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POPULATION SIZE AND REPRODUCTIVE PERFORMANCE OF SEABIRDS ON SOUTHEAST FARALLON ISLAND, 2013

REPORT TO THE U.S. FISH AND WILDLIFE SERVICE FARALLON NATIONAL WILDLIFE REFUGE

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EXECUTIVE SUMMARY

(1) Under cooperative agreement with USFWS/Farallon NWR, Point Blue (formerly PRBO) monitors the population size and reproductive success of seabirds on Southeast Farallon Island (SEFI), California and has done so since 1971. We also collect information on oceanic conditions (sea surface temperature) and prey use (diet composition).

(2) During 2013, breeding populations increased for all species except Black Oystercatcher when compared to 2012.

(3) Reproductive success was greater relative to 2012 for most species and generally high for all species. Cassin's Auklets were the only species to exhibit a decline in success, but still had extremely high productivity compared to the long term mean for the 4th straight year.

(4) Brandt's Cormorants and Western Gulls exhibited high reproductive success for the first time since 2007 after several years of near complete breeding failure. Pelagic Cormorants rebounded from a complete breeding failure in 2012 to achieve their greatest reproductive performance since 2004.

(5) California Gulls successfully fledged a small number of chicks for the first time since they began nesting on the Farallones in 2008. Common Raven and Peregrine Falcon attended the island in the early season but did not attempt breeding.

(6) Sea-surface temperature (SST) was generally cool throughout the spring and summer. The mean seasonal SST for 2013 (11.30°C), was the coldest since 2008 and approximately 0.65°C below the long term average.

(7) Juvenile rockfish (*Sebastes* spp.) were abundant in seabird diet throughout the season while anchovies remained virtually absent. Krill was abundant close to the island through July, but became less so in the late summer, as evidenced by Cassin's Auklet diet.

INTRODUCTION

This report contains information on the reproductive performance and population size of seabirds on Southeast Farallon Island (SEFI; Farallon National Wildlife Refuge) and West End Island (WEI), California, during 2013. We monitored twelve species: Ashy Storm-petrel (ASSP), Double-crested Cormorant (DCCO), Brandt's Cormorant (BRCO), Pelagic Cormorant (PECO), Western Gull (WEGU), California Gull (CAGU), Black Oystercatcher (BLOY), Common Murre (COMU), Pigeon Guillemot (PIGU), Tufted Puffin (TUPU), Rhinoceros Auklet (RHAU), and Cassin's Auklet (CAAU). In addition, small numbers of Leach's Storm-petrels (LHSP) breed on the island but are grouped with ASSP for monitoring. Peregrine Falcon and Common Raven have also bred on SEFI in recent years but did not attempt to do so in 2013. Canada Geese did breed for the fourth straight year but failed to fledge any chicks.

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METHODS AND RESULTS

Reproductive Performance

The reproductive performance of seabirds on SEFI is summarized in Table 1 and compared to previous years (Fig. 1a, b). All reproductive parameters reported in Table 1 are based on nests in which at least one egg was produced. Clutch size, brood size, hatching success, and fledging success were determined for first attempts only. Hatching success is calculated as the number of chicks hatched divided by the number of eggs laid. Fledging success is calculated as the number of chicks fledged divided by the number of chicks hatched, for clutches in which at least one egg hatched. Productivity (number of chicks fledged per pair) was determined for first attempts and for all attempts (including first attempts, relays, and second-broods). We compared productivity for all attempts to values from the past 42 years for each species. For a detailed description of the methods used to determine reproductive success and breeding population size see Sydeman et al. (1987, 2001). Due to inaccessibility of TUPU crevices and poor visibility of DCCO and CAGU nesting areas, detailed reproductive data were not collected for these species.

Brandt's Cormorant – BRCO experienced very high reproductive success during 2013. After suffering near complete reproductive failure during three of the last four years, 2013 was the highest reproductive output since 1994. Mean productivity for the colony was 2.43 fledglings per pair. This is almost 50 times greater than last season and 71% greater than the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 22 April at the Corm Blind and 30 April at the Sea Lion Cove colony. The mean laying date for the colony was 12 May, approximately 3 weeks earlier than last season. There were more than twice as many breeding birds at the colony under the Corm Blind during 2013 and of the 109 sites followed for productivity assessment; only 3.6% (4 nests) were abandoned, compared to 93% last season. In addition, there were 59 followed nests at the Sea Lion Cove colony, with zero abandonment, compared to 100% abandonment in 2012. Mean clutch size across both colonies was 3.30 eggs per nest and hatching success was 73%. Mean brood size was 2.50 chicks per nest, 94% of which survived to fledging age.

Pelagic Cormorant **–** PECO rebounded from a complete breeding failure during 2012 with the highest productivity since 2004. Mean productivity for the colony was 2.18 chicks fledged per breeding pair. Hatching success and fledging success are difficult to determine for this species due to the small number of nests where we can see the entire contents. However, for those we were able to observe, mean clutch size was 3.13 eggs per nest, and brood size was 2.49 chicks per nest. Eggs and/or chicks were observed in 44 of the 86 followed sites and there were an additional 2 sites that had birds in incubation posture for extended periods. These were likely breeding sites, but it was not possible to confirm the presence of eggs or chicks. Birds began attending sites and building nests in March, but the first eggs were not observed until 15 May. The first chicks were observed on 9 June. Only 3 nests were abandoned during 2013, compared to all followed nests in 2012.

Western Gull **–** WEGU productivity rebounded from four consecutive years of extremely low productivity with the highest reproductive success since 2007, resulting in an average of 1.08 chicks per pair. This is more than three times (218%) higher than the productivity observed during 2012 and slightly above the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 28 April. Sixty-eight percent of the eggs hatched and 53% of those chicks survived to fledge. Mean clutch size was 2.70 eggs per nest and mean brood size was 1.86 chicks per nest.

California Gull **–** CAGU were successful in fledging chicks for the first time since a colony was established on the Farallones in 2008. They nested in the previously established colonies at Sea Pigeon Point and above Mirounga Beach, as well as establishing a few individual nests in among breeding Western Gulls. We monitored productivity of this species by counting the number of birds, nests and young from the lighthouse every 5 days throughout the season. Based on these counts we were able to determine that the CAGU did lay eggs and hatch chicks. A high count of 8 mostly to fully feathered chicks was observed on 20 July. We assumed that these individuals were fledged. Despite these successes, overall productivity remains very low due to high rates of predation by the larger and more aggressive Western Gulls.

Black Oystercatcher **–** A total of 38 sites were monitored in 2013, of which 18 were considered active. An active site is defined as: (1) a territory occupied by a pair on at least two occasions during the season; (2) a territory in which a bird was seen in incubation posture; or (3) a territory where an egg or chick was observed. Eggs and/or chicks were documented at 9 of these sites (50%). A total of 9 chicks fledged, yielding an average estimate of 1.1 fledglings produced per pair. Both the number of breeding sites and the number of chicks produced were lower than in 2012. The first eggs were observed on 12 May. BLOY nests are cryptic and difficult to observe; therefore clutch size, hatching success and fledging success were not determined.

Common Murre **–** During 2013, 265 Common Murre sites were monitored daily in the Upper Shubrick Point (USP) study plot, of which 248 were breeding sites (where an egg was laid). Productivity was 0.82 chicks fledged per pair. This is approximately 5% higher than last season and 12% above the long-term average of 0.73 (Fig. 1a). The first egg was observed in this plot on 12 April, the earliest on record for murres at the Farallones. Overall mean laying date for the plot was 2 May; approximately 2 weeks earlier than the long-term mean laying date for this colony. Hatching success was 83% and 96% of the hatched chicks survived to fledge.

The colony of Common Murres in Upper Upper (UU), under the Cormorant Blind, normally breeds later than the colony at USP. The first eggs were observed on 28 April this season and the mean lay date for the plot was 8 May. There were a total of 136 sites monitored this season (up 7% from 2012); 96 of which were breeding sites. Reproductive success for this colony was higher than USP in 2013 with 0.85 chicks fledged per breeding pair. Eighty-nine percent of the eggs hatched and 96% of the chicks hatched surviving to fledge (see Table 1). There was a much lower incidence of egg loss and gull predation when compared to previous years.

Pigeon Guillemot **–** A total of 120 sites were monitored during 2013, of which 86 were observed with at least one egg (72% of the total number of sites). The majority of nest sites were located on Lighthouse Hill or at Garbage Gulch, but there were also two sites in the Habitat Sculpture, and three in Rhinoceros Auklet nest boxes by Russia House. Productivity was 1.02 fledglings produced per pair (Table 1). This was approximately 52% higher than 2012 and 24% above the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 2 May, and the mean egg laying date was 20 May. The mean clutch size was 1.90 eggs per nest with 78% of those eggs hatching successfully. Mean brood size was 1.50 chicks per nest with 71% of the chicks produced survived to fledging age. There were 16 sites which were able to fledge a complete brood of two chicks (up from only 2 sites in 2012).

Rhinoceros Auklet – There were a total of 154 sites (boxes, crevices, and cave sites) monitored in 2013, 44% (n=68) of which were occupied by a breeding pair. This includes three

Rhinoceros auklets which bred in Cassin's Auklet nest boxes. Forty-four percent of nest boxes were occupied compared to 63% of camera sites. There were also 15 boxes occupied by other species (12 CAAU and 3 PIGU). Productivity during 2013 was 0.65 fledglings per pair. This is approximately 48% higher than in 2012 and 16% above the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 11 April. Eighty-one percent of the eggs successfully hatched and 80% of those chicks produced survived to fledge.

Cassin's Auklet – Occupancy of breeding birds in study boxes was exceptionally high during 2013 with 88% of the boxes (423 of 478) occupied this season, including 43 of 44 PRBO study boxes (98%). This is slightly higher than in 2012 and the highest site occupancy in the last 10 years. Productivity of auklets breeding in PRBO study boxes continued to be very high for the fourth consecutive year with 1.14 chicks fledged per breeding pair (including relay attempts). While this was down 7% when compared to 2012, it remains 63% greater than the long-term average of 0.72 chicks per pair for this species (Fig. 1a). Ninety-three percent of the eggs hatched and 93% of those chicks produced survived to fledge. During 2013, 40% of birds in PRBO study boxes and 40% of all sites that successfully fledged a chick attempted a second brood. The first egg was observed on 7 March and the mean laying date for PRBO boxes was 1 April, approximately 3 weeks earlier than the long term average.

For the past several seasons, we have reported the productivity of all followed sites in addition to that of the PRBO study boxes. This was done because we believed that in years of low breeding propensity (such as 2005) the increased sample size enabled us to more accurately reflect the success of the whole island population. The same is probably true for years of very high productivity. If all followed sites where an egg was laid are included in the analysis for this season, productivity would still be 1.02 chicks per pair (n=173). This is approximately 10% lower than the estimate derived from PRBO boxes but equal to the "all sites" estimate for 2012, and still exceptionally high productivity for this species.

Ashy Storm-Petrel – ASSP pairs laid eggs in 38% of the 97 followed sites (n=37) in 2013, down 10% from last season. Two of these 37 sites were new breeding sites discovered in the Habitat Sculpture during 2013. The first eggs were observed on 4 May. Ninety-two percent of the eggs hatched and 79% of the chicks successfully fledged. Overall productivity for this species was 0.73 chicks fledged per pair (including all relay attempts). This is approximately 28% higher than last season and 10% above the long-term average productivity for this species (Fig. 1a).It is the highest productivity recorded for storm-petrels at the Farallones since 1993.

Other breeders – Over the past several seasons, Peregrine Falcons, Common Ravens and Canada Geese have bred on SEFI during the seabird season. However, during 2013, it appears that only the Canada Geese attempted to breed. Two pairs of Canada Geese nested on the Marine Terrace. Three pairs were present on the island in March and two nests were discovered. We are unsure if the third pair ever attempted to breed, but they may have had a nest on Sea Pigeon Point where we could not view it. The first nest was discovered on 31 March with 7 eggs and the second was discovered approximately 1 week later. By 16 May both nests were abandoned and it appears that no chicks hatched. All geese departed the island by late June. A pair of Peregrine Falcons was seen on SEFI throughout the winter and early spring and appeared to be exhibiting territorial behavior. However, by early May, there was only one falcon sporadically seen around the island and there were no signs of nesting behavior. Likewise, a pair of Common Ravens was observed at the island during the first half of February. By mid month, one had left and the second individual remained through early March. No ravens were observed after March 3rd and there was no evidence of nesting. Finally, a pair of Rock Wrens appears to have bred on Little Lighthouse Hill this spring. Although we never found the nest site, two individuals were regularly observed in the area foraging and carrying food items. Later in the spring, the number jumped to seven, likely including recently fledged chicks. All wrens had departed the island by the end of May.

