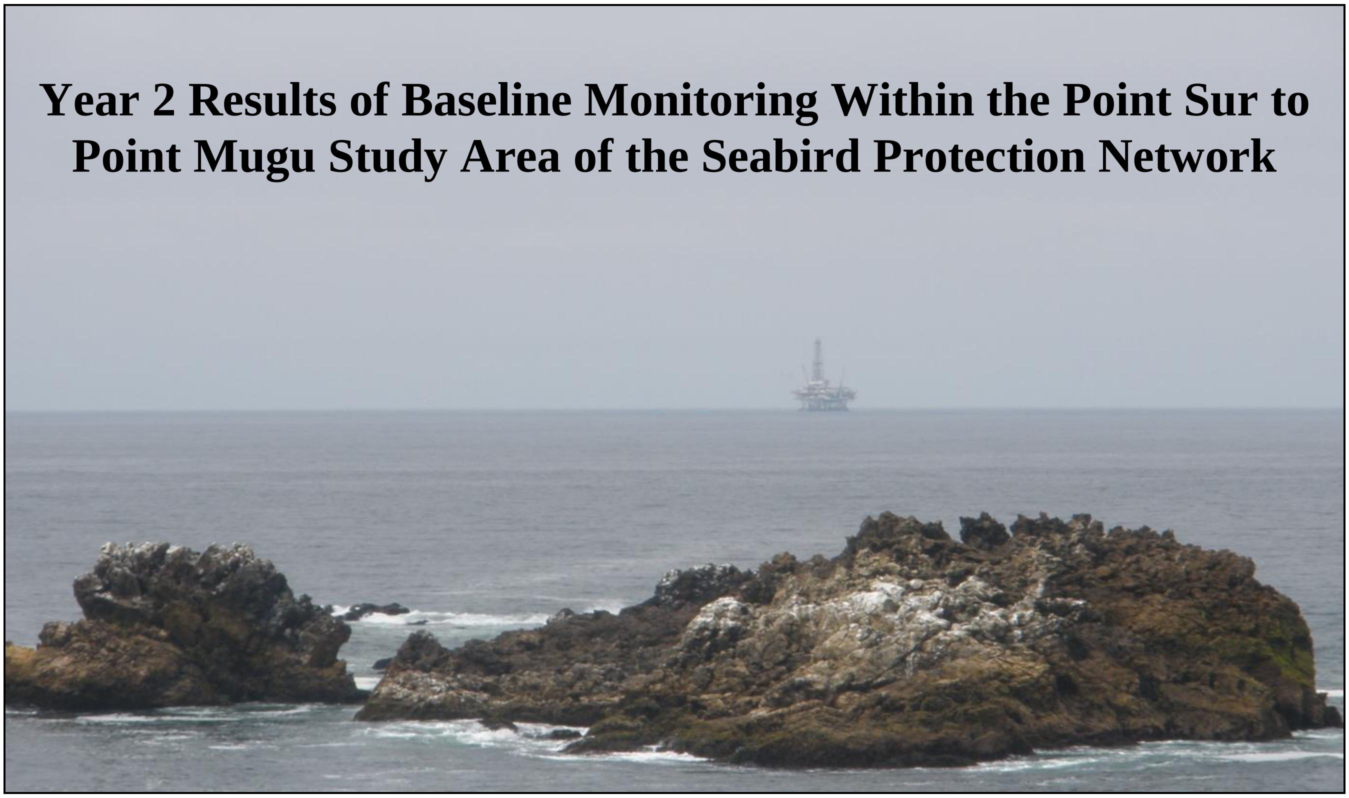
Year 2 Results of Baseline Monitoring Within the Point Sur to Point Mugu Study Area of the Seabird Protection Network



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

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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 large populations of all focal species breeding at Shell Beach and that 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. Results from 2012 showed a similar distribution of breeding populations throughout the study area, though population sizes were lower in 2012 for most species. Shell Beach, Montaña de Oro and Estero Bluffs continued to have the highest rates of disturbance, but disturbance rates were overall lower in 2012. Breeding productivity (measured as number of fledglings produced per breeding pair) was highest at VAFB, an area of very little disturbance, for most species in both years. While outreach and law enforcement efforts are currently underway, it is important to recognize that measurable impacts of these efforts will take time to detect. It is important to recognize that many of the changes we measure in seabird variables will be responses to variability in the underlying oceanographic variables driving prey availability. Dissecting changes in population and breeding productivity due to outreach and law enforcement efforts from those due to oceanographic variability will require long term data. Furthermore, the variability that we observed in human behavior between years illustrates the difficulty in attributing changes in disturbance rates to outreach and law enforcement efforts. That being said, we were able to at least partially attribute decreases in boat disturbance at Shell Beach in 2012 to outreach and law enforcement efforts targeted at a single group that caused multiple disturbances in 2011. Given the level of variability in seabird metrics and human behavior, the success of the PSPM chapter will require continued monitoring to guide the adaptive management of outreach and law enforcement efforts.

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.

Transcect 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 $\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 2 Baseline Monitoring

Appendices I through VIII show the 2012 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, Pigeon Guillemots were the most abundant species breeding within the baseline study region. Brandt's Cormorants were the second most abundant, followed by Pelagic Cormorants, Western Gulls, 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 532 birds and 1,078 birds, respectively. 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). Smaller numbers of Brandt's Cormorants were found breeding at Shell Beach (264 birds) and South Vandenberg AFB (372 birds).

Pigeon Guillemots were found breeding within all transects except Estero Bluffs. The largest population was at South Vandenberg AFB (1,441 birds) while moderate populations were found at Montaña de Oro (239 birds), PG&E Trail (203 birds), Shell Beach (329 birds), and North Vandenberg AFB (193 birds). Small populations were found at Piedras Blancas (14 birds), San Simeon/Cambria (26 birds), and Diablo Canyon (66 birds).

Western Gulls were found breeding within all transects except Estero Bluffs. The largest population was found at PG&E Trail (104 birds) and Shell Beach (146 birds). Moderate populations were found at Piedras Blancas (50 birds), Diablo Canyon (46 birds), and South Vandenberg AFB (68 birds). Small populations were found at San Simeon/Cambria (14 birds), Montaña de Oro (18 birds), and North Vandenberg AFB (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 (234 birds) while moderate populations were found at PG&E Trail (88 birds), Diablo Canyon (82 birds) and South Vandenberg AFB (154 birds). Small populations were found at Montaña de Oro (8 birds) and North Vandenberg AFB (10 birds).

Double-crested Cormorants were found breeding only at San Simeon and Shell Beach with 56 birds and 156 birds, respectively.

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

Comparison of 2011 and 2012 Breeding Populations

Figure 2 shows breeding population size and distribution for each of the six breeding focal species during 2011 and 2012. Overall, there was either no change or decreased 2012 populations at most sites. 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.

Vandenberg Time Series (1999-2012)

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, will all species showing positive growth (Figure 3). 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 3). 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 3). 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). The quadratic model provided the best fit for the Pigeon Guillemot population, though the trend appears more linear (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. The quadratic model provided the best fit for Black Oystercatchers. This trend is being driven by stable territory occupancy in the latter part of the time series, with 2012 having the highest number of occupied territories in the time series (Figure 3). Black Oystercatchers are territorial and their population at Vandenberg is likely limited by the number of available territories. The quadratic model showed the best fits for Western Gulls (Figure 3). 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 marks the first major decrease in this population, with the number of birds dipping below the 2005 values.

Seabird Roost Utilization

Figure 4 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 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 Cormoants, and Western Gulls; Estero Bluffs was an important area for Double-crested Cormants and Pelagiac 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 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.

Disturbances to Breeding and Roosting Sites

Rates of Human-Caused Disturbance

Figures 5 through 10 show the number of disturbances recorded per hour of observation at each transect. Each figure compares disturbance rates between 2011 and 2012 for a given 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. Overall, disturbance rates were lower in 2012 than in 2011. Brandt's Cormorants (Figure 5) showed a major decrease in disturbance rates at Shell Beach. Water sources accounted for the majority of disturbances in both years, but ground sources contributed more to disturbances at Estero Bluffs and Diablo Canyon in 2012. Water sources accounted for most disturbances to Pelagic Cormorants (Figure 6) as well. Disturbance rates were highest at Shell Beach, Diablo Canyon, and Estero Bluffs in 2011. Rates decreased substantially at all 3 sites in 2012. The type and distribution of disturbances to Double-crested Cormorants (Figure 7) varied between 2011 and 2012. All disturbances in 2011 occurred at Shell Beach, with the majority being from water sources. In 2012, disturbance rates at Shell Beach were reduced, but disturbances were observed at San Simeon/Cambria and Estero Bluffs for the first time. The majority of disturbances to Western Gulls (Figure 8) were from ground sources in 2011 and 2012. Disturbance rates decreased in 2012, with the largest decreases occurring at Piedras Blancas, Montaña de Oro, and Shell Beach. Disturbance rates for Black Oystercatcher (Figure 9) were highly variable between 2011 and 2012. Disturbances were caused by water and ground sources and were highest at Estero Bluffs and Montaña de Oro in 2011. Disturbance rates decreased in 2012 and disturbances were observed at North and South Vandenberg for the first time. All disturbances to Brown Pelicans occurred at Shell Beach in both 2011 and 2012. Disturbance rates were highest in 2011, with air and water sources contributing equally. Sources of disturbance in 2012 were ground and air.

Rates of Naturally Caused Disturbances

Figures 5 through 10 show 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). Rates of natural disturbance were lower in 2012 than in 2011. In 2011, rates of natural disturbance were overall 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 of Brandt's cormorants at these sites. There were no Brandt's Cormorants breeding at either of these two sites in either year 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.

Types of Disturbances

Figures11 through 13 show 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 were very few disturbances recorded at most locations in 2012 and the largest disturbances were recorded at Estero Bluffs, Montaña de Oro, and Shell Beach.

The majority of potential disturbances at Piedras Blancas, San Simeon/Cambria, and Estero Bluffs (Figure 11) were from humans on foot, with and without dogs and human-powered boats (e.g., kayakers, surfers). There were no actual disturbances at Piedras Blancas in 2012. Actual disturbances at San Simeon/Cambria and Estero Bluffs were primarily from humans on foot, followed by human-powered boats. Shore-based fishers also caused disturbance at Estero Bluffs in 2012.

The majority of potential disturbances at Montaña de Oro, PG&E Trail, and Diablo Canyon (Figure 12) were from humans on foot. There was a higher diversity of air and water sources than observed at the locations in Figure 11. There were no actual distrubances at PG&E Trail in 2012. Humans on foot and shore-based fishing caused actual disturbances at Montaña de Oro while research boats (other boat) and humans on foot caused actual disturbances at Diablo Canyon.

Sources of potential disturbance were much more diverse at Shell Beach, North Vandenberg, and South Vandenrberg (Figure 13) than the locations in Figures 11 and 12. The majority of potential and actual disturbances at Shell Beach were from human-powered boats and recreational power boats. Airplanes, helicopters, and shore-based fishing also caused actual disturbances at Shell Beach. Actual disturbances at North Vandenberg included one instance of a human on foot and a helicopter. Actual disturbances at South Vandenberg included one instance each of humans on foot, an airplane, and shore-based fishing.

Disturbance Rates on Weekends vs. Weekdays and On PG&E Trail on Open vs. Closed Days

Figure 14 shows disturbance rates on weekdays and weekends in 2011 and 2012 using locations that received adequate weekend coverage. There was no obvious trend in weekend versus weekday disturbance rates among sites. Montaña de Oro had more weekend disturbances than weekday disturbances in both years while PG&E Trail had more weekend disturbances in 2011 and South Vandenberg in 2012. However there were more weekday disturbances at Piedras Blancas (2011), San Simeon/Cambria (2011), Estero Bluffs (2012), and Shell Beach (2012).

Figure 15 shows disturbance rates at the PG&E Trail on days open to the public versus days closed to the public. Overall, there were very few disturbances recorded in 2011 and no disturbances recorded in 2012. As expected, there were more disturbances recorded during days open to the public in 2011 than days closed to the public.

Seabird Reproductive Success

Figure 16 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 was also a decrease in Pelagic Cormorant reproductive success on South Vandenberg. 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.

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. 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. 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. 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).

DISCUSSION

Seabird Disturbance

As with 2011, we recorded the highest disturbance rates at Shell Beach, Montaña de Oro, and Estero Bluffs in 2012. However, disturbance rates were variable among sites and among years. Overall, disturbance rates were lower in 2012 than in 2011, with the largest decrease in disturbance rates observed at Shell Beach. We attribute at least part of the decrease at Shell Beach to actions taken by the PSPM outreach and law enforcement teams in 2012. In 2011, the majority of the water-based disturbances were caused by a single boat tour business that would approach seabird breeding and roosting sites for passenger viewing (see Robinette et al. 2012a). The PSPM outreach and law enforcement teams each approached the business and explained the importance of keeping a safe distance from important seabird sites. We observed the tour boat on multiple occasions again in 2012 and their behavior had definitely changed. While the boat would still approach seabird sites for viewing, the captain kept a better distance and caused fewer disturbances.

We also observed variability in the sources of human disturbance between 2011 and 2012. In fact, most of the decrease observed in 2012 was due to decreases in water-based disturbance; whereas ground-based disturbances actually increased at sites like Estero Bluffs and San Simeon/Cambria. Understanding the sources of variability in human behavior will be important as the PSPM develops a long-term strategy for decreasing human-caused disturbances. It is also important to note that variability in seabird behavior can potentially influence disturbance rates. We measured lower rates of natural disturbance in 2012 as well, indicating that 1) seabirds may have been more sensitive to potential disturbance events in 2011, whether human-caused or natural, 2) the higher rate of natural disturbances in 2011 potentially made seabirds more sensitive to human-caused disturbances, or vice versa, or 3) there were fewer seabirds using the study area in 2012 and thus fewer instances of both human-caused and natural disturbances. While breeding population sizes were lower in 2012 for most species, this was not necessarily true for the mean number of birds observed roosting at each site. Thus, there is no evidence that there were fewer seabirds using the study area in 2012. It is possible that decreases in alternative prey for potential seabird nest predators (e.g., crows, ravens, etc.) resulted in more harassment at seabird nesting sites. For example, we documented multiple instances of gulls harassing nesting Brandt's Cormorants at Diablo Canyon in 2011 and an entire sub-colony of Brandt's Cormorant nests was depredated by a coyote in the same year (see Robinette et al. 2012a). If shortages of alternative prey were happening on a regional scale in 2011, then they could explain the increases observed in natural disturbances to seabirds. It is also possible that broader oceanographic conditions acting on prey availability are influencing seabird sensitivity to potential disturbance events. This, however, has not been well studied and it is difficult to predict a potential relationship between oceanography and disturbance rates with only two years of data. Understanding the factors that influence human and seabird behavior and how variability in these behaviors translates into variability in disturbance rates will require developing a multiple year data time series. However, it is important to understand these relationships in order to accurately assess the effectiveness of outreach and law enforcement strategies.

Finally, it is becoming apparent that some seabird species lend themselves to more accurate disturbance monitoring than others due to factors such as habitat use and population size. For example, Brandt's Cormorants are very abundant and use habitats like large nearshore rocks and coastal bluff tops, whereas Pelagic Cormorants are less abundant and tend to use cliff faces that may or may not be secluded. Thus, the disturbance rates observed in Brandt's Cormorants may be more accurate due to the ease of viewing this species whereas disturbance rates in Pelagic Cormorants may be underestimated due to the difficulty in observing this species. Given this, it may be necessary to develop key surrogate species, such as Brandt's Cormorants and Western Gulls, to index overall disturbance conditions for each area. Black Oystercatchers are a particularly difficult species for documenting disturbances due to their cryptic and illusive nature. Additionally, there is often human activity already taking place in rocky intertidal habitat when we approach a site to survey. Thus, it is possible that oystercatchers are present but then flushed out of the area by human activities before we arrive. These types of disturbances go unrecorded. A better approach to assessing the impacts of disturbance on oystercatchers may be to simply document the amount of human use at multiple sites and then compare oystercatcher population size and reproductive success among areas with varying degrees of human use. This approach would require a long term data series so that environmental factors affecting annual prey availability could be controlled for.

PSPM Breeding Population and Roost Utilization

Overall, the distribution of each species among the nine transect areas was similar between 2011 and 2012, though population sizes varied between years. The variability we observed in population sizes was likely not due to variability in disturbance rates. In fact, we observed a decrease in population size for most species in 2012 despite decreased disturbance rates. The variability we observed in population sizes is more likely due to variability in oceanographic conditions that influence prey availability. 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). 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 13-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 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.* 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.

