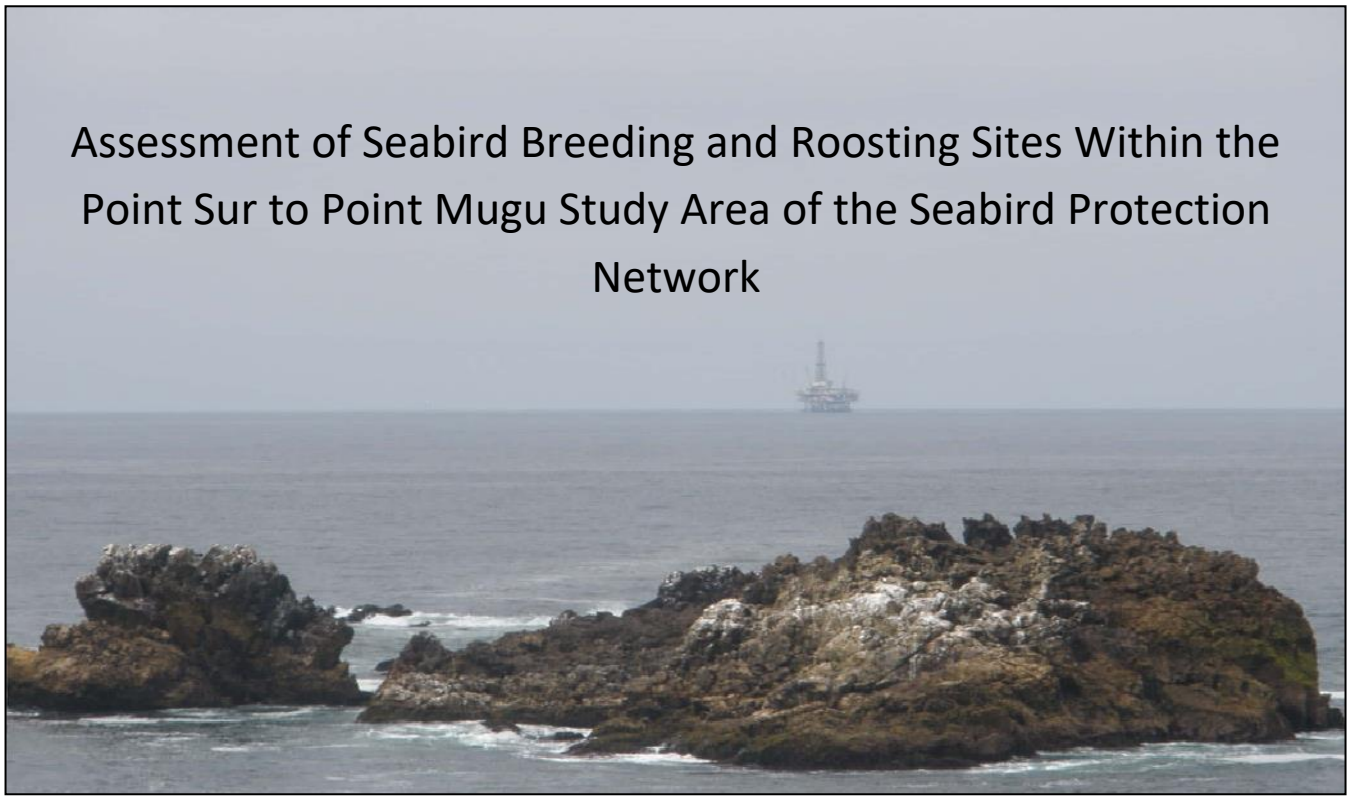
Assessment of Seabird Breeding and Roosting Sites Within the Point Sur to Point Mugu Study Area of the Seabird Protection Network



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

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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 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.

Eight focal seabird species have been identified by the SPN: Brown Pelican (*Pelecanus occidentalis*), Brandt's Cormorant (*Phalacrocorax penicillatus*), Double-crested Cormorant (*P. auritus*), Pelagic Cormorant (*P. pelagicus*), Black Oystercatcher (*Haematopus bachmani*), Western Gull (*Larus occidentalis*), Common Murre (*Uria aalge*), and Pigeon Guillemot (*Cepphus columba*). Common Murres were not found breeding within the Point Sur to Point Mugu study area during the last statewide seabird census (see Carter et al. 1992), though a colony historically bred at Prince Island, just off San Miguel Island and this is considered a potential breeding location with a bird sighting on the island during the early breeding season in 1999 (Manuwal et al. 2001). Initial efforts of the Point Sur to Point Mugu chapter will focus on the remaining seven species. All of these species breed throughout the study region, though Brown Pelican breeding is limited to Anacapa Island.

Cormorants and pelicans have plumage that is wetted when they forage in the ocean. Roosting and conserving energy is an important behavior of these species and much of their day, both during and

outside the breeding season, is spent resting and drying their plumage (Hobson 1997, Wallace and Wallace 1998, Jeremy et al. 1999, Jaques and Strong 2002). Thus, the coastal habitats within the study area provide important year round roosting sites for both cormorants and pelicans. Furthermore, Brown Pelican's gather in large communal groups by night at specific sites selected for protection from potential mammalian predators and human disturbance (Jaques and Strong 2003).

The purpose of this document is to outline the current state of knowledge about population distributions throughout the Point Sur to Point Mugu study area. Additionally, since the goal of the SPN is to decrease human-caused disturbance to both breeding and roosting sites, we summarize the current information available on the impacts of human disturbance to breeding colonies and roosting sites. Finally, we provide management recommendations to guide the BLM as they develop their Point Sur to Point Mugu SPN chapter.

METHODS

Study Area

The Point Sur to Point Mugu study area can be divided into three biologically distinct subareas: 1) central California, 2) southern California, and 3) the northern Channel Islands. The central and southern California subareas are divided by the well-excepted, major faunal transition at Point Conception (Hayden and Dolan 1976). More recent studies have also suggested that coastal biological communities at the northern Channel Islands are unique from the southern California mainland (Ebeling et al. 1980, Murray and Littler 1981, Pondella and Allen 2000, and Pondella et al. 2005). We will recognize these distinctions within our assessment.

In central California, low levels of human development and disturbance, especially when compared to southern California, along with large areas of preserved coastal habitat make it an important area for seabird breeding and roosting. Similarly, there is little coastal development and large areas of preserved habitat at the northern Channel Islands. Conversely, much of the coastal habitat in southern California has been developed. There is also an overall lack of the rocky and coastal bluff habitats used by many of the SPN focal species. Much of the available habitat is more suitable for species like the endangered California Least Tern (*Sternula antillarum browni*). Though not a SPN focal species, the Least Tern is an important component of the southern California subarea. We therefore summarize data for this species in addition to the SPN focal species.

The SPN focal species have been documented at 125 colony locations within the Point Sur to Point Mugu study area (Carter et al. 1992). We have grouped these colonies into 15 'assessment areas' that we consider to be manageable areas for long-term monitoring, outreach and law enforcement (see Figure 1). The data presented within this document are summarized generally by the three biologically important subareas and more specifically by the 15 assessment areas.

