Point Blue Report

Seabird Population and Disturbance Monitoring Within the Point Sur to Point Mugu Study

Report to the Bureau of Land Management, California Coastal National Monument, and the Torch/Platform Irene Trustee Council

March 31, 2015

Conservation science for a healthy planet

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Seabird Population and Disturbance Monitoring Within the Point Sur to Point Mugu Study Region of the Seabird Protection Network, 2011 – 2014

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Point Blue Conservation Science

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EXECUTIVE SUMMARY

Background

In 2010, the Torch/Platform Irene Oil Spill Trustee Council initiated a new chapter of the Seabird Protection Network (SPN) to oversee the central California coast from Point Sur to Point Mugu (PSPM). The overarching goal of the PSPM chapter is to protect seabirds and improve nesting success by reducing human disturbance to breeding and roosting sites along central California. To accomplish this goal, the PSPM chapter established outreach and law enforcement teams to educate the public about the importance of protecting seabirds from human-caused disturbance. The PSPM chapter also established a monitoring team to 1) inform and guide the outreach and law enforcement teams and 2) assess the efficacy of outreach and law enforcement efforts in reducing disturbance at seabird breeding and roosting sites. In 2011-2012, we conducted two years of baseline monitoring at nine sites within the PSPM study area (Figure 1). The baseline monitoring was conducted within a before-after-control-impact (BACI) design with six impact sites (Piedras Blanca, San Simeon/Cambria, Estero Bluffs, Montaña de Oro, PG&E Trail, and Shell Beach) representing varying levels of potential human-caused disturbance and three control sites where public access is restricted (Diablo Canyon, North Vandenberg, and South Vandenberg). The results from this baseline period guided outreach efforts at the three sites with the highest disturbance rates: Shell Beach, Montaña de Oro, and Estero Bluffs. We continued to monitor these sites and the two Vandenberg control sites in 2013 and 2014. Additionally, in 2013 and 2014, we partnered with the Morro Coast Audubon Society to develop a citizen science program to monitor Estero Bluffs and Montaña de Oro. Herein, we compare results from 2013-2014 to the two years of baseline monitoring and make recommendations for continued outreach and monitoring. We also compare results of citizen science monitoring to monitoring conducted by trained biologists and make recommendations for continued use of citizen science monitoring within the PSPM chapter.

Methods Overview

At each site, we monitored breeding population size, reproductive success, roost utilization, and rates of human-caused disturbance for the seven focal species identified in the initial PSPM assessment report (Robinette and Acosta 2011): Brandt's Cormorants, Double-crested Cormorants, Pelagic Cormorants, Pigeon Guillemots, Western Gulls, Black Oystercatchers, and Brown Pelicans. Brown Pelicans do not breed within the study area but rely on the coastal habitat for roosting after they disperse from breeding sites. We monitored breeding population size and roost utilization using weekly transect surveys from April through July. We monitored productivity by following individual nests visible from land and calculated annual breeding productivity as number of fledglings produced per breeding pair. We recorded all human-caused disturbances observed during all surveys and calculated disturbance rates as number of disturbances per hour of observation.

Key Findings

1) Citizen scientists and trained biologists produced similar results, but there were some important differences. Overall, estimates of roost utilization and disturbance rates were higher for citizen scientists while estimates for breeding population were higher for trained biologists. Differences in estimated disturbance rates were likely due to the timing of surveys with citizen scientists conducting more weekend surveys (when more humans are using coastal areas) than trained biologists. Differences in estimated roost utilization were largest with the three cormorant species which can be difficult to identify. Thus, misidentification of cormorant species likely contributed to differences between citizen scientists and trained biologists.

2) Patterns of breeding population size, roost utilization, and disturbance rates were similar between 2013-2014 and the baseline years. There were large numbers of birds breeding at Shell Beach and South Vandenberg, while Shell Beach and Estero Bluffs were identified as important roost sites. Disturbance rates were higher at Shell Beach and Estero Bluffs than the two Vandenberg control sites. Overall, disturbance rates were higher in 2013-2014 than the baseline years despite outreach efforts. However, there were no disturbances recorded at Montaña de Oro in 2013-2014.

3) Roost utilization was higher in 2013-2014 than during the baseline years. This likely contributed to the higher disturbance rates observed in 2013-2014 as the probability of birds interacting with humans increases as roost utilization increases in a given area. Roost utilization was also highly variable among sites, likely a response to variability in localized prey availability.

4) There was a notable increase in disturbance by kayakers at Shell Beach and by walking humans at Estero Bluffs in 2013-2014 compared to baseline years. This may have been related to weather, though we did not conduct any analyses to investigate the impacts of weather on disturbance rates. In general, we expect to see more humans using coastal habitats during periods of warm temperatures and low winds.

5) There was a notable decrease in disturbance caused by recreational power boats at Shell Beach in 2012. We attribute this to activities by a single tour company that caused high disturbance rates in 2011. This company was approached by the PSPM outreach and law enforcement groups prior to the 2012 breeding season. Disturbances by this company increased again in 2013 and 2014, though overall disturbances caused by this group were lower in 2013-2014 than during the baseline years.

Management Recommendations

Outreach efforts should continue to target water-based disturbance sources at Shell Beach and ground-based disturbance sources at Shell Beach, Montaña de Oro and Estero Bluffs. These are the leading sources of disturbance at these sites. Monitoring should continue at impact and control sites to assess the impacts of outreach efforts and guide further development of the outreach program. The Vandenberg control sites will be important in allowing future analyses to distinguish between impacts of human-caused disturbance and variability in local oceanographic conditions. These types of analyses depend on multiple year time series data and will be important for assessing the long-term impacts of outreach efforts on breeding population size, reproductive success, and roost utilization within the PSPM study area. Finally, the citizen science component should continue to be developed and sustained. The initial two years of the program produced encouraging results. However, more training and continued assessment will be needed to improve species identification and consistency among individual citizen scientists.

INTRODUCTION

Background

On September 28, 1997, a 20" transport pipeline connecting the Torch/Platform Irene oil extraction platform to an onshore storage facility in Santa Barbara County ruptured, creating an oil spill releasing at least 163 barrels (6,846 gallons) of crude oil emulsion into the Pacific Ocean. This oil spill affected approximately 17 miles of coastline in northern Santa Barbara County, impacting a variety of natural resources including seabirds, sandy and gravel beach habitats, rocky intertidal shoreline habitats, and use of beaches for human recreation. As a result of mitigation for these damages, a trustee council was formed to identify and oversee restoration activities. The trustee council, collectively known as the Trustees, included representatives from the United States Fish and Wildlife Service (USFWS), Vandenberg Air Force Base (VAFB), California Department of Fish and Game (CDFG), and the California State Lands Commission (CSLC).

The first task of the Trustees was to create a Restoration Plan and Environmental Assessment (RP/EA) to describe the extent of environmental impacts from the oil spill. The RP/EA identified restoration alternatives and the Trustees, together with public input, selected five 'Most Preferred Restoration Alternatives'. These five alternatives included a 'Seabird Colony Enhancement Project' which aims to restore injured seabird resources to pre-spill conditions.

The primary goal of the Seabird Colony Enhancement Project is to protect seabirds and improve nesting success by reducing human disturbance to breeding and roosting sites along central California. The RP/EA called for collaboration with the Seabird Protection Network (SPN) established by the Gulf of the Farallones National Marine Sanctuary (GFNMS) to create a new SPN chapter focused on the Torch/Platform Irene oil spill impact area. The geographic extent of this new chapter includes the coastal mainland of California from Point Sur, Monterey County, to Point Mugu, Ventura County.

The United States Department of the Interior, Bureau of Land Management (BLM) has been charged with implementing the Point Sur to Point Mugu (PSPM) SPN chapter. The chapter has three components: 1) education and outreach, 2) coordinated law enforcement, and 3) seabird colony and human disturbance monitoring. This report summarizes the efforts of the outreach component from 2011-2014. The monitoring component is charged with identifying areas of high disturbance within the PSPM study area and determining if and how seabird populations are responding to outreach and law enforcement efforts. The information collected by the monitoring team is used to inform the outreach and law enforcement components, allowing them to concentrate their efforts and adapt their approach in response to new information.

Impacts of Disturbance on Seabirds

Viewing or approaching seabirds at close distances can have a negative impact at the individual and population level. Nesting colonial seabirds are particularly sensitive to human disturbances, especially when humans enter the nesting area (Carney and Sydeman 1999). Intrusions result in birds flushing from the colony, leaving eggs and chicks vulnerable to predators such as gulls and ravens. While some birds return to nests after the disturbance event, others will abandon nesting efforts. For example, Brandt's Cormorants have been observed to abandon nests en masse from even single events of human intrusion to the colony (McChesney 1997). Similarly, gulls have experienced nest loss through abandonment, intraspecific aggression, and intra/interspecific predation following human intrusion into nesting colonies (Carney and Sydeman 1999).

Although often not as easily identified, close approaches to colonies by humans (e.g., by boats, surfers, etc.) can cause impacts similar to direct human intrusions (Carney and Sydeman 1999). Several studies have shown reductions in breeding success or population sizes as a result of close approaches (e.g., Wallace and Wallace 1998, Carney and Sydeman 1999, Thayer et al. 1999, Beale and Monaghan 2004, Bouton et al. 2005, Rojek et al. 2007). For example, gulls can experience a decrease in hatching success with an increased level of disturbance introduced by nearby human recreation and there is evidence that it may even cause a decrease in gull population (Carney and Sydeman 1999). Cormorants have been known to flush from nests when approached, leaving contents exposed to predators and the elements. Disturbances have also discouraged late-nesting birds from settling in at affected areas (Carney and Sydeman 1999). Cormorants can also be disturbed by noise, night lighting, gulls squawking in reaction to humans or other predators, and by close approach from marine vessels (boats, kayaks, etc). Additionally, the severity of cormorant reactions to disturbances increases over time rather than decreasing due to acclimation to disturbances. Repeated disturbances causing birds to flush nesting sites during the nest initiation stage appeared to cause birds to become more sensitive through time (Acosta et al. 2007).

Human disturbance to non-breeding birds can be hard to detect, but the most obvious effect is causing birds to flush their roosting locations. Chronic disturbance can lead to a decrease in body condition, metabolic rate, habitat use, and reproductive success (Jaques and Strong 2002). The more disturbances a bird experiences, the greater energy cost it incurs by responding to these events. As with breeding colonies, close approaches to roosting sites can cause impacts similar to direct human intrusions (Jaques et al. 1996, Jaques and Strong 2002).

Within the Point Sur to Point Mugu study area, Jaques and Strong (2002) showed that kayakers, small boats and shoreline user groups were the most common source of seabird disturbance while helicopters caused the most disturbance per event. They calculated average disturbance rates for southern California to be 0.53 flushing events per hour of observation. Disturbance rates within the Shell Beach area (one of our focal areas for baseline monitoring) were higher than those recorded at any southern

California site, and rates during the 1999-2000 period had increased almost fourfold compared to the 1980s. During our 2011-2012 baseline period, determined that Shell Beach continued to show high disturbance rates, far higher than any of the other sites investigated (Robinette et al. 2012a, Robinette et al. 2013). Moderate disturbance rates were also observed at Montaña de Oro Park and Estero Bluffs State Park.

Monitoring Goals and Overarching Monitoring Approach

The ultimate goal of this monitoring program is to establish a causal link between human activities and seabird disturbances so that the disturbances can be reduced. Biologists and resource managers must determine whether or not changes observed at seabird colonies are due to the success of outreach and enforcement efforts versus other co-varying factors. There are various ways to accomplish this. Some programs may take a 'before-after' approach by comparing performance indicators measured before outreach and enforcement efforts are initiated to those measured afterward. If baseline or 'before' data do not exist, a program may take a 'control-impact' approach by comparing performance indicators at locations where outreach and enforcement efforts are concentrated to those at a control site where no outreach and enforcement take place. The more robust approach to establishing causation is to combine these into a 'before-after-impact-control' (BACI) monitoring program (McDonald et al. 2000). Such a program involves measuring indicators at impact and control sites before and after the onset of outreach and enforcement efforts. There are two general approaches to BACI monitoring. If a long period of baseline data exists, then the investigator can take a time series approach, monitoring a single pair of impact and control plots. However, if a baseline time series does not exist, then multiple impact and control sites must be used.

The Initial Monitoring Plan for the PSPM program (Robinette 2011) outlines our BACI approach to determine the efficacy of outreach and law enforcement activities on population size, reproductive success, and rates of human-caused disturbance at focal colonies. The first two years of BACI monitoring were used to establish baseline conditions within the initial implementation area (Piedras Blancas to Vandenberg Air Force Base) defined within (Robinette and Acosta 2011). The information gained from baseline monitoring was used to guide the development of outreach and law enforcement programs and to select areas of interest for continued monitoring in 2013 and 2014. Continued monitoring after the initial three years will be used to gauge the efficacy of and adaptively manage the outreach and law enforcement programs. Herein, we summarize the results of four years of monitoring (2011 - 2014) within the PSPM study region. We also compare data collected in 2013 and 2014 to those collected during the baseline years (2011-2012) when outreach and law enforcement strategies were being developed. Furthermore, we partnered with the Morro Coast Audubon Society (MCAS) in 2013 and 2014 to develop a citizen science program to monitor the Estero Bluffs and Montaña de Oro sites. We make an initial comparison of these data to those collected by Point Blue biologists. Finally, we use the results of these analyses to make recommendations for the continued development of the PSPM outreach program and the sustainability of the PSPM monitoring program.

METHODS

Baseline Study Area (2011-2012)

The initial baseline monitoring program focused on the area between Piedras Blancas and Vandenberg Air Force Base (AFB). We identified nine areas to serve as impact and control sites for BACI monitoring (Figure 1). We selected these areas using data from Carter et al. (1992) and Jacques and Strong (2002). The following criteria were used to pick the areas.

1) The area contains significant numbers of breeding and roosting seabirds.

2) The area contains either a high, moderate, or low degree of potential disturbance by the sources identified in Jaques and Strong (2002). Selecting areas with varying degrees of potential disturbance is important for the BACI design of the monitoring program. Areas with moderate to high potential for disturbance will serve as impact areas, while areas with low potential will serve as controls.

3) The area is accessible, though monitors may need to coordinate with land managers.

4) The areas are distributed throughout the baseline study region.

We placed each site into control, moderate impact and high impact areas based on information available within the initial assessment report (Robinette and Acosta 2011). We will continue to revise these designations as data are collected throughout the three-year baseline period.

Control Areas include Diablo Canyon, North Vandenberg AFB, and South Vandenberg AFB. These areas are not open to public and have very little human activity occurring along the coast. This is especially true for North and South Vandenberg AFB. There is a considerable amount of scientific research that occurs within the coastal waters at Diablo Canyon and this site may be re-categorized as moderate impact as disturbance data are collected. Additionally, North and South Vandenberg AFB are the only areas where time series data of annual breeding population size and reproductive success exist for all focal species. PRBO has been monitoring seabird breeding dynamics at Vandenberg AFB since 1999. Thus, it makes sense that these areas be designated as controls as they represent the best areas to understand annual variability in the relative absence of human-caused disturbance.

Moderate Impact Areas include Piedras Blancas and PG&E trail. Both of these areas have limited public access. PG&E trail is managed by Pacific Gas and Electric and is open five days a week from 8am to 5pm. There is a daily limit of 275 hikers and all hikers are met by trail guides prior to accessing the trail. The trail guides discuss rules and inform the hikers about the impacts of human-caused disturbance to wildlife. Piedras Blancas has more public access throughout the area, but has two docent programs to educate the public. First, BLM leads guided tours of the Point Piedras Blancas lighthouse area. The area is otherwise closed to the public. Second, Friends of the Elephant Seals educate tourists attracted to important elephant seal haul-outs about the impacts of disturbance on wildlife.

High Impact Areas include San Simeon/Cambria, Estero Bluffs, Montaña de Oro, and Shell Beach. San Simeon, Montaña de Oro, and Estero Bluffs are all state parks with coastal trails for public access. Cambria and Shell Beach are developed with residential areas and hotels along the coast. This is especially true for Shell Beach where development has occurred up to the coastal bluffs that are important habitat for breeding and roosting seabirds. The coastal waters of these areas also receive substantial amount of recreational use in the forms of kayaking, surfing, fishing, etc.

Areas Selected For Continued Monitoring (2013-2014)

Based on the results from the baseline monitoring period (see Robinette et al. 2012a and Robinette et al. 2013), we selected six sites for continued monitoring in 2013 and five sites for continued monitoring in 2014: Estero Bluffs, Montaña de Oro, PG&E Trail (2013 only), Shell Beach, and North and South Vandenberg. These sites were selected based on the presence of large breeding populations (Shell Beach and PG&E Trail), the interest of a citizen science group to take on monitoring efforts (Estero Bluffs and Montaña de Oro) and the need to maintain adequate control sites for our BACI design (North and South Vandenberg).

In 2011 and 2012, trained biologists conducted surveys at all nine sites. In 2013, trained biologists conducted surveys at Estero Bluffs, Montaña de Oro, PG&E Trail, Shell Beach, and North and South Vandenberg while citizen scientists conducted surveys at Estero Bluffs and Montaña de Oro. Thus, there was overlap in survey sites between trained biologists and citizen scientists in 2013 and we were able to compare results by trained biologist versus citizen scientists at Montaña de Oro and Estero Bluffs (see Comparison of Trained Biologists versus Citizen Scientists below). In 2014, trained biologists continued to monitor North and South Vandenberg while citizen scientists monitored Montaña de Oro and Estero Bluffs. Surveys at Shell Beach were initiated by trained biologists but were discontinued during the first week of June due to lack of funding.

PSPM Focal Species

The RP/EA identified eight species that would benefit from decreased human disturbance: Common Murres, Pelagic Cormorants, Brandt's Cormorants, Double-Crested Cormorants, Western Gulls, Black Oystercatchers, Pigeon Guillemots, and California Brown Pelicans. Common Murres do not breed in the focal region identified within the PSPM Initial Monitoring Plan (Robinette 2011). We therefore focused on the remaining seven species. Six of these species breed within the initial focal region. Though Brown Pelicans do not breed within this region, the coastal habitats provide important roosting areas during their post-breeding migration and overwintering. Important life history information for each species is presented below.

Pelagic Cormorant. Pelagic Cormorants typically breed on rocky seacoasts and island cliffs. This species attempts only one successful brood per season. If the first nesting attempt fails (the chicks do not survive to fledging), subsequent "relay" nesting attempts may be undergone. Relay attempts will take place at the same nest site, usually in the original nest. Nests are located on high, steep, inaccessible rocky cliffs facing water. Nests are of the platform type, and are made of sticks, seaweed and grass, debris, or only moss. Pelagic Cormorants lay 3-7 eggs (3-5 eggs is most common) during a single nesting attempt. Both sexes incubate the eggs for 26-35 days. Fledging occurs in 40-50 days.

