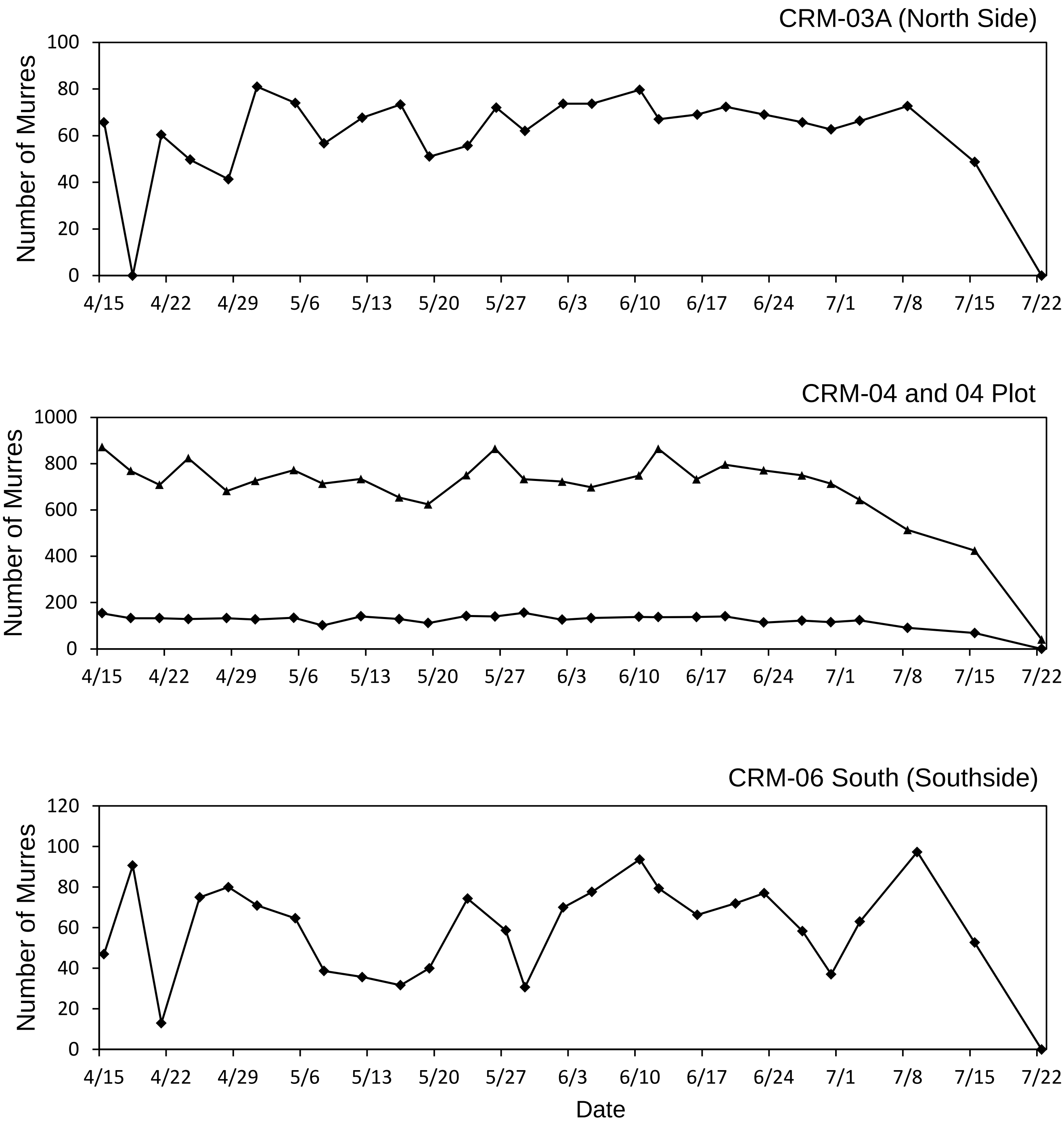


Figure 22. Seasonal attendance of Common Murres at CRM-03A, CRM-04 (and CRM-04 Plot), and CRM-06 South, Castle-Hurricane Colony Complex, 15 April to 22 July, 2014.