Population Estimates

Population size and island-wide chick production was estimated for all species except ASSP and RHAU; breeding population size estimates (number of individuals) are presented in Table 2 and Fig. 7. All estimates include West End Island unless otherwise stated.

Ashy and Leach's Storm-petrels – We continued our long-term mark/recapture study to estimate ASSP population trends. We operated two netting locations (Lighthouse Hill and Carp Shop) for a total of 7 evenings between April and August. As a result, we banded a total of 467 Ashy storm-petrels and recaptured 44 that had been banded in previous years. In addition, there were 21 birds banded this season that were recaptured later in the season. Catch per hour of netting effort was 26.29 birds per hour (see Figure 10). This is up approximately 2% from 2012, but still approximately 10% below the mean capture rate for the last 10 years. Our largest single night was 4 June on which 166 birds were caught at the Lighthouse Hill site. There were also 8 Leach's storm-petrels and 1 Fork-tailed storm-petrel banded this season.

Double-crested Cormorant – The DCCO colony is located on Maintop on West End Island. Counts of this colony were conducted every five days from atop Lighthouse Hill on SEFI using a spotting scope. A total of 15 counts were made in 2013, beginning on 26 April and ending on 25 July, when juveniles became indistinguishable from adults. On 12 May we counted a peak number of 182 "well-built" nests with birds in incubating posture. To estimate the minimum population size we multiplied the number of well-built nests by two, which yields a total of 364 breeding birds. This estimate is approximately 65% greater than in 2012 and 16% above the 10-year average population for this species (Table 2). There was a high count of 140 chicks observed during the 30 June census.

Brandt's Cormorant – The BRCO breeding population was censused during ground-based surveys on 4 June and a boat survey on 5 June. While most of the population initiated breeding in early May, approximately 150 new Brandt's nests were established in late June at Great Murre Cave and Sea Pigeon Gulch and censused on July 1st. These nests were added to the total from the earlier census. A grand total of 3,706 "well-built" nests were counted (Fig. 2) during the surveys. We then multiplied the number of nests by 2 to yield an overall population estimate of 7,412 breeding birds (Table 2). This estimate is 115% greater than 2012 but still approximately 23% below the 10-year average (Table 2). We multiplied the total number of nests by the mean productivity to estimate an island-wide production of approximately 9,000 fledglings, up substantially from the approximately 86 fledglings produced in 2012.

Pelagic Cormorant – The PECO breeding population was censused during a ground-based survey on 4 June and a boat-based survey on 5 June. We counted a total of 186 fair to well-built nests (Fig. 3) during the survey. We then multiplied this number by 2 to yield an overall breeding population of 372 birds (Table 2). This estimate for Pelagic Cormorants is approximately 25% higher than 2011 and 38% higher than the 10-year average. We multiplied the total number of nests by the mean productivity to estimate an island-wide production of approximately 400 fledglings.

Western Gull – The WEGU census was conducted on 3 June. To facilitate counting, the island was sub-divided into plots that were counted individually. Breeders and non-breeding (roosting) birds were counted separately. Counts of roosting birds were not included in the population estimate. The total number of birds counted was 16,062 (Fig. 4). Because not all breeding birds were present at the time of the census, we calculated a correction factor to convert counts of individuals into breeding pairs. The correction factor was derived by multiplying the number of nests in the three study plots (C, H, and K) by 2, then dividing the product by the number of adults present in the plots during the census. We then multiplied the average correction factor (1.317) of these three plots by the total number of adults counted, to arrive at our population estimate (Appendix I). Therefore, we estimated a breeding population of 21,148 birds (Table 2). We then multiplied the population estimate by the mean annual reproductive success to estimate an overall production of 11,420 fledglings on SEFI in 2013. The population estimate for WEGU is approximately 33% higher than in 2012 and 23% greater than the 10-year average (Table 2).

California Gull – CAGU were censused every five days throughout the season beginning on 9 April. A peak count of 261 “well-built” nests was counted on 22 May resulting in a breeding population estimate of 522 birds. This estimate is approximately 640% higher than the estimate for last season and 86% higher than the 5 year mean for this population. It is worth noting that, unlike previous years, both the Mirounga Beach and Sea Pigeon Point colonies had their maximum counts on the same census. The peak count for total birds was 849 on 16 May, up from a peak count of 177 in 2012. The total count included many immature birds which were present in the colony but not breeding and hence not factored into calculating the breeding population estimate.

Black Oystercatcher - We estimated the population of BLOY by surveying all known breeding sites visible from Lighthouse Hill and the marine terrace. Of the 38 sites that were monitored this year, 18 were considered active sites. Therefore, we estimated a breeding population of 36 birds, a decline of 10% relative to 2012 and equal to the 10-year average population. We estimated an island wide production of 9 chicks fledged. This estimate does not reflect birds on parts of West End Island not visible from the SEFI vantage points.

Common Murre – The COMU breeding population has grown to the point where counting individual birds has become impossible and we will no longer attempt to census the entire colony. USFWS will continue to conduct annual aerial photographic surveys and count the number of birds present in the photos when money for analysis becomes available. Point Blue will continue to track population trends using data from our Index Plot counts. There are 23 Index Plots set up around SEFI and WEI which are counted in early June during the peak incubation period. Each plot is counted three times each day for 10 consecutive days. Trends are determined by comparing the overall seasonal mean plot counts to the counts from the previous year to develop an index of population change. During 2013, we recorded the highest mean counts in the time series with values approximately 13% higher than in 2012 and 25% higher than in 2006, the last year a full island census was conducted (Figure 11). Although we no longer produce a population estimate, we can make a rough projection based on the relative change in our Index Plots between the current year and the last full census. These projected numbers are not reported, but are plotted on Figure 7 to illustrate the overall population trend.

As in previous years, a correction factor was calculated using data from the USP, UU, and X study plots to account for breeding adults not present during the census (see Nur and Sydeman 2002). The correction factor generated for 2013 was derived by multiplying the number of breeding sites in each plot by 2, and then dividing the product by the mean number of adults present on the survey dates (Appendix II), yielding a correction factor of 1.47. This method assumes that the extra birds observed in the plots are the mates of breeding individuals and not simply wanderers or non-breeders. This correction factor may be used to convert the number of birds counted during USFWS aerial surveys into an estimate of breeding pairs.

Pigeon Guillemot – Our estimate of the breeding population of PIGU is derived by counting adults rafting on the water around SEFI at dawn (0700-0830) throughout the month of April, before the birds begin regular attendance of sites. Our peak count during these morning surveys was 3,880 birds on 18 April. This count was approximately 6% higher than the peak count from 2012 and 40% greater than the 10 year mean for morning surveys (Table 2 and Fig. 7).

Tufted Puffin – The island-wide TUPU survey was conducted primarily in two parts; a one-week period from 30 May to 10 June and a second survey from 29 July to 11 August. The criteria for determining if a site was occupied by a breeding pair were as follows: (1) two or more sightings of a bird entering the site or two birds seen at the site on multiple occasions, (2) one or more sightings of a bird entering the site with nesting material early in the season, or (3) one or more sightings or a bird entering a site with fish late in the season. Note that survey methodologies were changed after the 2007 season to include a more comprehensive late season survey. See the 2008 report for details.

During the 2013 surveys, a total of 143 active sites were observed, 37 of which were confirmed to have chicks based on observations of birds delivering fish to the site. Based on these observations, we estimated a breeding population of 286 birds (Table 2). This is approximately 17% greater than 2012 and 77% greater than the 10 year average population for this species (Fig. 7).

Rhinoceros Auklet – An island-wide estimate of breeding population size for RHAU is difficult to obtain because they nest underground and are crepuscular (active only at dawn or dusk). Netting for mark/recapture and diet sampling was continued in 2013. A total of 78 new birds were banded and 67 were recaptured (19 birds were captured multiple times during the season). There were greater numbers of new birds banded this season but fewer individuals recaptured when compared to last season.

Cassin's Auklet – Similar to the RHAU, CAAU is another burrow/crevice-nesting nocturnal seabird that is difficult to census. In 1991 we established twelve 10 x 10m index plots to monitor burrow density (Table 3). A complete census of nest sites on SEFI was conducted in 1989, at which time a breeding population of 29,880 birds was estimated (Carter et al. 1992). To estimate the breeding population in prior years, we applied the percent difference between the 1991 and current year counts in the index plots to the 1989 estimate. This calculation assumed that burrow counts in our index plots did not differ substantially between 1989 and 1991. Although index plot counts from 1989 are not available to test this assumption, this method provided our best estimate of population size and was employed until 2009. In September of 2009, we conducted a new all island burrow count, replicating the methods used by Carter et al. (1992). This method resulted in an estimate of only 14,512 Cassin's Auklets on SEFI and 17,640 including West End and the Islets. During 2012, we counted a total of 350 burrows/crevices in the index plots, up approximately 15% from 2012. Therefore, using the same methodology, but with the updated whole island estimate generated in 2009, we estimated a 2013 breeding population of roughly 22,577 birds ([350/225] x 14512) on Southeast Farallon Island. Total island-wide production (number of breeding pairs x mean productivity) was estimated at 12,870 fledglings on SEFI. The breeding population estimate is 15% greater than in 2012 and approximately 23% greater than the 10-year average (Table 2). However, caution should be used in comparing the 2013 value to the 10-year average since a different baseline was used in previous seasons.

DISCUSSION

Weather and Ocean Conditions:

Oceanic conditions during 2013 were generally cool and productive. The mean seasonal SST from March to August (11.30°C) was approximately equal to 2012 and 0.64°C cooler than the long-term mean for these months. Likewise, monthly values were close to or below the mean for five of the six months (Fig. 6a, b), being slightly warmer only during the month of August. Generally, cool SSTs are correlated with greater ocean productivity in the California Current System resulting from stronger upwelling along the coast (Barber et al. 1985). Strong northwest winds throughout the spring coupled with the cooler water resulted in generally high ocean productivity and a fair to good year for many of the seabirds.

Juvenile rockfish were abundant in chick diet throughout the chick rearing period (Fig. 8). Overall, rockfish comprised 85% of the diet for Common Murres and 59% for Pigeon Guillemots and 66% for Rhinoceros Auklet diet. The majority of the juvenile rockfish encountered were Shortbelly Rockfish (*Sebastes jordanii*). The Shortbelly Rockfish were the main species encountered in seabird diet during the 70's and 80's but have generally been less dominant in recent years when a more varied species assemblage (including Yellowtail, Widow, Blue and Black Rockfish) has been more common.

Rockfish are an important component of seabird diet at the Farallones and a high proportion of rockfish in the diet typically correlates with high productivity. The generally high abundance of juvenile rockfish in the diet for murres and guillemots likely contributed to their breeding success this season. In addition, feeding rates were higher this year for all species studied and the total number of feedings observed during murre diet watches was approximately 76% greater than last season. This suggests that it was easy for foraging adults to locate prey and they were able to make shorter foraging trips when provisioning dependent offspring.

Anchovies were the most important component of chick feedings for murres and auklets between 2002 and 2008 and were also a major component of Brandt's cormorant diet during years of high reproductive success (Fig. 12). This important prey has all but disappeared from the diet of Farallon seabirds since 2009. During 2013, anchovies accounted for only 2% of the diet for Common Murres and 0.5% in the Rhinoceros Auklet diet (Fig. 8). Sculpins, lingcod, saury, smelt, octopus and squid were other important components of the diet this season. Cormorant pellets were collected from breeding colonies in August but have not yet been analyzed. Figure 12 depicts the recent trends in Brandt's Cormorant diet. Based on the high reproductive performance, we would expect to see some change in the diet, perhaps with more rockfish and less reliance on flatfishes and sculpins than in previous poor years.

The National Marine Fisheries Service conducts mid-water trawls during May of each year to assess the abundance and distribution of important forage fishes, including juvenile rockfish, anchovy and squid. The NMFS surveys during 2013 indicated the highest abundance of young of the year rockfish in the history of the survey with shortbelly rockfish being the dominant species. In addition, there continues to be a high abundance of squid and very few anchovy or sardines encountered during the surveys (Sakuma et al. 2012). These results are very similar to what we observed in the seabird diet.

