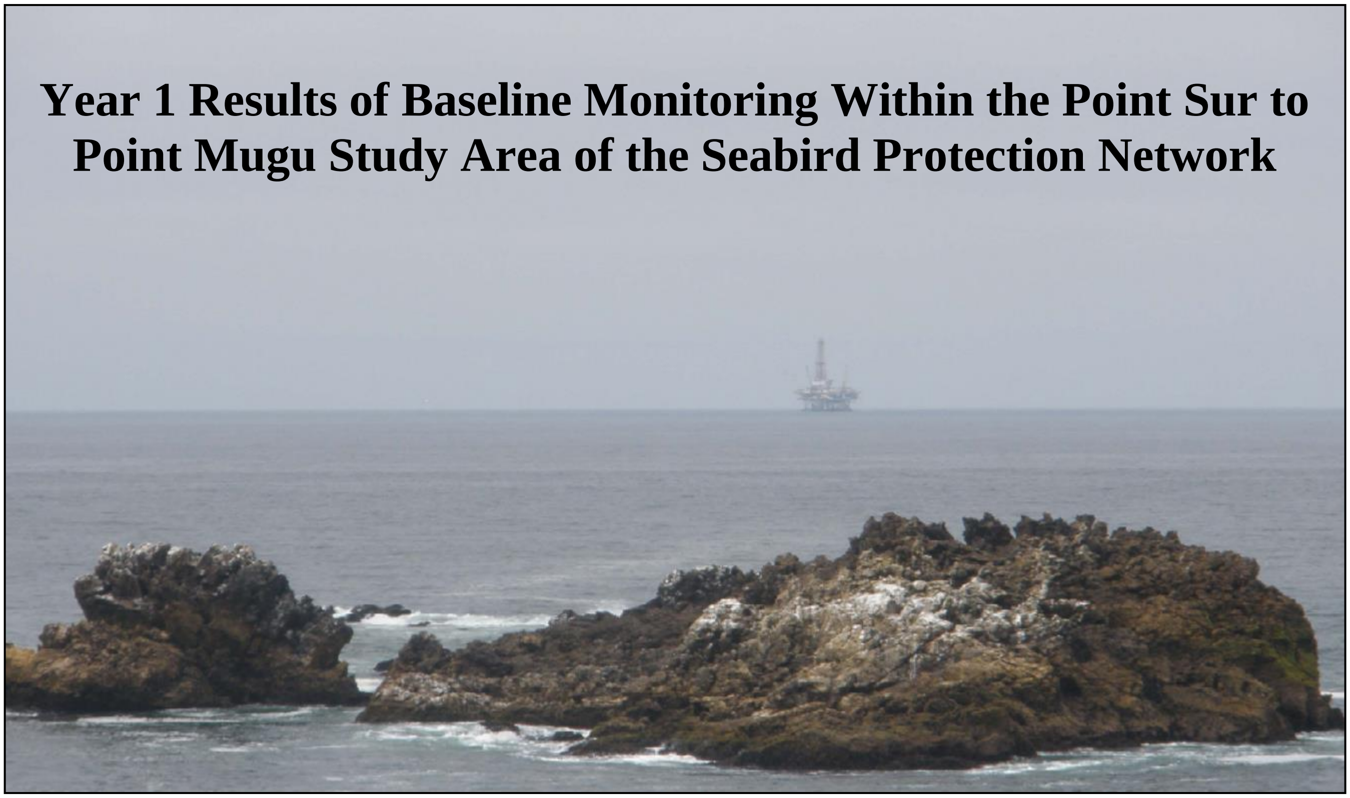
Year 1 Results of Baseline Monitoring Within the Point Sur to Point Mugu Study Area of the Seabird Protection Network



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

November 15, 2012

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Suggested Citation: Robinette, D., S. Acosta and J. Howar. 2012. Year 1 Results of Baseline Monitoring Within the Point Sur to Point Mugu Study Area of the Seabird Protection Network. Unpublished Report, PRBO Conservation Science, Petaluma, CA.

Table of Contents

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List of Tables

List of Figures

Acknowledgements

This project was supported by the U.S. Bureau of Land Management under cooperative agreement #L11AC20073 and the U.S. Department of Defense with vendor pay MORD # XUMUOS101711, project number F4D3D30307M002. We would especially like to thank Eric Morgan, Lauren Wilson, and the Torch/ Platform Irene Trustee Council for providing us the opportunity to study the diverse seabird habitats along this unique stretch of central California coastline. This is Point Reyes Bird Observatory contribution no. 1882.

EXECUTIVE SUMMARY

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 SPN 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 SPN established outreach and law enforcement teams to educate the public about the importance of protecting seabirds from human-caused disturbance. The PSPM SPN 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, we conducted the first year of baseline monitoring within the PSPM study area. Per recommendations within the initial assessment of the PSPM study area, we focused our efforts along the central California coast between Piedras Blancas and Vandenberg Air Force Base. Within this baseline focal area, we selected nine sites with varying degrees of human activities and presumed disturbance rates: Piedras Blancas, San Simeon/Cambria, Estero Bluffs, Montaña de Oro, PG&E Trail, Diablo Canyon, Shell Beach, North Vandenberg AFB, and South Vandenberg AFB. At each site, we monitored breeding population size, reproductive success, roost utilization, and rates of human-caused disturbance for the seven focal species identified by the PSPM SPN: 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.

Results from 2011 showed that Brandt's Cormorant was the most abundant species breeding within the baseline study region. Pigeon Guillemots were the second most abundant, followed by Western Gulls, Pelagic Cormorants, Double-crested Cormorants and Black Oystercatchers. There were large populations of all focal species breeding at Shell Beach. The other sites varied in their importance to the different focal species. Shell Beach was also an important roost site for most of the focal species. Disturbance rates were highest at sites most accessible to the public: Shell Beach, Montaña de Oro, and Estero Bluffs. Based on these results, we recommend initial outreach and law enforcement efforts be focused primarily at Shell Beach and then at Montaña de Oro and Estero Bluffs. While Estero Bluffs is not an important breeding area, it is an important roosting area for Pelagic Cormorants and likely Brandt's Cormorants. Montaña de Oro is an important breeding area for Pigeon Guillemots and Black Oystercatchers.

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 and also the northern Channel Islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel).

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 will have three components: 1) education and outreach, 2) coordinated law enforcement, and 3) seabird colony and human disturbance monitoring. The monitoring component will identify areas of high disturbance within the study area and determine if and how seabird populations are responding to outreach and law enforcement efforts. This information will be used to inform the outreach and law enforcement components to allow them to concentrate their efforts and adapt their approach in response to monitoring results.

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.

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 outlines the two overarching approaches being used to monitor seabirds within the study area (Robinette 2011). Aerial surveys will be used to determine baseline abundance and distribution of surface nesters (i.e., Brandt’s Cormorants and Double-crested Cormorants) throughout the study area (see Capitolo et al. 2011, 2012) while ground-based monitoring will follow a BACI design and will be used to determine the efficacy of outreach and law enforcement activities on population size, reproductive success, and levels of human disturbance at focal colonies. Aerial surveys provide a cost-effective means by which to census broad areas for population size and distribution of colonial surface nesters, but only provide limited data on the occurrence of disturbances needed to assess the efficacy of outreach and law enforcement. Furthermore, aerial surveys do not provide estimates of annual productivity or rates of human disturbance. Thus, ground-based monitoring will need to be conducted to fill these data gaps. The analysis of aerial survey data will guide the expansion of the monitoring program throughout the PSPM study area. The first three years of BACI monitoring will be used to establish a baseline of population abundance and distribution, breeding productivity, and levels of human disturbance and will be limited to the initial implementation area (Piedras Blancas to Vandenberg Air Force Base (AFB)) defined within (Robinette and Acosta 2011). The information gained from monitoring will guide the development of outreach and law enforcement programs within this initial implementation area. 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 present results from the first year of baseline monitoring for the BACI component. Results of aerial surveys can be found in Capitolo et al. (2011, 2012). Furthermore, we compare our population estimates from ground surveys to those from aerial surveys to better understand the strengths and weaknesses of each approach. Finally, we summarize a 13-year time series of annual seabird population sizes from Vandenberg AFB (see ‘Study Area’ below) to help understand population trends before the implementation of the PSPM program.

METHODS

Study Area

The initial baseline monitoring program will focus 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 have preliminarily 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.

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 will therefore focus 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

Beginning in April (when seabird nest initiation is typically well under way), we monitored breeding and roosting seabirds at each of the nine areas in Figure 1. We conducted three types of surveys at each location: transect surveys, nest monitoring, 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 IX.

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 $\leq$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

RESULTS

Seabird Breeding Populations

Year 1 Baseline Monitoring

Appendices I through IX show population distributions for each species within each of the nine transects. Table 1 summarizes the total population size (i.e., all counting blocks combined) for each transect. Overall, Brandt's Cormorant was the most abundant species breeding within the baseline study region. Pigeon Guillemots were the second most abundant, followed by Western Gulls, Pelagic Cormorants, Double-crested Cormorants and Black Oystercatchers.

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 and Diablo Canyon with 1,086 birds and 1,934 birds, respectively. However, the population at Piedras Blancas was largely underestimated by our ground surveys (see 'Comparison of Ground and Aerial Surveys for Brandt's Cormorants' below) and likely comparable to PG&E and Diablo Canyon. Smaller numbers of Brandt's Cormorants were found breeding at Shell Beach (332 birds) and South Vandenberg AFB (386 birds).

Pigeon Guillemots were found breeding within all transects except Estero Bluffs. The largest population was at South Vandenberg AFB (1,005 birds) while moderate populations were found at Montaña de Oro (209 birds), PG&E Trail (210 birds), Shell Beach (358 birds), and North Vandenberg AFB (107 birds). Small populations were found at Piedras Blancas (14 birds), San Simeon/Cambria (24 birds), and Diablo Canyon (49 birds).

Western Gulls were found breeding within all the transects. The largest population was found at PG&E Trail (148 birds), Diablo Canyon (110 birds), and Shell Beach (218 birds). Moderate populations were found at Piedras Blancas (64 birds) and South Vandenberg AFB (91 birds). Small populations were found at San Simeon/Cambria (24 birds), Estero Bluffs (2 birds), Montaña de Oro (14 birds), and North Vandenberg AFB (14 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 birds) while moderate populations were found at PG&E Trail (102 birds) and South Vandenberg AFB (134 birds). Small populations were found at Diablo Canyon (40 birds) and North Vandenberg AFB (10 birds)

Double-crested Cormorants were found breeding only at San Simeon and Shell Beach with 84 birds and 90 birds, respectively.

Black Oystercatchers were found breeding within all transects but San Simeon/Cambria. The largest populations were found at South Vandenberg AFB (16 birds), Diablo Canyon (12 birds), PG&E Trail (12 birds), and Montaña de Oro (10 birds). There were six birds breeding at Piedras Blancas, four at Estero Bluffs, and eight at Shell Beach.

Comparison of Ground and Aerial Surveys for Brandt's Cormorants

Table 2 shows the results of our comparison of Brandt's Cormorant population estimates between ground surveys and aerial surveys conducted by Capitolo et al. (2012). Aerial surveys estimated larger populations at nine of the 13 comparable sites. Ground surveys underestimated breeding populations at two sites that had to be viewed from a long distance (Pecho Rock and Point Sal) and one site where cormorants bred on the westward slope of an offshore rock (Piedras Blancas Island). Ground estimates at these sites were >90% less than aerial estimates. Additionally, ground estimates were 30-53% less than aerial estimates for three of the 13 comparable sites (PG&E Unnamed Rocks, Diablo Rock and Mainland, and North Pismo Rocks). In these cases, we feel that ground surveys provided adequate coverage of the sites and may have produced more accurate estimates than aerial surveys. Aerial surveys may have overestimated breeding numbers at these sites by misidentifying roosting birds as breeding birds. These sites had the largest Brandt's Cormorant roosts within the baseline study area (see 'Seabird Roost Utilization' below). There was <25% difference between ground and aerial surveys for the rest of the sites.

Vandenberg Time Series (1999-2011)

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 3). There were no population declines over the time series. All species showed either positive growth or no growth (Figure 2). All three models provided a good fit for Pelagic Cormorants, with the quadratic model providing a slightly better fit than linear or exponential growth. However, the trend over the time series appears almost linear (Figure 2). We will develop a better understanding of how this population is growing as we continue to add to our time series. Exponential growth provided the best fit for Brandt's Cormorants (Figure 2). 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). Exponential growth provided the best fit for the Pigeon Guillemot population, though the trend appears more linear (Figure 2). 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. There was no significant trend in population for Black Oystercatchers, indicating that the Vandenberg oystercatcher population has also been stable over the time series (Figure 2). Black Oystercatchers are territorial and their population at Vandenberg is likely limited by the number of available territories. We surveyed all available breeding habitat on Vandenberg and did not locate any new territories in 2011. Linear and quadratic growth models showed the best fits for Western Gulls (Figure 2). The Western Gull population has been increasing steadily since the beginning of the time series. However, the growth curve appears to be reaching a plateau, indicating that the population is reaching its carrying capacity at Vandenberg.

Seabird Roost Utilization

Tables 4 and 5 summarize data on roost utilization for the five focal species that roost in aggregations of multiple birds: Brown Pelican, Double-crested Cormorant, Brandt's Cormorant, Pelagic Cormorant, and Western Gull. Of these, the Brown Pelican is the only species not breeding within the baseline study area. We categorized each counting block within a given transect as a major (>1,000 birds), moderate (500-1,000 birds), and minor (<500 birds) roost per the definitions outlined within Robinette and Acosta (2011). The majority of roosts were minor for all species. We identified moderate roosts for Brandt's Cormorants at PG&E Trail, Diablo Canyon, and Shell Beach. We did not identify any major roosts for any of the focal species. Table 4 summarizes the number and percent of total counting blocks within a given transect that contained moderate and minor roosts. With the exception of Brown Pelicans at Montaña de Oro, all species were found roosting at multiple sites throughout each transect. Brandt's Cormorants, Pelagic Cormorants, and Western Gulls were more widespread in their roost utilization, using >50% of the available counting blocks within most transects. Conversely, Brown Pelicans and Double-crested cormorants were more limited in their roost utilization, using <50% of the available counting blocks within most transects.