Brandt's Cormorant. Brandt's Cormorants typically breed on open ground in rocky areas along seacoast cliff tops or grassy slopes. Nests have occasionally been found inshore on brackish bays. This species attempts only one successful brood per season. If the first nesting attempt fails (the chicks do not survive to fledging), subsequent “relay” nesting attempts may be undergone. Relay attempts occur at the same nest site and usually in the original nest. Brandt’s Cormorants avoid building nests on the steep cliffs which Pelagic Cormorants favor. Nests are composed of seaweed and other marine vegetation (sticks are not used to form nests). Brandt’s Cormorants lay 3-6 eggs (4 eggs is most common). Incubation lasts 29-30 days. Fledging occurs in 30-40 days.

Double-Crested Cormorant. Double-Crested Cormorants typically breed on ground or cliffs, in trees or shrubs. This species typically attempts only one successful brood per season. Second broods have been reported but are extremely rare. If the first nesting attempt fails (the chicks do not survive to fledging), subsequent “relay” nesting attempts may be undergone. Double-Crested Cormorants lay 1-7 eggs (5 eggs is most common) during a single nesting attempt. Both sexes incubate the eggs for 25-28 days. Fledging occurs in 40-50 days.

Western Gull. Western Gulls typically nest on rocky islets and coastal cliffs. This species attempts only one successful brood per season. If the first nesting attempt fails (the chicks do not survive to fledging), subsequent “relay” nesting attempts may be undergone. Nests are perennial and are usually located on cliff ledges, grassy hillsides, or sometimes on human built structures. Western Gulls lay 1-5 eggs (3 is the most common number). Western Gulls are colonial and have been known to share nesting sites with other seabirds. Incubation ranges from 25-29 days (26 days is the average length). Chicks fledge in 42-49 days, yet often don’t disperse from the colony until after 70 days.

Black Oystercatcher. Black Oystercatchers typically breed on rocky coasts and islands, although nests have been occasionally found on sandy beaches. This species attempts only one successful brood per season. If the first nesting attempt fails (the chicks do not survive to fledging), subsequent "relay" nesting attempts may be undergone. Black Oystercatchers are monogamous, and have long-term pair bonds. They are also year round residents who continually defend their feeding territories. Nests are of the scrape form, and are usually built above the high tide line in weedy turf, beach gravel, or rock depressions. Black Oystercatchers lay 1-3 eggs (2 eggs is most common). Incubation lasts 24-29 days. Chicks are precocial at hatching, but highly dependent on their parents for an extended period of time. Chicks rely on parents to show them food, and to teach them about appropriate food selection. Chicks fledge in approximately 35 days.

Pigeon Guillemot. Pigeon Guillemots typically breed in burrows in coastal cliffs or caves. This species attempts only one successful brood per season. If the first nesting attempt fails (the chicks do not survive to fledging), subsequent "relay" nesting attempts may be undergone. Guillemots typically nest in small colonies. Nests are perennial, with high nest site fidelity. Pigeon Guillemots lay 1-2 eggs (2 is the most common number). Both the male and female incubate the eggs, for a period of 25-38 days (with 29 days being average). Young fledge in 29-54 days, with 38 days being the average fledging time. During the breeding season, guillemots raft in small groups on the water adjacent to their nesting crevices. This behavior is most common in the early mornings.

California Brown Pelican. California Brown Pelicans breed on the northern Channel Islands and migrate north along the California coast after breeding. Brown Pelicans breeding in Mexico also migrate north after breeding. During the post-breeding season, pelicans rely on coastal habitats as important roosting sites. Pelicans typically begin to appear within the SCCNC in May and June, with numbers increasing, but variable, through August and September. Peak roosting numbers are typically reached in December and January.

Monitoring Methods

In each year, we began surveys during the first week of April and continued through the end of July. Trained biologists conducted three types of surveys at each location: transect surveys, nest monitoring, and disturbance monitoring. Citizen scientists conducted transect surveys and disturbance monitoring. The goals of these surveys were to assess baseline 1) seabird breeding population size and distribution, 2) seabird breeding productivity at multiple colonies within the SCCNC study area, and 3) levels of human disturbance at important seabird breeding colonies and roost sites.

Transect Monitoring

Goals. The goals of transect monitoring are three-fold: 1) to document the size and distribution of annual breeding and roosting populations for each focal species within the baseline study area, 2) to identify nests that can be followed for estimating annual productivity, and 3) to identify areas of dense breeding and roosting populations to monitor for disturbance.

Areas Surveyed. We conducted transect surveys within each of the nine general areas identified above. For each area, we defined a transect that can be traveled by foot and car within four hours. Each transect is shown in Figure 1. We divided each transect into counting blocks viewable from predetermined observation points. The counting blocks for each transect are shown in Appendices I through VIII.

Methods. Beginning the week of April 1, we conducted one transect survey per week at each of the nine areas. We conducted surveys between the hours of 0600 and 1000 as this is the peak time for Pigeon Guillemot rafting activity and roosting activity by non-breeding birds. For each survey, we began at one end of the transect and visited each observation point. We alternated starting points between the north and south ends of the transect on a weekly basis to minimize time bias on guillemot raft counts. From each observation point, we scanned the adjacent count blocks using binoculars and a spotting scope. We recorded the number of nesting, roosting, and rafting (for guillemots only) birds observed within each counting block. We recorded data on each of the focal species identified above.

Nest Monitoring

Goals. The overarching goal of nest monitoring is to record annual nesting phenology and estimate annual colony productivity. Both phenology and productivity are good indicators of the underlying oceanographic conditions affecting annual population size. Recording phenology requires weekly checks on individual nests within a given colony. Productivity can be calculated as either 1) the number of fledglings produced per adult breeding pair or 2) the percentage of total eggs laid that hatched and successfully grew into fledglings. The first calculation requires only knowledge of the number of fledglings produced within a given nest. The second requires more detailed knowledge of how many eggs were laid, how many of those eggs hatched, and how many of those chicks fledged. In this report, we use the first method to calculate productivity as we were able to collect this data at all areas. However, in some areas, we were able to obtain views of nests to collect data on number of eggs laid. These data can be analyzed at a later date if a more detailed analysis of productivity is warranted.

Methods. We identified monitorable nests during our transect surveys of each focal area. A monitorable nest is one for which eggs, chicks, and fledglings can be clearly viewed and enumerated without disturbing the nesting adults; though in some cases we were only able to view chicks and fledglings. Once nests were identified, we monitored them every 7 days. During each monitoring visit, we recorded 1) nest condition, 2) number of adults attending the nest and whether one is in incubating posture, 3) number of eggs, 4) number of chicks, 5) the feather condition of chicks, 6) number of fledglings and 7) if nest fails, the reason for nest failure to the extent possible (i.e., Were abandoned eggs left in the nest? Were dead chicks observed in the nest? Was there evidence of predation?).

Disturbance Monitoring

Goals. The goals of disturbance monitoring are 1) to identify human activities that cause disturbance, 2) to identify human activities that do not cause disturbance, 3) to estimate rates of human-caused disturbance at individual colonies, and 4) to estimate rates of natural (e.g., predator-caused) disturbance at individual colonies. Disturbance is defined as any event that results in one or more of the following:

1) Birds flushing (birds flying off the rock).
2) Birds displacing (moving from their nest or resting site).
3) Eggs or chicks being:
    a. exposed (adult moves away from the egg or chick),
    b. displaced (egg or chick moves from nest site), or
    c. taken (egg/chick is depredated).
4) Birds becoming visibly agitated.

Methods. We recorded all disturbances observed during any of the surveys mentioned above. Additionally, we identified 1-2 important nesting/roosting sites to monitor within each transect surveyed. Sites were selected based on their use by breeding and roosting seabirds and the ease of viewing from a land-based observation point. We monitored each selected site once a week during one of the following 3-hour blocks: 0600-0900, 0900-1200, 1200-1500, and 1500-1800. We rotated the time blocks weekly to determine whether patterns of disturbance change with time of day. Additionally, we made observations during weekdays and weekends to determine whether patterns of disturbance change throughout the week.

At the beginning of each survey, we recorded the number of breeding and roosting birds present for each species. We recorded all land-based human activity and boat traffic within 1,500 feet, and aircraft flying at altitude of <1000 feet and within 1,500 horizontal feet of breeding/roosting seabirds, regardless of whether disturbance occurred or not. Additionally, we recorded all natural events (e.g., predatory bird flying over, large waves crashing) that cause disturbance. When a disturbance occurred, we recorded the following information:

1. Number of birds disturbed and reaction type for each species.
2. Number of nests with eggs and chicks exposed for each species.
3. Source of disturbance.
4. Source altitude and distance from nesting area affected
5. Activity of disturbance source
6. Identification information (e.g., type of vessel or aircraft and any identifying information like license number).
7. Direction of travel/Duration

Comparison of Trained Biologists versus Citizen Scientists

Table 1 shows the comparison of citizen scientist (MCAS) results to Point Blue biologist (PB) results for breeding population estimates, mean roost utilization, and rates of human-caused disturbance. We calculated the percent difference between the two groups for each metric by subtracting the MCAS value from the PB value and dividing this difference by the PB value. For roost utilization, we also calculated the difference in terms of number of standard deviations. For this, we divided the difference between PB and MCAS by the mean standard deviation for the two groups. We could not do this for population size or disturbance rates as these two metrics are estimated over the entire season and standard deviation cannot be calculated. Roost utilization is estimated on a weekly basis and is therefore presented as mean ± SD.

The greatest differences between PB and MCAS were in estimates of roost utilization followed by estimates of human caused disturbance and then estimates of breeding population. Roost utilization can be highly variable within a given season, so it is no surprise that there were large differences between the two groups. Percent differences were large, especially at Montaña de Oro. However, when we look at differences in terms of number of standard deviations, most of the differences are within one standard deviation, indicating that differences are large because variability in the data is high. The greatest differences at both locations were observed with the various cormorant species. This was especially true at Montaña de Oro and can be partially explained by a single week in June in which there were very large numbers of Double-crested Cormorants observed on a single MCAS survey that were not present during the PB survey. We also noticed differences between individual observers suggesting that identification of individual cormorant species was challenging and not always accurate. Overall, roosting estimates at Estero Bluffs were much more similar between the two groups.

Disturbance rates estimated using citizen science data were higher than those using trained biologist data at both sites. This difference was mostly due to 1) citizen scientists spending more time on surveys and thus logging more hours of observation and 2) citizen scientists primarily completing surveys on weekends when a greater number of humans are using the coast. In general, MCAS numbers for roosting birds and disturbance rates tended to be greater than those collected by PB biologists while the opposite was true for numbers of breeding birds. Given the differences between the two observer groups and in an effort to maintain consistency over the 2011-2013 time series, we use data from PB biologists for estimating all metrics at Estero Bluffs and Montaña de Oro in 2013. For 2014, we used data collected by MCAS to estimate all metrics. The impact of this decision is likely minimal, but should be considered when interpreting the 2014 results for Montaña de Oro and Estero Bluffs.

RESULTS

Seabird Breeding Populations

Baseline Monitoring (2011-2012)

Figure 2 summarizes the breeding population sizes and distributions of all six breeding focal species during our baseline (2011-2012) surveys. Population estimates for individual counting blocks within each of the nine transects can be found in Robinette et al. (2012a) and Robinette et al. (2013). Overall, Brandt's Cormorants and Pigeon Guillemots were the most abundant species breeding within the baseline study region, followed by Pelagic Cormorants, Western Gulls, Double-crested Cormorants and Black Oystercatchers. At most sites, there was either no change in population sizes between the two years or decreased populations in 2012. Exceptions to this include increased 2012 populations for Double-crested Cormorants at Shell Beach, Pigeon Guillemots at South Vandenberg, and Black Oystercatchers at Estero Bluffs and Shell Beach. The largest decreases were observed for Brandt's Cormorants at PG&E Trail and Diablo Canyon; Double-crested Cormorants at San Simeon/Cambria; Western Gulls at PG&E Trail, Diablo Canyon, and Shell Beach; and Black Oystercatchers at Piedras Blancas, Montaña de Oro, and PG&E Trail.

In the following sections, breeding population sizes are reported for each species by location. Population sizes are shown in parentheses for 2011 and 2012, respectively -- i.e., (2011 & 2012).

Brandt's Cormorants were found breeding at Piedras Blancas, PG&E Trail, Diablo Canyon, Shell Beach, and South Vandenberg AFB. They were most abundant at PG&E Trail (1,086 & 532 birds) and Diablo Canyon (2,170 & 1,078 birds). Smaller numbers of Brandt's Cormorants were found breeding at Shell Beach (332 & 264 birds) and South Vandenberg AFB (386 & 372 birds). Piedras Blancas (118 & 156 birds) had the smallest numbers of the sites where Brandt's Cormorants bred. However, based on aerial surveys conducted in 2011, the population at Piedras Blancas was likely underestimated by our ground surveys and likely comparable to PG&E and Diablo Canyon (see Robinette et al. 2012a).

Pigeon Guillemots were found breeding within all transects except Estero Bluffs. The largest population was at South Vandenberg AFB (1,005 &

1,441 birds) while moderate populations were found at Montaña de Oro (209 & 239 birds), PG&E Trail (210 & 203 birds), Shell Beach (358 & 329 birds), and North Vandenberg AFB (107 & 193 birds). Small populations were found at Piedras Blancas (14 & 14 birds), San Simeon/Cambria (24 & 26 birds), and Diablo Canyon (49 & 66 birds).

Western Gulls were found breeding within all transects except Estero Bluffs. The largest population was found at PG&E Trail (148 & 104 birds) and Shell Beach (218 & 146 birds). Moderate populations were found at Piedras Blancas (64 & 50 birds), Diablo Canyon (110 & 46 birds), and South Vandenberg AFB (91 & 68 birds). Small populations were found at San Simeon/Cambria (24 & 14 birds), Montaña de Oro (14 & 18 birds), and North Vandenberg AFB (14 & 6 birds).

Pelagic Cormorants were found breeding at Montaña de Oro, PG&E Trail, Diablo Canyon, Shell Beach, North Vandenberg AFB, and South Vandenberg AFB. The largest population was found at Shell Beach (240 & 234 birds) while moderate populations were found at PG&E Trail (102 & 88 birds), Diablo Canyon (40 & 82 birds) and South Vandenberg AFB (134 & 154 birds). Small populations were found at Montaña de Oro (6 & 8 birds) and North Vandenberg AFB (10 & 10 birds).

Double-crested Cormorants were found breeding only at San Simeon (84 & 56 birds) and Shell Beach (90 & 156 birds).

Black Oystercatchers were found breeding within all transects but San Simeon/Cambria. The largest populations were found at South Vandenberg AFB (16 & 14 birds), and Diablo Canyon (12 & 10 birds). Moderate but variable numbers were at Shell Beach (8 & 14 birds) and PG&E Trail (12 & 4 birds). Small populations were found at Piedras Blancas (6 & 2 birds), Estero Bluffs (4 & 8 birds), Montaña de Oro (10 & 6 birds), and North Vandenberg (6 & 2 birds).

2013 & 2014 Results at Sites Selected for Continued Monitoring

Appendices I through V show raw population estimates for all counting blocks within the six transects surveyed in 2013 and five transects surveyed in 2014. These numbers are summarized by transect in Table 1. Results for 2013 and 2014 were similar to the baseline years. The largest populations of all species were observed at PG&E Trail, South Vandenberg AFB, and Shell Beach while smaller numbers were observed at Estero Bluffs, Montaña de Oro, and North Vandenberg AFB. Among-year trends for Shell Beach and Vandenberg AFB are discussed below. There was an increase in Black Oystercatcher numbers between 2013 and 2014 (4 & 6 birds, respectively) and a decrease in Western Gull numbers (2 & 0 birds, respectively) at Estero Bluffs. Pigeon Guillemots were also observed for the first time in our monitoring efforts at Estero Bluffs in 2014. We have no confirmation of breeding activity by guillemots at Estero Bluffs. There were decreases for all species breeding at Montaña de Oro between 2013 and 2014.

Shell Beach Time Series (2011-2014)

Figure 3 shows population trends for all six breeding focal species at Shell Beach from 2011 through 2014. Brandt's Cormorants, Pigeon Guillemots, and Western Gulls showed increasing trends over the time series with both Brandt's Cormorants and Western Gulls experiencing a dip in 2012. Pelagic Cormorants, Double-crested Cormorants, and Black Oystercatchers showed increasing trends through 2013 followed by sharp declines in 2014.

Vandenberg Time Series (1999-2014)

We ran regression analyses to determine which of three models (linear, quadratic, and exponential growth) best described the trend for each species breeding at Vandenberg AFB (Table 2). There were no population declines over the time series, with all species showing positive growth (Figure 3). All three models provided a good fits for all species but Black Oystercatchers. There were no significant trends for Black Oystercatchers, but the linear and exponential growth models produced low p-values (0.051 and 0.056, respectively) suggesting that these trends may play out as the time series continues. The quadratic model produced the best fit for all other species. Brandt's Cormorants are a recent addition to the Vandenberg seabird community, with first nests observed by Nancy Francine in 1995 (Carter et al. 1996). Their population grew slowly in the initial years and growth rate has been increasing since 2003. The Western Gull population has been increasing steadily since the beginning of the time series. However, the growth curve began plateau in 2008, indicating that the population is reaching its carrying capacity at Vandenberg. 2012 marked the first major decrease in this population and perhaps the beginning of a decreasing trend. Though the quadratic model was the best fit for Pelagic Cormorants and Pigeon Guillemots, the trends for both species appear more linear in Figure 3. The guillemot population at Vandenberg has been stable until recent years. Recent growth in this population has been primarily driven by a new sub-colony located within the North Vandenberg transect. It is possible that the growth rate for the Pelagic Cormorant population has increased in recent years. We will develop a better understanding of how both populations are growing as we continue to add to our time series. The lack of significant trend for the Black Oystercatcher population is due to stable territory occupancy between 2005 and 2012. Black Oystercatchers are territorial and their population at Vandenberg is likely limited by the number of available territories. The population has been decreasing since 2012 and there is concern that recent years of low reproductive success may be an indication that this population is beginning to decline.

Seabird Reproductive Success

Baseline Monitoring (2011-2012)

Figure 5 shows the mean (±SE) fledglings produced per breeding pair for each transect compared to the mean of all sites combined for 2011 and 2012. Overall, reproductive success was higher in 2011 than 2012 for all species. The largest decreases were observed at Montaña de Oro, PG&E Trail, Diablo Canyon, and Shell Beach. There were no changes between years at South Vandenberg for all species but Pelagic Cormorants, for which reproductive success decreased in 2012. Increases in reproductive success occurred for Brandt's Cormorants at Piedras Blancas, Pelagic Cormorants at North Vandenberg, and Western Gulls at North Vandenberg, though Western Gull success was highly variable at North Vandenberg in both years.

Brandt's Cormorants. Reproductive success in Brandt's Cormorants was at or above the study region mean for most locations in 2011 and at or below the study region mean for most locations in 2012. South Vandenberg was the only location where reproductive success was well above the mean in 2012.

Pelagic Cormorants. Reproductive success in Pelagic Cormorants was close to the study region mean at most locations in 2011 and below the mean at most sites in 2012, with two exceptions; North and South Vandenberg were above the mean in 2012.