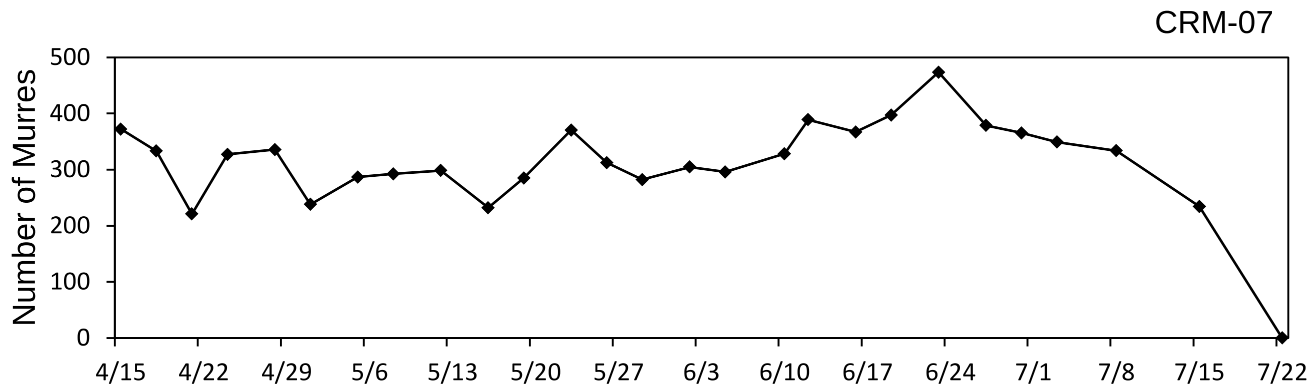


Figure 23. Seasonal attendance of Common Murres at CRM-07, Castle-Hurricane Colony