Table 5 identifies the largest roost within a given transect for each species and shows the mean number of birds and variability in use for these largest roosts throughout our study period (April through July). For all breeding species, the largest roosts were located within transects with large breeding populations. The exception was Estero Bluffs where relatively large numbers of Brandt's and Pelagic Cormorants roosted without breeding, though variability in roosting was high (c.v. >130). Overall, within-season variability was low at roosts close to large breeding sites (c.v. <100). However, roosting of Double-crested Cormorants was variable at Shell Beach (c.v. = 103.25), one of the only two transects where they breed. Double-crested Cormorants began building nests in a residential area within counting block sb13 early in the breeding season, but were hazed by local residents and forced to abandon this site. We later found them breeding within counting block sb1. This shift in breeding location likely contributed to the variable use of sb13. Brown Pelican roost utilization was highly variable throughout the study period at all sites. Spring and summer is a period of highly variable roost utilization along the central California coast (Robinette and Howar 2007). This is the period when pelicans are migrating north from their southern breeding sites.

Figure 3 shows the mean 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. Shell Beach had the largest means for four of the five species (Pelagic Cormorants, Double-crested Cormorants, Western Gulls, and Brown Pelicans). Pelagic Cormorants also had large means for Estero Bluffs and Western Gulls for PG&E Trail and Diablo Canyon. The largest mean for Brandt's Cormorants was at Diablo Canyon.

Disturbances to Breeding and Roosting Sites

Rates of Human-Caused Disturbance

Figure 4 shows the number of disturbances recorded per hour of observation at each transect for each of the focal species. Rates were calculated using both breeding and roosting birds and are reported for three broad categories defining where the source of the disturbances was located: ground, air, or water. We recorded high disturbance rates for all species at Shell Beach. The majority of these disturbances were from human activities on the water. Air and ground activities also contributed to disturbances of cormorants at Shell Beach and air activities contributed to disturbances of Brown Pelicans. Most disturbances to Western Gulls at Shell Beach were due to activities on the ground.

There were no disturbances recorded for Double-crested Cormorants and Brown Pelicans at other sites. We recorded high disturbance rates for Pelagic Cormorants at Estero Bluffs and Diablo Canyon. Most of these disturbances were from activities on the water with some ground-based disturbances at Estero Bluffs. Low disturbance rates were also recorded for Pelagic Cormorants at San Simeon/Cambria, Montaña de Oro, and PG&E Trail. Low disturbance rates were recorded for Brandt's Cormorants at Estero Bluffs, Montaña de Oro, and PG&E Trail. The highest disturbance rates for Western Gulls were recorded at Montaña de Oro. These were all ground-based disturbances. Low disturbance rates were also recorded for Western Gulls at Estero Bluffs, Montaña de Oro, and PG&E Trail. The highest disturbance rates for Black Oystercatchers were recorded at Estero Bluffs and Montaña de Oro. All disturbances at Estero Bluffs were from activities on the water while all disturbances at Montaña de Oro were from activities on the ground.

Rates of Naturally Caused Disturbances

Figure 4 shows natural disturbance rates incurred by each species. Natural disturbance rates were averaged over all transect locations for a given species. Sources for natural disturbance included wildlife (e.g., gulls, raptors) and physical sources (e.g., large waves crashing on a breeding or roosting site). In most cases, rates of natural disturbance were much lower than those of human caused disturbance. Two exceptions were Estero Bluffs and Montaña de Oro where human-caused disturbance rates for Brandt's Cormorants were lower than natural rates. However, the low natural disturbance rates may be a result of low presence at these sites. There were no Brandt's Cormorants breeding at either of these two sites and roosting numbers were low to moderate. Overall, Brandt's Cormorants had the highest natural disturbance rates of all the focal species. Natural disturbance rates were likely higher for Brandt's Cormorants because they breed in larger colonies that are more obvious to potential predators. Much of the disturbance to Brandt's Cormorants was caused by Western Gulls (potential nest predators) at Diablo Canyon and Peregrine Falcons at PG&E Trail. Additionally, a large group of Brandt's Cormorant nests were lost to coyote predation at Diablo Canyon (see *Seabird Reproductive Success* below).

Types of Disturbances

Figure 5 shows the types of potential and actual disturbances observed at each transect. 'Potential' disturbances include all activities that occurred close enough to the breeding/roosting site that they could have, but not necessarily, caused a disturbance while ‘actual’ disturbances include only those activities that actually disturbed breeding or roosting birds. It is important to note that this figure does not give information about the number of disturbances that occurred at a given site (see sections above for this information) and includes activities relevant to all of the focal species.

As noted above, there was little to no disturbance at Piedras Blancas, San Simeon/Cambria, North Vandenberg AFB, and South Vandenberg AFB. The majority of potential and actual disturbances at Piedras Blancas were from humans on foot. Airplanes were also an import source of potential disturbance, but were never recorded causing an actual disturbance. The majority of potential disturbances at San Simeon/Cambria were from humans on foot. There were two actual disturbances recorded: one from a human on foot with a dog and the other from a kayaker. The majority of potential disturbances on North Vandenberg AFB were from humans on foot and private fishing boats. Additional sources included airplanes, helicopters, and surfers. While there is little coastal activity occurring on Vandenberg AFB in general, there is some recreation use by military personnel and their families. Much of this occurs on the northern part of the base. Despite the limited use, there were no actual disturbances recorded on North Vandenberg AFB. There was one instance of a motor vehicle on the ground disturbing birds on South Vandenberg AFB. No other potential disturbances were recorded for this transect.

We recorded moderate levels of disturbance at Estero Bluffs, Montaña de Oro, PG&E Trail, and Diablo Canyon. The majority of potential and actual disturbances at Estero Bluffs were from kayakers, with some disturbances also caused by humans on foot. The majority of potential disturbances at Montaña de Oro were from humans on foot and then airplanes and kayakers. Other sources included helicopters, humans with dogs, scuba divers, paddle boarders, party boats, private fishing boats, private motor boats, yachts, and inflatable motor boats (zodiacs). One hundred percent of the actual disturbances were caused by humans on foot. The majority of potential disturbances at PG&E Trail were caused by humans on foot and then airplanes. Other sources included helicopters, motor vehicles, kayakers, surfers, and private fishing boats. Actual disturbances were caused by helicopters and one event with a motor vehicle on the ground. The majority of potential disturbances at Diablo Canyon were from research vessels and airplanes. Other sources included a jet ski (involved in research) and a private fishing boat. Actual disturbances were caused by a research vessel and a private fishing boat.

We recorded the highest levels of disturbances at Shell Beach. Additionally, Shell Beach had the highest diversity of potential disturbance sources. The majority of potential disturbances were from humans on foot both with and without dogs. We also observed moderate numbers of potential disturbances from airplanes, kayakers, private fishing boats, and inflatable motor boats. Other sources included gyrocopters, helicopters, model airplanes, ultralights, loud noises, motor vehicles on land, commercial fishing boats, commercial kelp harvester, paddle boarders, private motor boats, sailboats, and surfers. The majority of actual disturbances were caused by humans on foot and then kayakers and inflatable motor boats. The majority of disturbances from inflatable motor boats were caused by a single boat that provided small tours to the public. As part of the tour, the boat would drive by coastal rocks at high speeds and flush roosting birds. The captain of the boat was also observed climbing cliffs where all three cormorant species bred. The Point Sur to Point Mugu law enforcement team contacted the owner of the boat and observed activities became less extreme, though the boat was still observed during multiple surveys.

<u>Seabird Reproductive Success</u>

Figure 6 shows the mean(±SE) fledglings produced per breeding pair for each transect compared to the mean of all sites combined. Brandt's Cormorants produced a mean of 1.9 fledglings per breeding pair among all transects. Breeding success was above average at Shell Beach and South Vandenberg AFB, close to the mean at PG&E Trail and slightly below the mean at Diablo Canyon. The low productivity at Diablo Canyon was partially due to coyote predation. More than 100 nests were taken by coyotes within counting block dc6. Birds at this counting block established nests on an easily accessible slope on the mainland whereas most other nests at Diablo Canyon were established on offshore rocks or steep slopes that were more difficult to access. Breeding success for Brandt's Cormorants was well below the mean at Piedras Blancas but may have been underestimated due to the difficulty of viewing nests at this site.

Pelagic Cormorants produced a mean of 1.8 fledglings per breeding pair among all transects. Breeding success at most sites was close to the mean. However, breeding success at Montaña de Oro and Diablo Canyon was below average. Western Gulls produced a mean of 0.9 fledglings per breeding pair among all transects. Breeding success was above the mean at Shell Beach, close to the mean at Diablo Canyon and South Vandenberg AFB, and well below the mean at Piedras Blancas, PG&E Trail and North Vandenberg AFB. Black Oystercatchers produced a mean of 0.2 fledglings per breeding pair among all transects. Breeding success was above the mean at South Vandenberg AFB and close to the mean at PG&E Trail and Shell Beach. We did not observe any fledglings at Piedras Blancas, Estero Bluffs, or Montaña de Oro.

DISCUSSION

The initial assessment of the Point Sur to Point Mugu study area (Robinette and Acosta 2011) relied heavily on data from Carter et al. (1992) and Carter et al. (1996). Since those studies, there has been no comprehensive effort to collect data on seabird breeding populations within our baseline study area (Piedras Blancas to Vandenberg AFB). The exception is the aerial photographic surveys used to monitor breeding populations of Brandt's and Double-crested cormorants. At the time of Carter et al. (1992), Pecho Rock at Diablo Canyon was the southern mainland breeding limit for Brandt's Cormorants. Since then, new colonies of Brandt's Cormorants have been established within the Shell Beach and South Vandenberg AFB transect areas. Data from Capitolo (2011) showed population increases in the Point Buchon area (PG&E Trail and Diablo Canyon). Additionally, Capitolo et al. (2011) identified a new colony of Double-crested Cormorants breeding at Shell Beach and we identified a new colony at San Simeon in 2011.

Overall, the distribution of each species among the nine transect areas was similar between Carter et al. (1992) and our 2012 estimates. However, we did observe large differences in total population sizes for Brandt's Cormorants, Pigeon Guillemots, and Western Gulls within our baseline study area. Both Brandt's Cormorants and Pigeon Guillemots showed large population decreases (5,227 to 3,856 birds and 2,534 to 1,976 birds, respectively) while Western Gulls showed a large increase (378 to 685 birds). These differences are not surprising as our baseline 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). Thus, it is difficult to determine whether the decreases we observed represent a decrease in the overall population size or represent annual variability in breeding effort. It is important to develop a time series of annual population estimates in order to distinguish between changes in population size and variability in breeding effort. A time series exists for seabird breeding populations at Vandenberg AFB. Despite annual variability in breeding effort, all species but Black Oystercatchers have shown increases in breeding populations from 1999 to 2011.

We observed the most dramatic changes since Carter et al. (1991) at the Shell Beach transect area. In addition to the new colonies of Brandt's and Double-crested Cormorants, our population estimates for Pelagic Cormorants and Western Gulls at Shell Beach are approximately four times larger than those reported in Carter et al. (1992). Based on our data from 2011, 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.* 1995, 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.

Though Shell Beach appears to be a hot spot for breeding and roosting seabirds, it is also the site that received the most human-caused disturbance for most of our focal species. This area has the largest human population of our nine transect areas, with three small cities (Pismo Beach, Shell Beach, and Avila Beach) established directly along the bluffs. There is a high diversity of coastal and ocean users in this area as evident by the high diversity of potential disturbance sources identified. Given its importance to breeding and roosting seabirds, this site will need to be a focal area for the Point Sur to Point Mugu outreach and law enforcement teams. Two other areas that received high rates of human-caused disturbance were Estero Bluffs and Montaña de Oro. Though neither of these areas are immediately adjacent to coastal cities, they both are state parks with coastal trails. Much of the disturbance at both sites was from ground-based activities, though activities on the water contributed to disturbance rates at Estero Bluffs. Additionally, there were several air and water activities at Montaña de Oro that presented potential disturbance threats, though no actual disturbances were recorded for these sources.

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 (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.

Each of the nine transects that we surveyed were somewhat unique in their importance to our focal seabird species and the levels of human-caused disturbance they received. In the Year 1 Monitoring Plan, we identified sites around Point Buchon, namely the PG&E Trail and Montaña de Oro, as areas of potential high human-caused disturbance. Our results from 2011 confirmed these predictions, but also highlighted the need to continue monitoring each of the nine transect areas over the long term. Below, we outline the importance of each of the transects to the overall baseline study area.

Piedras Blancas has a large population of Brandt's Cormorants (based on aerial surveys as our ground surveys did not provide an accurate measurement), moderate breeding populations for Black Oystercatchers and Western Gulls, and a small population of Pigeon Guillemots. The area provides roosting habitat for all focal species. We likely underestimated the number of Brandt's Cormorants roosting at Piedras Blancas Island for the same reason we underestimated the breeding population there. Furthermore, this site likely becomes more important for Brown Pelicans later in the year. There were very low disturbance rates at this site. The few disturbances we documented were primarily caused by humans on foot.

San Simeon/Cambria has one of only two breeding colonies of Double-crested Cormorants within our baseline study area (excluding the Morro Bay area which was not covered by our monitoring efforts). There are also small breeding populations of Pigeon Guillemots, Black Oystercatchers and Western Gulls. The area provides roosting habitat for all focal species. There were low disturbance rates in this area that were caused by humans on foot and kayakers.

