RESTORATION AND MONITORING OF COMMON MURRE COLONIES IN CENTRAL CALIFORNIA: ANNUAL REPORT 2015

REPORT TO THE
LUCKENBACH TRUSTEE COUNCIL

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FINAL REPORT

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Cover photo: Aerial photograph of Devil's Slide Rock, 3 June 2015 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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Observations of the Devil's Slide area colonies were conducted under a scientific collection permit from the County of San Mateo Parks Department. 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 NOAA overflight regulation zones of the Greater Farallones and Monterey Bay National Marine Sanctuaries were conducted under NOAA permit GFNMS-2012-001 (issued to University of California Santa Cruz).

EXECUTIVE SUMMARY

Efforts in 2015 represented the 20th 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 other impacts. Subsequently, the project was supported by the 1998 *Command* and extended *Luckenbach* oil spills. From 1996 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 the success 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 was conducted at three Common Murre colony complexes with less intensive monitoring at four additional colonies. For human, or anthropogenic disturbance, disturbance rates per hour were compared to a 2005-2006 baseline, when standardized monitoring began. In 2015, 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. Disturbance rates for planes, helicopters and watercraft combined in 2015 were significantly less than the baseline 2005-2006 mean. While agitation events accounted for 62% of the events at DSRM, there were 12 aircraft related flushing events and an indication that flushing rates for aircraft were above baseline means. Few aircraft and watercraft detections were recorded at Point Reyes Headlands (PRH) and the three Drakes Bay colonies, with four watercraft and two aircraft disturbances total. Overall disturbance rates for those colonies were not significantly different than baseline means. At the Castle-Hurricane Colony Complex (CHCC), a combined eight aircraft and watercraft disturbances were recorded. Although the overall disturbance rate was 320% greater than the baseline mean, it was not significantly different.

General aviation (e.g., private or charter) planes and helicopters were the most commonly observed aircraft and caused more than 70% of disturbances at all monitored colonies, followed by U.S. Coast Guard helicopters, military helicopters, research planes and unknown helicopters. Private recreational fishing boats accounted for 79% of watercraft detections and 71% of watercraft disturbances. Ten watercraft were recorded inside state Special Closures at DSR and Stormy Stack/Double Point Rocks; four of these events resulted in disturbances to seabirds.

Common Murre attendance on Devil's Slide Rock continues to demonstrate recovery of this formerly extirpated colony. The peak count of 2,012 murres was the greatest single count since colony restoration began in 1996. The estimate of 3,070 breeding birds based on a single aerial photographic count was 4.5% less than the 2014 estimate and was similar to or greater than pre-extirpation estimates in 1979-1982. Common Murre productivity, or reproductive success, was considerably greater at DSR than at either PRH or CHCC. Productivity was substantially greater than the long-term average at DSR and near the long-term averages at both PRH and CHCC. However, murres at PRH continued a pattern of lower productivity started that has been since 2011. While major disturbance from Brown Pelicans has been responsible for low productivity in some years, that was not the case in 2015. Disturbance and nest predation by Common Ravens may be a partial cause for lower murre productivity at PRH, but evidence for this is lacking and this topic needs further investigation.

There were fewer Brandt's Cormorant (*Phalacrocorax penicillatus*) nests counted from mainland vantage points in 2015 than in 2014 at all colonies, but aerial survey counts are needed to provide a more complete comparison. Brandt's Cormorant productivity in 2015 was below the long-term average at DSR but near average at PRH and CHCC. Productivity of Pelagic Cormorants (*Phalacrocorax pelagicus*) was monitored at DSRM only, where it was less than the long-term average. Western Gull (*Larus occidentalis*) and Black Oystercatcher (*Haematopus bachmani*) nesting success was monitored at DSRM and CHCC. Gulls did not successfully breed at DSRM in 2015, and productivity at CHCC was less than the long-term average.

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, followed by a permanent closure in September 2002 in waters less than 110 meters deep (60 fathoms) from Point Reyes to Point Arguello (Forney et al. 2001). 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, unpublished 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 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 2015, 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 recently colonized in 2007.

Here we summarize colony surveillance and monitoring efforts conducted at central California nearshore murre colonies in 2015. Similar to past years, we 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 2015 (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. Mainland portions of DSCC are either part of the Devil's Slide Trail County Park or are privately owned. Mainland portions of CHCC are areas that 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.

Monitoring Effort

To track monitoring effort, observers record a start time to the nearest minute upon arrival at a field vantage point and record an end time when departing the vantage point. From these data, the total number of observation hours are calculated irrespective of the number of observers (i.e., it is *not* a calculation of person-hours). For calculating the total observation hours for a colony or colony complex, observation hours from all vantage points are combined. When multiple observers are present at multiple vantage points simultaneously, the total hours of observation was calculated as hours on site regardless of the number of people observing (i.e., not double counted). Time transiting between vantage points is not included.

Disturbance

Anthropogenic and non-anthropogenic disturbance affecting murres or other seabirds was recorded at each study colony. Disturbance events included any instances in which adult birds were agitated or alarmed (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 colony or roost). Numbers of disturbed seabirds within each disturbance category for each disturbance event were recorded. Numbers of eggs or chicks exposed, displaced, depredated or otherwise lost were also recorded. When seabirds were disturbed by a traceable human source (e.g., helicopter with recorded tail number), a Seabird Protection Network wildlife disturbance report was filed. These reports included pertinent information on the event and photos (when available).

Monitoring effort was calculated for each colony and colony complex except for Bird Island . In order to compare disturbance among colonies and among years, disturbance rates were calculated. Anthropogenic disturbance rates were calculated during the breeding season as the number of disturbance events per hour of observation (monitoring effort) at each 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 the annual Pacific Coast Dream Machines event that takes place in late April at the Half Moon Bay Airport, observers were stationed most of the day to view potential disturbance events at Devil's Slide Rock. This event includes an aircraft fly-in which in some years has caused high rates of seabird disturbance. In 2009 the Seabird Protection Network began conducting outreach specifically directed toward pilots attending this event and has continued to do so each year since. The aircraft disturbance rate during the 2016 Dream Machines event was compared to a baseline rate (calculated as the mean of the 2005-2008 events; prior to the start of intensive outreach). For non-anthropogenic disturbances, we reported the species that caused disturbance(s) and summarized major events. This comparison differs from past years' reports, which compared the total number of disturbances instead of disturbance rates.

In addition to disturbance events, all aircraft flying at or below an estimated 1,000 ft (305 m) above sea level and within 1,500 ft (460 m) horizontal distance as well as all watercraft within about 1,500 ft (460 m) of the nearest seabird breeding or roosting area were recorded to identify 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) or directly to a CDFW Warden as well as to the Seabird Protection Network. 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 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; CDFW).

Disturbance rates were compared to the baseline mean rates (mean of 2005-2006). Generalized linear model (GLM) with a Poisson distribution was used to compare disturbance rates between sites, previous years and the baseline mean (R Core Team, 2013). P-values are reported; standard deviations and confidence intervals are reported.

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 two subcolonies at PRH (see below). Seasonal attendance data were collected regularly at all colonies throughout the field season, typically until all chicks fledged and adult attendance ceased. Breeding season counts were conducted during a standardized period between 0930-1400 h. At certain subcolonies or plots, murre counts were compared to long-term means (2008-2014) for each calendar week, and to 95% confidence intervals.

Point Reyes Headlands

Seasonal attendance at PRH was recorded at all murre subcolonies visible from mainland observation points once per week from 16 April to 13 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 15 April to 2 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 2015, 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: early morning (0700-0900 h) and late afternoon (after 1500 h). Monitoring of the north side of the rock began on 16 April, and monitoring of the south side of the rock began on 21 May when it became clear that most of the Brandt's Cormorants were nesting on that side. Counts of the north side were conducted from the bluff above the north end of Rodeo Beach, while counts of the south side were done from the Bird Island overlook.

Devil's Slide Rock & Mainland, San Pedro Rock
Murres on DSR were counted every other day from 14 April to 12 August from the Traditional Pullout. On Devil's Slide Mainland (DSM), attendance patterns were monitored once per week wherever murres could be viewed (see map, Figure 4). Access to the best observation point for viewing Turtlehead (DSR-05) and Turtlehead Boulder was limited to short periods of time 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 27 July. At four subcolonies, separate subarea counts were also conducted: CRM-04 (productivity plot and entire rock), CRM-03-B (south and east sides), CRM-06-South (north and south sides), and HPR-02 (Ledge and Hump plots). In 2015, counts were not conducted from the Woodrat Bluff observation point because road damage and resulting road repairs in 2013 resulted in the removal of the turnout previously used for access. Thus, counts of CRM-06-South (North side) could not be conducted.

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-

04, locations of returning or new breeding and territorial sites were identified using maps and photographs updated from the 2014 breeding season. At CRM-03-B, a subset of potential breeding sites was followed, at the discretion of the field biologist. At DSR, all followed sites were mapped and numbered using digiscoped photographs of the colony, as well as 2015 aerial photographs (Figure 6). 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. Chicks were considered to have fledged if they survived to at least 15 days of age. Results from 2015 were compared to previous long-term means: DSR and CRM, 1996-2014 (n = 19 years); and PRH, 1996-2002 and 2005-2014 (n = 17 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.

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 in 2014 compared to 2013 in plots A and B respectively. In 2014, Plot C was eliminated from monitoring because of difficult viewing conditions (compared to 13 sites followed in 2013). In 2015, a new plot was added (Plot D), located on a relatively narrow ledge below Plot A (Figure 6). This plot was added in an effort in an attempt to examine edge effects, which had been previously monitored by following Plot C. At DSM, all visible sites were monitored at one active subarea: Lower Mainland South (DSR-05-A-Lower). All active sites in plots and subareas were monitored beginning 20 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-03-B in 2015, for the eighth year in a row. A subset of active sites was monitored beginning 13 May. In 2013, the vantage point for monitoring CRM-04 was moved about 100 m south because of road construction. This new vantage point provided improved views of the productivity plot and we subsequently continued using it in 2015.

Common Murre Co-attendance and Chick Provisioning

Murre co-attendance and chick provisioning observations, or time budget surveys, were conducted at DSR only. Surveys were conducted on 15 July, 17 July, and 20 July following standardized methods (see Parker 2005, McChesney et al. 2006). All three surveys were 12 hours in duration. Fourteen breeding sites with chicks were monitored each day, resulting in a total of 41 site-days. High-powered spotting scopes (65-130X) were used to conduct observations. Adult arrivals, departures, and food deliveries to chicks (including prey type, size, and fate when distinguishable) were recorded at each monitored site to the nearest minute. In addition, the number of birds at each site was recorded every 15 minutes throughout the survey to detect possible missed arrivals or departures. Results from 2015 were compared to the 1999-2013 long-term mean (data not available for 2009 and 2014).

Seabird Nest Surveys

Nest and bird counts of non-murre seabirds were conducted one to two times per week 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 reported were the combined total of seasonal peak counts at each subcolony or subarea. Peak counts in 2015 included nests with brooded chicks. Additionally, a boat survey was conducted at DSRM in 2015 to survey nests not visible from mainland vantage points. For comparison to 2014 counts, only land-based count totals were compared for PRH and CHCC, as boat surveys were not conducted that year; however. For DSRM and SPR, combined land and boat survey totals were used for comparison to 2014.

Brandt's Cormorant Productivity

Breeding phenology and reproductive success of Brandt's Cormorants were monitored at PRH, DSRM, and CHCC. Because colonies of this species often switch nesting areas from year-to-year, monitoring was conducted where mainland vantage points provide adequate views to see nest contents.

At PRH in 2015, Brandt's Cormorants were monitored at three subareas of Cone Rock (PRH-13) known as Upper Cone (PRH-13-UC), Cone Shoulder (PRH-13-CS), and Lower Cone (PRH-13-LC), as well as the small rocks and mainland cliffs within PRH-14-A and PRH-14-E. At DSRM, monitoring was conducted at DSR (DSR-01), Upper Mainland South (DSR-05-A-UPPER), Lower Mainland South (DSR-05-A-LOWER), Turtlehead (DSR-05-B) and South of Turtlehead Cliffs (DSR-05-C). At CHCC, only a small sample of four nests at CRM-06-A-N could be monitored.

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 2015 were compared to prior long-term means for DSRM (1997-2007, 2010-2014; n = 16 years), CHCC (1997-2001, 2006-2014; n = 14 years) and PRH (1997-2001, 2006-2014; n = 14 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 of age. 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 long-term averages.

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 30 minutes 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 from 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 2015. At DSCC, the entire area from the south side of San Pedro Rock to the South Bunker (DSRM- 04; Figure 4) was surveyed. At CHCC, the Rocky Point and Woodrat Bluff 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 2015 field season monitoring effort across all four colony complexes totaled 992 on-site hours (Table 1). Aircraft and watercraft detections and all anthropogenic disturbances within our monitoring areas at PRH, DBCC, DSRM, and CHCC are summarized in Tables 2-11, Figures 7-11, and Appendixes 1-2. At all areas combined in 2015, there were 55 aircraft detections combined, which were categorized as 35 planes (64%) and 20 helicopters (36%). Overall, 40 (73%) of these overflights resulted in disturbance to seabirds (e.g. agitation, displacement or flushing, Tables 8-11). A total of 25 planes (71% of planes detected), and 15 helicopters (75% of helicopters detected) caused disturbance. Eight helicopters (15% of all detected aircraft) and six planes (10% of all detected aircraft) caused displacement and/or flushing of murres. The most frequently detected aircraft categories were general aviation planes

(56% of all aircraft detections, resulting in 50% of all disturbances) and general aviation helicopters (14% of aircraft detections resulting in 21% of all disturbances; Figure 7).

There were 14 watercraft detections within 1,500 feet of monitored colonies, including 11 recreational fishing boats, one charter fishing boat, and two groups of kayaks. Eight of these events resulted in disturbance: seven from recreational fishing boats, and one from a group of kayakers (Figure 8).

A total of 48 Wildlife Disturbance Reports were completed and submitted to the Seabird Protection Network in 2015 (four from PRH, two from DBCC, 38 from DSRM and four from CHCC). These included 25 reports of agitation and 23 reports of flushing. Forty of the reports involved aircraft disturbance, and eight involved watercraft disturbance.

There were 10 watercraft recorded entering Special Closures recorded in 2015, including three at Stormy Stack/DPR and seven at DSR. Four of these resulted in disturbance, including two at Stormy Stack/DPR and two at DSR. All Special Closure violations were reported to the Seabird Protection Network and CDFW; several of the violations at DSR prompted local wardens to visit the site in order to witness violations and attempt to contact violators.

Point Reyes Headlands

Only three planes and two watercraft were detected at PRH in 2015 (Tables 2-3; Figures 9-10). The only disturbances recorded were from two small, private recreational fishing boats and two general aviation planes. One of the watercraft flushed a small number of Common Murres and the other flushed small numbers of murres and Western Gulls. Both of the planes caused Common Murres to be agitated.

Although the 2015 combined plane, helicopter and watercraft disturbance rate of 0.008 disturbances/hr was 79% less than the baseline mean, the difference was not significant. Neither detection rates nor disturbance rates for planes (0.008 disturbances/hr,), helicopters (0 disturbances/hr) and watercraft (0.008 disturbancest/hr,) were significantly different than baseline means (P = 0.27, P = 1.00, respectively; Figure 10).

Drakes Bay Colony Complex

At Point Resistance, only one helicopter was observed and there were no observed disturbance events (Table 4, Figure 11). At Millers Point Rocks, there were no detections or disturbance events observed (Table 5, Figure 11).

At Double Point Rocks, there were three watercraft detections, all within the Stormy Stack/Double Point Rocks Special Closure (Tables 6, 7; Figure 11). Two of these detections caused flushing (0.052 disturbances/hr, Table 6) of low to moderate numbers of murres, Brandt’s Cormorants and/or Brown Pelicans.

Devil's Slide Rock and Mainland

In 2015, there were 37 disturbance events recorded (Tables 8-9; Figures 9-10): 21 were from planes (72% of planes detected); 14 from helicopters (88% of helicopters detected); and two from watercraft (29% of watercraft). The combined disturbance rate of 0.077 disturbances/hr was significantly less than the baseline mean ($P = 0.03$). Differences in disturbance rates of 43%, 24%, and 85% less than the baseline means for planes ($P = 0.53$), helicopters ($P = 0.99$) and watercraft ($P=0.36$), were not significant.

There were 14 total flushing events, including: five general aviation planes, four general aviation helicopters, one military helicopter, one U.S. Coast Guard helicopter, one unknown helicopter, one large private recreational fishing boat, and a group of three kayaks. The largest numbers of birds affected by one aircraft was caused by a pair of helicopters that flushed 800 murres on a southbound pass, only about 350 ft above DSR. The overall rate of disturbance events involving displacement and/or flushing of seabirds (0.028 disturbances/hr) was 7.8% less than the baseline mean but the difference was not significant.

The annual Pacific Coast Dream Machines event occurred on 26 April 2015. Weather conditions were clear the day of the event, unlike some years when fog prevents aircraft from flying low along the coast. Observers were stationed at the observation point for Devil's Slide Rock from 0817 h to 1602 h to record overflights and disturbance events. Thirteen aircraft detections and 12 disturbances were recorded. Only three aircraft were within our standard detection zone (1000 ft above sea level, 1500 ft horizontal distance) and an additional 10 were planes that caused disturbance to DSR seabirds from outside the standard detection zone. Of the disturbances, there were 10 agitation events (nine general aviation planes and one general aviation helicopter) and two flushing events (two general aviation planes). The reasons for apparently greater than usual behavioral reactions to aircraft flying beyond our standard detection zone was not clear.

The aircraft disturbance rate during the Dream Machines event (1.55 disturbances/hr) was the greatest since 2011 (215% greater than 2014, 739% greater than 2013 and 0.5% greater than 2012) but slightly lower (3.5%) than the baseline mean. Using real-time information provided by field observers, SPN staff made contact with pilots of observed aircraft if they subsequently landed at the Half Moon Bay Airport.

Castle-Hurricane Colony Complex

At CHCC, two planes, one helicopter and two watercraft caused disturbance to Common Murres (Tables 10-11). The combined rate of 0.025 disturbances/hr was similar (7.4% less) to 2014 and although it was 320% greater than the baseline mean, this difference was not significant ($P = 0.78$).

Non-Anthropogenic Disturbance

Point Reyes Headlands

In 2015, nine flushing events were recorded from non-anthropogenic sources. Common Ravens were responsible for 78% (n = 7), Turkey Vultures for 11% (n = 1), and California sea lions for 11% (n = 1). A total of seven eggs and one chick were observed to be taken from Lighthouse Rock (PRH-03B) during these events, by ravens and Western Gulls. The largest disturbance event was caused by one California sea lion climbing up Lower Cone Rock (PRH-13), and resulted in 400 murres being displaced or flushed and three eggs depredated by Western Gulls. Ravens flushed and/or displaced an average of 121 (range = 20-400) murres per disturbance event. Despite relatively few disturbance events compared to 2014, a cache of approximately 50 murre eggs was discovered on the mainland cliffs near the lighthouse.

Drakes Bay Colony Complex

One non-anthropogenic disturbance event was observed at Point Resistance in 2015, involving approximately 131 roosting Brown Pelicans. Eggs and chicks were not observed to have been lost, but two hundred murres were displaced. At Millers Point Rocks non-anthropogenic disturbance was not observed in 2015. At Double Point Rocks, six flushing and one displacement event from non-anthropogenic sources were observed, including five events caused by Common Ravens, one caused by Brown Pelicans, and one caused by a California sea lion. Two eggs were observed to be depredated by ravens as a result of these events at DPR. The maximum number of murres flushed or displaced in a given disturbance event was 1,000 birds, which occurred during an event caused by ravens, and another event caused by a California sea lion.

Devil’s Slide Rock and Mainland

In 2015, 23 flushing events and four displacement events were recorded at DSRM from non-anthropogenic sources. Brown Pelicans were responsible for 70% (n = 19) and Common Ravens for 30% (n = 8). Murre eggs were not observed to be taken from DSR in 2015. The largest disturbance event was caused by two ravens, and resulted in 600 murres being displaced or flushed from DSR which was nearly the entire colony. Ravens flushed and/or displaced an average of 323 (range = 26-600) murres per disturbance event, while roosting Brown Pelicans flushed and/or displaced an average of 34 murres (range = 5-205).

Castle-Hurricane Colony Complex

Non-anthropogenic disturbance was not observed at CHCC in 2015.

Common Murre Seasonal Attendance Patterns

Point Reyes Headlands

All well-established nesting areas were active with confirmed breeding in 2015. The date of peak counts was variable, ranging from 16 April to 6 July among subcolonies. For 48% of all PRH subcolonies (Figures 12-18), peak numbers were recorded before the first egg lay date from our monitored plots on Lighthouse Rock (23 May). Just over 70% of the subcolonies were no longer attended by murres by 3 August; others, including plots on Lighthouse Rock (PRH-03B), still had small numbers of birds present through the last count on 3 August (Figure 12).

Comparing attendance patters in 2015 to other recent years, no clear, consistent differences emerged. Numbers of murres in Lighthouse Rock and Boulder Rock plots appeared lower than 2008-2014 averages (Figure 26). There is some indication that variability in counts is related to inter-observer bias.

Drakes Bay Colony Complex

Point Resistance
Murre attendance at PRS was extremely variable into mid-May, when the rock was not even attended on some days (Figure 19). Following a peak count on 7 May, counts were relatively stable through May and June, and then decreased by half by 26 July as birds departed the colony. Attendance ceased entirely by 31 July. Consistent attendance through late July suggests that there was likely successful breeding at PRS. Compared to the 2008-2014 mean, attendance was greater than the long-term averages throughout the 2015 season (Figure 27).

Millers Point Rocks
Murre attendance at MPR has been extremely variable from year-to-year and has been tied to nesting Brandt's Cormorants. In 2015, most attendance was on the North Rock (MPR-01) where all of MPR's Brandt's Cormorants nested (Figure 19). Attendance appeared to steadily increase during the first three weeks of May then was relatively consistent through mid-July, after which numbers declined. All attendance had ceased by 31 July. The consistent attendance through the egg and chick periods suggests that some murres may have successfully bred. Murres were observed at MPR South Rock (MPR-02) on only three surveys and very small numbers attended MPR-05 after 21 May.

Double Point Rocks
Attendance at Stormy Stack (DPR-01) was fairly consistent through early July, with a peak count on 15 May (Figure 19). Attendance declined through mid-July, with a few additional peaks, suggesting that there was successful breeding at DPR. Attendance declined dramatically between 23 July and 2 August. Some of the variability in counts may be due to inter-observer bias. There were no clear differences in attendance patterns between 2015 and the 2008-2014 mean (Figure 27).