Productivity:

The 2013 seabird breeding season was a very productive year for all species (Fig. 1a, b). Brandt's Cormorants, Pelagic Cormorants and Cassin's Auklets exhibited exceptionally high breeding success during 2013. Common Murres, Rhinoceros Auklets and Pigeon Guillemots also had productive years with higher productivity than last season and also above the long-term mean. Western Gulls rebounded from four straight years of very poor breeding success and fledged chicks at a rate equivalent to the long-term mean. Black Oystercatchers had slightly lower average reproductive success in 2013, there were fewer breeding sites and the overall number of chicks produced was lower than last season. We have included the 80% confidence limits (dashed horizontal lines) on the long-term productivity graphs (Fig. 1a) to help illustrate the signals in the annual mean productivity and to highlight the extreme years (i.e. those years that fall into the upper or lower 10% of the distribution). Note that strong El Niño years (1983, 1992, and 1998) fall below this range for most species. During 2013, Cassin's Auklets productivity was above the upper 80% confidence interval, indicating exceptionally high reproductive performance. Likewise, Brandt's Cormorant and Pelagic Cormorant also exceeded the upper confidence interval, indicating especially high productivity for these species. No species were below the lower confidence interval for average productivity this season (Fig. 1a).

Cassin's Auklets exhibited high productivity again this season and the 1.14 chicks fledged per breeding pair is within the top five years since studies began in 1972. This marks the fourth consecutive year of exceptional reproductive performance for Cassin's Auklets. Auklet success was once again driven by abundant prey resources (primarily euphausiids) and a high rate of successful double brooding. Cassin's Auklets are the only alcid capable of successfully fledging multiple broods in the same season, and they only do this in the southern portion of their range (Ainley et al. 2011). Although the overall rate of double brooding was greater than the 29% observed during 2012, the proportion of those second broods that were successful was lower. Fifty-seven percent of those sites that attempted a second brood successfully fledged a second chick. This decrease in the proportion of successful second broods resulted in the small decline in productivity observed in 2013, relative to last season. First brood success rates continued to be high.

Reproductive success of COMU was also higher than 2012 as well as being above the long-term mean for this species. Murres seemed to thrive once again on a high abundance of juvenile rockfish in the chick diet. In contrast to most seasons, the USP study plot did not have the highest productivity of the four study plots followed on the island. The Upper Upper plot had slightly higher success in 2013 (see Table 1). This may be due in part to a reduction in egg and chick loss from Western Gull predation. With gulls able to find alternative prey resources, there was a proportionally smaller impact on murres.

Rhinoceros Auklets and Pigeon Guillemots also exhibited increased breeding success. Overall productivity for these species was above the long-term mean, but within the normal range of interannual variation. The increased success was likely due to the greater abundance of juvenile rockfish available for chick diet. Guillemots in particular seemed to thrive with more sites able to fledge two chicks than in previous years.

Brandt's Cormorants achieved high reproductive success in 2013 with greater than two chicks fledged per breeding pair. This is the highest breeding success since 1999 and the first since 2007 to exceed the long-term mean (Fig. 1a). In contrast to the previous five seasons, hatching success and fledging success were high and there was a low rate of nest abandonment. Reasons for this abrupt turnaround are as yet unclear. Although cormorant diet samples have not yet been analyzed for this season, anchovies and other large forage fishes continued to be scarce in the diet of murres and auklets. Juvenile rockfish, particularly Shortbelly Rockfish, were abundant this year and may have provided a suitable substitute. After suffering complete breeding failure in 2012, Pelagic Cormorants also rebounded this season with their highest breeding success since 2004. Like the Brandt's Cormorants, fledging success was high and there was a low rate of abandonment. Pelagic Cormorants are more reliant on rockfishes and other nearshore species and likely benefited from the overall abundance of these prey items this season.

Cormorants breeding at other central California colonies also exhibited higher than average breeding success and increased breeding effort during 2013 when compared to the long-term means for those sites (USFWS unpublished; A. Fuller pers. comm.). Productivity was also greater than in 2012 and the highest observed in at least 5 years. Colonies along the south central coast also exhibited high success this season. Point Blue monitoring sites at Vandenberg Air Force Base had the highest breeding populations since monitoring began in 1999 and productivity was both above the long term average and the highest in 9 years (Robinette et al. 2013; J. Howar pers. comm).

Western Gulls had their most productive season since 2007. After four consecutive years of extremely poor breeding success, 2013 seemed like a banner year, though overall productivity was roughly equal to the long-term mean for this species (Fig. 1). There was an overall increase in breeding effort by established pairs and a large influx of first time breeders in all study plots. Intraspecific predation continued to be the single greatest cause of mortality, but the need to prey on chicks appeared to be mitigated by a greater availability of other prey resources such as juvenile rockfish and squid. Over the past few seasons, rockfish has been abundant in the diet of other species, but may not have been available to surface feeders like the Western Gulls.

Populations:

Breeding population sizes were higher than the 2012 estimates for all species except Black Oystercatcher. Population increases ranged from approximately 6% for PIGU to 645% for CAGU when compared to last season, while BLOY were down 10%.

Pigeon Guillemot population estimates reported in this document do not necessarily represent breeding birds because the census method does not distinguish between breeders and non-breeders. The raft counts used to estimate the Pigeon Guillemots most likely reflect the total population attending the colony during the pre-breeding period, but may not represent the proportion of the population that breeds. During 2013, Guillemot numbers increased by approximately 6% to an all time high estimate of 3,880 individuals, continuing the positive growth trend observed in this population since 2002. Occupancy of monitored PIGU crevices was approximately 72% during 2013, up approximately 10% from last season. This suggests that, in addition to more birds present at the island, there was also a greater breeding effort this season.

Historically, the Common Murre population on the Farallones was estimated to be between 400,000 and 1 million birds, but egg collecting, oiling, gill net entanglement and human disturbance drastically reduced these numbers. (Ainley and Lewis, 1974, Sydeman *et al.*1997). Murre populations were beginning to recover in the late 1970's and early 1980's (Figure 7), but were then decimated by a series of oil spills and high adult mortality in gill net fisheries. Favorable oceanographic conditions and abundant prey, relatively strong reproductive success, and elevated juvenile survival, coupled with likely immigration from northern murre colonies, led to rapid population growth over the last decade. While we no longer census the entire island, we have continued to track murre population trends using our index plots. Index plot counts indicated a 13% increase in murre numbers this year when compared to 2012 and a 25% increase relative to the last full island census in 2006. In addition, there were a greater number of breeding sites in all followed plots this season with increases ranging from 7% in Upper Upper to 13% on Tower Point. This apparent increase is likely driven by an influx of new breeders taking advantage of favorable prey resources this season. It should be noted that although we believe that overall index plot trend reflects the population trend for the island, much of the change may be driven by differences in only a few of the index plots, particularly on WEI and by the Cormorant Blind. Other plots have remained stable or changed in opposition to the overall trend. The relative ability to detect changes in murre numbers is related to the level of saturation in a plot. Plots that are already very dense would not have the power to detect population growth because there is simply no room for more birds to breed in these areas. Conversely plots that are sparse have plenty of area for more birds to colonize but would not necessarily detect declines. Therefore, we believe that by combining the data from all of the plots we get a representative sample for the colony as a whole.

Farallon Cassin's Auklets declined considerably since the early 1970's (Fig. 7), and remain at less than one-third of the population estimate made in 1972. Unfortunately, no information is available on population numbers between 1972 and 1989. This population suffered substantial mortality during the strong 1997/1998 El Niño event and reached its lowest abundance (10,458 birds) in 1998. Between 2001 and 2004, the population was increasing rapidly. However, the breeding population declined again during 2005 and 2006, coinciding with reduced breeding effort and lower reproductive success before slowly rebounding. The burrow counts for 2013 were 15% higher than in 2012 and the highest since 2004 (Table 3). The greatest changes in burrow counts were in areas with deep soil on the marine terrace where fewer burrows were excavated last season. Data from Known-age nest sites suggest that the apparent population growth observed over the last few seasons is due to an influx of young breeders. During 2013, more than 60% of our followed sites were occupied by birds between 2 and 5 years of age, including many birds from the 2010 and 2011 cohorts which were breeding for the first time in 2013. This is the third consecutive year of increasing population, coinciding with greater reproductive success and higher ocean productivity. The recent growth trend contradicts the longer term declines in burrow density in our index plots indicating an overall population decline of 2.4% per year since 1991 (Fig. 9; Point Blue unpublished data). It is worth noting though there have been varying periods of growth and decline throughout this period and it is too early to tell if this population is truly increasing or if this is contrary to the long-term trend.

Tufted Puffins are surveyed during two surveys, one week long survey in May during the pre-breeding and early egg laying period and a second two week survey during August when puffins are feeding chicks. Population estimates are based on the overall number of active sites observed during these surveys. The Farallon population was exhibiting an increasing trend during the early part of the decade, but declined substantially following the 2004 season. Since 2008, we have seen rapid growth and 2013 set a new high for the number of active nest sites observed for this species on the Farallones.

Approximately 50% of the world population of Ashy Storm-petrels breeds on the Farallones, but little is known about their true population status. Sydeman et al. (1998) reported a 35% decline in their population between 1972 and 1992 while analysis of catch per unit effort during netting suggested stable or increasing numbers during the last decade. The mean standardized capture rate (number of birds caught per hour of effort) increased from approximately 13 birds/hour (s.d. = 8.85, n = 9) to 40 birds/hour (s.d. = 7.66, n = 4) between 1999 and 2007 but then declined for the next three years. The number of birds captured per hour of netting effort during 2013 was approximately equal to 2012 with 26 birds/hour (s.e. = 7.5, n= 7; see Fig. 10). Evaluating catch per unit effort is useful for determining a coarse trend but does not consider the proportion of birds caught that are non breeders, or potential changes in recapture probabilities through time and as such cannot be used to estimate the true population. However, knowing if a population is increasing, decreasing or stable is still extremely important for management. Recent analysis of CPUE data has been used to generate a new population index for storm-petrels at the Farallones (Nur et al. 2013). This index shows a population decline from 1992 to 2001, followed by large increases in storm-petrel captures between 2001 and 2007, and a declining trend from 2007 to the present. The nature of the increase in capture rates from 2001 to 2007 is unclear, but corresponded with other seabird species which demonstrated strong population growth during consistent productive ocean conditions in the early 2000's (Warzybok and Bradley 2010). The reversal of this rapid growth starting in 2007, resulting in decline, is associated with observations of high Burrowing Owl abundance and high predation on storm-petrels in the most recent years, suggesting further evidence of the impacts of increased Burrowing Owl abundance and predation on storm-petrels. Using a population-dynamic model based on population trends in recent years, with no reduction in Burrowing Owl abundance (assuming recent conditions continue into the future), the the Farallon ashy storm-petrel population is expected to decline (by 3.36-7.19% per year) or remain nearly stable under the most positive interpretations of the data, without the possibility of substantial population growth (Nur et al. 2013).

Brandt's Cormorant and Pelagic Cormorant populations declined substantially since the early part of the 1980’s (Nur and Sydeman 1999, Fig. 7) but began to recover since the early 2000’s. The BRCO breeding population expanded rapidly from 1999 to 2007, but crashed following the 2007 season. It is likely that some of the apparent decline was a result of birds either skipping breeding due to unfavorable conditions or moving to a different colony. However, the continued low breeding population, despite a return to more favorable ocean conditions during the last few years, indicates that there was likely significant adult mortality during this period. In contrast to this recent decline, the 2013 breeding population was more than double the number of breeding birds observed in 2012. While it remains less than 40% of the population observed before the crash, it is a step towards recovery. The increase observed this season was likely driven by an influx of first time breeders, including many that bred on parts of the island not formerly occupied by this species. The Pelagic Cormorant breeding population peaked in 2004. However, the population crashed following that season and has been slow to recover. Breeding populations were extremely low through 2007 but have been slowly increasing over the past six years. During 2013, the population was slightly higher than last season, but still much reduced compared to pre-2005 populations.

In summary, 2013 was a very good year for Farallon seabirds with higher breeding populations and increased productivity for most species. Cassin’s Auklets were again able to take advantage of high zooplankton production and fledge many chicks. Likewise, murres, guillemots, auklets, gulls and cormorants were able to capitalize on a high abundance of rockfish throughout the early season to achieve greater breeding success. Anchovies and other forage fishes continue to be largely absent from seabird diet, but it would appear that the birds were able to compensate this season with other prey items. The high productivity of cormorants and gulls in 2013 is encouraging after several years of very poor productivity, but we remain concerned about the long term outlook for these species in the face of changing ocean climate and increasing unpredictability of prey resources.