Estero Bluffs has small breeding populations of Black Oystercatchers and Western Gulls. However, this area is an important roosting area for Pelagic Cormorants and we suspect it is also an important foraging area. The area provides roosting habitat for all focal species. The Disturbance rates were relatively high and caused by humans on foot and kayakers.

Montaña de Oro State Park has large breeding populations of Pigeon Guillemots and Black Oystercatchers and small breeding populations of Pelagic Cormorants and Western Gulls. The area provides roosting habitat for all focal species, though we did not record Brown Pelicans roosting here. Disturbance rates were moderate to high and primarily caused by humans on foot.

PG&E Trail has large breeding populations of all focal species but Double-crested Cormorants. This is one of two areas that that had a breeding population of Brandt's Cormorants that was >1,000 individuals. The area provides roosting habitat for all focal species and is important to roosting Brandt's Cormorants, Pelagic Cormorants, and Western Gulls. Despite a high level of human activity on the coastal trail, disturbance rates were low and mostly due to three instances of a helicopter(s) flying along the coast.

Diablo Canyon has large breeding populations of Brandt's Cormorants, Black Oystercatchers, and Western Gulls and moderate populations of Pelagic Cormorants and Pigeon guillemots. This was the only area that had a breeding population of Brandt's Cormorants that was >1,500 individuals. The area provides roosting habitat to all focal species and is important to roosting Brandt's Cormorants, Pelagic Cormorants, Western Gulls, and Brown Pelicans. Disturbance rates were low and primarily due to boats conducting research adjacent to the PG&E power plant.

Shell Beach had large populations of Pelagic Cormorants, Pigeon Guillemots, and Western Gulls. There were also moderate populations of Black Oystercatchers and Brandt's Cormorants. The site had one of only two Double-crested Cormorant breeding colonies within the baseline study area. The area is important to all focal species for roosting and had the largest number of roosting Brown Pelicans of all the transects. There were high disturbance rates for all seabird species with a high diversity of sources from land, air, and water.

North Vandenberg AFB had moderate breeding populations of Pigeon Guillemots and Black Oystercatchers and small breeding populations of Pelagic Cormorants and Western Gulls. The area provides roosting habitat for all focal species and is important to roosting Brandt's Cormorants and Brown Pelicans. Though there is some coastal access and recreational activities for military personnel and their families, there were no disturbances recorded on North Vandenberg AFB in 2011.

South Vandenberg AFB had large breeding populations of Pelagic Cormorants, Pigeon Guillemots, and Black Oystercatchers and moderate populations of Brandt's Cormorants and Western Gulls. The area provides roosting habitat for all focal species and is important for roosting Brandt's Cormorants and Brown Pelicans. There was only one disturbance recorded on South Vandenberg AFB. This was from a motorized vehicle on land. Overall, there is very little human activity along the South Vandenberg AFB transect and military personnel are discouraged from entering coastal areas.

MANAGEMENT RECOMMENDATIONS

1) Based on our results from Year 1 of this three-year baseline monitoring, we recommend that the law enforcement and outreach teams focus their initial efforts at Shell Beach. This area has large breeding populations of all PSPM focal species and also received high rates of human-caused disturbance. Additionally, outreach and law enforcement efforts should be initiated at Estero Bluffs and Montaña de Oro. 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 PSPM law enforcement team should continue to compile a list of actionable laws and regulations that are applicable to protecting roosting and breeding seabirds. This list should be summarized within a comprehensive document that informs the monitoring and outreach teams on which human activities should be reported and which can only be documented but not acted upon. Once this document is finalized, the law enforcement, outreach, and monitoring teams should work together to develop a protocol of how to report actionable violations to the law enforcement team.

3) After the three years of baseline disturbance data are collected, the monitoring team should conduct a more thorough analysis of disturbance rates at each site. The analysis should compare disturbance rates among control, moderate impact, and high impact areas and investigate differences in disturbance rates 1) during week days versus weekends, 2) under open versus closed trail conditions (i.e., PG&E Trail), and 3) inside versus outside marine protected areas. Additionally, the analysis should compare rates of natural disturbance to rates of human-caused disturbance to gain a better understanding of the degree to which humans are causing disturbance beyond natural levels. Understanding the temporal and spatial variability in disturbance rates will be important when assessing the efficacy of outreach and law enforcement efforts.

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) Morro Bay should eventually be included in PSPM monitoring efforts. It is currently covered with the aerial surveys, but these surveys do not provide information on disturbance rates or reproductive success. Morro Bay presents challenges to our ground-based monitoring approach. The majority of nesting birds are on the north and west faces of Morro Rock which can't be viewed from land. Thus, breeding population size and reproductive success cannot be measured from land. However, the rock can be monitored for human activity and roosting areas around Morro Bay can also be monitored. Morro Bay may present an opportunity for the PSPM chapter to invite local groups like the Morro Bay Natural History Museum, Morro Coast Audubon or Cal Poly San Luis Obispo to engage in the monitoring program. After initial discussions with these groups, we decided it would not be useful to include citizen science in our rigorous ground-based monitoring program. However, any additional information that can be collected in the Morro Bay area will be helpful in guiding PSPM outreach and law enforcement efforts.

6) 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. Number of breeding birds for each focal species within each of the 9 transects in 2011.

Transect	Double-crested Cormorant	Brandt's Cormorant	Pelagic Cormorant	Pigeon Guillemot	Western Gull	Black Oyster-catcher
Piedras Blancas	0	118	0	14	64	6
San Simeon/Cambria	84	0	0	24	24	0
Estero bluffs	0	0	0	0	2	4
Mont. de Oro	0	0	6	209	14	10
PG&E Trail	0	1086	102	210	148	12
Diablo Canyon	0	1934	40	49	110	12
Shell Beach	90	332	240	358	218	8
No Vandenberg	0	0	10	107	14	6
So Vandenberg	0	386	134	1005	91	16
Total	174	3856	532	1976	685	74

Table 2. Comparison of Brandt's Cormorant breeding population numbers from ground surveys and aerial surveys from Capitolo (2012).

Transect	Comparable Location	Aerial	Ground	% Difference
Piedras Blancas	Piedras Blancas Island	953	57	-94%
PG&E Trail	Unnamed Rocks	819	543	-34%
Diablo Canyon	Pup Rock	83	68	-18%
	Lion Rock	186	155	-17%
	Diablo Rock & Mainland	638	444	-30%
	Diablo Canyon	247	275	11%
	Pecho Rock	268	25	-91%
Shell Beach	Shell Beach Rocks	60	64	7%
	North Pismo Rocks	215	102	-53%
Vandenberg, North	Point Sal	5	0	-100%
Vandenberg, South	Destroyer Rock	8	6	-25%
	Point Arguello	159	161	1%
	North Rocky Point	25	25	0%

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.

	Linear	Quadratic	Exponential Growth
Pelagic Cormorant	$p < 0.001$ $R^2 = 0.735$	$p = 0.001$ $R^2 = 0.744$	$p < 0.001$ $R^2 = 0.728$
Brandt's Cormorant	$p < 0.001$ $R^2 = 0.792$	$p < 0.001$ $R^2 = 0.834$	$p < 0.001$ $R^2 = 0.876$
Pigeon Guillemot	$p = 0.051$ $R^2 = 0.304$	$p = 0.151$ $R^2 = 0.315$	$p = 0.047$ $R^2 = 0.313$
Black Oystercatcher	$p = 0.054$ $R^2 = 0.324$	$p = 0.170$ $R^2 = 0.325$	$p = 0.067$ $R^2 = 0.296$
Western Gull	$p < 0.001$ $R^2 = 0.879$	$p < 0.001$ $R^2 = 0.959$	$p < 0.001$ $R^2 = 0.762$

Table 4. Number of counting blocks and percent of total counting blocks per transect that contain moderate (500-1,000 birds during at least one survey) and minor (<500 birds on any given) roosts for each species.

Species	Transect	Moderate (500 – 1,000)		Minor (<500)	
		# of roosts	% of blocks	# of roosts	% of blocks
Brown Pelican	Piedras Blancas	0	0%	4	20%
	San Simeon/Cambria	0	0%	1	8%
	Estero Bluffs	0	0%	7	70%
	Montaña de Oro	0	0%	0	0%
	PG&E Trail	0	0%	1	10%
	Diablo Canyon	0	0%	5	42%
	Shell Beach	0	0%	10	63%
	Vandenberg AFB, North	0	0%	7	33%
	Vandenberg AFB, South	0	0%	4	22%
Double-crested Cormorant	Piedras Blancas	0	0%	3	15%
	San Simeon/Cambria	0	0%	3	25%
	Estero Bluffs	0	0%	6	5%
	Montaña de Oro	0	0%	1	10%
	PG&E Trail	0	0%	1	10%
	Diablo Canyon	0	0%	2	17%
	Shell Beach	0	0%	12	75%
	Vandenberg AFB, North	0	0%	6	29%
	Vandenberg AFB, South	0	0%	4	22%
Brandt's Cormorant	Piedras Blancas	0	0%	12	60%
	San Simeon/Cambria	0	0%	11	92%
	Estero Bluffs	0	0%	10	100%
	Montaña de Oro	0	0%	6	60%
	PG&E Trail	1	10%	8	80%
	Diablo Canyon	3	25%	9	75%
	Shell Beach	1	6%	13	81%
	Vandenberg AFB, North	0	0%	9	43%
	Vandenberg AFB, South	0	0%	10	56%
Pelagic Cormorant	Piedras Blancas	0	0%	10	50%
	San Simeon/Cambria	0	0%	11	92%
	Estero Bluffs	0	0%	10	100%
	Montaña de Oro	0	0%	10	100%
	PG&E Trail	0	0%	10	100%
	Diablo Canyon	0	0%	9	75%
	Shell Beach	0	0%	13	81%
	Vandenberg AFB, North	0	0%	7	33%
	Vandenberg AFB, South	0	0%	13	72%
Western Gull	Piedras Blancas	0	0%	18	90%
	San Simeon/Cambria	0	0%	12	100%
	Estero Bluffs	0	0%	10	100%
	Montaña de Oro	0	0%	10	100%
	PG&E Trail	0	0%	10	100%
	Diablo Canyon	0	0%	12	100%
	Shell Beach	0	0%	16	100%
	Vandenberg AFB, North	0	0%	9	43%
	Vandenberg AFB, South	0	0%	17	94%

Table 5. List of the largest roosts identified within each transect with the highest and lowest counts observed in 2011. Also shown are mean and coefficient of variation (c.v. = Std.Dev/mean*100) calculated over all surveys in 2011.

Species	Transect	Counting Block	High Count	Low Count	Mean	C.V.
Brown Pelican	Piedras Blancas	pb18	44	0	4.78	229.57
	San Simeon/Cambria	sc06	12	0	0.80	387.30
	Estero Bluffs	eb09	16	0	1.24	323.21
	Montana de Oro	No roosting observed	---	---	---	---
	PG&E Trail	pg01	3	0	0.44	203.91
	Diablo Canyon	dc01	70	0	17.62	116.21
	Shell Beach	sb03	223	0	30.20	195.91
	Vandenberg, North	van01	113	0	15.31	215.21
	Vandenberg, South	vas18	111	0	14.18	223.11
Double-crested Cormorant	Piedras Blancas	pb06	2	0	0.22	246.74
	San Simeon/Cambria	sc01	63	29	39.63	28.99
	Estero Bluffs	eb03 & eb04	2	0	0.12	412.31
	Montana de Oro	mo03	2	0	0.12	412.31
	PG&E Trail	pg01	2	0	0.19	290.08
	Diablo Canyon	dc09 & dc10	1	0	0.11	300.00
	Shell Beach	sb13	258	0	59.53	103.25
	Vandenberg, North	van09	4	0	0.56	204.96
	Vandenberg, South	vas18	18	0	4.65	113.85
Brandt's Cormorant	Piedras Blancas	pb13	175	16	105.56	43.42
	San Simeon/Cambria	sc06	58	1	11.00	136.88
	Estero Bluffs	eb08	60	0	7.82	181.34
	Montana de Oro	mo02	16	0	1.35	289.75
	PG&E Trail	pg07	600	0	360.63	45.68
	Diablo Canyon	dc09	879	281	437.67	49.85
	Shell Beach	sb05	500	0	182.23	86.91
	Vandenberg, North	van01	163	0	14.38	296.45
	Vandenberg, South	vas15	105	0	41.29	83.22
Pelagic Coromorant	Piedras Blancas	pb05	39	1	13.39	75.70
	San Simeon/Cambria	sc07	31	0	2.20	362.91
	Estero Bluffs	eb08	85	1	19.41	137.65
	Montana de Oro	mo03	35	0	12.12	91.61
	PG&E Trail	pg06	33	0	19.25	53.43
	Diablo Canyon	dc09	22	11	15.78	24.50
	Shell Beach	sb15	76	0	50.27	40.14
	Vandenberg, North	van09	17	0	4.88	114.55
	Vandenberg, South	vas18	47	0	9.12	142.79
Western Gull	Piedras Blancas	pb13	33	3	18.72	43.54
	San Simeon/Cambria	sc06	120	0	11.93	258.33
	Estero Bluffs	eb09	43	0	5.24	191.79
	Montana de Oro	mo01	16	0	2.59	142.00
	PG&E Trail	pg09	45	0	25.25	48.23
	Diablo Canyon	dc06	46	8	16.33	71.66
	Shell Beach	sb12	123	0	39.20	82.77
	Vandenberg, North	van09	42	0	16.25	73.66
	Vandenberg, South	vas18	42	0	16.06	75.16