Annual Breeding Productivity

As with breeding population size, breeding productivity (measured as the number of fledglings produced per breeding pair) varied among sites. Breeding productivity in both 2011 and 2012 was highest at the Vandenberg sites for all species but Western Gulls. Western Gull breeding productivity was highest at Shell Beach in both years, perhaps indicating that this species is benefitting from the high human presence in this area. Overall, breeding productivity was lower in 2012 than in 2011 for all species. These results reflect oceanographic changes that have been occurring in the California Current System within the same period. While La Niña conditions persisted through the winter of 2011, Multivariate El Niño Index (MEI) values became increasingly neutral through the spring and summer (PaCOOS 2011). In 2012, conditions moved from neutral to more El Niño-like conditions toward the end of the breeding season (PaCOOS 2012). El Niño conditions are not favorable for ocean productivity. Thus, it is likely that the decreased breeding productivity in 2012 reflects the diminishing oceanographic conditions as the 2012 breeding season progressed.

Robinette et al. (2012b) summarize trends in breeding productivity for seabirds breeding at Vandenberg AFB from 2000 to 2012. Trends for all species are similar for the earlier years of the time series. Productivity was average to above average from 2000 to 2003 and mostly below average from 2004 to 2007. This trend was also observed in California Least Tern productivity at Vandenberg AFB (Robinette et al. 2012c). Trends since 2007 vary by species. For Brandt's Cormorants, productivity has been average through 2009 and has increased in recent years. For Pelagic Cormorants, productivity has been close to average from 2008 to 2012. For Western Gulls, productivity has been average to below average since 2007. And for Black Oystercatchers, productivity has remained well below average since 2007. Thus, despite the increasing trends in breeding population, the PSPM study region appears to be in a period of average to below average breeding productivity.

In 2011 and 2012, 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 all species at the sites with the highest disturbance rates: Estero Bluffs, Montaña de Oro, and Shell Beach. However, breeding productivity for Pelagic Cormorants at Shell Beach was similar to Vandenberg in 2011 and breeding productivity for Brandt's Cormorants was at Shell Beach was greater than Vandenberg in 2011. 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.

Importance of Each Survey Location

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 Shell Beach, the PG&E Trail, and Montaña de Oro as areas of potential high human-caused disturbance. Our results from 2011 and 2012 showed that, while Shell Beach and Montaña de Oro had moderate to high rates of disturbance, the PG&E Trail had very low rates. Additionally, we identified Estero Bluffs as another area of moderate to high disturbance. Shell Beach 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. Estero Bluffs and Montaña de Oro should also be focal areas for outreach and law enforcement. Though neither of these areas is 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 in 2011 and 2012.

The variability in disturbance rates among sites and years also highlighted the need to continue monitoring each of the nine transect areas over the long term. Below, we outline the importance of each transect area 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 in 2011 and mostly due to three instances of a helicopter(s) flying along the coast. There were no disturbances recorded in 2012.

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 and two (one helicopter and one human on foot) recorded in 2012.

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 (a motorized vehicle) recorded on South Vandenberg AFB in 2011 and three (one airplane, one human on foot, and one shoreline fisher at the Boathouse) in 2012. Overall, there is very little human activity along the South Vandenberg AFB transect and military personnel are discouraged from entering coastal areas aside from the Boathouse recreational area.

MANAGEMENT RECOMMENDATIONS

1) Based on our results from the first two years 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) 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 2012.

Transect	Double-crested Cormorant	Brandt's Cormorant	Pelagic Cormorant	Pigeon Guillemot	Western Gull	Black Oyster-catcher
Piedras Blancas	0	156	0	14	50	2
San Simeon/Cambria	56	0	0	26	14	0
Estero bluffs	0	0	0	0	0	8
Mont. de Oro	0	0	8	239	18	6
PG&E Trail	0	532	88	203	104	4
Diablo Canyon	0	1078	82	66	46	10
Shell Beach	156	264	234	329	146	14
No Vandenberg	0	0	10	193	6	2
So Vandenberg	0	372	154	1441	68	14
Total	212	2402	576	2511	452	60

Table 2. 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	$p < 0.001$ $R^2 = 0.781$	$p = 0.001$ $R^2 = 0.792$	$p < 0.001$ $R^2 = 0.768$
Brandt's Cormorant	$p < 0.001$ $R^2 = 0.831$	$p < 0.001$ $R^2 = 0.876$	$p < 0.001$ $R^2 = 0.888$
Pigeon Guillemot	$p = 0.051$ $R^2 = 0.313$	$p = 0.151$ $R^2 = 0.318$	$p = 0.047$ $R^2 = 0.314$
Black Oystercatcher	$p = 0.013$ $R^2 = 0.445$	$p = 0.047$ $R^2 = 0.458$	$p = 0.022$ $R^2 = 0.392$
Western Gull	$p < 0.001$ $R^2 = 0.671$	$p < 0.001$ $R^2 = 0.908$	$p = 0.001$ $R^2 = 0.632$

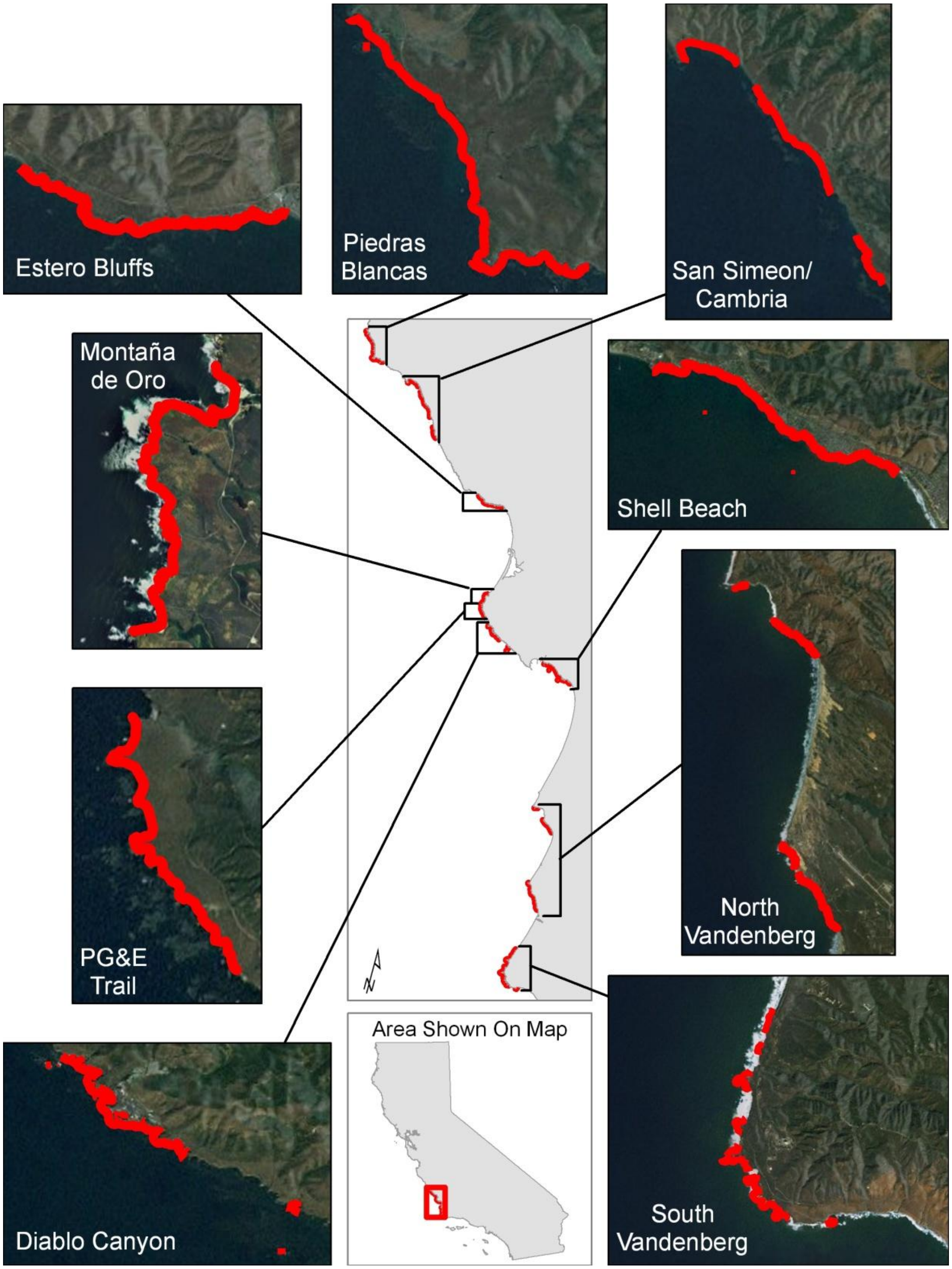


Figure 1. Map of the PSPM baseline study area with each of the nine transects surveyed in 2011 and 2012.

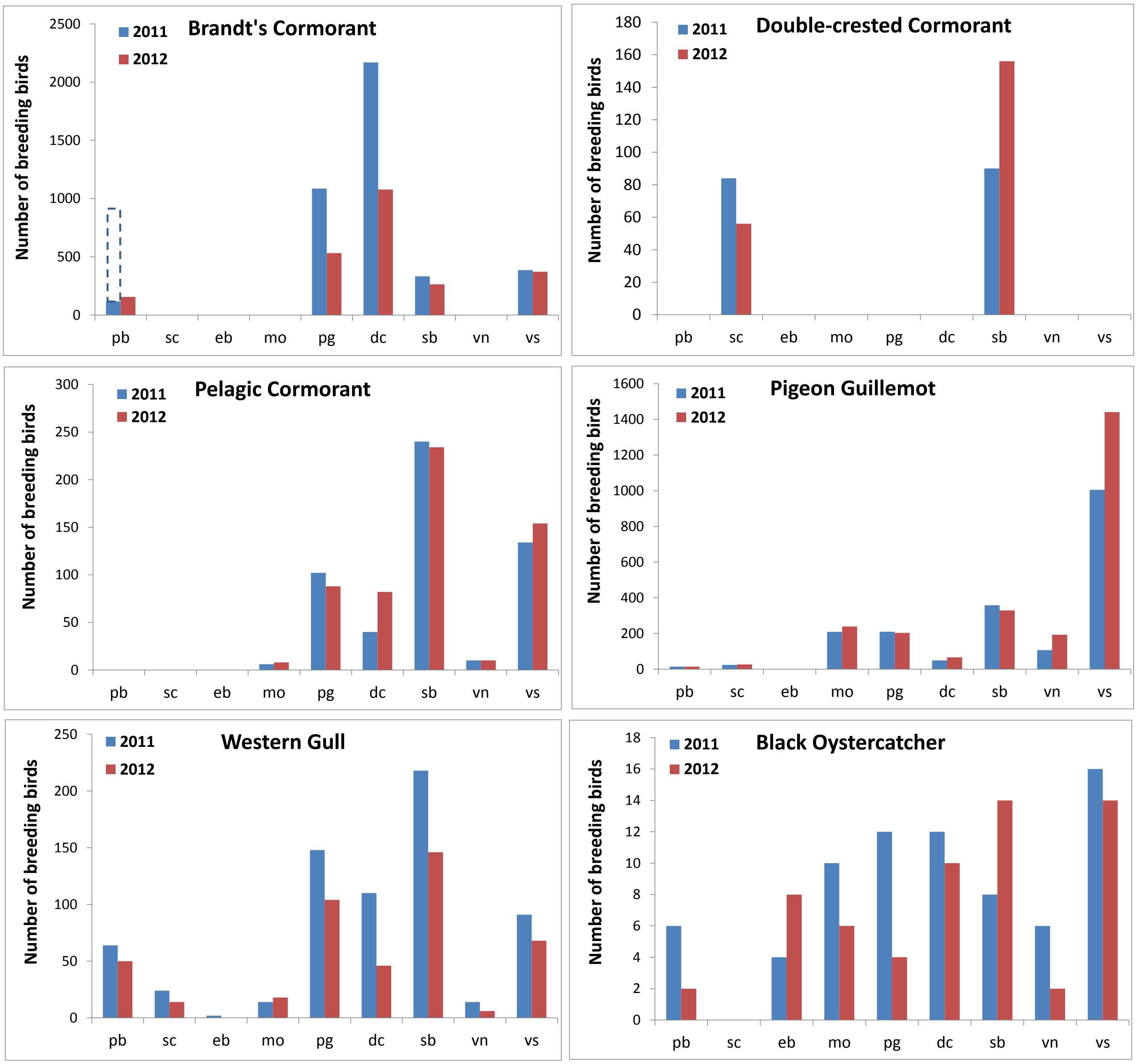


Figure 2. Comparison of 2011 and 2012 breeding population distributions among each of the nine transects for Brandt's Cormorants, Double-crested Cormorants, Pelagic Cormorants, Pigeon Guillemots, Western Gulls, and Black Oysterchatchers. Dashed bar for Brandt's Cormorants at Piedras Blancas indicates the 2011 population estimate for aerial surveys conducted by Capitolo et al. (2012). pb = Piedras Blancas, sc = San Simeon/Cambria, eb = Estero Bluffs, mo = Montaña de Oro, pg = PG&E Trail, dc = Diablo Canyon, sb = Shell Beach, vn = North Vandenberg, and vs = South Vandenberg.

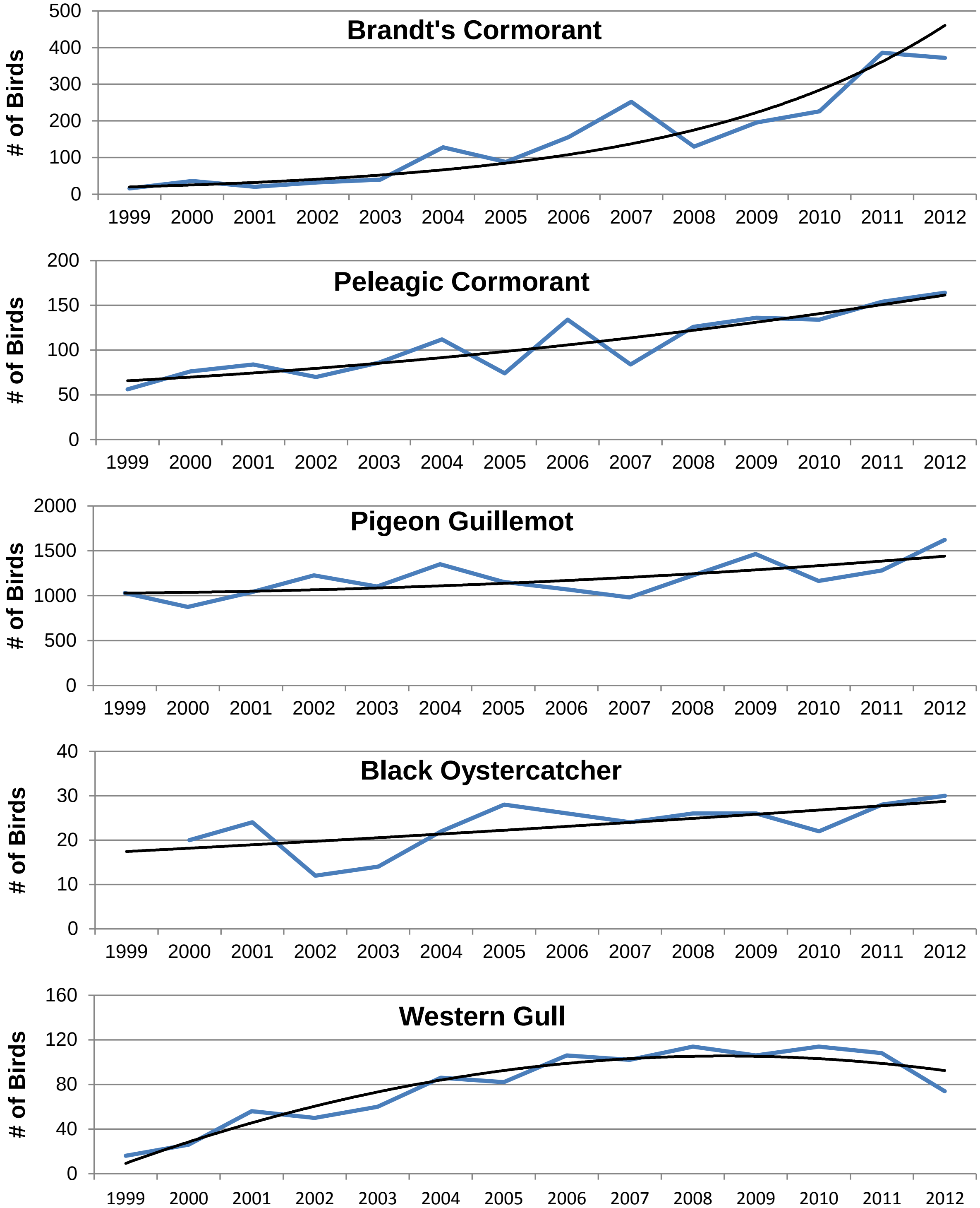


Figure 3. Trends in breeding populations for five species breeding at Vandenberg AFB from 1999 to 2012. Blue lines show variability annual breeding populations while black lines were derived from regression analyses and show trends over the time series.