Data and Literature Search

Seabird Breeding Populations

Only two studies to date (Sowls et al. 1980 and Carter et al. 1992) have documented breeding populations of all SPN focal species throughout entire Point Sur to Point Mugu study area. Sowls et al. (1980) conducted surveys between 1975 and 1980 while Carter et al. (1992) conducted surveys between

1989 and 1991. We used the most recent of these studies (Carter et al. 1992) to summarize the distribution of focal species throughout the study area. More recent studies conducted within the study area (Carter et al. 1996 and Capitolo et al. 2011) have focused on a few of the assessment areas and a limited subset of the SPN focal species. We make comparisons of assessment area populations from these more recent studies to the populations reported within Carter et al. (1992) in an attempt to identify recent changes in breeding population sizes. Additionally, we summarize the 12-year population time series from the Vandenberg Air Force Base (VAFB) assessment area (see Robinette and Howar 2011a).

It is important to recognize that each of the studies mentioned above used different methods to collect data. We have briefly summarized the methods used by each study below. The results of comparisons across studies should be interpreted with the realization that different methods have their unique biases.

Carter et al. (1992) used a variety of methods for their state-wide survey. Populations of most SPN focal species were documented using a combination of boat- and land-based surveys. Additionally, Brandt's Cormorant populations were documented using aerial photographic surveys. Central and southern California mainland colonies were surveyed in May and June of 1989 while the north Channel Island colonies were surveyed in May of 1991. Carter et al. (1992) reported raw numbers of nests and birds in addition to total numbers of breeding birds that were derived using correction factors that took into account breeding phenology and colony attendance patterns of each species. The correction factors were based on work conducted by Emslie and Sydeman (1989). We used the corrected numbers of breeding birds to summarize population distributions throughout the Point Sur to Point Mugu study area.

Carter et al. (1996) summarized the results of aerial photographic surveys for important Brandt's and Double-crested Cormorant colonies in California. Colonies from the Point Sur to Point Mugu study area included those at the northern Channel Islands and two colonies between Point Sur and Point Conception: Plaskett Rock in the Big Sur, South assessment area and Pup Rock and Adjacent Mainland in the Point Buchon assessment area. The surveys were conducted in May or June of 1993, 1994, and 1995. We compared these data to the Carter et al. (1992) population estimates of the same colonies. Carter et al. (1996) reported raw numbers of nests in their summary, as opposed to the corrected total number of birds discussed above. We therefore compared numbers from Carter et al. (1996) to the raw numbers of nests reported in Carter et al. (1992).

Capitolo et al. (2011) summarized the results of aerial photographic surveys for Brandt's and Double-crested Cormorant colonies throughout the mainland portion of the Point Sur to Point Mugu study area. Double-crested Cormorant colonies were surveyed in June of 2010 and Brandt's Cormorant colonies were surveyed in May of 2010, with a subset of colonies also surveyed in April and June of 2010. We did not compare these numbers to Carter et al. (1996) because there was very little overlap in colonies surveyed. We did compare numbers to Carter et al. (1992). As with the Carter et al. (1996) comparison, we used raw numbers of nests in or comparisons.

Robinette and Howar (2011a) summarize a 12-year time series (1999-2011) of all seabird species breeding at VAFB. Five of the eight SPN focal species nest at VAFB: Brandt's Cormorant, Pelagic Cormorant, Western Gull, Pigeon Guillemot, and Black Oystercatcher. VAFB is the only assessment area with recent, long-term data on population and productivity. Weekly land-based surveys are conducted throughout the breeding season (March through August) at all colonies identified throughout the assessment area.

California Least Tern Breeding Population

Most Calilfornia Least Tern colonies in California are intensively monitored annually and data are stored in a database maintained by the California Department of Fish and Game (CDFG). Multiple decades' worth of data exist for many of these colonies. Because the California Least Tern is not one of the SPN focal species, we did not analyze time series data for this assessment. Instead, we summarized data on population distribution taken from Marschalek (2011) to identify important Least Tern colonies within the Point Sur to Point Mugu study area.

Brown Pelican Roosting Sites

Atlases of important Brown Pelican roost sites have been developed for southern California (USFWS 2009) and central and northern California (Jaques et al. 2008). Both atlases summarize data from ground-based, boat, and aerial surveys conducted from 1986-2007. They identify important day and night communal roosts. Night roosts generally provide more protection from potential predators and can be used by thousands of pelicans on a given night (Jaques and Strong 2003). However, identifying night roosts requires more effort than traditional daytime surveys. Thus, while the atlases identify confirmed night roosts in the study area, there are likely more night roosts that have not yet been confirmed. We summarize the number of day and confirmed night roosts within each study area. We further divided day roosts into categories of major (>1,000 birds), moderate (500-1,000 birds), or minor (<500 birds) use.

We also summarize seasonal patterns of Brown Pelican roost utilization within the Vandenberg assessment area using data collected by PRBO from 2001-2006 (Collier et al. 2002, Robinette et al. 2003, Robinette and Collier 2004, Robinette and Lanser 2006a and b, Howar and Robinette 2007).

Human-caused Disturbance

Unfortunately, there are no range-wide studies to summarize levels of disturbance throughout the Point Sur to Point Mugu study area. We did, however, find two reports that summarize disturbance issues within the study area. Jaques and Strong (2002) summarize disturbances at select Brown Pelican roost sites from 1986-1991 and 1999-2000. They documented disturbances at four sites in the Santa Barbara Channel, South assessment area, two sites in the Santa Barbara Channel, North assessment area, and three sites in the Shell Beach assessment area. PG&E (2010) summarize two and a half seasons of seabird monitoring (July – August, 2007 and February – August, 2008 & 2009) after the opening of a public trail in the Point Buchon assessment area. They compare their results to a baseline inventory of nesting seabirds conducted in 2005 (PG&E 2006). In addition to these reports, we conducted a thorough search for literature on human-caused disturbance at seabird breeding and roosting sites. We

summarize the information found in Jaques and Strong (2002) and PG&E (2010) and present a general summary of available information on the impacts of disturbance to seabird populations.

RESULTS

Seabird Breeding Populations

Data from Carter et al. (1992) show Brandt's Cormorants to be the most abundant of the SPN focal species breeding within the Point Sur to Point Mugu study area with an estimated 32,700 birds (Table 1). Western Gulls showed the next highest abundance (14,535 birds) followed by California Brown Pelicans (10,680 birds), Pigeon Guillemots (5,917 birds), Pelagic Cormorants (3,521 birds), Double-crested Cormorants (1,334 birds), and Black Oystercatchers (317 birds). The majority of all species but Pigeon Guillemots were found breeding at the Channel Islands (Figure 2). Guillemots were split almost equally between the Channel Islands and central California. Within the Channel Islands, San Miguel Island was an important area for Brandt's Cormorants, Double-crested Cormorants and Pigeon Guillemots; Santa Rosa Island was an important area for Pelagic Cormorants; Santa Cruz Island was an important area for Black Oystercatchers; and Anacapa Island was an important area for Brown Pelicans, Double-crested Cormorants, and Western Gulls. In fact, Anacapa Island was the only assessment area where Brown Pelicans bred. Within central California, Big Sur, North was an important area for Double-crested Cormorants and Brandt's Cormorants; Big Sur, South was important for Brandt's Cormorants and Western Gulls; Piedras Blancas was important for Brandt's Cormorants; Point Buchon was important for Brandt's Cormorants, Pelagic Cormorants, and Western Gulls; Shell Beach was important for Black Oystercatchers; and Vandenberg Air Force Base was important for Pigeon Guillemots. In fact, the largest population of Pigeon Guillemots throughout the study areas was within the Vandenberg assessment area.