Bird Island

Surveys were conducted at Bird Island from 16 April to 30 July 2015. Very small numbers murres were observed on 68% of observation days (n = 37 days). The average number of murres observed on days when they were present was four (range = 0-13, n = 25 days). Murres continued to use the small area under the remains of a former U.S. Navy Compass House, on the far western end of the rock. Fewer murres were counted on average in 2015 compared to 2014, but the murres were observed attending Bird Island on a greater number of days in 2015 than in 2014. However, eggs or chicks were not confirmed, and it appeared unlikely that successful nesting took place.

Devil's Slide Rock and Mainland, San Pedro Rock

Devil's Slide Rock

Murres were observed on all count days between 14 April and 9 August 2015, except for 24 April. Murres were completely absent from the rock on 12 August following the end of breeding activity (Figure 20). Similar to most other years, the greatest counts were recorded during the few weeks before the first eggs; in 2015, this was during the first few weeks of May. The peak count of 2,012 murres on 3 May was 5.3% greater than the 2014 peak count of 1,911 murres. Attendance patterns were relatively consistent from late May to late July through most of the egg-laying, incubation and chick periods. This period was followed by a rapid decline in early August as adults and chicks departed the colony.

Comparing attendance patterns in 2015 to the 2008-2014 average, a few differences are apparent (Figure 27). In particular, numbers of murres present throughout the season were considerably greater in 2015. Also, peak numbers appeared to be slightly later than average, and birds may have vacated more synchronously, in 2015.

From photographs obtained during the annual seabird colony aerial survey on 3 June, 1,895 murres were counted, similar to the 2014 count of 1,971 murres. This count was considerably greater than our standardized land-based counts of 1,515 and 1,202 murres on 2 and 4 June, respectively (Figure 20). The greater aerial survey count likely reflects the more complete colony coverage provided by this method. To derive an approximate estimate of the DSR breeding population size, we applied the correction factor of 1.62 calculated for murres at Southeast Farallon Island in 2015 (Warzybok et al. 2015). 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 1,895 birds yields an estimate of 3,070 breeding birds, or about 1,535 breeding pairs. This estimate is only 4.5% less than the estimate of 3,213 breeding birds in 2014 (Fuller et al. 2015) and is 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 and San Pedro Rock

Lower Mainland South (DSR-05A-Lower) was the only mainland subarea with consistent murre attendance in 2015. Attendance was fairly consistent from early May to mid-July and attendance ceased between 20 July and 3 August (Figure 21). Murre attendance was fairly similar to 2014 (see Fuller et al. 2015). Murres were not observed on San Pedro Rock in 2015.

Castle-Hurricane Colony Complex

Attendance counts CHCC began on 14 April. At most subcolonies, attendance was relatively consistent from early May through late June (egg and early chick periods). Peaks in numbers in late June to early July (mid- to late chick period; Figures 22-25) at several subcolonies may have been related to greater attendance of nonbreeding subadults. Attendance in late July was highly variable. While most subcolonies had few birds left by month's end and some (e.g., HPR-01) were completely vacant by 21 July, others (e.g., HPR-02) still had high attendance up until the last count day on 20 July. This suggests that, unlike most years when breeding is fairly synchronized among most subcolonies, timing of breeding at some subcolonies was considerably later than in our monitored plot on CRM-04, where the last chick fledged by 19 July (see below). Seasonal attendance at CRM and HRP subcolonies was similar to the long-term mean (2008-2014, Figure 28).

At CRM-03B, murre numbers declined precipitously at the end of May and attendance ceased by 10 June (Figure 22), consistent with breeding failure at this site (see below). Somewhat similarly, decline in mid-June at Esselen Rock (BM227X) likely signified that either many birds did not breed or experienced nesting failures. The small numbers (n = 20-30) that did remain through late July may have been a minor contingent successful breeders.

Common Murre Productivity

Point Reyes Headlands

A total of 166 sites were monitored at Ledge (n = 92;) and Edge (n = 74;) plots on Lighthouse Rock. The first egg of the season on Lighthouse Rock was observed on 20 May but was not in a monitored plot. When Edge and Ledge plots were combined, the mean egg-laying date (exclusive of replacement eggs) was 29 May ± 0.5 days, (range = 23 May – 17 June; n = 99; Table 12), three days later than the long-term mean (26 May ± 2.1 days). Twelve total replacement eggs were laid, including a likely third clutch at a site in Ledge Plot. Seven of these replacement eggs hatched and one chick fledged. Overall productivity was 0.49 chicks fledged per pair, slightly less than the long-term average (0.51 ± 0.06). Productivity was influenced by both relatively low (56.5%) hatching and fledging (79.5%) success. Chicks fledged at an average age of 28 ± 0.5 days (n = 63), and the last chick was observed on 6 August (Figure 29).

Devil's Slide Rock and Mainland

Of 199 sites followed within DSR plots, 167 (84%) were breeding, 29 (15%) were territorial, and three (1%) were sporadic. The first murre egg was observed on 20 May, outside the productivity plots. At all sites combined, the mean egg-laying date (exclusive of replacement eggs) was 7 June ± 1.1 days (range = 21 May – 28 June, n = 116; Table 12), which is 13 days later (and outside two standard errors) than the long-term average (25 May ± 1.9 days). A total of 168 eggs were laid, including only one replacement egg. Overall productivity of 0.78 chicks fledged per pair was greater than the upper 95% confidence interval of the long-term average (0.63 ± 0.05; Figure 29). Greater than average productivity was influenced by 88.1% hatching success and 88.5% fledging success. Chicks that fledged remained on the rock for an average of 24 ± 0.4 days (n = 131), and the last chick was seen on 2 August.

Thirteen breeding sites were followed on Lower Mainland South (DSR-05A-LOWER). Mean egg-lay date was 5 June ± 2.9 days (range = 29 May – 15 June, n = 6; Table 12). A total of 13 eggs were laid, and 11 eggs hatched. Five chicks fledged from DSM in 2015 resulting in overall productivity of 0.38 chicks fledged per pair, which was outside the upper 95% confidence interval of the long-term mean (0.24 ± 0.10; 2005-2014).

Castle-Hurricane Colony Complex

Of 110 total monitored sites in the CRM-04 plot in 2015, 104 (95%) were breeding and 6 (5%) were territorial (Table 12). The first murre egg on CRM-04 was observed on 8 May. The mean egg-laying date was 18 May ± 0.5 days (range = 8 May – 12 June; n = 104), three days later than the long-term average of 15 May ± 2.3 days. Replacement eggs were not observed. Overall productivity of 0.56 chicks per pair was within 95% confidence interval of the long-term mean (0.53 ± 0.05 chicks per pair; Figure 26). Chicks fledged at an average age of 23 ± 0.3 days (n = 58) and the last chick was seen on 18 July.

For the seventh consecutive year, murres were monitored and bred on the east side of CRM-03B; however, breeding was unsuccessful in 2015. Of 53 sites monitored, 5 (9%) were breeding and 48 (91%) were sporadic. The mean egg-laying date was 30 May ± 2.3 days (range = 24 May – 4 June; n = 5; Table 12), 12 days later (and outside two standard errors, Figure 29) than the long-term average of 18 May ± 2.1 days. Replacement clutches were not observed. No eggs hatched. All five breeding sites, and all other attending murres, abandoned CRM-03B by 10 June. Long-term average productivity at CRM-03B is 0.44 ± 0.08 chicks per pair (1999-2003, 2005, 2008-2014; n = 13 years).

Common Murre Co-attendance and Chick Provisioning

At DSR, the mean percent of time that pairs with chicks spent in co-attendance over three all day watches was 21.1% ± 0.027 (range = 7.8 – 39.7%; n = 14), which is outside two standard errors of the long-term (1999-2013) average of 13.6% ± 0.01. There were 253 mate arrivals recorded. On average, mates arrived 0.51 ± 0.03 times per site per hour (range = 0.33 – 0.66; n = 14). Of all mate arrivals seen, 51% were observed with prey and 49% did not have prey. Of the confirmed prey deliveries, 96.9% were consumed by chicks, 2.3% were consumed by the adult who brought the fish in, and 0.8% were dropped on the ground. The mean chick provisioning rate was 0.25 ± 0.02 feedings per hour (range: 0.11 – 0.39; n =14); this was within two standard error of the long-term mean (0.24 ± 0.02; 1999-2013).

Brandt’s Cormorant Nest Surveys and Productivity

Seasonal peak nest counts of Brandt’s Cormorants obtained from weekly land surveys, and the total from a combined boat and land survey conducted once on 25 June (DSRM and SPR only) are reported (Figure 13). In most years, not all nests are visible from our observation points, so nest counts should be considered a minimum. Consequently comparisons to previous years should also be considered with caution. Inclusion of aerial photographic survey data 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 16 April to 6 July. Well-built nests were recorded at Area F (PRH-06F), The Hooves (PRH-07A), PRH-08, Trinity Point (PRH-08A), Cone Rock (PRH-13; several subareas), PRH-14A and PRH-14E. The first well-built nest was observed on 16 April. The peak single-day count of nests for all subcolonies combined was 196 nests on 6 July, 15% less than the 2014 peak single-day count (230). The sum of the seasonal peak counts for each subcolony was 199 nests, 18% less than in 2014 (242 nests; Table 13).

Productivity

A total of 132 nests were monitored at five subareas, and 129 were egg-laying sites (Table 14). The start of nest monitoring for each subarea followed the timing of nest initiation: PRH-14A began on 20 April; PRH-14E East on 28 April; PRH-14E West on 30 April; Cone Shoulder (PRH-13CS) on 4 May; PRH-14A Mainland on 5 May; Lower Cone (PRH-13LC) on 9 May; and Upper Cone (PRH-13CU) on 8 June. For all subareas combined, the average clutch initiation date of 21 May ± 1.3 days (range = 22 April – 25 June, n = 123) for first clutches was five days later but within two standard errors of the long-term mean of 16 May ± 3.9 days. Three replacement clutches were observed. The first chick was observed on 24 May. Overall productivity of 1.79 chicks fledged per pair (subarea range = 0.71 – 2.47) nearly identical to the long-term average (1.80 ± 0.2; Figure 27). Breeding success per nest was 0.81 (subarea range = 0.42 – 1.00, Figure 30). The greatest productivity value was in the subarea with the earliest clutch initiation date while the lowest productivity value was in the subarea with the latest clutch initiation date.

Drakes Bay Colony Complex

Nest surveys

Brandt’s Cormorant nest surveys were conducted from 15 April to 10 July (Table 13). The first well-built nests were observed at PRS and MPR-01 on 17 April and at DPR on 15 April. Well-built nests were not observed on MPR-02 in 2015. The peak count of nests for MPR was 79 nests on both 14 and 18 June, 29% less than the peak count in 2014 (102). The peak count for PRS-02 was four nests on 28 June, 89% less than the peak count in 2014 (38). The peak count for DPR-02 (Stormy Stack), of 39 nests, occurred on 16 June, and was 26% less than the peak count in 2014 (53). However, many of the nests on DPR-02 may have been out of view.

Bird Island
Surveys were conducted from 16 April to 30 July. Large numbers of roosting Brandt's Cormorants were present consistently throughout the season, with counts reaching greater than 3,000 roosting birds. Brandt's Cormorant nesting was confirmed on Bird Island, with a peak count of 36 nests on 28 June. Successful breeding was likely, as possible chicks were noted by volunteer observers.

Devil's Slide Rock and Mainland
Nest surveys
Nests and territorial sites were counted between 15 April and 10 July. The first well-built nests were observed on 27 April. The peak count of nests on DSR was 15 nests on 6 July. On the mainland, nesting occurred on Upper Mainland South (DSR-05A-UPPER; peak count of three nests), Lower Mainland South (DSR-05A-LOWER; peak count of 34 nests), Turtlehead (DSR-05B; peak count of 32 nests), and South of Turtlehead Cliffs (DSR-05C; peak count of one nest).

The peak single day count for DSRM combined was 62 nests on 22 June, 39% less than the 2014 peak count (103 nests). The sum of the seasonal peak counts was 85 nests (Table 13), 19% less than the 2014 count of 105 nests. No additional nests were found during a boat survey.

Productivity

In 2015, Brandt's Cormorant breeding at DSRM was characterized by a longegg-laying period (28 April – 24 June), early egg losses, consistent abandonment throughout early July, and an unexplained larger abandonment event of near the end of July. During the late July abandonment event, 27 nests with chicks of various stages were lost. Adult birds did not return to their nests, leaving Turtlehead (DSR-05B) strewn with nests still filled with dead chicks. It is unclear whether the abandonment was initiated by a disturbance event, a predation event, poor prey conditions or other factors.

A total of 81 breeding sites were monitored at five DSRM subareas in 2015: DSR (DSRM-01), Upper Mainland South (DSRM-05A-UPPER), Lower Mainland South (DSRM-05A-LOWER), Turtlehead (DSRM-05B), and South of Turtlehead Cliffs (DSRM-05C; Table 14). The first egg was observed on DSR on 28 April. For all nests combined, the mean clutch initiation date of 22 May ± 1.3 days (range = 28 April to 24 June) was 10 days later (outside two standard errors, Figure 30) than the long-term mean of 12 May ± 2.7 days. Overall productivity of 0.16 chicks fledged per pair (subarea range = 0.13 – 3.00; n = 13) was well below the 95% confidence interval of the long-term average of 1.79 ± 0.2 (Figure 30). Breeding success per nest was 0.32, indicating the high rate of nest abandonment. There were eight replacement clutches observed in 2015.

Castle-Hurricane Colony Complex
Nest surveys
Brandt's Cormorant nest surveys were conducted from 14 April to 10 July. Subcolonies or subareas with confirmed breeding in 2015 were BM227X-02, BM227X-03, CRM-06A-N and CRM-06B-S. The first well-built nests were observed on 20 April at BM227X-03, on 4 May at

CRM-06B-S, on 15 May at BM227X-02 and on 21 May at CRM-06A-N. At all CHCC subcolonies combined, the peak single survey nest count of 86 nests was recorded on 16 June; 63% less than the 2014 peak count of 234. The sum of the peak subcolony counts was 110 nests, 57% less than the 2014 count of 255 nests (Table 13).

Productivity
Only a small sample (n = 4) of Brandt's Cormorant nests on the CRM mainland (CRM-06A-N) could be followed for productivity (Table 14). All other nesting areas were too far from vantage points. The mean clutch initiation date was 15 May ± 2.0. The first chick was observed on 10 June. Overall productivity was 2.0 chicks fledged per pair. The sample size was too small to make meaningful comparisons to long-term means.

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

Nest and bird surveys

Seasonal peak weekly counts of nests (Pelagic Cormorant, Western Gull, and Black Oystercatcher) or birds (Pigeon Guillemot) from weekly land-based surveys are reported. At DSCC, a single boat survey also were conducted on 25 June to count cormorant, oystercatcher and gull nests not detected from land-based counts and to conduct a complete Pigeon Guillemot count. Nest counts were combined with land-based counts as applicable while guillemot counts were considered separately (Tables 13 and 15). Because boat surveys were only conducted at DSCC in 2015, comparisons to 2014 were only made for these sites.

Pelagic Cormorant
Pelagic Cormorant well-built nests were first observed at PRH on 13 May, at DBCC on 28 April, at DSRM on 4 May, and at CHCC on 14 April. Nest counts at PRH and DBCC were 78% and 74% less than in 2014, respectively. At DSCC (including DSRM and SPR), combined nest counts from both land and boat surveys were 72% less than in 2014. Nest counts at CHCC were 26% less than in 2014. Pelagic Cormorant nesting areas typically vary from year to year and some to many nests may not be visible from land-based observation points. This can especially be the case at PRH, where most of the nesting Pelagic Cormorants cannot be viewed from our mainland vantage points. Because of this, nest counts should be considered a minimum estimate and comparisons to previous years should be considered with caution when a boat survey was not conducted.

Western Gull
Compared to 2014, there were fewer nests observed at PRH (26%), DSCC (including SPR; 20%) and CHCC (29%) and the same number of nests at DBCC.

Black Oystercatcher
Nest counts for Black Oystercatchers were comparable to 2014, except for PRH, where only three nests were observed, compared to an exceptionally high count of 10 nests in 2014. Three total nests were observed at DBCC colonies, two at DSRM and three at CHCC.

Pigeon Guillemot
At PRH, the peak standardized count from the lighthouse of 145 birds on 19 May was similar to the peak 2014 count of 141. Although surveys of Drakes Bay colonies were not done at standardized times (i.e. 30 minutes after sunrise - 0830 h), peak counts were less than 2014 peak counts at PRS (44% less), MPR (33% less), and DPR (7.3% less).

At DSCC, the peak land-based count of 170 guillemots on 12 May was 33% less than in 2014 (255). The 2015 boat survey count at DSRM was 49 guillemots, 69% less than the 2014 boat survey count (158). At CHCC, the peak standardized count was 28 guillemots on 6 June, 100% greater than the in 2014 (14).

Productivity

Productivity results for Pelagic Cormorants, Western Gulls, and Black Oystercatchers are summarized in Table 16. 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 Turtlehead (DSR-05B) and Lower Mainland South (DSR-05A-LOWER). Productivity at DSRM of 0.44 chicks fledged per pair was well below the 95% confidence interval of the long-term mean (1.67 ± 0.2 chicks fledged per pair; 2006 – 2014; Figure 31).

Western Gull
Nests were monitored at DSRM and CHCC. No chicks fledged at DSRM. Productivity of 0.54 chicks fledged per pair at CHCC was near the long-term mean (2006-2014; Figure 32).

Black Oystercatcher
Black Oystercatcher productivity was not followed at DSRM in 2015 due to lack of breeding sites in the survey area. At CHCC no chicks fledged at two nests followed.

DISCUSSION

Anthropogenic Disturbance

In 2015, DSRM had the greatest rates of aircraft and watercraft activity of our monitored colonies and consistent with the long-term pattern. Also like past years, aircraft (especially planes) far outnumbered watercraft for both detections and disturbances. General aviation planes and general aviation helicopters made up the majority of both aircraft detections and disturbances, and the majority of watercraft detections and disturbances were from small recreational fishing boats.

At PRH and DSRM, an apparent pattern of overall disturbance rates declining compared to the previous year continued. At DSRM, in particular, the overall disturbance rate was significantly less than the 2005-2006 baseline mean. Reduced disturbance is likely at least partially a result of several years of efforts by the Seabird Protection Network to educate pilots about the location of the DSR colony and potential impacts of disturbance. Although the overall disturbance rate at CHCC was similar to the long-term average in 2015.

In past years, the annual Pacific Coast Dream Machines event has resulted in elevated levels of aircraft activity and disturbance at DSR. Monitoring efforts were coordinated with pilot outreach efforts conducted by GFNMS staff. Although only three aircraft overflights were recorded within our standard detection zone in 2015, 12 overflights resulted in disturbance, including two flushing events; 10 disturbance events were from planes flying outside the standard detection zone.

In 2015, seven watercraft were detected inside the state Special Closure at DSR, and three at Stormy Stack (DPR), which was similar to numbers observed in 2014 (six at DSR and one at DPR). This suggests that more outreach to boaters may be needed to increase awareness of Special Closures. Because of the communication between field staff and CDFW wardens, many of these violations in 2015 were addressed quickly.

Non-Anthropogenic Disturbance

At all colonies combined in 2015, Brown Pelicans caused 48% (n = 21) of recorded non-anthropogenic disturbance events while Common Ravens caused 41% (n = 20). Despite a large local population and regular breeding on the DSM cliffs, raven disturbance and predation had not been major problems at DSRM but incidents on both the rock and mainland have increased in frequency over the last two years. Ravens have been observed on Devil's Slide Rock since 2009; however 2014 was the first year since colony restoration that ravens caused the majority of non-anthropogenic disturbance events. This is a concern for the DSR murre colony, especially given its relatively small size. Raven predation also may be hindering murre reproduction at PRH. Consistently low breeding success the last five years and the large cache of murre eggs found near the large Lighthouse Rock colony in 2015 suggests that raven predation may be greater than what is actually observed during the few hours a day this subcolony is monitored, although other factors may be contributing to low murre breeding success.

Brown Pelicans (mostly immature) have caused large-scale disturbances at monitored murre colonies in the past, sometimes resulting in near to total breeding failure at affected colonies (e.g., Fuller et al. 2013). In 2015, disturbance events were generally of low impact to breeding murres and were characterized by groups of roosting pelicans, or pelicans arriving at a rock. In contrast, some events in past years involved pelicans walking through murre colonies or attempting to steal fish.

Attendance and Reproductive Success

While the standardized land-based maximum count of the murre colony on DSR in 2015 was the greatest on record, and 5.3% greater than in 2014, this was only a single day count early in the season prior to egg-laying. Comparisons with other recent years clearly show that daily attendance was considerably greater in 2015 than the average of the previous seven years. Based on an aerial photograph count, the breeding population estimate of 3,213 birds appeared similar to 2014. Analyzing subsequent years of data 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 1979-1982 period, 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, which reflected earlier breeding. Colony departure at PRH and DSR in 2015 was earlier than 2014, even though initiation of breeding was later than average. Consistent attendance at non-breeding "clubs" at PRH suggested a healthy population of subadults. This and other clubs at PRH 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. Depending on the year, murres may attend (often sporadically) the North Rock (MPR-01), South Rock (MPR-02), or Blue Cheese (MPR-03), usually in association with nesting Brandt's Cormorants. In 2015, murres regularly attended MPR-02; consistent with the previous pattern, this was also where all of MPR's Brandt's Cormorants nested. Consistent attendance from early May to late July suggests that at least some murres may have bred successfully on MPR-02. The reasons for typically erratic attendance and poor productivity at MPR are unclear. In past years, raven disturbance and egg predation has been observed and was thought to impact the colony (McChesney, 2007). Raven disturbance has not been observed at MPR since 2010, so it is uncertain if ravens continue to disrupt colony activity or if other factors are involved.

Murre attendance at Bird Island 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 2015 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 later than average at all colonies in 2015. Murre productivity was considerably greater than average at DSR, continuing a general pattern observed over the last six seasons. High productivity suggests abundant prey resources within foraging distance of the colony.

While murre productivity at PRH was near the long-term mean, success during the period 2011-2015 has been consistently less than in the 1997-2010 period, when PRH birds often had the greatest productivity among our monitored colonies. For the past five years, however, PRH birds have consistently had the lowest productivity. While Brown Pelican disturbance clearly impacted murre breeding in some years (e.g., 2011 and 2012), in other years such as 2015 the causes of low murre productivity have been much less clear. Raven disturbance and nest predation may still be contributing to low murre productivity at PRH. However, raven disturbance and nest predation have been prevalent at PRH since at least the mid-1990s (e.g.

Thayer et al. 1999; Parker et al. 1999; USFWS, unpublished data), and we have no indication that recent disturbance and predation is greater than in previous years. 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 and needs further investigation.

Murres once again bred in small numbers on DSM and produced five fledglings. Productivity was greater than average, but still quite poor when compared to more established colonies. While breeding on DSM has occurred nearly every year since 2005, murre breeding locations within this area sometimes change from year to year and breeding success has been poor.