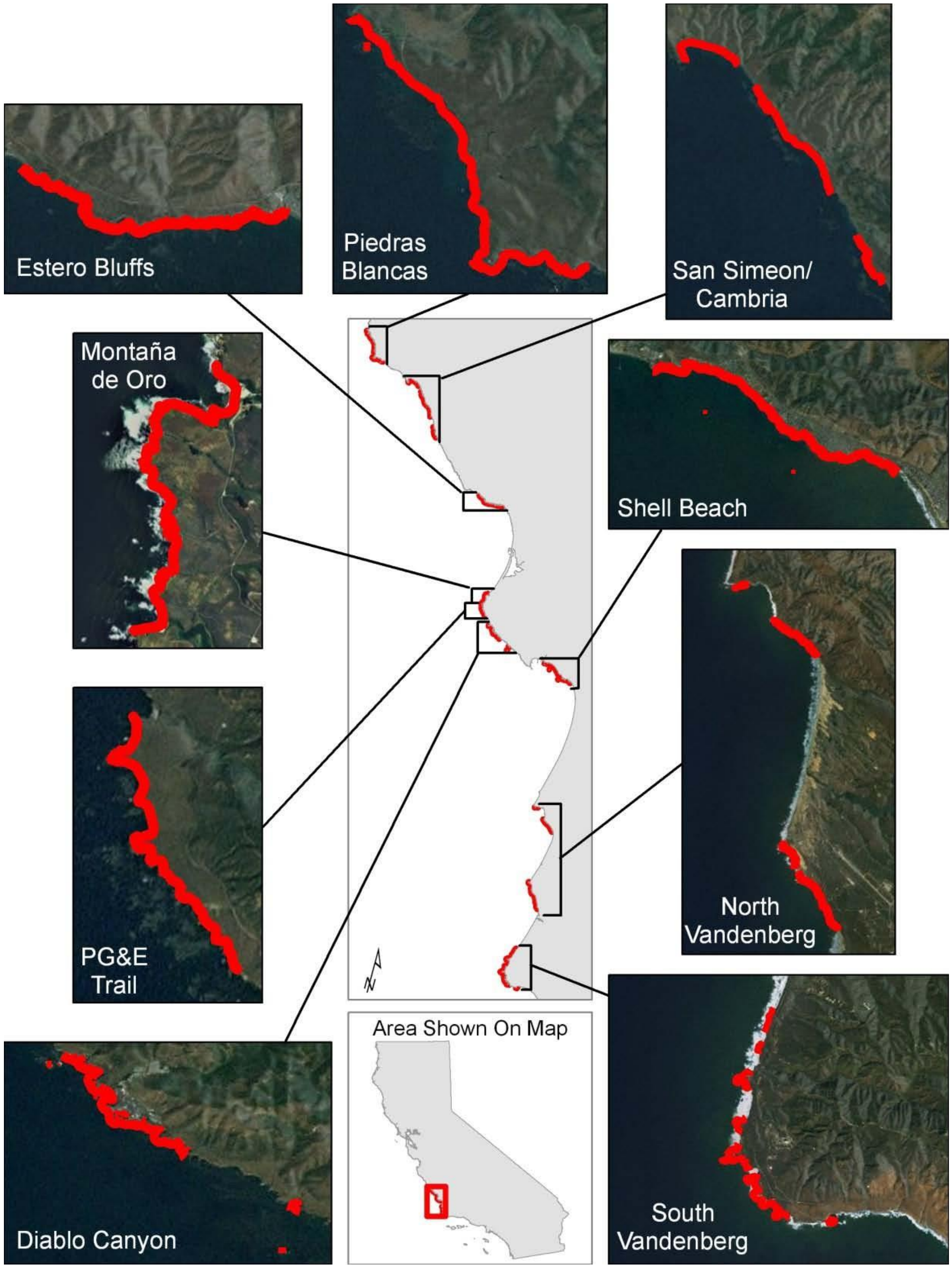


Figure 1. Map of the PSPM baseline study area with each of the nine transects surveyed in 2011.

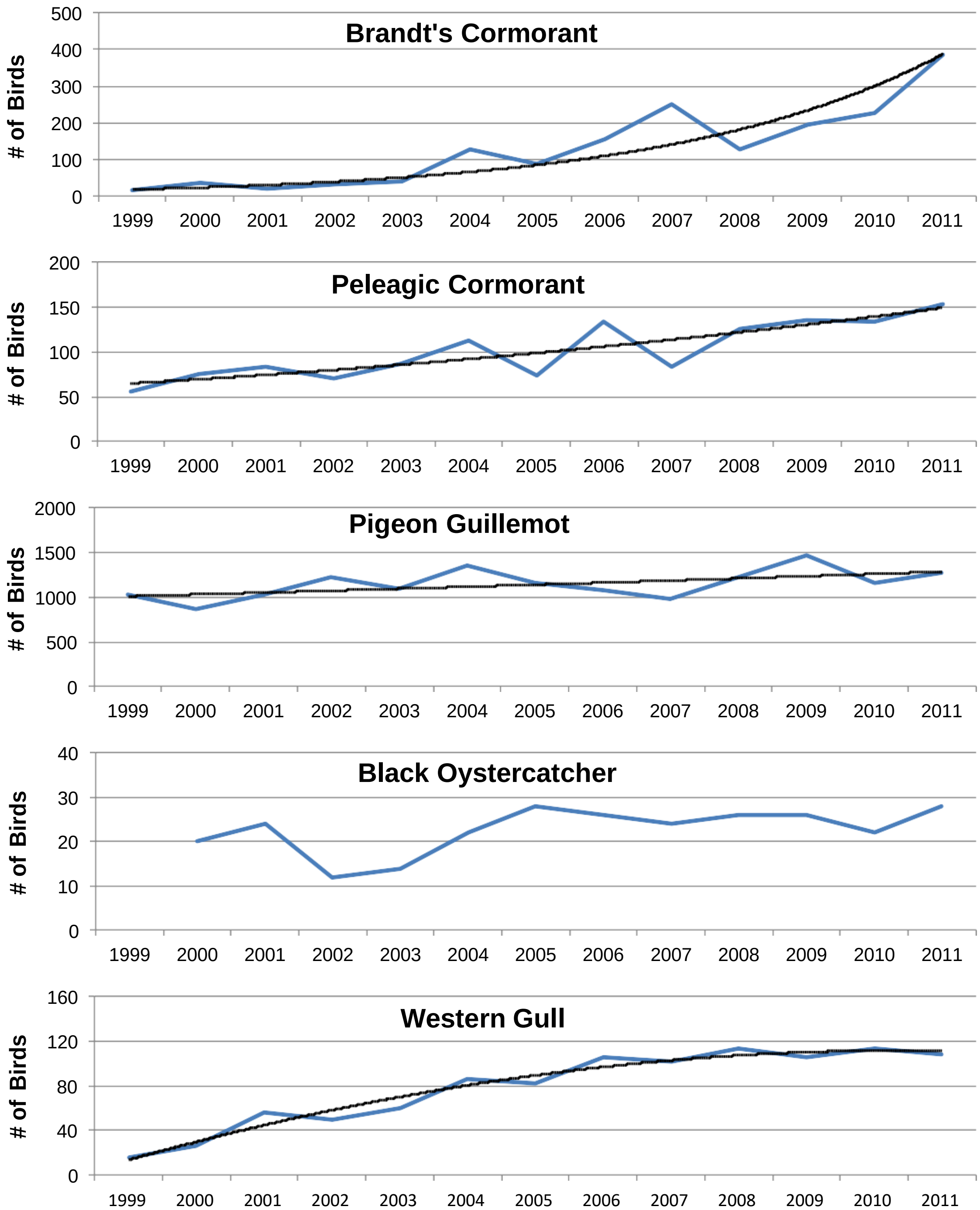


Figure 2. Trends in breeding populations for five species breeding at Vandenberg AFB from 1999 to 2011. Blue lines show variability annual breeding populations while black lines were derived from regression analyses and show trends over the time series.

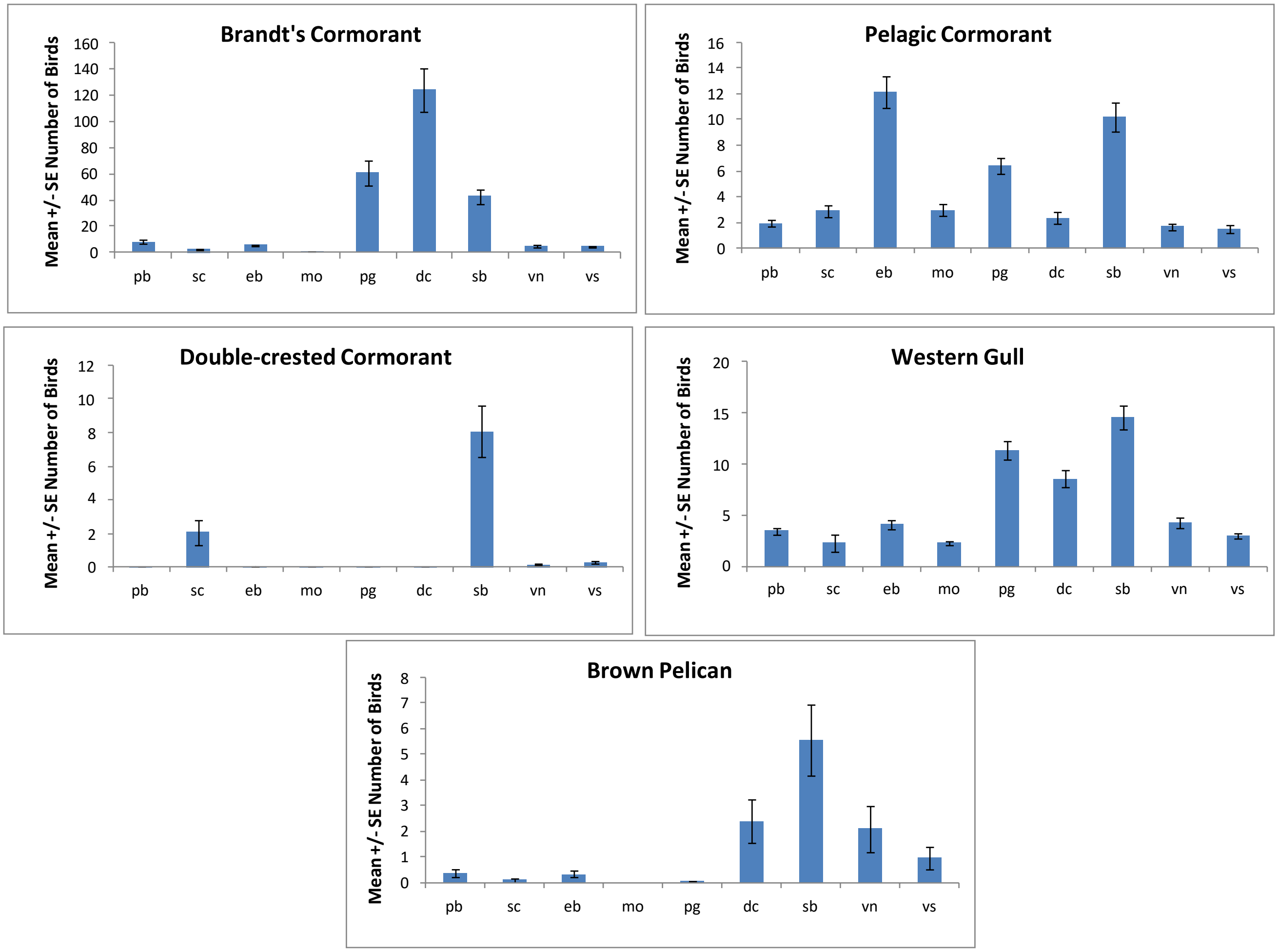


Figure 3. Mean number of roosting birds within each of the nine transects in 2011. Bars represent standard error for the mean calculated from the total number of observations of a species at each transect. pb = Piedras Blancas, sc = San Simeon/Cambria, eb = Estero Bluffs, mo = Montaña de Oro, pg = PG&E Trail, dc = Diablo Canyon, sb = Shell Beach, vn = North Vandenberg AFB, vs = South Vandenberg AFB.

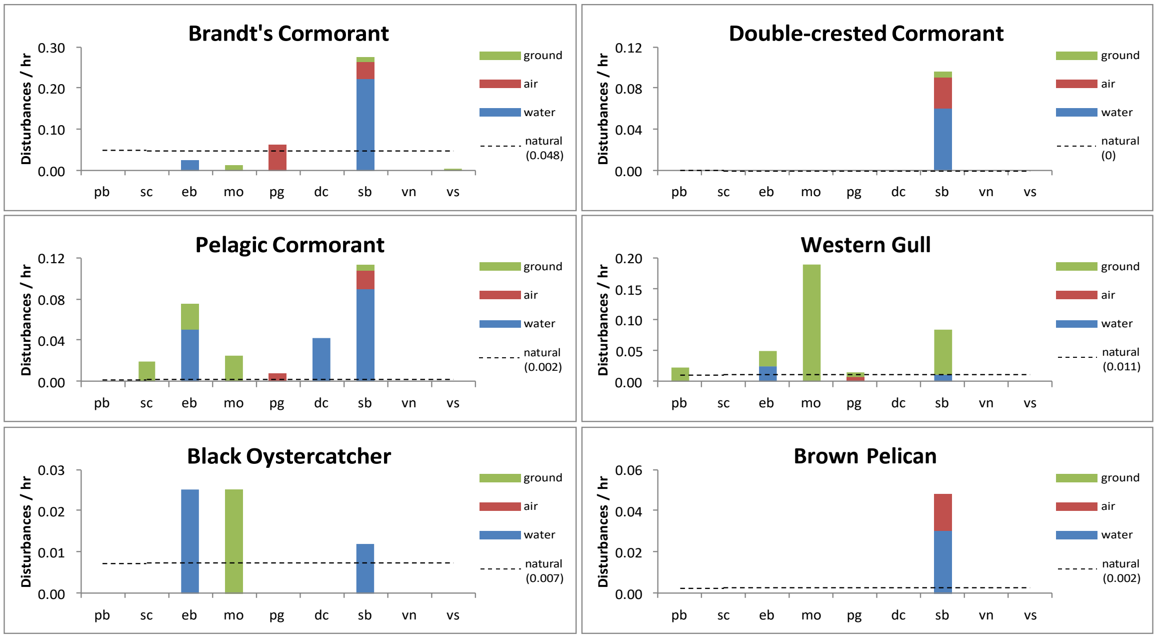


Figure 4. Number of disturbances per hour of observation from ground, air, and water sources at each of the nine transects in 2011. Dashed lines show the rate of "natural" disturbances averaged over all transects for a given species. pb = Piedras Blancas, sc = San Simeon/Cambria, eb = Estero Bluffs, mo = Montaña de Oro, pg = PG&E Trail, dc = Diablo Canyon, sb = Shell Beach, vn = North Vandenberg AFB, vs = South Vandenberg AFB.