At the time of Carter et al. (1992), only Western Gulls, Pigeon Guillemots, and Black Oystercatchers were breeding in southern California and these were limited to the Santa Barbara, North assessment area. Conversely, the California Least Tern is very abundant in southern California. Approximately 93% of the Point Sur to Point Mugu population breed within the Santa Barbara Channel, South assessment area (Table 2). The remaining seven percent are spread relatively evenly between two colonies in the Pismo to Point Sal and Vandenberg assessment areas. A small colony has been established in the Santa Barbara Channel, North assessment area in recent years with a maximum population of 12 birds recorded in 2004 (Marschalek 2005). However, this colony was not active at the time of Marschalek (2011).

Data from Carter et al. (1996) show declines in Brandt's Cormorant populations at San Miguel Island and Plaskett Rock (Big Sur, South assessment area; Figure 3). Other colonies within the study area had changed little since Carter et al. (1992). The Double-crested Cormorant population at Anacapa Island showed a slight decline since Carter et al. (1992) while that at San Miguel Island showed a slight increase (Figure 4).

Surveys from Capitolo et al. (2011) covered more colonies within the study area than Carter et al. (1996). These data show decreases in Brandt's Cormorant populations at the Big Sur, North, Big Sur,

South, and Piedras Blancas assessment areas (Figure 5). There was a large increase in population at Morro Bay and a slight increase at Point Buchon. Additionally, new colonies had been established at Shell Beach, Vandenberg Air Force Base, Santa Barbara Channel, North, and Santa Barbara Channel, South. There was also a new Double-crested Cormorant colony established in Shell Beach. There was a large increase in the Double-crested Cormorant population at Morro Bay and little change at Big Sur, North. Carter et al. (1992) reported a small population of Double-crested cormorants at Big Sur, South, but this colony was not active during the Capitolo et al. (2011) surveys.

Robinette and Howar (2011a) showed population increases in all SPN focal species breeding within the Vandenberg assessment area (Figure 6). Population increases were greatest for Brandt's and Pelagic Cormorants. Brandt's Cormorants were first discovered breeding at Vandenberg in 1995 and their population has grown to almost 400 birds. Pigeon Guillemots and Black Oystercatchers have shown slight population increases over the time series. Much of the oystercatcher population increase occurred early in the time series and appears relatively stable in recent years. Conversely, the guillemot population has been stable until recent years. Recent growth in this population has been primarily driven by the establishment of a new sub-colony. The Western Gull population has been increasing steadily since the beginning of the time series. However, the growth curve appears to be reaching a plateau, indicating that the population is reaching its carrying capacity within the Vandenberg assessment area.

California Brown Pelican Roosting

A total of 93 daytime communal roosts have been identified within the Point Sur to Point Mugu study area (Table 3). Eight of these are major roosts (>1,000 birds), 16 are moderate roosts (500-1,000 birds), and 69 are minor roosts (<500 birds). The majority of roosts were located within the two Santa Barabara Channel assessment areas in southern California and the Vandenberg and Shell Beach assessment areas in central California, though most of these were minor roosts. Most major roosts were located within the Shell Beach and Pismo to Point Sal assessment areas. There were more natural occurring roost sites in central California, while southern California roosts were dominated by man-made structures like piers, breakwaters, and jetties. In fact, Mugu Lagoon was identified as perhaps the only estuary site within southern California that is high quality and receives regular use (Capitolo et al. 2002, Jaques and Strong 2002).

There were a total of 14 night roosts confirmed within the study area, though more will likely be confirmed with more effort. Eight of the confirmed night roosts were in southern California: six in the Santa Barbara, South assessment area and two in the Santa Barbara, North assessment area. In central California, one night roost was located within the Vandenberg assessment area, three within Shell Beach, one within Piedras Blancas, and one within Big Sur, South.

Seasonal patterns at Vandenberg Air Force Base showed an absence of pelicans from March to early May in all years but 2005. Pelicans are typically at their breeding colonies during this time of year and begin dispersing in May. Roost utilization from May to October is variable among years and peak roosting numbers typically occur between mid October and late December. Peak season numbers were also variable among years with the highest numbers recorded in 2001, 2004 and 2006 and the lowest in 2003 and 2005. The diet of Least Terns breeding within the Vandenberg assessment area suggests a

high abundance of northern anchovies (*Engraulis mordax*), an important prey for Brown Pelicans, within the area in 2001 and 2006 and a low abundance in 2003 and 2005 (Robinette and Howar 2011b). Thus, it is likely that interannual variability in roosting numbers can be explained by localized prey availability.

Human-caused Disturbance to Seabird Breeding Sites

All of the literature that we reviewed supported the fact that 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). Recommended approach distances for visitors viewing cormorants are between 50-100 meters (Carney and Sydeman 1999), but can vary depending on the number of people visiting the area. In regards to some species, a larger group of people may require a further approach distance than a small group in order to not disturb nesting birds (Beale and Monaghan 2004).

Common Murres, a SPN focal species found outside the Point Sur to Point Mugu study area, have faced human disturbances in many different ways including fishing practices, oil spills, aircraft overflights, and boater recreation. The population in central California was impacted greatly in the 1980's with mortality from gillnet fishing and oil spills; effects in which murres showed a slow recovery (Rojek et al. 2007). In one case, disturbance monitoring of a Common Murre colony took place after a small shipwreck occurred in the Point Reyes National Seashore. Rescue efforts of the 1 person crew and the cleanup efforts following, caused one colony to abandon while others experienced low reproductive success due to the disturbance and predation by other species (Thayer et al. 1999). Fixed-wing aircraft and helicopters that approach within 305 meters are known to flush Common Murres from nesting sites as well as boats that approach within 50 meters of a colony with results of lost eggs and chicks (Rojek et al. 2007).

Pigeon Guillemots nest in rocky crevices along the coast and on islands and the effects of disturbances can be less obvious than surface nesting species. However some observations show that guillemots react negatively to disturbances such as alarm calls from gulls and loud noises from boating activity (Nelson 1987). One study even presents the possibility that the reproductive success of one species of guillemot was much lower when exposed to more frequent disturbances by humans (Cairns 1980).

Black Oystercatchers have long been negatively impacted by human disturbance and encroachment throughout its range along the Pacific Coast of North America, including the extirpation of some breeding populations (Kenyon 1949, Morse et al. 2006). Ground nesting birds, including oystercatchers can be particularly vulnerable to disturbances because they inhabit coastal areas where human recreation is high. There is evidence that human disturbance can decrease chick survival in some species of beach-nesting shorebirds (Ruhlen et al. 2003). If oystercatchers are kept from their nests, eggs and young chicks can be easy prey for surrounding gulls (Ainley and Lewis 1974). In addition to their vulnerability to disturbances, oystercatchers have a small population size, limited distribution, and a low rate of reproductive success (Morse et al. 2006).