RESEARCH AND MANAGEMENT RECOMMENDATIONS

In addition to the continuation of research efforts, we recommend the following actions (listed in order of priority) for enhancing the protection, conservation and management of seabirds on SEFI:

1. With the recent petition to get the Ashy Storm-petrel listed under the Endangered Species Act and a need to quantify the current and future population trends of this species, it is more important than ever to increase our understanding of ASSP population dynamics. Analysis of the complex dynamics of the relationship between House Mice, Burrowing Owls and Ashy Storm-Petrels was completed during 2013 and the results are available in Nur et al. (2013). The introduction of novel techniques to aid in our understanding of ASSP populations (such as nest motes, pit tags and radar) should also be strongly considered.

2. To further our understanding of the foraging ecology of SEFI seabirds, we recommend continuation of novel monitoring techniques including deployment of time-depth recorders and GPS tags (or similar devices on select species) and, measurements of physiological state (e.g. body condition, possibly endocrine analysis). Novel monitoring tools will greatly enhance our ability to understand Farallon population trends (e.g. how food is affecting Cassin's auklets and Brandt's cormorants) in support of management decisions. Novel technology will also allow us to examine marine habitat use and foraging behavior, which is critical to the evaluation of current and potential new marine protected areas around the Farallon NWR.

3. Relatively little is known about the activities of Farallon seabirds during the non-breeding season. We recommend the development of new research initiatives to examine the diet, energy expenditure, behavior, habitat use and environmental interactions of seabirds during the portion of their annual cycle when they are away from the colony in order to develop a more complete understanding of the factors influencing the Farallon populations.

4. Tufted Puffins are difficult to monitor and little is known about their reproductive success on the Farallones. We propose assessment and modification of our research methods, including the potential use of nest boxes to allow limited monitoring of the breeding parameters for this species.

5. Anomalous weather, light winds and high air temperatures in recent years has resulted in heat stress for Cassin's Auklets breeding in artificial nest boxes. To mitigate this, we have installed additional shade structures on all of the occupied nest boxes. We also initiated a study to examine differences in microclimate among shaded nest boxes, unshaded nest boxes, and natural burrows (see Appendix III in the 2010 Farallon Island Seabird Report for more details on this study). Funding for the development of further mitigation measures has recently been awarded as part of the Cosco Busan Oil Spill restoration plan. Once the restoration plan is finalized and the funds are released, we will begin the process of evaluating new box designs and mitigation measures that will allow us to create artificial habitat that both facilitates research and is adaptable to a changing climate.

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Table 1. Mean (± 1 SD) productivity of eight species of seabirds at Southeast Farallon Island, California, 2013. Sample sizes in parentheses. All values based on first attempts only unless stated otherwise.

Species	Clutch Size (no. eggs laid)	Brood Size (no. chicks hatched)	Chicks Fledged/Pair	Chicks Fledged/Pair (includes relays)	Hatching Success	Fledging Success
BRCO	3.30 ± 0.77 *(152)*	2.50 ± 1.17 *(141)*	2.30 ± 1.08 *(168)*	2.43 ± 0.95 *(168)*	0.73 ± 0.34 *(131)*	0.94 ± 0.16 *(123)*
PECO	3.13 ± 0.92 *(15)***	2.49 ± 1.08 *(43)***	2.18 ± 1.21 *(45)*	2.18 ± 1.21 *(45)*	0.44 ± 0.52 *(4)*	0.95 ± 0.11 *(21)*
WEGU	2.70 ± 0.54 *(243)*	1.86 ± 1.05 *(246)*	1.08 ± 1.08 *(246)*	1.08 ± 1.08 *(246)*	0.68 ± 0.36 *(242)*	0.53 ± 0.42 *(209)*
COMU* USP	1.00 (248)	0.83 ± 0.37 (248)	0.80 ± 0.40 (247)	0.82 ± 0.39 (247)	0.83 ± 0.37 (248)	0.96 ± 0.19 (206)
COMU* UU	1.00 (96)	0.89 ± 0.32 (96)	0.85 ± 0.36 (96)	0.85 ± 0.36 (96)	0.89 ± 0.32 (96)	0.96 ± 0.19 (85)
PIGU	1.90 ± 0.31 *(86)*	1.50 ± 0.68 *(86)*	1.01 ± 0.61 *(83)*	1.02 ± 0.60 *(83)*	0.78 ± 0.34 *(86)*	0.71 ± 0.32 *(74)*
RHAU*	1.00 *(68)*	0.81 ± 0.40 *(68)*	0.65 ± 0.48 *(68)*	0.65 ± 0.48 *(68)*	0.81 ± 0.40 *(68)*	0.80 ± 0.40 *(55)*
CAAU*	1.00 *(43)*	0.93 ± 0.26 *(43)*	0.86 ± 0.35 *(43)*	1.14 ± 0.56 *(43)*	0.93 ± 0.26 *(43)*	0.93 ± 0.27 *(40)*
ASSP*	1.00 *(37)*	0.92 ± 0.28 *(37)*	0.73 ± 0.45 *(37)*	0.73 ± 0.45 *(37)*	0.92 ± 0.28 *(37)*	0.79 ± 0.41 *(34)*

* COMU, RHAU, CAAU and ASSP lay only one egg per clutch
** PECO sites are difficult to see into. Numbers are based on the maximum number of eggs or chicks observed
Note: CAAU productivity presented here is based on the PRBO study boxes only, so that it can be compared to previous years.

Table 2. Breeding population size estimates of seabird species on the South Farallon Islands, 2003-2013. Estimates include Southeast and West End Islands unless otherwise noted.

Species	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2003-2012 average
DCCO	364	220	360	260	194	206	444	474	130	458	392	314
BRCO	7,412	3,450[b]	4,916	5,132	1,248	4,840	20,788	15,692	11,732	16,754	11,222	9,577
PECO	372	298[b]	206	320	268	250	64	40	28	706	510	269
WEGU	21,148	15,846	17,406	18,218	15,747	20,152	15,852	17,399	16,547	17,969	16,838	17,197
CAGU	522	70	208	396	192	534	-	-	-	-	-	280
BLOY	36	40	48	38	38	40	42	36	30	26	26	36
COMU	[e]	[e]	[e]	271,787[e]	242,759[e]	248,321[e]	250,032[e]	211,355	183,092	169,079	107,105	198,680
PIGU [d]	3,880	3,645	3,461	3,317	2,851	2,875	2,774	2,607	1,375	2,530	2,383	2,782
TUPU [c]	286	244	246	234	216	106	59	108	82	166	?	162
CAAU [a]	22,577	19,609	17,866	12,964	14,512	16,121	19,540	13,597	16,202	29,229	23,692	18,333

[a] Estimate for Southeast Farallon Island only. Estimate from 2009 to present based on 2009 whole island burrow/crevice count. Prior to 2009 all estimates were based on 1989 survey (see text)

[b] No boat census conducted. Total estimate generated using correction factor for areas not surveyed.

[c] TUPU population estimates were recalculated in 2008 to correct for unequal survey effort in prior seasons (see text)

[d] Estimates derived from morning raft counts. Evening counts used prior to 2002 and are considerably lower (see text).

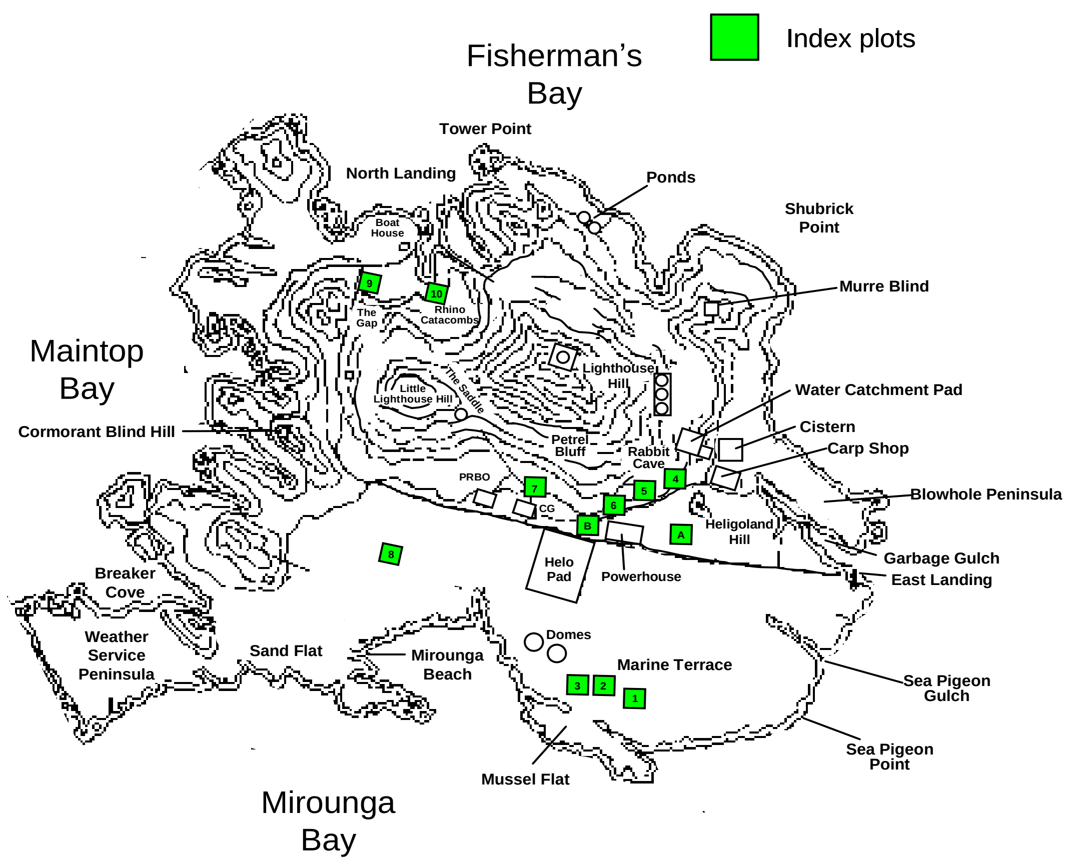
[e] No complete census done. See percent change in Index Plot counts for trends (Figure 11 and text).

Table 3. Cassin's Auklet burrow counts from 12 (10m x 10m) index plots on Southeast Farallon Island for 2013. The previous 10 seasons as well as the initial plot counts from 1991 are shown for comparison.

Year	MT1	MT2	MT3	S4	S5	S6	S7	MT8	R9	N10	EA	EB	Total
1991	18	9	12	43	42	22	31	20	80	49	14	27	367
2003	20	9	22	15	26	7	15	15	84	49	8	21	291
2004	36	25	37	21	28	10	20	18	95	34	9	26	359
2005	15	10	23	11	14	5	9	11	65	20	5	11	199
2006	14	5	25	10	11	6	3	8	58	21	3	3	167
2007	26	13	23	18	14	6	17	10	73	22	5	13	240
2008	17	13	20	20	15	8	14	2	53	20	2	14	198
2009	13	11	27	11	5	5	8	8	81	41	2	13	225
2010	14	9	16	10	9	3	11	9	73	29	0	18	201
2011	17	14	27	12	9	4	17	9	90	54	1	23	277
2012	31	25	33	15	11	4	14	-	91	48	6	26	304
2013	31	31	26	17	15	4	16	11	98	60	7	34	350
2003-2012 average	20	13	25	14	14	6	13	10	76	34	4	17	246

Note: Plot MT8 not counted in 2012 due to high pinniped numbers and cormorants breeding in the area