Western Gulls. Reproductive success in Western Gulls was variable among sites during both years. Reproductive success at Piedras Blancas, San Simeon/Cambria, Montaña de Oro was below average in both years while that at Shell Beach was above average in both years. Reproductive success at Diablo Canyon and South Vandenberg was average in 2011 and below average in 2012. Conversely, reproductive success at North Vandenberg was below average in 2011 and average in 2012.

Black Oystercatchers. Reproductive success for Black Oystercatchers was also variable among sites. There were no fledglings produced in either 2011 or 2012 at Piedras Blancas, Estero Bluffs, Montaña de Oro, Diablo Canyon and North Vandenberg. Reproductive success was average at PG&E Trail in 2011 and at Shell Beach in 2011 and 2012. South Vandenberg was the only location where reproductive success was above average in both years. However, there was high variability in reproductive success within all sites that produced fledglings in 2011 and 2012. At Vandenberg, reproductive success has been below the long-term (13-year) average since 2007 (see Robinette et al. 2012b).

Shell Beach Time Series (2011-2014)

Figure 6 shows the mean +/- SE fledglings produced per breeding pair for Brandt's Cormorants, Pelagic Cormorants, Western Gulls, and Black Oystercatchers breeding at Shell from 2011 through 2013. Surveys ended early during the 2014 breeding and we were therefore unable to calculate reproductive success in 2014. Instead, we report the number of nests that failed prior to their estimated hatch date (i.e., nests that failed at the egg stage) and compare this to the same metrics calculated for 2011 through 2013 with the caveat that 2014 values are likely underestimates as many birds were still incubating nests when we stopped our surveys. We report these values in Table 3.

Reproductive success showed similar among-year patterns for all species but Western Gulls. Reproductive success was highest in 2011, followed by a drop in 2012 and then increased again in 2013. Reproductive success in 2013 was similar to 2011 for Black Oystercatchers and lower than 2011 for Brandt's and Pelagic Cormorants. Reproductive success for Western Gulls was similar in 2011 and 2012 and then declined in 2013. The mean proportion of nests failed from 2011 to 2014 (Table 3) was highest for Double-crested Cormorants and Black Oystercatchers and lowest for Brandt's Cormorants. Pelagic Cormorants and Western Gulls showed similar failure rates over the time series. In 2014, nest failure rates were lower than the 2011-2014 mean for all species but Brandt's Cormorants. Brandt's Cormorant nest failure rates were similar to the 2011-2014 mean. The low nest failure rates observed in 2014 may simply be underestimates due to the shortened survey season. It is interesting to note that overall reproductive success in 2014 was below the long-term mean for the same species breeding at Vandenberg AFB (see Vandenberg section below). Additionally, the patterns of reproductive success for 2011-2013 shown in Figure 6 are similar to those observed for the same species at Vandenberg AFB in those years. Thus, local oceanographic variables appear to be regulating reproductive success at the two sites in a similar fashion and nest failure rates at Shell Beach in 2014 were likely higher than what we estimated.

Vandenberg Time Series (1999-2014)

Figure 7 shows the annual reproductive success (mean number of fledglings per nest) for Brandt's Cormorants, Pelagic Cormorants, Western Gulls, and Black Oystercatchers from 1999 to 2014. Reproductive success for all four species was average to above average from 2000 to 2003 and mostly below average from 2004 to 2007. Trends since 2007 vary by species. The long-term (1999-2014) mean for Brandt's Cormorants was 2.53 fledglings per nest. Annual reproductive success for Brandt's Cormorants was below average through 2010 and increased in recent years. The long-term mean for Pelagic Cormorants was 1.62 fledglings per nest. Annual reproductive success was close to average from 2008 to 2013 and then well below average in 2014. The low fledging rate in 2014 is the lowest fledge rate on record for Vandenberg. The long-term mean for Black Oystercatchers was 0.87 fledglings per nest. Since 2007, Black Oystercatcher reproductive success has remained well below average with 2013 being the first year in the time series with no fledglings produced. The long-term mean for Western Gulls was 1.28 fledglings per nest. As with Black Oystercatchers, annual reproductive success for Western Gull has been below average since 2007.

The trends observed in reproductive success for Brandt's Cormorants, Pelagic Cormorants, and Western Gulls at Vandenberg from 2011 to 2013 were similar to those seen at Shell Beach for the same time period. Reproductive success was highest in 2011 and 2013 and lower in 202 for Brandt's Cormorants, highest in 2011 and lower in 2012 and 2013 for Pelagic Cormornants, and declined steadily from 2011 through 2013 for Western Gulls. Reproductive success for Black Oystercatchers at Vandenberg has been declining steadily since 2006, with 2003 and 2004 showing the lowest reproductive success on record. While Black Oystercatcher reproductive success at Shell Beach was similar in all years, it is noteworthy that reproductive success at Shell Beach was well below the long term (1999-2014) mean calculated for Vandenberg. Thus, the factors leading to low reproductive success at Vandenberg may also be acting on Shell Beach.

Seabird Roost Utilization

Baseline Monitoring (2011-2012)

Figure 8 shows the mean ± SE number of birds roosting throughout a given transect per week (i.e., numbers of roosting birds were summed across all counting blocks for a given week) for each of the roosting species in 2011 and 2012. Shell Beach was an important roosting area for all species in both years; PG&E Trail and Diablo Canyon were important areas for Brandt's Cormorants, Pelagic Cormorants, and Western Gulls; Estero Bluffs was an important area for Double-crested Cormorants and Pelagic Cormorants; and San Simeon/Cambria was an important area for Double-crested Cormorants. Pelagic Cormorants and Western Gulls were the most wide-spread in their roost utilization. Western Gulls showed little difference in roost utilization among years aside from a decrease in the use of Shell Beach in 2012. Pelagic Cormorant roost utilization was more variable with increased use of PG&E Trail and Diablo Canyon in 2012 and decreased use of Estero Bluffs and Shell Beach. Brandt's Cormorants showed increased use of Shell Beach in 2012 and decreased use of Diablo Canyon, while Double-crested Cormorants showed increased use of Estero Bluffs and decreased use of Shell Beach. Brown Pelican roost utilization was the most variable of all species. There was a very large increase in use of Shell Beach in 2012, but numbers were highly variable among weeks as indicated by the high standard error in 2012. Brown Pelicans are a seasonal species within the PSPM study region. Pelicans typically arrive in the area in mid-summer after they disperse from southern breeding colonies (Robinette and Acosta 2011). Peak numbers occur in fall, but the magnitude of annual peaks varies among years.

Sites Selected for Continued Monitoring (2011-2014)

Figure 9 shows the mean ± SE number of birds roosting from 2011 through 2014 at the six sites selected for continued monitoring. The patterns of roost utilization in 2013 and 2014 are similar to those observed during the baseline years, with large numbers of birds for all species using the Shell Beach site. Estero Bluffs continued to be an important site for Double-crested and Pelagic Cormorants, though fewer Pelagic Cormorants roosted at this site in 2013 and 2014 than during the baseline years. Double-crested Cormorant roost utilization in 2014 was much higher at Estero Bluffs than prior years, though numbers were highly variable throughout the year. PG&E Trail was an important site for Brandt's and Pelagic Cormorants in all years with Pelagic Cormorant numbers increasing from 2011 through 2013 (PG&E Trail was not monitored in 2014). Brandt's Cormorant numbers at PG&E Trail were similar in all three years. Montaña de Oro and North and South Vandenberg received similar use with moderate numbers of Pelagic Cormorants and Western Gulls and small numbers of all other species. Numbers of these species were similar among years, though there were larger numbers of Western Gulls roosting at North Vandenberg in 2013 and 2014 than during the baseline years. Brown Pelican roost utilization was mostly limited to the Shell Beach site. Roost utilization at this site was variable within and among years, but overall higher for 2013 and 2014 than during the baseline years.

Disturbances to Breeding and Roosting Sites

Baseline Monitoring (2011-2012)

Figure 10 shows rates of human-caused disturbance in 2011 and 2012 for Brandt's Cormorants, Pelagic Cormorants, Double-crested Cormorants, and Brown Pelicans. Patterns among sites were similar for both years with the majority of disturbances occurring at Shell Beach. There were also high levels of disturbance at Estero Bluffs for Brandt's Cormorants, Pelagic Cormorants, and Double-crested Cormorants. There was a large decrease in disturbance rates at most sites in 2012. This was especially true for Shell Beach where disturbance rates for all species dropped dramatically between 2011 and 2012. There were, however, increases in disturbance rates for Brandt's and Double-crested Cormorants at Estero Bluffs between 2011 and 2012. Though all disturbances of Brown Pelicans occurred at Shell Beach, it is important to note that the majority of Brown Pelican roost utilization also occurred at Shell Beach in these years. There were very few pelicans roosting at other sites.

Sites Selected for Continued Monitoring (2013-2014)

Figure 11 shows disturbance rates from three general human source categories (air-based, ground-based, and water-based) for the six sites selected for continued monitoring in 2013. The among site patterns in 2013 were similar to those observed during the baseline years with the majority of disturbances occurring at Shell Beach and moderate levels of disturbance occurring at Estero Bluffs. The majority of disturbances at Shell Beach were from water-based sources while the majority of those at Estero Bluffs were from ground-based sources. This similar to source patterns observed during the baseline years (see Robinette et al. 2012a and Robinette et al. 2013).

Figures 12 shows detailed sources of disturbance for the three sites where disturbances were recorded in 2013. Disturbances recorded at Estero Bluffs were split evenly between walking humans and commercial fishing boats. There were also water-based disturbances at Estero Bluffs, including recreational fish boats and human powered boats (e.g., kayaks). There was one instance of an airplane causing disturbance at North Vandenberg. The sources of disturbance at Shell Beach were more diverse than at the other sites, with disturbances recorded for all categories but commercial fishing boat. The overwhelming majority of disturbances caused at Shell Beach were by human powered boats (mostly kayaks). There were also high occurrences of disturbances in the recreational power boat and humans walking categories. The majority of the recreational power boat disturbances were caused by a single tour company operating out of the Port of San Luis.

Patterns of disturbance at Montaña de Oro and Estero Bluffs in 2014 were similar to those observed in 2013 (Figure 13). Disturbance patterns for Shell Beach in 2014 are discussed below. As with 2013 and the two baseline years, the majority of disturbances at Estero Bluffs were caused by ground-based sources in 2014. Disturbance rates at Estero Bluffs were similar between 2013 and 2014. There were no disturbances recorded in 2013 and 2014 for the four focal species at Montaña de Oro.

Shell Beach Time Series (2011-2014)

Figure 14 shows patterns of disturbance at Shell Beach from 2011 through 2014. The majority of disturbances in all years were from water-based sources. There was a sharp decline in disturbance rates between 2011 and 2012 that was likely due to outreach efforts targeted at the single tour company causing a much of the disturbance. However, disturbance rates increased in 2013 beyond the levels observed in 2011. Overall, disturbance rates were higher in 2013 and 2014 than during the baseline years.

Figure 15 shows the detailed sources of disturbance at Shell Beach from 2011 through 2014. Recreational power boats (namely the tour boat) caused the majority of disturbances in 2011 while human powered boats (mostly kayaks) caused the majority of disturbances in 2012 through 2014. Disturbances by recreational power boats decreased through the time series while disturbances by kayaks increased through the time series. Humans walking along the coast caused moderate levels of disturbance in 2011, 2013, and 2014 and helicopters caused moderate levels of disturbance in 2011 and 2014. The increase in disturbances by kayaks and walking humans in 2013 and 2014 compared to baseline years may have been a result of more favorable weather conditions for these activities in 2013 and 2014.

DISCUSSION

Patterns of breeding population size, roost utilization, and disturbance rates were similar between 2013-2014 and the baseline years. There were large numbers of birds breeding at Shell Beach and South Vandenberg, while Shell Beach and Estero Bluffs were identified as important roost sites. Disturbance rates were higher at Shell Beach and Estero Bluffs than the two Vandenberg control sites. Overall, disturbance rates were higher in 2013-2014 than the baseline years despite outreach efforts. However, there were no disturbances recorded at Montaña de Oro in 2013-2014. The increased disturbance rates in 2013-2014 are likely attributable to two factors. First, roost utilization was overall higher in 2013-2014, especially at Shell Beach where much of the disturbance took place. Second, we suspect that favorable weather conditions resulted in an increased use of coastal areas by humans in 2013-2014. It is important to recognize that a successful outreach program will take time to develop. While there were notable immediate successes at Shell Beach after targeted outreach efforts, changing the behavior of the larger communities using Shell Beach, Estero Bluffs, and Montaña de Oro will take persistent efforts over several years.

The long-term trends at Vandenberg show increasing populations for all focal species despite recent years of average to below average reproductive success. The pattern of reproductive success for Western Gulls and Black Oystercatchers are concerning as reproductive success has been consistently below average since 2007 for oystercatchers and consistently below average since 2004 for gulls. The patterns observed in annual population size and reproductive success at Shell Beach from 2011-2014 are similar to those observed at Vandenberg over the same time period, indicating that local oceanographic conditions are a strong factor regulating populations throughout the PSPM study area.

The PSPM study area is located along a portion of the California coastline that experiences exceptionally strong, seasonal wind-generated upwelling events (Wing et al. 1998, Bograd et al. 2000). There is much interannual fluctuation in biological productivity throughout this area. Because of this, there are likely to be considerable interannual fluctuations in the size and reproductive performance of breeding seabird populations throughout the area (Boekelheide and Ainley 1989, Ainley et al. 1994, Ainley et al. 1995). Several studies have shown that prey availability is an important factor regulating seabird breeding population size and colony productivity. Prey availability has been shown to affect coloniality (whether birds form large or small colonies), the timing of reproduction, clutch sizes, levels of egg abandonment, chick growth, and non-predator related chick mortality (Anderson and Gress 1984, Safina and Burger 1988, Pierotti and Annetti 1990, Massey et al. 1992, Ainley et al. 1995, Monagham 1996, Golet et al. 2000).

In order to understand the impacts of annual disturbance rates on population size, we will need to isolate disturbance effects from the effects of annual prey availability. This will require developing a long term data series on population size and disturbance rates that will allow us to investigate the impact of disturbance while controlling for the underlying oceanographic mechanisms affecting prey availability and population size. A 15-year time series exists for seabird breeding populations at Vandenberg AFB and this time series will be important for deciphering disturbance impacts as the PSPM time series is developed. Despite annual variability in breeding effort, all species have shown increases in breeding population size at Vandenberg from 1999 to 2012. Thus, any benefits that seabird populations receive from PSPM outreach and law enforcement efforts will likely be occurring on top of already increasing population trends. Moving forward, it will be important to compare population trends in areas with active outreach and law enforcement to the continued trend for Vandenberg, where very few disturbances occur.

Based on our 2011-2014 results, Shell Beach appears to be a hot spot for both breeding and roosting birds. In addition to the availability of high quality breeding and roosting habitat, we suspect that seabirds are attracted to this area because of high prey availability. There are large patches of dense kelp throughout the area, perhaps the largest within our baseline study area. Additionally, we suspect that there is a retention area adjacent to the Shell Beach transect area. Retention areas are areas of recirculating water that can retain planktonic bodies, preventing their offshore transport during upwelling (Graham and Largier 1997). Retention areas can provide refuge for planktonic larvae against offshore transport (Wing et al. 1995a, 1998) and, thus, increase the probability that the larvae settle into habitats as juveniles. This is important because juvenile fish are important prey to coastally breeding seabirds like cormorants and guillemots (Hobson 1997, Wallace and Wallace 1998, Robinette et al. 2007). Additionally, retention areas retain nutrients and phytoplankton for long periods of time (Graham and Largier 1997), thereby enhancing primary productivity and potentially attracting nektonic organisms such as schooling fishes and squid. Many studies have shown that retention areas can be created in the lee of large and small coastal promontories (Wing et al. 1995b, 1998, Graham and Largier 1997, Mace and Morgan 2006a,b) and several retention areas have been identified in the California Current System (Wing et al. 1995b, 1998, Graham and Largier 1997, Mace and Morgan 2006a,b). We suspect that the greater Point Buchon promontory that shelters Port San Luis creates a retention area. In addition to this possible retention area, Trainer et al. (2000) and Robinette et al. (2007) provided evidence of a small retention area in the lee of the Point Arguello promontory (South Vandenberg AFB transect). The Point Arguello promontory is an important breeding area for all five of our breeding focal species. We also suspect that there is a retention area in the lee of the Estero Bluffs. While the habitat at Estero Bluffs is not suitable to support breeding for most of our focal species, it was a very important roosting area for Pelagic Cormorants and a moderate, though variable, roosting site for Brandt's Cormorants.

It is important to note that while we were able to monitor Brown Pelican roost utilization during our study period (April through July), this is not the peak roosting season for Brown Pelicans in central California. Brown

Pelicans breed on Anacapa and Santa Barbara Islands in southern California and the islands of Baja California, Mexico. They disperse north along the California coast after their breeding season. Howar and Robinette (2007) monitored seasonal roost utilization at Vandenberg AFB over several years (2001-2006) and showed that pelicans were virtually absent in the spring, appeared in low numbers throughout the summer, and showed moderate to high peaks in the fall and early winter. This is similar to patterns reported by Briggs et al. (1981), Briggs et al. (1983), and Capitolo et al. (2002) who all reported fall peaks in Brown Pelican roosting in southern and central California. Furthermore, roosting patterns of all the focal species are likely to change outside of the breeding season when birds are no longer tied to their nesting sites.

Throughout 2011-2014, most sites showed similar or lower productivity for all species when compared to the Vandenberg sites. The lower productivity observed at other sites may or may not be due to disturbance. Overall, productivity was lower for cormorants at Shell Beach where the highest disturbance rates were recorded, but higher for Western Gulls. As we develop a time series of productivity for multiple sites within the PSPM study region, we should be able to correlate differences in breeding productivity to disturbance rates at each site. Breeding productivity will therefore be a key metric to follow when assessing short-term benefits of PSPM outreach and law enforcement efforts.

MANAGEMENT RECOMMENDATIONS

1) Outreach efforts should continue to target water-based disturbance sources at Shell Beach and ground-based disturbance sources at Shell Beach, Montaña de Oro and Estero Bluffs. These are the leading sources of disturbance at these sites. Shell Beach is a very important area because it has large breeding populations of all PSPM focal species and is heavily used by roosting seabirds. It also received the highest rates of human-caused

disturbance throughout all four years of monitoring. We also feel that Estero Bluffs and Montaña de Oro are important sites. Though these areas do not have large breeding populations of all focal species, they are nonetheless import for different reasons. Montaña de Oro has important breeding habitat for Pigeon Guillemots and Black Oystercatchers while Estero Bluffs has important roosting habitat (and likely foraging habitat) for Pelagic Cormorants and likely Brandt's Cormorants. Both areas receive heavy use by the public and showed moderate to high levels of human-caused disturbance. Both areas are managed by California State Parks, a PSPM partner currently leading the outreach efforts.