Like past years, murre productivity was also poor at CRM-03B, where only five breeding sites were recorded and all birds abandoned the rock by early June. Murres often abandon CRM-03B when Brandt's Cormorants do not breed among them, as was the case in 2015. The reasons for this, and for consistently poor breeding success, are unclear but may reflect on individual quality, habitat suitability, or a combination of factors. Murre breeding success at the long-term Farallon Island plot, offshore at the Farallon Islands, was slightly less than average (Warzybok et al. 2015).

Brandt's Cormorants nest counts from our mainland vantage points in 2015 were less than 2014 at all colonies, although confirmation from aerial photographic surveys is needed. Similar to Common Murres, breeding was later than average at all monitored colonies. Productivity was average at PRH but very low at DSRM, where many nests were mysteriously abandoned late in the breeding season. At DSRM, this was the one of the four worst years for productivity since the Common Murre Restoration Project began monitoring. Poor breeding success and small breeding population size at DSRM continued a pattern begun in 2008-2009, when a population crash in the Gulf of the Farallones associated with a large decline of northern anchovies (*Engraulis mordax*) occurred (Capitolo et al. 2014, Elliott et al. 2015). Unfortunately, most Brandt's Cormorants at CHCC nested too far away for productivity monitoring and our sample size there was too small for meaningful comparisons. In comparison, Brandt's Cormorant breeding success on the nearby Farallon Islands was slightly above average (Warzybok et al. 2015).

Pelagic Cormorants experienced similar nest abandonment to Brandt's Cormorants at DSRM, with below average productivity. In contrast, Pelagic Cormorant breeding success at the Farallon Islands was slightly greater than average in 2015 (Warzybok et al. 2015). Western Gulls, similar to the past several years, had poor productivity at both DSRM and CHCC.

At DSR in 2015, greater than average co-attendance rates of murre breeding pair members and greater than average chick provisioning rates suggest the abundant availability of local prey. However, both co-attendance and chick provisioning rates were extremely variable among the three survey days. A large bait ball was observed from shore less than one kilometer west of DSR for the entire first survey day on 15 July, which attracted Humpback Whales (*Megaptera novaeangliae*) and large numbers of various seabird species. By 20 July, the bait ball was no longer present, resulting in single-day co-attendance and chick provisioning rates that were much comparatively low. Adult murres were able to find plentiful prey at times, but prey availability seemed to be fleeting temporally, and patchy geographically.

Much of the North Pacific Ocean experienced warmer than average sea surface temperatures (SST) in the first half of 2015 with corresponding winds resulting in near average coastal upwelling (Leising et al. 2015). At the Farallon Islands, monthly mean SST was greater than average during the seabird breeding season (March to August; Warzybok et al. 2015). Central California fisheries data indicated abundant juvenile rockfish (*Sebastes* spp.), juvenile sanddabs (*Citharichthys* spp.), and market squid (*Loligo opalescens*), average or below average abundance of krill, and low abundance of northern anchovies and Pacific sardines (*Sardinops sagax*; Leising et al. 2015). Piscivorous seabirds at the Farallon Islands fed primarily juvenile rockfish and anchovies to their chicks, which is a departure from the past several years when anchovies were nearly absent from seabird diets (Warzybok et al. 2015). We assume that seabirds at our nearshore monitored colonies fed on similar prey.

Observations from local fishermen, pelagic birdwatching and whale watching trips reported an abundance of schooling prey such as anchovies and Pacific mackerel (*Scomber japonicus*) through the summer and fall, especially nearshore where cold water was concentrated. The abundant schooling fish attracted large numbers of seabirds, such as Common Murres and Sooty Shearwaters (*Ardenna grisea*), and humpback whales into nearshore waters of the Gulf of the Farallones and Monterey Bay (G. McChesney, pers. obs.; many observers). Despite this, beached bird survey programs such as Greater Farallones BeachWatch and Monterey Bay Beachcombers recorded a very large Common Murre die-off during late summer and fall, mainly of juvenile birds that apparently starved (J. Roletto and L. Henkel, pers. comm.). Reasons for the die-off are not yet understood, especially given what appeared to be abundant local prey.

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 the 2015 field season marked the second year of pedestrian access to 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 provided a great opportunity for outreach. Increased outreach efforts should continue to be pursued, including coordination with San Mateo County Parks trail ambassadors.

- The causes of low murre productivity at PRH deserve further investigation.

- Annual aerial surveys of central California murre and Brandt's Cormorant colonies continued in 2015 in cooperation with CDFW, University of California Santa Cruz, and USFWS Migratory Birds. However, no sustained funding is currently available to continue these surveys as well as count nests and birds from the photographs. As murre numbers have increased, land-based counts have become more difficult and even less accurate. Additionally, some seabird nesting areas are only visible from aerial photographs. Thus, aerial photographic surveys are essential to accurately monitor murre and certain other species populations.

- As the numbers and densities of murres on monitored breeding colonies increase, 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.

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Table 1. Monitoring effort of study colonies or colony complexes, April 2015 to August 2015. See Methods for description of calculations.

Colony/Colony Complex	Start date	End date	Number of observation days	Total Hours[1]
Point Reyes Headlands	16 April 2015	13 August 2015	83	236
Point Resistance	17 April 2015	31 July 2015	22	15
Millers Point Rocks	17 April 2015	31 July 2015	22	16
Double Point Rocks	15 April 2015	2 August 2015	20	39
San Pedro Rock	14 April 2015	12 August 2015	8	28
Devil's Slide Rock & Mainland	14 April 2015	12 August 2015	115	458
Castle-Hurricane Colony Complex	14 April 2015	27 July 2015	83	200

[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 2015, and comparison to baseline means. Detection and disturbance rates reported as numbers per observation hour. Dash indicates no events.

			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	3	0.013	2	-	-	0.008	-	0.040	0.020	-68%	-57%
Helicopter	-	-	-	-	-	-	-	0.001 (± 0.001)	0.001 (± 0.001)	-100%	-100%
Watercraft	2	0.008	-	-	2	0.008	0.008	0.097 (± 0.030)	0.015 (± 0.002)	-92%	48%
Total	5	0.021	-	-	2	0.008	0.008	0.138 (±0.022)	0.037 (± 0.019)	-85%	-79%

[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, 2015. Dash indicates no events.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean Number Seabirds Flushed/ Displaced	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds
Plane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helicopter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Watercraft	21 (12-30)	2	25 (20-30)	-	-	-	-	-	-	1	12	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	21 (12-30)	2	25 (12-30)	-	-	-	-	-	-	1	12	-	-	-	-

Table 4. Total detected watercraft and aircraft and resulting disturbances to seabirds at Point Resistance in 2015, and comparison to baseline means. Detection and disturbance rates reported as numbers per observation hour. Dash indicates no events.

			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	-	-	-	-	-	-	-	0.018 (± 0.018)	0.0	-100%	-100%
Helicopter	1	0.067	-	-	-	-	-	0.0	0.0	100%	-100%
Watercraft	-	-	-	-	-	-	-	0.018 (± 0.018)	0.018 (± 0.018)	-100%	-100%
Total	1	0.067	-	-	-	-	-	0.036 (±0.036)	0.018 (± 0.018)	88%	-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 2015, and comparison to baseline means. Detection and disturbance rates reported as numbers per observation hour. Dash indicates no events.

			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	-	-	-	-	-	-	-	0.044 (± 0.044)	0.0	-100%	-100%
Helicopter	-	-	-	-	-	-	-	0.022 (± 0.022)	0.022 (± 0.022)	-100%	-100%
Watercraft	-	-	-	-	-	-	-	0.185 (± 0.015)	0.054 (± 0.031)	-100%	-100%
Total	-	-	-	-	-	-	-	0.252 (±0.082)	0.076 (±0.009)	-100%	-100%

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

Table 6. Total detected watercraft and aircraft and resulting disturbances to all seabirds at Double Point Rocks in 2015, and comparison to baseline means. Detection and disturbance rates reported as numbers per observation hour. Dash indicates no events.

			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	-	-	-	-	-	-	-	0.009 (±0.009)	0.009 (±0.009)	-100%	-100%
Helicopter	-	-	-	-	-	-	-	0.047 (±0.030)	0.028 (±0.011)	-100%	-100%
Watercraft	3	0.078	-	-	2	0.052	0.052	0.289 (±0.057)	0.082 (±0.005)	-73%	-36%
Total	3	0.078	-	-	2	0.052	0.052	0.345 (±0.036)	0.118 (±0.003)	-77%	-56%

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

Table 7. 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 Double Point Rocks, 2015. Dash indicates no events.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean Number Seabirds Flushed/ Displaced	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds
Plane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helicopter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Watercraft	254.5 (26-493)	2	47 (10-83)	2	209 (8-410)	-	-	1	8	-	-	-	-	-	-
Total	254.5 (26-493)	2	47 (10-83)	2	209 (8-410)	-	-	1	8	-	-	-	-	-	-

Table 8. Total detected watercraft and aircraft and resulting disturbances to all seabirds at Devil's Slide Rock & Mainland in 2015, and comparison to baseline means. Detection and disturbance rates reported as numbers per observation hour. Dash indicates no events.

			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	29	0.063	16	-	5	0.046	0.011	0.311 (±0.081)	0.073 (± 0.023)	-80%	-37%
Helicopter	16	0.035	7	-	7	0.031	0.015	0.076 (± 0.004)	0.040 (± 0.015)	-54%	-24%
Watercraft	7	0.015	-	-	2	0.004	0.004	0.071 (± 0.008)	0.030 (± 0.005)	-79%	-86%
Total	52	0.114	23		14	0.076*	0.028	0.459 (± 0.077)	0.154 (± 0.033)	-75%	-50%

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

* Indicates statistically significant values

Table 9. 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, 2015. Dash indicates no events.

		COMU Disturbance		BRCO Disturbance		PECO Disturbance		BRPE Disturbance		WEGU/UNGU Disturbance		BLOY Disturbance		PIGU Disturbance	
Source	Mean Number Seabirds Flushed/ Displaced	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds	Number Events	Mean Number birds
Plane	61 (11-360)	5	81 (11-300)	3	13 (10-20)	-	-	-	-	-	-	-	-	-	-
Helicopter	178 (5-800)	7	197 (5-800)	4	9 (1-25)	-	-	-	-	-	-	-	-	-	-
Watercraft	220 (155-255)	1	30	2	205 (155-255)	-	-	-	-	-	-	-	-	-	-
Total	186.57 (5-800)	13	132 (5-800)	9	54 (1-255)	-	-	-	-	-	-	-	-	-	-

Table 10. Total detected watercraft and aircraft and resulting disturbances to all seabirds at Castle-Hurricane Colony Complex in 2015, and comparison to baseline means. Detection and disturbance rates reported as numbers per observation hour. Dash indicates no events.

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	3	0.015	1	-	1	0.010	0.005	0.064 (±0.013)	0.003 (±0.003)	-77%	236%
Helicopter	3	0.015	-	-	1	0.005	0.005	0.003 (±0.003)	0.002 (±0.002)	404%	152%
Watercraft	2	0.010	1	-	1	0.010	0.005	0.002 (±0.002)	0.0	395%	100%
Total	8	0.040	2	-	3	0.025	0.015	0.069 (±0.014)	0.006 (±0.006)	-42%	320%

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

Table 11. 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, 2015. Dash indicates no events.

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	100	1	100	-	-	-	-	-	-	-	-	-	-	-	-
Helicopter	100	1	100	-											
Watercraft	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Total	67.7	3	67.7	-	-	-	-	-	-	-	-	-	-	-	-

Table 12. Common Murre breeding phenology and reproductive success at Point Reyes Headlands (2 plots and combined), Devil's Slide Rock & Mainland (DSR, 3 plots and combined; DSM), and Castle Rocks & Mainland (CRM; 2 plots), 2015. 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	92	80	29 May (5/23-6/17; 53)	89	29 June (6/24-7/18; 33)	53.9% (89)	27 July (7/19-8-7; 33)	72.9% (48)	0.56 (80)
PRH-Edge	74	55	30 May (5/25-6/17; 46)	58	1 July (6/27-8/3; 33)	60.3% (53)	28 July (7/21-8/5; 30)	88.6% (35)	0.44 (55)
PRH-(combined)	166	135	29 May (5/23-6/17; 99)	147	30 June (6/24-8/3; 66)	56.5% (147)	27 July (7/19-8/7; 63)	79.5% (83)	0.49 (135)
Devil's Slide Rock and Mainland (DSRM)									
DSR-A	100	87	3 June (5/21-6/20; 59)	87	2 July (6/22-7/10; 45)	93.1% (87)	28 July (7/22-8/3; 74)	91.4% (81)	0.85 (87)
DSR-B	70	59	2 June (5/24-6/15; 45)	60	3 July (6/23-7/13; 38)	86.7% (60)	28 July (7/13-8/3; 48)	92.3% (57)	0.81 (59)
DSR-D	29	21	15 June (6/4-6/28; 12)	21	6 July (7/4-7/10; 4)	71.4% (21)	29 July (7/24-8/2; 9)	60.0% (15)	0.43 (21)
DSR (combined)	199	167	7 June (5/21-6/28; 116)	168	4 July (6/22-7/13; 87)	88.1% (168)	28 July (7/13-8/3; 131)	88.5% (148)	0.78 (167)
DSM	13	13	5 June (5/29-6/15; 6)	13	6 July (6/29-7/15; 10)	84.6% (13)	22 July (7/18-7/27; 5)	45.5% (11)	0.38 (13)
Castle Rocks and Mainland (CRM)									
CRM-04	110	104	18 May (5/8-6/12; 104)	104	19 June (6/9-6/29; 83)	79.8% (104)	12 July (7/3-7/19; 58)	69.9% (83)	0.56 (104)
CRM-03B	53	5	30 May (5/24-6/4; 5)	5	-	-	-	-	0.00 (5)

[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 13. Peak counts of nests for Brandt's Cormorants (BRCO) and Pelagic Cormorants (PECO) obtained during land, boat, and combined land/boat counts (total), in 2015.

Species	Colony	Land[1]	Boat[3]	Total Count[2]
Brandt's Cormorant	Point Reyes Headlands	199	-	199
	Point Resistance	4	-	4
	Miller's Point Rocks	79	-	79
	Double Point Rocks	39	-	39
	Bird Island (Point Bonita)	36	-	36
	Devil's Slide Rock & Mainland	85	0	85
	San Pedro Rock	0	0	0
	Bench Mark-227X	90	-	90
	Castle Rocks & Mainland	20	-	20
	Hurricane Point Rocks	0	-	0
Pelagic Cormorant	Point Reyes Headlands	9	-	9
	Point Resistance	5	-	5
	Miller's Point Rocks	4	-	4
	Double Point Rocks	2	-	2
	Devil's Slide Rock & Mainland	35	3	38
	San Pedro Rock	0	4	4
	Bench Mark-227X	4	-	4
	Castle Rocks & Mainland	16	-	16
	Hurricane Point Rocks	3	-	3

[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 vantage points were counted.

Table 14. Brandt's Cormorant breeding phenology and reproductive success at Point Reyes Headlands, Devil's Slide Rock & Mainland, and Castle Rocks & Mainland, 2015. 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						
Lower Cone (PRH-13LC)	8	15 May (5/11-5/24; 8)	3.00 (1-4; 8)	44.0% (25)	1.38 (0-3, 8)	0.63 (5)
Cone Shoulder (PRH-13CS)	62	17 May (5/05-6/01; 58)	3.00 (1-4; 59)	71.4% (189)	2.18 (0-4, 62)	0.94 (58)
Cone Upper (PRH-13CU)	24	16 June (6/07-6/25; 22)	2.70 (1-4; 23)	26.2% (65)	0.71 (0-3, 24)	0.42 (10)
PRH-14A	15	10 May (4/22-5/28; 15)	3.27 (3-4; 15)	75.5% (49)	2.47 (2-3, 15)	1.00 (15)
PRH-14E	20	15 May (4/29-6/20; 20)	2.80 (1-4; 20)	55.4% (56)	1.55 (0-4, 20)	0.85 (17)
Total - Point Reyes	129	21 May (4/22-6/25; 123)	2.94 (1-4; 125)	60.2% (384)	1.79 (0-4, 129)	0.81 (105)
Devil's Slide Rock and Mainland						
Devil's Slide Rock (DSR-01)	5	30 May (5/15-6/24; 5)	2.40 (2-4; 5)	20% (5)	0.20 (5)	0.20 (5)
South of Turtlehead Cliffs (DSR-05C)	1	10 May (1)	3.00 (1)	100% (1)	2.00 (1)	2.00 (1)
Turtlehead (DSR-05B)	51	18 May (4/28-6/14; 51)	1.94 (1-4; 51)	17.3% (52)	0.17 (52)	0.35 (52)
Mainland South (DSR-05ALOWER)	23	29 May (5/20-6/15; 23)	3.08 (2-4; 23)	4.4% (23)	0.13 (23)	0.13 (23)
Mainland South (DSR-05AUPPER)	1	7 May (1)	3.00 (1)	100% (1)	3.00 (1)	3.00 (1)
Total – Devil's Slide	81	22 May (4/28-6/24; 81)	2.32 (1-4; 81)	15.9% (82)	0.16 (82)	0.32 (82)
Castle Rocks and Mainland						
CRM-06AN	4	15 May (5/11-5/21; 4)	3.00 (4)	66.6% (12)	2.00 (0-3; 4)	0.75 (4)

[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 15. Peak counts of nests (Black Oystercatcher and Western Gull) and of birds (Pigeon Guillemot), from land, boat, and combined land/boat counts (Total), in 2015.

Species	Colony	Land[1]	Boat[2]	Total Count[3]
Black Oystercatcher	Point Reyes Headlands	3	-	3
	Point Resistance	0	-	0
	Miller's Point Rocks	1	-	1
	Double Point Rocks	2	-	2
	Devil's Slide Rock & Mainland	0	0	0
	Bench Mark-227X	0	-	0
	Castle Rocks & Mainland	2	-	2
	Hurricane Point Rocks	1	-	1
Western Gull	Point Reyes Headlands	87	-	87
	Point Resistance	0	-	0
	Miller's Point Rocks	8	-	8
	Double Point Rocks	5	-	5
	San Pedro Rock	0	3	3
	Devil's Slide Rock & Mainland	9	0	9
	Bench Mark-227X	3	-	3
	Castle Rocks & Mainland	14	-	14
	Hurricane Point Rocks	3	-	3
Pigeon Guillemot	Point Reyes Headlands[4]	145	-	145
	Point Resistance	25	-	25
	Miller's Point Rocks	34	-	34
	Double Point Rocks	51	-	51
	Devil's Slide Colony Complex	170	49	219
	Castle-Hurricane Colony Complex[5]	28	-	28

[1] Sum of peak seasonal counts at each subcolony.
[2] In several cases, Black Oystercatcher and Western Gull nests were counted only if they could not be seen from mainland vantage points. A dash indicates that a boat survey was not conducted.
[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.

Table 16. Productivity of Pelagic Cormorants, Black Oystercatchers, and Western Gulls at Devil's Slide Rock and Mainland (DSRM), and Castle-Hurricane Colony Complex (CHCC), 2015. 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]
DSRM	16	7	0.44 (2-3; 16)	0.19 (16)	-	-	-	-	3	0	0.00	0
CHCC	-	-	-	-	2	0	0.00 (2)	0.00 (2)	13	7	0.54 (0-2; 13)	0.31 (13)

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

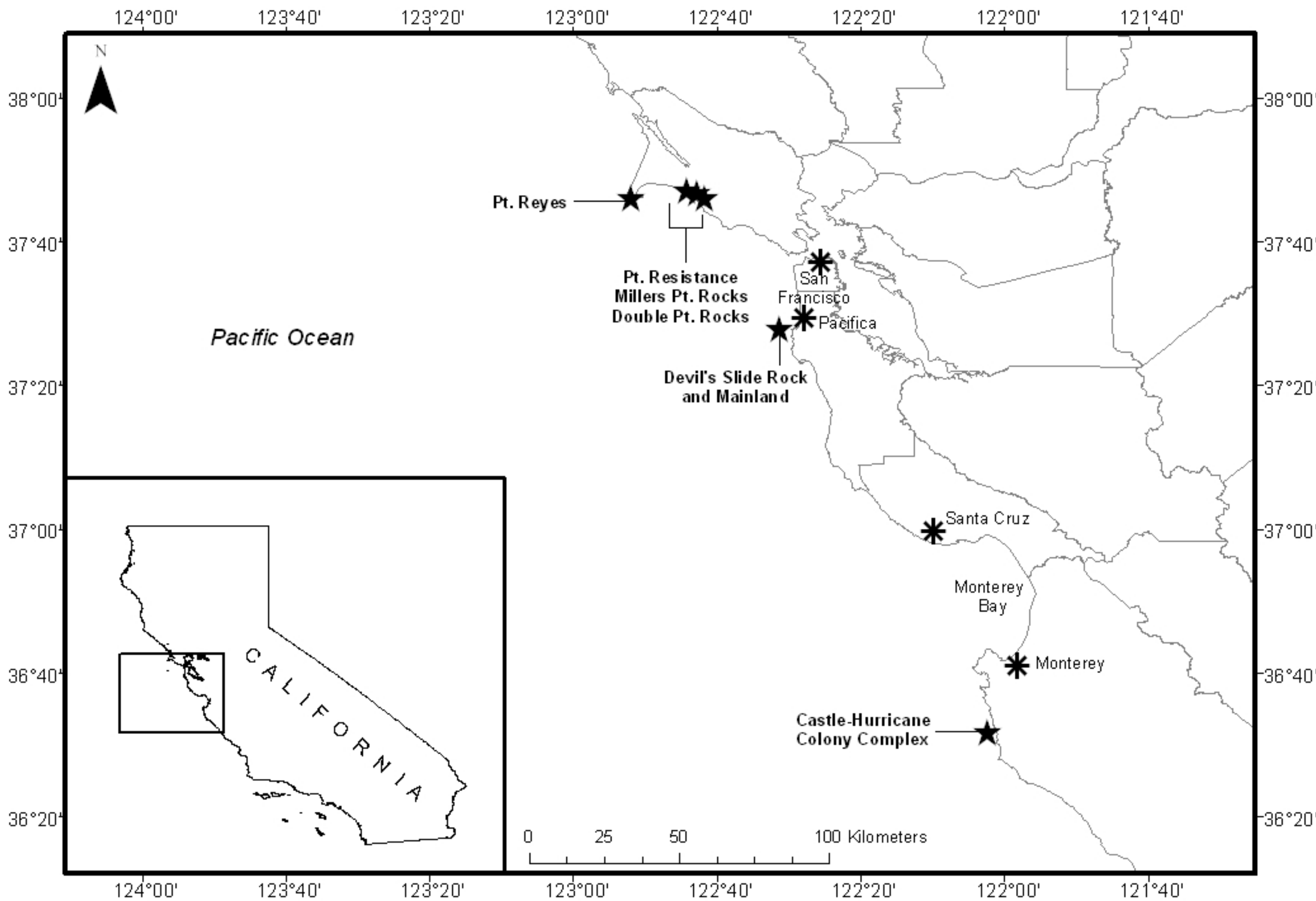


Figure 1. Study area showing locations of study colonies or colony complexes along the Central California coast where seabird disturbance, attendance and breeding biology are monitored.