Cassin's Auklet Index Plots



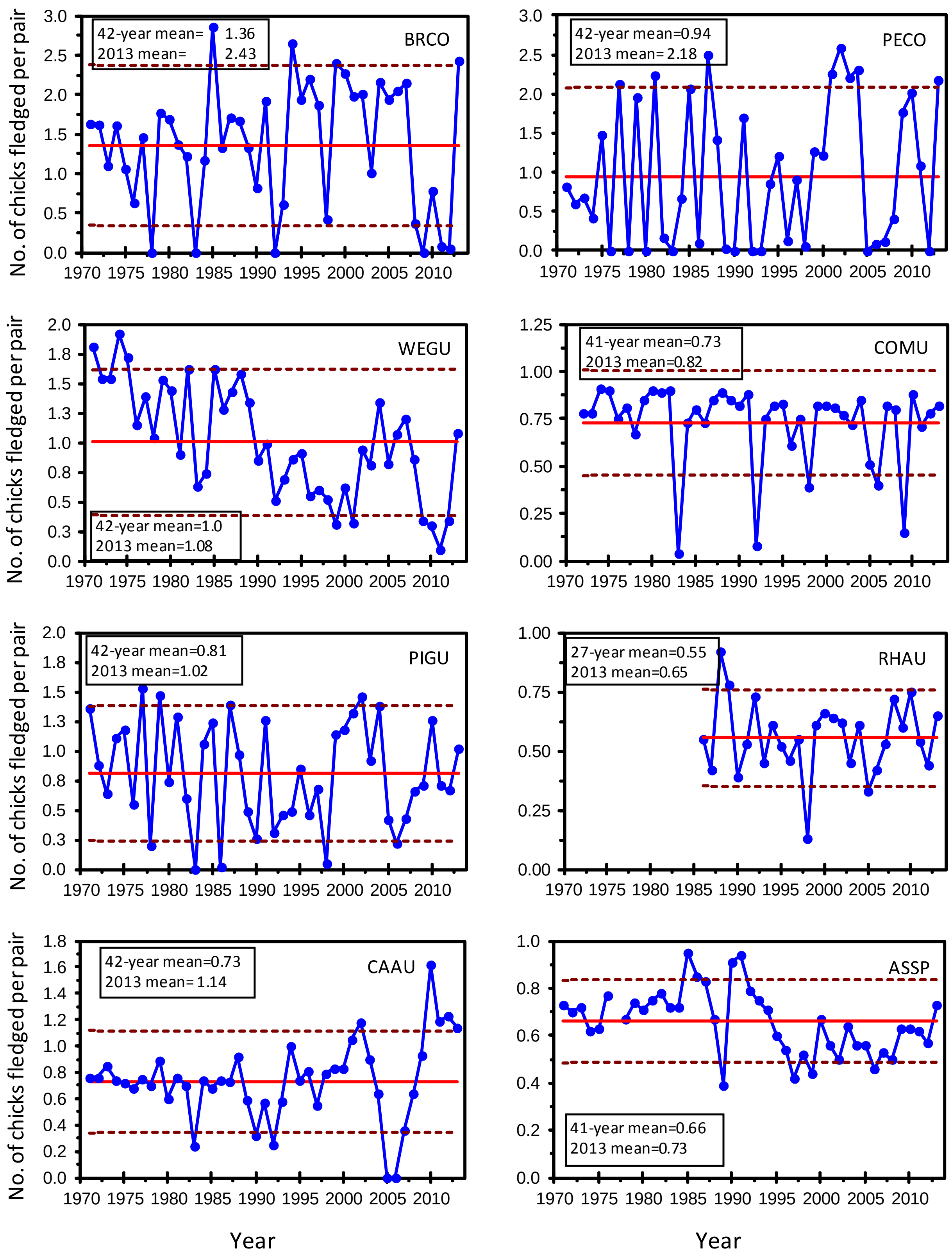


Fig. 1a. Productivity of 8 species of seabirds on Southeast Farallon Island, 1971-2013. Productivity is measured as number of chicks fledged per breeding pair (includes first attempts, relays and second broods). The bold horizontal line indicates mean productivity from all attempts between 1971 and 2012. The dashed lines represent the 80% confidence interval for the long term mean. Please note the different scales on the y-axis.

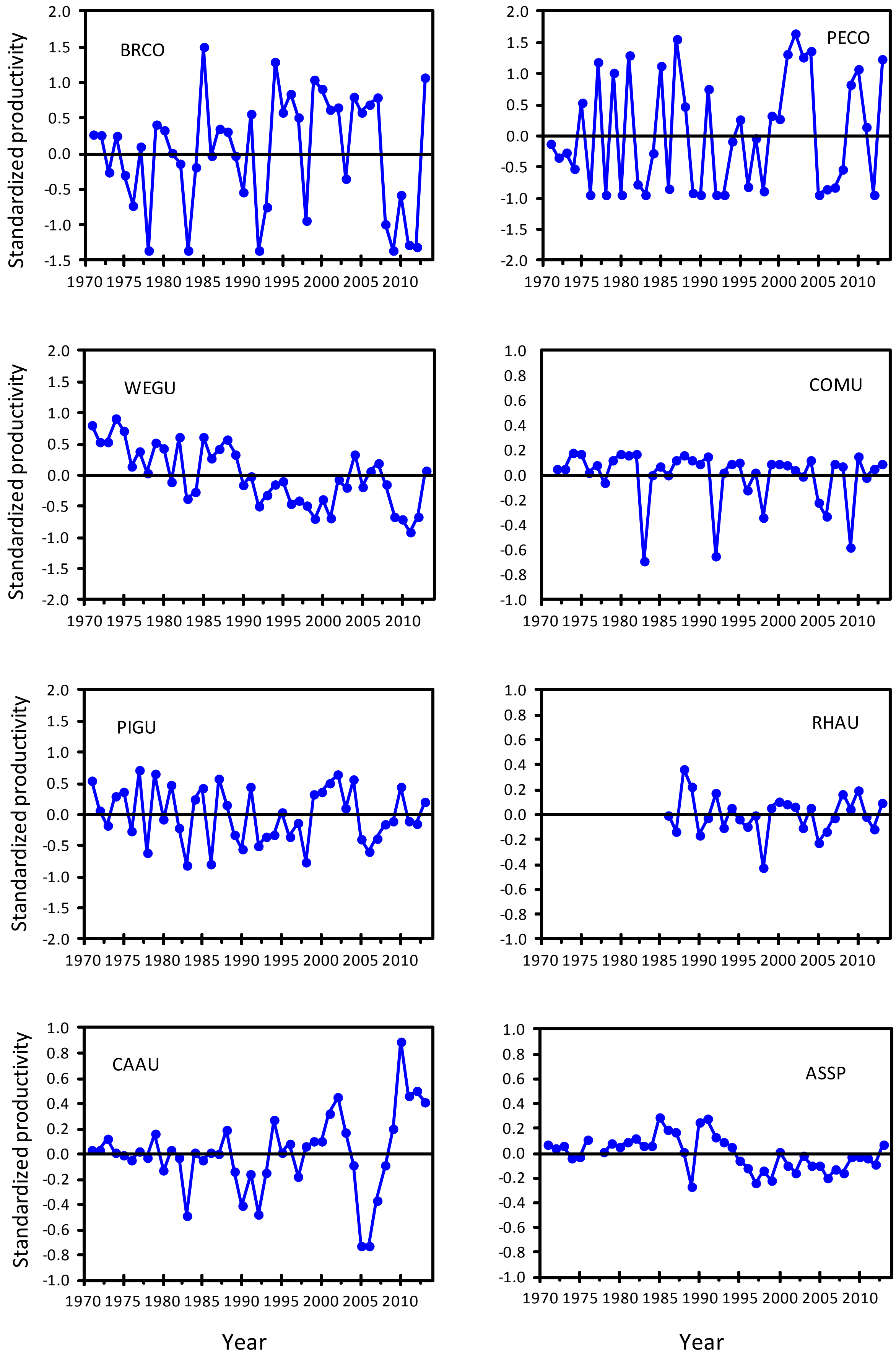


Fig 1b. Standardized productivity anomalies (annual productivity - long term mean) for 8 species of seabirds on SEFI, 1971-2013.

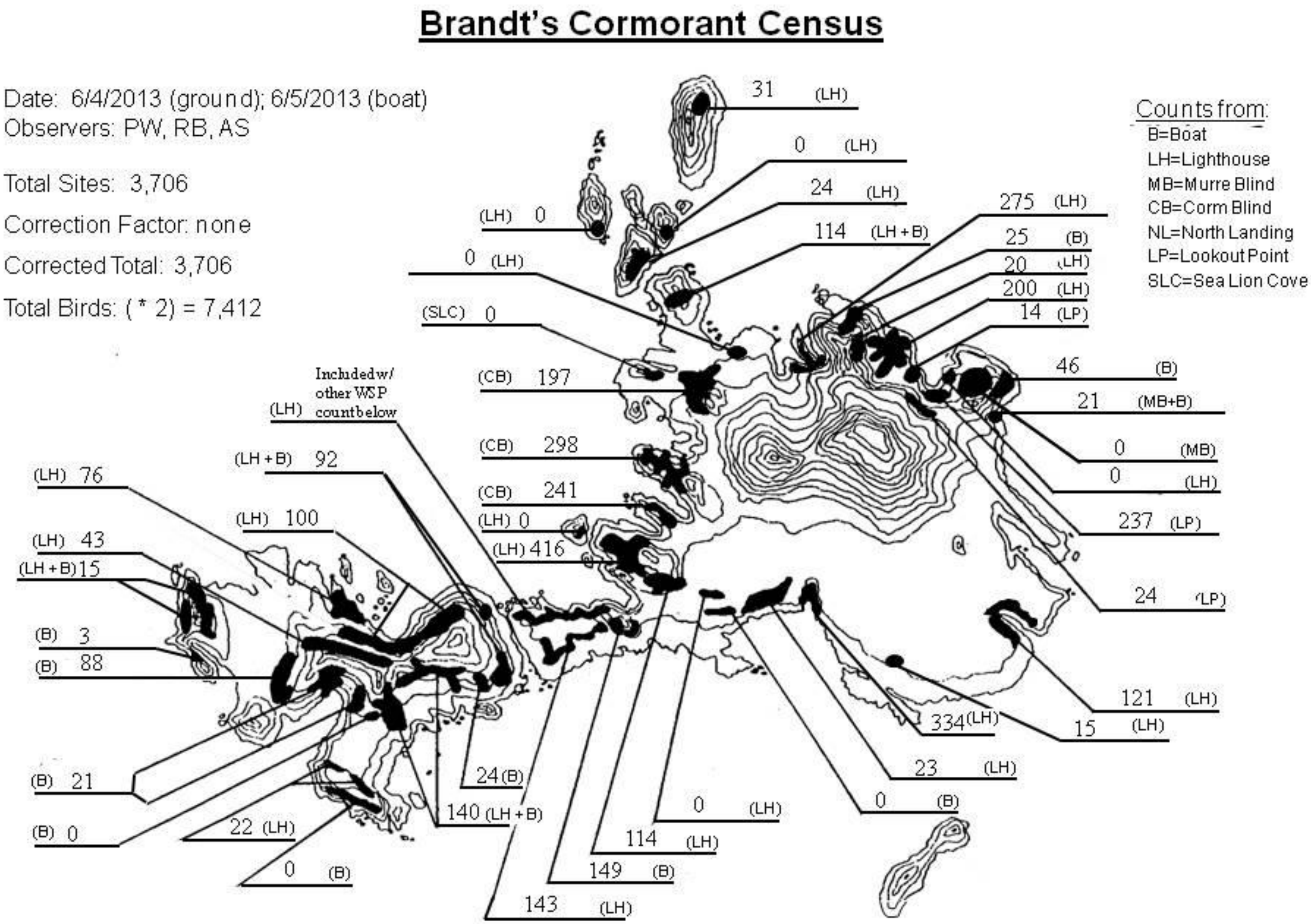


Figure 2: Counts of Brandt's Cormorants on Southeast Farallon Island during the 2013 census. Surveys were conducted from the following locations: Lighthouse Hill (LH), Murre Blind (MB), Cormorant Blind (CB), North Landing (NL), and Boat (B).

