POPULATION SIZE AND REPRODUCTIVE PERFORMANCE OF SEABIRDS ON SOUTHEAST FARALLON ISLAND, 2012

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

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December 2012

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EXECUTIVE SUMMARY

(1) Under cooperative agreement with USFWS/Farallon NWR, 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 2012, breeding populations increased for Cassin's Auklet, Pigeon Guillemot and Pelagic Cormorant, while declining or stable for all other species when compared to last season.

(3) Reproductive success was mixed. Cassin's Auklets, Common Murres and Western Gulls achieved greater success relative to 2011. Productivity for all other species declined.

(4) Brandt's Cormorants were reduced to near complete breeding failure and Pelagic Cormorants failed to fledge any chicks this season. Western Gull productivity, though higher than in 2011, remained extremely low for the fourth consecutive year.

(5) California Gulls nested on the island but failed to fledge any chicks. Single pairs of 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 2012 (11.36°C), was the coldest since 2008 and approximately 0.6°C below the long term average.

(7) Juvenile rockfish (*Sebastes* spp.) were abundant in seabird diet early in the season, but were replaced by sculpins, squid, octopus, smelt and saury as the season progressed. Anchovies were virtually absent. Krill was abundant close to the island throughout much of the season, as evidenced by Cassin's Auklet diet.

(8) A Northern Gannet arrived at the island in April and remained for the summer and fall. This represents the first record for this species in the Pacific basin.

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 2012. 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 2012. Canada Geese did breed for the third straight year but failed to fledge any chicks.

We are indebted to our research assistants: Jennifer Aragon, Michael Johns, Ilana Nimz, Emma Kelsey, Laney White, Erica Lander, Alexandra Gulick, Annie Schmidt and Sophie Webb for their invaluable assistance in the field. Jim Tietz supervised data collection during the fall. We are also very grateful for support provided by the skippers of the Farallon Patrol, our colleagues in the mainland PRBO office, and personnel from the San Francisco Bay National Wildlife Refuge.

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 40 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, no reproductive data were collected for these species.

Brandt's Cormorant – BRCO experienced near complete reproductive failure during 2012, the third time in the last four years. Mean productivity for the colony was 0.05 fledglings per pair. This is approximately 37% lower than last season and 96% below the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 10 May at the Sea Lion Cove colony and under the Corm Blind on 11 May. The mean laying date for the colony was not until 1 June. As in the previous few seasons, Brandt's Cormorants arrived at the colony late and began setting up nests but most abandoned the attempt. There were a total of only 58 breeding attempts at the colony under the Corm Blind, 54 of which were abandoned during the egg or early chick stage. In addition, there were many other nests initiated and abandoned before eggs were laid. Mean clutch size was 2.67 eggs per nest but hatching success was a meager 28% due to nest abandonment and gull predation. Mean brood size was 0.84 chicks per nest, only 6% of which survived to fledging age. There were a total of 41 breeding attempts at the Sea Lion Cove colony. Approximately 35% of those attempts hatched at least one chick, but all nests were subsequently abandoned. No chicks fledged.

Pelagic Cormorant **–** PECO suffered complete breeding failure during 2012. 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 3.17 eggs per nest, and brood size was 0.24 chicks per nest. Eggs and/or chicks were observed in 12 of the 86 followed sites and there were an additional 23 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 30 May. The first chicks were observed on 4 June.

Adults started abandoning nest attempts on 9 June and all nests were abandoned by early July.

Western Gull **–** WEGU productivity continued to remain low in 2012 (Fig. 1a), resulting in an average of only 0.34 chicks per pair. Though this is slightly higher than the productivity observed during 2011, it is still approximately 67% lower than the long-term mean productivity for this species (Fig. 1a). Breeding was delayed this year and the first eggs were not observed until 1 May. Fifty percent of the eggs hatched but only 26% of those chicks survived to fledge. Mean clutch size was 2.46 eggs per nest and mean brood size was 1.25 chicks per nest.

California Gull **–** CAGU again attempted to breed on the Farallones during 2012. 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, but no chicks survived to fledging. High rates of predation by the larger and more aggressive Western Gulls, likely coupled with generally poor success for gulls this season resulted in complete breeding failure of this colony for the fifth straight year.

Black Oystercatcher **–** A total of 38 sites were monitored in 2012, of which 20 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 12 of these sites (60%). A total of 10 chicks fledged, yielding an average estimate of 1.2 fledglings produced per pair. Both the number of breeding sites and the number of chicks produced were lower than in 2011, though the average productivity (number of chicks fledged per pair) was 20% higher than during 2011. The first eggs were observed on 19 May. BLOY nests are cryptic and difficult to observe; therefore clutch size, hatching success and fledging success were not determined.

Common Murre **–** During 2012, 248 Common Murre sites were monitored daily in the Upper Shubrick Point (USP) study plot, of which 222 were breeding sites (where an egg was laid). Productivity was 0.78 chicks fledged per pair. This is approximately 10% higher than last season and roughly 7% above the long-term average of 0.73 (Fig. 1a). The first eggs were observed in this plot on 28 April but the overall mean laying date for the plot was 13 May; approximately equal to the long-term mean laying date for this colony. Hatching success was 88% and 88% 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 10 May this season and the mean lay date for the plot was 20 May. There were a total of 127 sites monitored this season (up 5.8% from 2011); 90 of which were breeding sites. Reproductive success for this colony was lower than USP in 2012 with 0.44 chicks fledged per breeding pair. Hatching and fledging success in this plot were also considerably lower than in the USP plot with 66% of eggs hatching, and 62% of the chicks hatched surviving to fledge (see Table 1). Much of the egg and chick loss was a direct result of gull predation at this colony.

Pigeon Guillemot **–** A total of 116 sites were monitored during 2012, of which 75 were observed with at least one egg (65% of the total number of sites). The majority of nest sites were located on Lighthouse Hill or at Garbage Gulch, but there was also one site in the Habitat Sculpture, and two in Rhinoceros Auklet nest boxes by Russia House. Productivity was 0.67 fledglings produced per pair (Table 1). This was approximately 6% lower than 2011 and 18% below the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 7 May, and the mean egg laying date was 24 May. The mean clutch size was 1.68 eggs per nest with 80% of those eggs hatching successfully. Mean brood size was 1.33 chicks per nest, but only 54% of the chicks produced survived to fledging age. There were only two sites which were able to fledge a complete brood of two chicks.