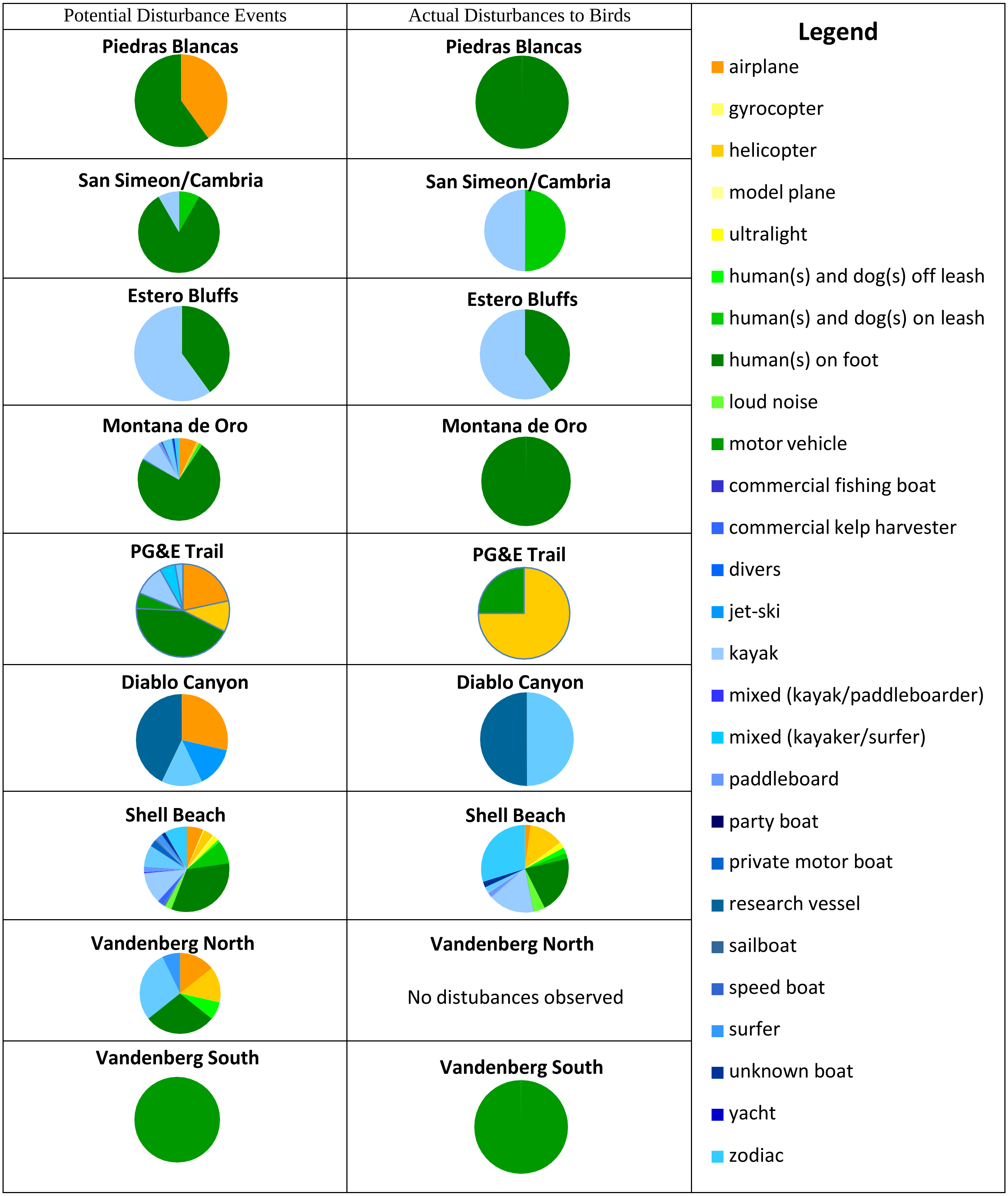


Figure 5. Types of potential disturbance events versus actual disturbances to birds. Oranges and yellows = air; greens = ground, blues= water-based disturbances.

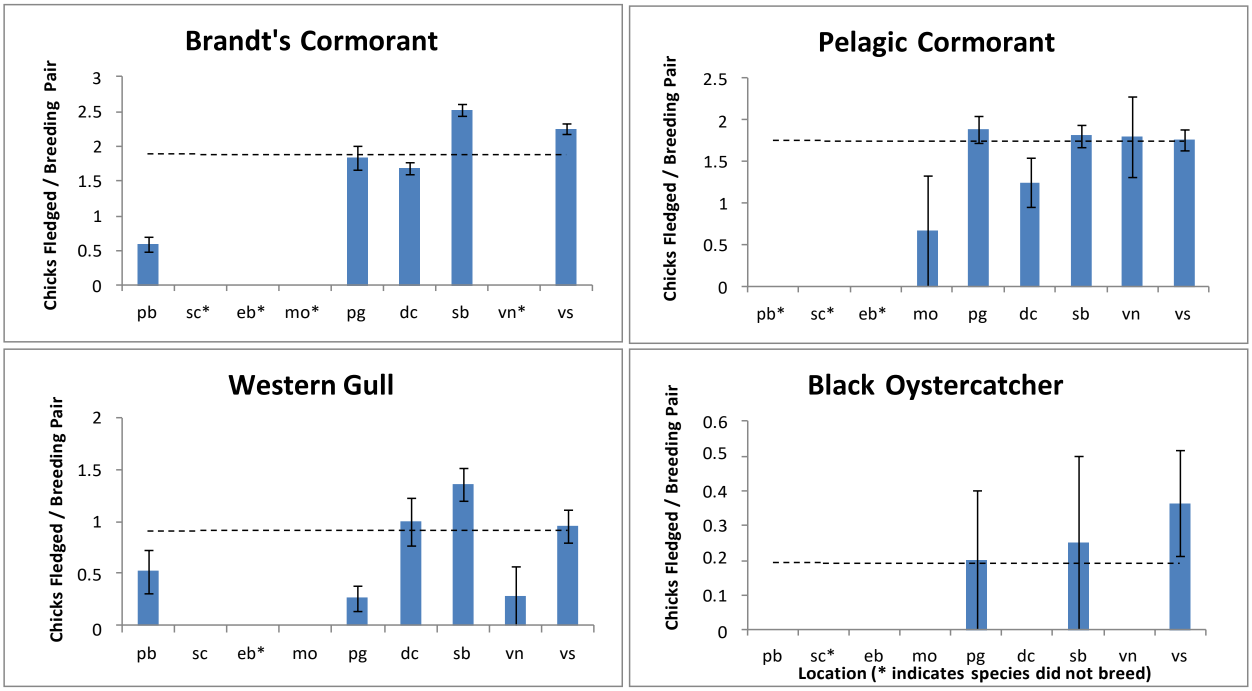
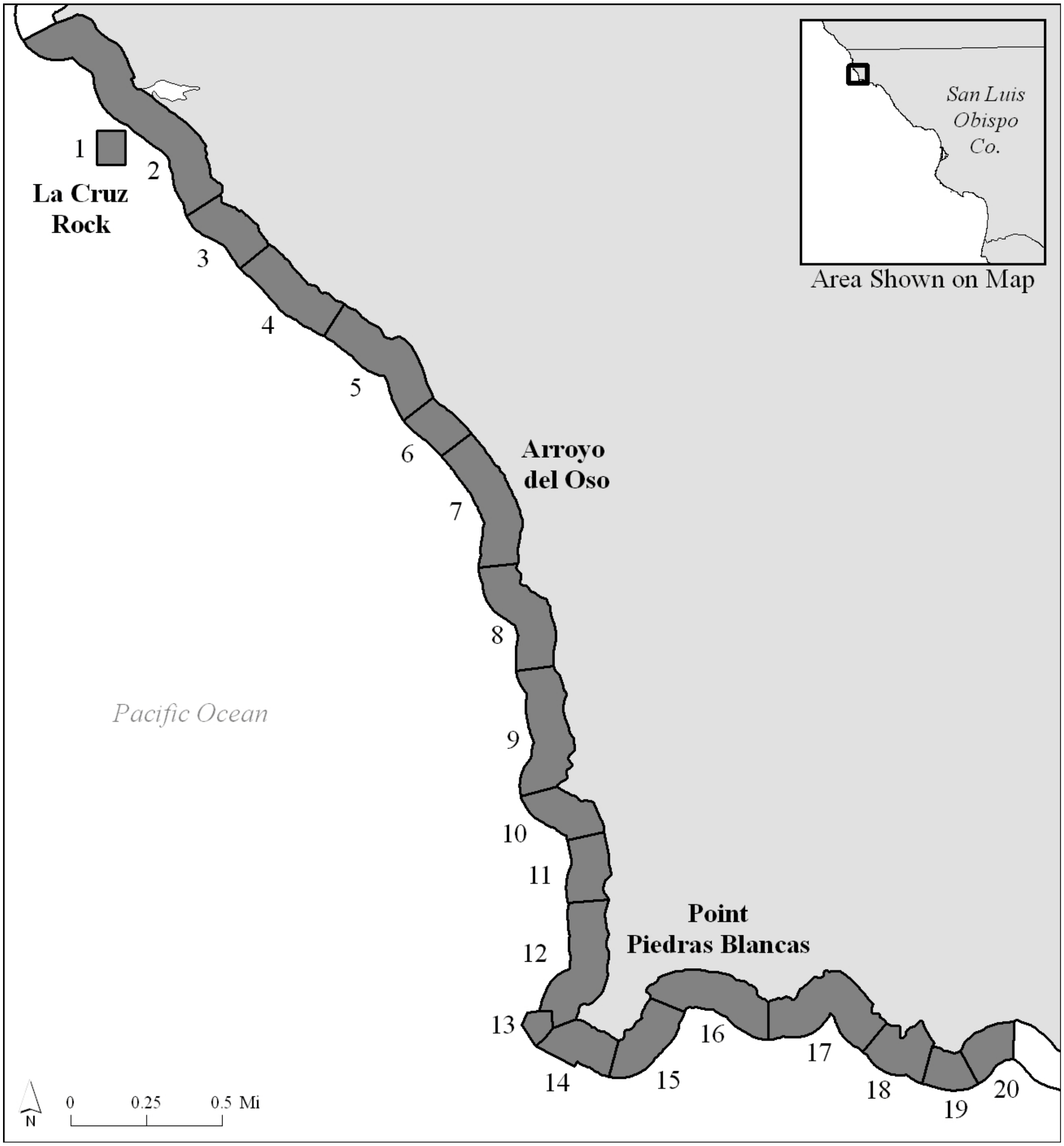


Figure 6. Mean number of chicks fledged per breeding pair for each PSPM focal species within each transect. Bars represent standard error and the dashed line represents the mean across all transects. The * indentifies transects where a given species did not breed. pb = Piedras Blancas, sc = San Simeon/Cambria, eb = Estero Bluffs, mo = Montaña de Oro, pg = PG&E Trail, dc = Diablo Canyon, sb = Shell Beach, vn = North Vandenberg AFB, vs = South Vandenberg AFB.