Pelagic Cormorant Census

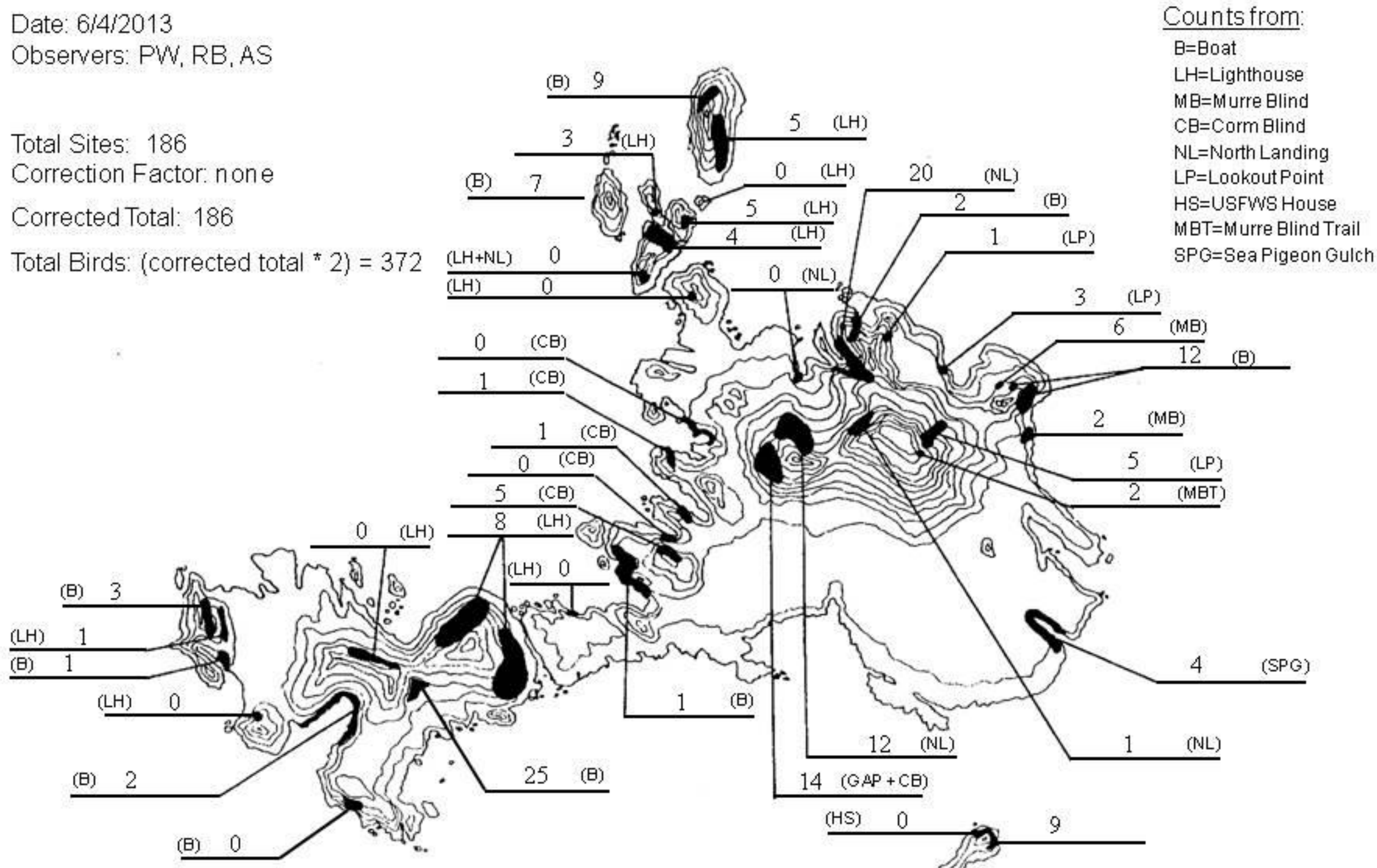


Figure 3: Counts of Pelagic Cormorants on Southeast Farallon Island during the 2013 census. Surveys were conducted from the following locations: Lighthouse Hill (LH), Lookout Point (LP), Murre Blind (MB), Cormorant Blind (CB), North Landing (NL), USFWS House (HS), Murre Blind Trail (MBT), Sea Pigeon Gulch (SPG), and Boat (B).

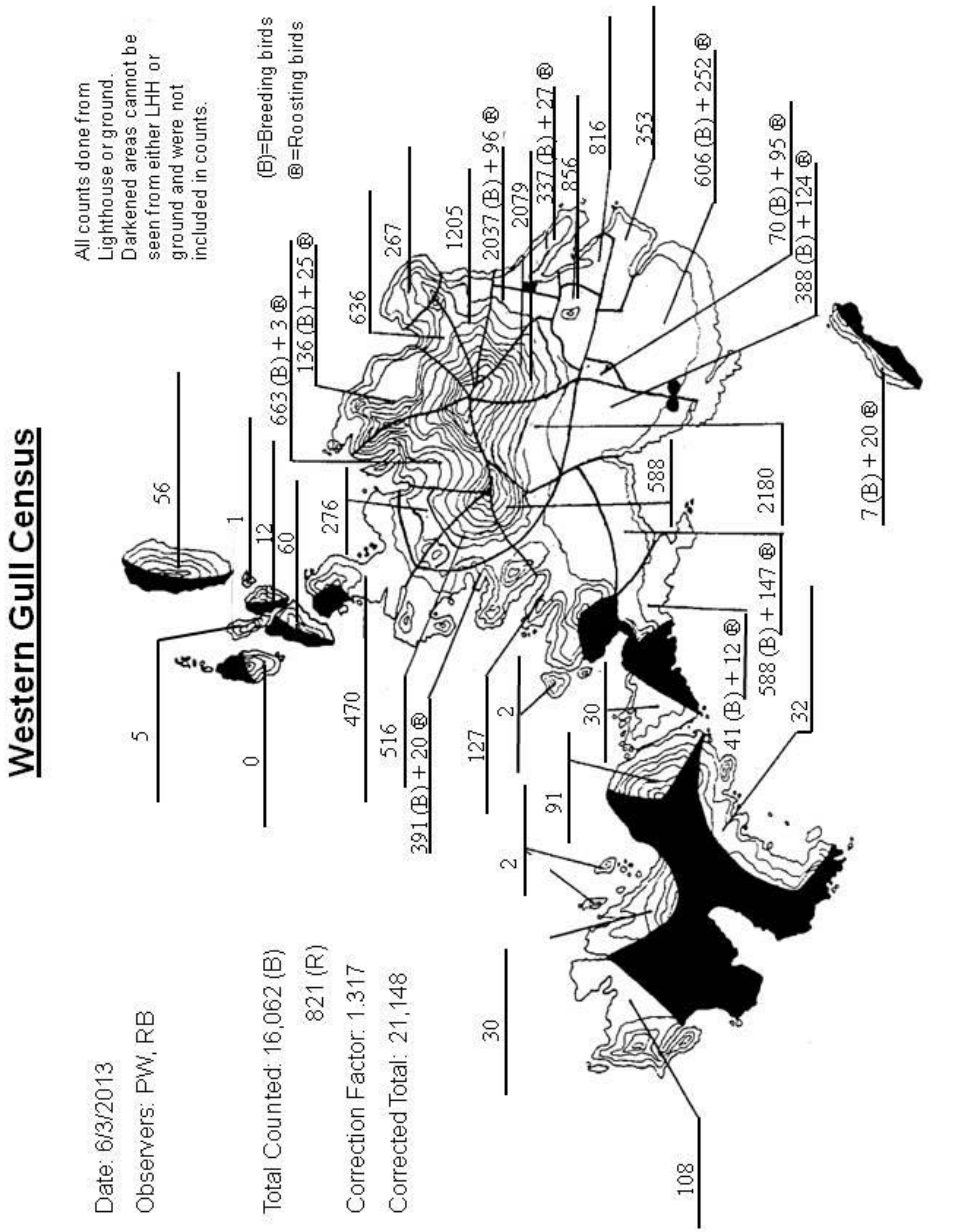


Figure 4: Counts of Western Gulls on Southeast Farallon Island during the 2013 census.

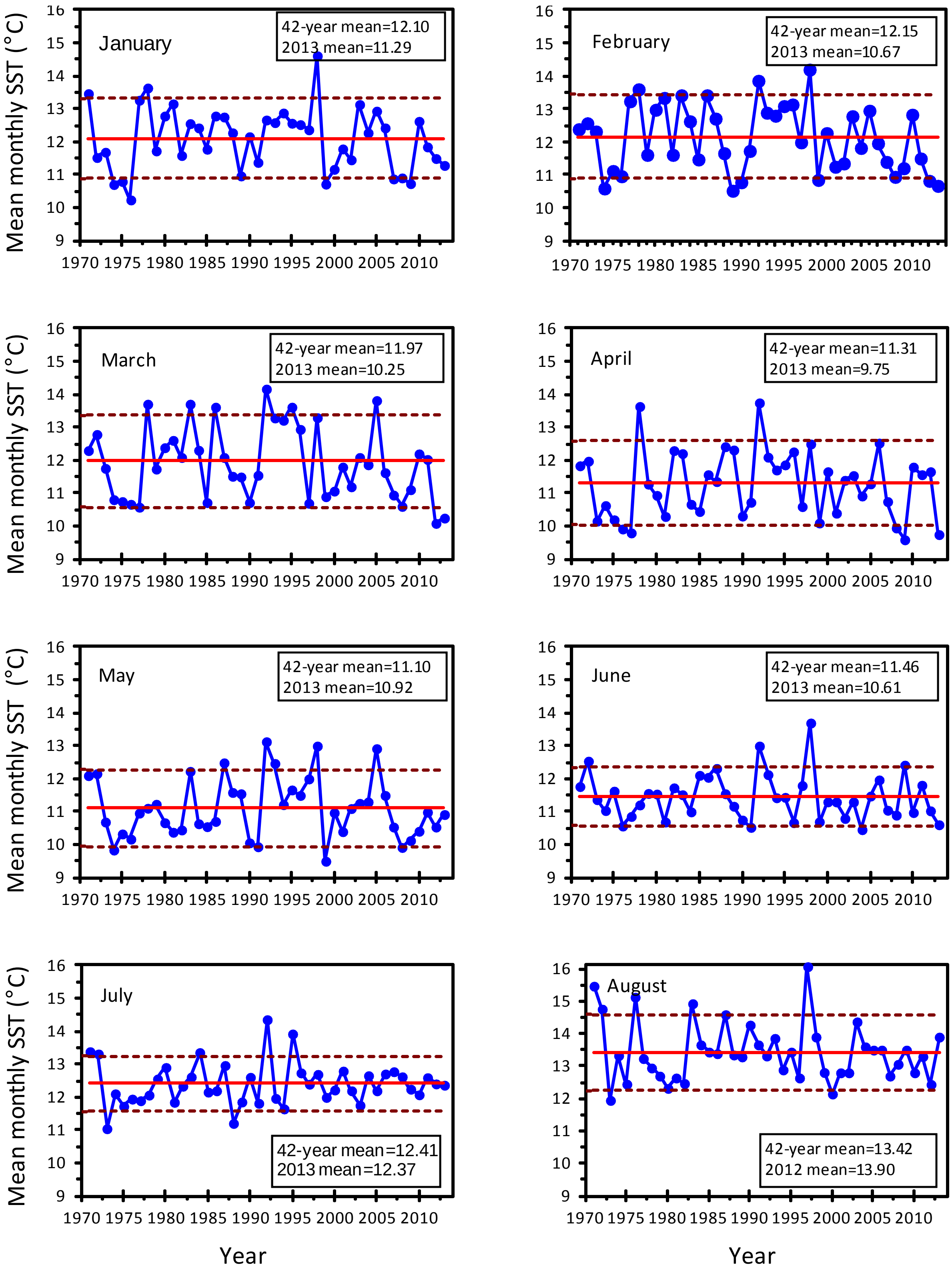


Fig. 6a. Monthly mean sea surface temperature (SST) at Southeast Farallon Island, 1971-2013. SST was measured daily from Water Sample Point, near East Landing. The bold horizontal line indicates mean monthly SST from 1971 to 2012. The dashed lines represent the 80% confidence interval for the long term mean.