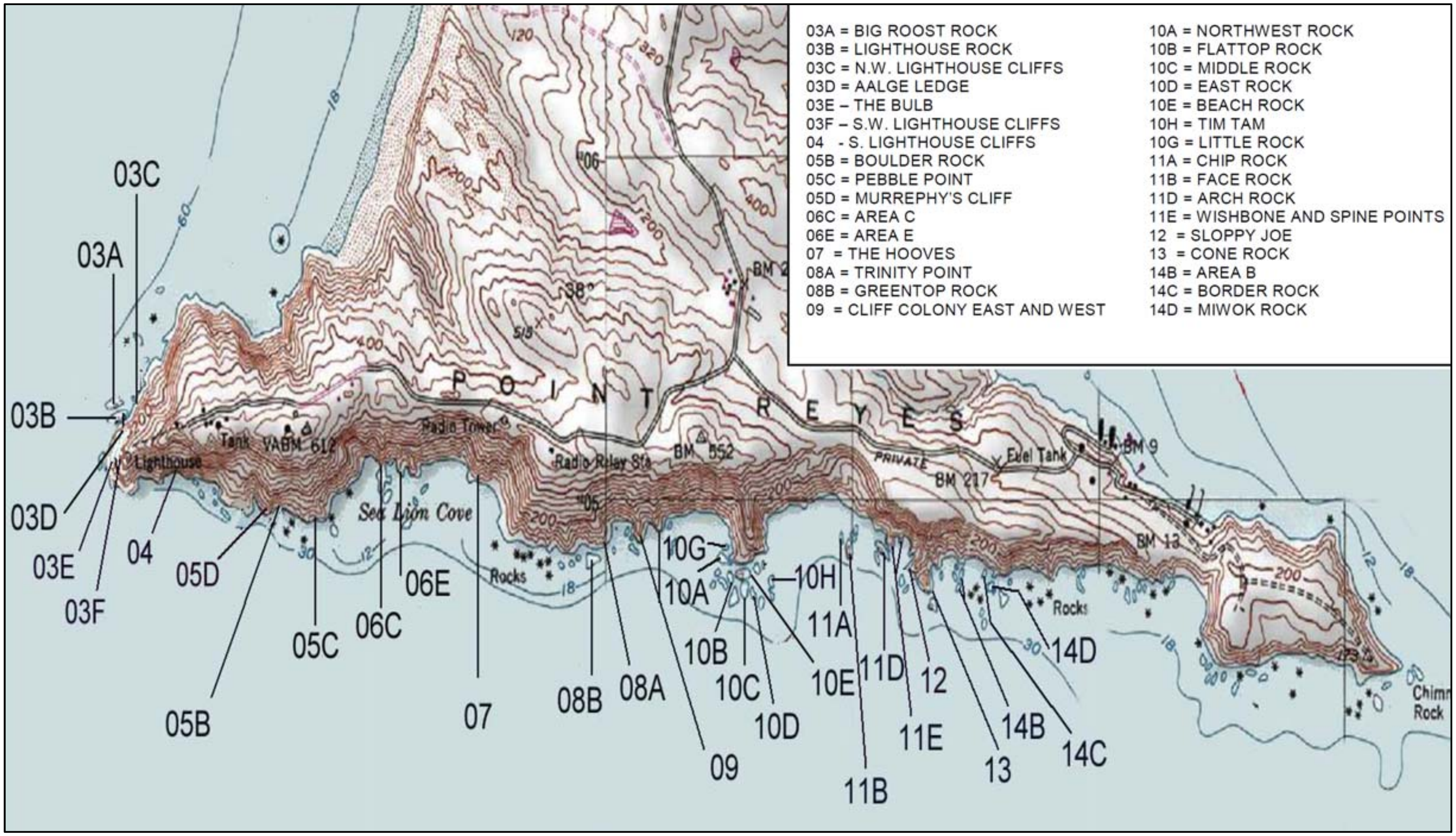


Figure 2. Point Reyes Headlands, including subcolonies 03A through 14D.

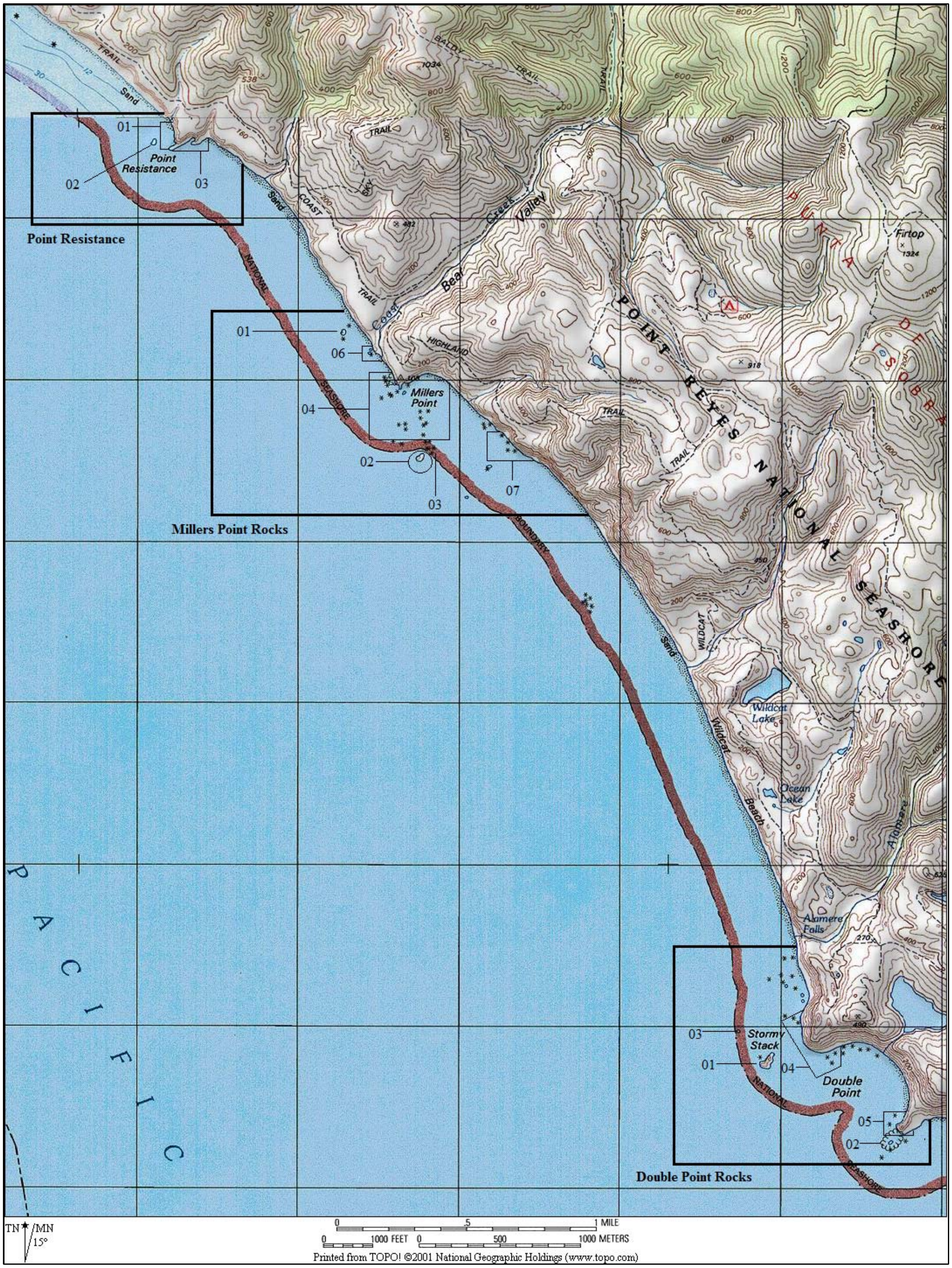


Figure 3. Drakes Bay Colony Complex, including Point Resistance, Millers Point Rocks and Double Point Rocks colonies and subcolonies.

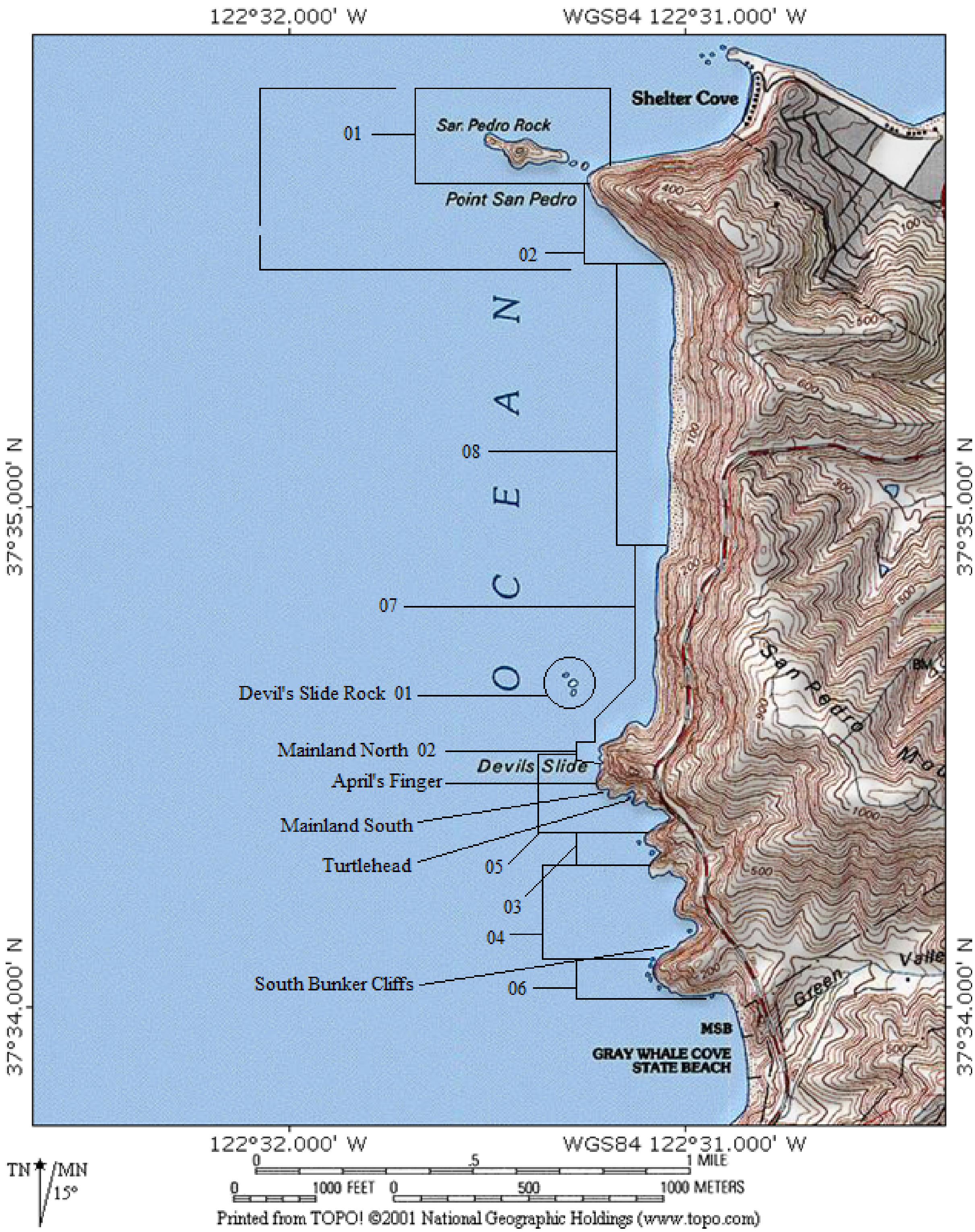


Figure 4. Devil's Slide Colony Complex, including San Pedro Rock and Devil's Slide Rock & Mainland colonies and subcolonies.

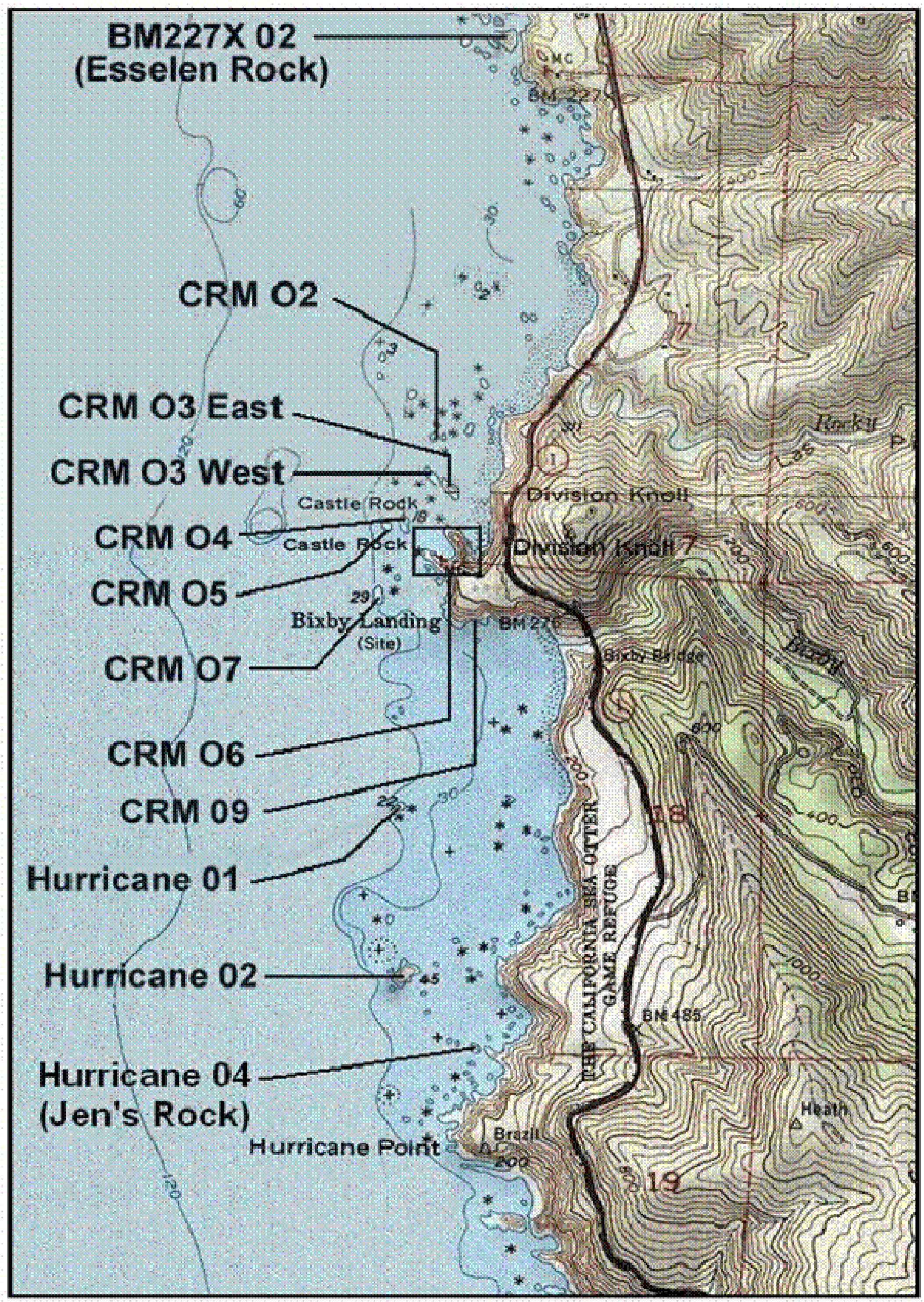


Figure 5. Castle-Hurricane Colony Complex, including Bench Mark-227X (BM227X), Castle Rocks and Mainland (CRM), and Hurricane Point Rocks (Hurricane) colonies and subcolonies.

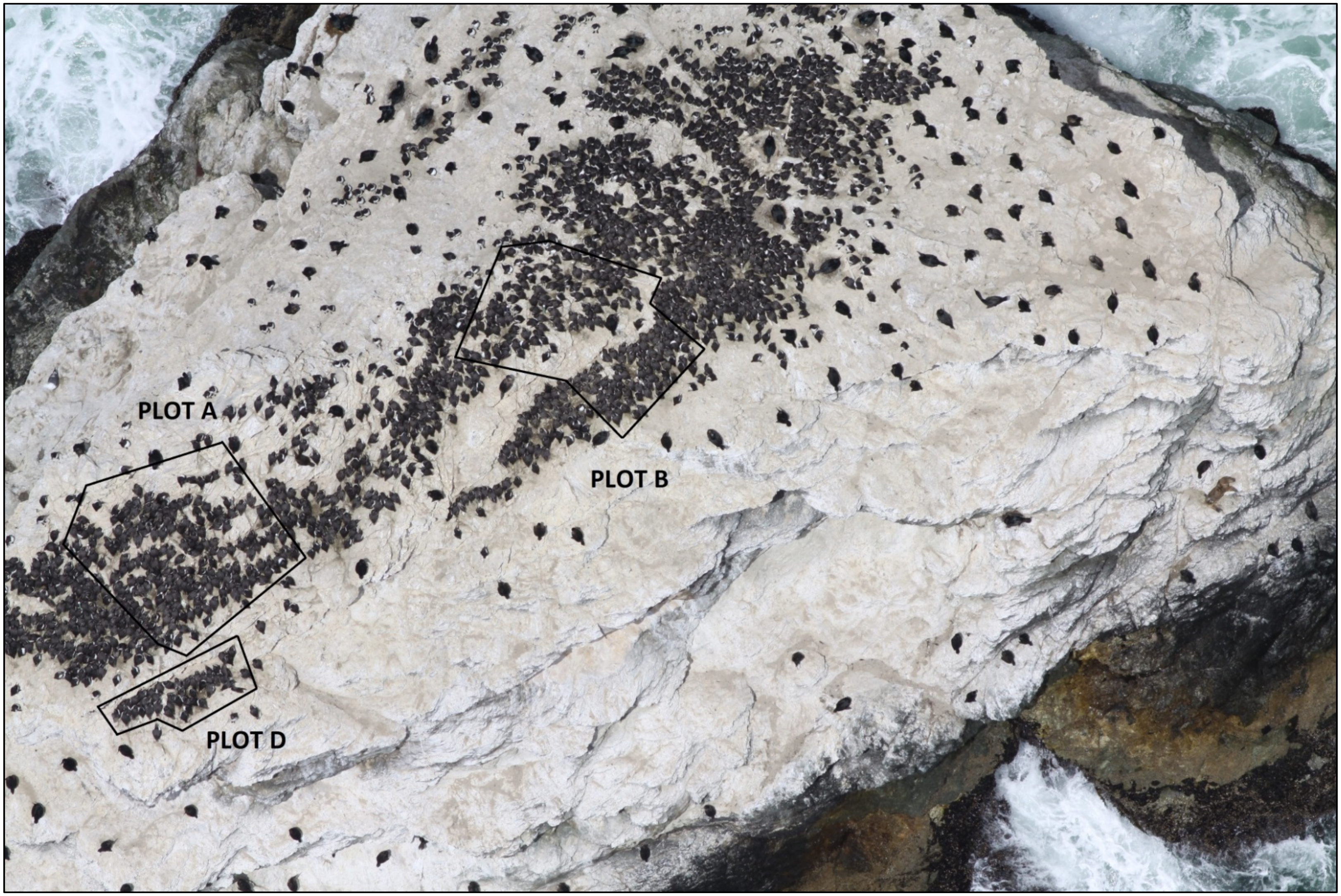


Figure 6. Aerial photograph of Devil's Slide Rock, 3 June 2015 (by P. Capitolo), showing the distribution of the Common Murre and Brandt's Cormorant breeding colony and boundaries of murre productivity plots.

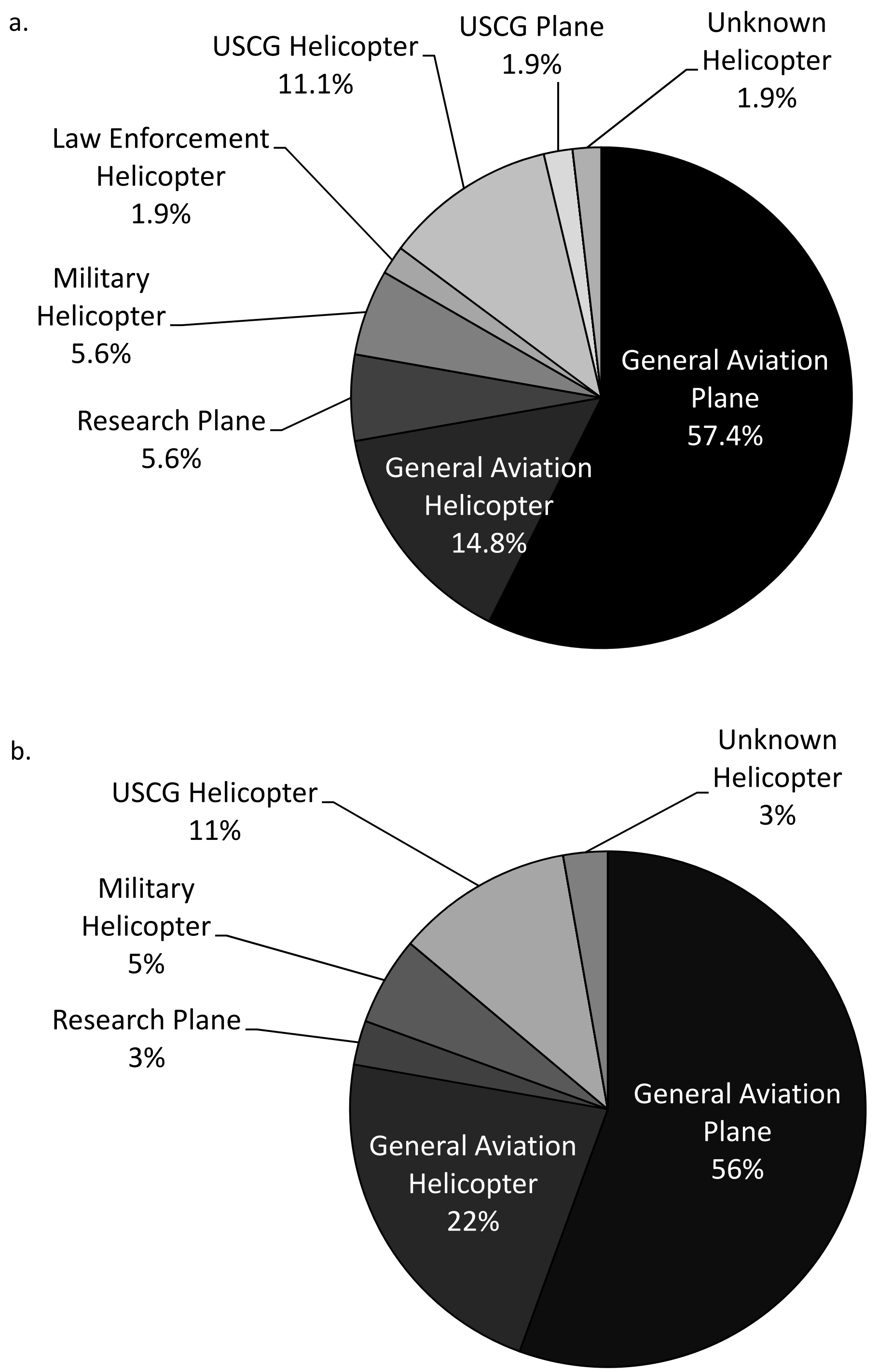


Figure 7. a. Aircraft detections (n = 53) and b. aircraft disturbances (n = 36) at Point Reyes, Drakes Bay, Devil's Slide Rock and Mainland and Castle Hurricane Colony Complex combined in 2015, categorized by type.