Rhinoceros Auklet – There were a total of 154 sites (boxes, crevices, and cave sites) monitored in 2012, 47% (n=73) of which were occupied by a breeding pair. This includes three Rhinoceros auklets which bred in Cassin's Auklet nest boxes. Forty percent of nest boxes were occupied compared to 80% of camera sites. There were also 15 boxes occupied by other species (13 CAAU and 2 PIGU). Productivity during 2012 was 0.44 fledglings per pair. This is 19% lower than 2011 and 21% below the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 22 April. Seventy-four percent of the eggs successfully hatched and 60% of those chicks produced survived to fledge.

Cassin's Auklet – Occupancy of breeding birds in study boxes was exceptionally high during 2012 with 85% of the boxes (407 of 478) occupied this season, including 43 of 44 PRBO study boxes (98%). Productivity of auklets breeding in PRBO study boxes was the second highest ever observed for this species with 1.23 chicks fledged per breeding pair (including relay attempts). This is approximately 4% higher than 2011 and 75% greater than the long-term average of 0.72 chicks per pair for this species (Fig. 1a). Eighty-four percent of the eggs hatched and 97% of those chicks produced survived to fledge. The first egg was observed on 19 March and the mean laying date for PRBO boxes was 6 April, approximately 2 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=165). This is approximately 17% lower than the estimate derived from PRBO boxes and 8% lower than the "all sites" estimate for 2011, but still exceptionally high productivity for this species.

Ashy Storm-Petrel – ASSP pairs laid eggs in 48% of the 95 followed sites (n=46) in 2012, down 11% from last season. Five of these 46 sites were new breeding sites discovered during 2012. The first eggs were observed on 14 May. Eighty-six percent of the eggs hatched and 68% of the chicks successfully fledged. Overall productivity for this species was 0.57 chicks fledged per pair (including all relay attempts). This is approximately 8% lower than last season and 13% below the long-term average productivity for this species (0.66).

Other breeders – Over the past several seasons, Peregrine Falcons, Common Ravens and Canada Geese have bred on SEFI. However, during 2012, it appears that only the Canada Geese attempted to breed. As in the last two seasons, a trio of Canada Geese nested on the Marine Terrace. Five birds arrived at the island during February and were observed continually throughout the spring. Although we are unable to positively identify the individual geese, it is likely that these were the same three individuals that bred on SEFI in 2011 along with the two offspring that had fledged. Juvenile Canada Geese remain with their parents through migration back to the breeding site the spring after fledging. During 2012, two nests were built. The first was discovered on 6 April with 6 eggs and the second was discovered on 10 April with 4 eggs. By 29 May both nests were destroyed and it appears that no chicks hatched. A pair of Peregrine Falcons was seen on SEFI throughout the winter and early spring and appeared to be exhibiting territorial behavior. However, by 18 May, there was only on falcon regularly seen around the island and there were no signs of nesting behavior. Likewise, a pair of Common Ravens was observed in the early season, but one disappeared by late spring and there was no evidence of nesting.

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 6 evenings between April and August. As a result, we banded a total of 394 Ashy storm-petrels and recaptured 39 that had been banded in previous years. In addition, there were 15 birds banded this season that were recaptured later in the season. Catch per hour of netting effort was 25.89 birds per hour (see Figure 10). This is down approximately 24% from 2011. Our largest single night was 17 June on which 131 birds were caught at the Lighthouse Hill site. There were also 12 Leach's storm-petrels banded this season and three recaptured that had been banded in previous seasons.

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 18 counts were made in 2012, beginning on 26 April and ending on 25 July, when juveniles became indistinguishable from adults. On 25 June we counted a peak number of 110 "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 220 breeding birds. This estimate is approximately 39% lower than 2011 and 36% below the 10-year average population for this species (Table 2). There was a high count of 54 chicks observed during the 16 July census.

Brandt's Cormorant – The BRCO breeding population was censused during a ground-based survey on 4 June. There was no boat survey this year so we applied a correction factor to account for those areas that would typically be surveyed during the boat census. The correction factor was generated by determining the proportion of the overall population counted from the boat in each of the past 5 seasons. We then took the average proportion of the last five seasons and applied that to this year's land based count, yielding a correction factor of 1.135. A total of 1,520 "well-built" nests were counted (Fig. 2) during the survey. After applying the correction factor, we estimated a total of 1,725 nests established on the island this season, yielding an overall population estimate of 3,450 breeding birds (Table 2). This estimate is down 30% from 2011 and approximately 68% lower than the 10-year average (Table 2). Brandt's initiated breeding in early May but many abandoned nests shortly after egg laying. We multiplied the total number of nests by the mean productivity to estimate an island-wide production of approximately 86 chicks.

Pelagic Cormorant – The PECO breeding population was censused during a ground-based survey on 4 June. There was no boat survey this year, so as with Brandt's Cormorants, we generated a correction factor to account for areas not censused. Using the same methods as above, yielded an average correction factor for the last five seasons of 1.383. We counted a total of 108 fair to well-built nests (Fig. 3) during the survey. After applying the correction factor to the original count, we estimated a total of 149 nests established on the island this season and an overall breeding population of 298 birds (Table 2). This estimate for Pelagic Cormorants is approximately 45% higher than 2011 and 6% higher than the 10-year average. No chicks fledged for Pelagic Cormorants in 2012.

Western Gull – The WEGU census was conducted on 5 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 10,707 (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 (1.478) 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 15,830 birds (Table 2). We then multiplied the population estimate by the mean annual reproductive success to estimate an overall production of 2,691 fledglings on SEFI in 2012. The population estimate for WEGU is approximately 9% lower than in 2011 and 7% below the 10-year average (Table 2).

California Gull – CAGU were censused every five days throughout the season beginning on 1 April. A peak count of 35 “well-built” nests was counted on 22 May resulting in a breeding population estimate of 70 birds. This estimate is approximately 66% lower than the estimate for last season and 81% lower than the 4 year mean for this population. It is worth noting that the Mirounga Beach colony had a maximum count of 22 nests on 20 June, while the Sea Pigeon Point colony had a maximum count of 24 nests on 22 May. In addition there were two pairs that nested away from the main colonies near Heligoland Hill. This resulted in a total of 48 “well-built” nests established on the island. As in previous years, we decided to use the peak number of nests counted on any given survey day for our population estimate, as we do with other species. The peak count for total birds was 177 on 27 April, including many immature birds which were present in the colony but not breeding.

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, 20 were considered active sites. Therefore, we estimated a breeding population of 40 birds, a decline of 17% relative to 2011, but still 21% higher than the 10-year average population. We estimated an island wide production of 10 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 is no longer censused in the traditional manner of counting all of the birds present on the island. The population has grown to the point where counting individual birds has become impossible and we will no longer attempt to make a population estimate for 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. PRBO 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. Index plot counts in 2012 were on average 15% lower than in 2011 and approximately equal to 2010 (Figure 11).