2) The citizen science component should continue to be developed and sustained. The initial two years of the program produced encouraging results. However, more training and continued assessment will be needed to improve species identification and consistency among individual citizen scientists. Success of this program will require 1) continued funding and support for MCAS to recruit and coordinate the efforts of citizen scientists and 2) continued funding to support data management and training of citizen scientists. It is important that this program be adaptively managed and, based on the initial results from 2013 and 2014, it is clear that protocols and training methods need further refinement in order to improve accuracy in species identification and enumeration.

3) Monitoring by trained biologists should continue at the key impact and control sites, namely Shell Beach and South Vandenberg AFB. Shell Beach is a very important site and outreach efforts should be guided by the best available scientific information. Furthermore, given the large number of breeding birds at Shell Beach, it will be important to continue monitoring reproductive success at this site. The citizen science program does not currently collect this information. The Vandenberg control site will be important in allowing future analyses to distinguish between impacts of human-caused disturbance and variability in local oceanographic conditions. These types of analyses depend on multiple year time series data and will be

important for assessing the long-term impacts of outreach efforts on breeding population size, reproductive success, and roost utilization within the PSPM study area.

4) The PSPM network should give some priority to maintaining the Vandenberg seabird time series. This is the only comprehensive time series for all PSPM focal species within the baseline study area. The trends generated with this time series will allow scientists to distinguish between oceanographic and human impacts on seabird populations within the baseline study area. This, too, will be important when assessing the efficacy of outreach and law enforcement efforts.

5) Brown Pelican roost utilization should be monitored during the fall and winter months when peak numbers occur along the central California coast. While we were able to record roosting numbers of pelicans, our study period is within the initial northward migration for Brown Pelicans. Roosting numbers are highly variable during this period and may not adequately identify import roosts for Brown Pelicans. Extending monitoring efforts into the fall and winter would require additional funding and could likely involve students from Cal Poly San Luis Obispo. However, data could be collected on all focal species (except Pigeon Guillemots which winter at sea) to gain a better understanding of which areas are important outside of the breeding season.

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Table 1. Comparison of breeding population, roost utilization, and disturbance rate estimates by Point Blue (PB) biologists and Morro Coast Audubon Society (MCAS) citizen scientists at Estero Bluffs and Montaña de Oro in 2013. Population estimates are numbers of breeding birds, roost utilization estimates are mean ± SD birds per survey, and disturbance rate estimates are number of disturbances per hour of observation. Differences are expressed as percent difference and number of standard deviations (SD) where SD could be calculated.

			Group Estimates		Difference	
Metric	Survey Site	Speices	PB	MCAS	%	SD
Breeding Population	Estero Bluffs	WEGU	2	4	+100%	n/a
		BLOY	4	4	0%	n/a
	Montaña de Oro	WEGU	22	14	-36%	n/a
		BLOY	6	2	-67%	n/a
Mean ±SD Roost Utilization	Estero Bluffs	BRAC	45.2 ±48.8	66.4 ±56.8	+47%	+0.4
		PECO	19.7 ±29.5	2.3 ±3.6	-88%	-1.1
		DCCO	44.0 ±39.2	71.5 ±46.1	+63%	+0.6
		All Corms	109.6±74.9	166.3 ±39.4	+52%	+1.0
		BRPE	24.1 ±44.6	35.5 ±53.3	+47%	+0.2
		WEGU	147.5 ±137.2	207.5 ±143.7	+41%	+0.4
	Montaña de Oro	BRAC	2.6 ±7.9	4.6 ±3.9	+77%	+0.3
		PECO	3.5 ±2.7	19.5 ±18.5	+457%	+1.5
		DCCO	0.1 ±0.3	4.9	+4800%	+0.7

				±12.6		
		All Corms	6.3 ±7.7	30.5 ±23.5	+384%	+1.6
		BRPE	0.6 ±2.7	2.0 ±6.4	+233%	+0.3
		WEGU	22.7 ±7.3	25.4 ±10.0	+12%	+0.3
Overall Disturbance Rate	Estero Bluffs	All Species	0.065	0.304	+368%	n/a
	Montaña de Oro	All Species	0.052	0.185	+256%	n/a

Table 2. Number of breeding birds for each focal species within each of the 6 transects in 2013 (A) and 2014 (B). Population estimates for individual counting blocks within each transects can be found in Appendices I through V.

(A) 2013

Transect	Double-crested Cormorant	Brandt's Cormorant	Pelagic Cormorant	Pigeon Guillemot	Western Gull	Black Oyster-catcher
Estero bluffs	0	0	0	0	2	4
Montaña de Oro	0	0	2	121	28	8
PG&E Trail	0	966	202	247	220	6
Shell Beach	244	508	272	331	226	28
No Vandenberg	0	0	8	116	10	8
So Vandenberg	0	504	208	1312	94	18
Total	244	1978	692	2127	580	72

(B) 2014

Transect	Double-crested Cormorant	Brandt's Cormorant	Pelagic Cormorant	Pigeon Guillemot	Western Gull	Black Oyster-catcher
Estero bluffs	0	0	0	12	0	6
Montaña de Oro	0	0	0	97	12	2
Shell Beach	84	632	242	344	250	14
No Vandenberg	0	0	0	123	10	4

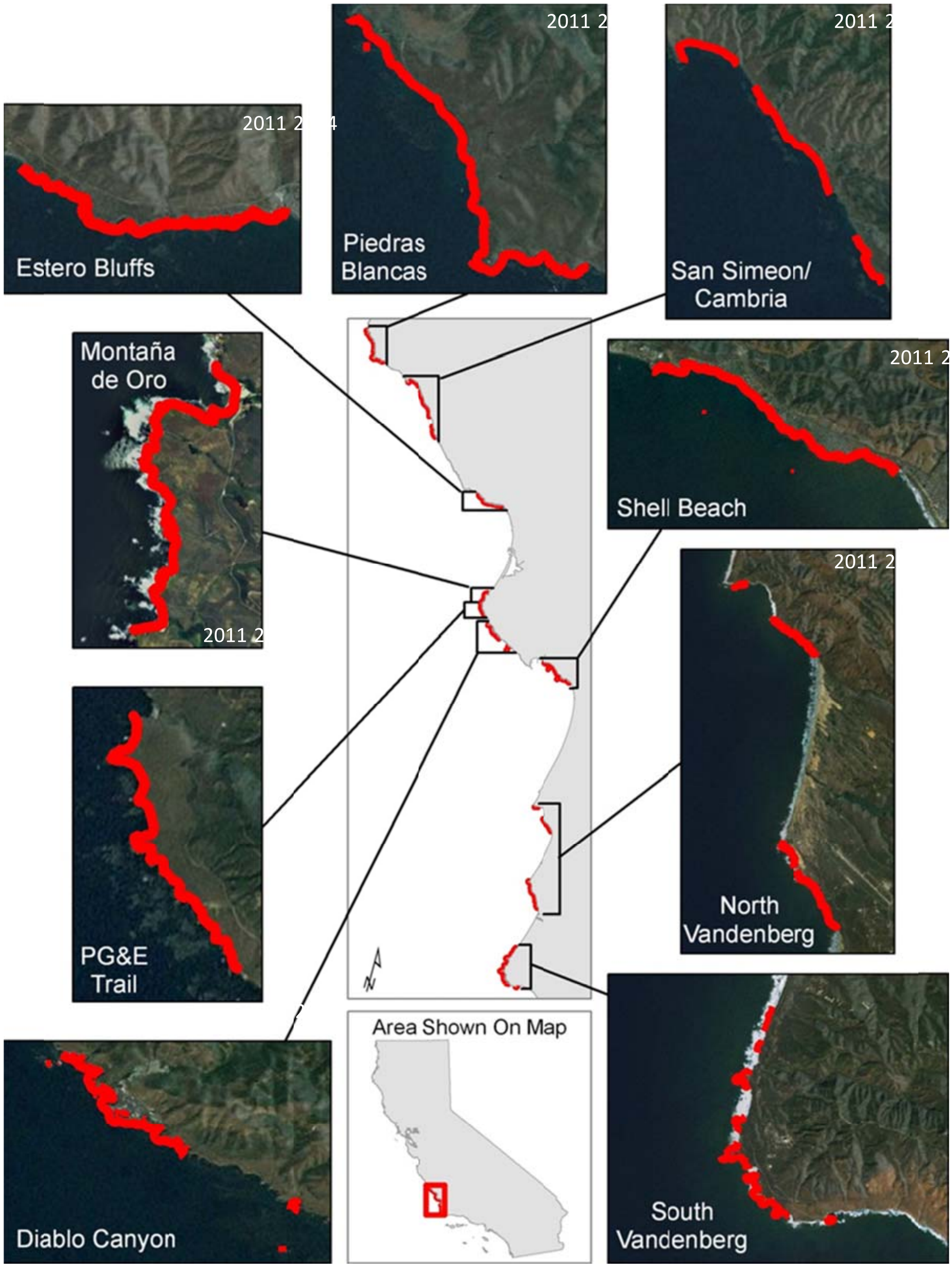
So Vandenberg	0	612	202	1372	74	16
Total	84	1244	444	1948	346	42

Table 3. Results of regression analyses to determine best fitting models for population trends of Pelagic Cormorants, Brandt's Cormorants, Pigeon Guillemots, Black Oystercatchers, and Western Gulls breeding on VAFB from 1999 through 2014.

	Linear	Quadratic	Exponential Growth
Pelagic Cormorant	$p < 0.001$ $R^2 = 0.821$	$p < 0.001$ $R^2 = 0.872$	$p < 0.001$ $R^2 = 0.840$
Brandt's Cormorant	$p < 0.001$ $R^2 = 0.840$	$p < 0.001$ $R^2 = 0.935$	$p < 0.001$ $R^2 = 0.916$
Pigeon Guillemot	$p = 0.004$ $R^2 = 0.458$	$p = 0.016$ $R^2 = 0.472$	$p = 0.004$ $R^2 = 0.455$
Black Oystercatcher	$p = 0.051$ $R^2 = 0.262$	$p = 0.103$ $R^2 = 0.315$	$p = 0.056$ $R^2 = 0.253$
Western Gull	$p = 0.001$ $R^2 = 0.560$	$p < 0.001$ $R^2 = 0.897$	$p = 0.001$ $R^2 = 0.547$

Table 4. Nest failures at Shell Beach from 2011-2014. *Note: 2014 season surveys ended on 6/9/15, so values may be underestimates. Nest failure is defined as abandonment before estimated hatch date.

	2011			2012			2013			2014*		
	# Nests	# Failed	*% Failed*	# Nests	# Failed	*% Failed*	# Nests	# Failed	*% Failed*	# Nests	# Failed	*% Failed*
BRAC	63	1	*1.6*	76	17	*22.4*	79	9	*11.4*	83	12	*14.5*
DCCO	43	43	*100.0*	13	13	*100.0*	33	33	*100.0*	42	20	*47.62*
PECO	55	9	*16.4*	78	43	*55.1*	88	47	*53.4*	90	17	*18.9*
WEGU	57	21	*36.8*	55	19	*34.6*	55	26	*47.3*	75	2	*2.7*
BLOY	2	2	*100.0*	8	6	*75.0*	13	9	*69.2*	4	1	*25.0*


Estero Bluffs
Piedras Blancas
San Simeon/ Cambria
Montaña de Oro
Shell Beach
North Vandenberg
PG&E Trail
Area Shown On Map
South Vandenberg
Diablo Canyon

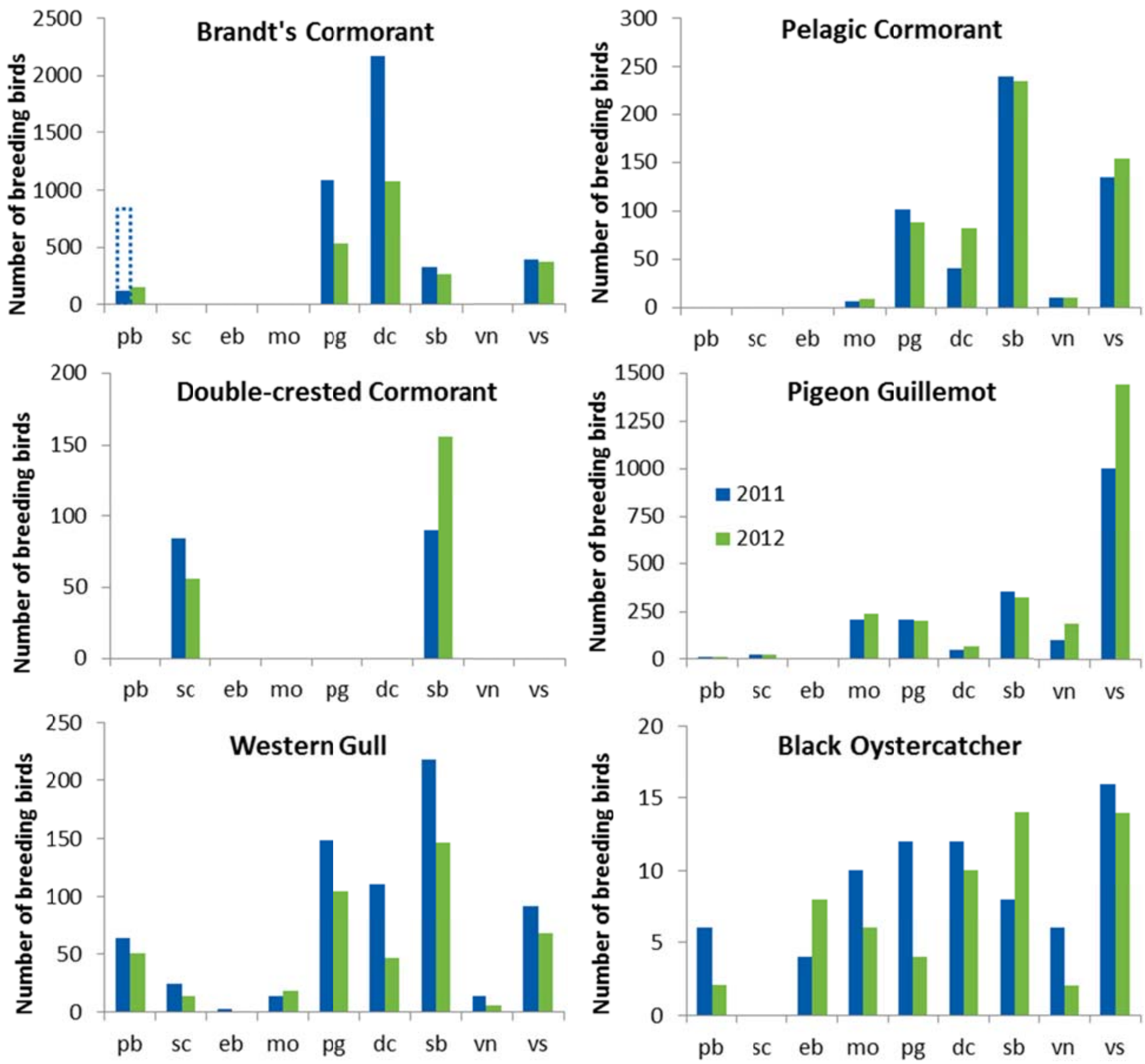


Figure 1. Map of the PSPM baseline study area with each of the nine transects surveyed in 2011 to 2014.

Figure 2. Comparison of 2011 and 2012 breeding population distributions among each of the nine transects for Brandt's Cormorants, Pelagic Cormorants, Double-crested Cormorants, Pigeon Guillemots, Western Gulls, and Black Oystercatchers. Dashed bar for Brandt's Cormorants at Piedras Blancas indicates the 2011 population estimate for aerial surveys conducted

by Capitolo et al. (2012). pb = Piedras Blancas, sc = San Simeon/Cambria, eb = Estero Bluffs, mo = Montana de Oro, pg = PG&E Trail, dc = Diablo Canyon, sb = Shell Beach, vn = North Vandenberg, and vs = South Vandenberg.

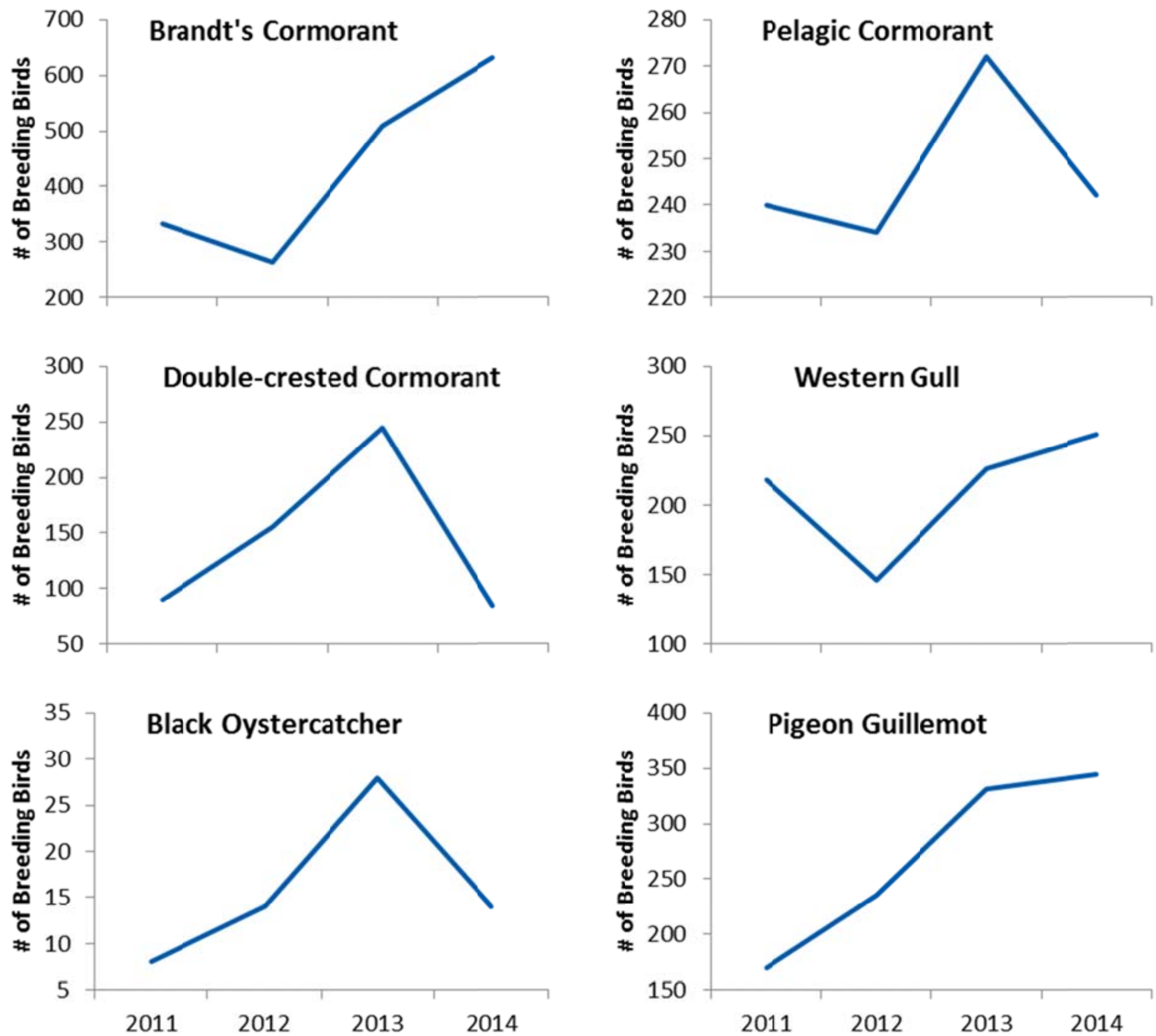


Figure 3. Number of breeding birds of six species at Shell Beach, 2011-2014. Note: 2014 surveys ended on June 9, so breeding pairs established after that date are not included in the 2014 counts.