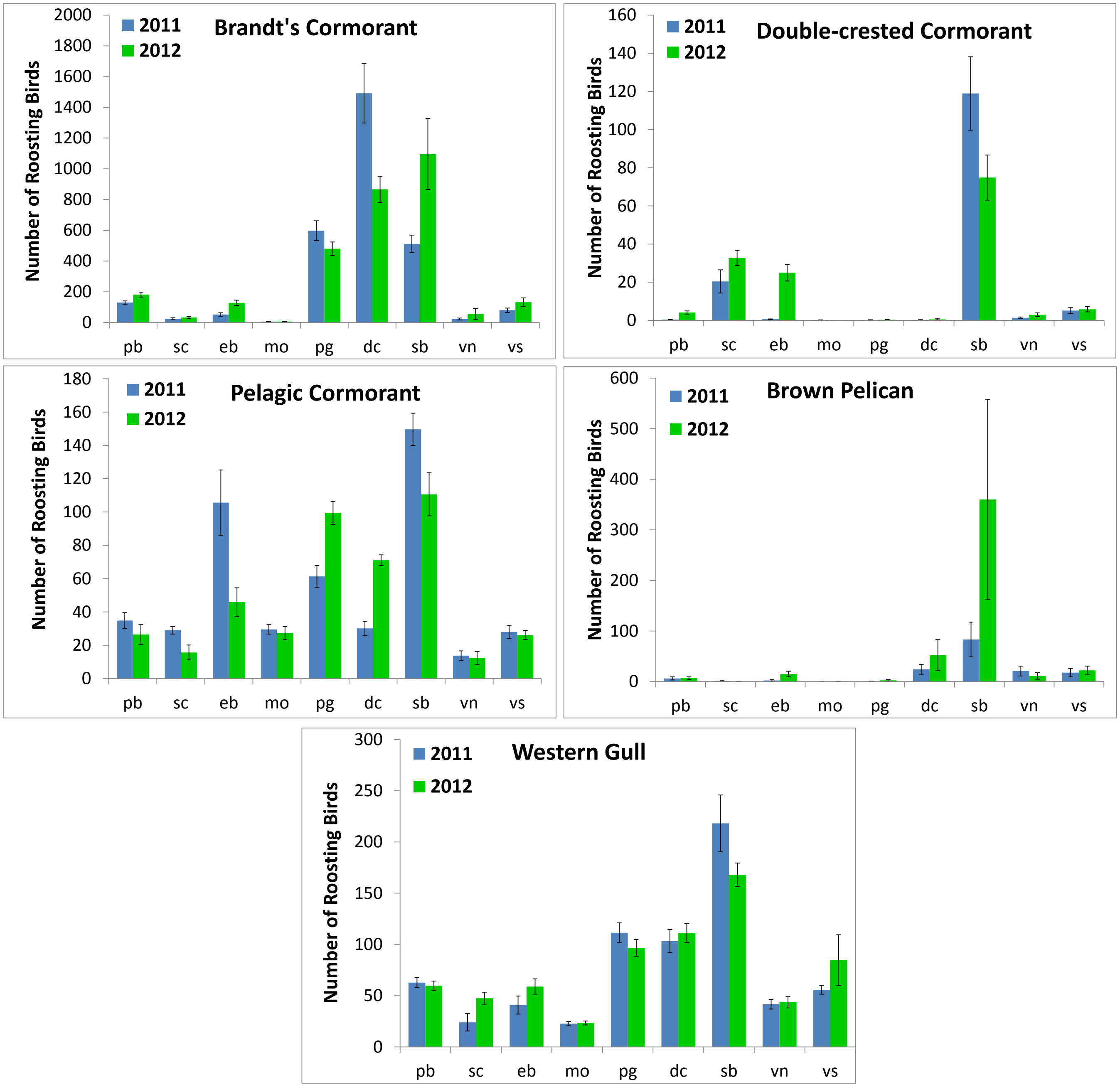


Figure 4. Mean number of roosting birds within each of the nine transects in 2011 and 2012. Bars represent standard error for the mean calculated from the weekly total number of observations of a species within each transect. pb = Piedras Blancas, sc = San Simeon/Cambria, eb = Estero Bluffs, mo = Montaña de Oro, pg = PG&E Trail, dc = Diablo Canyon, sb = Shell Beach, vn = North Vandenberg AFB, vs = South Vandenberg AFB.

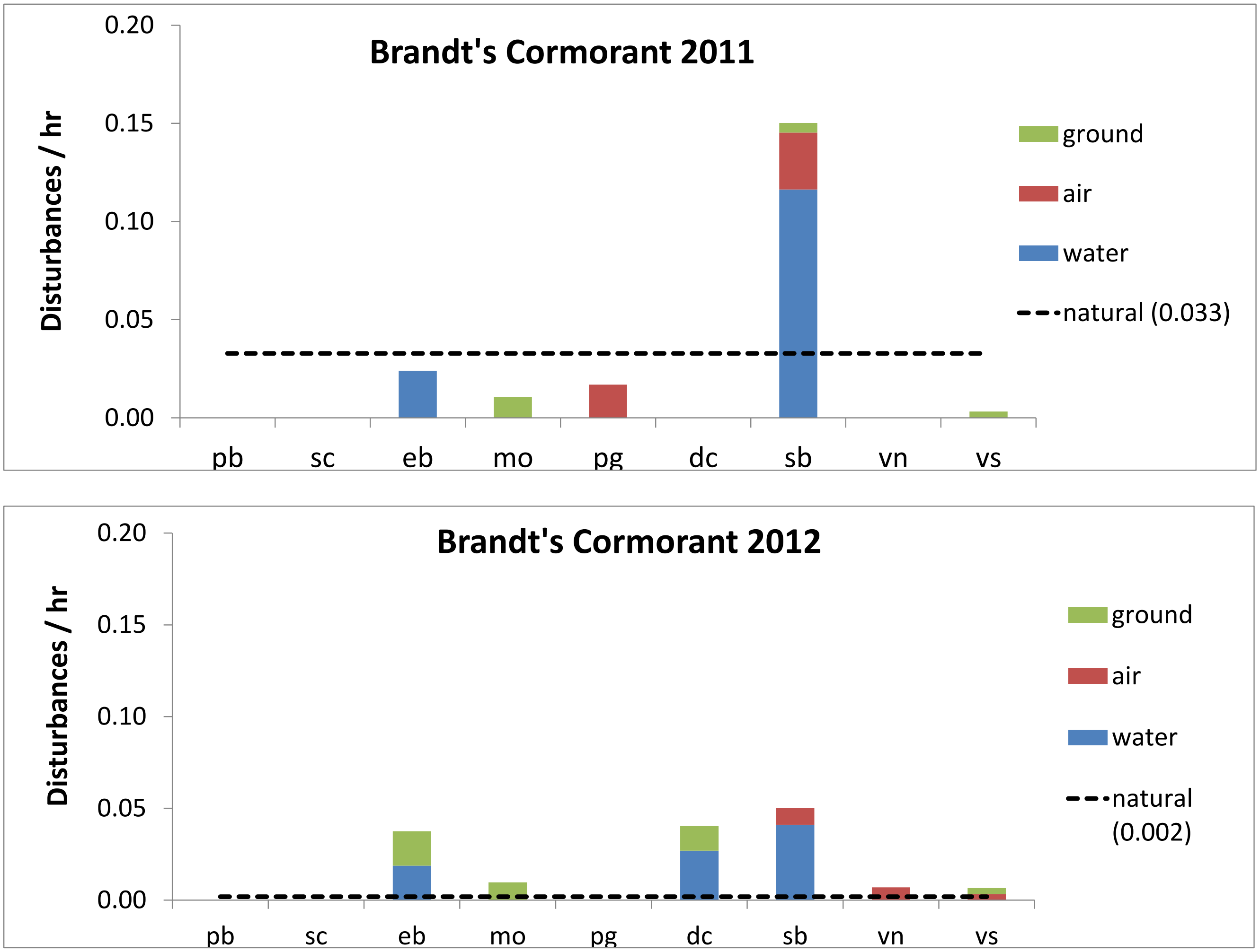


Figure 5. Number of disturbances to Brandt's Cormorants per hour of observation from ground, air, and water sources at each of the nine transects in 2011 and 2012. Dashed lines show the rate of "natural" disturbances averaged over all transects for a given year. See Figure 2 for location definitions.

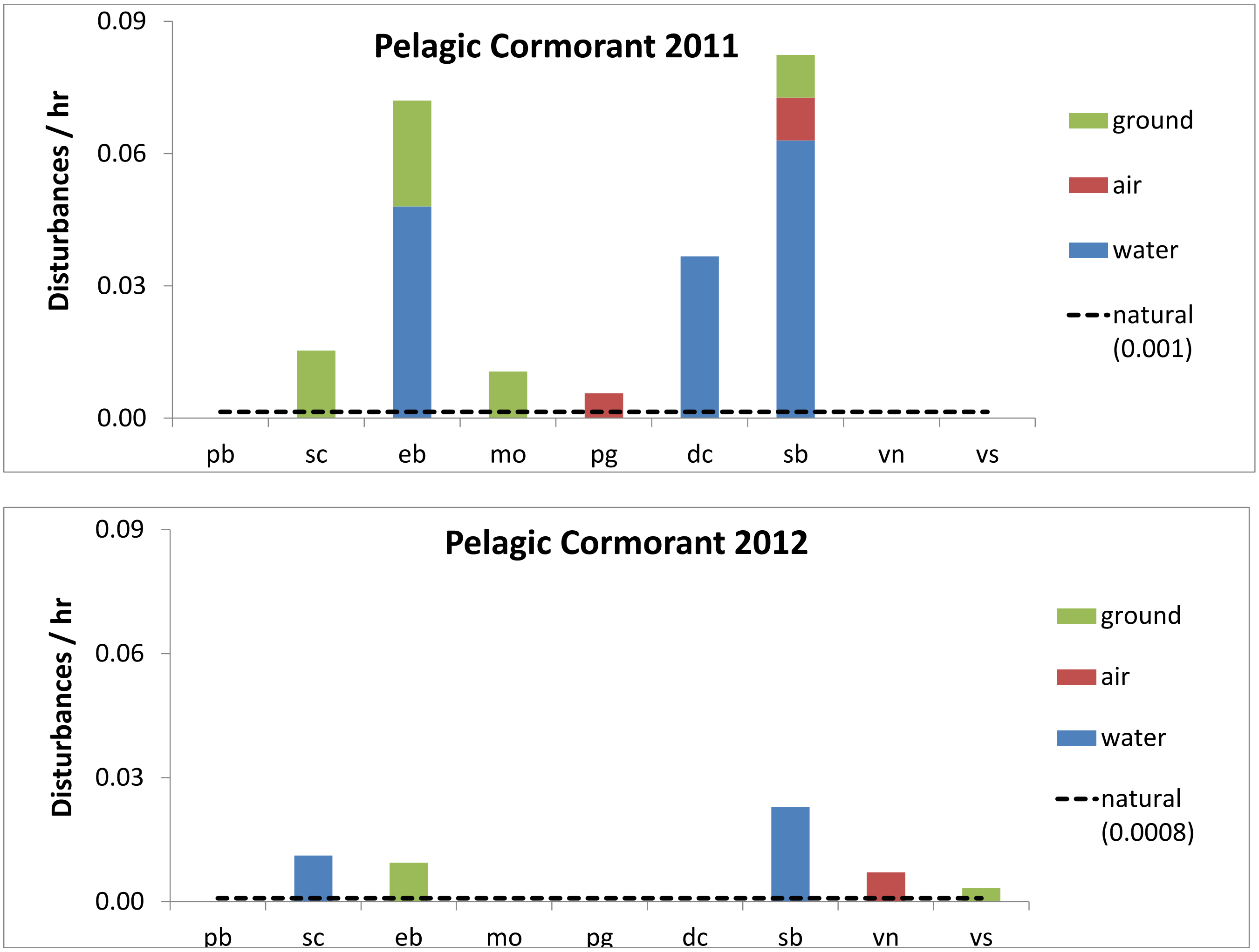


Figure 6. Number of disturbances to Pelagic Cormorants per hour of observation from ground, air, and water sources at each of the nine transects in 2011 and 2012. Dashed lines show the rate of "natural" disturbances averaged over all transects for a given year. See Figure 2 for location definitions.

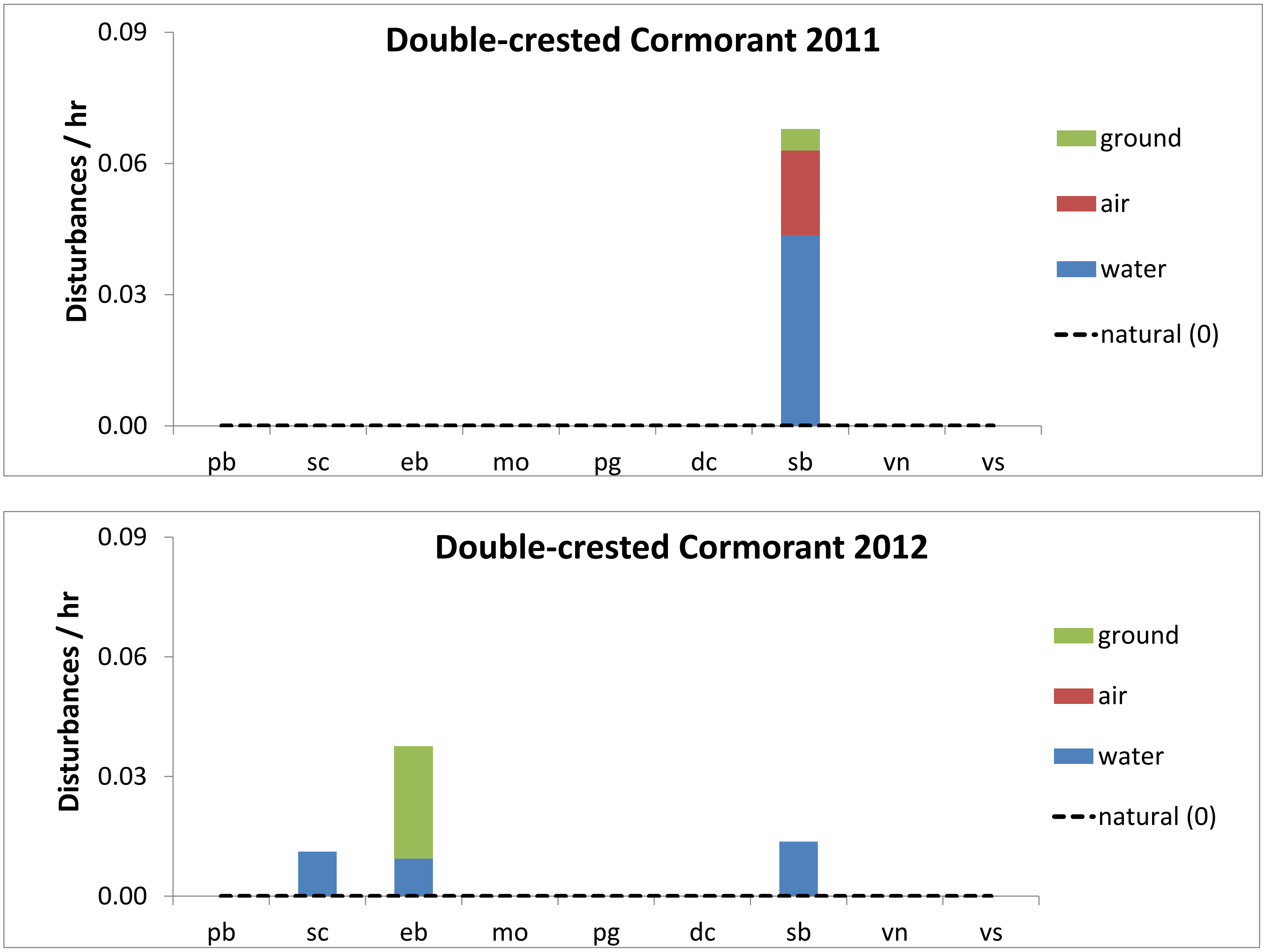
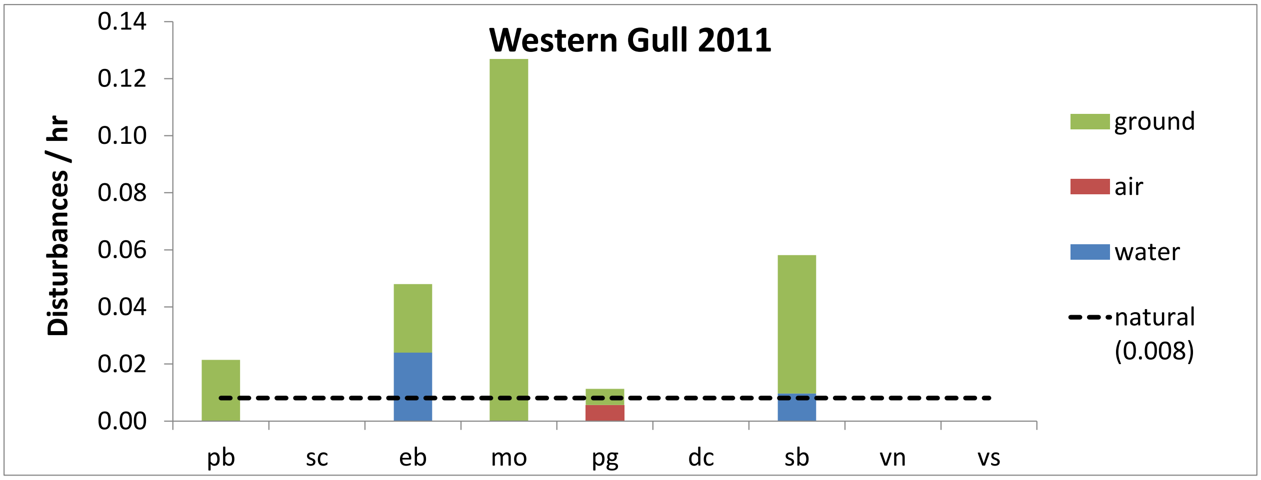