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 2012 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 1.56. 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 3,645 birds on 18 April. This count was approximately 5% higher than the peak count from 2011 and 45% 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 22 to 27 May and a second survey from 4 to 17 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 2012 surveys, a total of 122 active sites were observed, 27 of which were confirmed to have chicks based on observations of birds delivering fish to the site.

One chick was seen at the entrance to a site on Little Lighthouse Hill. Based on these observations, we estimated a breeding population of 244 birds (Table 2). This is approximately equal to the TUPU breeding population numbers from 2011 (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 2012. A total of 30 new birds were banded and 73 were recaptured (21 birds were captured multiple times during the season). There were fewer new birds banded this season as well as 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 304 burrows/crevices in the index plots, up approximately 10% from 2011. Therefore, using the same methodology, but with the updated whole island estimate generated in 2009, we estimated a 2012 breeding population of roughly 19,609 birds ([304/225] x 14512) on Southeast Farallon Island. Total island-wide production (number of breeding pairs x mean productivity) was estimated at 12,056 fledglings on SEFI. The breeding population estimate is 10% greater than in 2011 and approximately 7% greater than the

10-year average (Table 2). However, caution should be used in comparing the 2012 value to the 10-year average since a different baseline was used in previous seasons.

DISCUSSION

Weather and Ocean Conditions:

Oceanic conditions during 2012 were generally cool and productive. The mean seasonal SST from March to August (11.36°C) was 0.69°C cooler than last season and 0.6°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 April. 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 early in the chick rearing period, but declined in early July and minor prey items became relatively more important (Fig. 8). Overall, rockfish comprised 45% of the diet for Common Murres and 42% for Pigeon Guillemots. Rockfish were slightly less prevalent in Rhinoceros Auklet diet, comprising just 24% of diet samples collected, down about 25% from 2011. In addition, the species composition for rockfish observed in the auklet diet was notably different this season. Approximately 60% 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 25% greater than last season. This suggests that it was easier 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 since 2009. During 2012, anchovies comprised a small proportion of the diet for murres and were completely absent in the auklet diet (Fig. 8). Sculpins, lingcod, saury, smelt, octopus and particularly squid were other important components of the diet this season. Squid and smelt each comprised approximately 20% of the diet for murres in 2012. In most years these species only account for 4 to 6 percent of the diet. Octopus was also an unexpectedly prominent item in the diet this season. Normally occurring only rarely, octopus accounted for up to 9% of the diet for guillemots and auklets. 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 poor reproductive performance, we would expect similar results in 2012 with few anchovy and high proportions of flatfishes and sculpins.

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 2012 indicated a similar numbers of juvenile rockfishes when compared to 2011. In addition, there was a high abundance of squid and octopus 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. This season also produced the highest ever catches of gelatinous organisms like salps and pyrosomes. At times the sheer numbers of these organisms overwhelmed and damaged nets or simply prevented the trawls from occurring (K. Sakuma pers. comm.).

Productivity:

The 2012 seabird breeding season had mixed results for different species (Fig. 1a, b). Cassin's Auklets and Common Murres exhibited high breeding success during 2012 with Cassin's experiencing the third straight year of exceptionally high productivity. Western Gulls also had increased breeding success this season when compared to 2011, but continued to suffer extremely low overall productivity for the fourth straight year. Pigeon Guillemots, Rhinoceros Auklets, Brandt's Cormorants, Pelagic Cormorants and Ashy Storm-petrels all had lower productivity than during 2011 with both cormorant species suffering complete or nearly complete reproductive failure. Black Oystercatchers had slightly higher average reproductive success in 2012, but 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 2012, Cassin's Auklets productivity was above the upper 80% confidence interval, indicating exceptionally high reproductive performance. In contrast, Brandt's Cormorant and Western Gull productivity remained below the lower confidence level, indicating exceptionally poor years for these species. Pelagic Cormorants tend to be a boom or bust species and frequently suffer complete breeding failure (Fig. 1a), therefore zero productivity falls within the 80% confidence interval for this species.

Cassin's Auklets exhibited high productivity again this season and the 1.23 chicks fledged per breeding pair is the new second highest value recorded since studies began in 1972, just surpassing the 1.19 chicks per pair from 2011. This marks the third 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). During 2012, 46% of birds in PRBO study boxes and 29% of all sites that successfully fledged a chick attempted a second brood. Although the overall rate of double brooding was much lower than the 76% observed during 2011, the proportion of those second broods that were successful was higher. Seventy-five percent of those sites that attempted a second brood successfully fledged a second chick. In addition, the success rate of first broods was approximately 14% higher than last season, contributing to the overall high reproductive performance observed during 2012.

Reproductive success of COMU was also higher during 2012 as well as being above the long-term mean for this species. Murres seemed to thrive once again on a relatively high abundance of juvenile rockfish in the chick diet. In addition, they appeared to be able to compensate for periods of lower rockfish availability during the season by foraging on less favorable prey items such as squid and smelt. Although feeding rates were higher than last season; chicks still grew slowly and took longer to fledge than in typically productive years. This may suggest that although rockfish were prevalent in the diet, murres may have had to work a bit harder to provision growing young in the absence of anchovy and other high energy forage species. As usual, the USP study plot had the highest productivity of the four study plots followed on the island. The Upper Upper plot had much lower success (see Table 1) due in large part to a higher rate of egg loss resulting from Western Gull disturbance at this colony. There was also a large amount of Brown Pelican disturbance to some colonies (particularly Fertilizer Flat and Lower Shubrick Point) which are not regularly monitored. The pelicans would fly over or land in the colony, causing murres to flush and creating opportunities for gulls to swoop in and consume eggs and or chicks. A juvenile pelican was also observed consuming chicks as it lumbered through the colony causing chaos. It is not known how great an effect this had on overall productivity of the Farallones since all of the disturbance occurred away from our study plots, but it is likely significant. Incidental observations estimated several hundred to perhaps a few thousand eggs and/or chicks being lost during one particular disturbance event.

Rhinoceros Auklets and Pigeon Guillemots also exhibited reduced breeding success. As with murres, overall productivity for these species was slightly below the long-term mean. Fewer rockfish and a greater reliance on less favorable prey items such as saury, flatfishes, squid and octopus resulted in slower growth rates and lower fledging success relative to 2011. For both species, chicks took longer to grow and fledged at lower weights than in previous seasons. For Pigeon Guillemots, only two sites were able to fledge both chicks from a clutch leading to overall reduced productivity.