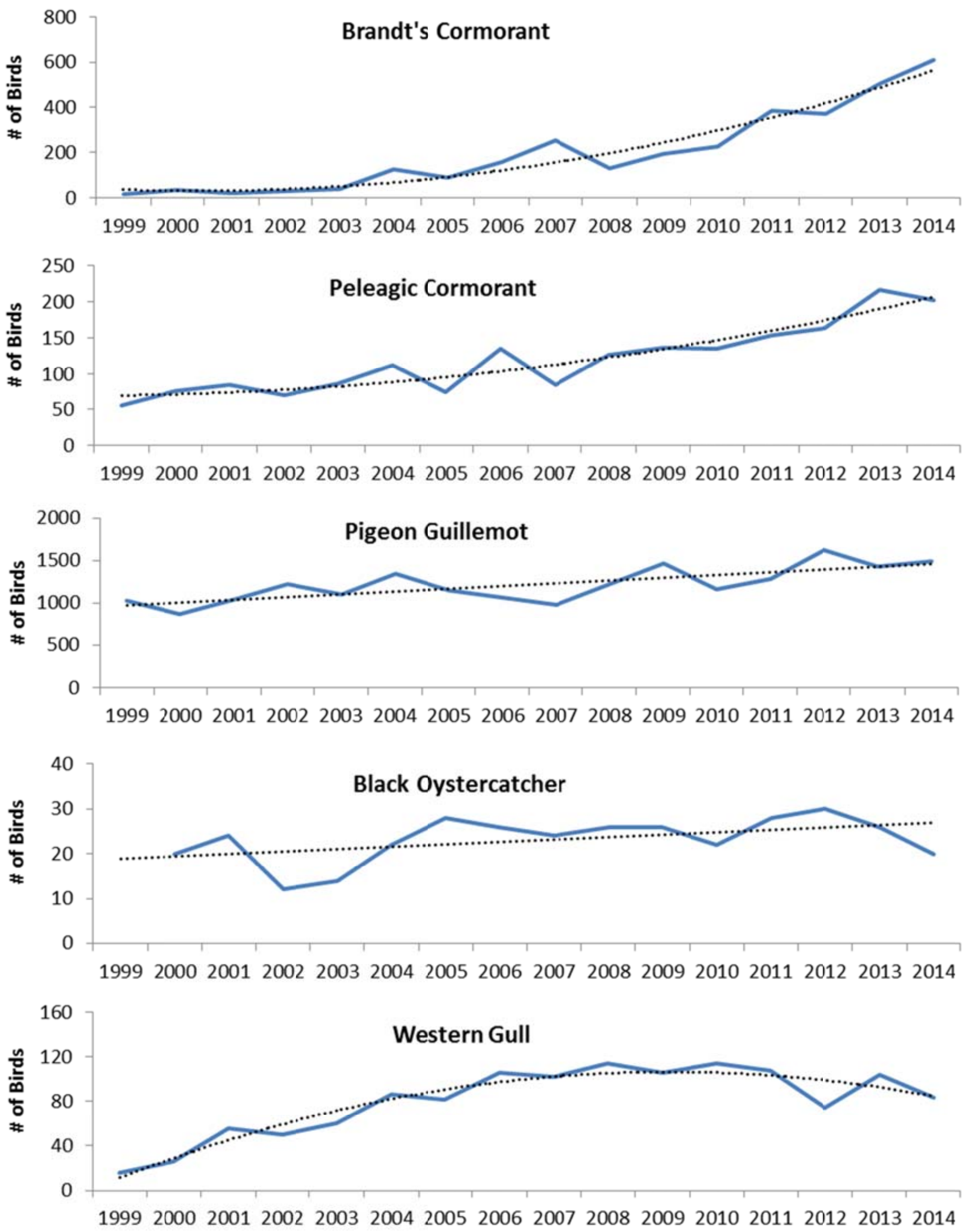
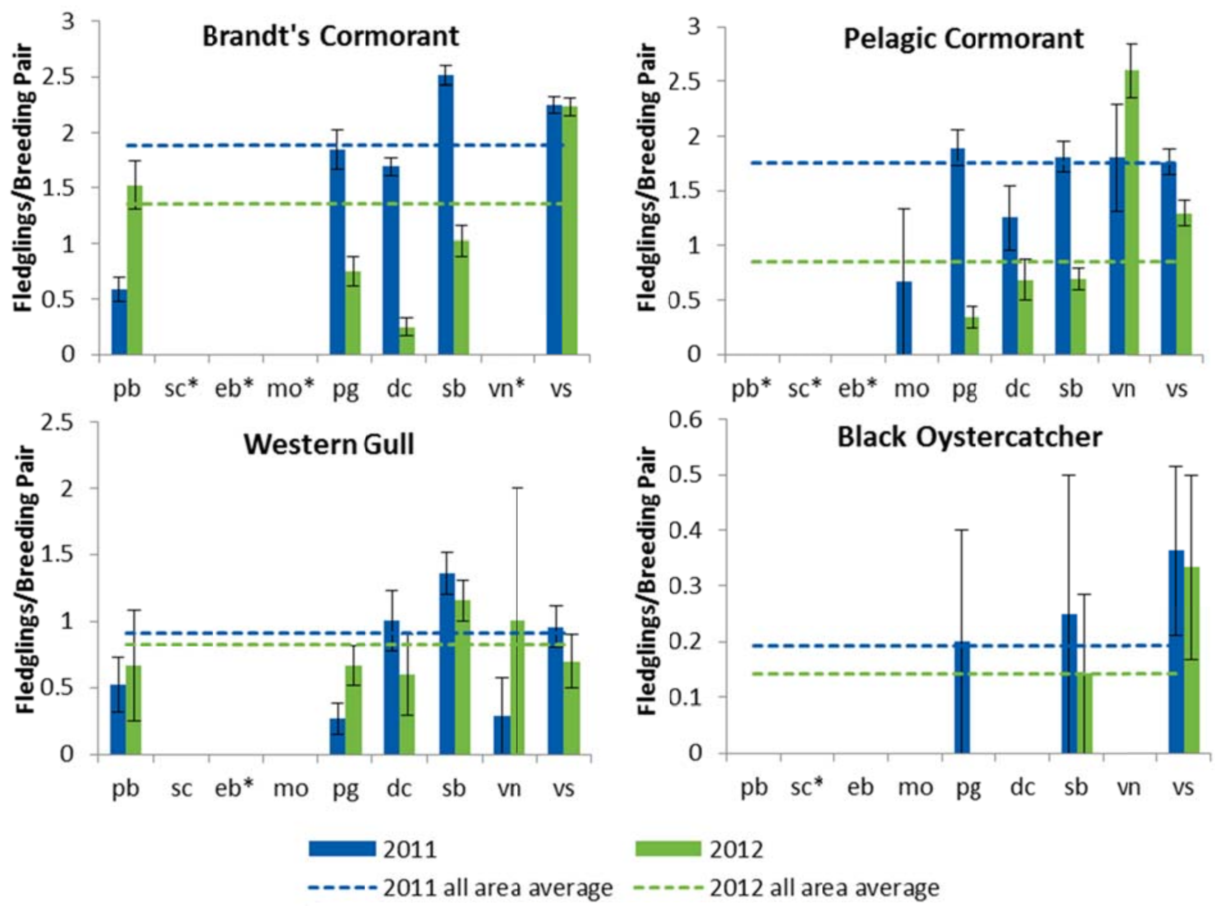


Figure 4. Trends in breeding populations for five species breeding at Vandenberg AFB from 1999 to 2014. Blue lines show variability in annual



breeding populations while black dashed lines were derived from regression analyses (see Table 3) and show trends over the time series.

Figure 5. Mean number of chicks fledged per breeding pair for each PSPM focal species within each transect in 2011 and 2012. Error bars represent standard error and the dashed line represents the mean across all transects. The * identifies transects where a given species did not breed. See Figure 2 for location abbreviations.

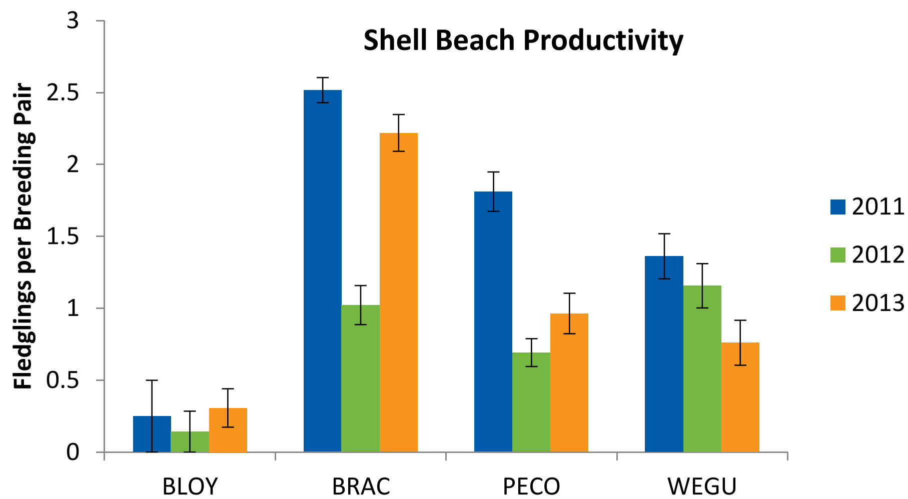


Figure 6. Mean number of chicks fledged per breeding pair for each PSPM focal species at Shell Beach from 2011 and 2013. Error bars represent standard error.

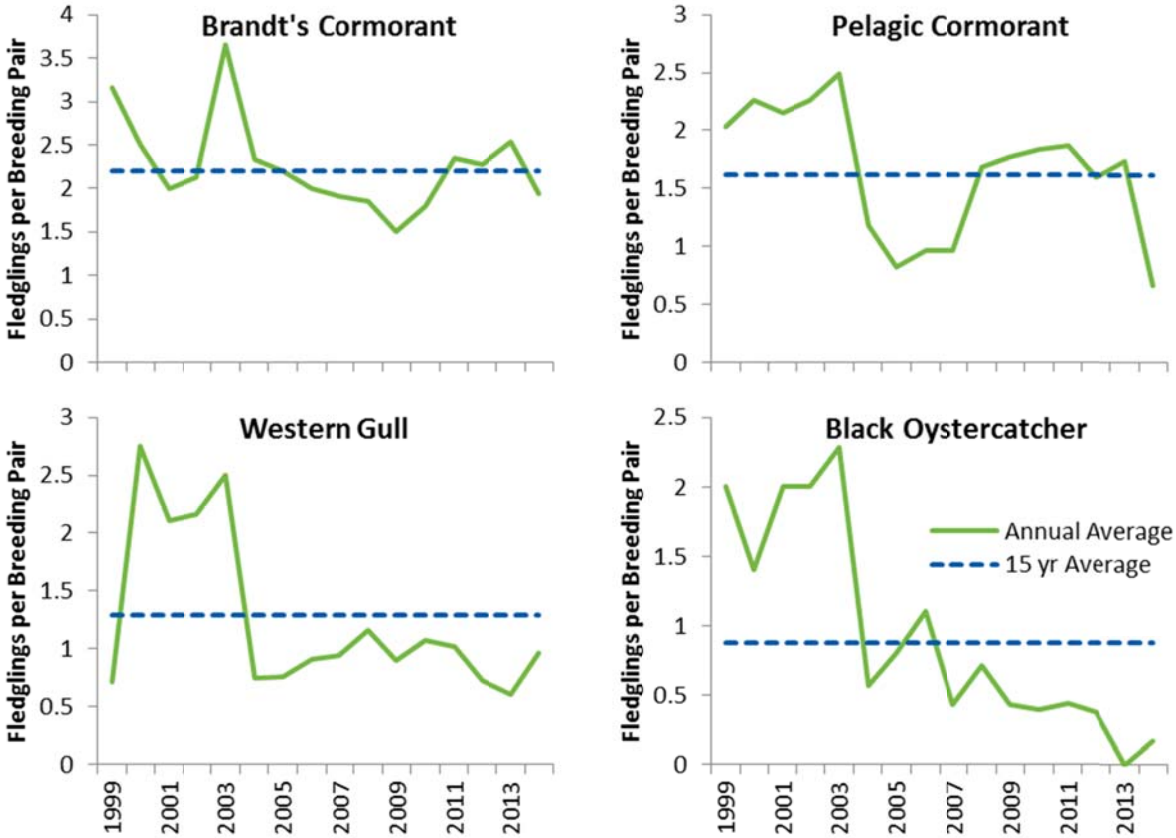


Figure 7. Estimates of reproductive success (fledglings per breeding pair) for Brandt's Cormorants, Pelagic Cormorants, Western Gulls, and Black Oystercatchers breeding at Vandenberg AFB, 1999 – 2014.

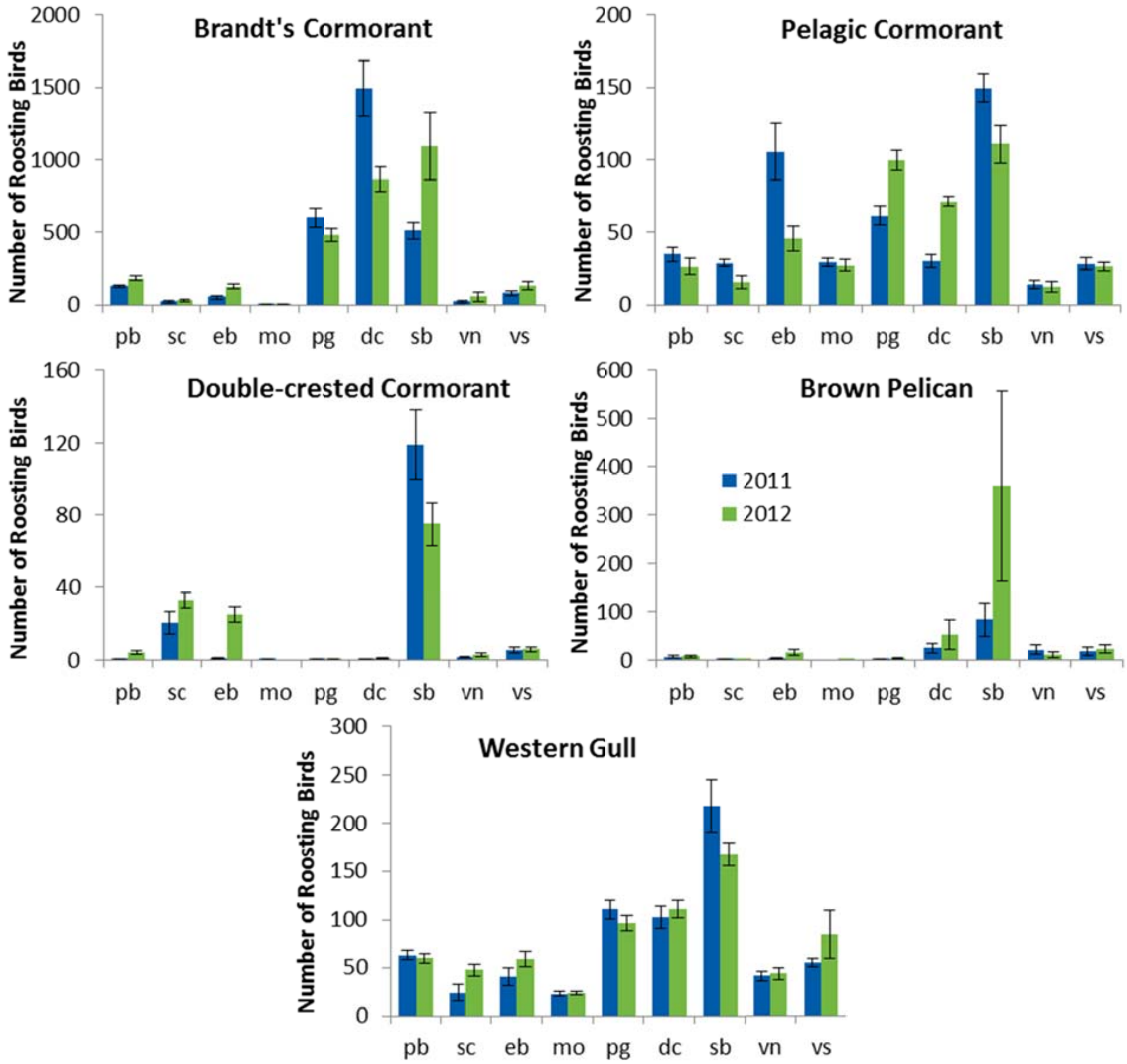


Figure 8. Mean number of roosting birds within each of the nine transects in 2011 and 2012. Error bars represent standard error. See Figure 2 for location abbreviations.