Complex, 15 April to 22 July, 2014.

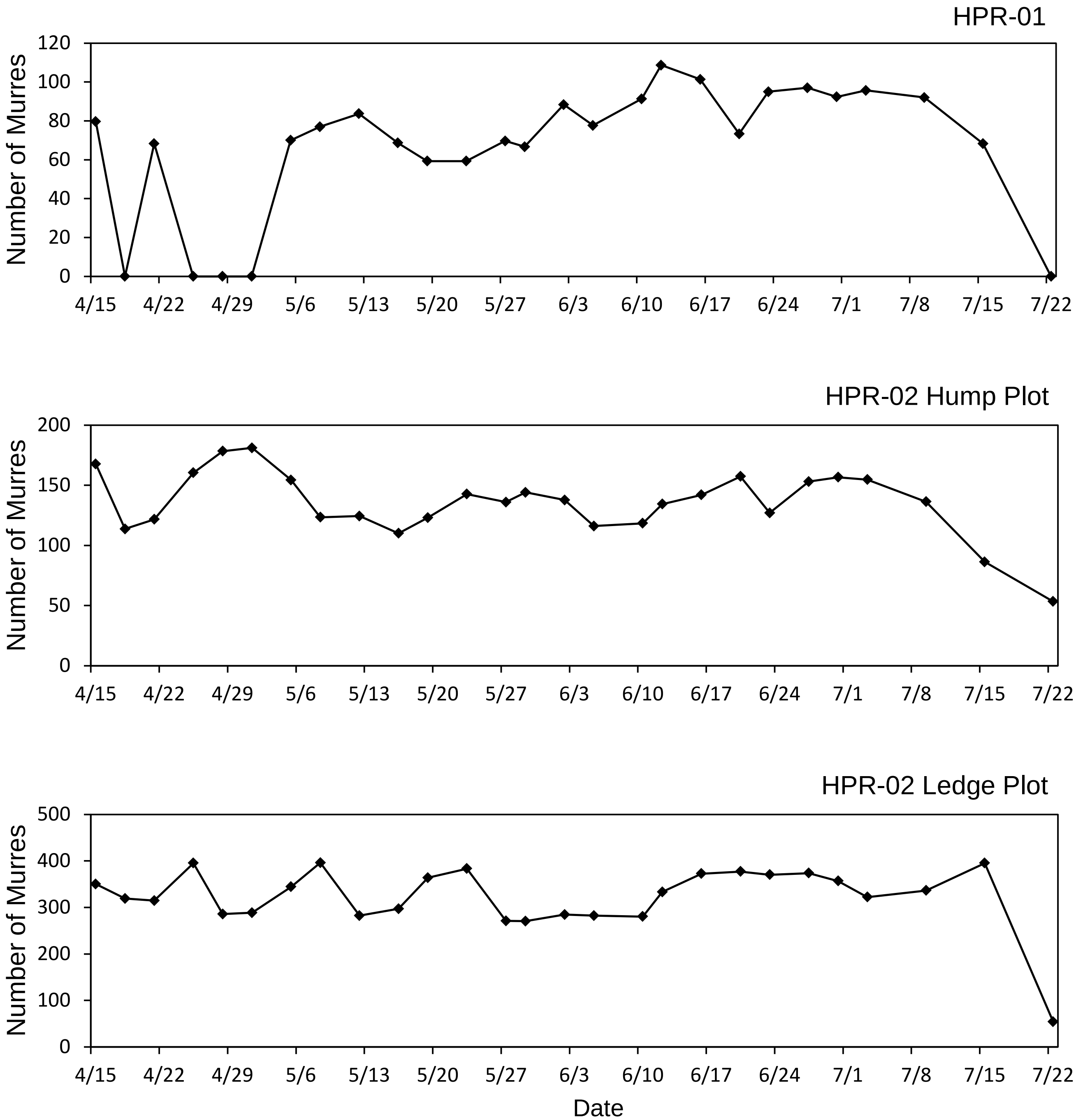
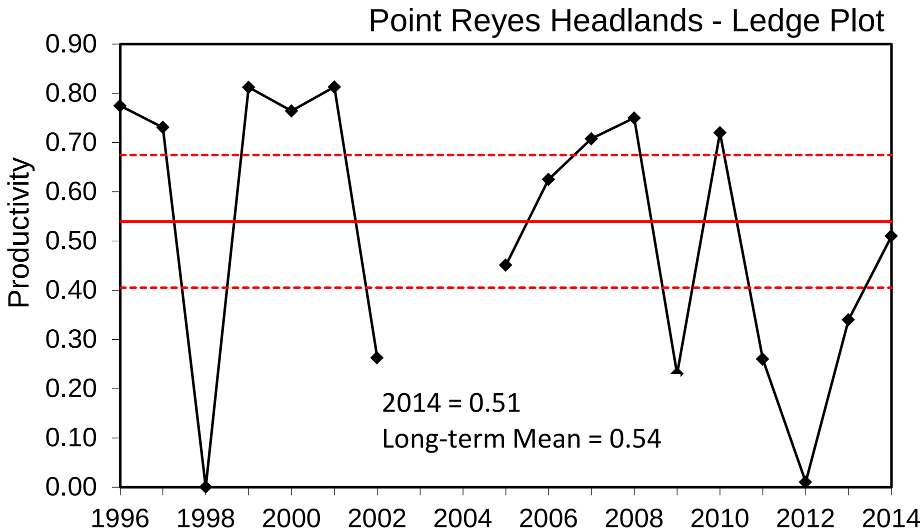