Within the Point Buchon assessment area, PG&E (2010) showed that the majority of disturbances occurred along a section of the Point Buchon trail that was in close visual proximity to several nesting areas. This was also an area where visitors occasionally left the trail and approached the bluffs. Seabird reactions to visitors were most apparent when the visitors lingered at the edge of the bluffs. Impacts of trail use and disturbance events to breeding populations were difficult to determine. It is important to recognize that annual variability in seabird population size and distribution is a natural phenomenon and often tied to oceanographic conditions. Differentiating impacts due to human activities versus oceanographic variability requires the use of detailed, long-term data sets that were not available for the PG&E (2010) study. Nonetheless, the report presented some concerning changes from pre-trail conditions. Two Pelagic Cormorant sites used in 2007 and 2008 were not used in 2009. Additionally, Pelagic Cormorants began using two new sites that were out of view from the trail. In 2008 and 2009, Brandt's Cormorants stopped using one site that was used during the 2005 baseline and 2007, the first year of monitoring after the trail was opened. Conversely, there were no obvious changes in Western Gull population size or distribution. Finally, the number of Black Oystercatcher nests increased during the post-trail period and oystercatchers nested at three new locations.

Human-caused Disturbance to Roosting Sites

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. They also noted that disturbance rates at natural habitats were approximately four times higher than those at man-made roost sites. Disturbance rates within the Shell Beach assessment area 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.

DISCUSSION

Seabird Breeding Populations

At the time of Carter et al. (1992), the majority of all seabird species but Pigeon Guillemots were breeding at the Channel Islands and very low numbers of three species bred along the southern California mainland. Important areas for central California included Big Sur, North and South, Piedras Blancas, Point Buchon, Shell Beach, and Vandenberg Air Force Base. Prior to 1995, Pecho Rock in San Luis Obispo County was the southern mainland breeding limit for Brandt's Cormorants (Carter et al. 1996). Since Carter et al. (1992), new colonies of Brandt's Cormorants have been established within the Shell Beach, Vandenberg Air Force Base and Santa Barbara Channel, North and South assessment areas. Additionally, one new colony of Double-crested Cormorants was established at Shell Beach. Data from Capitolo (2011) showed population decreases at Brandt's Cormorant colonies in the northern central California assessment areas and increases in the southern central California assessment areas. Finally, populations of all seabirds breeding within the Vandenberg assessment area have shown increasing trends since surveys began in 1999. Thus, it is likely that many of the central California assessment areas have experienced similar fluctuations since Carter et al. (1992).

Oceanographically, the Point Sur to Point Mugu study area is greatly influenced by the California Current System (CCS), an eastern boundary current that flows southward along the west coast of North America. As with other eastern boundary currents, the CCS is one of the most oceanographically variable areas in the world (Ainley et al. 1995). Additionally, the central California component of the Point Sur to Point Mugu 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). Finally, the area between Point Arguello and Point Conception marks a convergence between the cold waters of the CCS and the warm waters of the Santa Barbara Channel (Dever 2004, Ohashi & Wang 2004, Dong & Oey 2005). There is seasonal and interannual variability in the strength and direction of currents within this convergence area that leads to variability in ocean productivity. Thus, there is much interannual fluctuation in biological productivity throughout the Point Sur to Point Mugu study 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).

In order to distinguish between environmental and human impacts on seabird populations, it is essential that we understand how oceanographic variability affects seabirds within each assessment area. The data required to develop such an understanding takes many years to amass, as ocean conditions fluctuate on multiple temporal scales, from daily to decadal and beyond. Thus, establishing a baseline of population and reproductive trends within the Point Sur to Point Mugu study area will require long-term annual monitoring.

Brown Pelican Roost Utilization

The distribution and abundance of roosting Brown Pelicans in southern California can vary seasonally and annually and are greatly influenced by the timing and success of their reproduction, migration patterns, ocean conditions, and the distribution and availability of their prey source (Jaques and Strong 2003). Brown pelicans breed in the spring in Baja California as well as at the Channel Islands; therefore numbers of roosting birds along the mainland coast of southern California are low during these months and not very widespread (Briggs et al. 1981). Once breeding concludes, pelicans begin moving north in the late summer and into the fall and can be found throughout the study area and beyond. Anderson and Anderson (1976) suggest there are two ecotypically or behaviorally distinct populations of California Brown Pelicans. One population breeds in the Gulf of California, and the other more locally in the Southern California Bight (SCB). Birds from both populations migrate and overwinter throughout the study area.

There are known relationships between pelican post-breeding dispersal patterns and sea surface temperatures in the CCS. For example, Pelican densities at sea are positively correlated with sea surface temperatures (Anderson and Anderson 1976, Briggs et al. 1983) and the timing of peak pelican numbers along the central and northern California coast coincides with the timing of peak sea surface temperatures south of Point Reyes (Briggs et al. 1981, Briggs et al. 1983). Furthermore, Briggs et al. (1981, 1983) suggest that the relative importance of individual roost sites varies seasonally and among years because roosts closer to food supplies can be selected to maximize foraging efficiency while minimizing energy expenditure. Thus, roost utilization within the Point Sur to Point Mugu study area is highly variable both seasonally and annually and is closely tied to local prey availability. As with breeding population dynamics, understanding seasonal and annual variability in roost utilization within the Point Sur to Point Mugu study area will require long-term annual monitoring.

The appropriate roost habitat for Brown Pelicans has become limited. This is especially true in southern California where increased development along the coastline has resulted in the loss of natural roosting habitat (Jaques et al. 1996). The protection of these remaining areas has become an increasingly important management issue in California. Jaques and Strong (2002) note that while artificial structures provide critical roosting habitat for Brown Pelicans, the elevated levels of disturbance occurring at natural roosts warrants prioritizing these areas for management actions. They recommend a combination of public education, establishing buffer zones between roosts and people, and habitat manipulation to enhance or create island roost habitat.

DATA GAPS AND MANAGEMENT RECOMMENDATIONS

There is a general lack of available long-term data throughout the Point Sur to Point Mugu study area. The last region-wide census for all SPN focal species was Carter et al. (1992). In order to determine whether SPN outreach and law enforcement efforts are effective, long-term data sets for all SPN focal species will need to be established within several of the assessment areas. We make the following recommendations to fill data gaps and guide the initial outreach and law enforcement efforts of the Point Sur to Point Mugu SPN chapter.

1) Conduct a Chapter-wide Disturbance Study – While there are major data gaps throughout the Point Sur to Point Mugu study area, the most significant gaps are in our understanding of disturbance levels throughout the area. Therefore, a study should be initiated to identify areas of high and low human disturbance to breeding colonies and roosting sites. The initial study could involve interviewing land managers, conservationists, etc. to identify areas of concern and following up with short-term monitoring within areas of initial interest. The results would then guide the development of long-term monitoring programs within each of the three biologically important subareas.

2) Develop Monitoring Programs within Biologically Important Subareas – Initial implementation of the Point Sur to Point Mugu SPN chapter should be limited to one of the three biologically important subareas (e.g., central California). This will increase the likelihood of successful outreach, law enforcement, and monitoring efforts. Additionally, starting with one manageable subarea will allow for a model of communication among chapter components (e.g., outreach and law enforcement) and adaptive program management to be established. Once this model is well established, it can be implemented in the remaining two subareas.