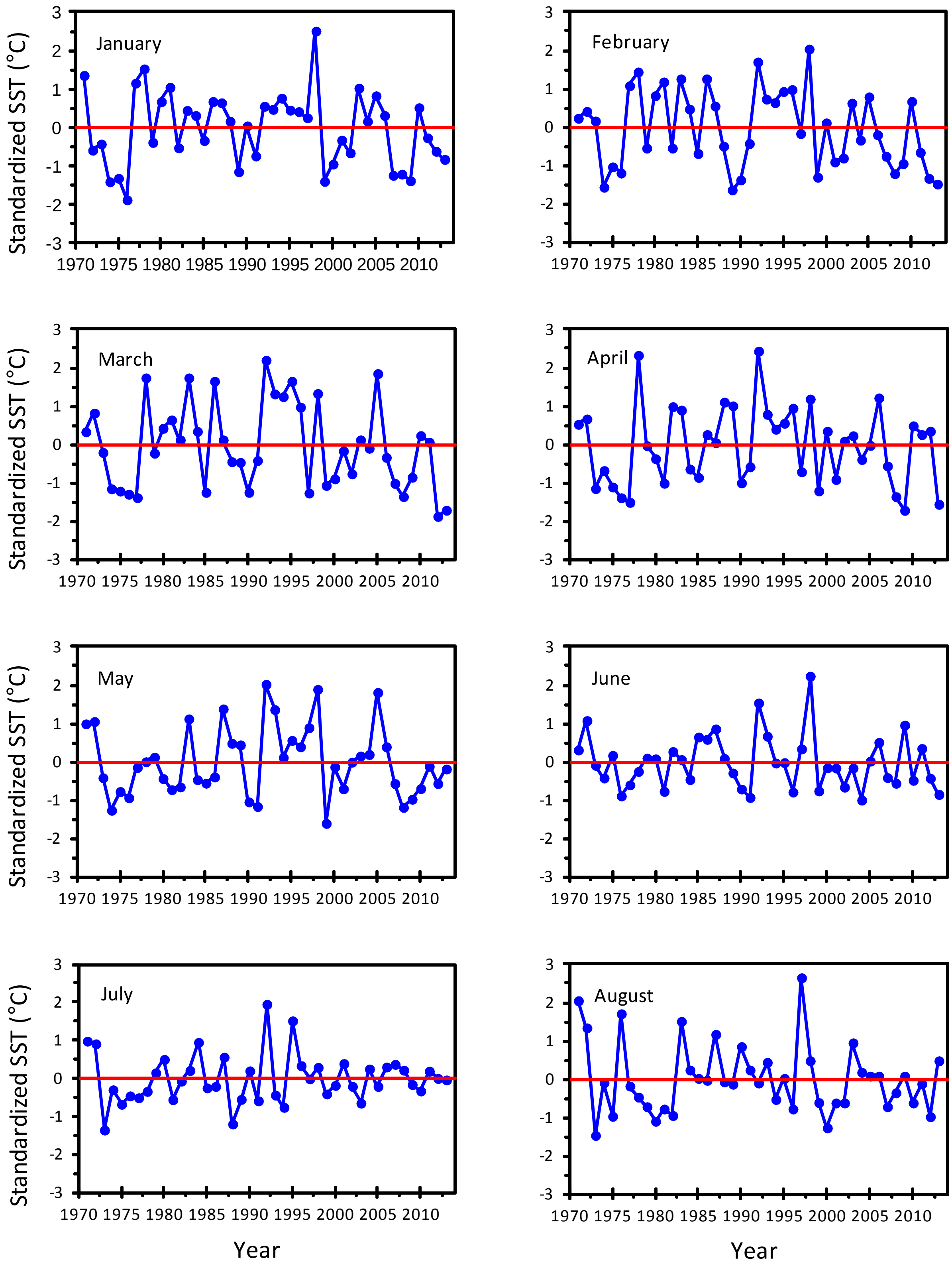


Fig. 6b Standardized Sea Surface Temperature (SST) anomalies (annual mean - long term mean) for SEFI, 1971-2013.

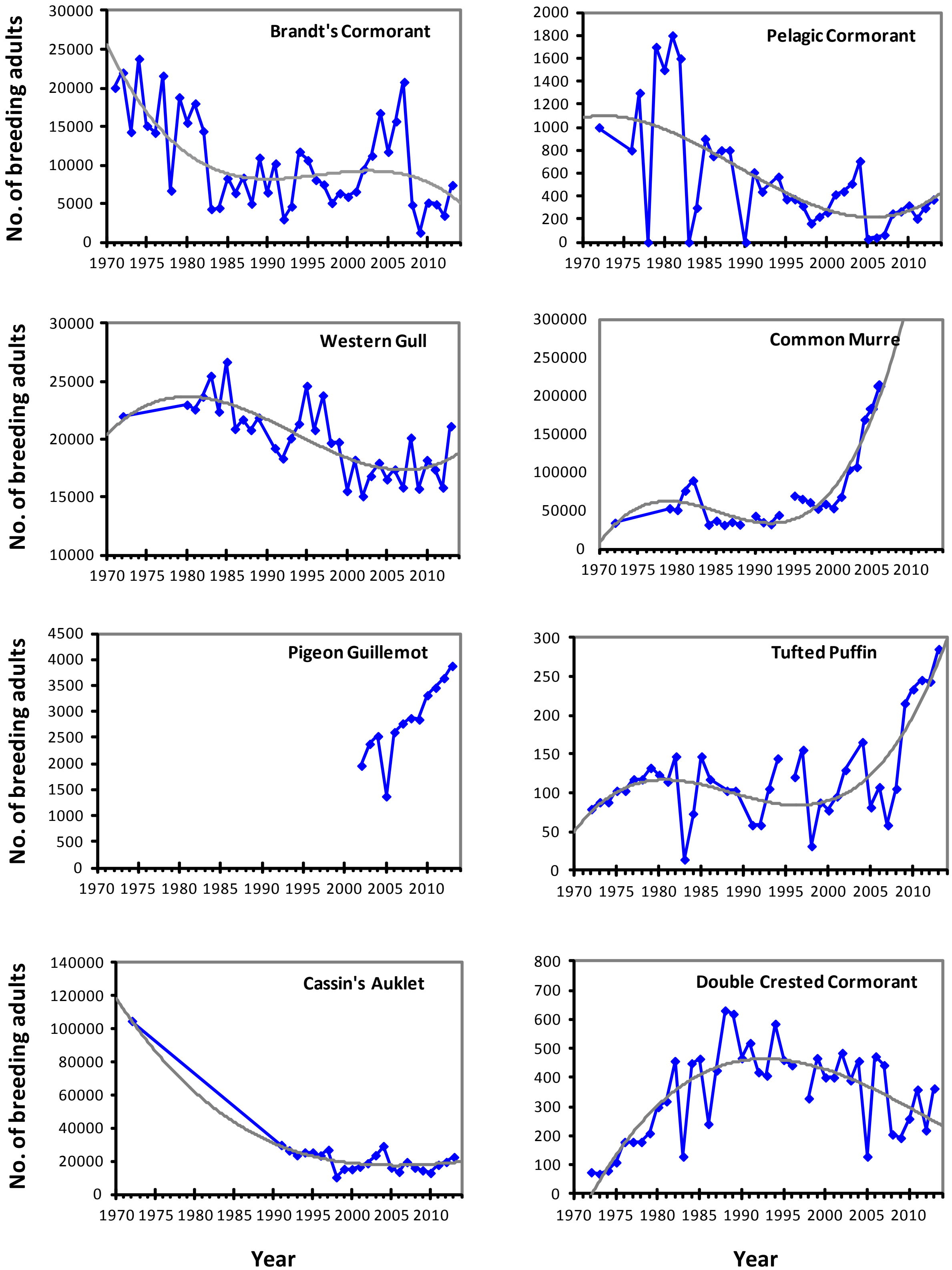


Fig. 7 Population trends for 8 species of seabirds on Southeast Farallon Island, 1972-2013. Populations were determined by counting either individuals or nests on all visible areas on SEFI and West End. We have fitted a third order polynomial trend line (in gray) for each species to help illustrate long term trends. Note the different scales on the Y-axis. PIGU evening raft counts done prior to 2002 are not comparable to current methods and are not displayed. COMU whole colony counts have not been made since 2006, points in red are estimated based on changes in the annual index plot counts relative to the last full survey (see Fig. 11 and text).

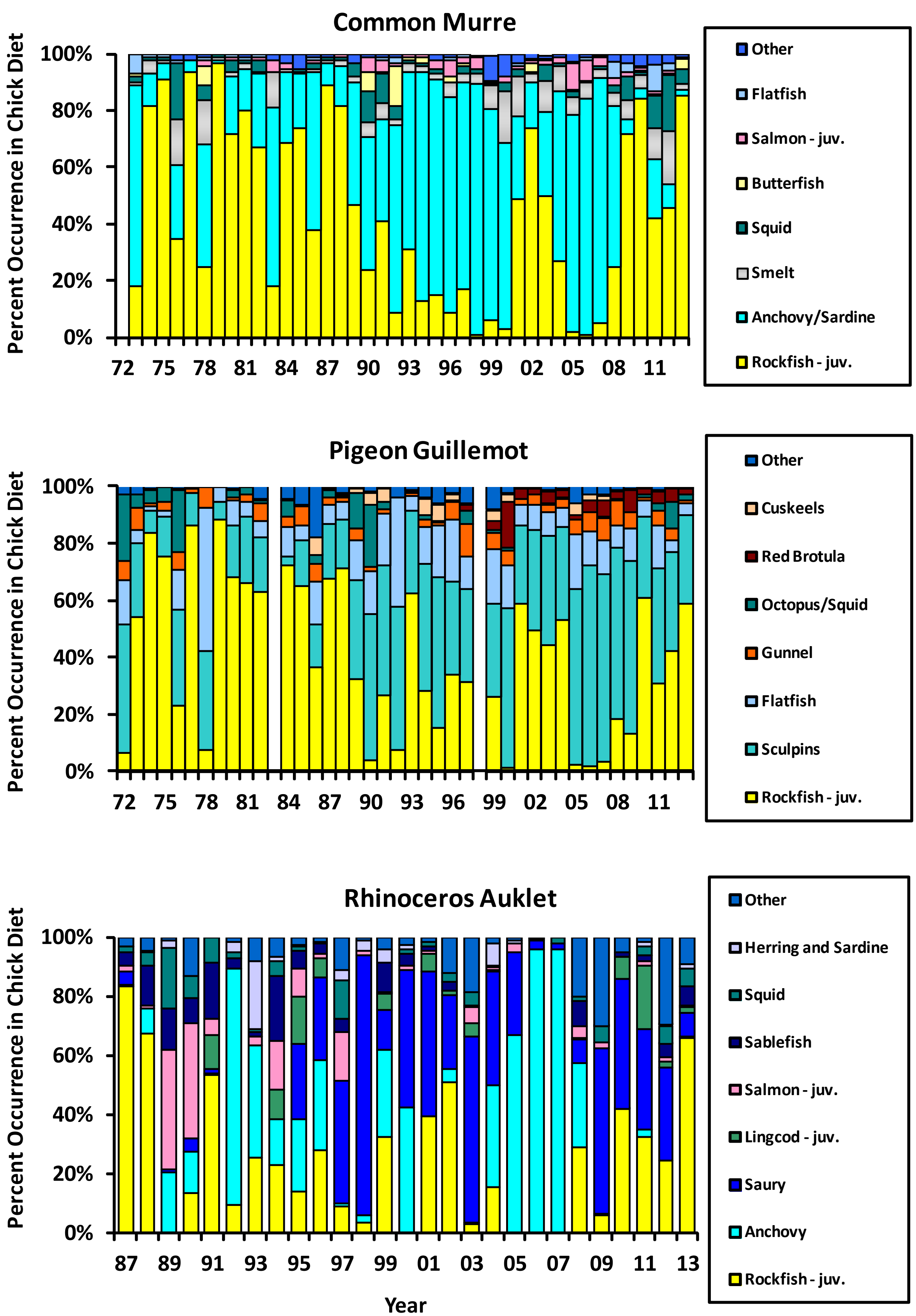


Fig. 8 Percent occurrence of common prey items, by year, in the diet of three species of seabirds on Southeast Farallon Island.