Brandt's Cormorants suffered very low reproductive success again in 2012, now the fifth consecutive year of poor productivity (Fig. 1a). Overall productivity was close to zero and the majority of breeding attempts were abandoned. The lack of anchovies and other larger forage fish is likely causing the continued reduced breeding effort and success for Brandt's Cormorants. Pelagic Cormorants suffered complete breeding failure this season for the first time since 2005. It is unclear why Pelagic Cormorants failed to fledge any chicks this year. Rockfish abundance seemed to be higher than last season, indicating that food was available to them, and they generally perform well when rockfish and sculpins are available in the diet, as they were this season. However, birds began abandoning their nests in early June, even those with eggs and chicks and by early July all breeding activity had ceased.

Cormorants breeding at other central California colonies also exhibited below average breeding success and reduced breeding effort during 2012 when compared to the long-term means for those sites (USFWS unpublished; A. Fuller pers. comm.). In contrast, colonies along the south central coast exhibited high success. PRBO monitoring sites at Vandenberg Air Force Base had breeding populations among the largest in their history and exceptionally high productivity for Brandt's Cormorants (Robinette et al. 2012; J. Howar pers. comm). Once again, continuing localized prey depletion likely played a major role in the failure of the SEFI colony.

Productivity of Western Gulls continued to be extremely poor for the fourth consecutive year despite a small increase over the 2011 season (Fig. 1). Low breeding effort and high rates of intraspecific predation coupled with low food availability continue to contribute to overall poor success. Most of the chicks that hatched disappeared within a few days as they were consumed by neighbors or non-breeding adults. In one case a chick was witnessed being consumed by its own parent. As mentioned above, prey availability is likely a major factor in the continued poor reproductive performance of the

Western Gulls. It is possible that even when prey is abundant in the area, it is simply not accessible to surface feeders.

Populations:

Breeding population sizes were lower than the 2011 estimates for all species except Cassin's Auklet, Pigeon Guillemot and Pelagic Cormorant. Population increases ranged from 5% for PECO and PIGU to 9% for CAAU when compared to last season, while decreases ranged from 1% for TUPU to 66% for California Gulls.

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. Occupancy of monitored PIGU crevices was approximately 65% during 2012, down approximately 10% from last season. This suggests that there was a lower breeding effort this season despite an overall increase in the number of birds observed at the colony.

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, coupled with relatively strong reproductive success and probable elevated juvenile survival between 2000 and 2004 led to incredible population growth since 2000. 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 12% decrease in murre numbers this year when compared to 2011 but approximately equal to the values from 2010. This is in opposition to what has been an overall increasing trend over the past decade. The apparent decrease observed this season is likely due to less favorable foraging conditions this season and possibly a reduced number of non-breeding birds attending the colony. 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 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 2012 were 10% higher than in 2011 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. This is the third straight 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; PRBO 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 2011 was a new high number of active nest sites ever observed for this species on the Farallones. The number of active sites in 2012 was essentially equal to last year with just one fewer site detected.

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. During 2012, we saw an decrease in the number of birds captured with 26 birds/hour of netting effort (s.e. = 5.7, n= 6; see Fig. 10). This value was approximately equal to the value from 2010. 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. 2012). 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 SEFI storm-petrel population is expected to decrease by 27.4% over a 10 year period (Nur et al. 2012).

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 and has not recovered. The 2009 population estimate was the lowest ever recorded for the Farallones and the population continues to be less than 25% of the population observed before the crash. 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 two years, indicates that there was likely significant adult mortality during this period. 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 then began to slowly increase. During 2012, the population was slightly higher than last season, but still much reduced compared to pre-2005 populations.

In summary, 2012 was a mixed for Farallon seabirds. Cassin’s Auklets were again able to take advantage of high zooplankton production and fledge many chicks. Likewise, murres were able to capitalize on a brief period of high rockfish abundance in the early season to achieve greater breeding success. However, less favorable ocean conditions and a lower abundance of forage fishes, particularly juvenile rockfish later in the season, likely contributed to the decline in productivity for other species when compared to last season. In contrast, Brandt’s Cormorants again suffered very low reproductive success, Pelagic cormorants failed to fledge any chicks and Western Gulls continued to have very low reproductive success. It seems that an overall depletion in the abundance of anchovies and other larger forage fish species resulted in very poor foraging conditions, reduced breeding success and reduced breeding effort for these species. The continuing poor performance of Brandt’s Cormorants and the increasing unpredictability of prey resources in particular are of great concern.

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 2012 and the results are available in Nur et al. (2012). 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.

LITERATURE CITED

Ainley, D.G., W. J. Sydeman, S.A. Hatch, and U.W. Wilson. 1994. Seabird population trends along the west coast of North America: causes and the extent of regional concordance. Studies in Avian Biology 15: 119-133.

Ainley, D.G. and T.J. Lewis. 1974. The History of Farallon Island Marine Bird Populations, 1854-1972. Condor 76:432-446.

Ainley, D.G. and R.J. Boekelheide (eds.) 1990. Seabirds of the Farallon Islands: Ecology, Dynamics, and Structure of an Upwelling-system Community. Stanford University Press. Stanford, CA.

Ainley, David, D. A. Manuwal, Josh Adams and A. C. Thoresen. 2011. Cassin's Auklet (Ptychoramphus aleuticus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/050 doi:10.2173/bna.50

Bradley, R., P. Warzybok, D. Lee, and J. Jahncke. 2011. Assessing Population Trends of the Ashy Storm Petrel on Southeast Farallon Island, California. Unpublished report to the US Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California. PRBO Contribution Number 1780.

Barber, R.T., F.P. Chavez, and J.E. Kogelschatz. 1985. Biological effects of El Niño. pp. 399-438. In: M. Vegas (Ed) Seminario Regional Ciencas Tecnologia y Agression Ambiental: El Fenomeno ‘El Niño’. Contec Press, Lima, Peru.

Carter. H.R., G.J. McChesney, D.L. Jaques, C.S. Strong, M.W. Parker, J.E. Takekawa, D.L. Jory, and D.L. Whitworth. 1992. Breeding populations of seabirds in California, 1989-1991. Unpublished Report of the U.S. Fish and Wildlife Service, Dixon, California.

Hester, M.M., T.G. Schuster, W.J. Sydeman, and P. Pyle. 1996. Population size and reproductive performance of seabirds on Southeast Farallon Island, 1996. Report to the Farallon National Wildlife Refuge, Newark, California.

Nur, N. and W.J. Sydeman. 1999. Survival, breeding probability, and reproductive success in relation to population dynamics of Brandt’s Cormorants *Phalacrocorax penicillatus*. Bird Study, 46:2-13.

Nur, N. and W.J. Sydeman. 2002. Statistical analysis of the ‘k’ correction factor used in population assessments of murres: Implications for monitoring. Unpublished Final Report, Point Reyes Bird Observatory, Stinson Beach, CA; U.S. Fish and Wildlife Service, Newark, CA.