3) Monitor Several Assessment Areas within Each Biologically Important Subarea – Baseline breeding population monitoring should be conducted at several assessment areas to begin filling data gaps. Monitoring at each location should be conducted on a weekly basis during the peak breeding season (April through July). While range-wide surveys such as Carter et al. (1992) are useful for gaining a general understanding of species abundance and distribution, it is important to recognize that breeding effort is variable within seasons and the timing of breeding can be variable among years. Thus, among-year comparisons of data from annual window surveys can be difficult to interpret. Weekly surveys allow for a better understanding of seasonal and annual variability in breeding effort. Weekly surveys will also be necessary for estimating parameters such as colony productivity (e.g., number of fledglings produced per breeding pair) and rates of human disturbance. At a minimum, we suggest weekly monitoring efforts record data on the following parameters for each SPN focal species: 1) population size and distribution, 2) colony reproductive success, 3) rates of human disturbance at breeding sites, and 4) rates of human disturbance at roosting sites.

4) Use Data from Vandenberg Air Force Base as a Baseline – The Vandenberg assessment area should be used as a baseline for comparison within the central California subarea. These data represent the only long-term time series for all SPN focal species within the study area. The Vandenberg seabird monitoring program can also serve as a model for implementing monitoring throughout the Point Sur to Point Mugu study area. Because the oceanographic conditions off central California result in high variability in seabird breeding effort and success, it will be difficult to determine whether changes observed at breeding and roosting sites are due to outreach and law enforcement efforts or natural oceanographic variability. Maintaining the long-term data set from Vandenberg will be important for understanding

relationships between seabird and oceanographic parameters within the study area and interpreting the effectiveness of outreach and law enforcement efforts.

5) Monitor Brown Pelican Roost Utilization Outside the Breeding Season – Weekly surveys of Brown Pelican roost utilization should occur outside of the breeding season. Peak use of roosts along the central California coast occurs from October to December and roost utilization is variable even within the peak period. Additionally, many of the roosts identified within the Brown Pelican roost atlases were only surveyed a few times. It is possible that the importance of many roosts was underestimated throughout the study area. For example, Robinette and Howar (2007) have shown that many roosts within the Vandenberg assessment area are more important than the atlases suggest. Weekly surveys over several years will be necessary to understand intra- and interannual variability in roost utilization.

6) Identify Brown Pelican Night Roosts within Each Assessment Area – While many night roosts were identified in the Brown Pelican roost atlases, not all night roosts have been identified throughout the Point Sur to Point Mugu study area. PRBO has data for the Vandenberg assessment area from 2008-2011, but these data have not been summarized. The protocols developed by PRBO can be expanded to identify important night roosts in other assessment areas.

7) Include Least Terns as a Southern California Focal Species – An effort should be made to discuss disturbance issues with the Least Tern management community. When the Point Sur to Point Mugu SPN chapter expands into southern California, Least Terns will be an important species to include. Because Least Terns nest in the open sand, they compete with humans for beach habitat. Disturbance is an issue at many colonies, but there is no organized outreach and law enforcement effort to deal with this problem in southern California. The Least Tern management community meets on an annual basis. These meetings would be a good place to begin gauging interest in a partnership with the Point Sur to Point Mugu SPN chapter.

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Table 1. Breeding population size (total number of birds) for each Seabird Protection Network focal species within each of the 15 assessment areas. Data were taken from Carter et al. (1992).

Assessment Area	California Brown Pelican	Double-crested Cormorant	Brandt's Cormorant	Pelagic Cormorant	Pigeon Guillemot	Western Gull	Black Oyster-catcher
Big Sur, North	0	36	1,526	164	303	83	4
Big Sur, South	0	2	2,277	129	93	422	10
Piedras Blancas	0	0	3,305	7	98	78	5
Morro Bay	0	24	117	53	24	114	0
Cambria/Estero Bluffs	0	0	0	0	0	0	0
Point Buchon	0	0	1,922	354	476	231	19
Shell Beach	0	0	0	61	425	49	23
Pismo to Point Sal	0	0	0	13	55	13	0
Vandenberg AFB	0	0	0	99	1,480	7	9
SB Channel, North	0	0	0	0	29	2	2
SB Channel, South	0	0	0	0	0	0	0
San Miguel Island	0	552	15,700	691	1,114	1,854	59
Santa Rosa Island	0	0	4,650	1,162	287	170	29
Santa Cruz Island	0	0	3,140	460	1,459	1,238	123
Anacapa Island	10,680	720	63	328	74	10,274	34
Total Pt Sur to Pt Mugu	10,680	1,334	32,700	3,521	5,917	14,535	317

Table 2. Least Tern population size at colonies within the central and southern California subareas. Also shown is the percentage of the total Point Sur to Point Mugu population residing within each subarea. Data were taken from Marschalek (2011).

Region	Assessment Area	Number of Birds	Percent of Population
Central California	Pismo to Point Sal	48	7.3%
	Vandenberg AFB	66	
Southern California	SB Channel, North	0*	92.7%
	SB Channel, South	1,454	
Total		1,568	

*A new Least Tern colony was established at Coal Oil Point, Santa Barbara in 2004. Annual breeding effort at the colony has been variable with a maximum of twelve birds breeding in 2004. There were no birds breeding at the time of Marshalak (2011).

Table 3. Number of day and night roosts at assessment areas within the central and southern California subareas. Number of day roosts is further broken down into number of major (>1,000 birds), moderate (500-1,000 birds), and minor (<500 birds) roosts. Data were taken from Jaques et al. (2008) and USFWS (2009).

Assessment Area	Day Roosts	Night Roosts	Day Roosts		
			Major	Moderate	Minor
Big Sur, North	6	0	0	0	6
Big Sur, South	4	1	0	1	3
Piedras Blancas	4	1	0	1	3
Cambria/Estero Bluffs	3	0	0	0	3
Morro Bay	8	0	1	3	4
Point Buchon	8	0	0	3	5
Shell Beach	10	3	3	2	5
Pismo to Point Sal	4	0	2	1	1
Vandenberg AFB	11	1	0	0	11
SB Channel, North	22	2	1	2	19
SB Channel, South	13	6	1	3	9
Total	93	14	8	16	69

Figure 1. Map of the Point Sur to Point Mugu study area showing the 15 assessment areas used in our analyses.