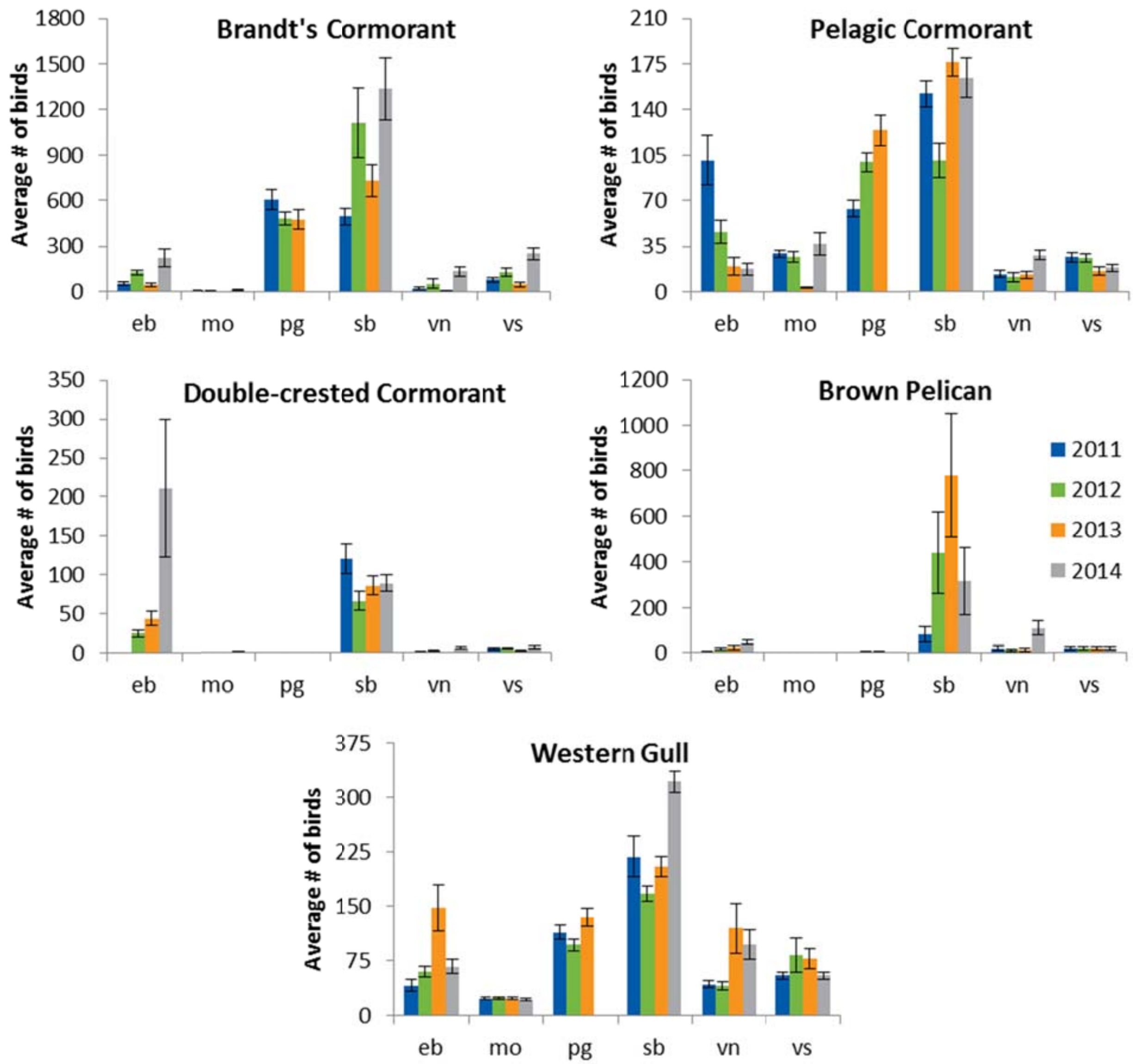


Figure 9. Mean number of roosting birds within six transects from 2011 to 2014. Error bars represent standard error. Note: there is no observation data for location "pg" in 2014. See Figure 2 for location abbreviations.

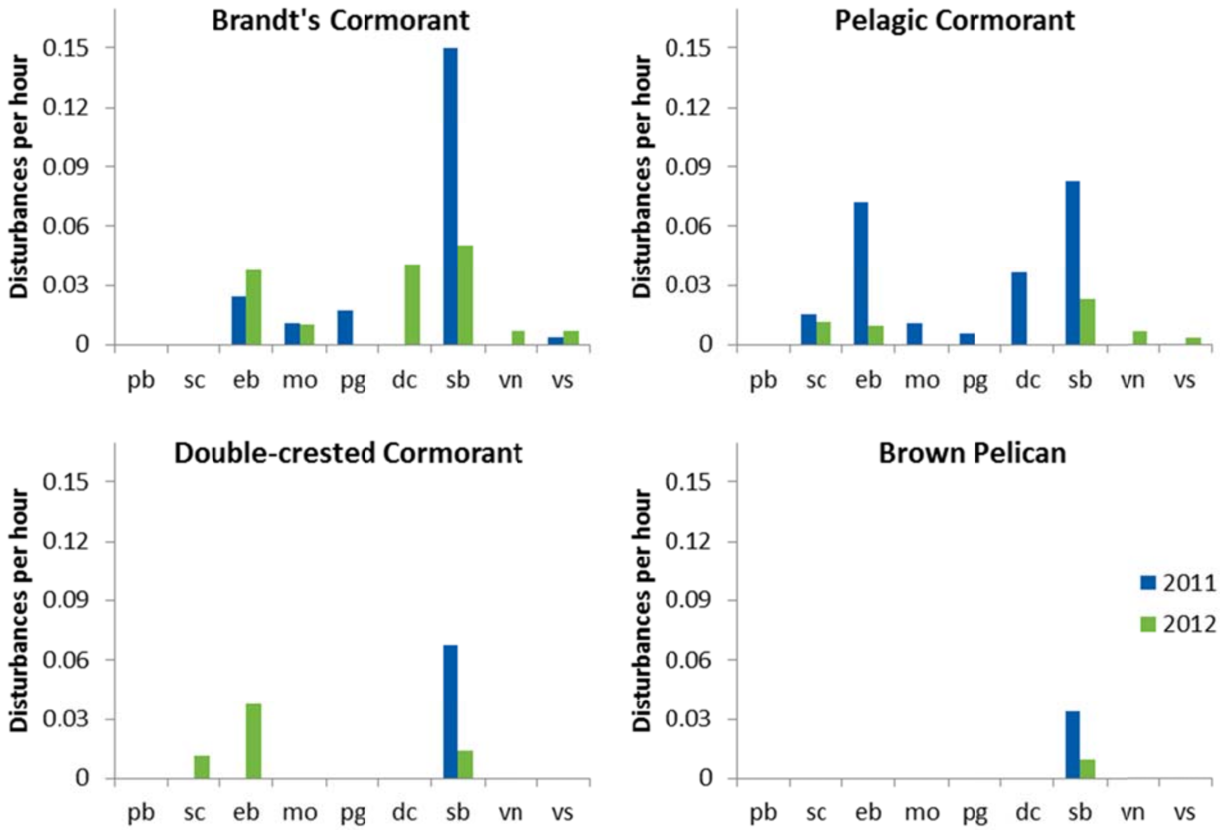


Figure 10. Comparison of 2011 and 2012 disturbance rates (number of disturbances per hour of observation) among each of the nine transects for Brandt's Cormorants, Pelagic Cormorants, Double-crested Cormorants, and Western Gulls. See Figure 2 for location abbreviations.

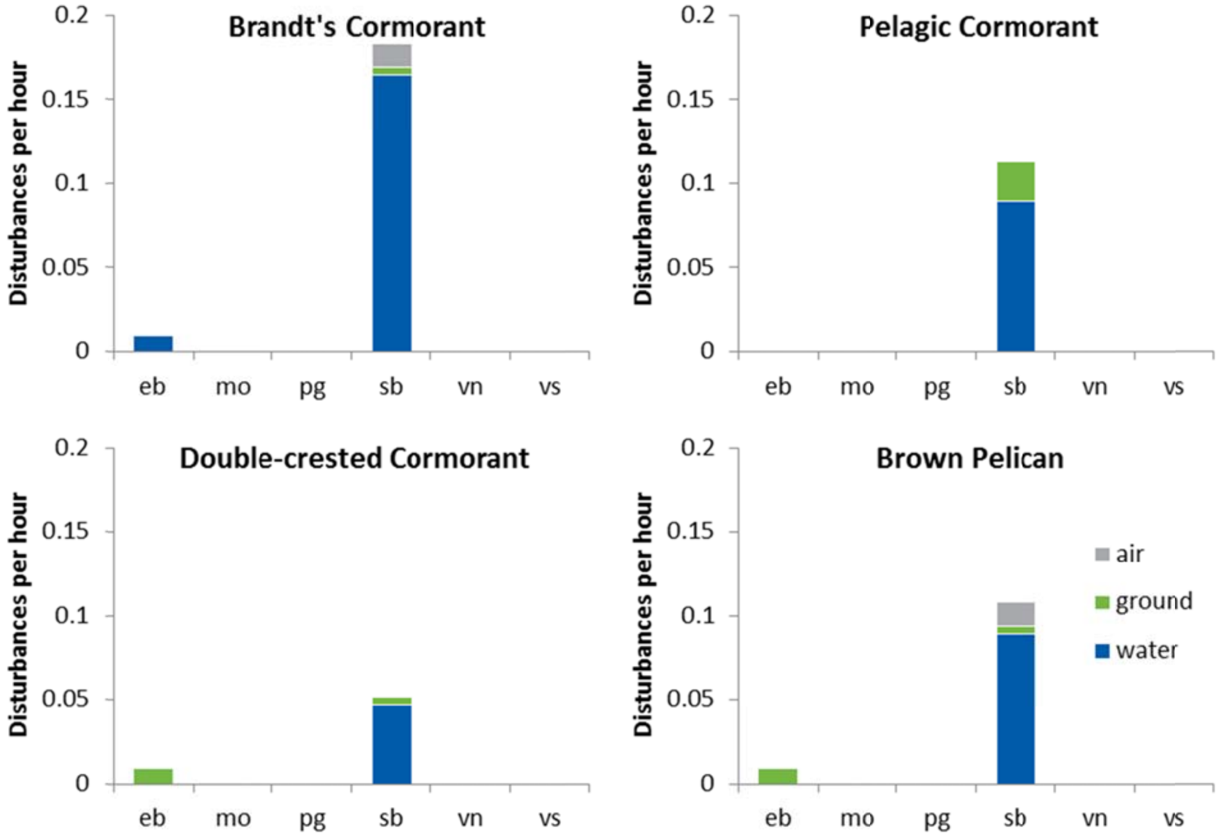


Figure 11. Comparison of air-, ground-, and water-based disturbance rates (number of disturbances per hour of observation) in 2013 among each of the six transects for Brandt's Cormorants, Pelagic Cormorants, Double-crested Cormorants, and Western Gulls. See Figure 2 for location abbreviations.

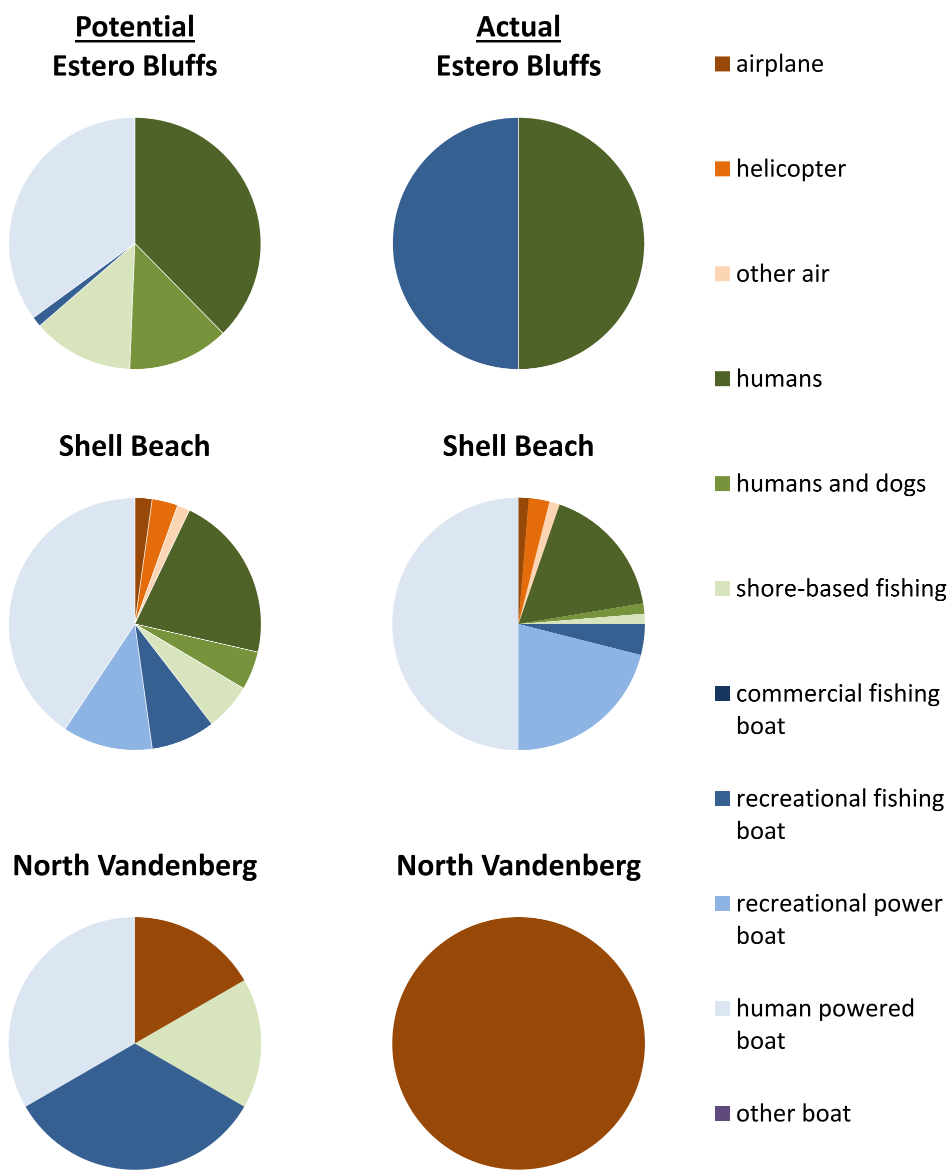


Figure 12. Sources of potential disturbance versus actual disturbance to birds at the three survey sites where disturbances were observed in 2013 (Estero Bluffs, Shell Beach, and North Vandenberg AFB).

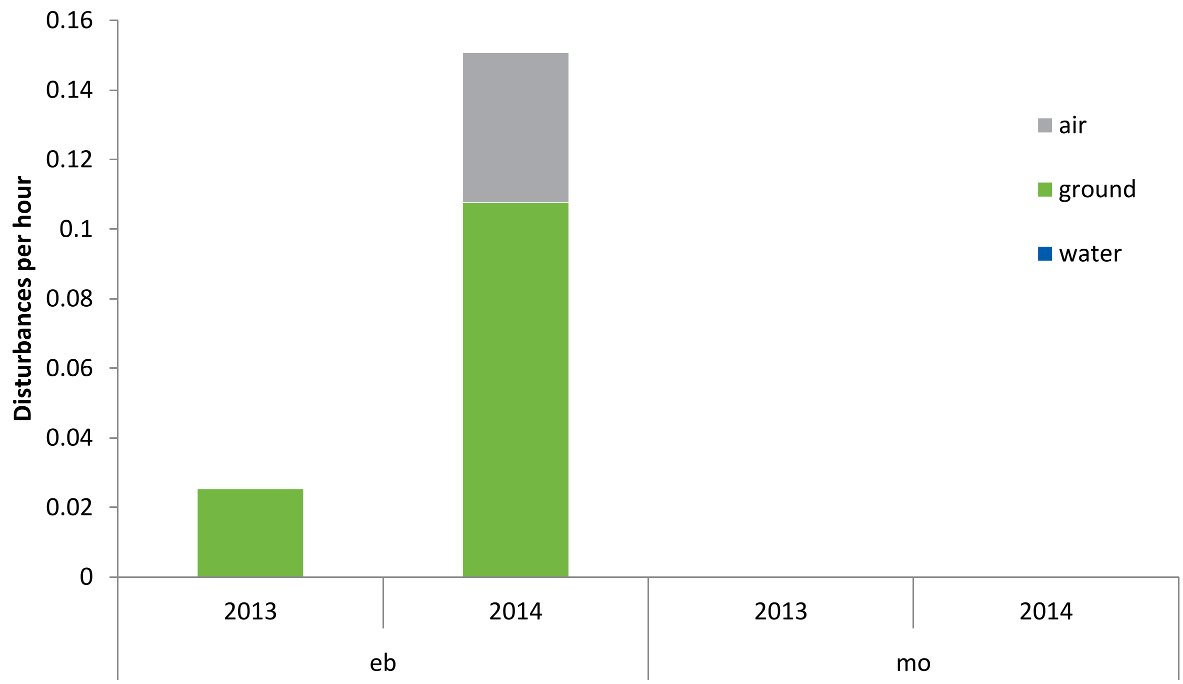


Figure 13. Comparison of air-, ground-, and water-based disturbance rates (number of disturbances per hour of observation) in 2013-2014 at Estero Bluffs (eb) and Montaña de Oro (mo) for Brandt's Cormorants, Pelagic Cormorants, Double-crested Cormorants, and Brown Pelicans combined. There were no water-based disturbances, and the listed species were not disturbed at Montaña de Oro in 2013 or 2014.

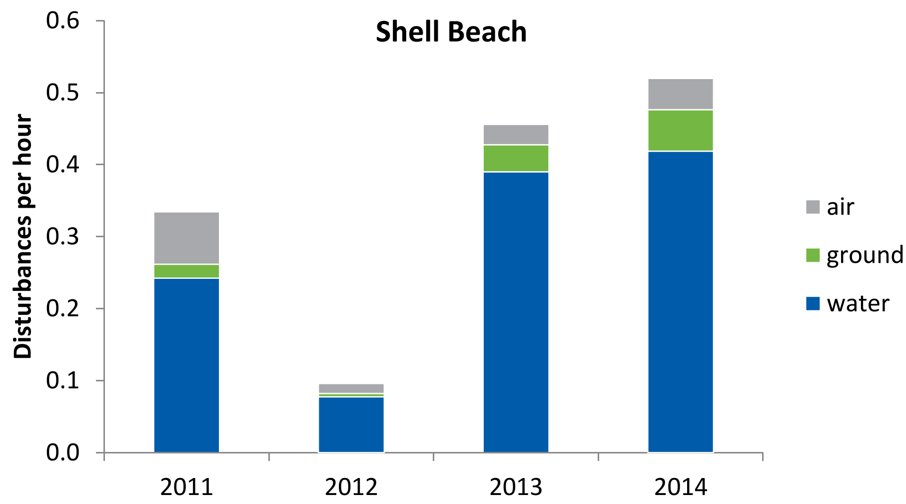


Figure 14. Comparison of r air-, ground-, and water-based disturbance rates (number of disturbances per hour of observation) in 2011-2014 at Shell Beach for Brandt's Cormorants, Pelagic Cormorants, Double-crested Cormorants, and Brown Pelicans combined.