Figure 7. Number of disturbances to Double-crested Cormorants per hour of observation from ground, air, and water sources at each of the nine transects in 2011 and 2012. Dashed lines show the rate of "natural" disturbances averaged over all transects for a given year. See Figure 2 for location definitions.



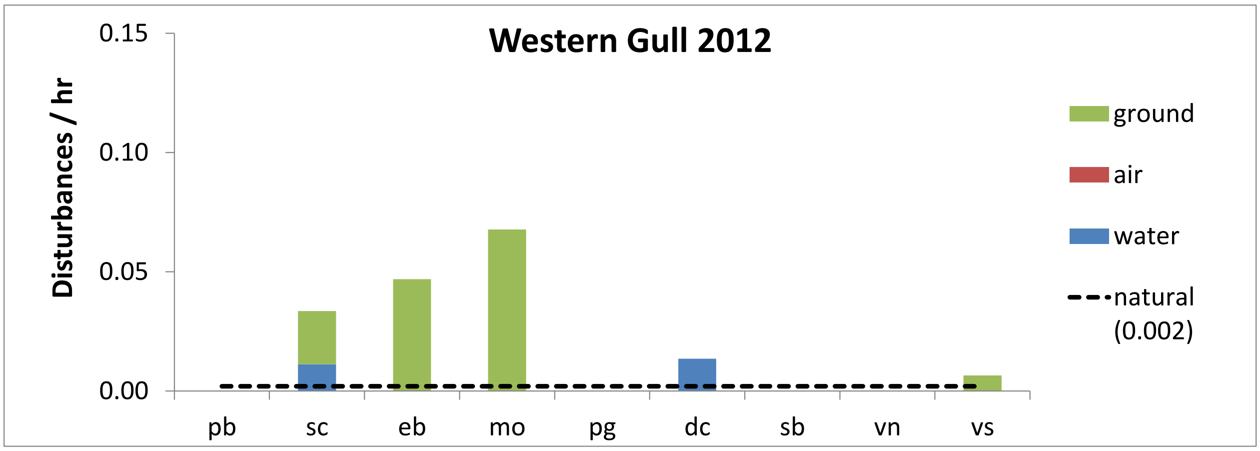
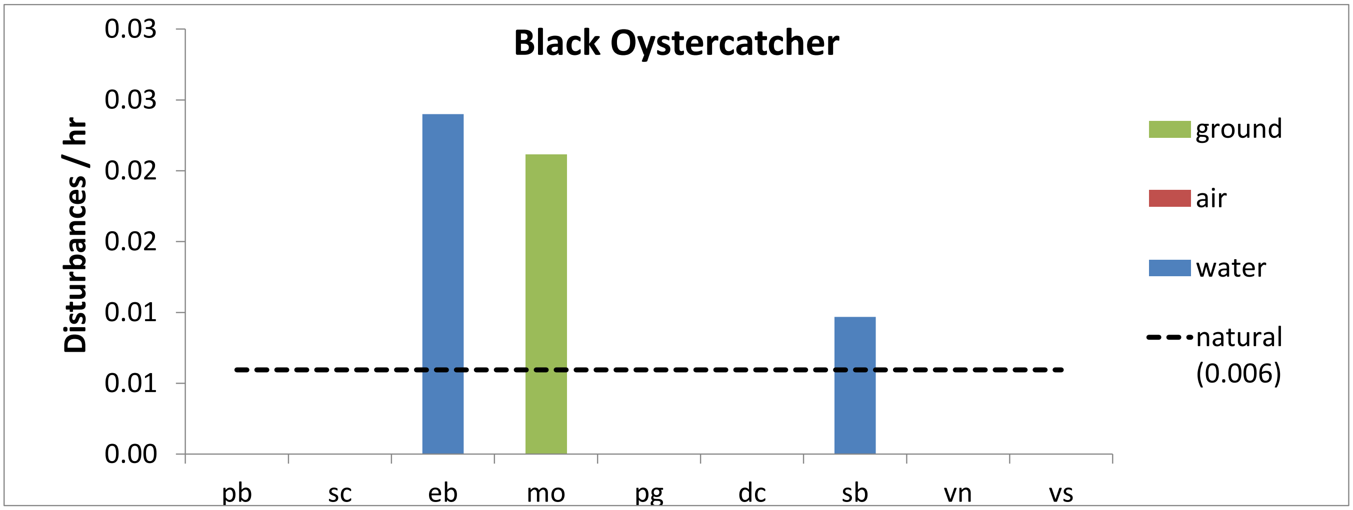


Figure 8. Number of disturbances to Western Gulls per hour of observation from ground, air, and water sources at each of the nine transects in 2011 and 2012. Dashed lines show the rate of "natural" disturbances averaged over all transects for a given year. See Figure 2 for location definitions.



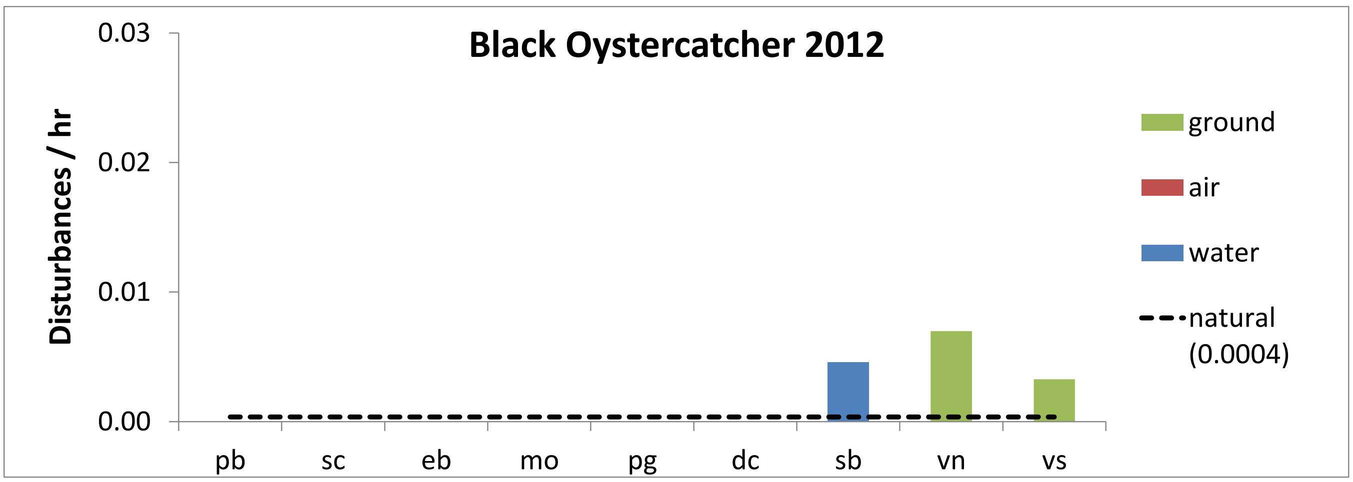


Figure 9. Number of disturbances to Black Oystercatchers per hour of observation from ground, air, and water sources at each of the nine transects in 2011 and 2012. Dashed lines show the rate of "natural" disturbances averaged over all transects for a given year. See Figure 2 for location definitions.

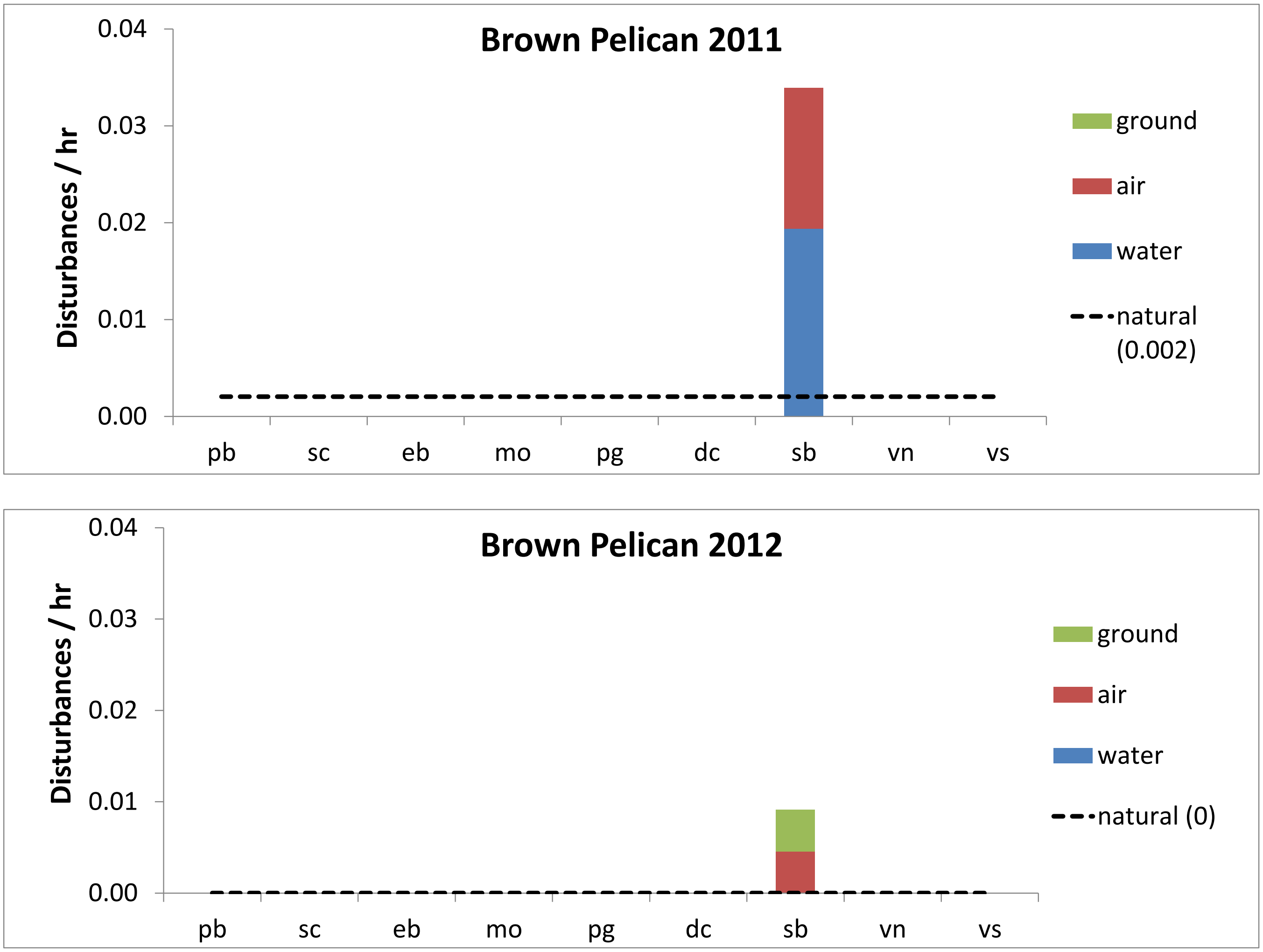


Figure 10. Number of disturbances to Brown Pelican per hour of observation from ground, air, and water sources at each of the nine transects in 2011 and 2012. Dashed lines show the rate of "natural" disturbances averaged over all transects for a given year. See Figure 2 for location definitions.

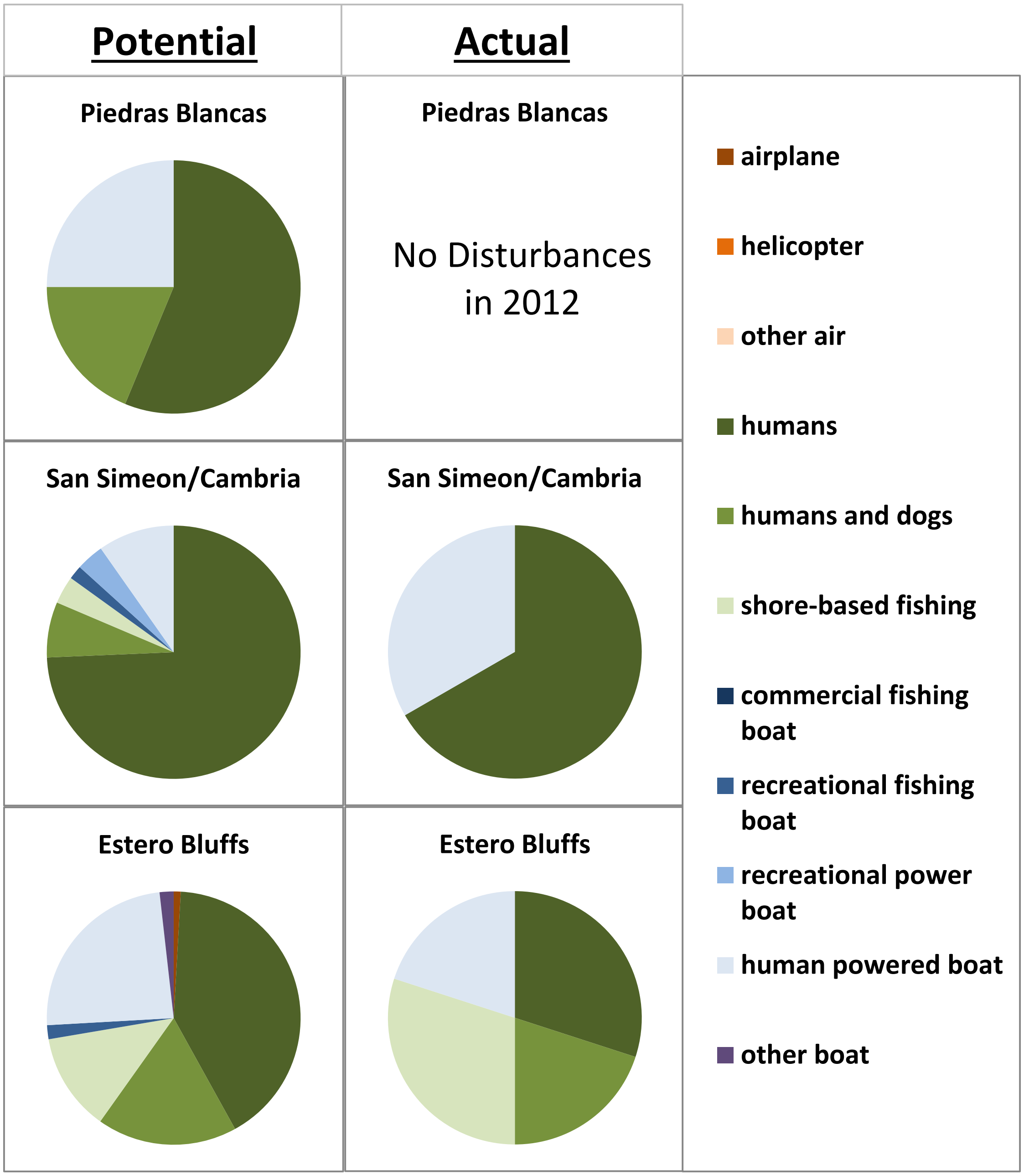


Figure 11. Types of potential disturbance events versus actual disturbances to birds at Piedras Blanca, San Simeon/Cambria, and Estero Bluffs in 2012.