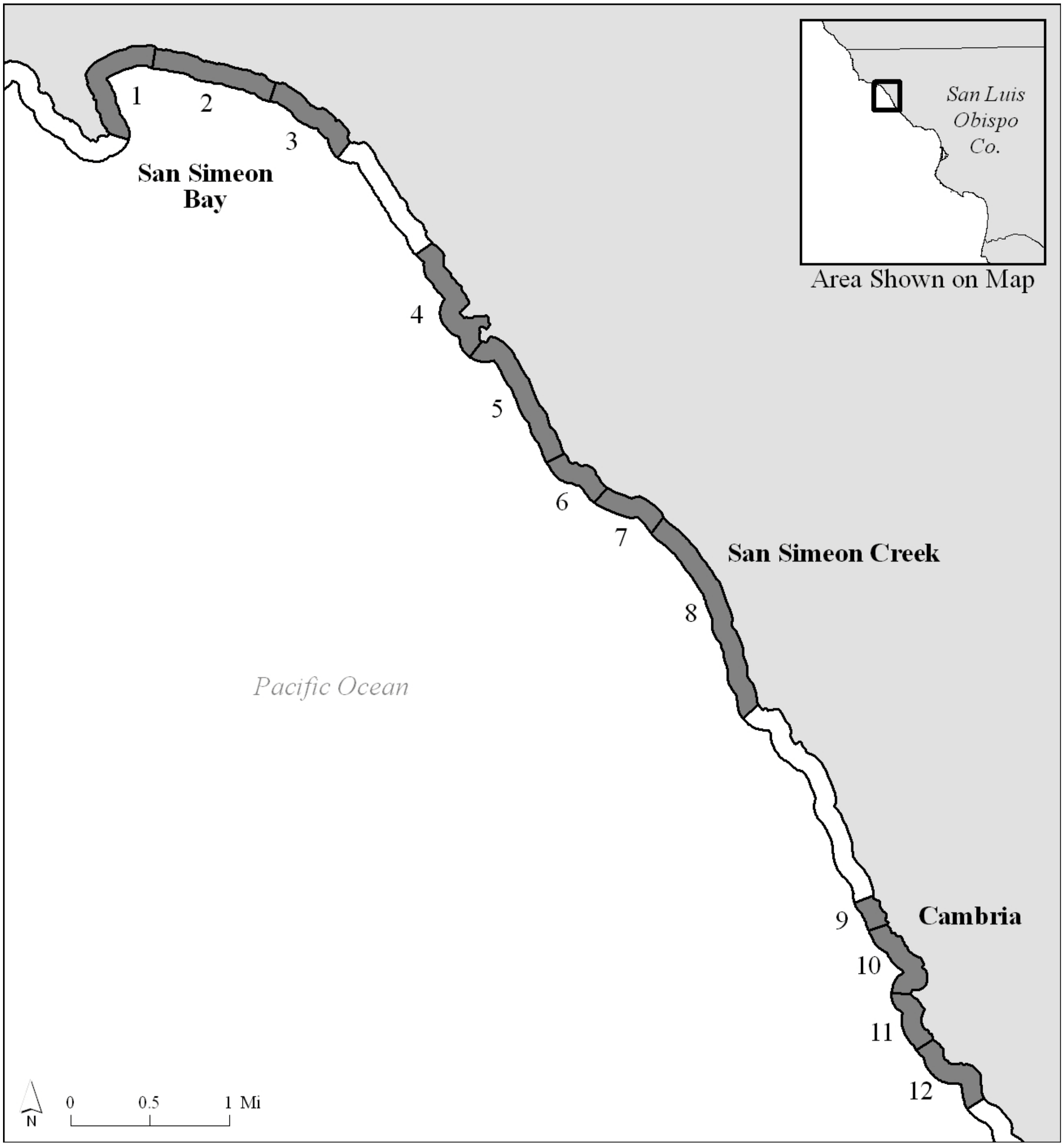
Appendix I: Population Estimates for the Piedras Blancas Sub-colonies



Population Estimates for the Piedras Blancas Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
pb1	Brandt's Cormorant	4	2	
	Western Gull	4	2	
	Black Oystercatcher	2	1	
pb2	Black Oystercatcher	2	0	
pb3	Black Oystercatcher	2	0	
pb4	Black Oystercatcher	1	0	
pb5	Black Oystercatcher	2	0	
pb6	Western Gull	2	2	
	Black Oystercatcher	2	0	
pb7	none	-	-	
pb8	none	-	-	
pb9	none	-	-	
pb10	Black Oystercatcher	6	0	
pb11	Black Oystercatcher	1	0	
pb12	none	-	-	
pb13	Brandt's Cormorant	114	57	
	Western Gull	8	4	
	Pigeon Guillemot	6	n/c	4/5/2011
	Black Oystercatcher	3	1	
pb14	Western Gull	6	3	
	Pigeon Guillemot	1	n/c	7/27/2011
	Black Oystercatcher	3	0	
pb15	Western Gull	10	5	
	Pigeon Guillemot	4	n/c	4/5/2011
	Black Oystercatcher	2	0	
pb16	Black Oystercatcher	1	0	
pb17	Western Gull	10	5	
	Black Oystercatcher	4	1	
pb18	Western Gull	24	12	
	Pigeon Guillemot	3	n/c	4/15/2011
	Black Oystercatcher	2	0	
pb19	none	-	-	
pb20	none	-	-	
TOTALS	**Brandt's Cormorant**	**118**	**59**	
	Western Gull	**64**	**32**	
	Pigeon Guillemot	**14**	**7**	
	Black Oystercatcher	**33**	**3**	

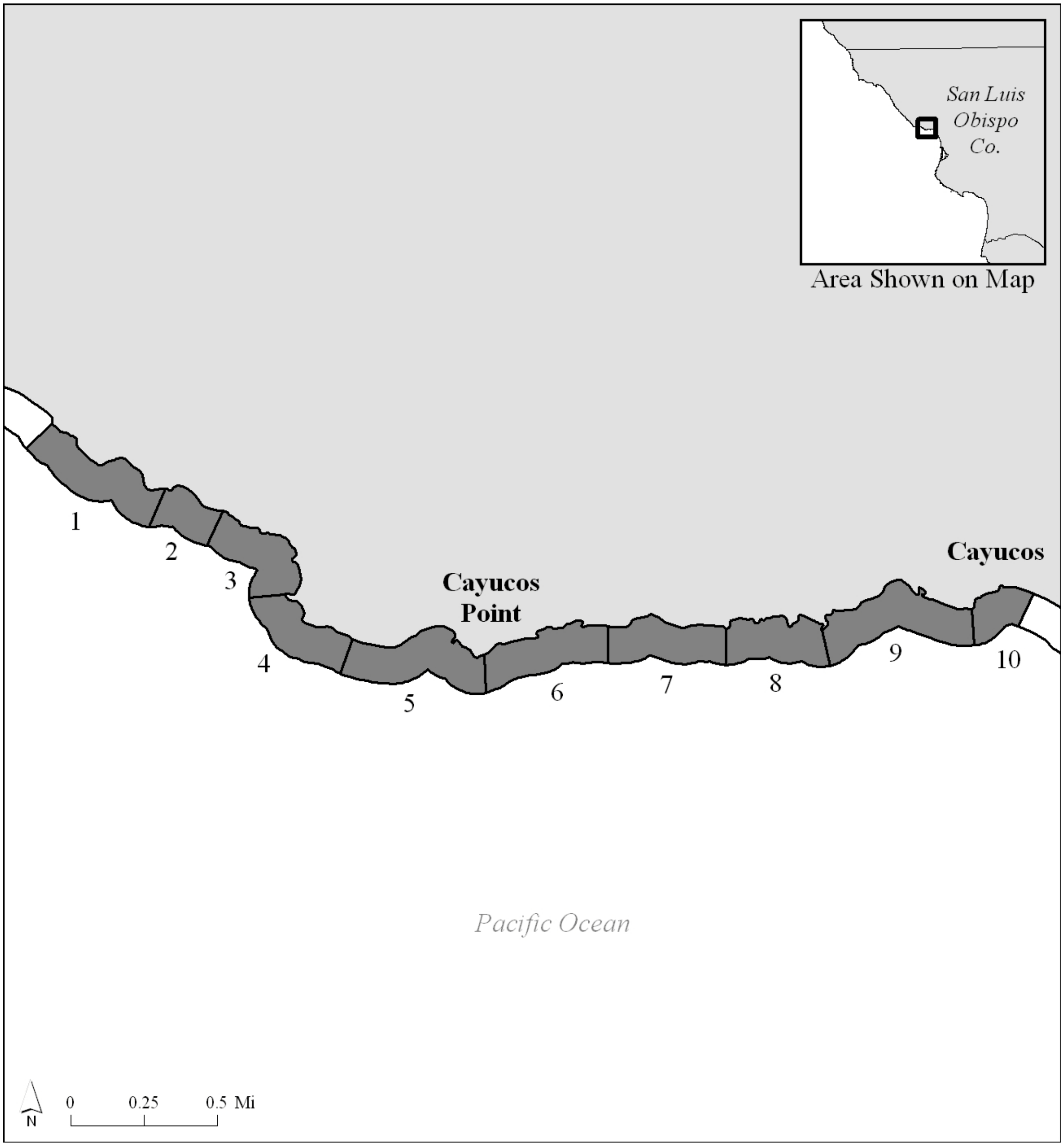
Appendix II: Population Estimates for the San Simeon/Cambria Sub-colonies



Population Estimates for the San Simeon/Cambria Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
sc1	Double-crested Cormorant	84	42	
	Western Gull	16	8	
	Pigeon Guillemot	24	n/c	7/19/2011
sc2	Black Oystercatcher	1	0	
sc3	Western Gull	2	1	
	Black Oystercatcher	1	0	
sc4	Black Oystercatcher	2	0	
sc5	Western Gull	2	1	
sc6	Western Gull	4	2	
sc7	none	-	-	
sc8	none	-	-	
sc9	Black Oystercatcher	1	0	
sc10	Black Oystercatcher	1	0	
sc11	Black Oystercatcher	1	0	
sc12	**none**	-	-	
TOTALS	**Double-crested Cormorant**	**84**	**42**	
	Western Gull	**24**	**12**	
	Pigeon Guillemot	**24**	**n/c**	
	Black Oystercatcher	**7**	**0**	

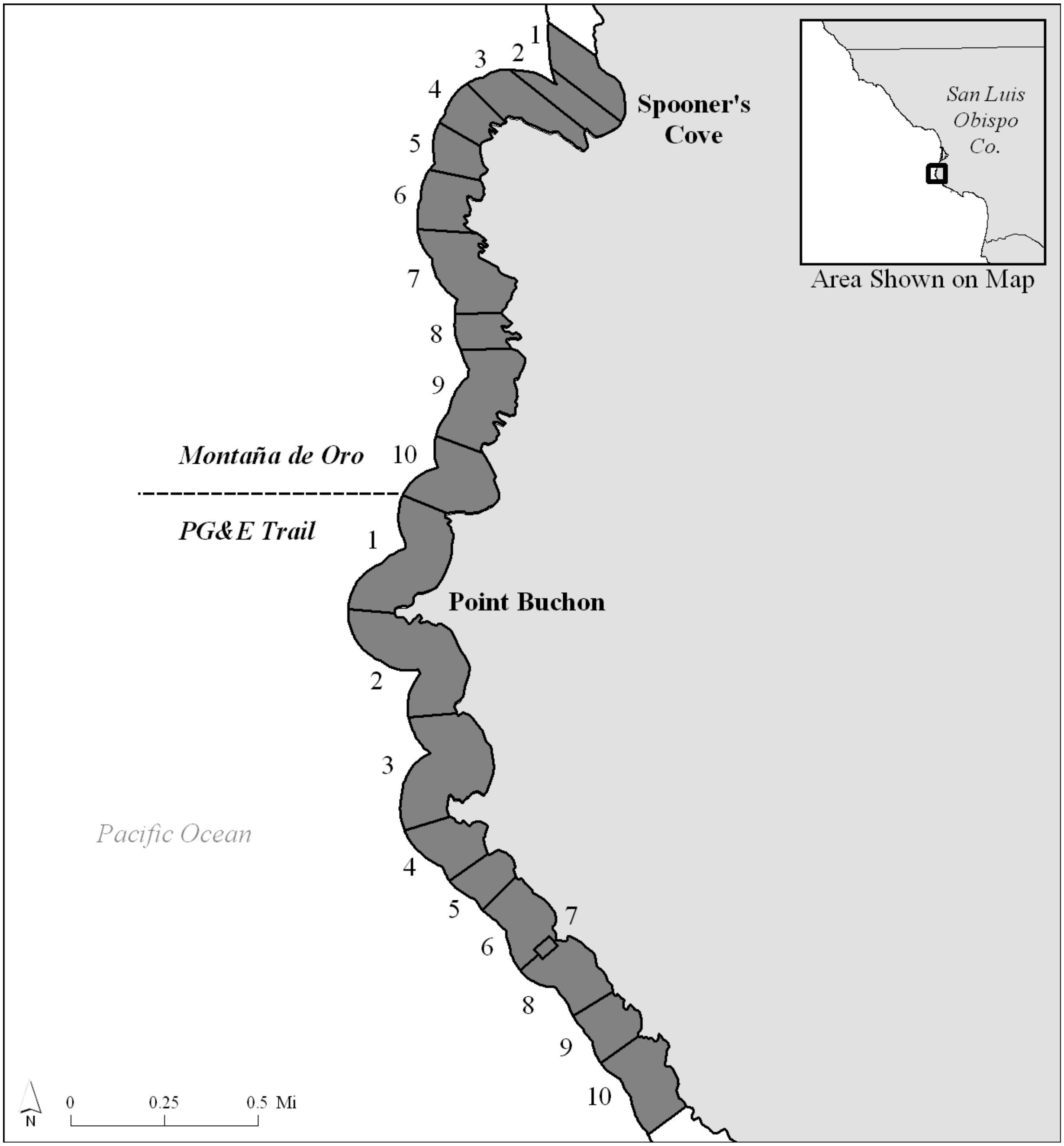
Appendix III: Population Estimates for the Estero Bluffs Sub-colonies



Population Estimates for the Estero Bluffs Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
eb1	Western Gull	2	1	
	Black Oystercatcher	1	0	
eb2	none	2	0	
eb3	none	4	0	
eb4	none	3	0	
eb5	none	1	0	
eb6	none	2	0	
eb7	none	2	0	
eb8	Black Oystercatcher	4	1	
eb9	Black Oystercatcher	1	1	
eb10	none	1	0	
TOTALS	**Western Gull**	**2**	**1**	
	Black Oystercatcher	**21**	**2**	