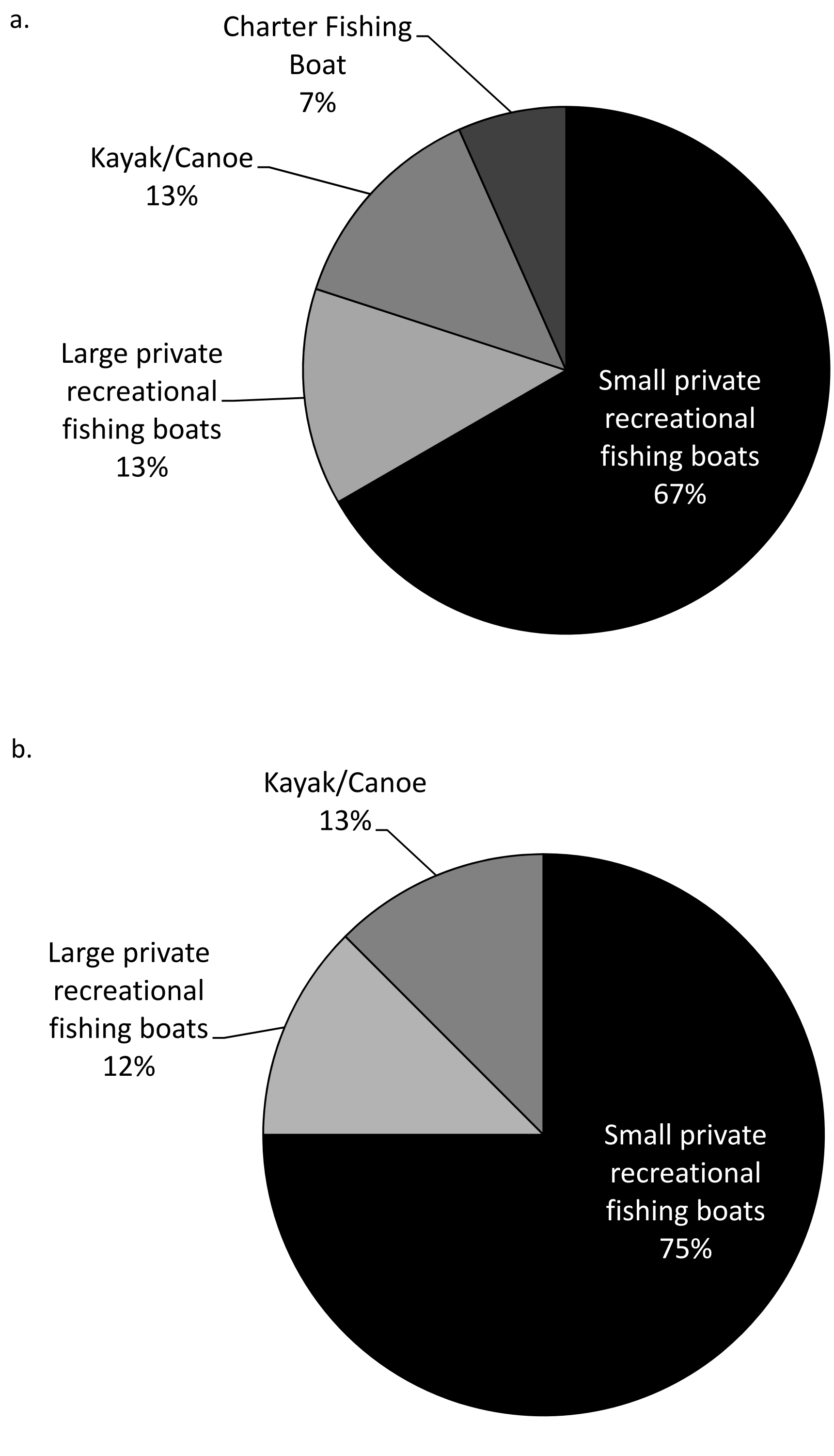
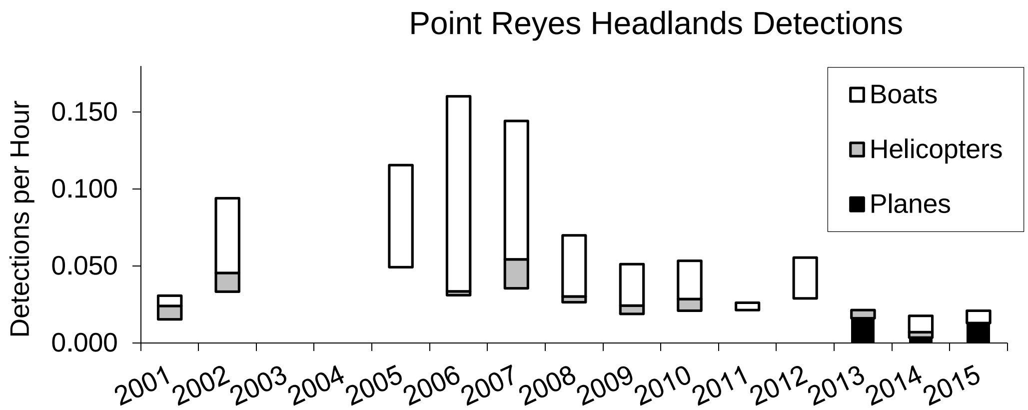
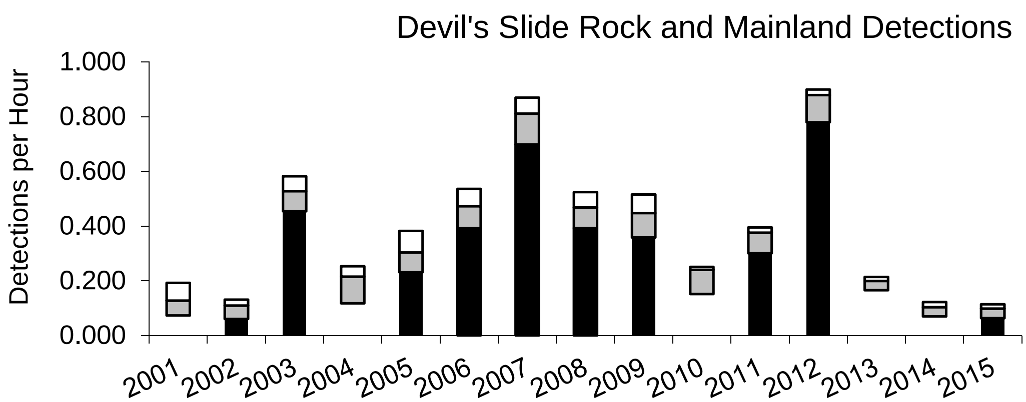


Figure 8. a. Watercraft detections (n = 15) and b. watercraft disturbances (n = 8) at Point Reyes, Drakes Bay, Devil's Slide Rock and Mainland and Castle Hurricane Colony Complex combined in 2015, categorized by type.





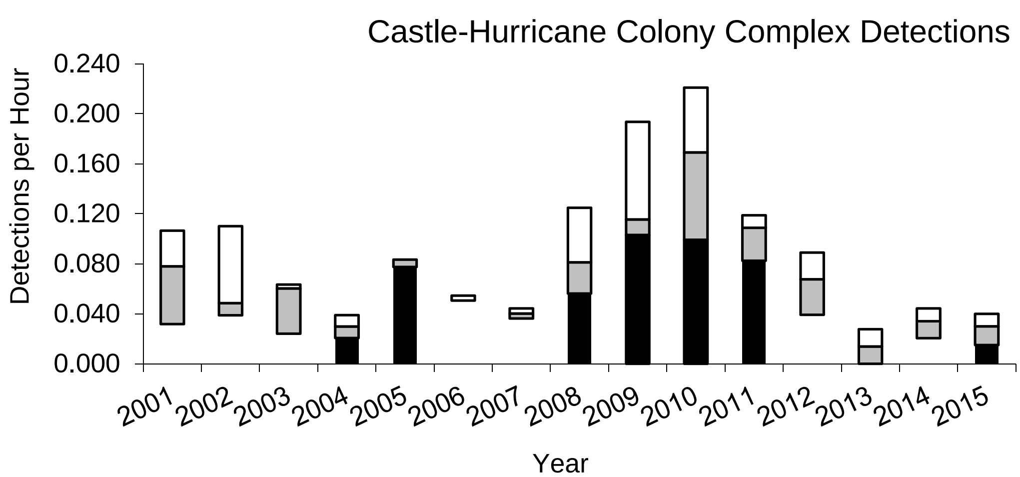


Figure 9. Detection rates (number of detections per observation hour) of boats, helicopters and planes at Point Reyes Headlands, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex, 2001 to 2015.

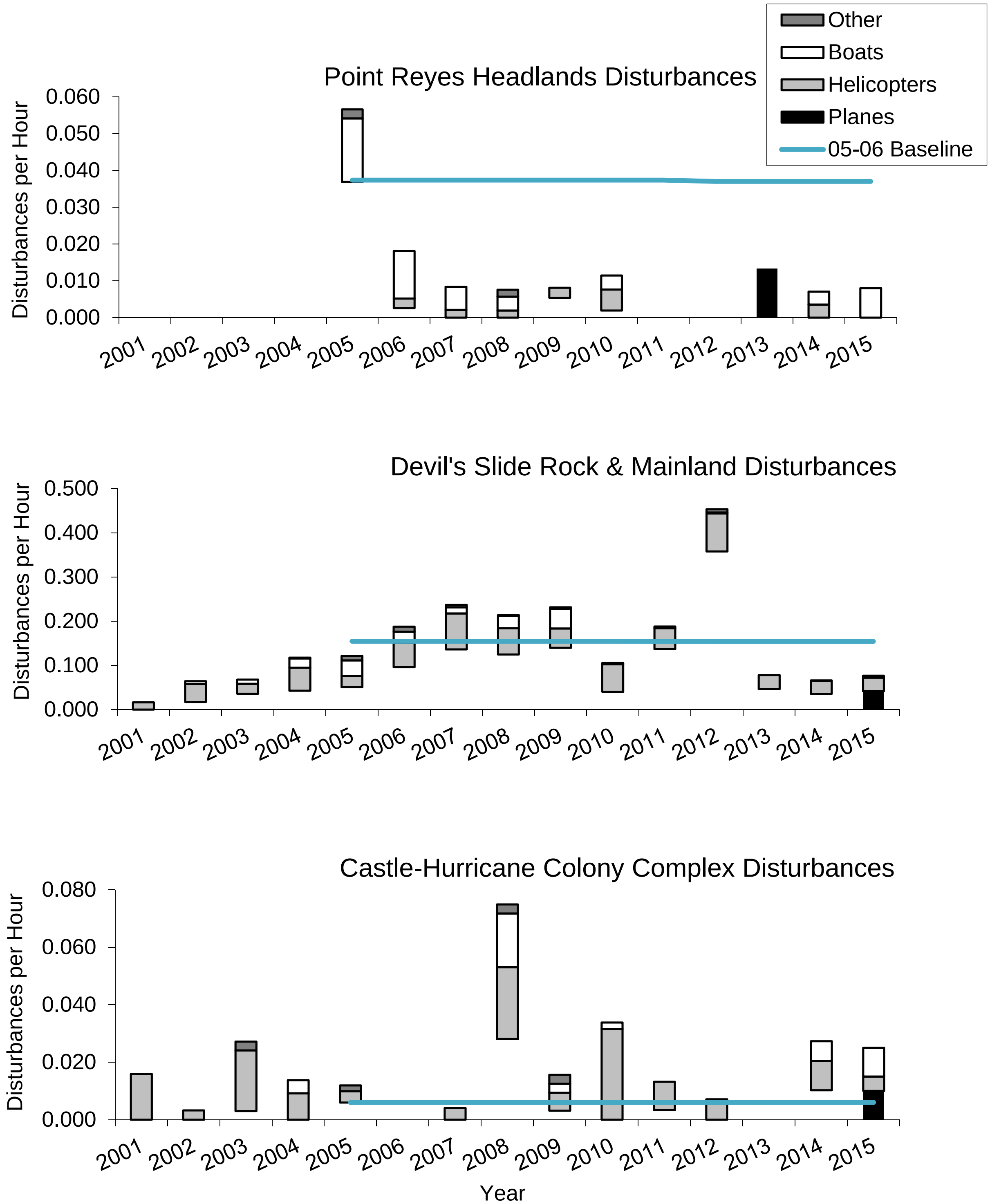


Figure 10. Disturbance rates (number of seabird disturbances per observation hour) from boats, helicopters, planes, and other anthropogenic sources at Point Reyes Headlands, Devil's Slide Rock and Mainland and Castle-Hurricane Colony Complex from 2001 to 2015. The horizontal line indicates the baseline mean disturbance rate from 2005 to 2006.

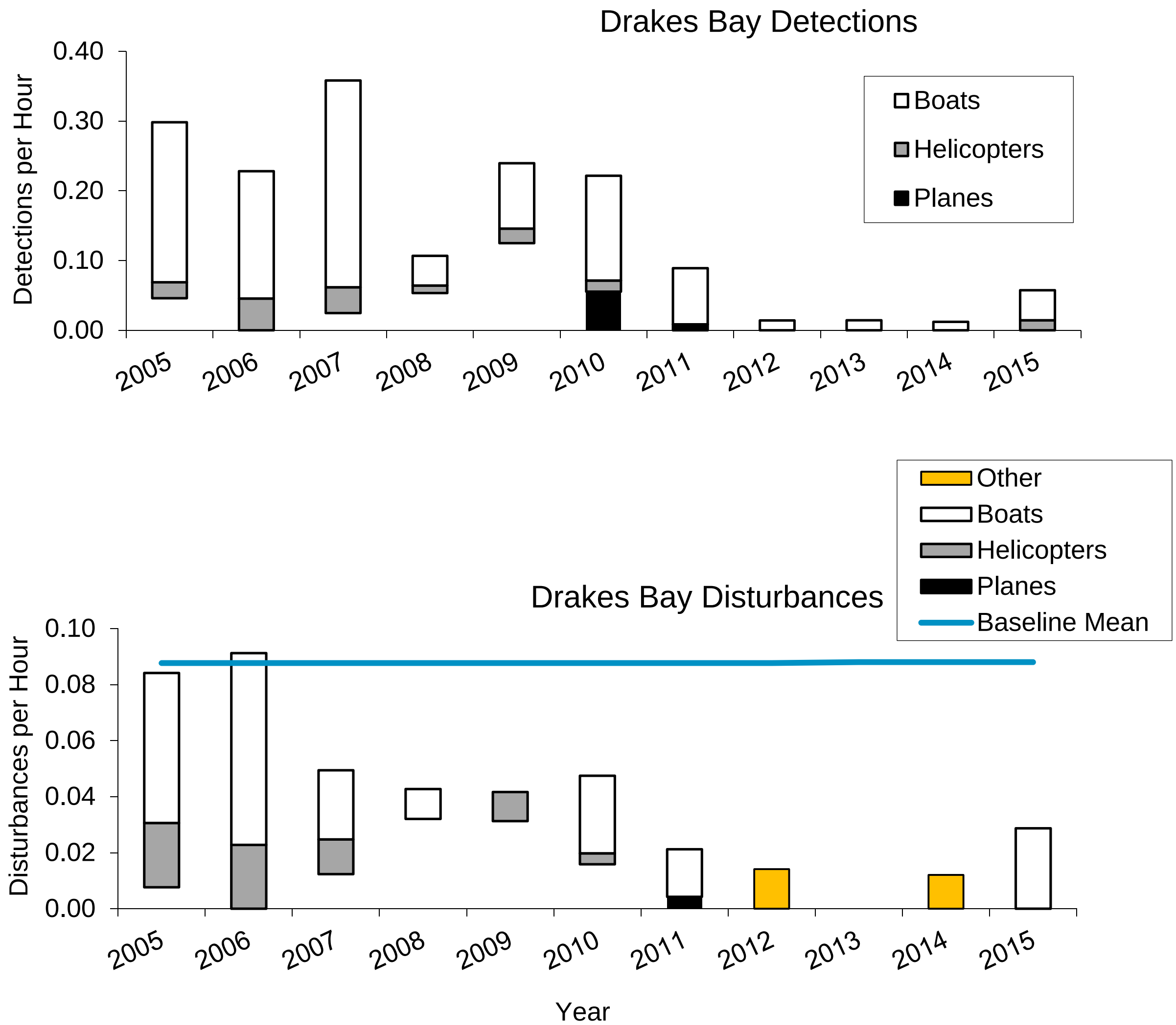


Figure 11. Detection and disturbance rates of boats, helicopters, planes and other anthropogenic sources (disturbances only) at Drakes Bay Colony Complex from 2005 to 2015. The horizontal line indicates the baseline mean disturbance rate from 2005 to 2006.

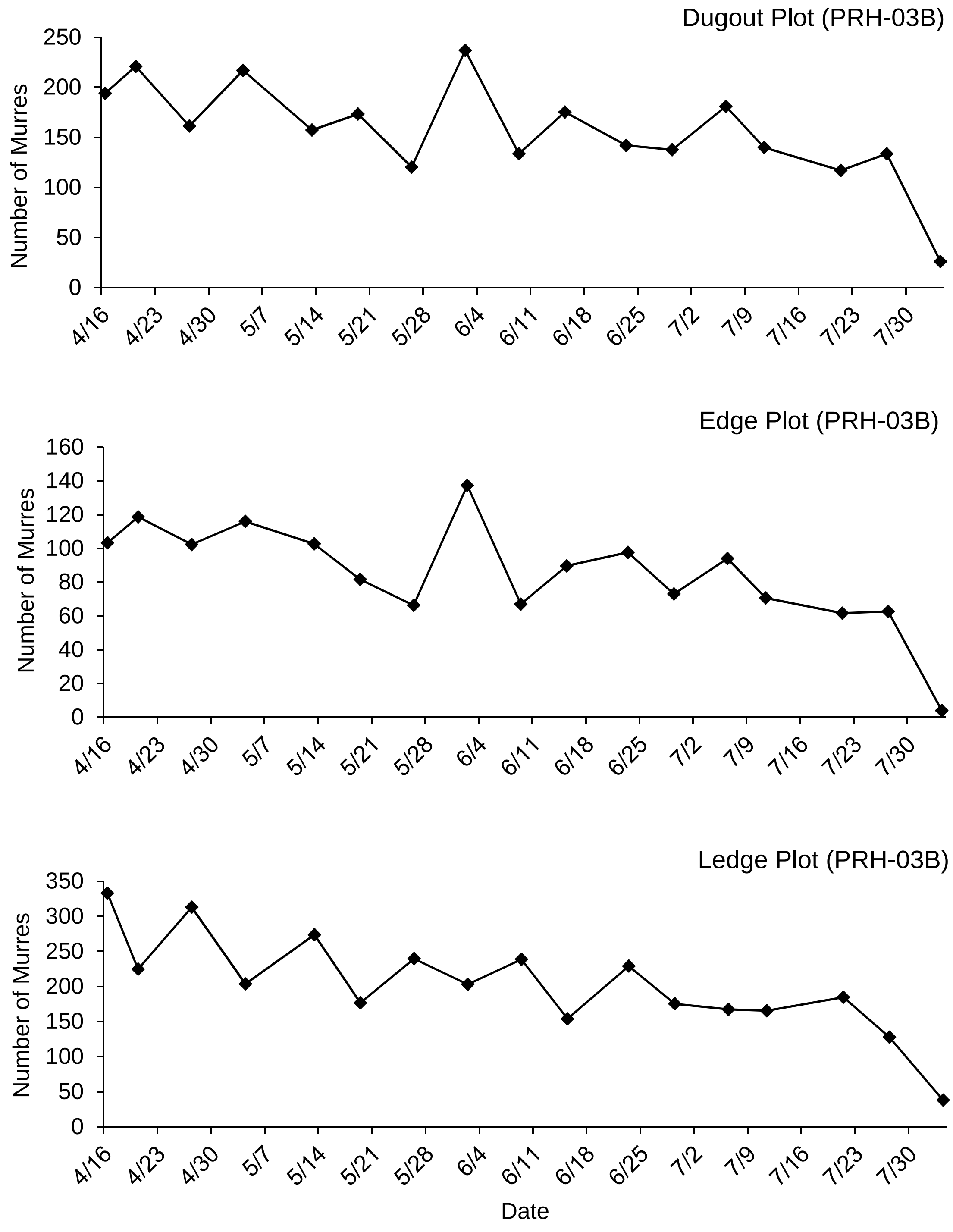


Figure 12. Seasonal attendance of Common Murres at Dugout, Ledge and Edge plots; Point Reyes Headlands, 16 April to 3 August, 2015.

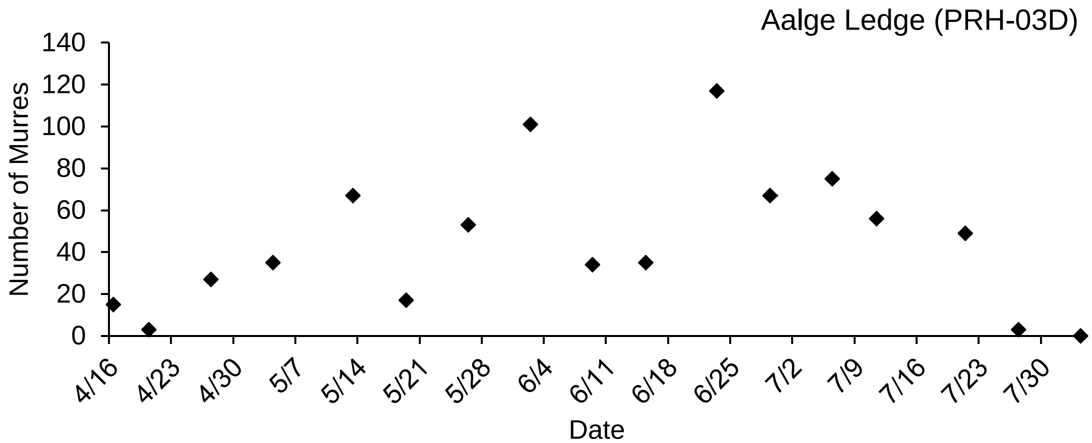


Figure 13. Seasonal attendance of Common Murres at Aalge Ledge; Point Reyes Headlands, 16 April to 3 August, 2015.