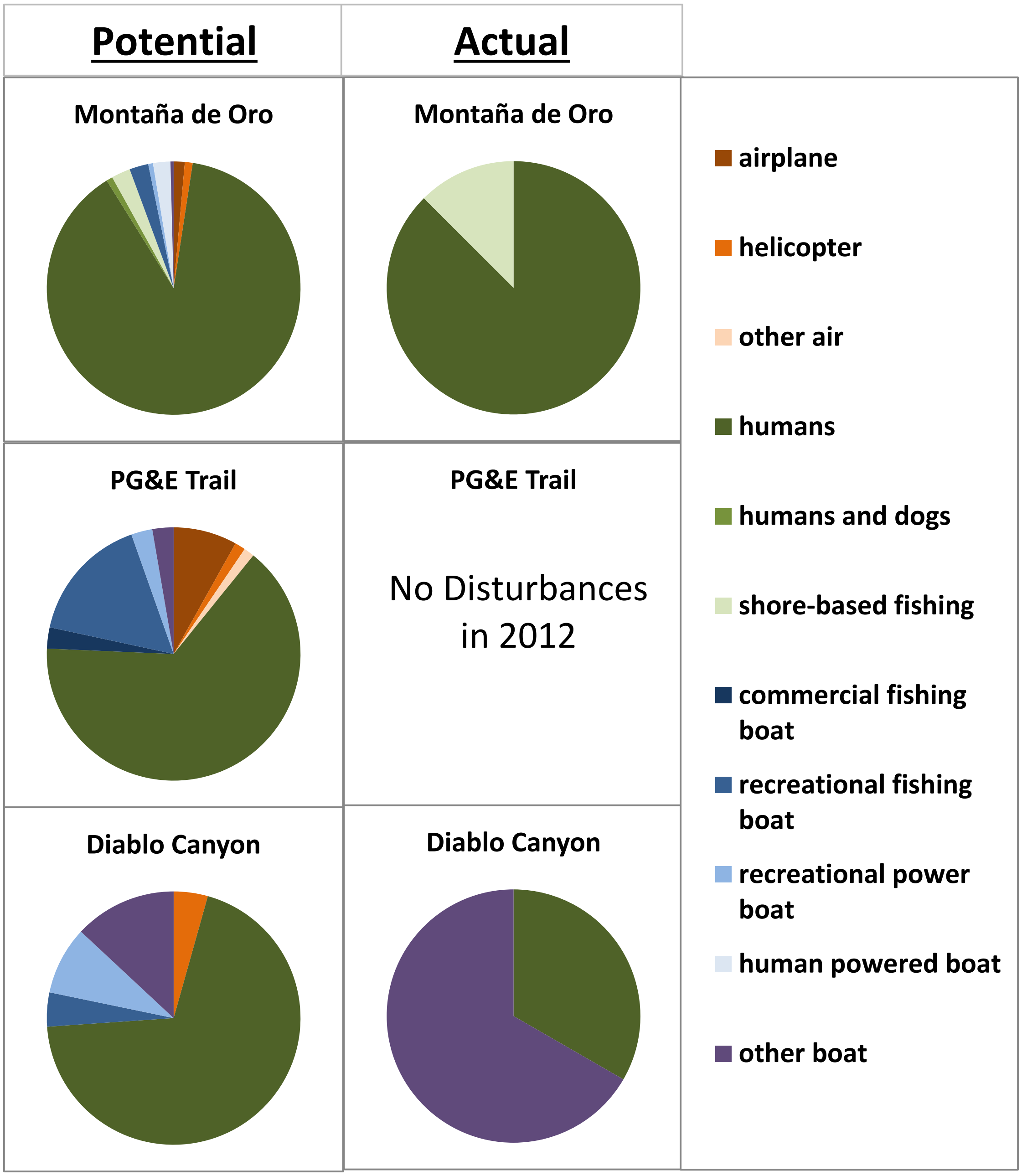


Figure 12. Types of potential disturbance events versus actual disturbances to birds at Montaña de Oro, PG&E Trail, and Diablo Canyon in 2012.

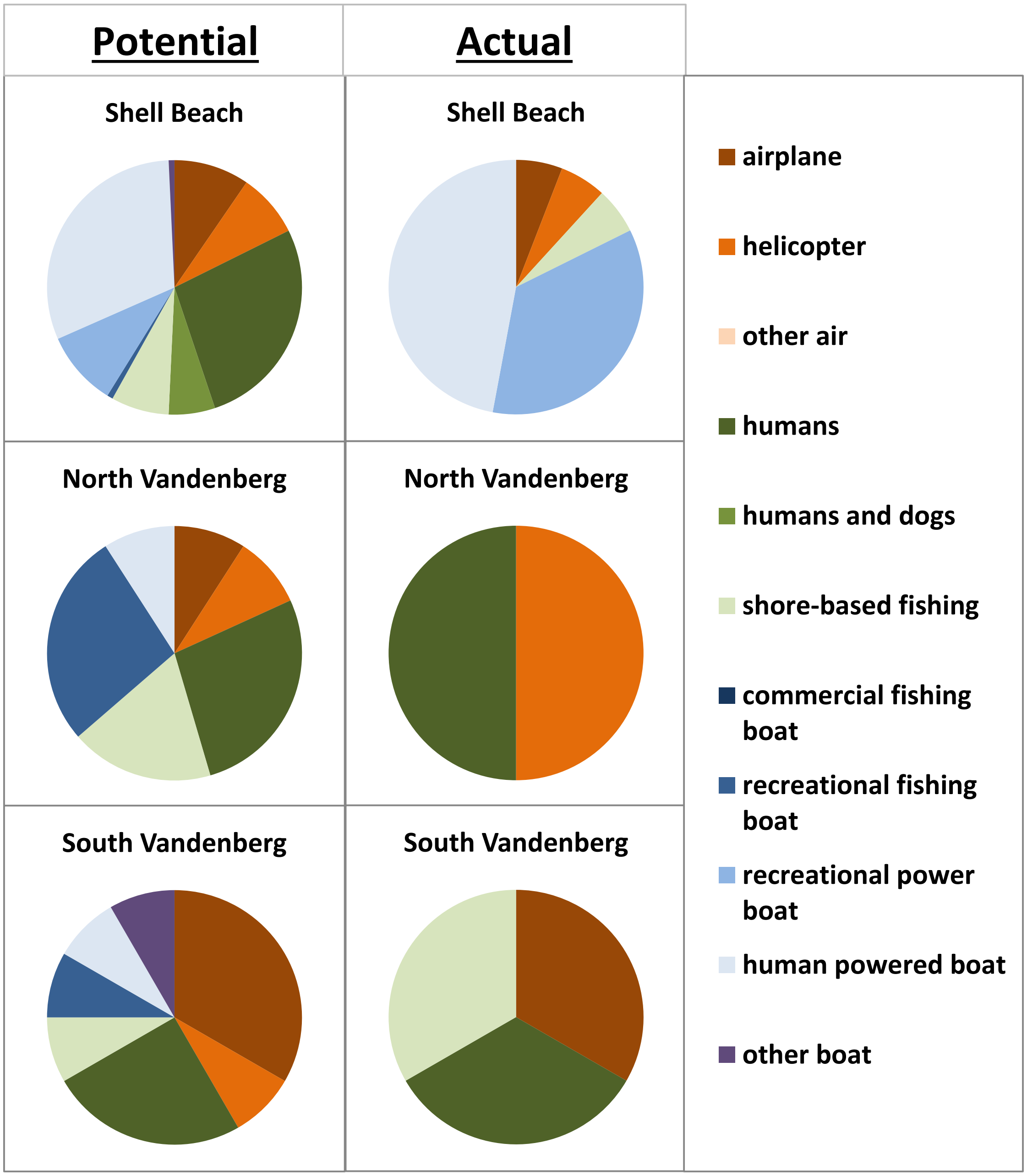


Figure 13. Types of potential disturbance events versus actual disturbances to birds at Shell Beach, North Vandenberg, and South Vandenberg in 2012.

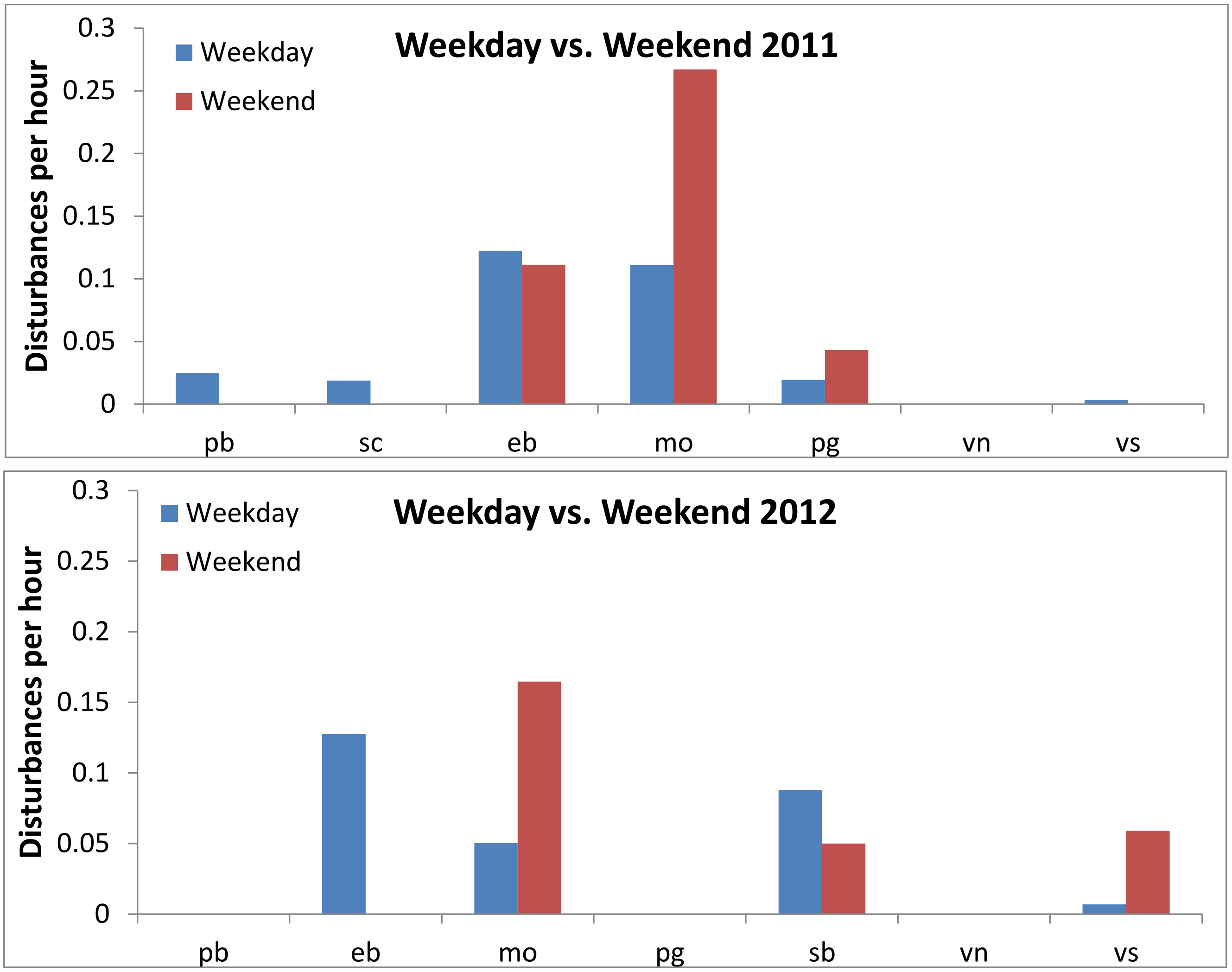


Figure 14. Comparison of disturbance rates (all species combined) during weekend and weekday surveys in 2011 and 2012.

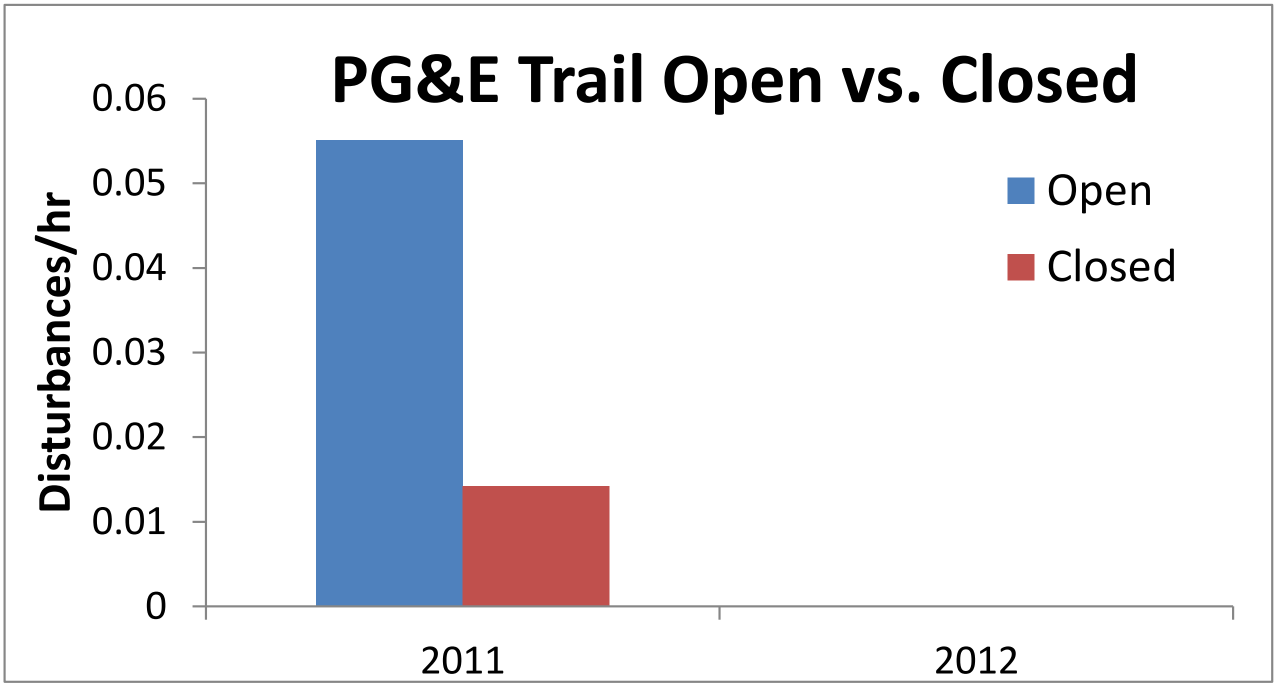


Figure 15. Comparison of disturbance rates (all species combined) on the PG&E Trail during days open to the public vs. closed to the public in 2011 and 2012. There were no disturbances recored on the PG&E Trail in 2012.