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



Population Estimates for the Montaña de Oro Sub-colonies

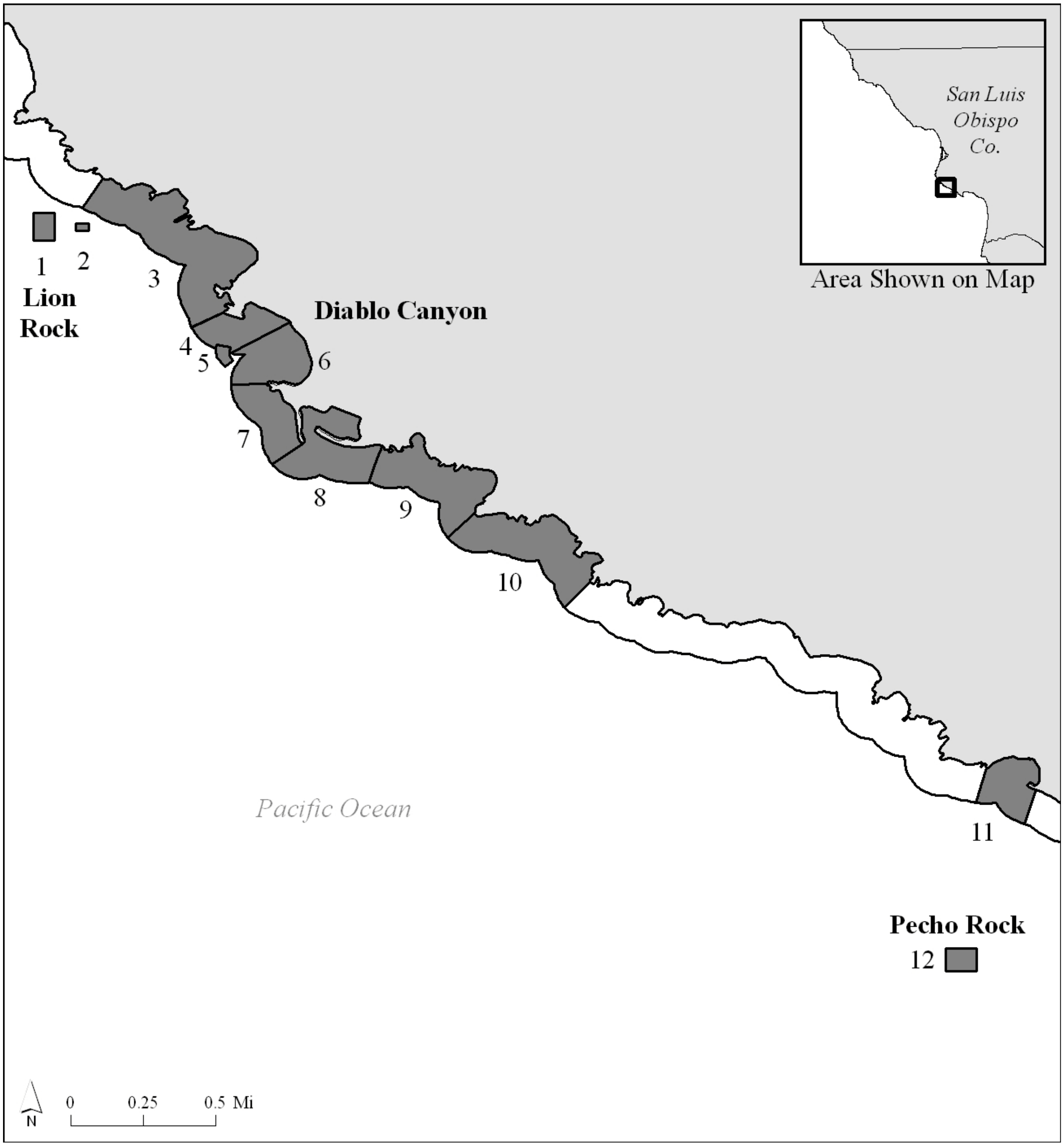
Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
mo1	Piegeon Guillemot	3	n/c	6/7/2011
	Black Oystercatcher	1	0	
mo2	Pigeon Guillemot	3	n/c	7/24/2011
	Black Oystercatcher	2	0	
mo3	Western Gull	2	1	
	Pigeon Guillemot	62	n/c	4/20/2011
	Black Oystercatcher	4	1	
mo4	Western Gull	2	1	
	Pigeon Guillemot	46	n/c	4/14/2011
	Black Oystercatcher	4	2	
mo5	Pigeon Guillemot	1	n/c	7/12/2011
	Black Oystercatcher	6	0	
mo6	Western Gull	4	2	
	Pigeon Guillemot	1	n/c	6/21/2011
	Black Oystercatcher	4	1	
mo7	Pigeon Guillemot	2	n/c	4/29/2011
	Black Oystercatcher	6	1	
mo8	none	-	-	
mo9	Western Gull	4	2	
	Pigeon Guillemot	37	n/c	7/12/2011
	Black Oystercatcher	10	0	
mo10	Pelagic Cormorant	6	3	
	Western Gull	2	1	
	Pigeon Guillemot	38	n/c	7/24/2011
	Black Oystercatcher	3	0	
TOTALS	**Pelagic Cormorant**	**6**	**3**	
	Western Gull	**14**	**7**	
	Pigeon Guillemot	**209**	**n/c**	
	Black Oystercatcher	**40**	**5**	

Population Estimates for the PG&E Trail Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
pg1	Pelagic Cormorant	2	1	
	Pigeon Guillemot	15	n/c	5/25/2011
	Western Gull	26	13	
	Black Oystercatcher	6	1	
pg2	Brandt's Cormorant	2	1	
	Pelagic Cormorant	14	7	
	Pigeon Guillemot	34	n/c	5/4/2011
	Western Gull	8	4	
	Black Oystercatcher	4	1	
pg3	Pigeon Guillemot	24	n/c	6/29/2011
	Western Gull	8	4	
	Black Oystercatcher	3	0	
pg4	Pelagic Cormorant	18	9	
	Pigeon Guillemot	25	n/c	6/22/2011
	Western Gull	2	1	
	Black Oystercatcher	2	0	
pg5	Pelagic Cormorant	16	8	
	Pigeon Guillemot	21	n/c	6/22/2011
	Western Gull	10	5	
	Black Oystercatcher	4	0	
pg6	Black Oystercatcher	2	1	
	Brandt's Cormorant	174	87	
	Pelagic Cormorant	36	18	
	Pigeon Guillemot	22	n/c	4/15/2011
	Western Gull	32	16	
	Black Oystercatcher	5	1	
pg7	Brandt's Cormorant	700	350	
	Pigeon Guillemot	4	n/c	6/8 & 7/13/2011
	Western Gull	4	2	
	Black Oystercatcher	3	0	
pg8	Brandt's Cormorant	36	18	
	Pigeon Guillemot	10	n/c	6/22/2011
	Western Gull	12	6	
	Black Oystercatcher	2	0	
pg9	Brandt's Cormorant	174	87	
	Pelagic Cormorant	6	3	
	Pigeon Guillemot	21	n/c	4/15/2011

	Western Gull	40	20	
	Black Oystercatcher	3	2	
pg10	Pelagic Cormorant	10	5	
	Pigeon Guillemot	34	n/c	7/2/2011
	Western Gull	6	3	
	Black Oystercatcher	2	0	
TOTALS	**Brandt's Cormorant**	**1086**	**543**	
	Pelagic Cormorant	**102**	**51**	
	Pigeon Guillemot	**210**	**n/c**	
	Western Gull	**148**	**74**	
	Black Oystercatcher	**34**	**6**	

Appendix V: Population Estimates for the Diablo Canyon Sub-colonies

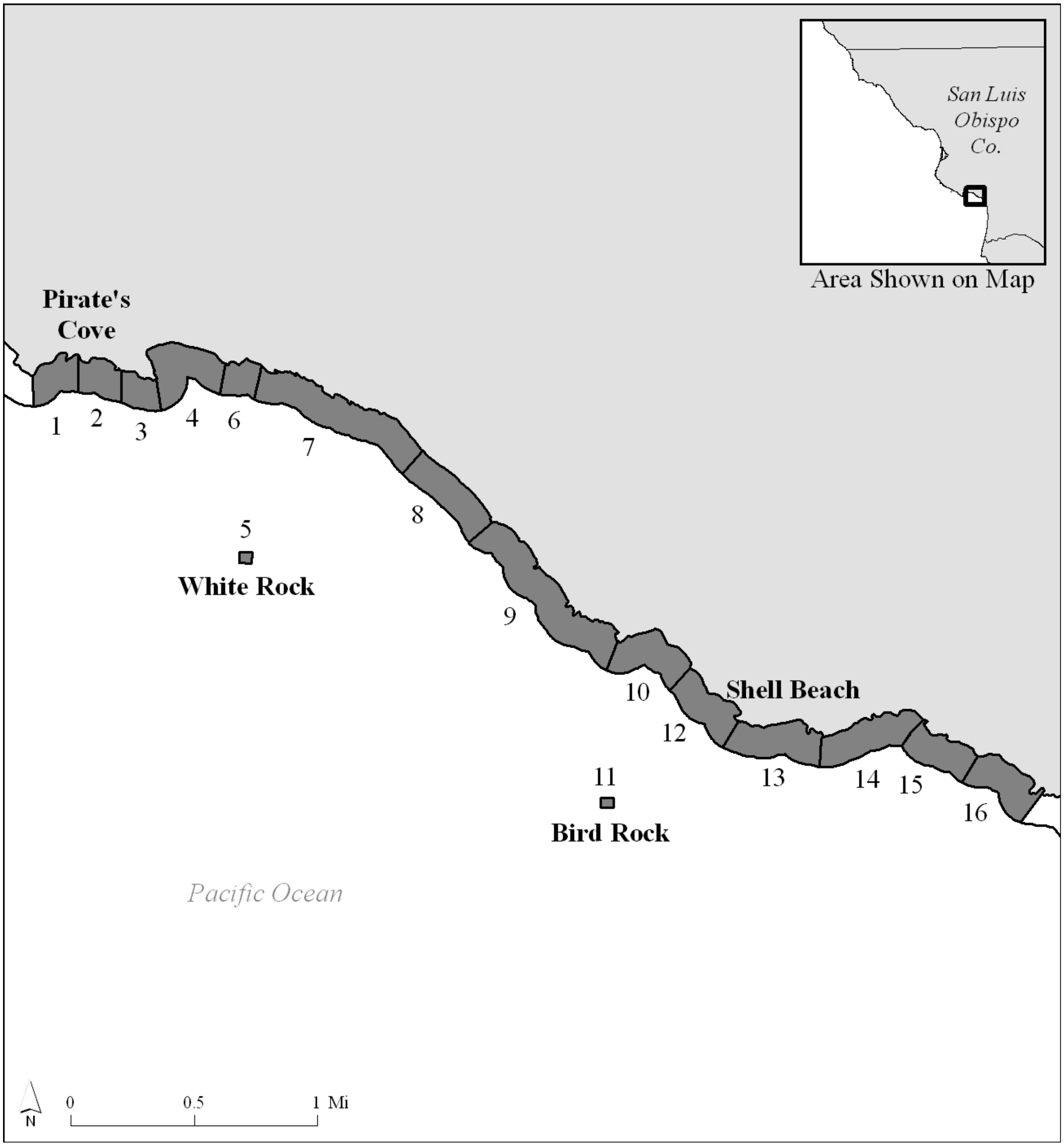


Population Estimates for the Diablo Canyon Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
dc1	Brandt's Cormorant	310	155	
	Western Gull	24	12	
dc2	Brandt's Cormorant	136	68	
	Western Gull	18	9	
dc3	Pigeon Guillemot	2	n/c	6/1 & 6/15/2011
	Western Gull	2	1	
	Black Oystercatcher	8	0	
dc4	Brandt's Cormorant	20	10	
	Pelagic Cormorant	6	3	
	Pigeon Guillemot	2	n/c	7/27/2011
	Western Gull	2	1	
	Black Oystercatcher	1	0	
dc5	Brandt's Cormorant	448	224	
	Pigeon Guillemot	5	n/c	7/27/2011
	Western Gull	14	7	
dc6	Brandt's Cormorant	420	210	
	Pelagic Cormorant	2	1	
	Pigeon Guillemot	1	n/c	6/22/2011
	Western Gull	10	5	
	Black Oystercatcher	3	0	
dc7	Western Gull	4	2	
	Black Oystercatcher	4	1	
dc8	Pigeon Guillemot	8	n/c	7/20/2011
	Western Gull	20	10	
	Black Oystercatcher	1	0	
dc9	Brandt's Cormorant	550	275	
	Pelagic Cormorant	26	13	
	Pigeon Guillemot	17	n/c	7/20/2011
	Western Gull	6	3	
	Black Oystercatcher	6	2	
dc10	Pelagic Cormorant	6	3	
	Pigeon Guillemot	14	n/c	6/28/2011
	Western Gull	10	5	
	Black Oystercatcher	4	3	
dc11	Black Oystercatcher	2	0	
dc12	Brandt's Cormorant	50	25	
TOTALS	**Brandt's Cormorant**	**1934**	**1085**	

Pelagic Cormorant	**40**	**20**
Pigeon Guillemot	**49**	**n/c**
Western Gull	**110**	**55**
Black Oystercatcher	**29**	**6**