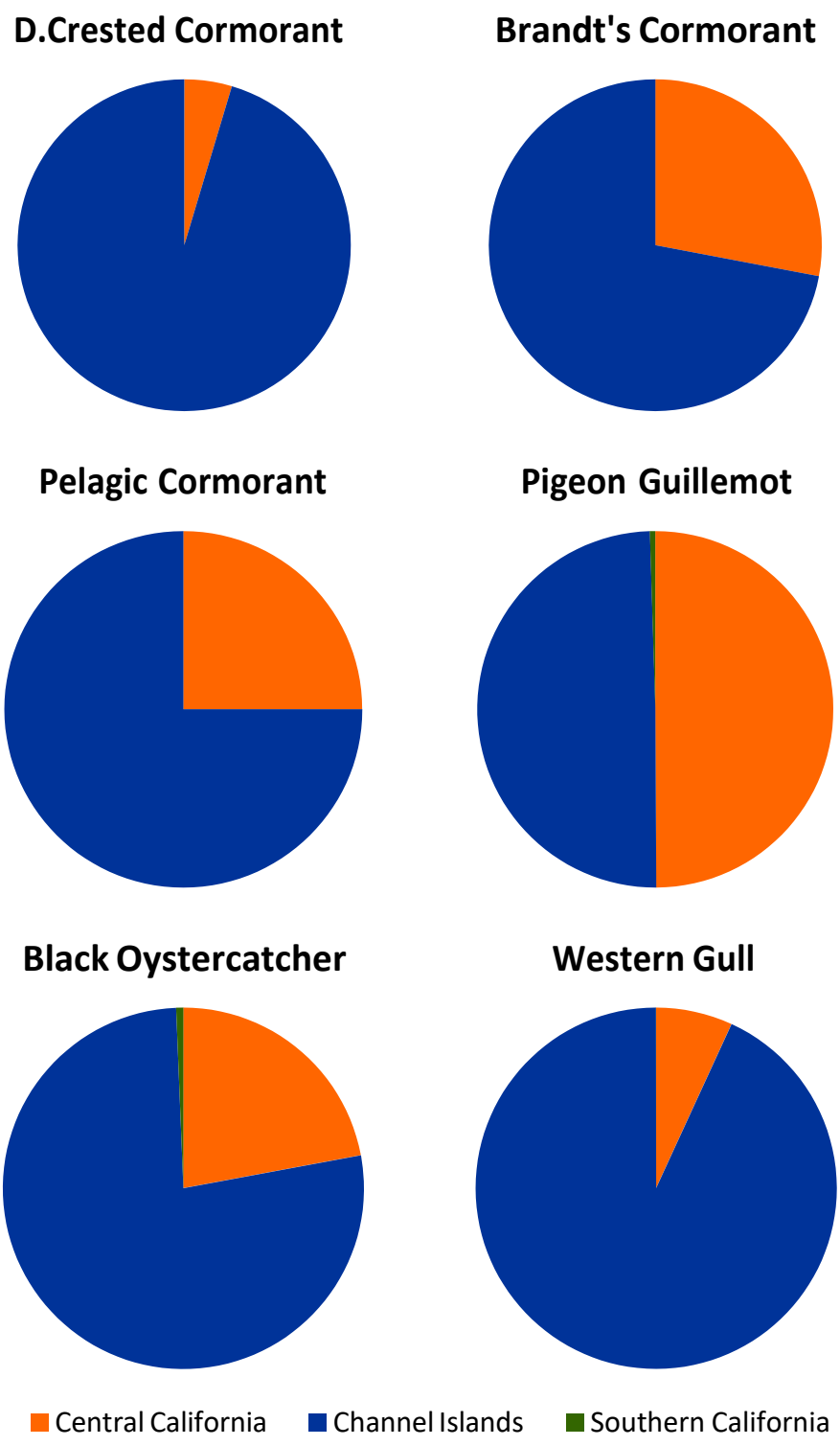

Figure 2. Distribution of breeding birds for six of the eight Seabird Protection Network focal species among the three biologically important subareas. Graphs were created using data from Carter et al. (1992).

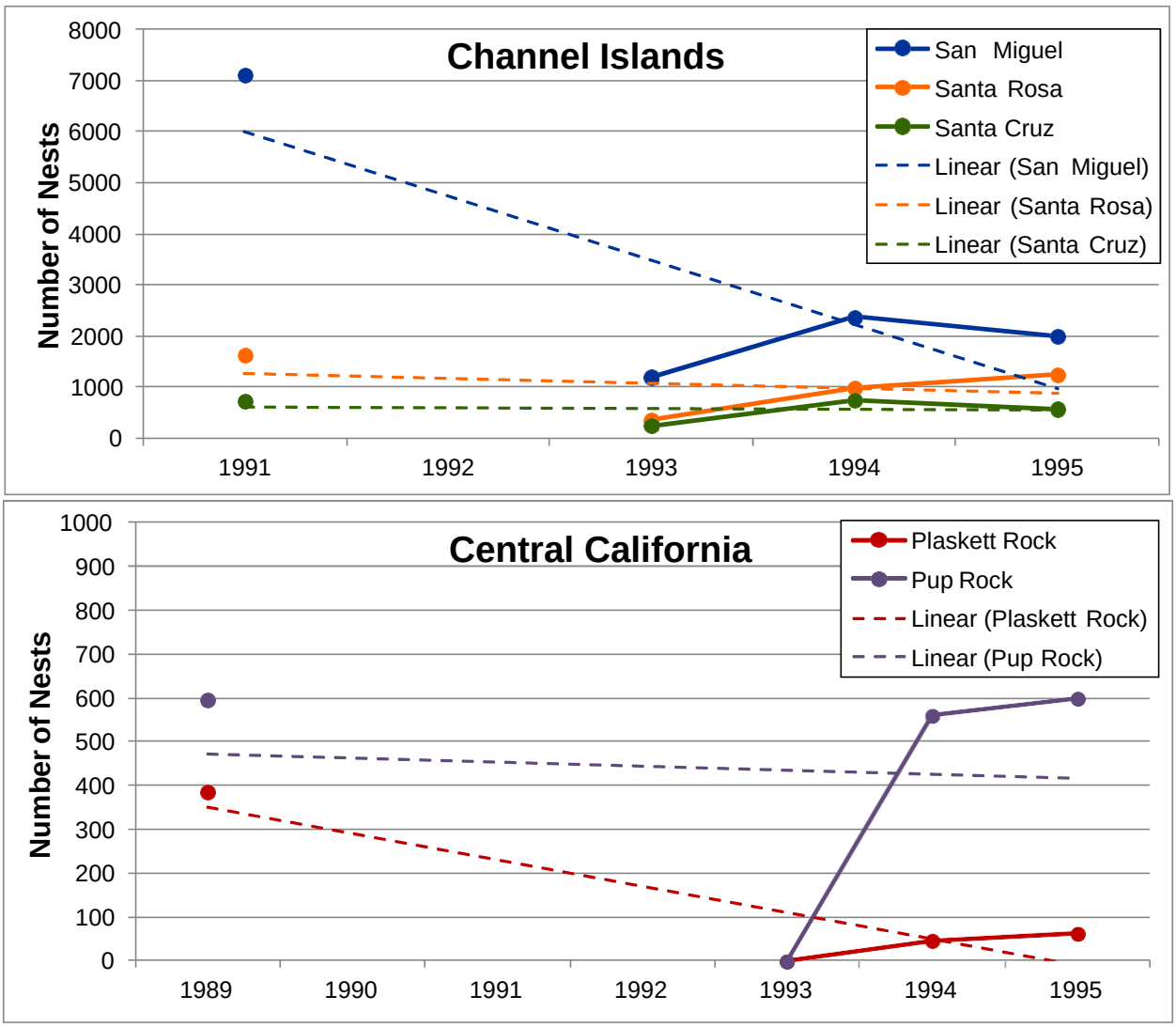

Figure 3. Change in Brandt's Cormorant breeding populations from 1991 to 1995 at three assessment areas in the northern Channel Islands subarea and from 1989 to 1995 at two assessment areas in the central California subarea. Dashed lines are linear regression lines showing trends over the time series. Graphs were created using data from Carter et al. (1992) and Carter et al. (1996).