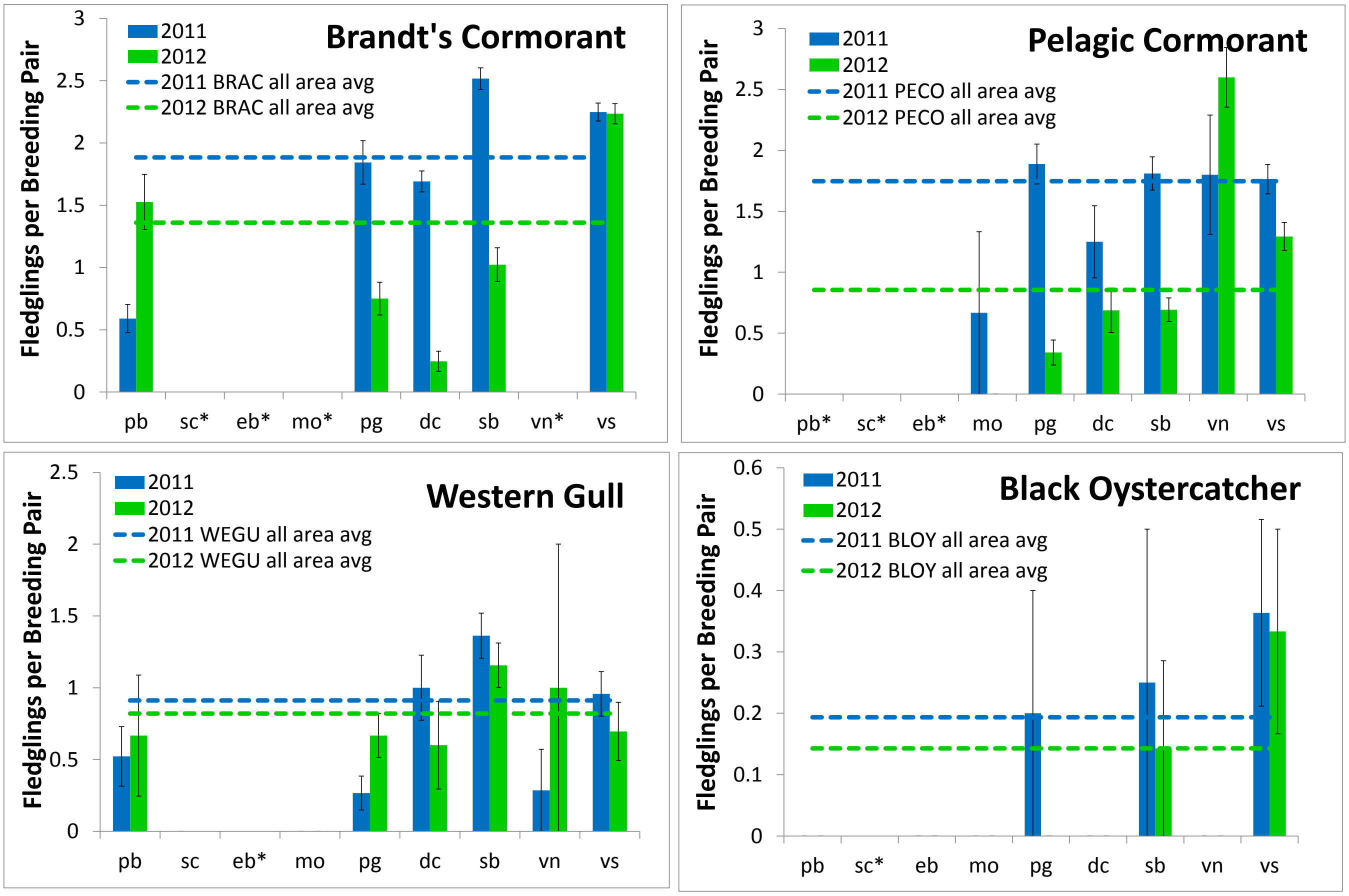
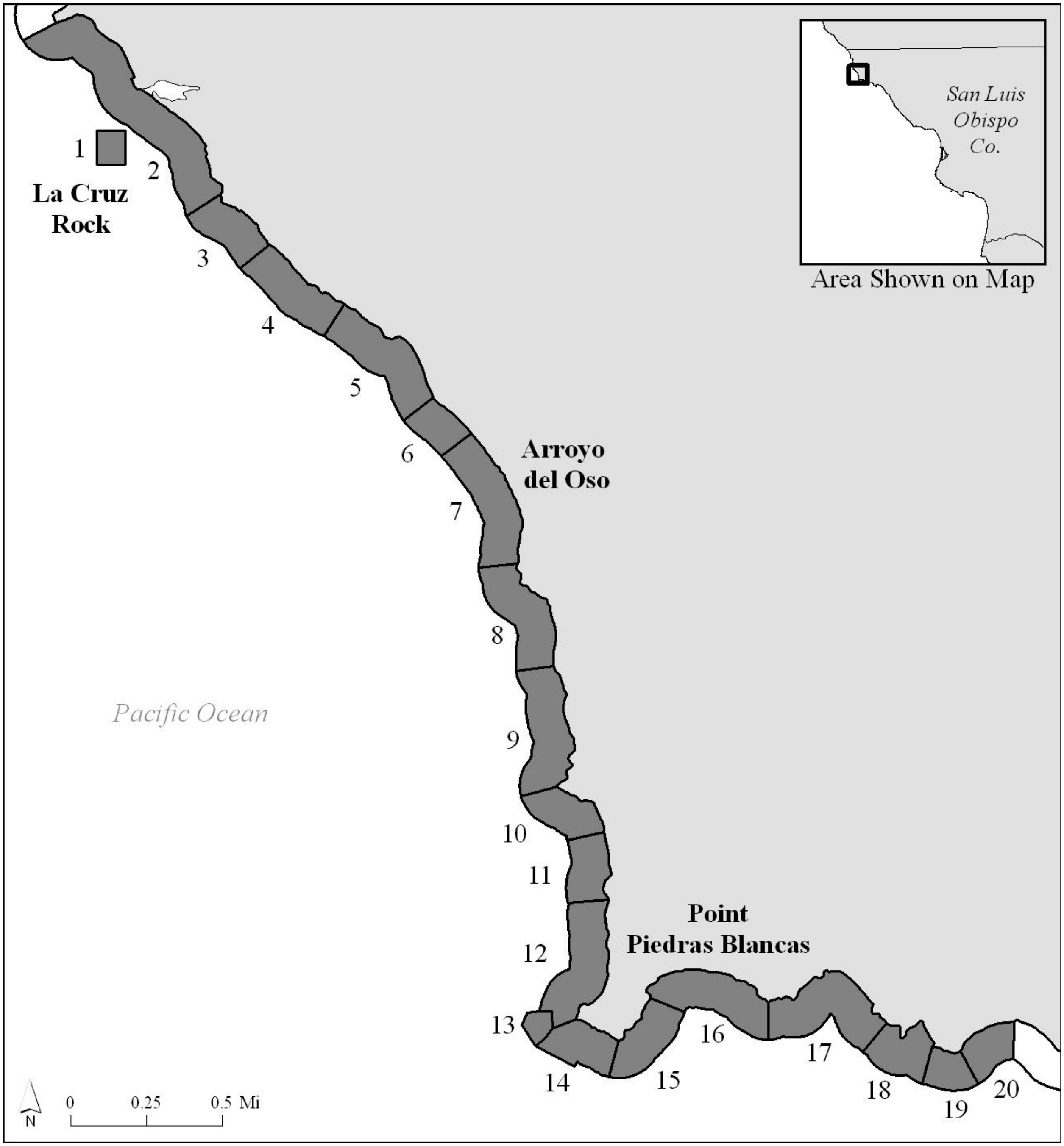


Figure 15. Mean number of chicks fledged per breeding pair for each PSPM focal species within each transect in 2011 and 2012. Bars represent standard error and the dashed line represents the mean across all transects. The * indentifies transects where a given species did not breed. See Figure 2 for location abbreviations.

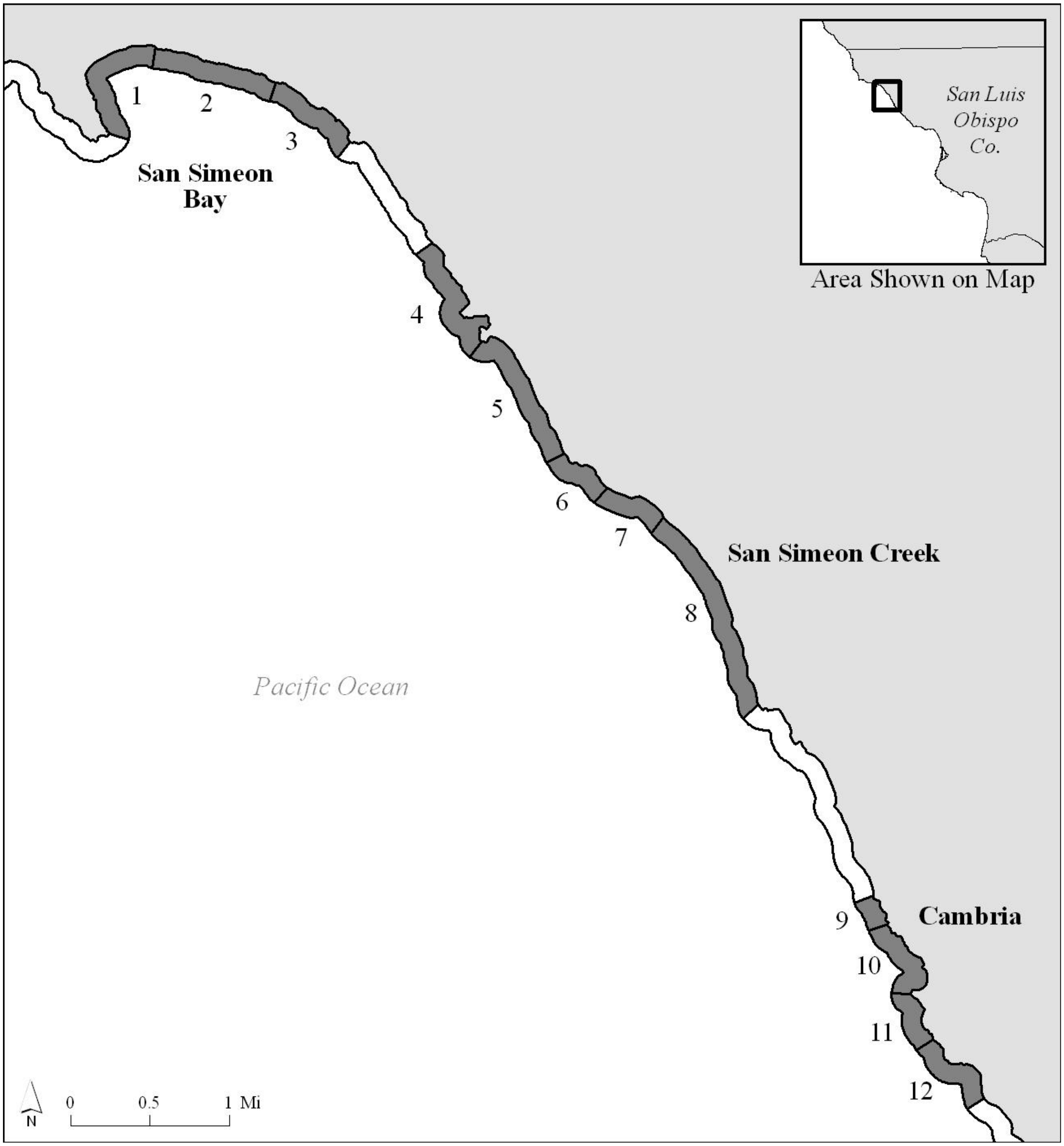
Appendix I: Population Estimates for the Piedras Blancas Sub-colonies



Population Estimates for the Piedras Blancas Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
pb1	Black Oystercatcher	1	0	
pb2	Western Gull	4	2	
	Black Oystercatcher	2	0	
pb3	Black Oystercatcher	2	0	
pb4	Black Oystercatcher	2	0	
pb5	Black Oystercatcher	2	0	
pb6	Western Gull	2	1	
pb7	Black Oystercatcher	1	0	
pb8	Black Oystercatcher	5	0	
pb9	Black Oystercatcher	2	0	
pb10	Black Oystercatcher	1	0	
pb11	Black Oystercatcher	2	0	
pb12	Black Oystercatcher	2	0	
pb13	Brandt's Cormorant	156	78	
	Western Gull	16	8	
	Pigeon Guillemot	8	n/c	6/12
	Black Oystercatcher	3	0	
pb14	Western Gull	2	1	
	Black Oystercatcher	2	0	
pb15	Western Gull	6	3	
	Pigeon Guillemot	3	n/c	5/24
pb16	Black Oystercatcher	2	0	
pb17	Western Gull	6	3	
	Black Oystercatcher	6	0	
pb18	Western Gull	10	5	
	Pigeon Guillemot	3	n/c	5/15
	Black Oystercatcher	3	1	
pb19	Black Oystercatcher	2	0	
pb20	none	-	-	
TOTALS	**Brandt's Cormorant**	**156**	**78**	
	Western Gull	**50**	**25**	
	Pigeon Guillemot	**14**	**n/c**	
	Black Oystercatcher	**40**	**1**	

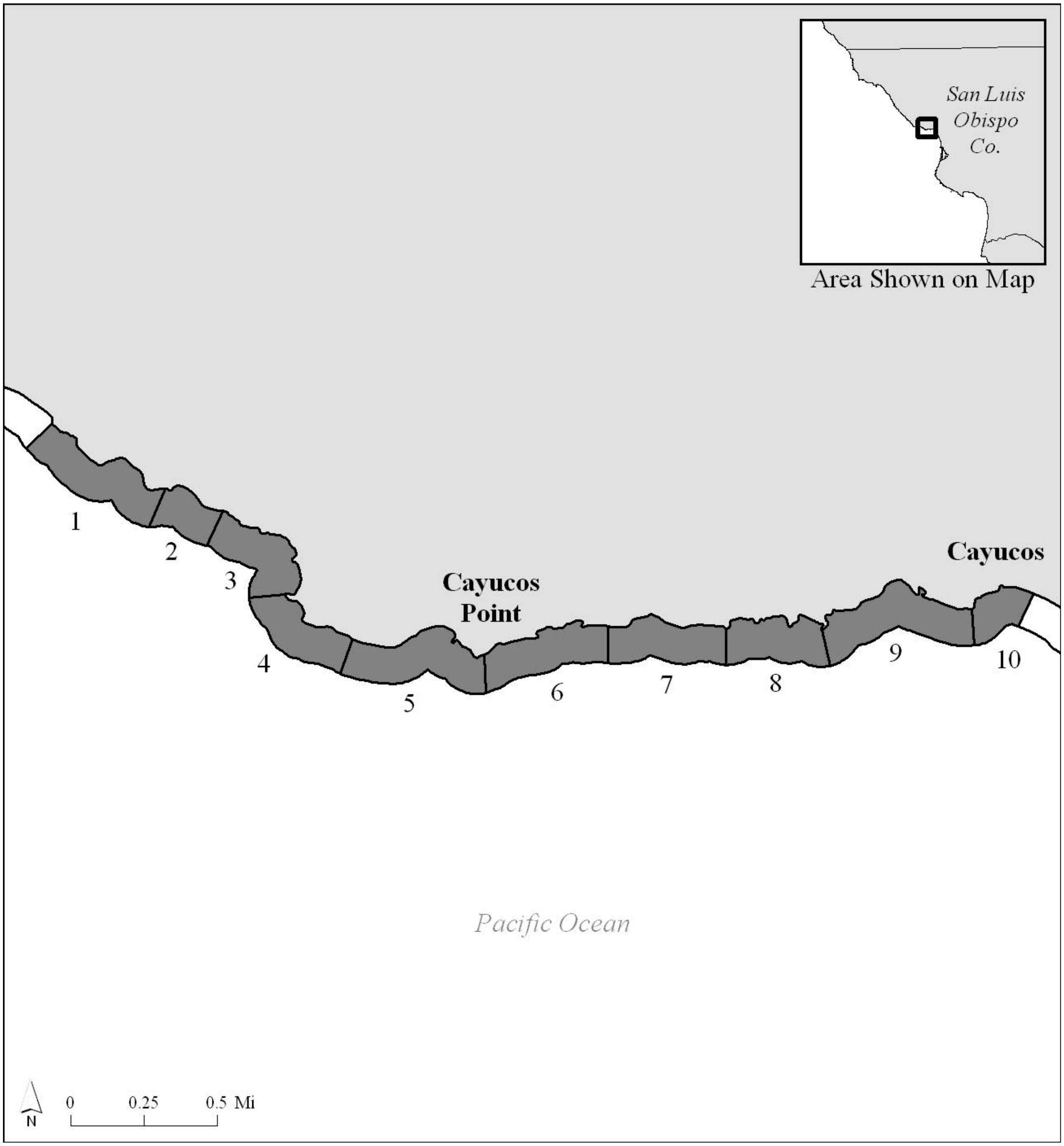
Appendix II: Population Estimates for the San Simeon/Cambria Sub-colonies