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

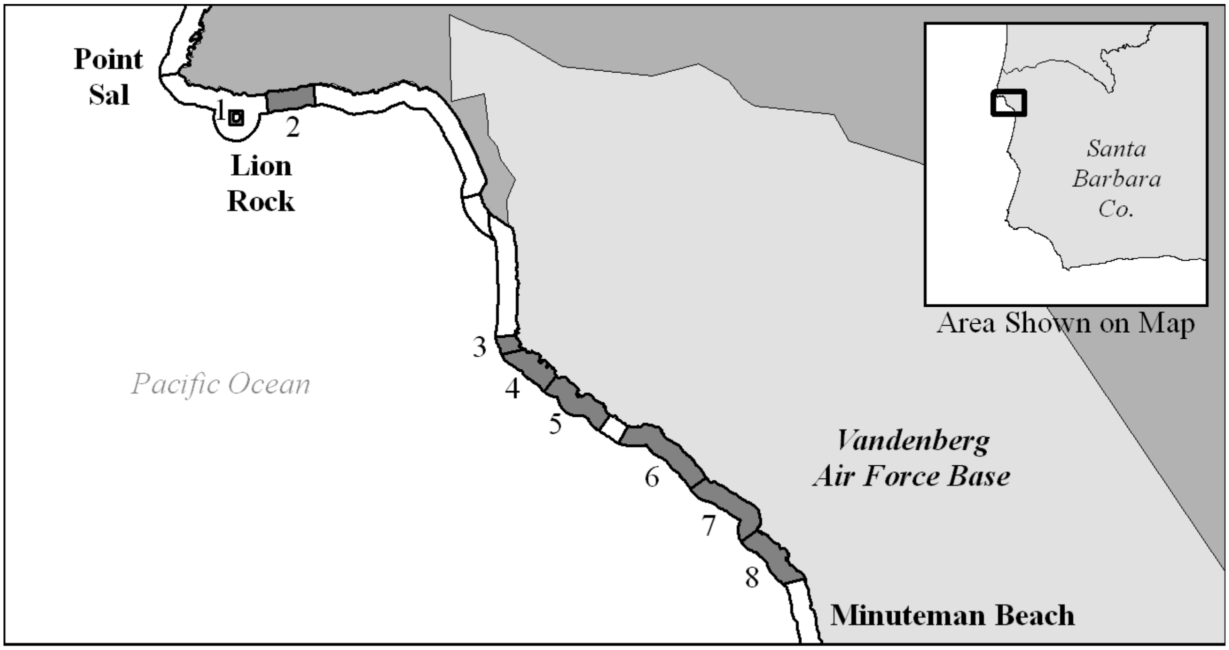


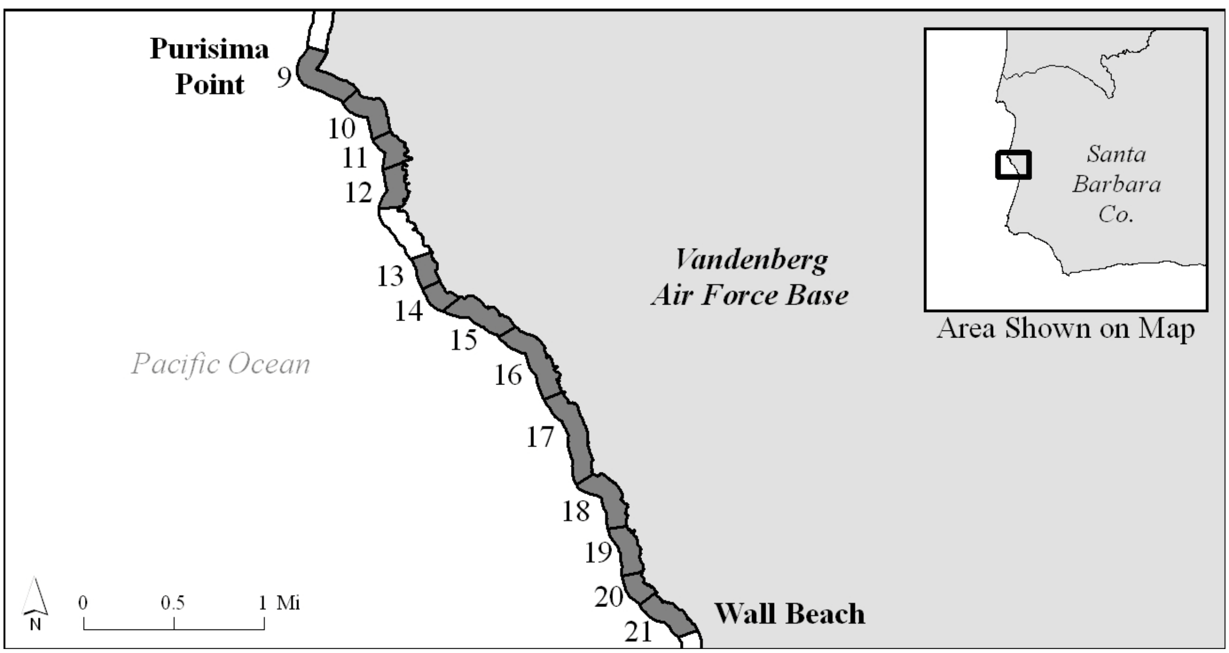
Population Estimates for the Shell Beach Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
sb1	Double-crested Cormorant	90	45	
	Brandt's Cormorant	64	32	
	Pelagic Cormorant	44	22	
	Pigeon Guillemot	41	n/c	7/28/2011
	Western Gull	6	3	
	Black Oystercatcher	4	1	
sb2	Pigeon Guillemot	32	n/c	4/13/2011
	Western Gull	2	1	
	Black Oystercatcher	2	0	
sb3	Pelagic Cormorant	64	32	
	Pigeon Guillemot	41	n/c	7/14/2011
	Western Gull	12	6	
	Black Oystercatcher	4	1	
sb4	Pigeon Guillemot	10	n/c	6/23/2011
	Black Oystercatcher	2	0	
sb5	Brandt's Cormorant	64	32	
	Black Oystercatcher	1	0	
sb6	Pelagic Cormorant	8	4	
	Pigeon Guillemot	14	n/c	7/20/2011
	Black Oystercatcher	2	0	
sb7	Pigeon Guillemot	9	n/c	6/15/2011
	Western Gull	4	2	
	Black Oystercatcher	1	0	
sb8	Pigeon Guillemot	8	n/c	6/8/2011
sb9	Pigeon Guillemot	22	n/c	6/1/2011
	Western Gull	6	3	
	Black Oystercatcher	3	0	
sb10	Pigeon Guillemot	4	n/c	7/6/2011
	Western Gull	2	1	
sb11	Black Oystercatcher	1	0	
sb12	Pelagic Cormorant	4	2	
	Pigeon Guillemot	9	n/c	7/20/2011
	Western Gull	14	7	
	Black Oystercatcher	1	0	
sb13	Pigeon Guillemot	18	n/c	5/25/2011
	Western Gull	24	12	
	Black Oystercatcher	4	1	

sb14	Brandt's Cormorant	54	27	
	Pelagic Cormorant	46	23	
	Pigeon Guillemot	42	n/c	5/11/2011
	Western Gull	50	25	
	Black Oystercatcher	2	0	
sb15	Brandt's Cormorant	150	75	
	Pelagic Cormorant	88	44	
	Pigeon Guillemot	45	n/c	4/28/2011
	Western Gull	26	13	
	Black Oystercatcher	2	0	
sb16	Pelagic Cormorant	16	8	
	Pigeon Guillemot	63	n/c	5/11/2011
	Western Gull	52	26	
	Black Oystercatcher	2	1	
TOTALS	**Double-crested Cormorant**	**90**	**45**	
	Brandt's Cormorant	**332**	**166**	
	Pelagic Cormorant	**240**	**n/c**	
	Pigeon Guillemot	**358**	**179**	
	Western Gull	**218**	**109**	
	Black Oystercatcher	**31**	**4**	

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

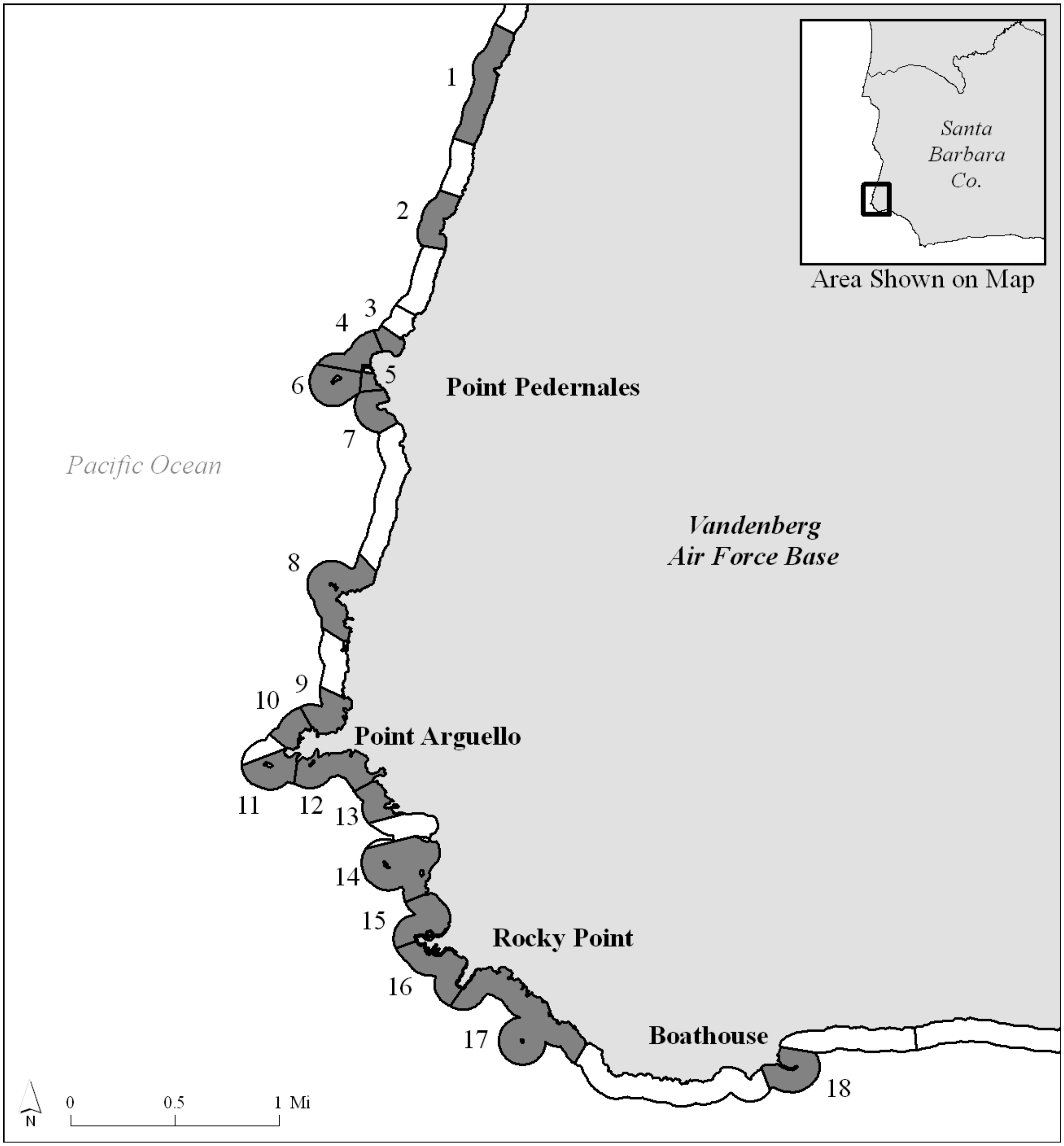




Population Estimates for the North Vandenberg Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
van1	none	-		
van2	Black Oystercatcher	2	1	
van3	Western Gull	2	1	
van4	Western Gull	4	2	
	Black Oystercatcher	2	1	
van5	Western Gull	2	1	
van6	none	-	-	
van7	none	-	-	
van8	none	-	-	
van9	Pigeon Guillemot	3	n/c	7/14/2011
van10	Pigeon Guillemot	29	n/c	4/10/2011
van11	Pigeon Guillemot	18	n/c	4/13/2011
van12	Pelagic Cormorant	10	5	
	Pigeon Guillemot	3	n/c	4/13/2011
	Western Gull	4	2	
	Black Oystercatcher	2	1	
van13	none	-	-	
van14	none	-	-	
van15	none	-	-	
van16	none	-	-	
van17	none	-	-	
van18	none	-	-	
van19	none	-	-	
van20	Pigeon Guillemot	14	n/c	4/21/2011
van21	Pigeon Guillemot	40	n/c	5/10/2011
	Western Gull	2	1	
TOTALS	**Pelagic Cormorant**	**10**	**5**	
	Pigeon Guillemot	**107**	**n/c**	
	Western Gull	**14**	**7**	
	Black Oystercatcher	**6**	**3**	

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



Population Estimates for the South Vandenberg Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
vas1	Pigeon Guillemot	39	n/c	6/7/2011
	Western Gull	2	1	
vas2	Pigeon Guillemot	14	n/c	5/12/2011
vas3	Pigeon Guillemot	29	n/c	5/12/2011
vas4	Pigeon Guillemot	28	n/c	4/6/2011
vas5	Pigeon Guillemot	70	n/c	4/27/2011
	Western Gull	4	2	
	Black Oystercatcher	4	2	
vas6	Brandt's Cormorant	12	6	
	Pigeon Guillemot	41	n/c	5/3/2011
vas7	Pigeon Guillemot	36	n/c	5/12/2011
	Western Gull	4	2	
vas8	Pigeon Guillemot	31	n/c	6/3 & 6/7/2011
	Western Gull	4	2	
	Black Oystercatcher	2	1	
vas9	Pigeon Guillemot	38	n/c	5/12/2011
	Western Gull	4	2	
vas10	Pigeon Guillemot	60	n/c	4/6/2011
vas11	Pigeon Guillemot	104	n/c	5/12/2011
	Western Gull	2	1	
vas12	Brandt's Cormorant	322	161	
	Pelagic Cormorant	122	61	
	Pigeon Guillemot	168	n/c	4/27/2011
	Western Gull	20	10	
	Black Oystercatcher	2	1	
vas13	Pigeon Guillemot	48	n/c	5/12/2011
	Western Gull	2	1	
vas14	Pigeon Guillemot	39	n/c	5/12/2011
	Western Gull	2	1	
	Black Oystercatcher	2	1	
vas15	Brandt's Cormorant	50	25	
	Pelagic Cormorant	12	6	
	Pigeon Guillemot	111	n/c	4/6/2011
	Western Gull	40	20	
	Black Oystercatcher	2	1	
vas16	Pigeon Guillemot	81	n/c	4/6/2011
	Western Gull	2	1	
vas17	Pigeon Guillemot	68	n/c	5/3/2011

	Western Gull	4	2
	Black Oystercatcher	2	1
vas18	Brandt's Cormorant	2	1
TOTALS	**Brandt's Cormorant**	**386**	**193**
	Pelagic Cormorant	**134**	**67**
	Pigeon Guillemot	**1005**	**n/c**
	Western Gull	**90**	**45**
	Black Oystercatcher	**16**	**7**