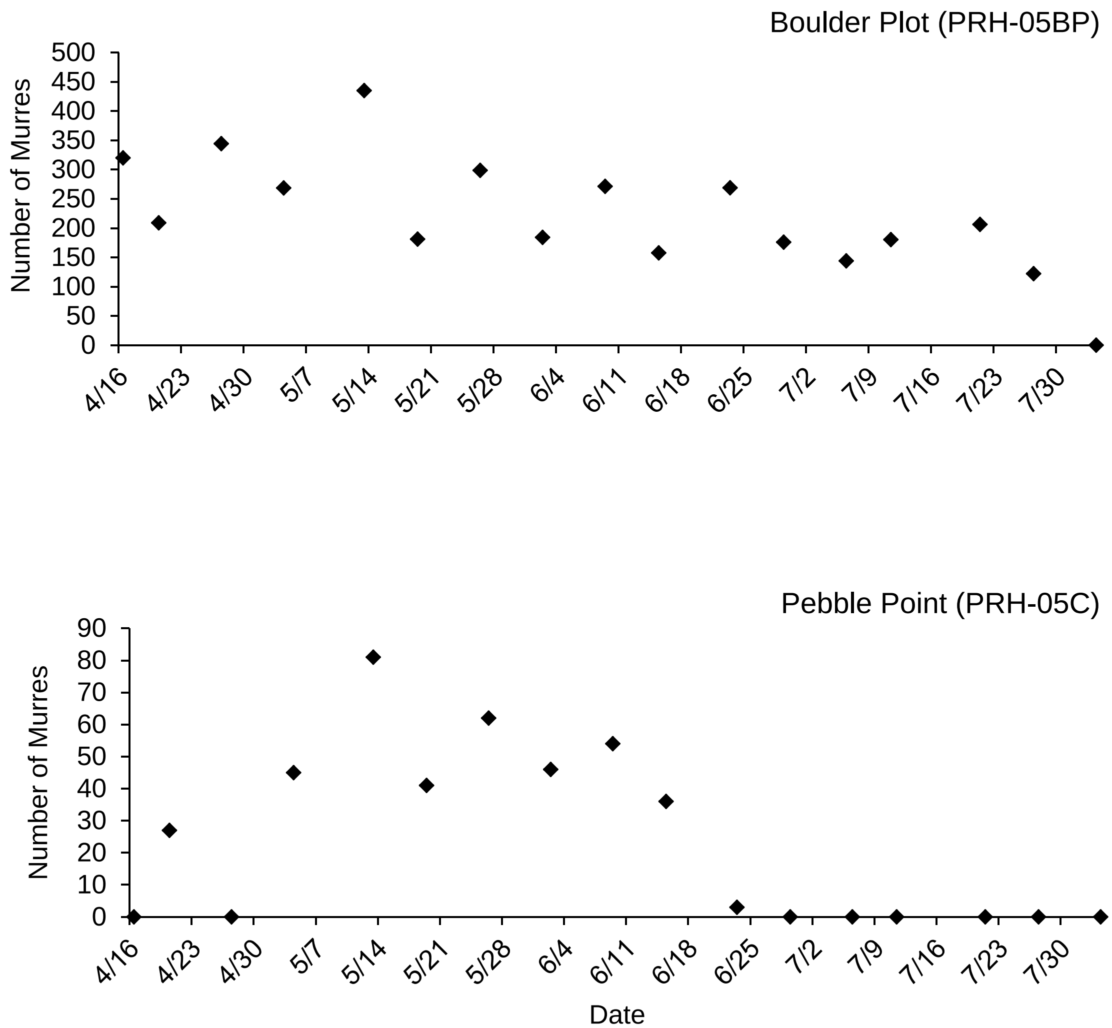


Figure 14. Seasonal attendance of Common Murres at Boulder Plot and Pebble Point; Point Reyes Headlands, 16 April to 3 August, 2015.

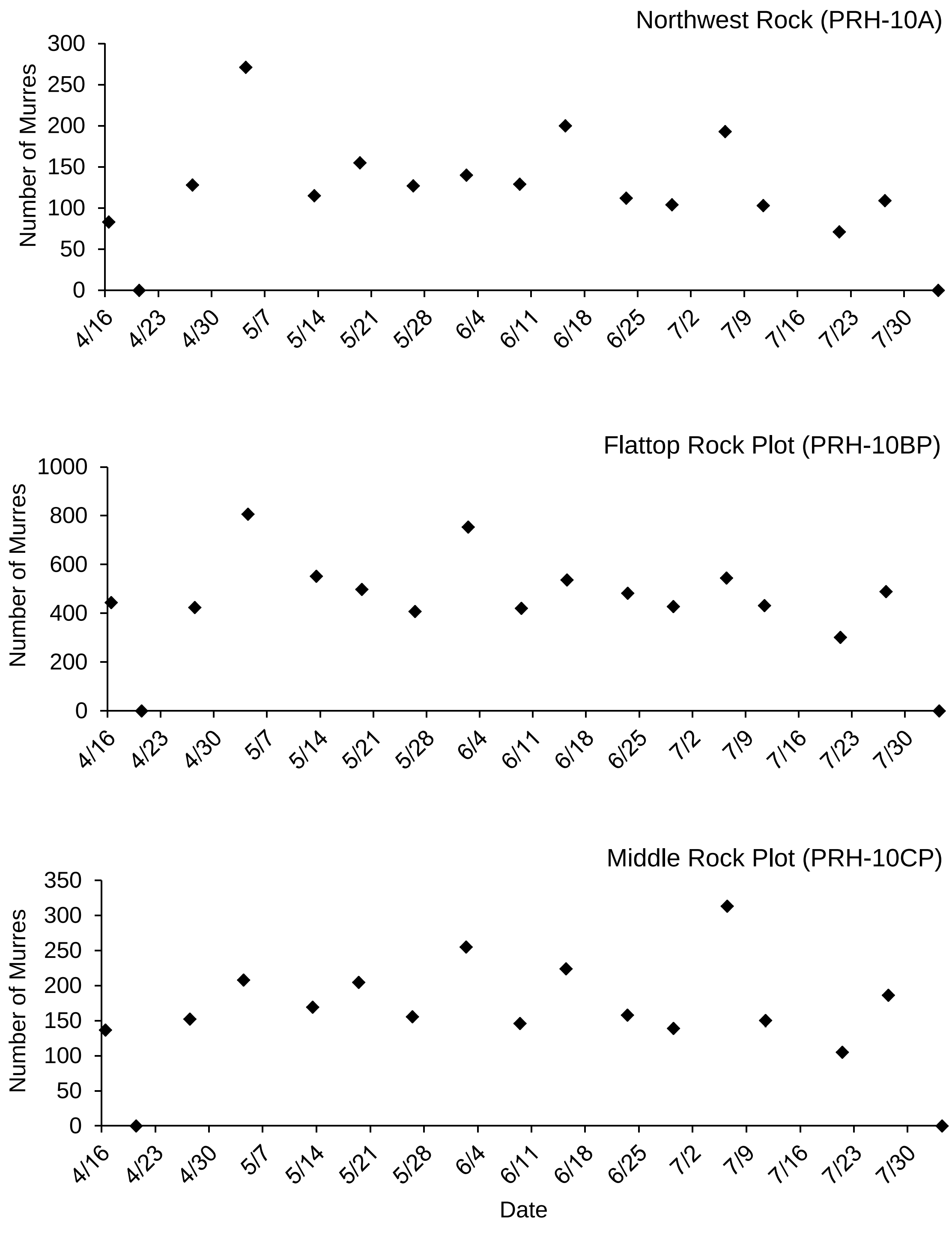
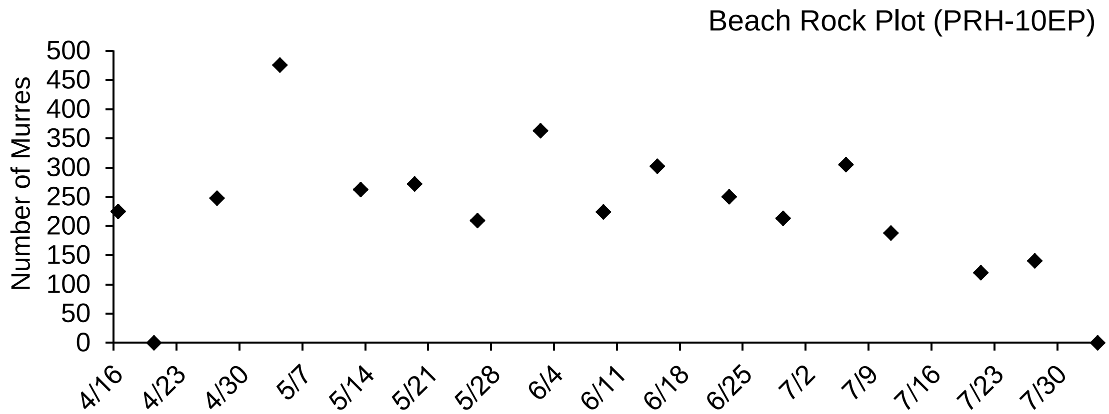


Figure 15. Seasonal attendance of Common Murres at Northwest Rock, Flattop Rock Plot, and Middle Rock Plot; Point Reyes Headlands, 16 April to 3 August, 2015.



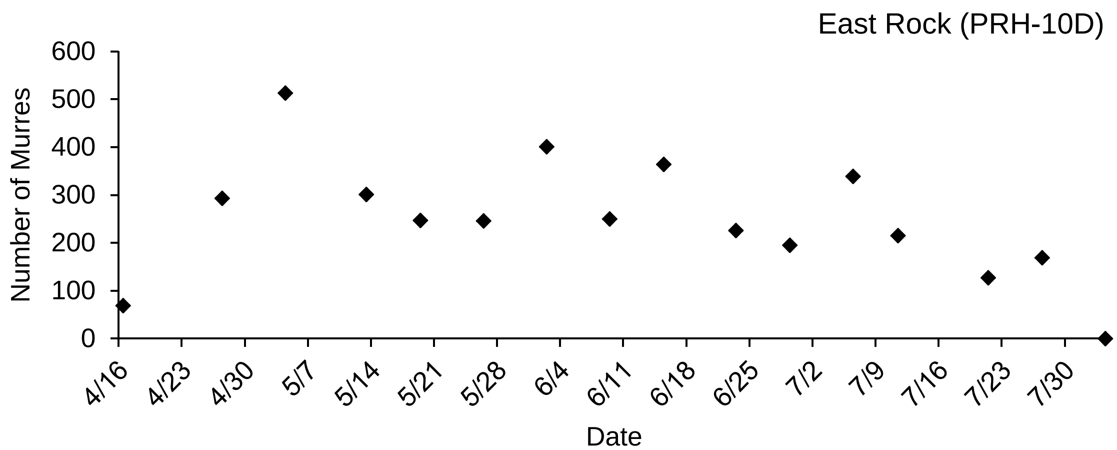


Figure 16. Seasonal attendance of Common Murres at Beach Rock Plot and East Rock; Point Reyes Headlands, 16 April to 3 August, 2015.

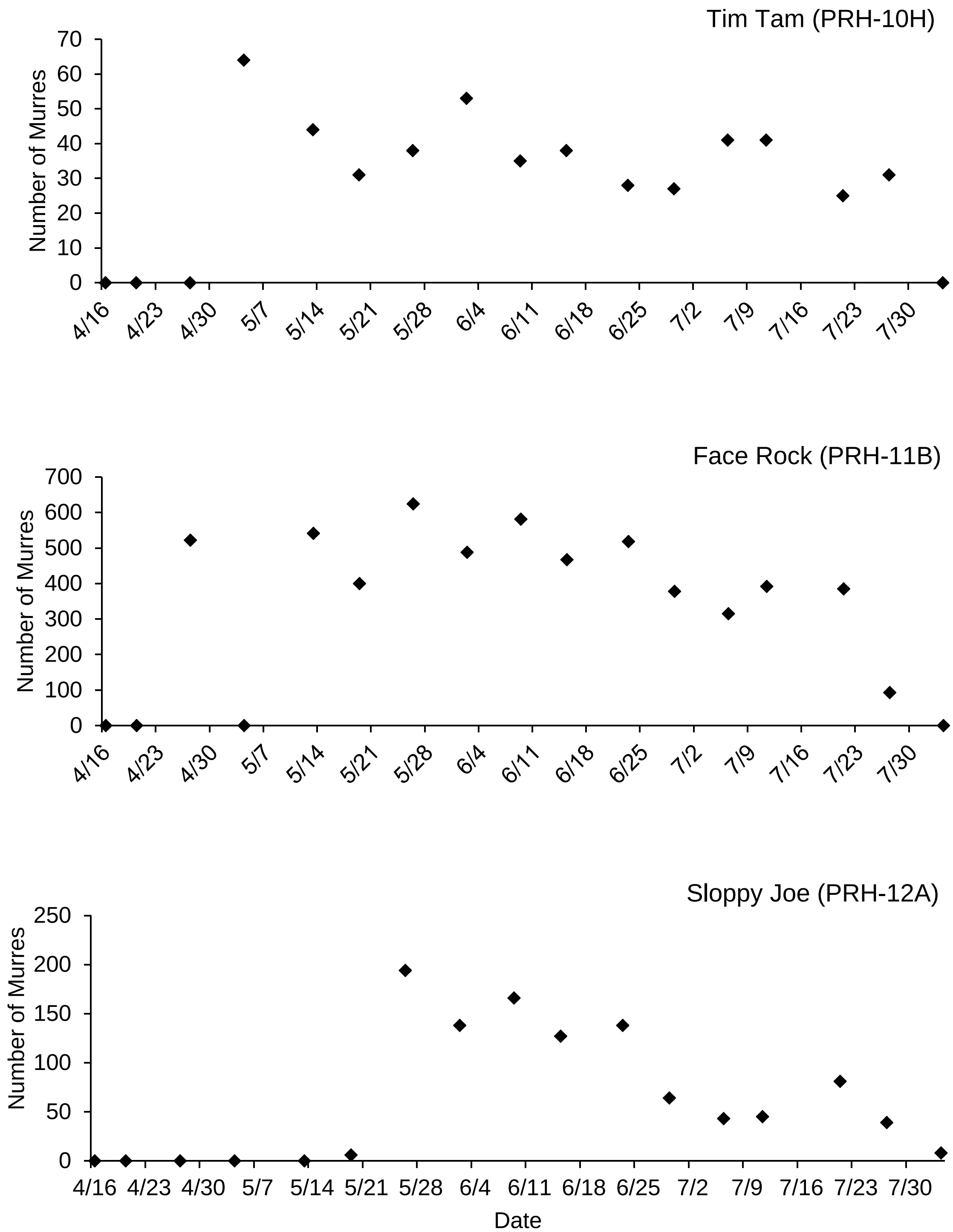


Figure 17. Seasonal attendance of Common Murres at Tim Tam, Face Rock and Sloppy Joe; Point Reyes Headlands, 16 April to 3 August, 2015.

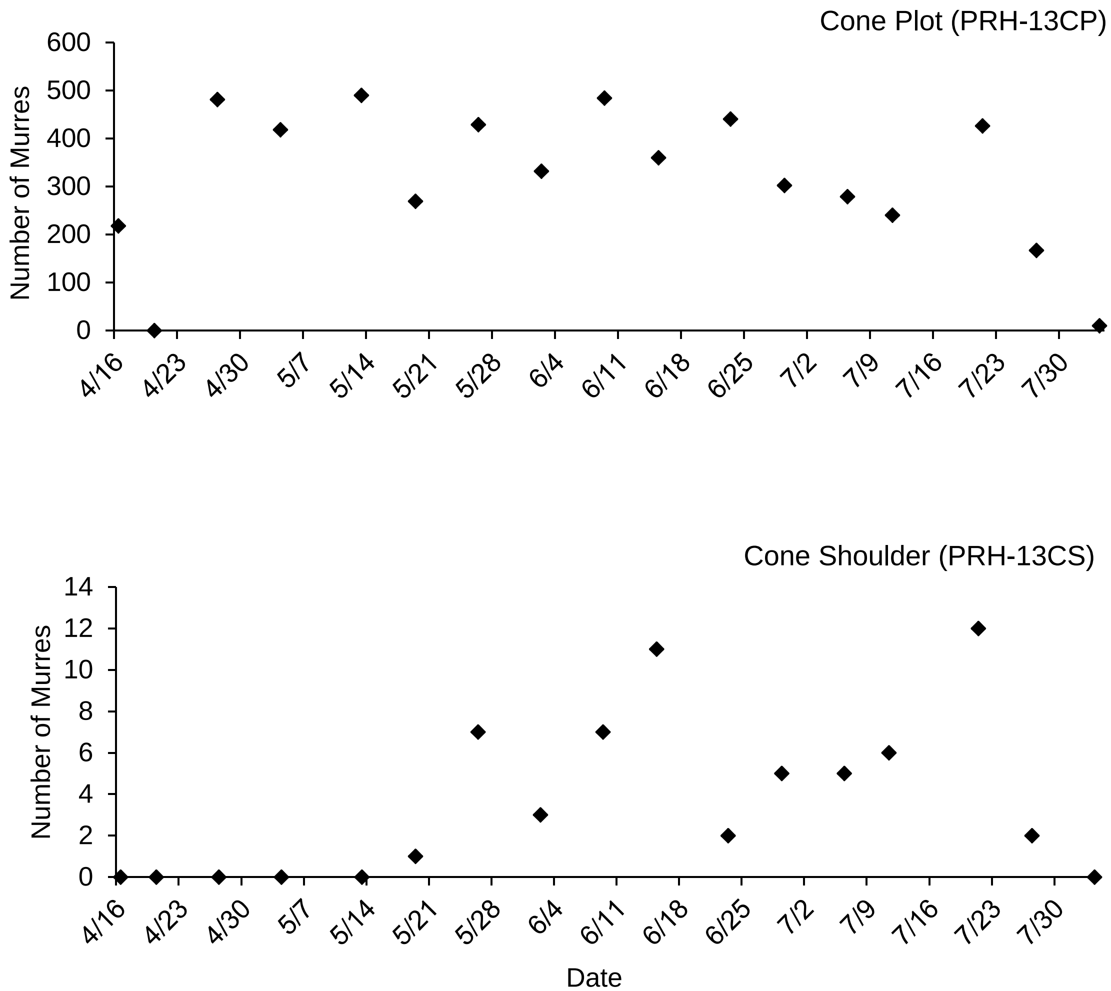


Figure 18. Seasonal attendance of Common Murres at Cone Plot and Cone Shoulder; Point Reyes Headlands, 16 April to 3 August, 2015.

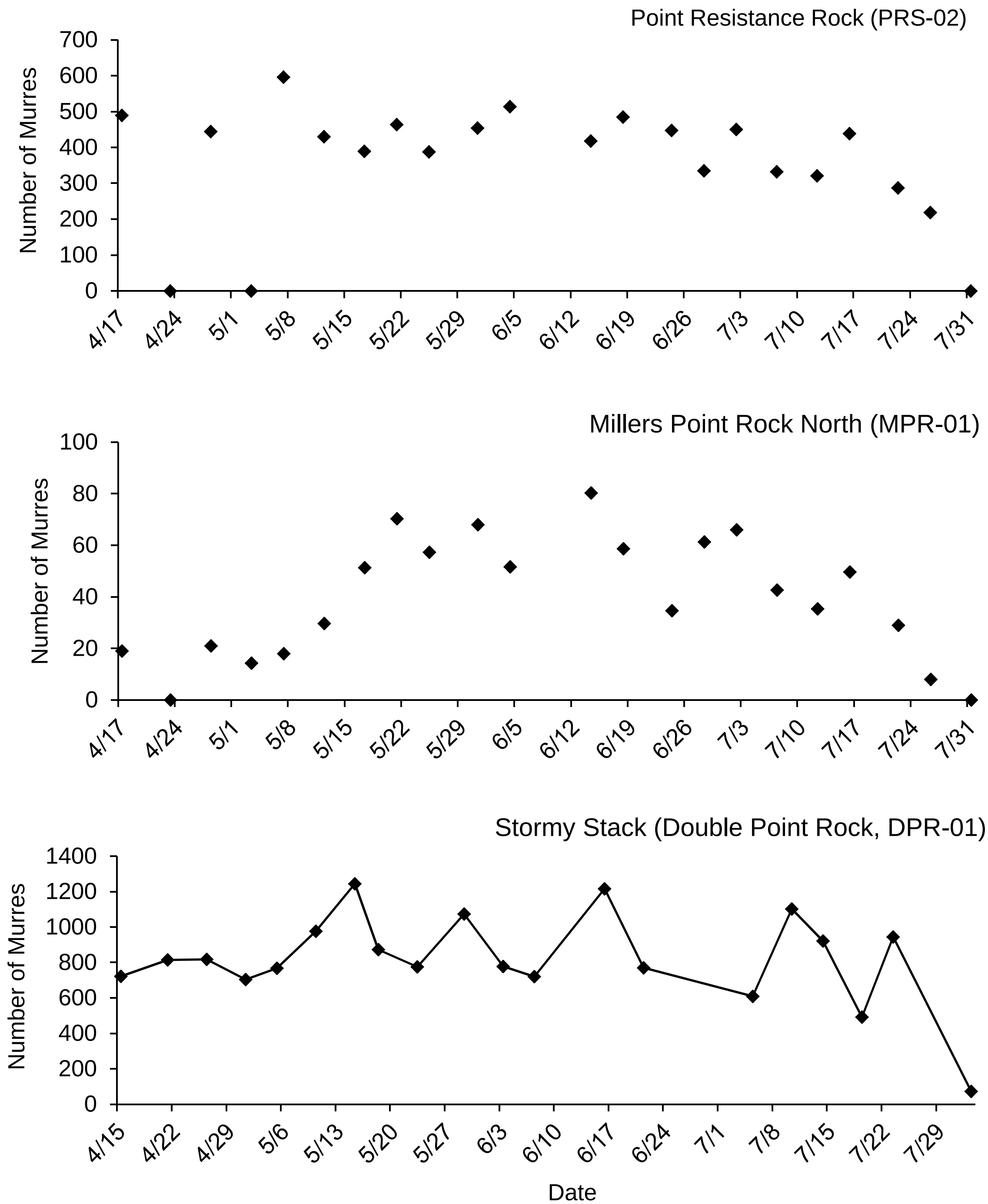


Figure 19. Seasonal attendance of Common Murres at Point Resistance, Millers Point North Rock and Stormy Stack (Double Point Rocks), 15 April to 2 August, 2015.