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	56	28	
	Western Gull	10	5	
	Pigeon Guillemot	23	n/c	6/7
sc2	none	-	-	
sc3	none	-	-	
sc4	Pigeon Guillemot	2	n/c	4/19
	Black Oystercatcher	2	0	
sc5	Black Oystercatcher	2	0	
sc6	none	-	-	
sc7	Western Gull	2	1	
	Black Oystercatcher	1	0	
sc8	Western Gull	2	1	
	Pigeon Guillemot	1	n/c	6/13
	Black Oystercatcher	2	0	
sc9	Black Oystercatcher	1	0	
sc10	none	-	-	
sc11	none	-	-	
sc12	Black Oystercatcher	1	0	
TOTALS	**Double-crested Cormorant**	**56**	**28**	
	Western Gull	**14**	**7**	
	Pigeon Guillemot	**26**	**n/c**	
	Black Oystercatcher	**9**	**0**	

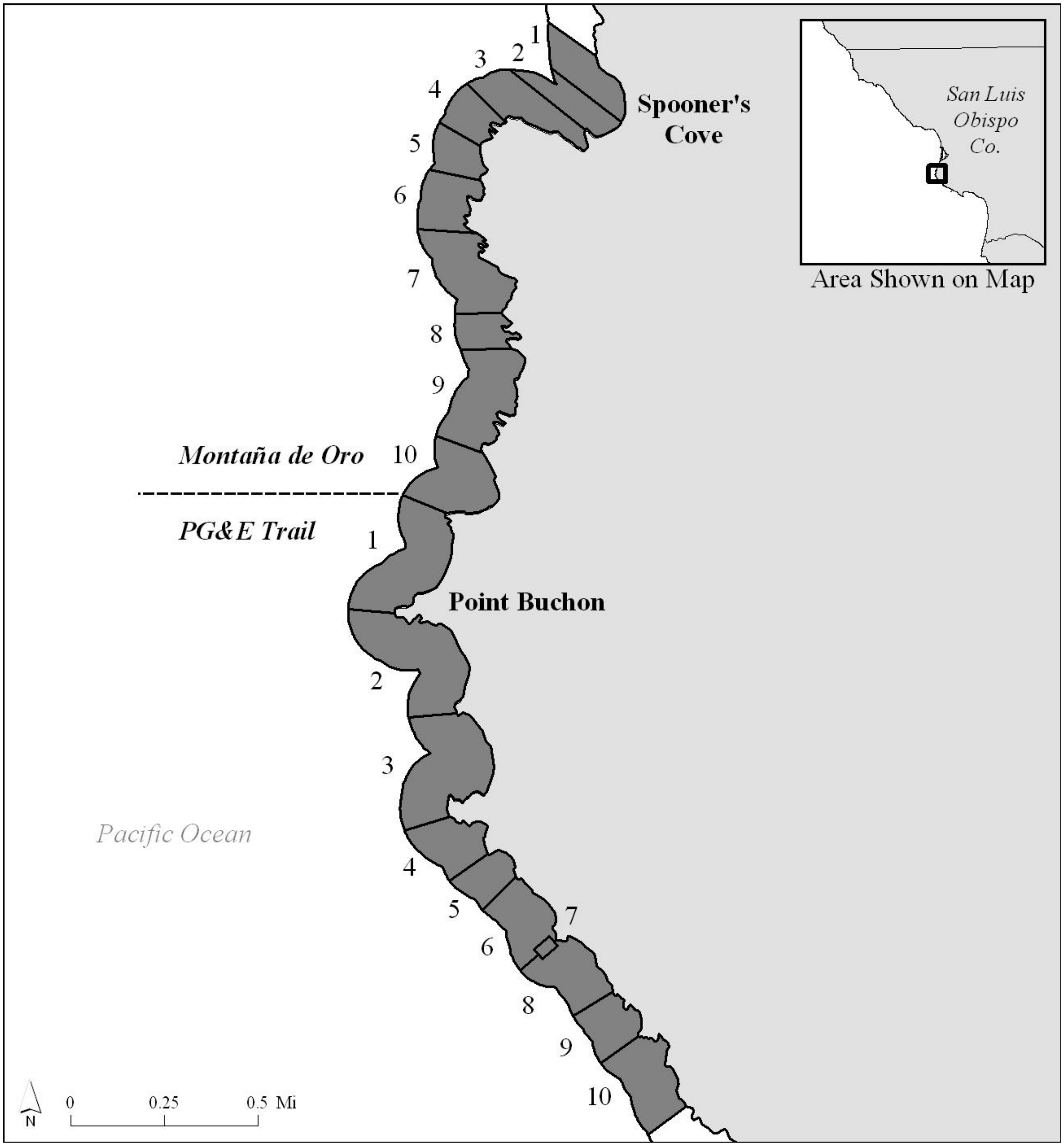
Appendix III: Population Estimates for the Estero Bluffs Sub-colonies



Population Estimates for the Estero Bluffs Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
eb1	Black Oystercatcher	2	0	
eb2	Black Oystercatcher	2	0	
eb3	Black Oystercatcher	2	0	
eb4	Black Oystercatcher	7	1	
eb5	Black Oystercatcher	4	2	
eb6	Black Oystercatcher	2	0	
eb7	Black Oystercatcher	4	0	
eb8	Black Oystercatcher	3	1	
eb9	Black Oystercatcher	2	0	
eb10	none	1	0	
TOTALS	**Black Oystercatcher**	**28**	**4**	

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



Population Estimates for the Montaña de Oro Sub-colonies

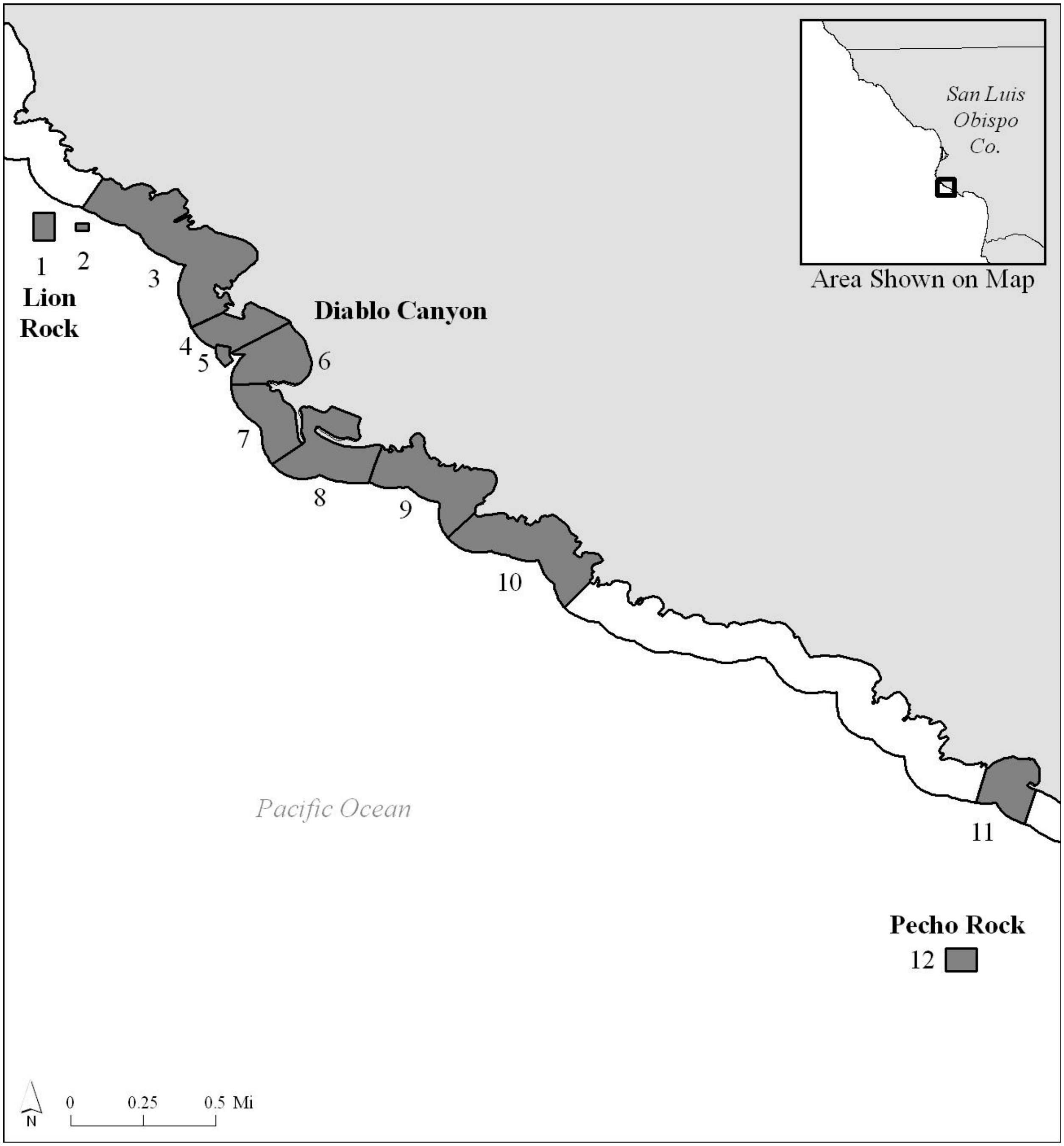
Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
mo1	Piegeon Guillemot	2	n/c	4/25, 5/28, 6/8
	Black Oystercatcher	5	0	
mo2	Pigeon Guillemot	44	n/c	4/28
	Black Oystercatcher	2	0	
mo3	Western Gull	2	1	
	Pigeon Guillemot	61	n/c	4/20
	Black Oystercatcher	3	0	
mo4	Western Gull	2	1	
	Black Oystercatcher	6	2	
mo5	Black Oystercatcher	4	0	
mo6	Western Gull	4	2	
	Pigeon Guillemot	2	n/c	5/20, 6/8, 6/15
	Black Oystercatcher	4	0	
mo7	Pigeon Guillemot	2	n/c	4/10
	Black Oystercatcher	2	0	
mo8	Western Gull	2	1	
	Pigeon Guillemot	4	0	5/11, 5/28
	Black Oystercatcher	4	0	
mo9	Western Gull	6	3	
	Pigeon Guillemot	51	n/c	4/20
	Black Oystercatcher	4	0	
mo10	Pelagic Cormorant	8	4	
	Western Gull	2	1	
	Pigeon Guillemot	73	n/c	4/10
	Black Oystercatcher	5	1	
TOTALS	**Pelagic Cormorant**	**8**	**4**	
	Western Gull	**18**	**9**	
	Pigeon Guillemot	**239**	**n/c**	
	Black Oystercatcher	**39**	**3**	

Population Estimates for the PG&E Trail Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
pg1	Brandt’s Cormorant	6	3	
	Pigeon Guillemot	34	n/c	4/22
	Western Gull	22	11	
	Black Oystercatcher	5	1	
pg2	Brandt's Cormorant	350	175	
	Pelagic Cormorant	6	3	
	Pigeon Guillemot	22	n/c	5/19
	Western Gull	12	6	
	Black Oystercatcher	2	0	
pg3	Pigeon Guillemot	18	n/c	5/3
pg4	Pelagic Cormorant	28	14	
	Pigeon Guillemot	16	n/c	4/22
	Western Gull	2	1	
	Black Oystercatcher	1	0	
pg5	Pelagic Cormorant	6	3	
	Pigeon Guillemot	22	n/c	5/19
	Western Gull	10	5	
	Black Oystercatcher	2	0	
pg6	Brandt's Cormorant	98	49	
	Pelagic Cormorant	42	21	
	Pigeon Guillemot	28	n/c	4/22
	Western Gull	28	14	
	Black Oystercatcher	4	1	
pg7	Brandt's Cormorant	78	39	
	Pigeon Guillemot	11	n/c	5/19
	Western Gull	6	3	
	Black Oystercatcher	4	0	
pg8	Pigeon Guillemot	19	n/c	4/22
	Western Gull	18	9	
pg9	Pigeon Guillemot	11	n/c	5/3
	Black Oystercatcher	1	0	
pg10	Pelagic Cormorant	6	3	
	Pigeon Guillemot	22	n/c	6/14
	Western Gull	6	3	
	Black Oystercatcher	3	0	
TOTALS	**Brandt's Cormorant**	**532**	**266**	
	Pelagic Cormorant	**88**	**44**	
	Pigeon Guillemot	**203**	**n/c**	

Western Gull	**104**	**52**
Black Oystercatcher	**22**	**2**

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

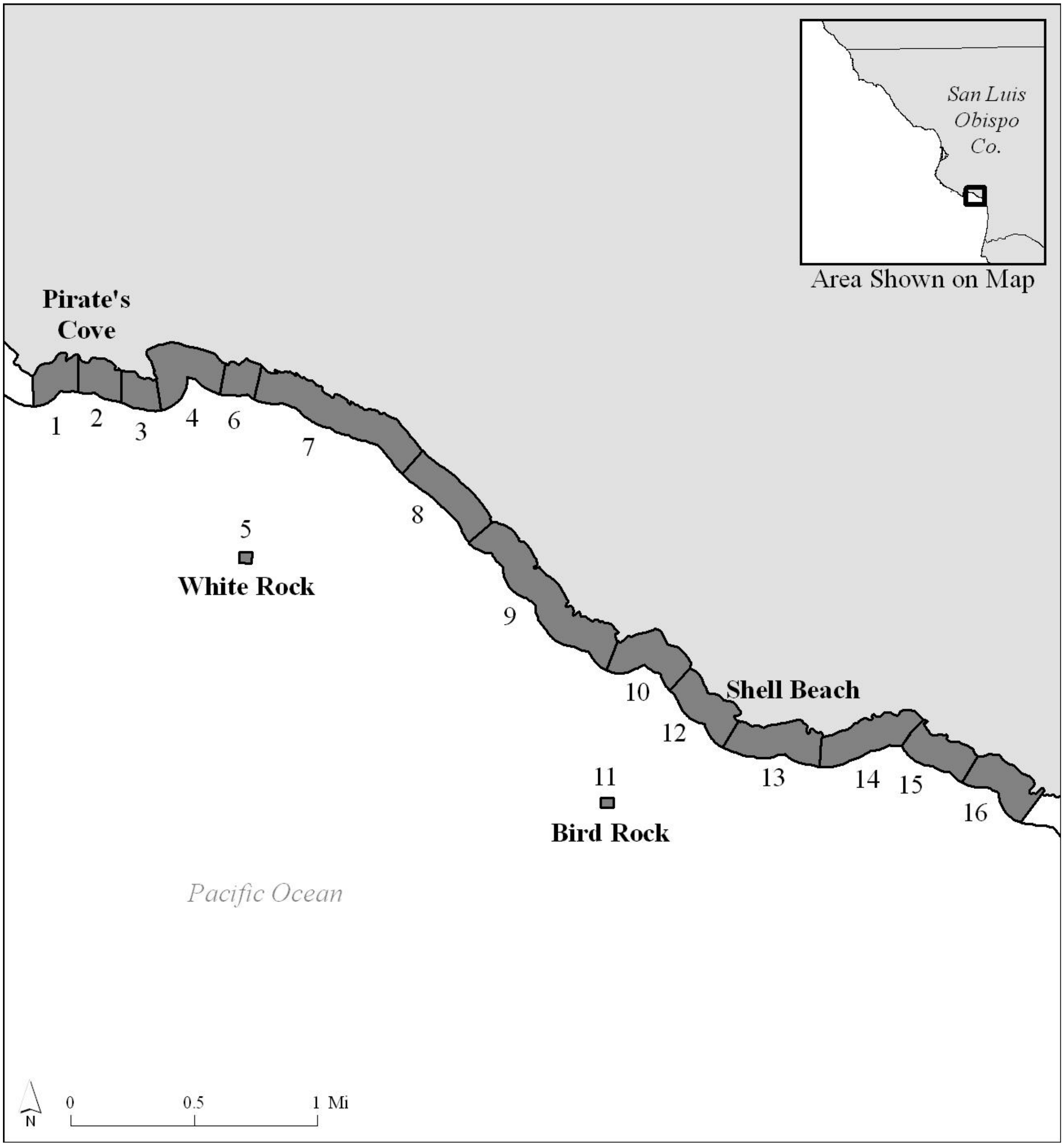


Population Estimates for the Diablo Canyon Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
dc1	Brandt's Cormorant	12	2	
	Pelagic Cormorant	2	1	
	Western Gull	14	7	
	Black Oystercatcher	2	0	
dc2	Brandt's Cormorant	374	187	
	Pelagic Cormorant	2	1	
	Western Gull	4	2	
	Black Oystercatcher	3	1	
dc3	Pigeon Guillemot	11	n/c	4/23
	Black Oystercatcher	4	0	
dc4	Pigeon Guillemot	10	n/c	5/14
	Western Gull	2	1	
	Black Oystercatcher	2	0	
dc5	Pigeon Guillemot	2	n/c	5/28
	Western Gull	4	2	
	Black Oystercatcher	2	1	
dc6	Western Gull	8	4	
	Black Oystercatcher	5	1	
dc7	Black Oystercatcher	2	0	
dc8	Brandt’s Cormorant	512	256	
	Pigeon Guillemot	3	n/c	4/16
	Western Gull	10	5	
	Black Oystercatcher	2	0	
dc9	Brandt's Cormorant	164	82	
	Pelagic Cormorant	34	17	
	Pigeon Guillemot	24	n/c	4/16
	Western Gull	2	1	
	Black Oystercatcher	5	0	
dc10	Brandt’s Cormorant	14	7	
	Pelagic Cormorant	40	20	
	Pigeon Guillemot	16	n/c	4/23
	Western Gull	2	1	
	Black Oystercatcher	5	1	
dc11	Brandt’s Cormorant	2	1	
	Pelagic Cormorant	4	2	
	Black Oystercatcher	3	1	
dc12	Black Oystercatcher	2	0	
TOTALS	**Brandt's Cormorant**	**1078**	**539**	