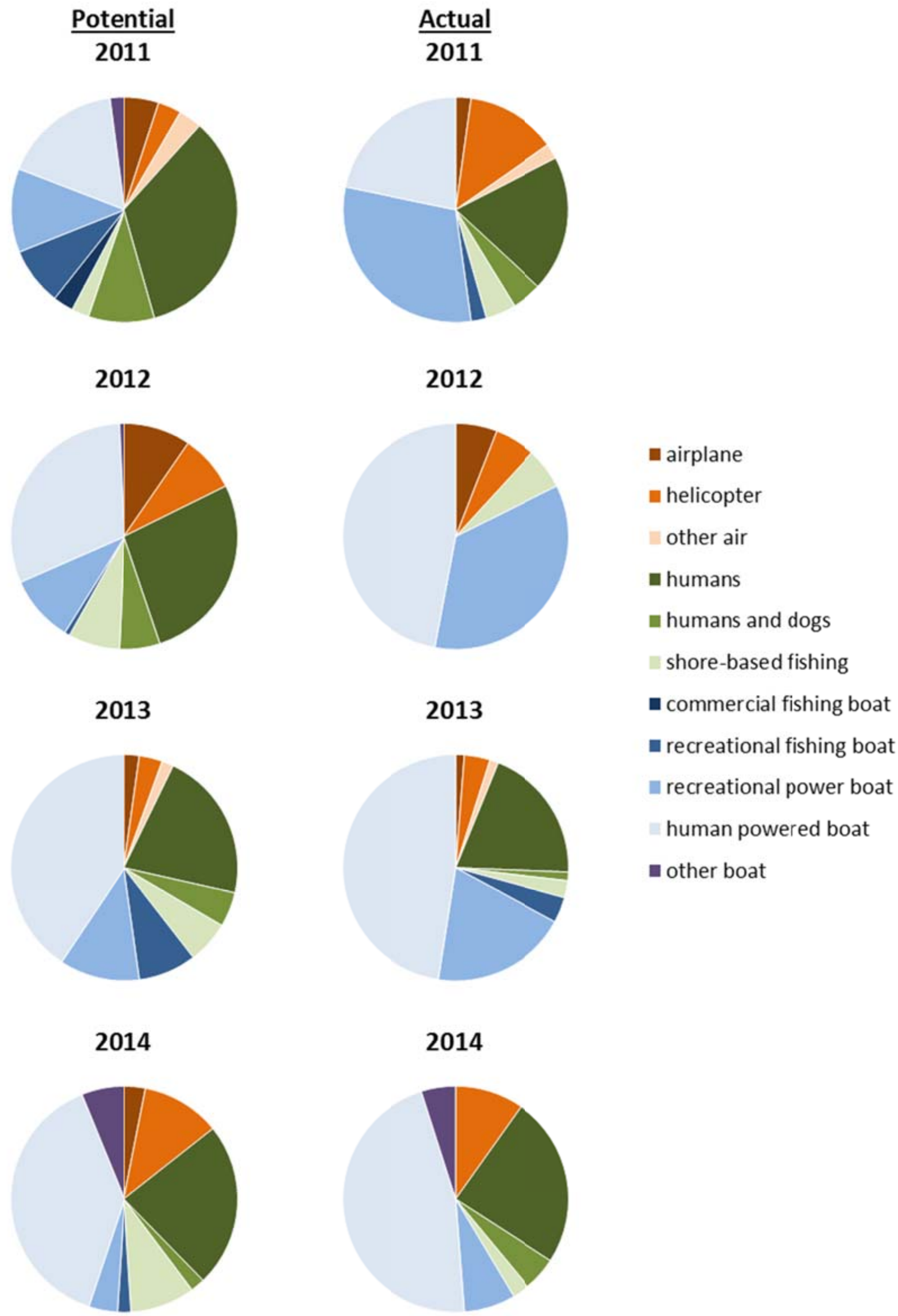
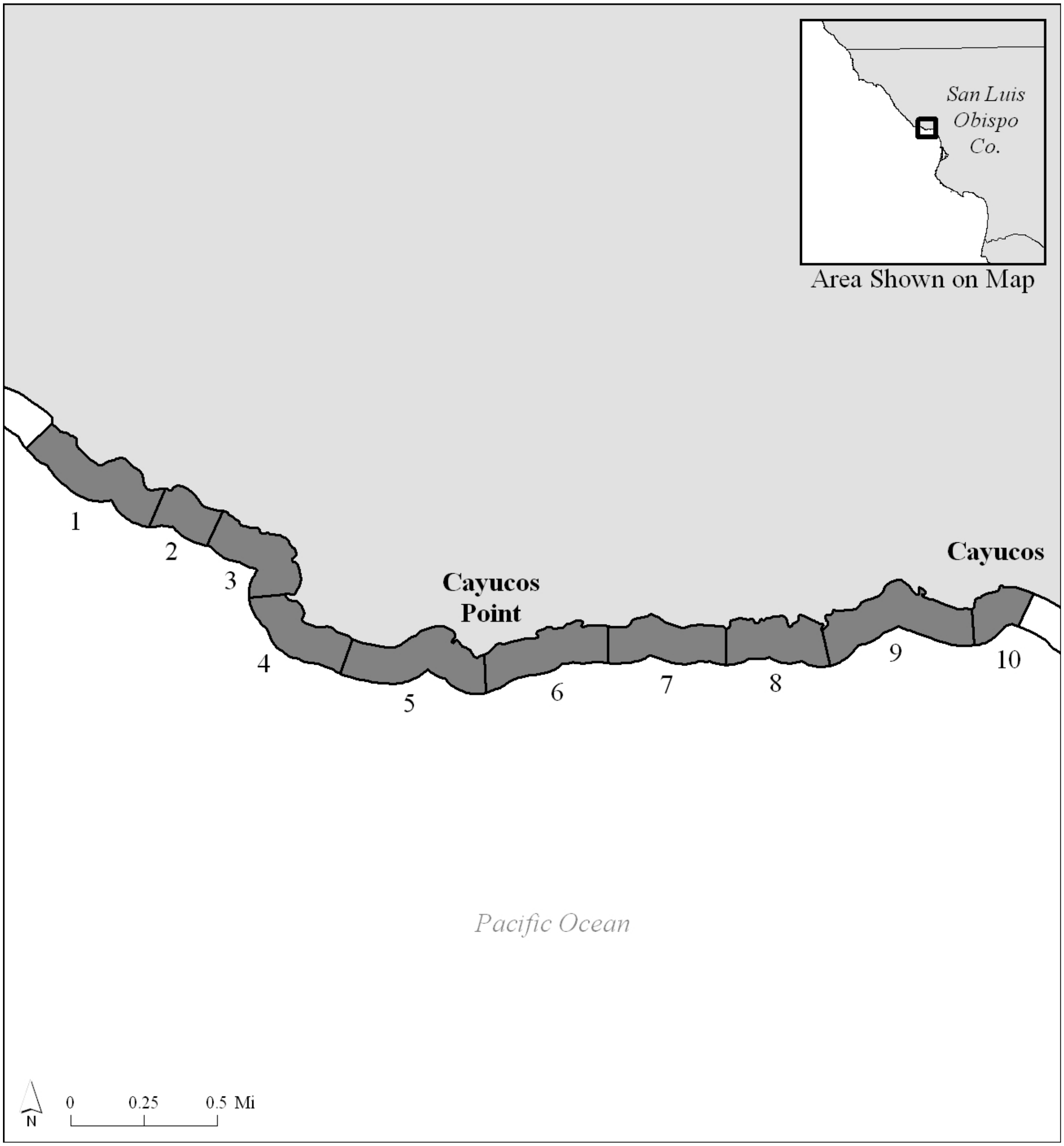

Potential
Actual
2011
2011
2012
2012
2013
2013
2014
2014
airplane
helicopter
other air
humans
humans and dogs
shore-based fishing
commercial fishing boat
recreational fishing boat
recreational power boat
human powered boat
other boat

Figure 15. Sources of potential disturbance events versus actual disturbances to birds at Shell Beach, 2011-2014.

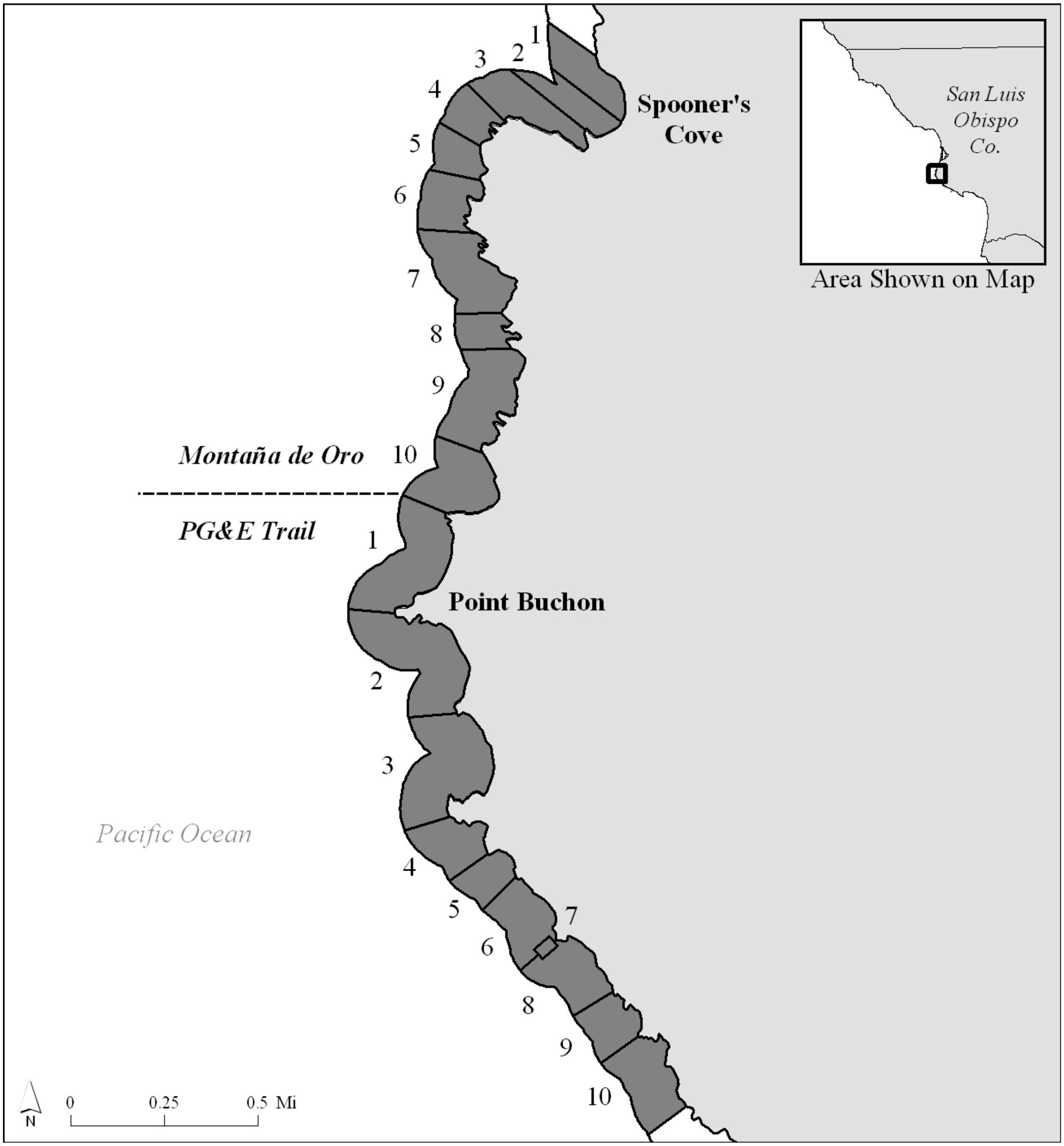
Appendix I: Population Estimates for the Estero Bluffs Sub-colonies



Population Estimates for the Estero Bluffs Sub-colonies 2013

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
eb1	Black Oystercatcher	1		
eb2	Black Oystercatcher	2		
eb3	Black Oystercatcher	8		
eb4	Black Oystercatcher	4		
eb5	Black Oystercatcher	4	1	
eb6	Black Oystercatcher	2		
eb7	Black Oystercatcher	3		
eb8	Black Oystercatcher	3	1	
eb9	Black Oystercatcher	2		
	Western Gull	2	1	
eb10	none	-	-	
TOTALS	**Black Oystercatcher**	**29**	**3**	
	Western Gull	**2**	**1**	

Appendix II: Population Estimates for the Montana de Oro and PG&E Trail Sub-colonies



Population Estimates for the Montana de Oro Sub-colonies 2013; 2014

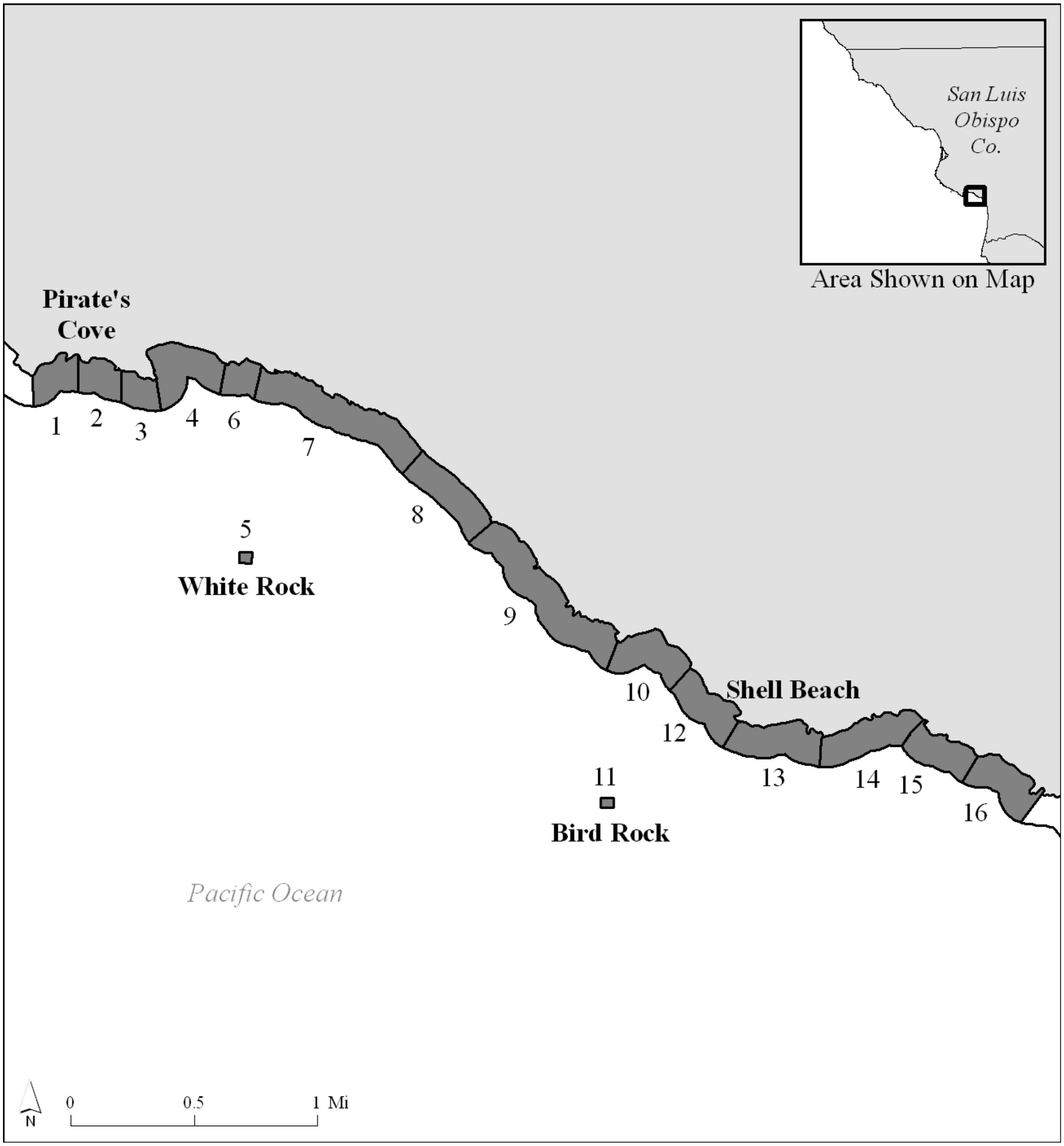
Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
mo1	Black Oystercatcher	2 ; 0	0 ; 0	
	Pigeon Guillemot	0 ; 3	nc	- ; 4/28
mo2	Black Oystercatcher	2 ; 0	0 ; 0	
	Pigeon Guillemot	23 ; 22	nc	5/30 ; 4/16
	Western Gull	0 ; 2	0 ; 1	
mo3	Black Oystercatcher	4 ; 0	1 ; 0	
	Pigeon Guillemot	45 ; 35	nc	4/15 ; 4/28
	Western Gull	2 ; 0	1 ; 0	
mo4	Black Oystercatcher	3 ; 0	1 ; 0	
	Pigeon Guillemot	0 ; 1	nc	- ; 5/15
mo5	Black Oystercatcher	2 ; 0	0 ; 0	
	Western Gull	2 ; 0	1 ; 0	
mo6	Black Oystercatcher	4 ; 0	0 ; 0	
	Western Gull	2 ; 0	1 ; 0	
mo7	Black Oystercatcher	2 ; 0	0 ; 0	
	Western Gull	2 ; 0	1 ; 0	
mo8	Pigeon Guillemot	0 ; 1	nc	- ; 5/15
mo9	Black Oystercatcher	2 ; 0	0 ; 0	
	Pigeon Guillemot	28 ; 25	nc	4/15 ; 4/12
	Western Gull	14 ; 10	7 ; 5	
mo10	Black Oystercatcher	2 ; 0	1 ; 0	
	Pigeon Guillemot	47 ; 30	nc	6/9 ; 4/16
	Pelagic Cormorant	4 ; 0	2 ; 0	
TOTALS	**Black Oystercatcher**	**23 ; 0**	**3 ; 0**	
	Pigeon Guillemot	**143 ; 117**	**nc**	
	Western Gull	**22 ; 12**	**11 ; 6**	
	Pelagic Cormorant	**4 ; 0**	**2 ; 0**	

Population Estimates for the PG&E Trail Sub-colonies 2013

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
pg1	Black Oystercatcher	4	0	
	Pigeon Guillemot	31	nc	5/6
	Western Gull	36	18	
pg2	Black Oystercatcher	2	0	
	Pigeon Guillemot	45	nc	4/17
	Western Gull	16	8	
	Brandt's Cormorant	462	231	
	Pelagic Cormorant	32	16	
pg3	Black Oystercatcher	1	0	
	Pigeon Guillemot	44	nc	4/17
	Western Gull	6	3	
	Brandt’s Cormorant	262	161	
	Pelagic Cormorant	10	5	
pg4	Black Oystercatcher	2	0	
	Pigeon Guillemot	40	nc	4/11
	Pelagic Cormorant	90	45	
pg5	Black Oystercatcher	2	0	
	Pigeon Guillemot	33	nc	5/28
	Western Gull	12	6	
	Pelagic Cormorant	4	2	
pg6	Black Oystercatcher	2	1	
	Pigeon Guillemot	35	nc	5/6
	Western Gull	56	28	
	Pelagic Cormorant	16	8	
pg7	Black Oystercatcher	2	0	
	Pigeon Guillemot	9	nc	5/21
	Western Gull	4	2	
	Brandt's Cormorant	6	0	
pg8	Black Oystercatcher	3	1	
	Pigeon Guillemot	21	nc	6/3
	Western Gull	44	22	
	Pelagic Cormorant	36	18	
pg9	Black Oystercatcher	2	1	
	Pigeon Guillemot	39	nc	6/3
	Western Gull	16	8	

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
pg10	Black Oystercatcher	1	0	
	Pigeon Guillemot	68	nc	4/17
	Western Gull	10	5	
TOTALS	**Brandt's Cormorant**	**730**	**392**	
	Pelagic Cormorant	**188**	**94**	
	Pigeon Guillemot	**365**	**nc**	
	Western Gull	**200**	**100**	
	Black Oystercatcher	**21**	**3**	