Nur, N., R. Bradley, L. Salas, and J. Jahncke. 2012. Modeling the Impacts of House Mouse Eradication on Southeast Farallon Island. Unpublished report to the US Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California. PRBO Contribution Number 1880

Robinette, D.P., J. Howar, A. Fleishman, and L. De Maio. 2012. Seabird Population Dynamics and Roost Utilization at Vandenberg Air Force Base, 2012. Unpublished Report, PRBO Conservation Science, Petaluma, CA.

Sakuma, K. 2011. Rockfish Recruitment and Ecosystem Assessment Cruise Report: May1-26, 2011. Unpublished report. NOAA NMFS SWFSC FED, Santa Cruz, CA.

Sydeman, W.J., S.D. Emslie, and P. Pyle. 1987. Population size and reproductive success of seabirds breeding on the Farallon Islands National Wildlife Refuge in 1987. Report to the Farallon National Wildlife Refuge, Newark, California.

Sydeman, W.J., H.R. Carter, J.E. Takekawa, and N. Nur. 1997. Common Murre *Uria aalge* population trends at the South Farallon Islands, California, 1985-1995. Unpublished Final Report, Point Reyes Bird Observatory, Stinson Beach, CA; U.S. Geological Survey, Dixon, CA; and U.S. Fish and Wildlife Service, Newark, CA.

Sydeman, W.J., N. Nur, E.B. McLaren, and G.J. McChesney. 1998. Status and trends of the Ashy Storm-petrel on Southeast Farallon Island, California, based upon capture-recapture analyses. The Condor, 100: 438-447.

Sydeman, W.J., M.M. Hester, J.A. Thayer, F. Gress, P. Martin, J. Buffa. 2001. Climate change, reproductive performance and diet composition of marine birds in the southern California Current system, 1969-1997. Progress in Oceanography, 49:309-329.

Thayer, J.A., T.C. Murray, M.M. Hester, and W.J. Sydeman. 1998. Conservation biology of rhinoceros auklets, *Cerorhinca monocerata*, on Año Nuevo Island, California, 1993-1998. Progress report to Año Nuevo State Reserve, California Department of Parks and Recreation, Bay Area District, California.

Thayer, J.A. and W.J. Sydeman. 2002. Breeding biology and ecology of Rhinoceros auklets, *Cerorhinca monocerata*, on Año Nuevo Island, California, 2002: Population assessments and estimates of food requirements. Unpublished report to the National Fish and Wildlife Foundation. PRBO Conservation Science, Stinson Beach, CA.

Table 1. Mean (± 1 SD) productivity of eight species of seabirds at Southeast Farallon Island, California, 2012. 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	2.67 ± 0.72 *(57)*	0.84 ± 1.18 *(58)*	0.05 ± 0.22 *(58)*	0.05 ± 0.22 *(58)*	0.28 ± 0.40 *(57)*	0.06 ± 0.16 *(22)*
PECO	3.17 ± 0.41 *(6)***	0.24 ± 0.62 *(21)***	0.00 *(29)*	0.00 *(29)*	0.13 ± 0.25 *(4)*	0.00 *(3)*
WEGU	2.46 ± 0.63 *(184)*	1.25 ± 1.09 *(185)*	0.34 ± 0.63 *(186)*	0.34 ± 0.63 *(186)*	0.50 ± 0.41 *(183)*	0.26 ± 0.34 *(122)*
COMU* USP	1.00 (222)	0.88 ± 0.33 (222)	0.77 ± 0.42 (221)	0.78 ± 0.41 (221)	0.88 ± 0.33 (222)	0.88 ± 0.32 (194)
COMU* Upper Upper	1.00 (90)	0.66 ± 0.48 (90)	0.40 ± 0.49 (90)	0.44 ± 0.50 (90)	0.66 ± 0.48 (90)	0.62 ± 0.49 (58)
PIGU	1.68 ± 0.47 *(75)*	1.33 ± 0.72 *(75)*	0.64 ± 0.54 *(72)*	0.67 ± 0.53 *(72)*	0.80 ± 0.37 *(75)*	0.54 ± 0.40 *(61)*
RHAU*	1.00 *(73)*	0.74 ± 0.44 *(72)*	0.44 ± 0.50 *(73)*	0.44 ± 0.50 *(73)*	0.74 ± 0.44 *(72)*	0.60 ± 0.49 *(53)*
CAAU*	1.00 (43)	0.84 ± 0.37 *(43)*	0.81 ± 0.39 *(43)*	1.23 ± 0.57 *(43)*	0.84 ± 0.37 *(43)*	0.97 ± 0.17 *(36)*
ASSP*[1]	1.00 (37)	0.86 ± 0.35 *(37)*	0.57 ± 0.50 *(37)*	0.57 ± 0.50 *(37)*	0.86 ± 0.35 *(37)*	0.68 ± 0.48 *(31)*

* 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

[1] ASSP productivity estimates based on all sites which completed breeding by Nov. 1st

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, 2002-2012. Estimates include Southeast and West End Islands unless otherwise noted.

Species	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2002-2011 average
DCCO	220	360	260	194	206	444	474	130	458	392	486	340
BRCO	3,450[b]	4,916	5,132	1,248	4,840	20,788	15,692	11,732	16,754	11,222	9,466	10,179
PECO	298[b]	206	230	268	250	64	40	28	706	510	442	274
WEGU	15,846	17,406	18,218	15,747	20,152	15,852	17,399	16,547	17,969	16,838	15,095	17,122
CAGU	70	208	396	192	534	-	-	-	-	-	-	333
BLOY	48	48	38	38	40	42	36	30	26	26	22	35
COMU	[e]	[e]	271,787[e]	242,759[e]	248,321[e]	250,032[e]	211,355	183,092	169,079	107,105	103,588	154,844
PIGU [d]	3,645	3,461	3,317	2,851	2,875	2,774	2,607	1,375	2,530	2,383	1,964	2,614
TUPU [c]	244	246	234	216	106	59	108	82	166	?	130	150
CAAU [a]	19,609	17,866	12,964	14,512	16,120	19,540	13,597	16,202	29,229	23,692	18,807	18,253

[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).