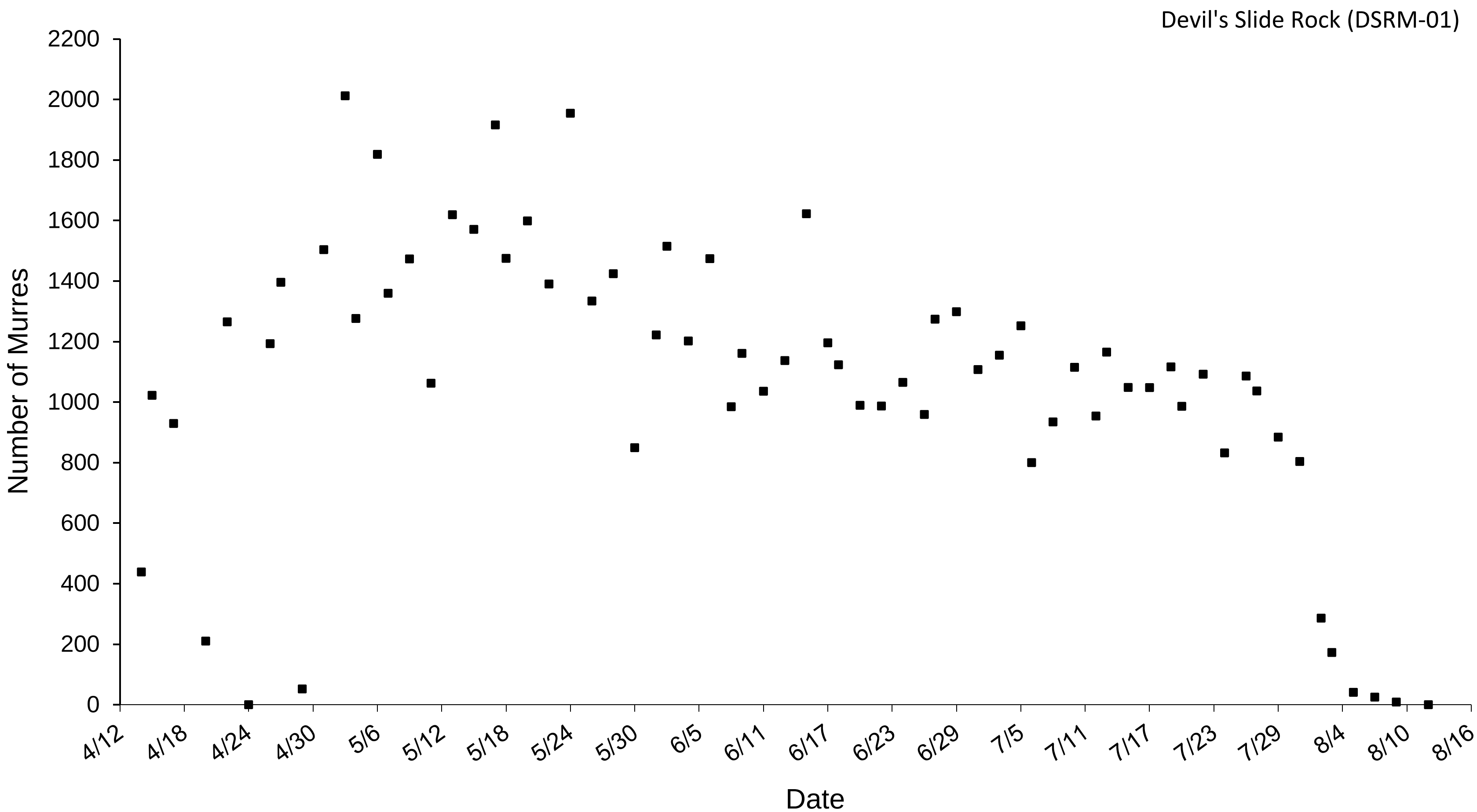


Figure 20. Seasonal attendance of Common Murres at Devil's Slide Rock, 14 April to 12 August, 2015.

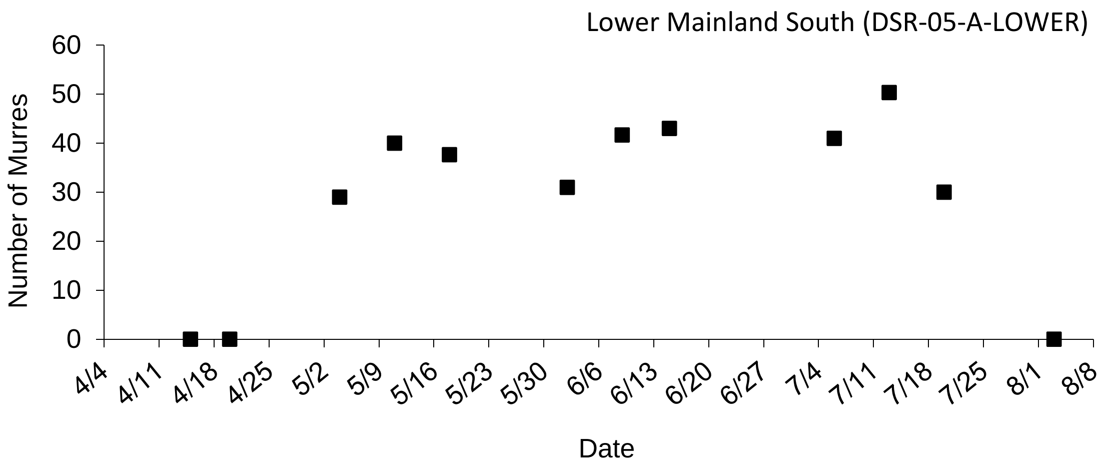


Figure 21. Seasonal attendance of Common Murres on Lower Mainland South, Devil's Slide Mainland, from 14 April to 3 August, 2015.

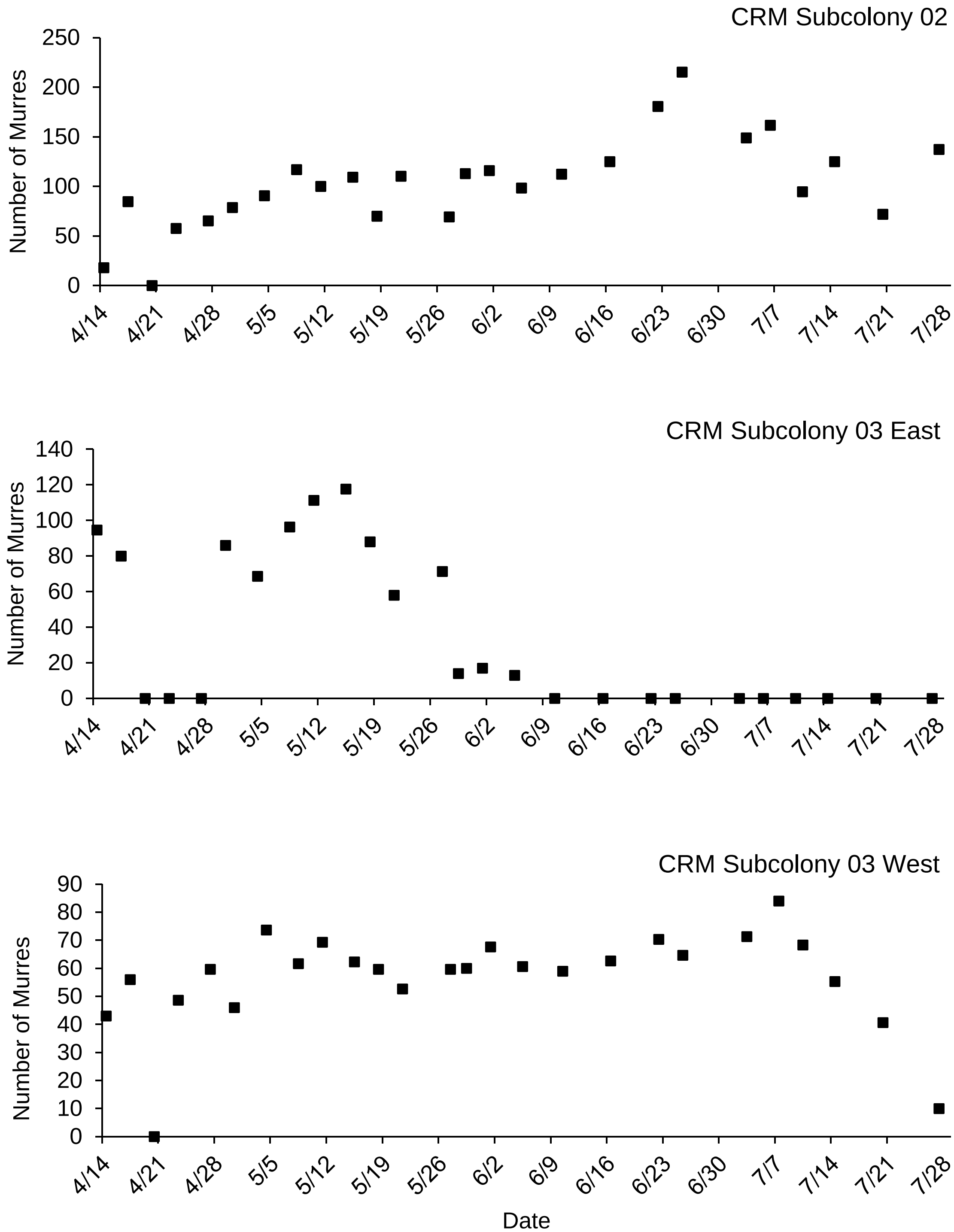


Figure 22. Seasonal attendance of Common Murres on subcolonies 02, 03 East and 03 West; Castle Hurricane Colony Complex, from 14 April to 27 July, 2015.

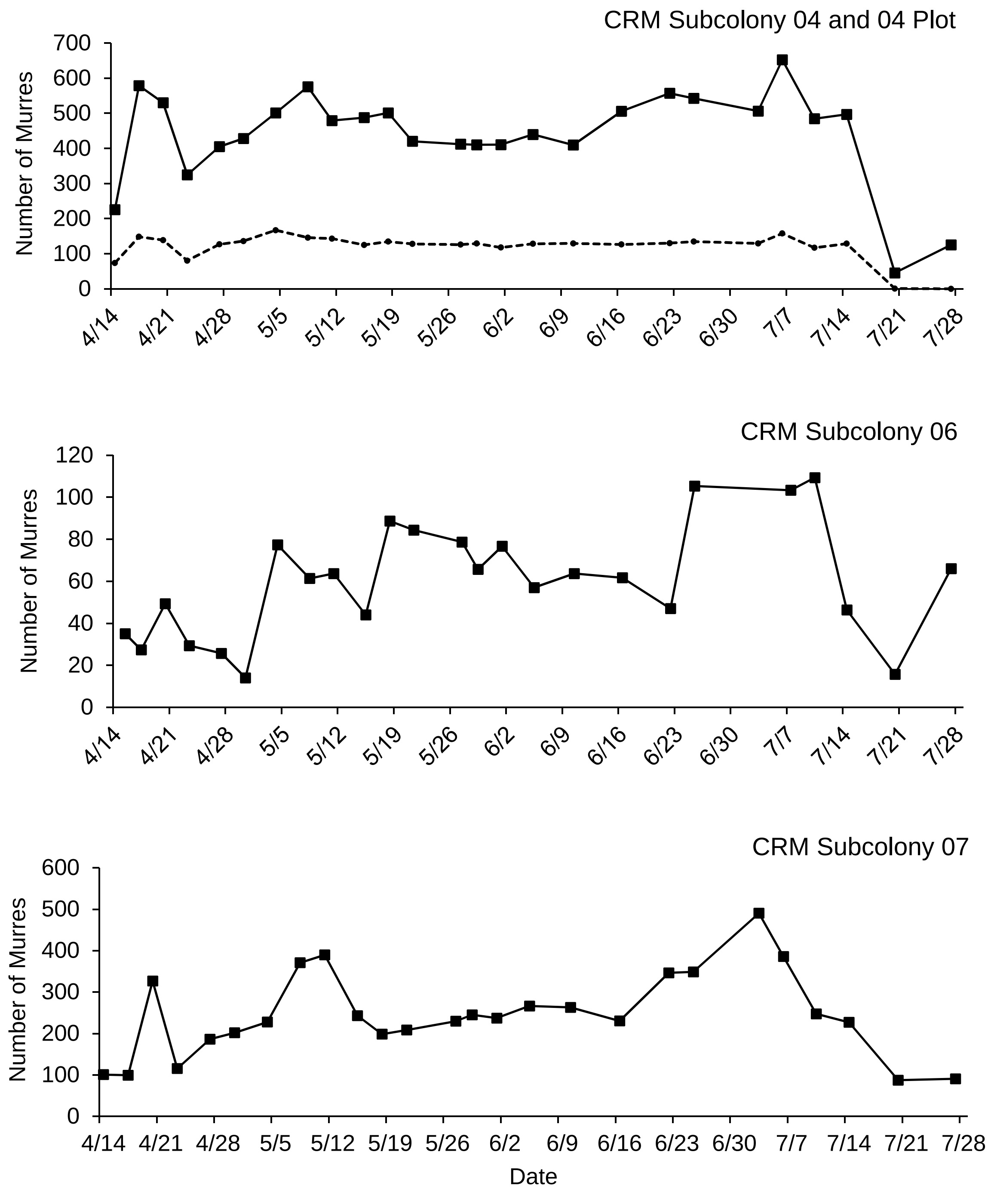


Figure 23. Seasonal attendance of Common Murres on subcolonies 04 and 04 Plot, 06 and 07; Castle Hurricane Colony Complex, from 14 April to 27 July, 2015.

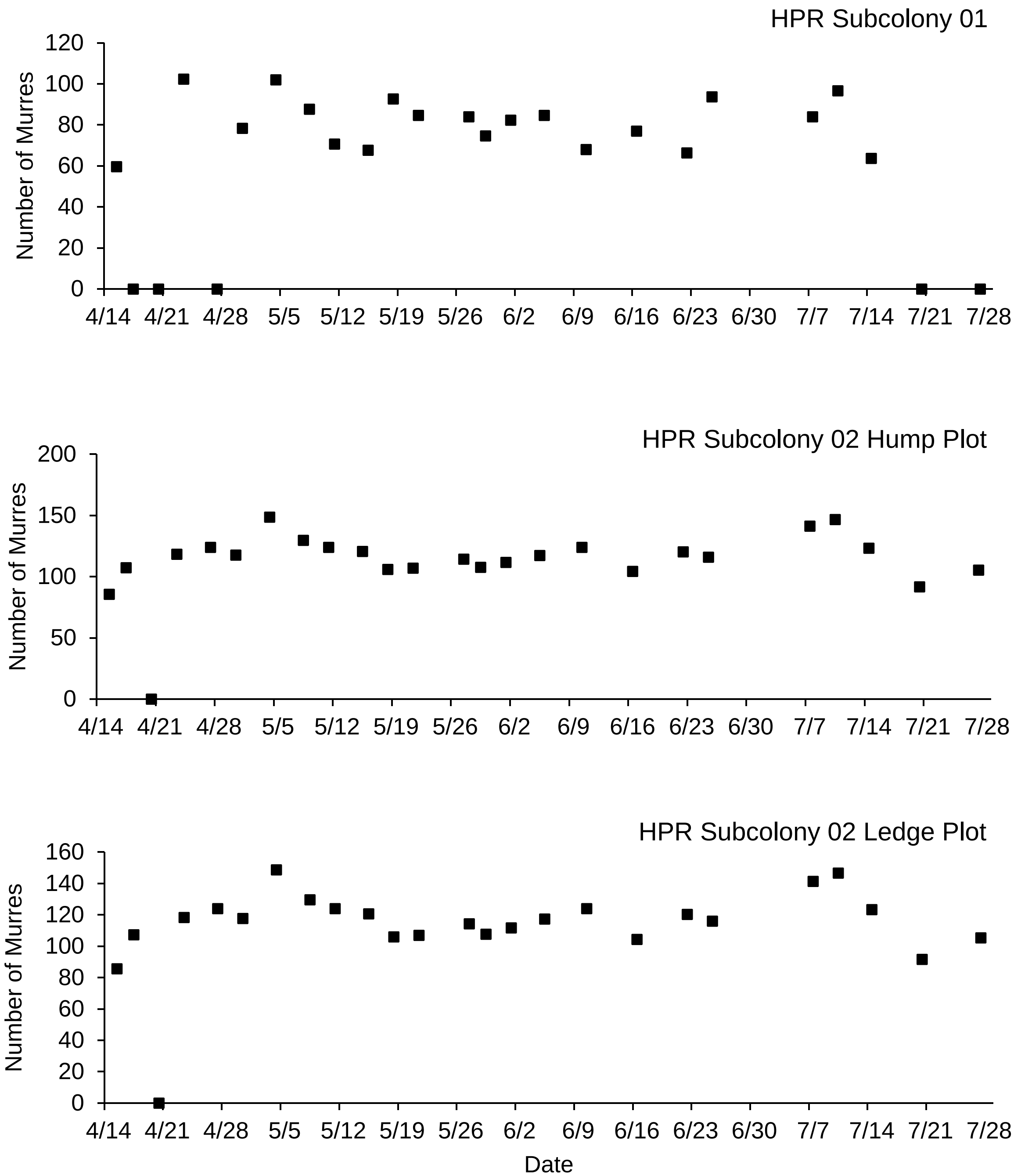


Figure 24. Seasonal attendance of Common Murres on Hurricane Point Rocks subcolonies 01, 02 Hump Plot and 02 Ledge Plot; Castle Hurricane Colony Complex, from 14 April to 27 July, 2015.

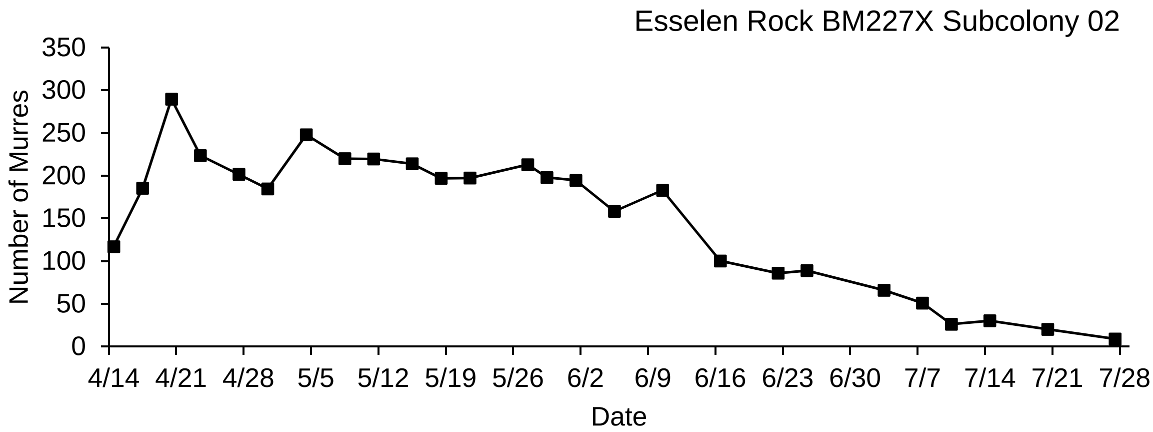


Figure 25. Seasonal attendance of Common Murres on Esselen Rock, BM227X subcolony 02; Castle Hurricane Colony Complex, from 14 April to 27 July, 2015

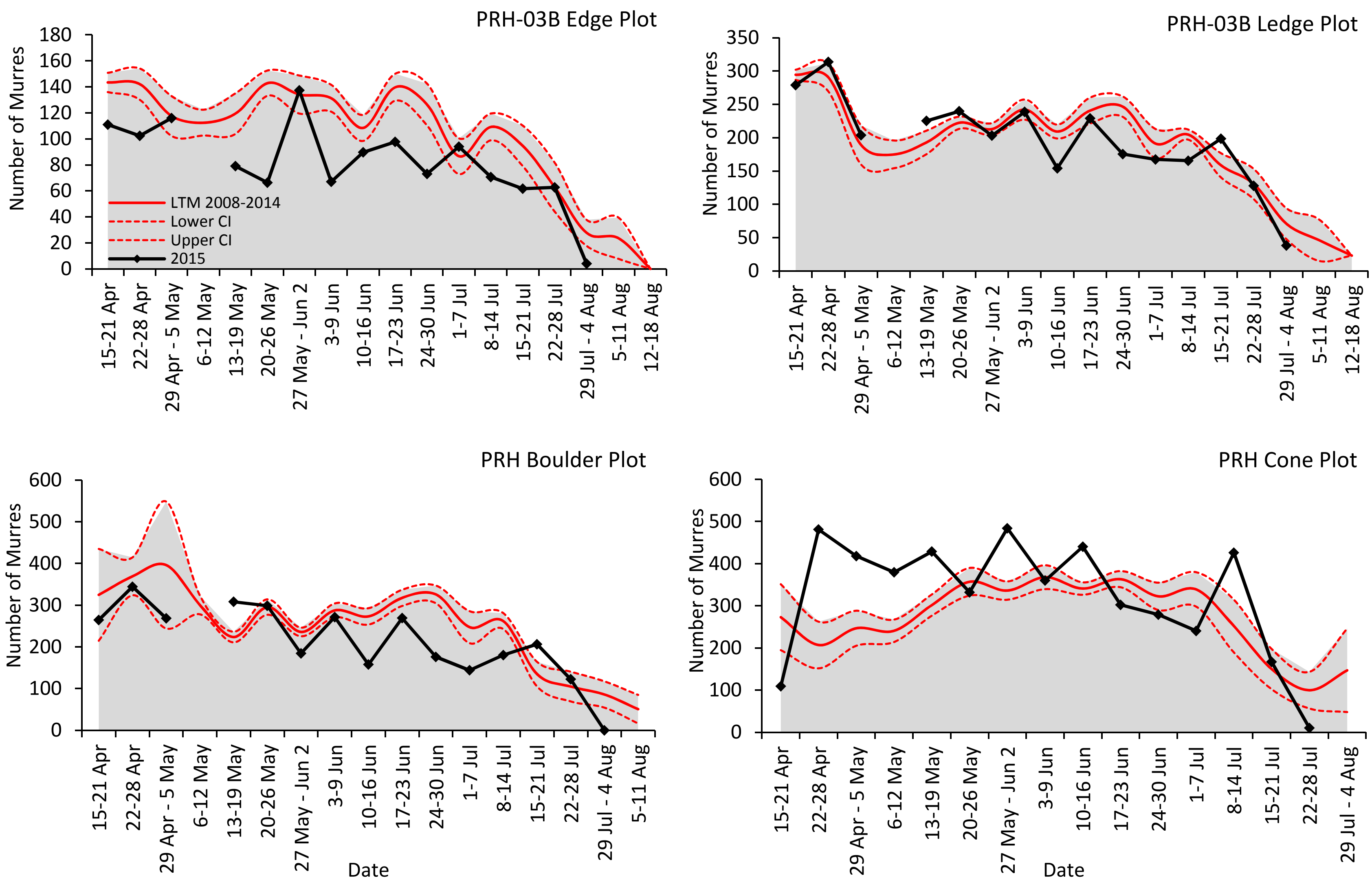


Figure 26. Seasonal attendance of Common Murres at Point Reyes Headlands (PRH) plots in 2015 compared to long term (2008-2014) means.