Figure 24. Seasonal attendance of Common Murres at HPR-01 and HPR-02 (Hump and Ledge Plots), Castle-Hurricane Colony Complex, 15 April to 22 July, 2014.



Point Reyes Headlands- Edge Plot

Figure 25. Productivity (chicks fledged per pair) of Common Murres at Point Reyes Headlands (Ledge and Edge plots), Devil's Slide Rock, and Castle Rock 04 plot, 1996-2014. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence interval.

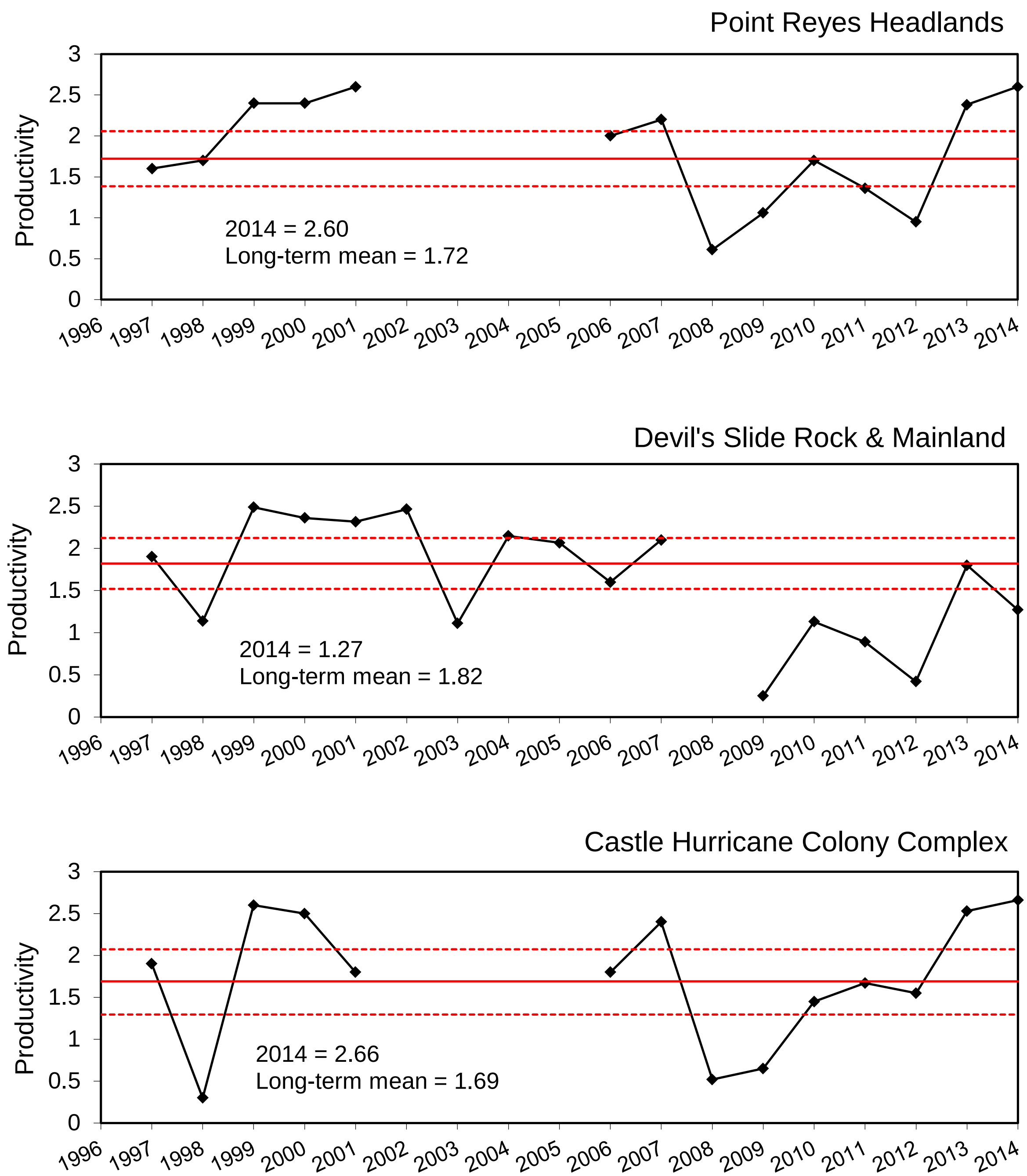


Figure 26. Productivity (chicks fledged per pair) of Brandt's Cormorants at Point Reyes Headlands, Devil's Slide Rock & Mainland, and Castle-Hurricane Colony Complex, 1996-2014. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence interval.

Appendix 1. Number of aircraft overflights detected categorized by type and resulting disturbance events recorded at Point Reyes Headlands, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex in 2014.

Aircraft Type	Total Detections		Number of Agitation Events		Number of Displacement Events		Number of Flushing Events		Total Disturbance Events	
	Plane	Helicopter	Plane	Helicopter	Plane	Helicopter	Plane	Helicopter	Plane	Helicopter
Point Reyes Headlands										
Aerial Photographic Survey Plane	1	0	0	0	0	0	0	0	0	0
USCG	0	1	0	1	0	0	0	0	0	1
Devil's Slide Rock and Mainland										
Commercial	5	0	2	0	0	0	2	0	4	0
USCG	0	1	0	1	0	0	0	0	0	1
Military	2	5	1	0	0	0	0	0	1	0
General Aviation	35	14	12	4	0	0	3	7	15	11
Kit Plane	1	0	1	0	0	0	0	0	1	0
Castle-Hurricane Colony Complex										
Aerial Photographic Survey Plane	2	0	1	0	0	0	0	0	1	0
USCG	2	0	1	0	0	0	0	0	1	0
General Aviation	2	1	1	0	0	0	0	0	1	0
Law Enforcement	0	3	0	0	0	0	0	3	3	0

Appendix 2. Number of watercraft detected categorized by type and resulting disturbance events recorded at Point Reyes Headlands, Double Point Rocks, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex, 2014.

Watercraft Type	Total Detections	Number of Agitation Events	Number of Displacement Events	Number of Flushing Events	Total Disturbance Events
Point Reyes Headlands					
Recreational (<25') Small Private	5	0	0	1	1
Double Point Rocks					
Recreational (<25') Small Private	1	0	0	0	0
Devil's Slide Rock and Mainland					
Recreational (<25') Small Private	2	0	0	0	0
Charter Fishing Boat	2	0	0	0	0
Kayak/Canoe	1	0	0	0	0
Stand Up Paddle Board[1]	1	1	0	1	2
Castle-Hurricane Colony Complex					
Kayak/Canoe	1	0	0	1	1
Recreational (>25') Large Private	2	1	0	0	1

[1] This event involved six total paddle boarders.