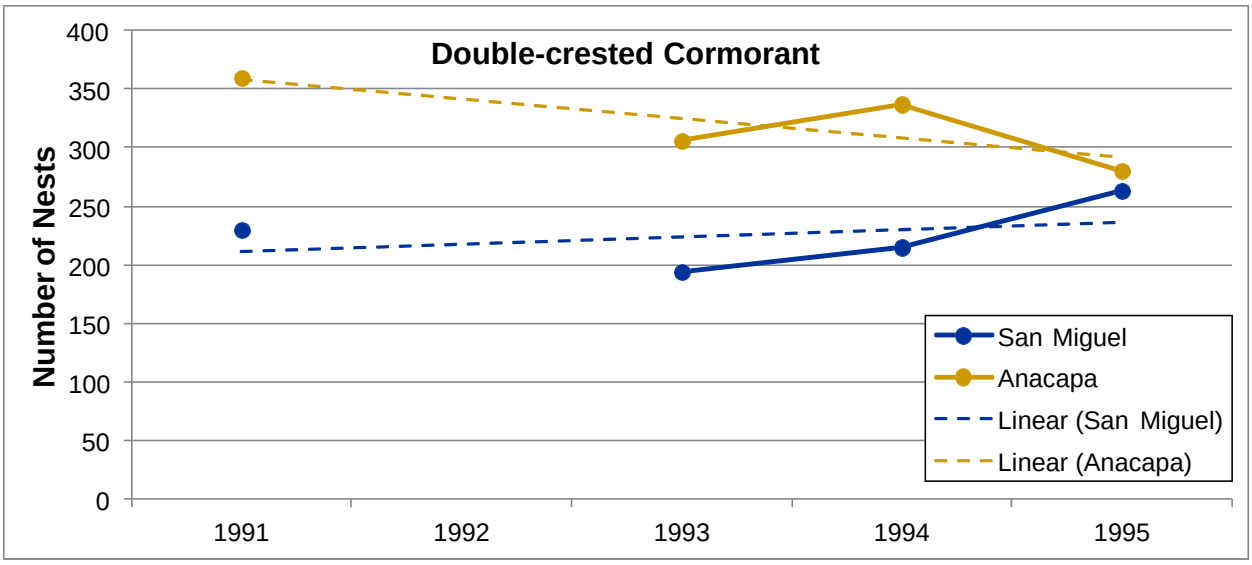

Figure 4. Change in Double-crested Cormorant breeding populations from 1991 to 1995 at two assessment areas in the northern Channel Islands subarea. Dashed lines are linear regression lines showing trends over the time series. Graph was created using data from Carter et al. (1992) and Carter et al. (1996).

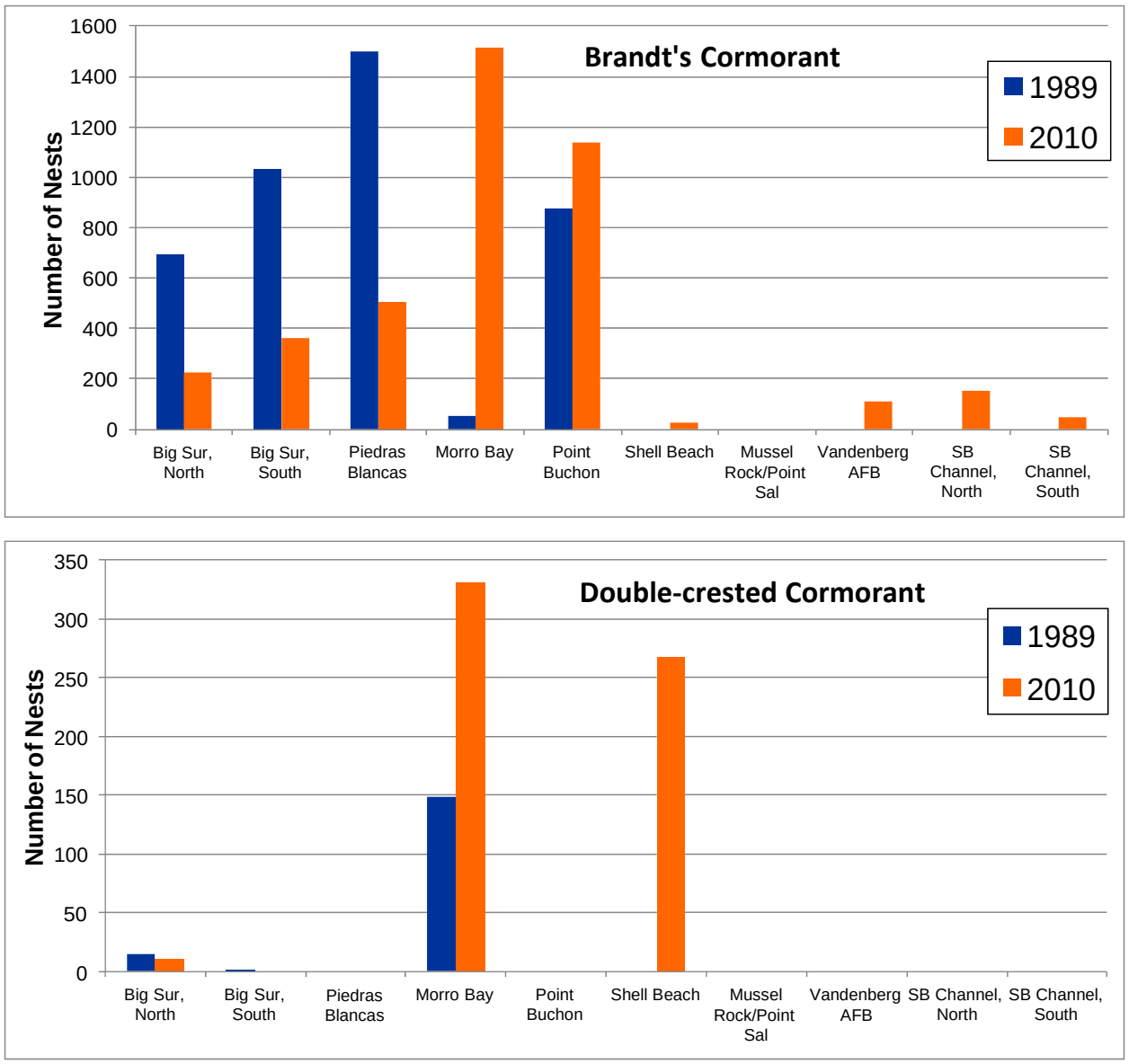

Figure 5. Changes in Brandt's and Double-crested cormorant populations within the central and southern California subareas between 1989 and 2010. Graphs were created using data from Carter et al. (1992) and Capitolo et al. (2011).