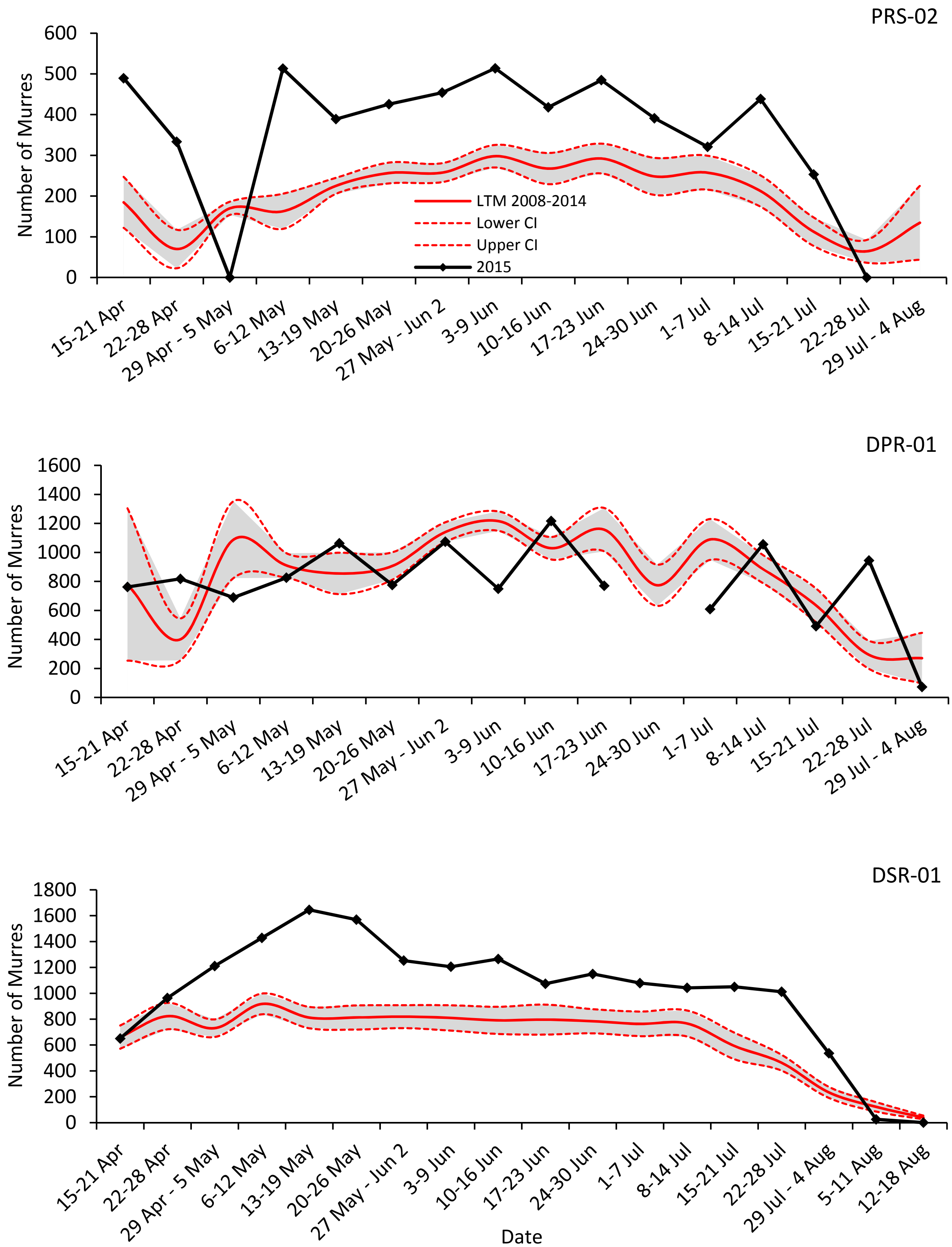


Figure 27. Seasonal attendance of Common Murres at Point Resistance (PRS), Double Point Rocks (DPR) and Devil's Slide Rock (DSR) in 2015 compared to long term (2008-2014) means.

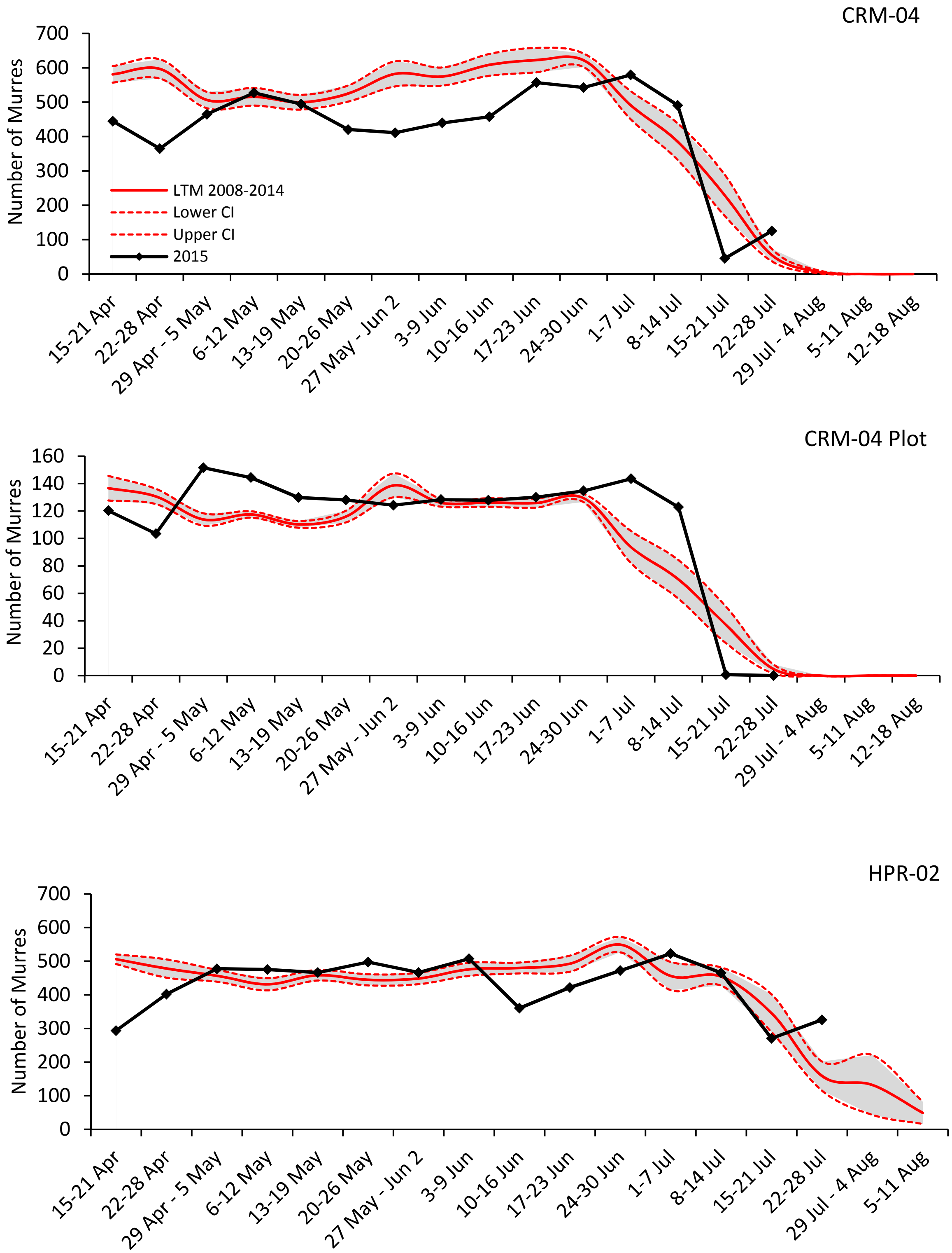


Figure 28. Seasonal attendance of Common Murres at Castle Rocks and Mainland (CRM) and Hurricane Point Rocks (HPR) in 2015 compared to long term (2008-2014) means.

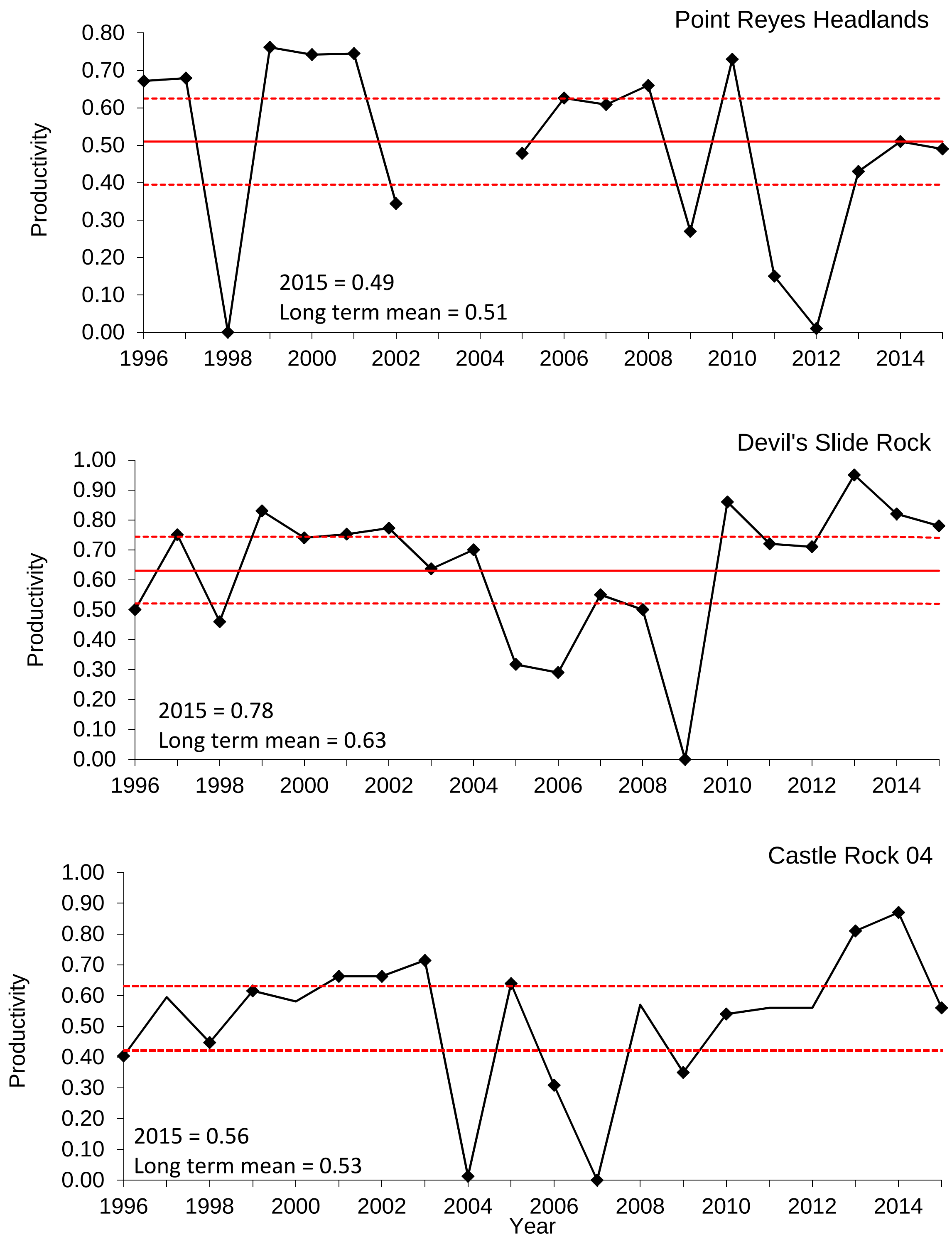


Figure 29. Productivity (chicks fledged per pair) of Common Murres at Point Reyes Headlands (Ledge and Edge plots), Devil's Slide Rock, and Castle Rock 04 plot, 1996-2015. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence intervals.

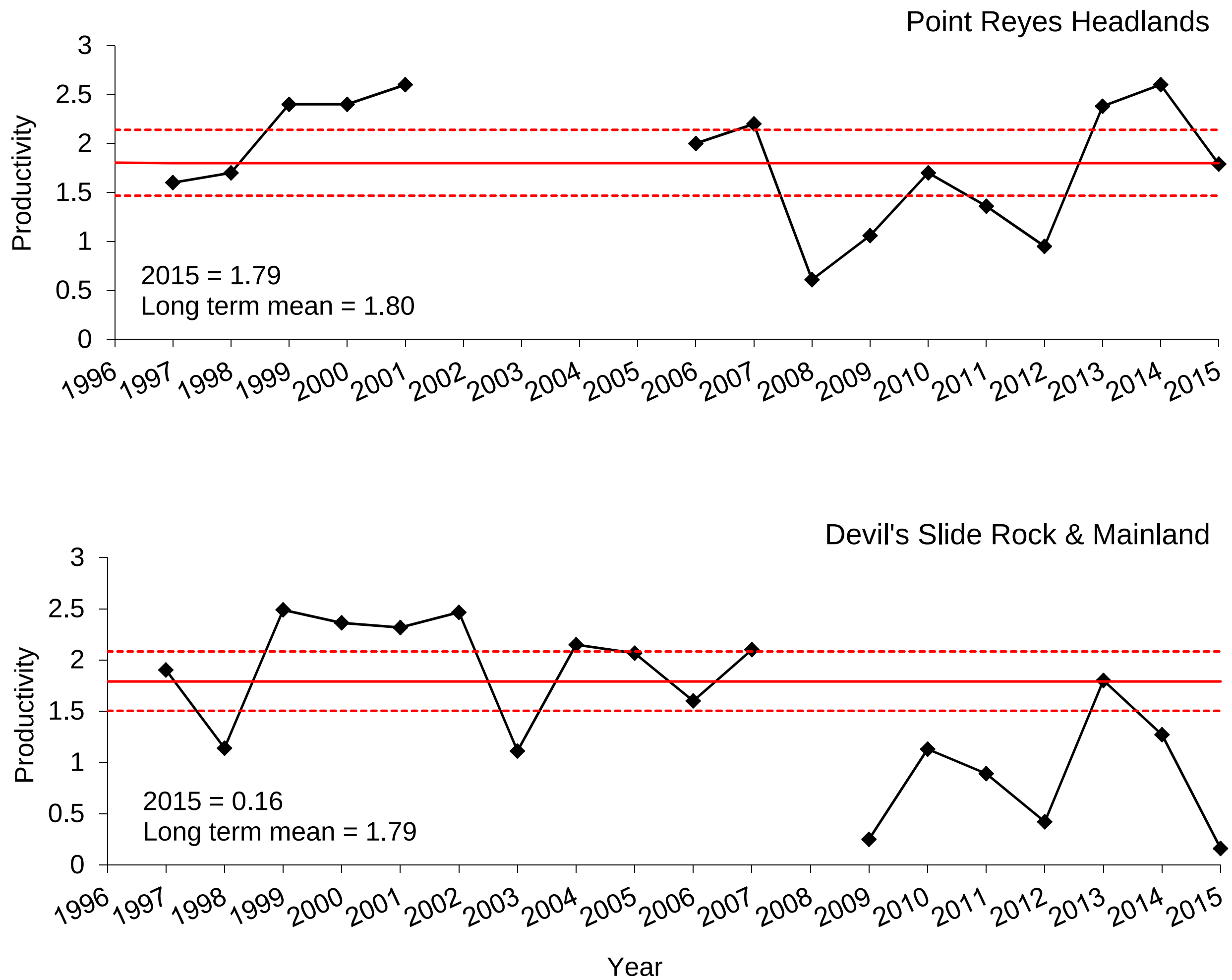


Figure 30. Productivity (chicks fledged per pair) of Brandt's Cormorants at Point Reyes Headlands and Devil's Slide Rock & Mainland, 1996-2015. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence intervals.

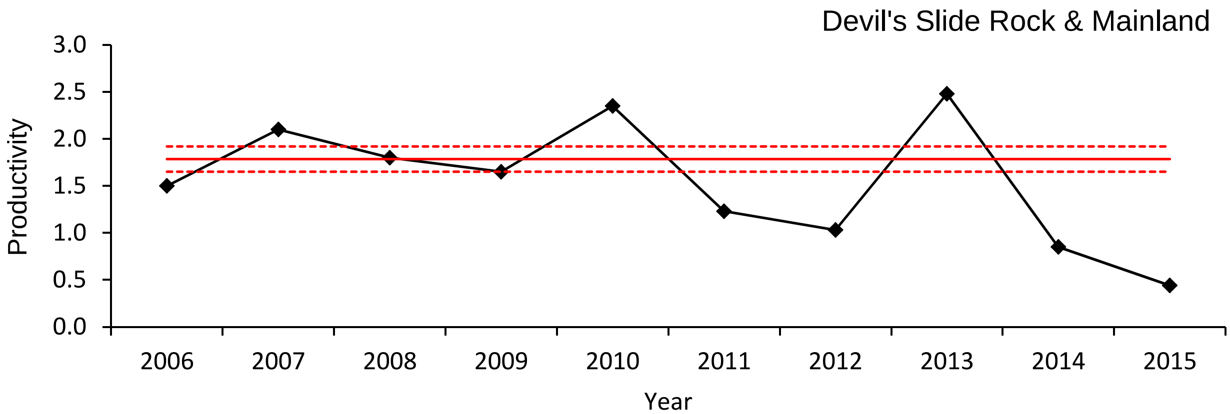


Figure 31. Productivity (chicks fledged per pair) of Pelagic Cormorants at Devil's Slide Rock & Mainland, 2006-2015. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence interval.

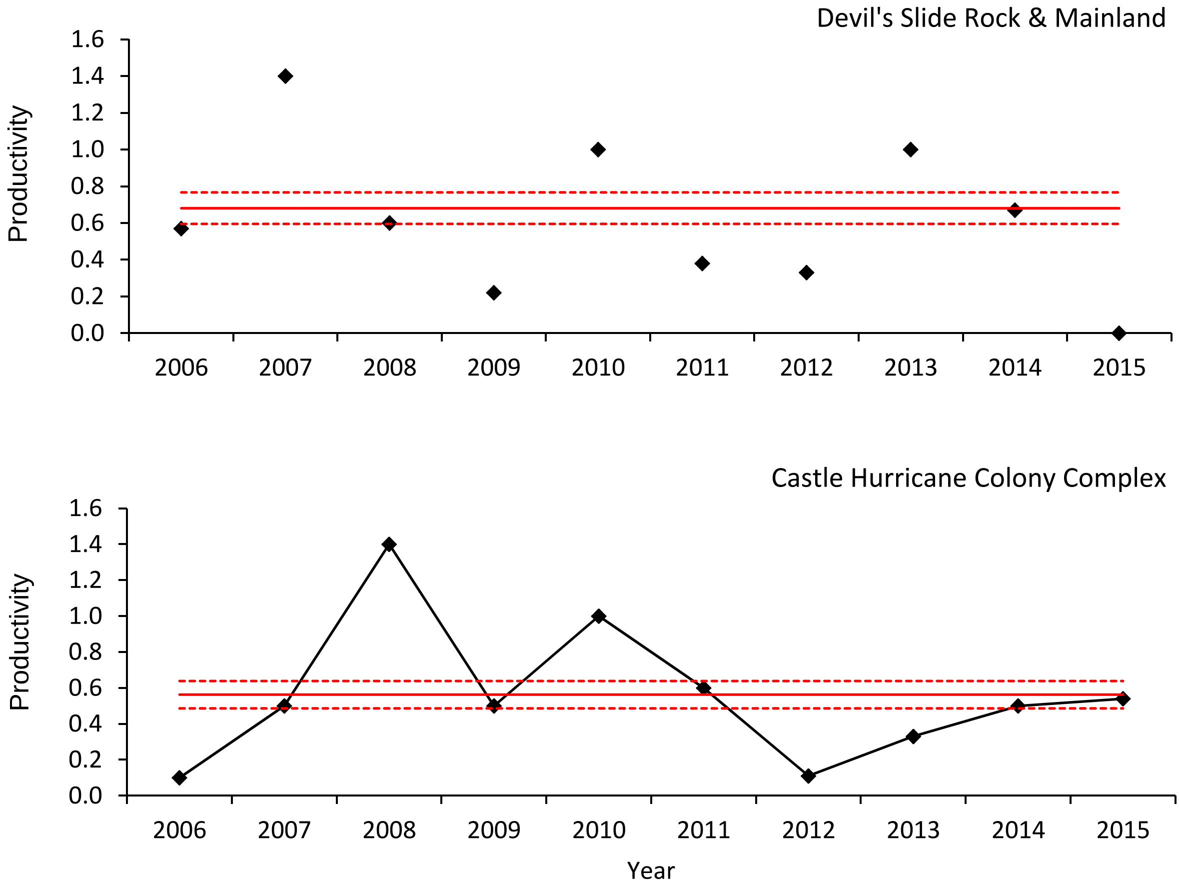


Figure 32. Productivity (chicks fledged per pair) of Western Gulls at Devil's Slide Rock & Mainland and Castle-Hurricane Colony Complex, 2006-2015. The solid horizontal line indicates the long-term weighted mean and the dashed lines represent the 95% confidence interval.

Appendix 1. Number of aircraft overflights detected categorized by type and resulting disturbance events recorded at Point Reyes, Point Resistance, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex in 2015.

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										
Research	1	0	0	0	0	0	0	0	0	0
General Aviation	2	0	2	0	0	0	0	0	2	0
Point Resistance										
Law	0	1	0	0	0	0	0	0	0	0
Devil's Slide Rock and Mainland										
General Aviation	28	8	16	4	0	0	5	4	21	8
USCG	0	5	0	3	0	0	0	1	0	4
Military	0	2	0	0	0	0	0	1	0	1
Unknown	0	2	0	1	0	0	0	1	0	2
Research	1	0	0	0	0	0	0	0	0	0
Castle-Hurricane Colony Complex										
USCG	1	1	0	0	0	0	0	0	0	0
General Aviation	1	0	2	0	0	0	1	0	2	0
Military	0	1	0	0	0	0	0	1	0	1
Research	1	0	1	0	0	0	0	0	1	0
Law	0	1	0	0	0	0	0	0	0	0

Appendix 2. Number of watercraft detected categorized by type and resulting disturbance events recorded at Point Reyes, Double Point Rocks, Devil's Slide Rock and Mainland, and Castle-Hurricane Colony Complex, 2015.

Watercraft Type	Total Detections	Number of Agitation Events	Number of Displacement Events	Number of Flushing Events	Total Disturbance Events
Point Reyes					
Recreational (<25') Small Private	2	0	0	2	2
Double Point Rocks					
Recreational (<25') Small Private	2	0	0	1	1
Charter	1	0	0	1	1
Devil's Slide Rock and Mainland					
Recreational (<25') Small Private	4	0	0	0	0
Recreational (>25') Large Private	1	0	0	1	1
Kayak/Canoe	2	0	0	1	1
Castle-Hurricane Colony Complex					
Recreational (<25') Small Private	2	1	0	1	2