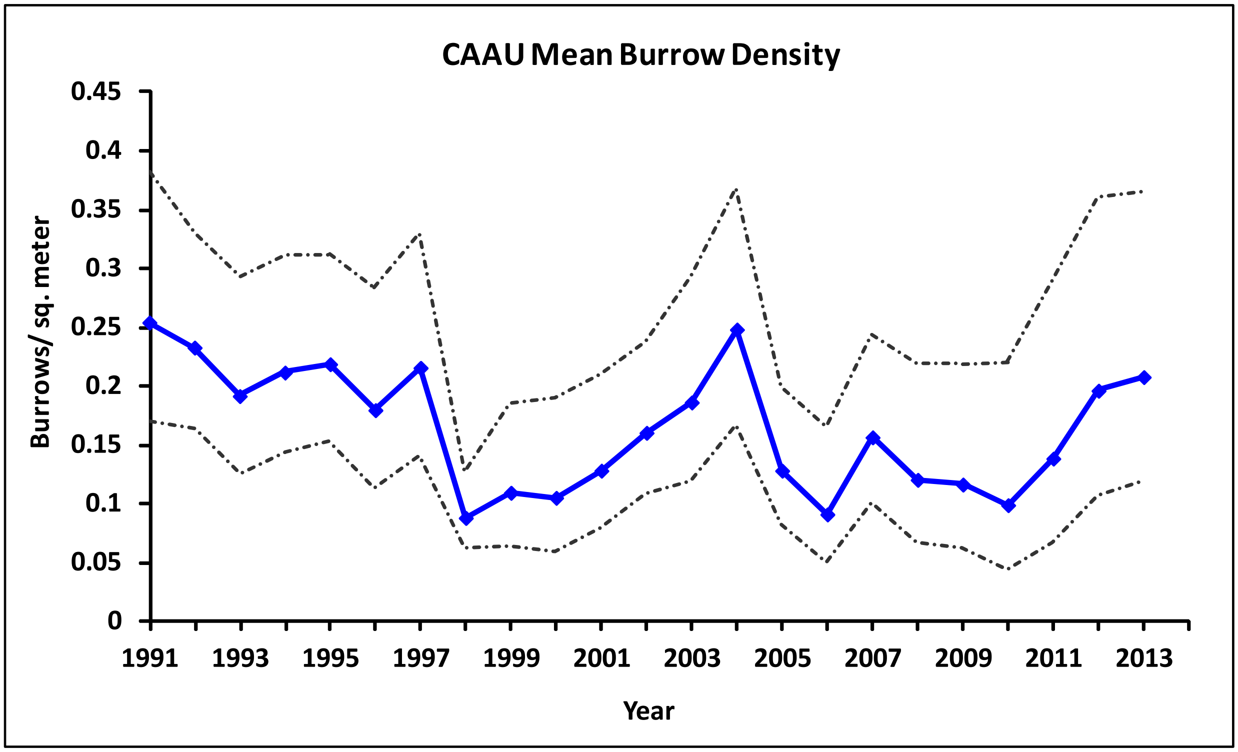


Fig. 9. Geometric mean burrow/crevice density in our 12 Cassin's Auklet Index Plots from 1991 to 2013. The blue line represents the annual mean values. The dashed lines represent the upper and lower bounds of the 95% confidence interval.

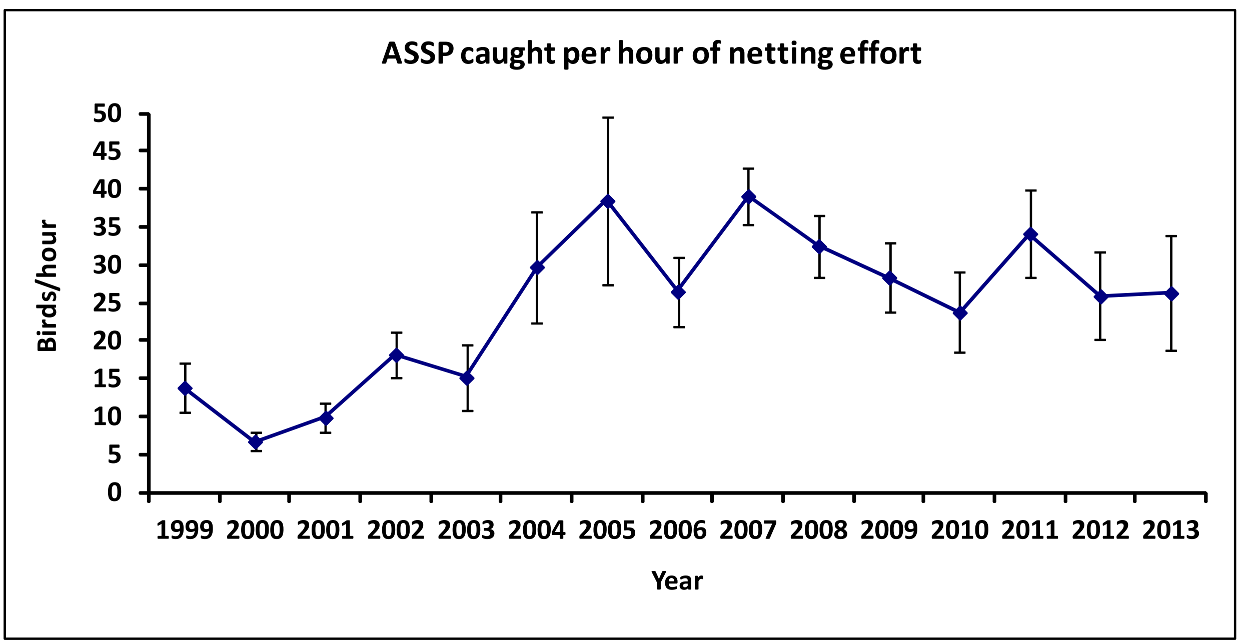


Fig 10. Mean number of Storm-petrels caught per hour of netting effort on SEFI from 1999 to 2013. Error bars represent the standard error for the mean calculated from all capture sessions in a given season.

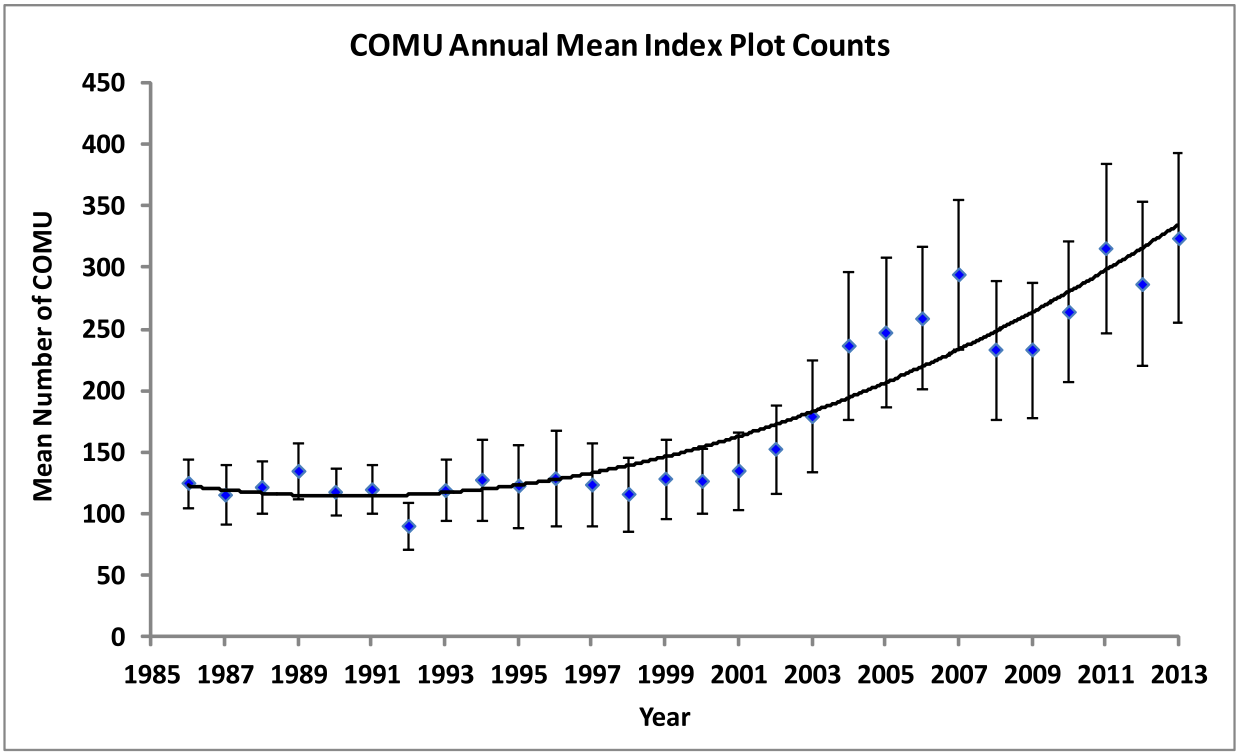


Fig. 11. Mean annual counts for Common Murre Index Plots from 1986 to 2013. Error bars represent the standard error of the mean calculated from all plots counted in any given season.

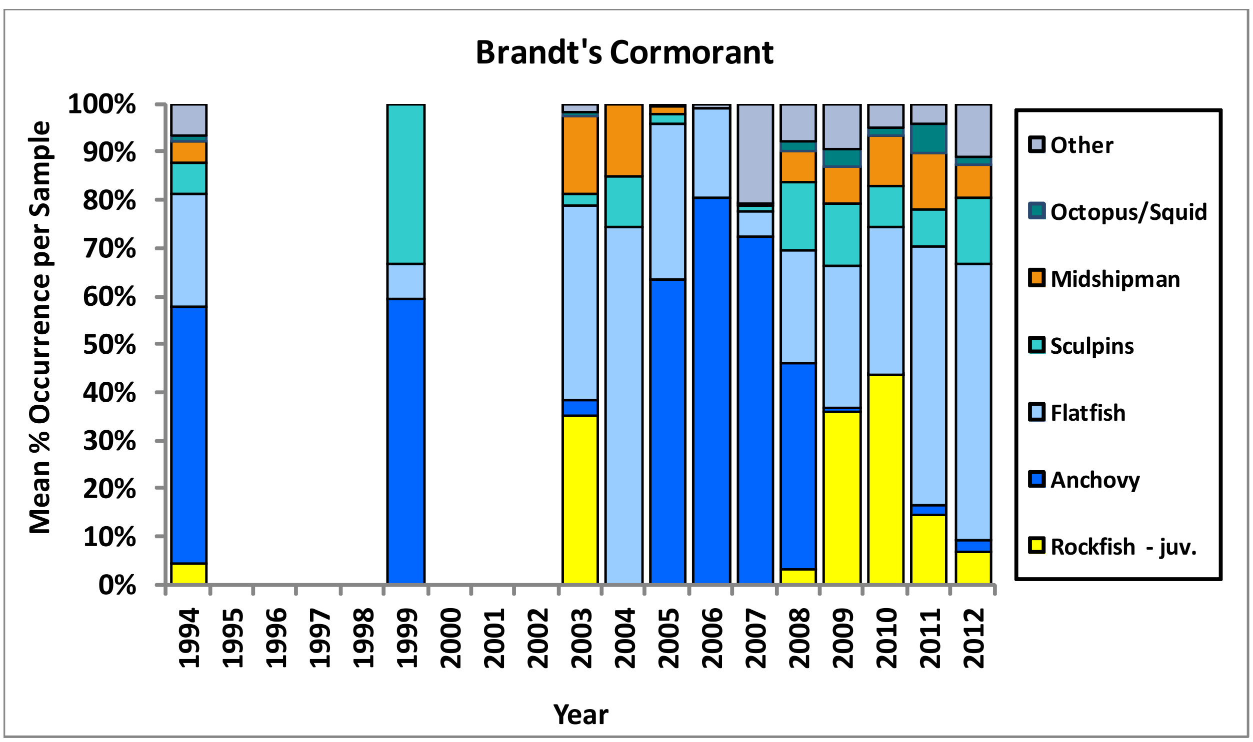


Fig. 12 Mean percent occurrence per sample of common prey items by year in the diet of Brandt's Cormorants on Southeast Farallon Island.

Appendix I. Calculation of correction factor for Western Gull census, 2013.

Area	Nest Count	Bird Count	Correction Factor
C	134	190	1.413
K	184	269	1.370
H (H1 only)	306	524	1.167
Total			**1.317**

Appendix II. Calculation of correction factor for Common Murre colony attendance, 2013. The correction factor was derived by multiplying the number of breeding sites in three study plots (USP, UU, and X) by 2, and then dividing the product by the mean number of adults present in each plot on the census dates. The correction factors generated for each plot were then averaged to derive a correction factor for the entire population.

USP

Date (Time)	Breeding Sites	No. of birds	Correction Factor
June 4 (1000)	248	293	1.69
June 5 (1000)	248	299	1.66
June 6 (1000)	248	295	1.68
June 7 (1000)	248	292	1.70
Mean	248	295	**1.68**

UU

Date (Time)	Breeding Sites	No. of birds	Correction Factor
June 4 (1000)	97	129	1.50
June 5 (1000)	97	119	1.63
June 6 (1000)	97	123	1.58
June 7 (1000)	97	114	1.70
Mean	97	121	**1.60**

X plot

Date (Time)	Breeding Sites	No. of birds	Correction Factor
June 4 (1000)	100	173	1.16
June 5 (1000)	100	188	1.06
June 6 (1000)	100	179	1.12
June 7 (1000)	100	167	1.20
Mean	100	177	**1.13**

Mean correction factor for SEFI 2013: **1.47**