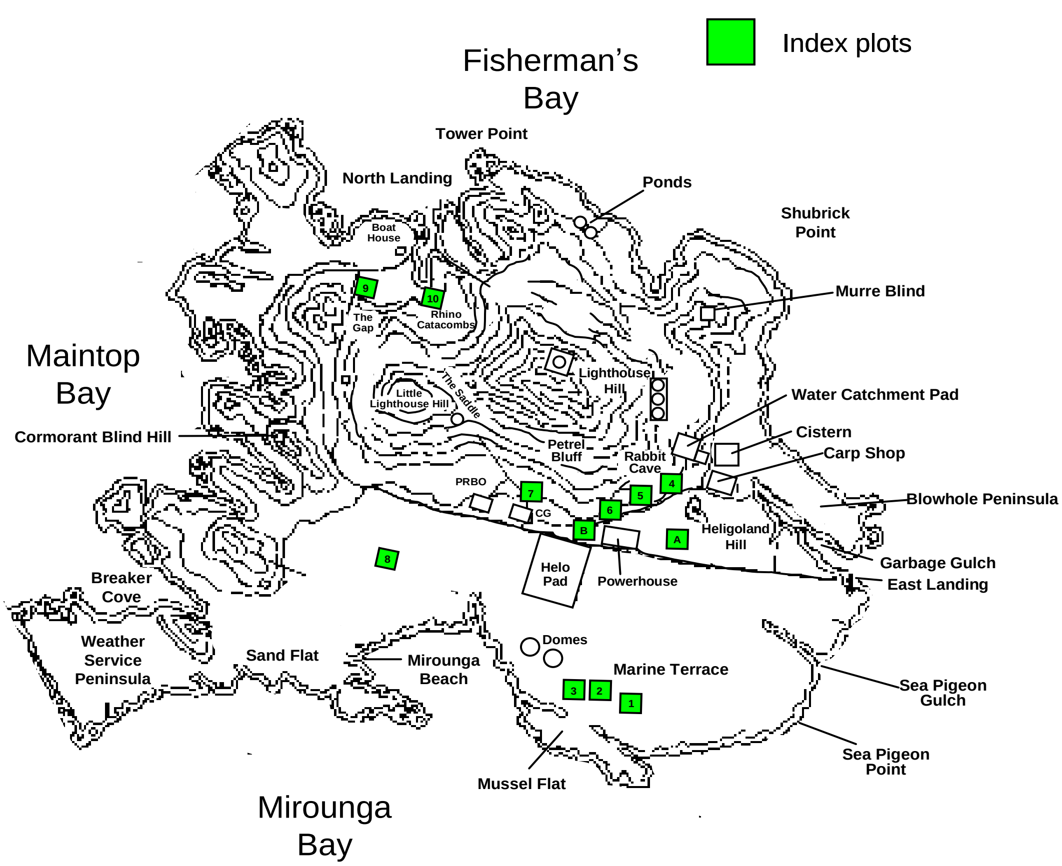
[e] No complete census done. See percent change in Index Plot counts for trends (Figure 11 and text).

Table 3. Cassin's Auklet burrow counts from 12 (10m x 10m) index plots on Southeast Farallon Island for 2012. 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
2002	20	9	20	14	20	14	8	13	47	45	6	15	231
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
2002-2011 average	19	12	24	14	15	7	12	10	72	34	4	16	239

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

Cassin's Auklet Index Plots



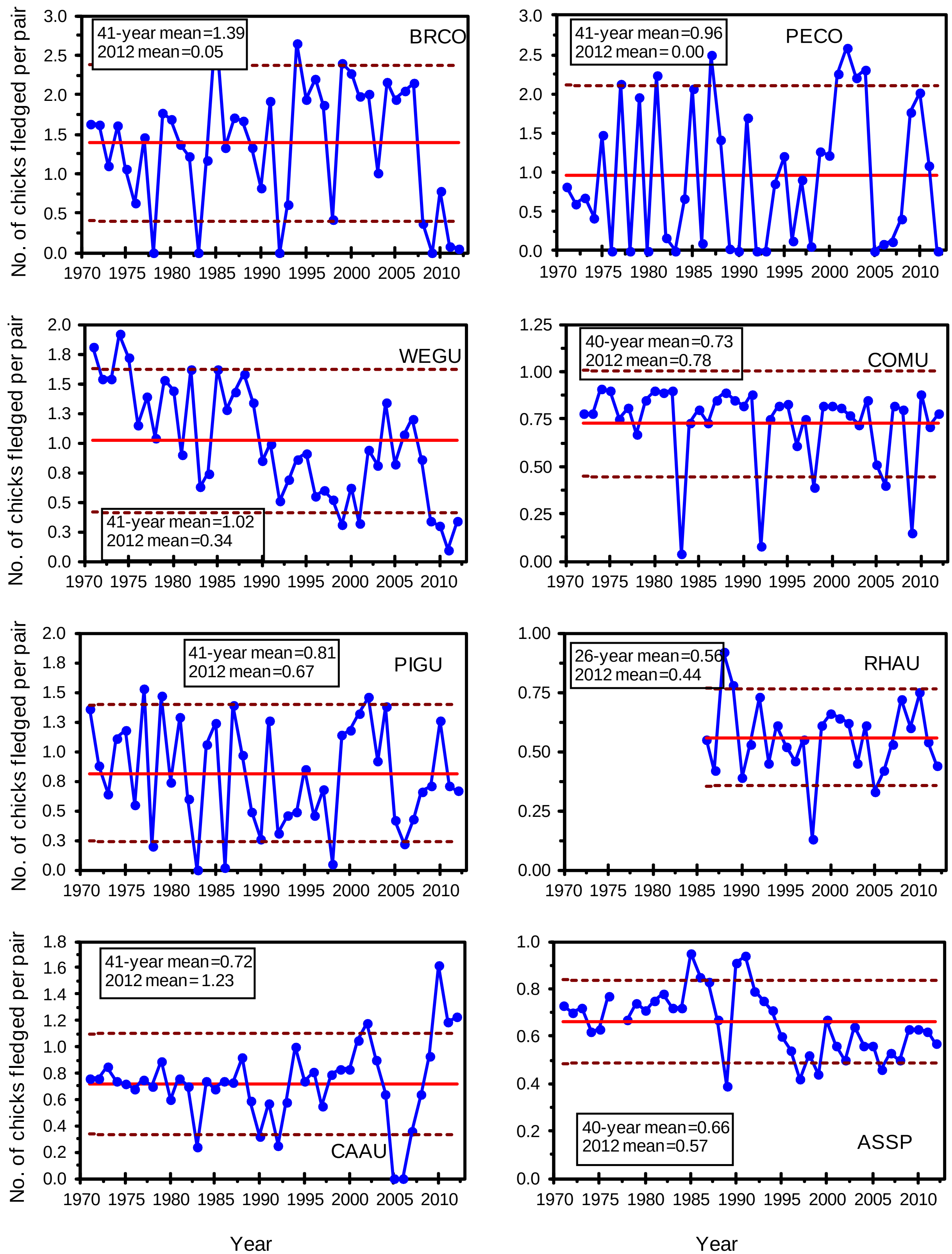


Fig. 1a. Productivity of 8 species of seabirds on Southeast Farallon Island, 1971-2012. Productivity is measured as number of chicks fledged per breeding pair (includes first attempts, relays and second broods). The bold horizontal line indicates mean productivity from all attempts between 1971 and 2011. The dashed lines represent the 80% confidence interval for the long term mean. Please note the different scales on the y-axis.