Pelagic Cormorant	**82**	**41**
Pigeon Guillemot	**66**	**n/c**
Western Gull	**46**	**23**
Black Oystercatcher	**37**	**5**

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

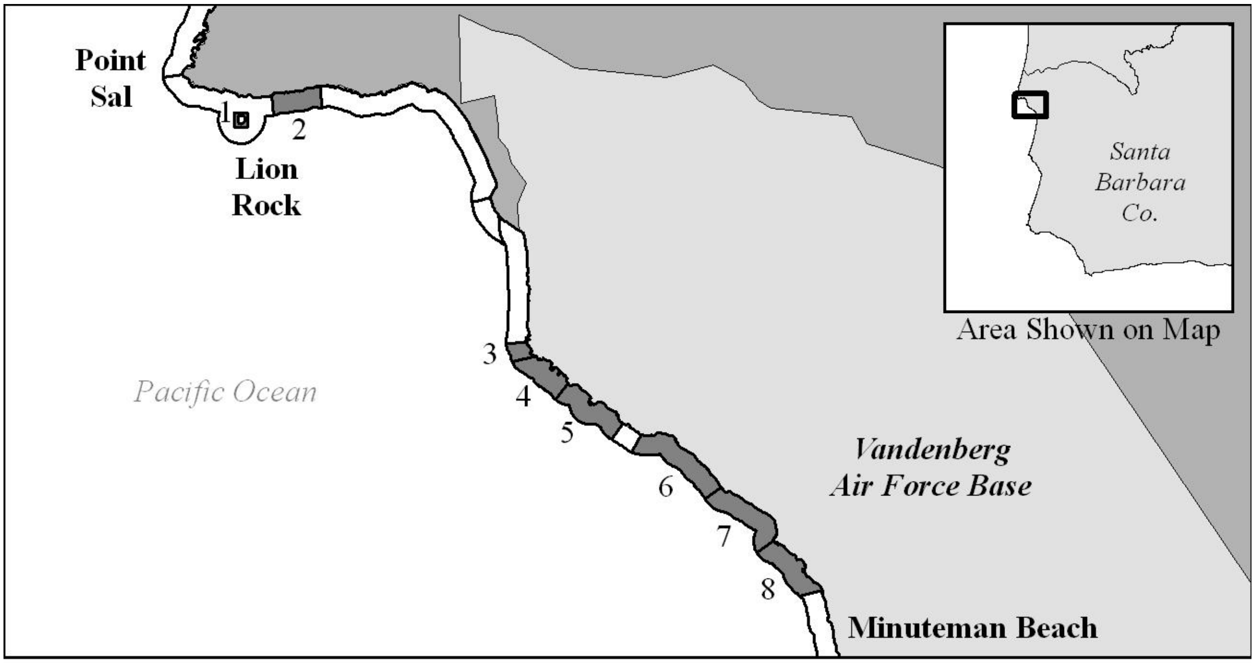


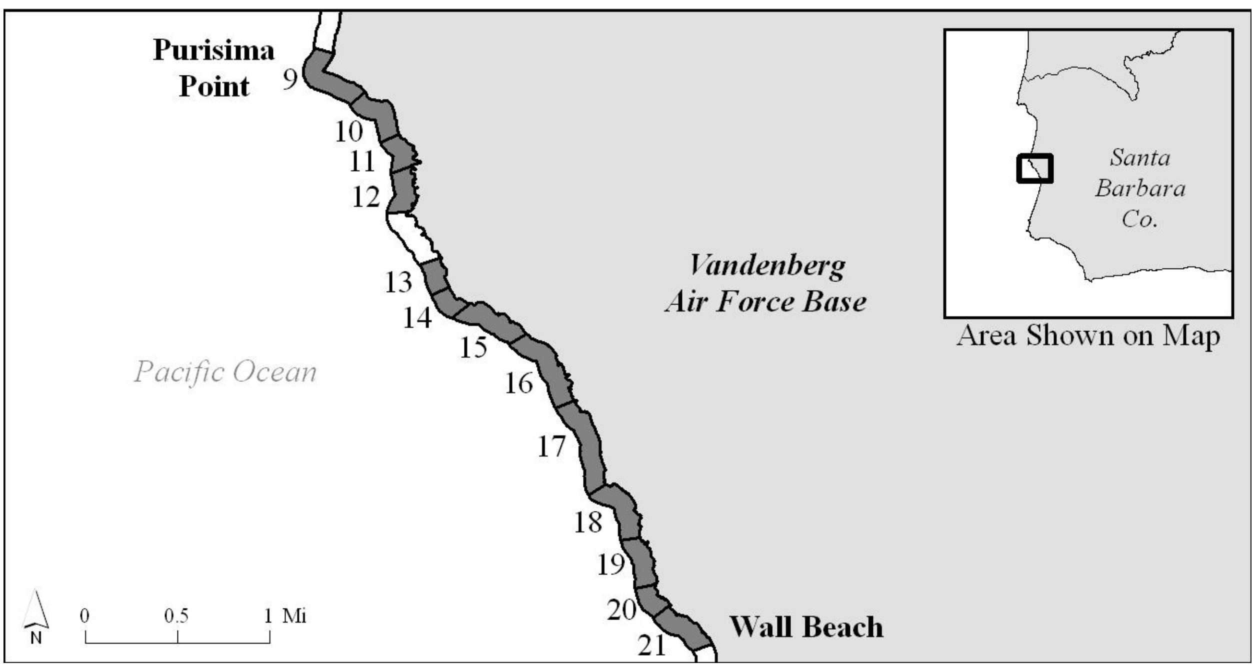
Population Estimates for the Shell Beach Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
sb1	Double-crested Cormorant	96	48	
	Brandt's Cormorant	86	43	
	Pelagic Cormorant	64	32	
	Pigeon Guillemot	15	n/c	5/15
	Western Gull	6	3	
	Black Oystercatcher	4	1	
sb2	Double-crested Cormorant	16	8	
	Brandt’s Cormorant	2	1	
	Pelagic Cormorant	58	29	
	Pigeon Guillemot	30	n/c	5/1
	Western Gull	6	3	
	Black Oystercatcher	2	0	
sb3	Double-crested Cormorant	44	22	
	Pigeon Guillemot	19	n/c	5/7
	Western Gull	10	5	
	Black Oystercatcher	3	1	
sb4	Pigeon Guillemot	4	n/c	4/22
sb5	Brandt's Cormorant	66	33	
	Western Gull	6	3	
sb6	Pigeon Guillemot	22	n/c	5/7
	Black Oystercatcher	1	0	
sb7	Pigeon Guillemot	19	n/c	4/20
	Black Oystercatcher	2	0	
sb8	Black Oystercatcher	3	0	
sb9	Brandt’s Cormorant	2	1	
	Pigeon Guillemot	40	n/c	4/20
	Western Gull	4	2	
	Black Oystercatcher	6	0	
sb10	Pigeon Guillemot	2	n/c	5/1
	Western Gull	4	2	
	Black Oystercatcher	2	1	
sb11	none	-	-	
sb12	Brandt’s Cormorant	2	1	
	Pelagic Cormorant	2	1	
	Pigeon Guillemot	10	n/c	4/20

	Western Gull	10	5	
	Black Oystercatcher	3	1	
sb13	Brandt's Cormorant	10	5	
	Pigeon Guillemot	26	n/c	4/22
	Western Gull	30	15	
	Black Oystercatcher	4	1	
sb14	Brandt's Cormorant	58	29	
	Pelagic Cormorant	30	15	
	Pigeon Guillemot	27	n/c	5/7
	Western Gull	26	13	
	Black Oystercatcher	4	0	
sb15	Brandt's Cormorant	28	14	
	Pelagic Cormorant	48	24	
	Pigeon Guillemot	50	n/c	4/22
	Western Gull	20	10	
	Black Oystercatcher	2	0	
sb16	Pelagic Cormorant	32	16	
	Pigeon Guillemot	65	n/c	5/7
	Western Gull	24	12	
	Black Oystercatcher	4	2	
TOTALS	**Double-crested Cormorant**	**156**	**78**	
	Brandt's Cormorant	**264**	**132**	
	Pelagic Cormorant	**234**	**117**	
	Pigeon Guillemot	**329**	**n/c**	
	Western Gull	**146**	**73**	
	Black Oystercatcher	**39**	**7**	

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

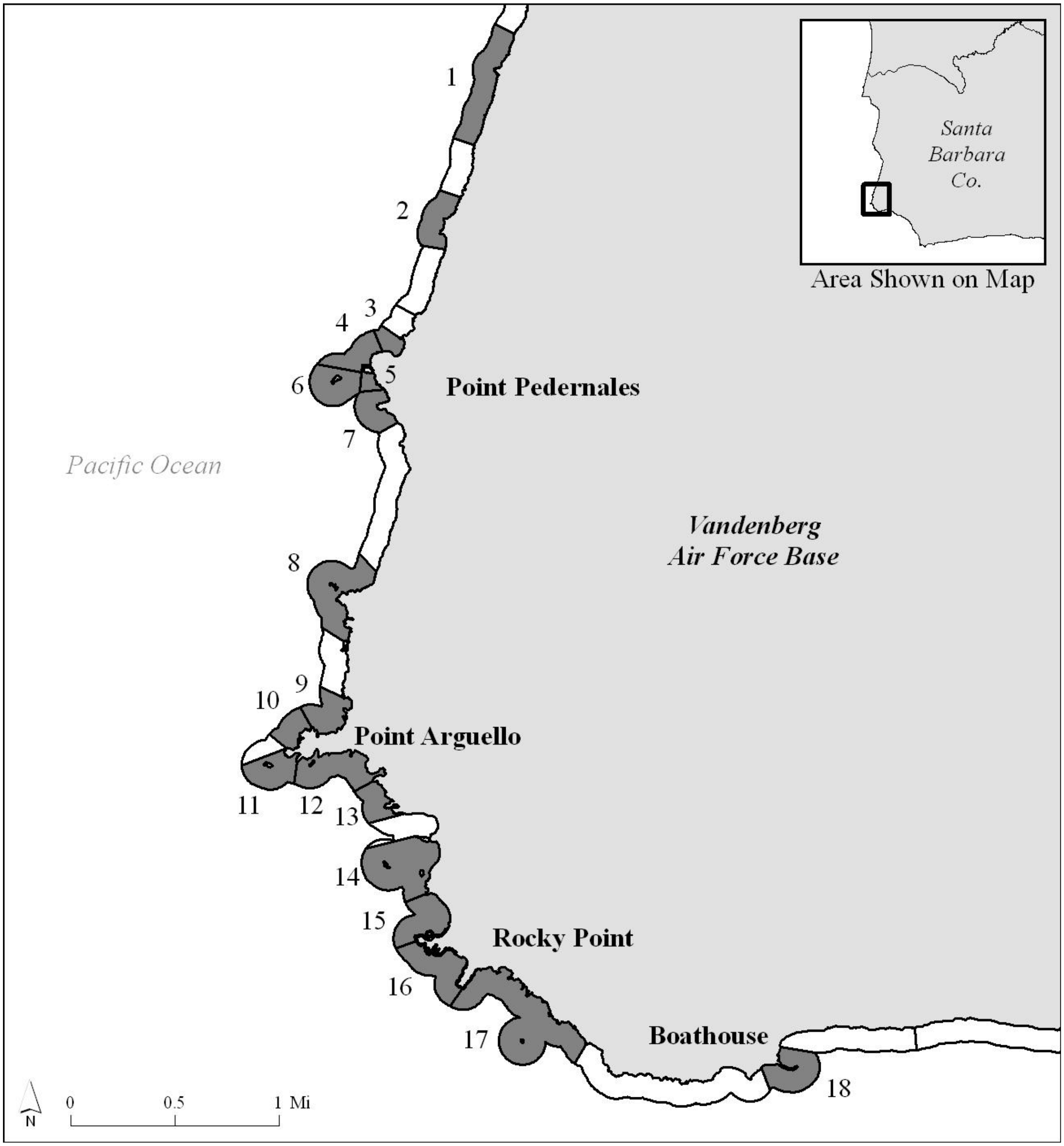




Population Estimates for the North Vandenberg Sub-colonies

Sub-colony	Species	# of Birds	# of Nests	Date Maximum # of Birds Observed (PIGU only)
van1	none	-	-	
van2	none	-	-	
van3	none	-	-	
van4	Western Gull	2	1	
	Black Oystercatcher	2	0	
van5	none	-	-	
van6	none	-	-	
van7	none	-	-	
van8	none	-	-	
van9	none	-	-	
van10	Pigeon Guillemot	44	n/c	4/19
van11	Pigeon Guillemot	60	n/c	5/1
	Western Gull	4	2	
van12	Pelagic Cormorant	10	5	
	Pigeon Guillemot	20	n/c	4/12
	Black Oystercatcher	2	1	
van13	none	-	-	
van14	none	-	-	
van15	none	-	-	
van16	none	-	-	
van17	none	-	-	
van18	none	-	-	
van19	Pigeon Guillemot	1	n/c	6/5
van20	Pigeon Guillemot	32	n/c	5/1
van21	Pigeon Guillemot	36	n/c	4/23
TOTALS	**Pelagic Cormorant**	**10**	**5**	
	Pigeon Guillemot	**193**	**n/c**	
	Western Gull	**6**	**3**	
	Black Oystercatcher	**4**	**1**	

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	149	n/c	5/1
	Western Gull	2	1	
vas2	Pigeon Guillemot	69	n/c	5/1
vas3	Pigeon Guillemot	70	n/c	6/14
vas4	Pigeon Guillemot	31	n/c	4/19
vas5	Pigeon Guillemot	61	n/c	5/16
vas6	Pigeon Guillemot	41	n/c	6/14
	Western Gull	2	1	
	Black Oystercatcher	4	1	
vas7	Pigeon Guillemot	36	n/c	5/16
	Western Gull	2	1	
vas8	Pigeon Guillemot	60	n/c	4/27
	Western Gull	6	3	
	Black Oystercatcher	4	2	
vas9	Pelagic Cormorant	2	1	
	Pigeon Guillemot	34	n/c	4/19
	Western Gull	2	1	
	Black Oystercatcher	2	0	
vas10	Pigeon Guillemot	87	n/c	5/1
vas11	Pelagic Cormorant	4	2	
	Pigeon Guillemot	112	n/c	6/14
	Western Gull	2	1	
vas12	Brandt's Cormorant	372	186	
	Pelagic Cormorant	138	69	
	Pigeon Guillemot	172	n/c	5/16
	Western Gull	18	9	
	Black Oystercatcher	2	1	
vas13	Pigeon Guillemot	27	n/c	4/27
vas14	Pigeon Guillemot	90	n/c	4/27
	Black Oystercatcher	4	1	
vas15	Pelagic Cormorant	10	5	
	Pigeon Guillemot	150	n/c	5/1 & 5/9
	Western Gull	30	15	
	Black Oystercatcher	4	1	
vas16	Pigeon Guillemot	114	n/c	3/29 & 4/27
	Black Oystercatcher	2	0	
vas17	Pigeon Guillemot	94	n/c	5/1

	Black Oystercatcher	2	1
vas18	Brandt's Cormorant	4	2
	Black Oystercatcher	2	0
TOTALS	**Brandt's Cormorant**	**372**	**186**
	Pelagic Cormorant	**154**	**77**
	Pigeon Guillemot	**1441**	**n/c**
	Western Gull	**68**	**34**
	Black Oystercatcher	**26**	**7**