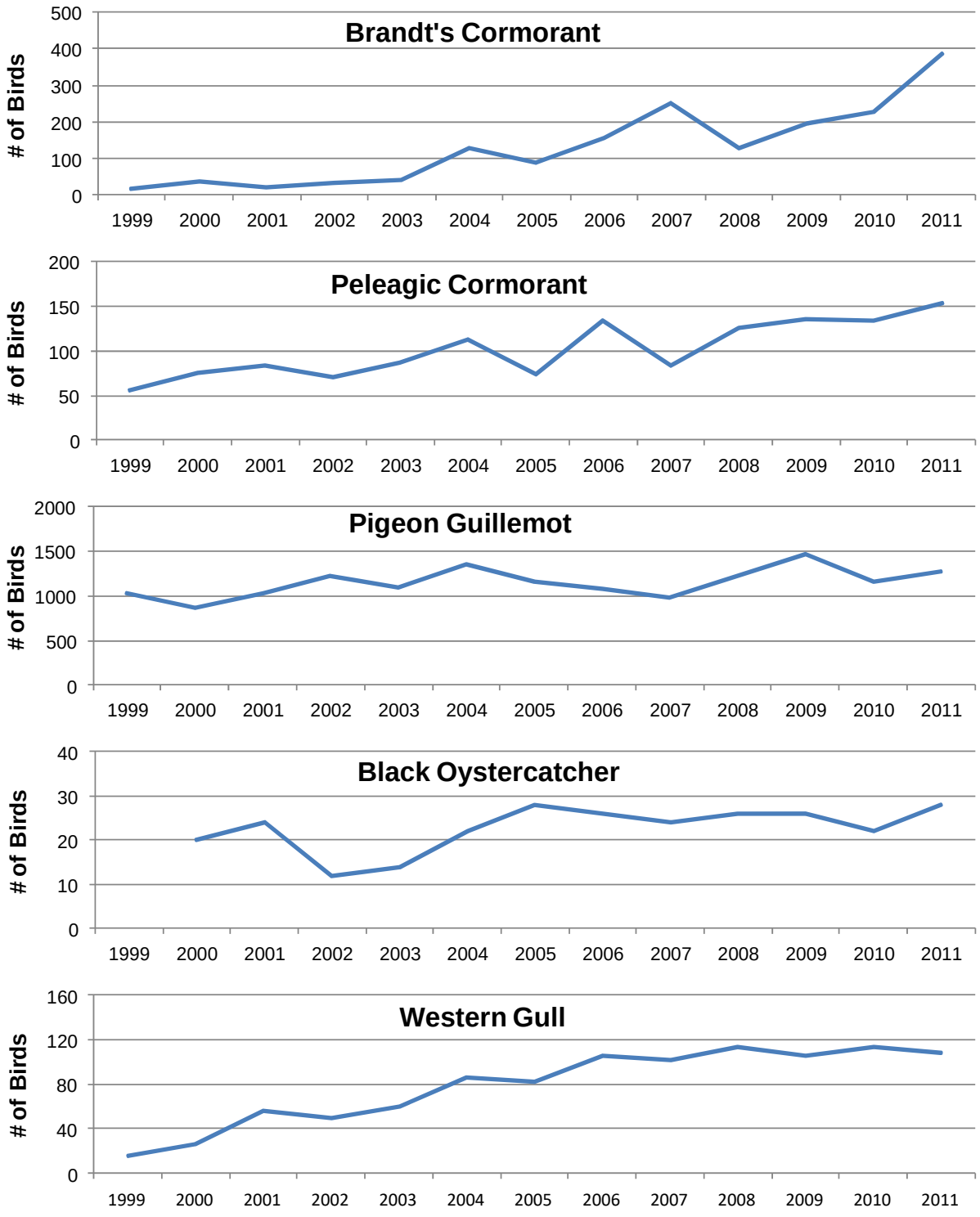

Figure 6. Changes in breeding population for five Seabird Protection Network focal species breeding at Vandenberg Air Force Base from 1999 to 2011. Graphs were created using data from Robinette and Howar (2011a).

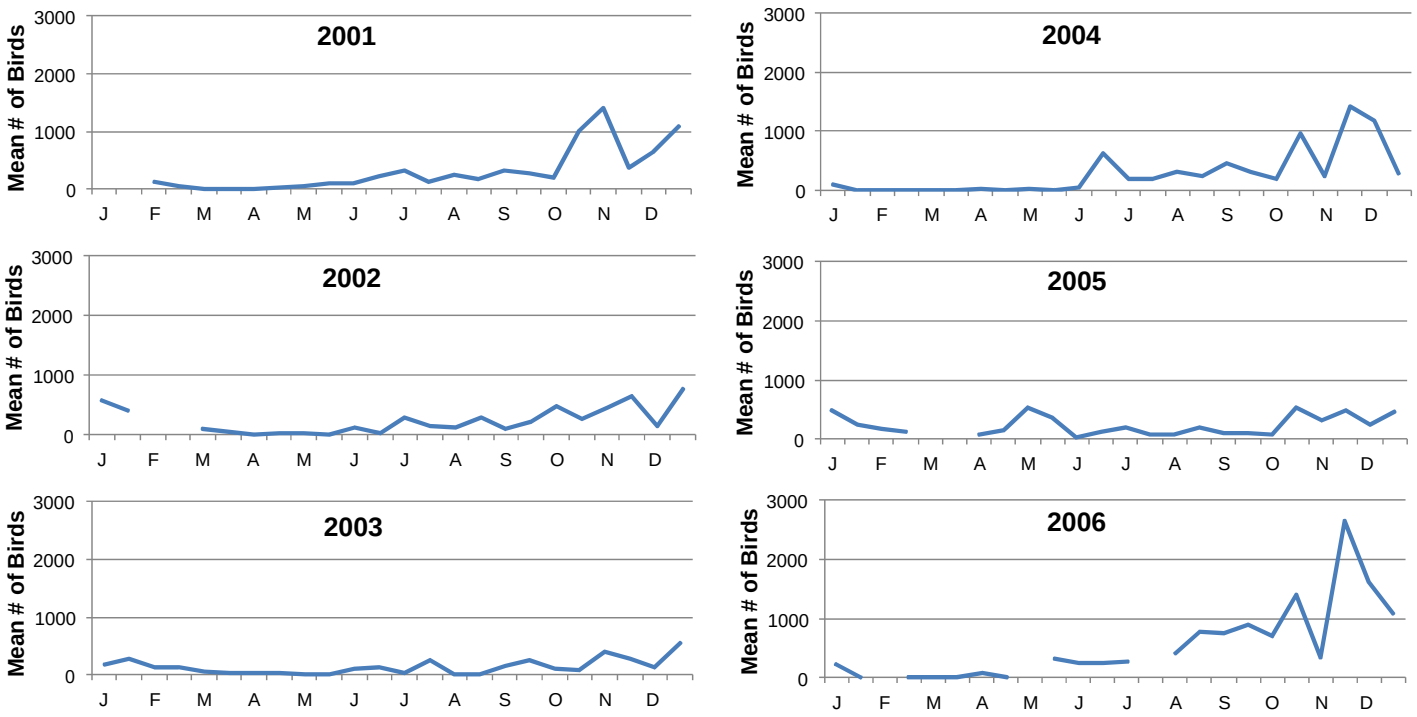

Figure 7. Seasonal trends in Brown Pelican roost utilization at Vandenberg Air Force Base from 2001 to 2006. Graphs were created using data from Collier et al. (2002), Robinette et al. (2003), Robinette and Collier (2004), Robinette and Lanser (2006a and b), and Howar and Robinette(2007).