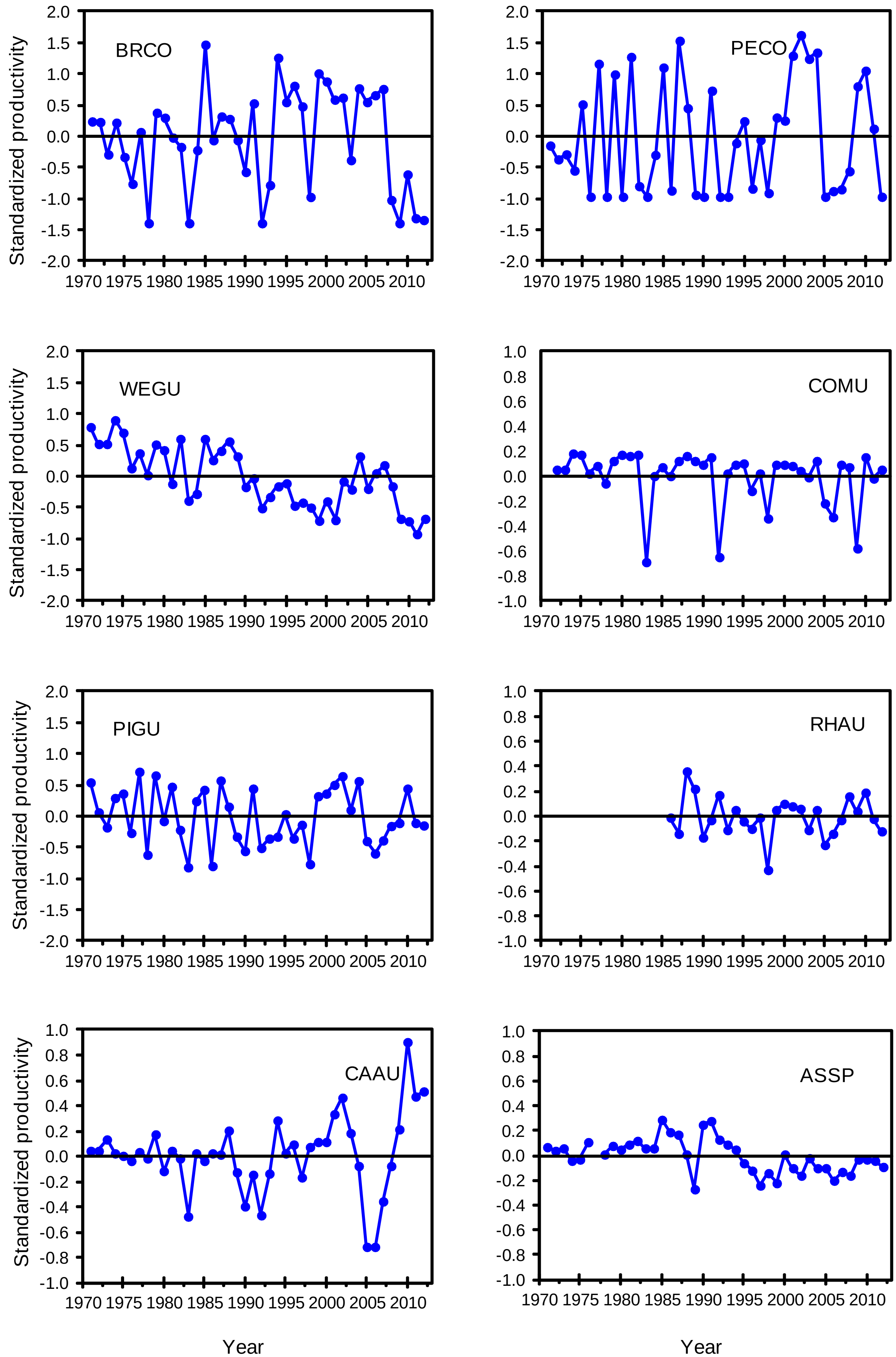


Fig 1b. Standardized productivity anomalies (annual productivity - long term mean) for 8 species of seabirds on SEFI, 1971-2012.