Appendix III: Population Estimates for the Shell Beach Sub-colonies

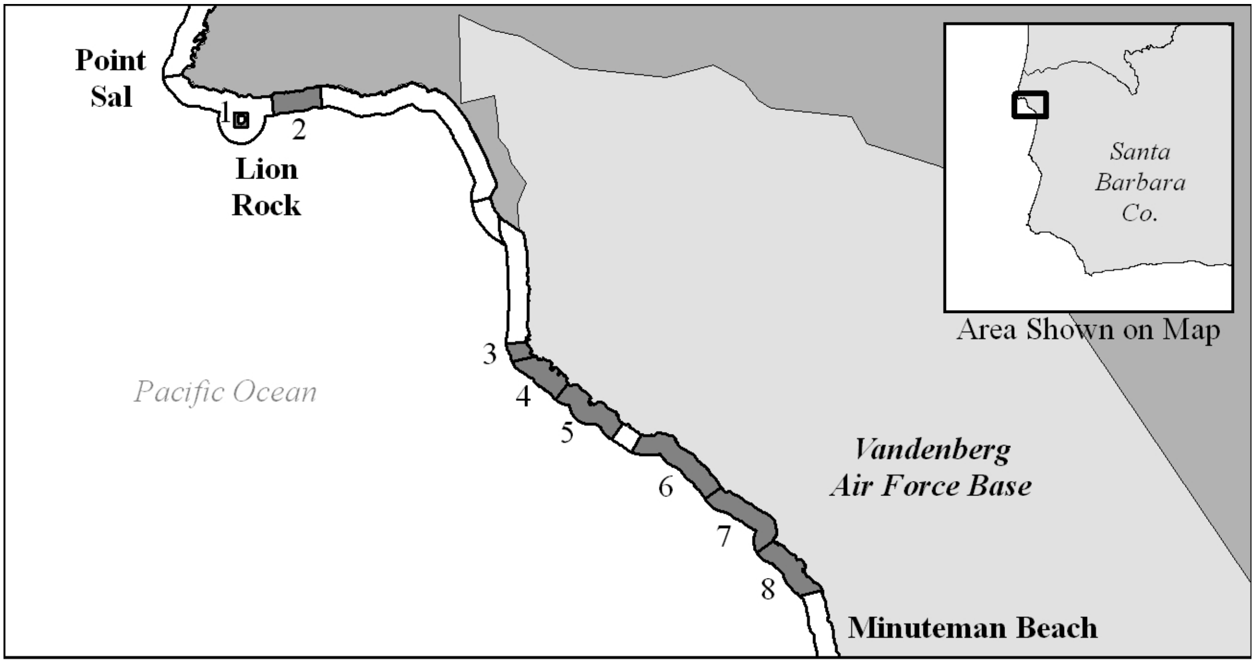


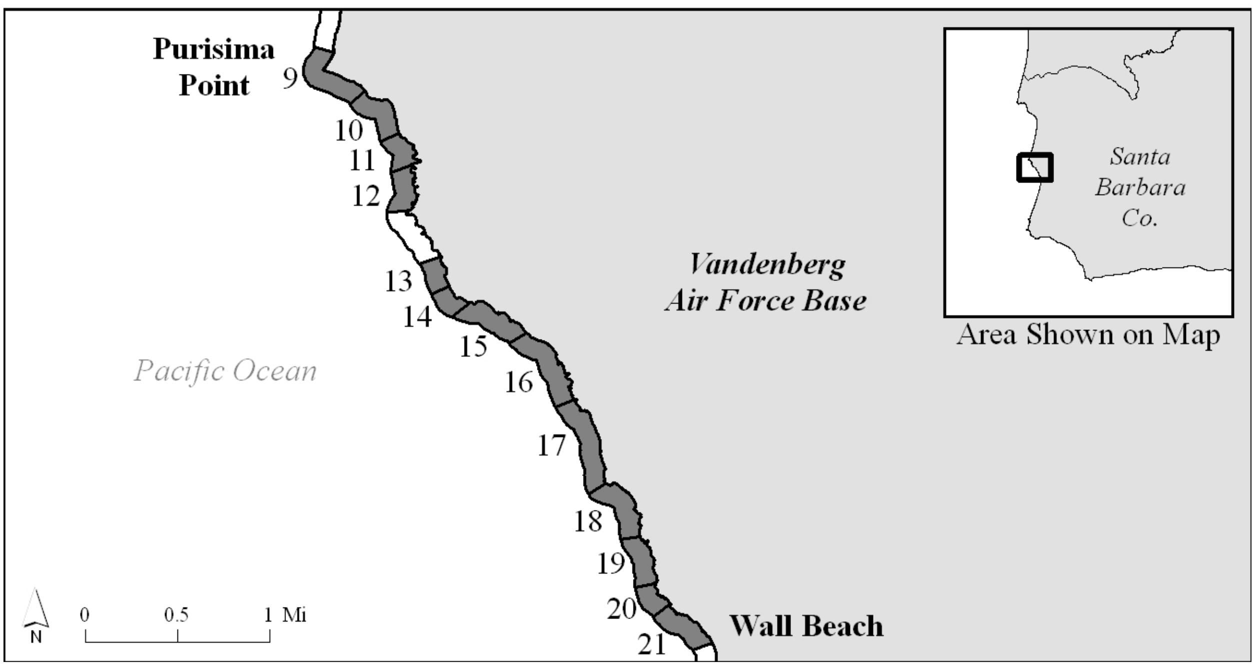
Population Estimates for the Shell Beach Sub-colonies 2013; 2014

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
sb1	Black Oystercatcher	4 ; 2	2 ; 2	
	Pigeon Guillemot	86 ; 29	nc	4/12 ; 5/2
	Western Gull	10 ; 12	5 ; 6	
	Brandt's Cormorant	34 ; 42	17 ; 21	
	Double-crested Cormorant	138 ; 82	69 ; 41	
	Pelagic Cormorant	56 ; 38	28 ; 19	
sb2	Black Oystercatcher	3 ; 4	2 ; 0	
	Pigeon Guillemot	35; 38	nc	4/12 ; 5/29
	Western Gull	16 ; 10	8 ; 5	
	Pelagic Cormorant	54 ; 64	27 ; 32	
sb3	Black Oystercatcher	1 ; 0	0 ; 0	
	Pigeon Guillemot	5 ; 15	nc	4/12 ; 4/25
	Western Gull	4 ; 6	2 ; 3	
sb4	Black Oystercatcher	2 ; 0	0 ; 0	
	Pigeon Guillemot	15 ; 3	nc	6/6 ; 5/29
	Western Gull	2 ; 2	1 ; 1	
sb5	Black Oystercatcher	1 ; 0	0 ; 0	
	Pigeon Guillemot	0 ; 1	nc	0 ; 4/18
	Brandt's Cormorant	130 ; 132	65 ; 66	
sb6	Black Oystercatcher	2 ; 2	1 ; 1	
	Pigeon Guillemot	19 ; 19	nc	4/12 ; 5/2
	Pelagic Cormorant	2 ; 6	1 ; 3	
sb7	Black Oystercatcher	4 ; 2	2 ; 1	
	Pigeon Guillemot	2 ; 8	nc	4 /12; 5/19
	Western Gull	2 ; 4	1 ; 2	
sb8	Black Oystercatcher	1 ; 2	0 ; 0	
	Pigeon Guillemot	2 ; 2	nc	5/23 ; 4/25
sb9	Black Oystercatcher	1 ; 3	0 ; 0	
	Pigeon Guillemot	41 ; 70	nc	4/19 ; 4/25
	Western Gull	6 ; 10	3 ; 5	
sb10	Black Oystercatcher	2 ; 2	1 ; 0	
	Pigeon Guillemot	4 ; 4	nc	6/6 ; 5/19
	Western Gull	14 ; 10	7 ; 5	
sb11	Pigeon Guillemot	0 ; 7	nc	- ; 5/9

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
sb12	Black Oystercatcher	5 ; 4	1 ; 1	
	Pigeon Guillemot	8 ; 8	nc	5/10 ; 4/25
	Western Gull	6 ; 4	3 ; 2	
	Brandt's Cormorant	4 ; 4	2 ; 2	
	Pelagic Cormorant	2 ; 0	1 ; 0	
sb13	Black Oystercatcher	4 ; 3	2 ; 1	
	Pigeon Guillemot	23 ; 25	nc	5/23 ; 4/18
	Western Gull	30 ; 42	15 ; 21	
	Brandt's Cormorant	0 ; 4	0 ; 2	
	Pelagic Cormorant	0 ; 6	0 ; 3	
sb14	Black Oystercatcher	2 ; 3	0 ; 0	
	Pigeon Guillemot	55 ; 36	nc	4 /12; 4/25
	Western Gull	32; 20	16 ; 10	
	Brandt's Cormorant	218 ; 112	109 ; 56	
	Pelagic Cormorant	28 ; 50	14 ; 25	
sb15	Black Oystercatcher	3 ; 2	1 ; 0	
	Pigeon Guillemot	42 ; 45	nc	5/9 ; 4/18
	Western Gull	28 ; 38	14 ; 19	
	Brandt's Cormorant	34 ; 112	17 ; 56	
	Double-crested Cormorant	0 ; 2	0 ; 1	
	Pelagic Cormorant	56 ; 64	28 ; 32	
sb16	Black Oystercatcher	4 ; 4	1 ; 2	
	Pigeon Guillemot	82 ; 87	nc	4/19 ; 4/18
	Western Gull	32 ; 42	16 ; 21	
	Pelagic Cormorant	30 ; 14	15 ; 7	
TOTALS	**Black Oystercatcher**	**39 ; 33**	**13 ; 8**	
	Pigeon Guillemot	**419 ; 397**	**nc**	
	Western Gull	**182 ; 200**	**91 ; 100**	
	Brandt's Cormorant	**420; 406**	**210 ; 203**	
	Double-crested Cormorant	**138 ; 84**	**69 ; 42**	
	Pelagic Cormorant	**228 ; 242**	**114 ; 121**	

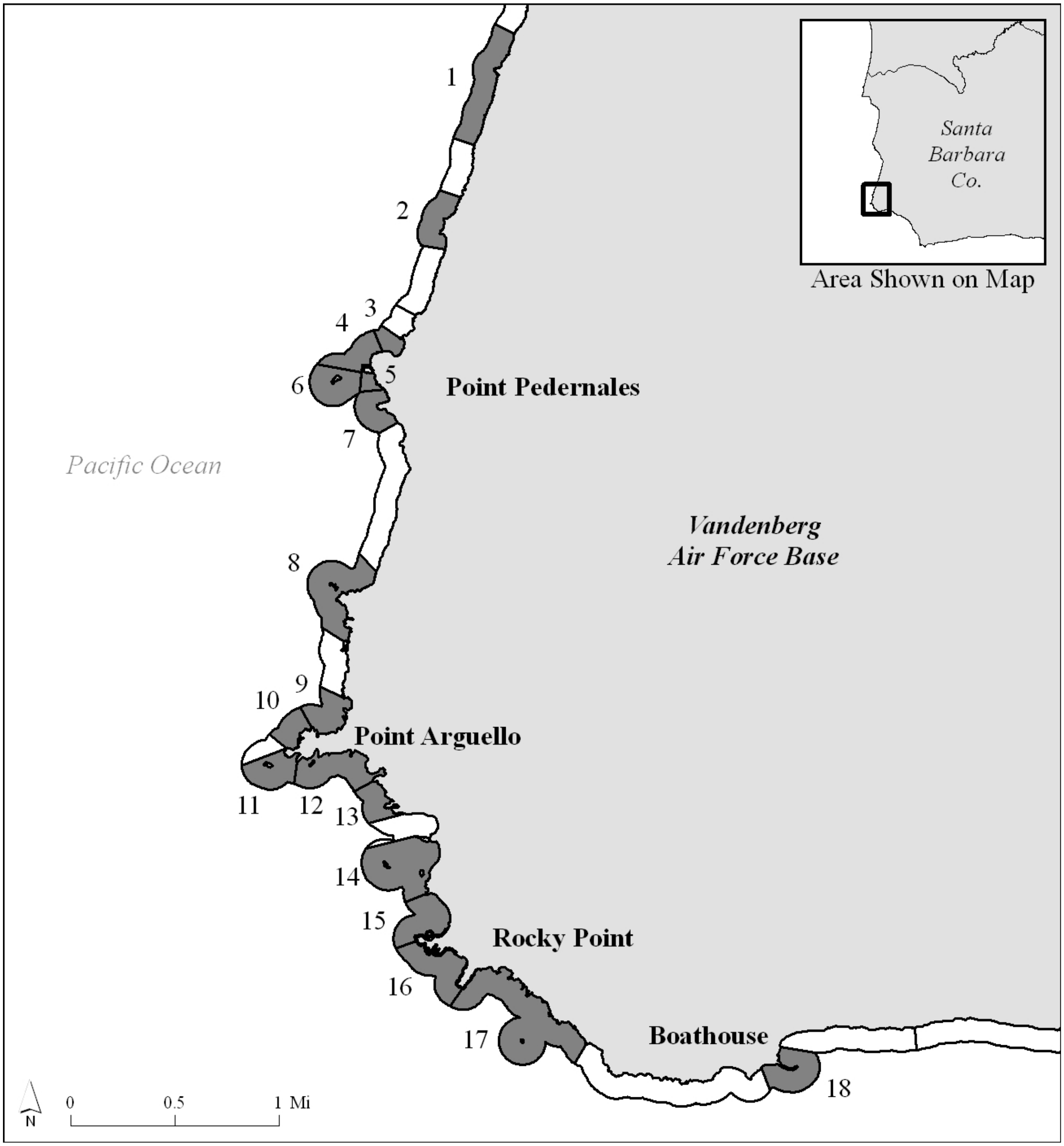
Appendix IV: Population Estimates for the North Vandenberg Sub-colonies





Population Estimates for the North Vandenberg Sub-colonies 2013; 2014

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
van1	none	-	-	
van2	none	-	-	
van3	Pigeon Guillemot	0 ; 2	nc	- ; 6/11
van4	Black Oystercatcher	2 ; 2	0 ; 1	
	Pigeon Guillemot	0 ; 2	nc	- ; 6/11
	Western Gull	4 ; 4	2 ; 0	
van5	none	-	-	
van6	none	-	-	
van7	none	-	-	
van8	none	-	-	
van9	none	-	-	
van10	Pigeon Guillemot	37 ; 27	nc	4/26 ; 6/2
van11	Pigeon Guillemot	26 ; 34	nc	5/9 ; 6/2
	Western Gull	4 ; 4	2 ; 2	
van12	Black Oystercatcher	2 ; 2	1 ; 0	
	Pigeon Guillemot	7 ; 2	nc	6/12 ; 6/2
	Pelagic Cormorant	8 ; 2	4 ; 0	
van13	none	-	-	
van14	Pigeon Guillemot	0 ; 6	nc	- ; 4/2
van15	Black Oystercatcher	2 ; 0	0 ; 0	
van16	none	-	-	
van17	none	-	-	
van18	Pigeon Guillemot	1 ; 0	nc	6/5 ; -
van19	Pigeon Guillemot	-	-	
van20	Pigeon Guillemot	24 ; 8	nc	4/25 ; 5/23
van21	Pigeon Guillemot	25 ; 57	nc	6/12 ; 6/5
TOTALS	**Black Oystercatcher**	**6 ; 4**	**1 ; 1**	
	Pigeon Guillemot	**120 ; 138**	**nc**	
	Western Gull	**8 ; 8**	**4 ; 2**	
	Pelagic Cormorant	**8 ; 2**	**4 ; 0**	



Appendix V: Population Estimates for the South Vandenberg Sub-colonies

Population Estimates for the South Vandenberg Sub-colonies 2013; 2014

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
vas1	Pigeon Guillemot	115 ; 81	nc	5/29 ; 4/22
	Western Gull	4 ; 2	2 ; 1	
vas2	Pigeon Guillemot	88 ; 42	nc	5/8 ; 6/12
vas3	Pigeon Guillemot	56 ; 37	nc	6/4 ; 4/10
vas4	Pigeon Guillemot	10 ; 40	nc	5/22 ; 4/2
vas5	Black Oystercatcher	4 ; 4	0 ; 1	
	Pigeon Guillemot	101 ; 78	nc	6/4 ; 4/10
	Western Gull	4 ; 4	2 ; 1	
vas6	Pigeon Guillemot	64 ; 58	nc	6/11 ; 4/10
	Brandt’s Cormorant	0 ; 6	0 ; 3	
vas7	Pigeon Guillemot	41 ; 54	nc	5/29 ; 4/22
	Western Gull	2 ; 2	1 ; 1	
vas8	Black Oystercatcher	2 ; 2	0 ; 1	
	Pigeon Guillemot	23 ; 46	nc	5/1 ; 5/14
	Western Gull	6 ; 6	3 ; 2	
vas9	Pigeon Guillemot	30 ; 39	nc	5/8 ; 4/10
	Western Gull	2 ; 6	1 ; 0	
vas10	Pigeon Guillemot	56 ; 83	nc	5/8 ; 4/22
	Pelagic Cormorant	0 ; 2	0 ; 1	
vas11	Pigeon Guillemot	107 ; 140	nc	5/8 ; 4/30
	Western Gull	2 ; 2	1 ; 1	
	Pelagic Cormorant	10 ; 36	5 ; 15	
vas12	Black Oystercatcher	2 ; 2	0 ; 1	
	Pigeon Guillemot	174 ; 246	nc	5/15 ; 4/30
	Western Gull	42 ; 26	21 ; 9	
	Brandt's Cormorant	504 ; 396	252 ; 193	
	Pelagic Cormorant	192 ; 162	96 ; 64	
vas13	Pigeon Guillemot	33 ; 72	nc	6/10 ; 4/30
vas14	Black Oystercatcher	2 ; 2	0 ; 1	
	Pigeon Guillemot	89 ; 63	nc	4/24 ; 4/16
	Western Gull	0 ; 2	0 ; 0	
	Brandt’s Cormorant	0 ; 8	0 ; 4	
vas15	Black Oystercatcher	2 ; 2	1 ; 1	
	Pigeon Guillemot	141 ; 131	nc	4/17 ; 4/16
	Western Gull	20 ; 16	10 ; 6	
	Brandt’s Cormorant	0 ; 204	0 ; 93	
	Pelagic Cormorant	6 ; 2	3 ; 1	

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
vas16	Pigeon Guillemot	89 ; 76	nc	5/1 ; 4/16
	Western Gull	2 ; 0	1 ; 0	
vas17	Black Oystercatcher	4 ; 2	1 ; 1	
	Pigeon Guillemot	95 ; 162	nc	5/1 ; 4/30
	Western Gull	2 ; 2	1 ; 1	
vas18	None			
TOTALS	**Black Oystercatcher**	**16 ; 14**	**2 ; 6**	
	Pigeon Guillemot	**1312 ; 1448**	**nc**	
	Western Gull	**86 ; 68**	**43 ; 22**	
	Brandt's Cormorant	**504 ; 614**	**252 ; 293**	
	Pelagic Cormorant	**208 ; 202**	**104 ; 81**	