Brandt's Cormorant Census

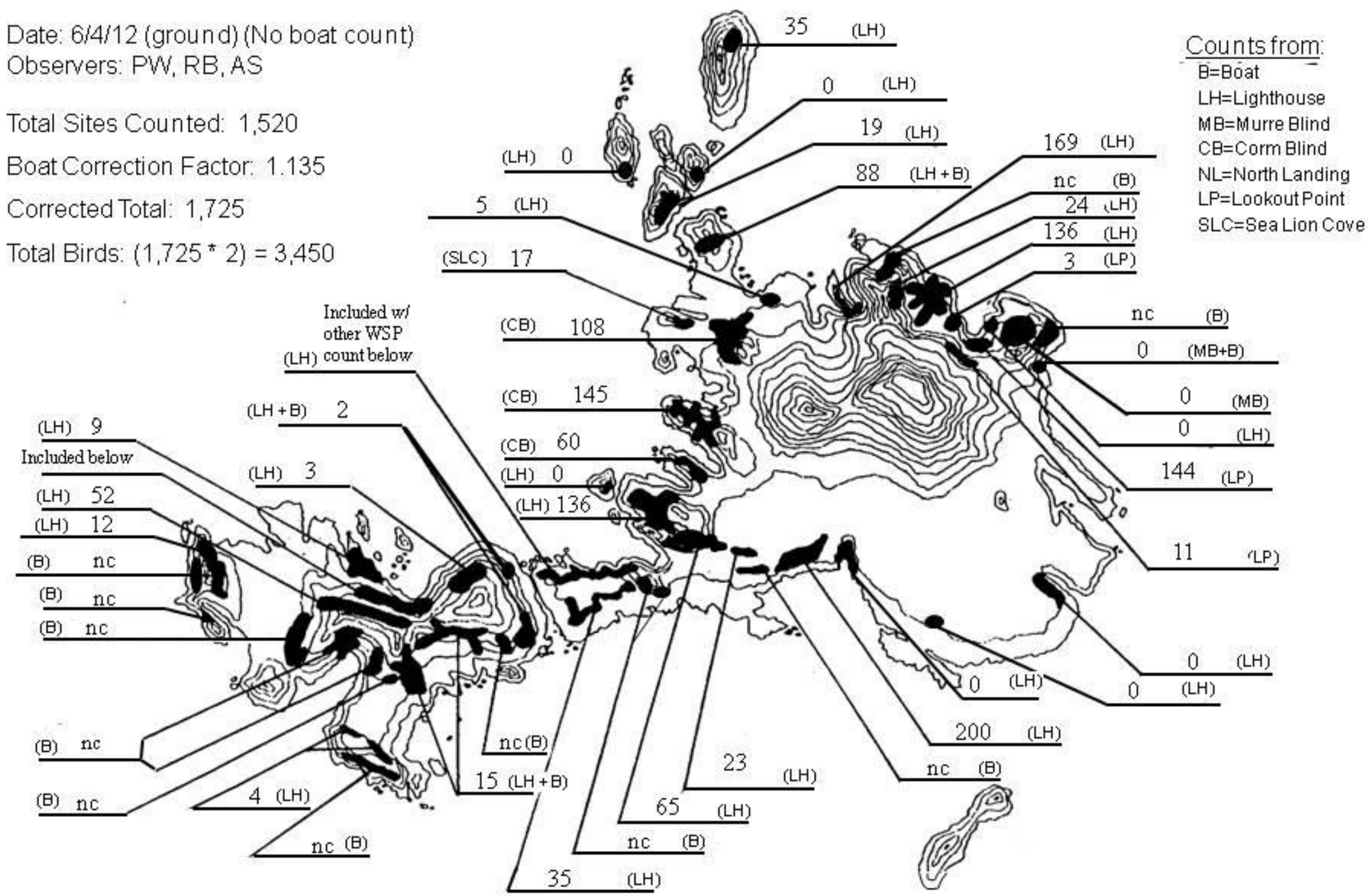


Figure 2: Counts of Brandt's Cormorants on Southeast Farallon Island during the 2012 census. Surveys were conducted from the following locations: Lighthouse Hill (LH), Murre Blind (MB), Cormorant Blind (CB), North Landing (NL), and Boat (B).

Pelagic Cormorant Census

Date: 6/4/12 (ground) (no boat count)
Observers: PW, RB

Total Sites Counted: 108

Boat Correction Factor: 1.383

Corrected Total: 149

Total Birds: (149 * 2) = 298

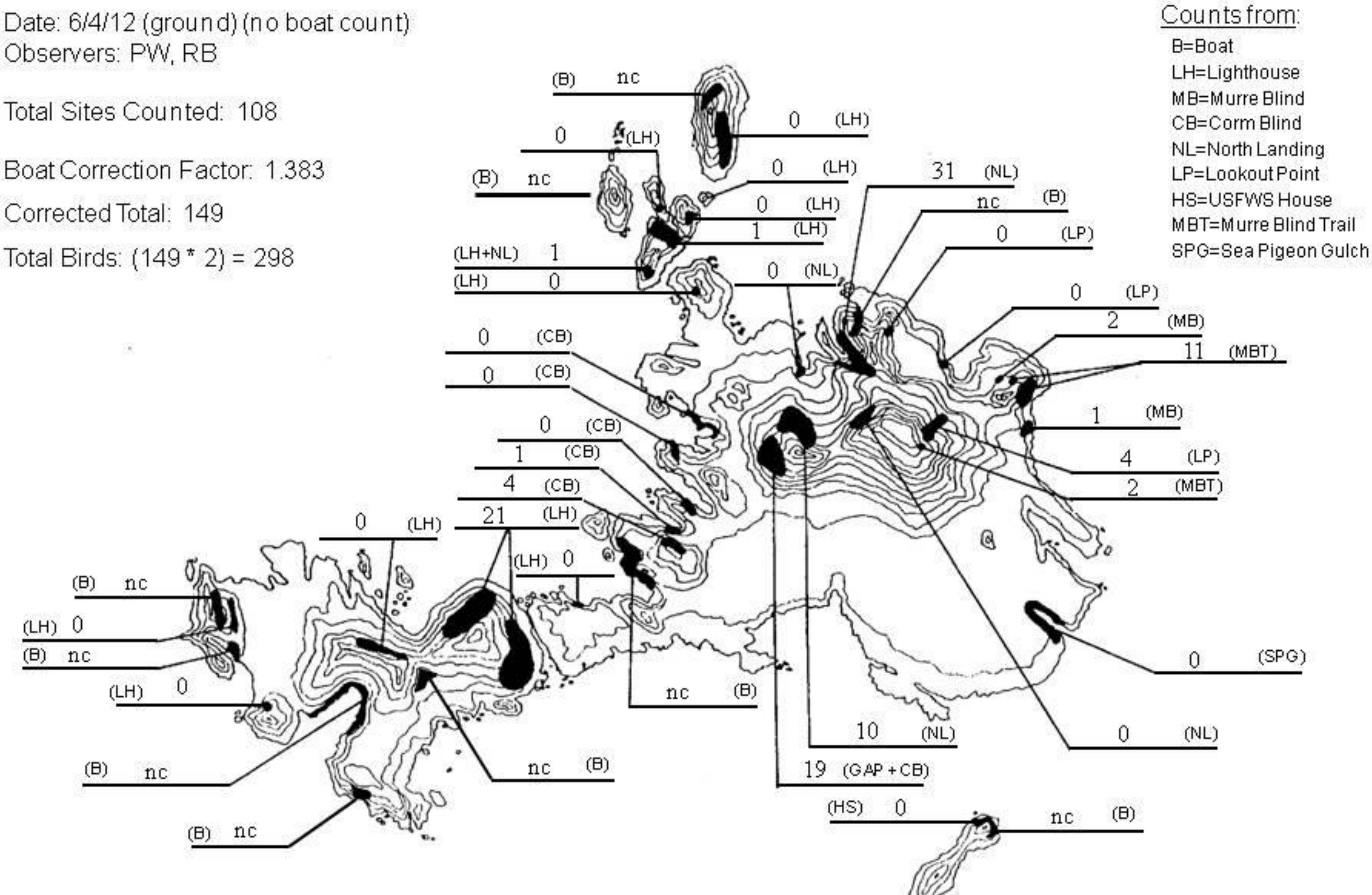


Figure 3: Counts of Pelagic Cormorants on Southeast Farallon Island during the 2012 census. Surveys were conducted from the following locations: Lighthouse Hill (LH), Lookout Point (LP), Murre Blind (MB), Cormorant Blind (CB), North Landing (NL), USFWS House (HS), Murre Blind Trail (MBT), Sea Pigeon Gulch (SPG), and Boat (B).

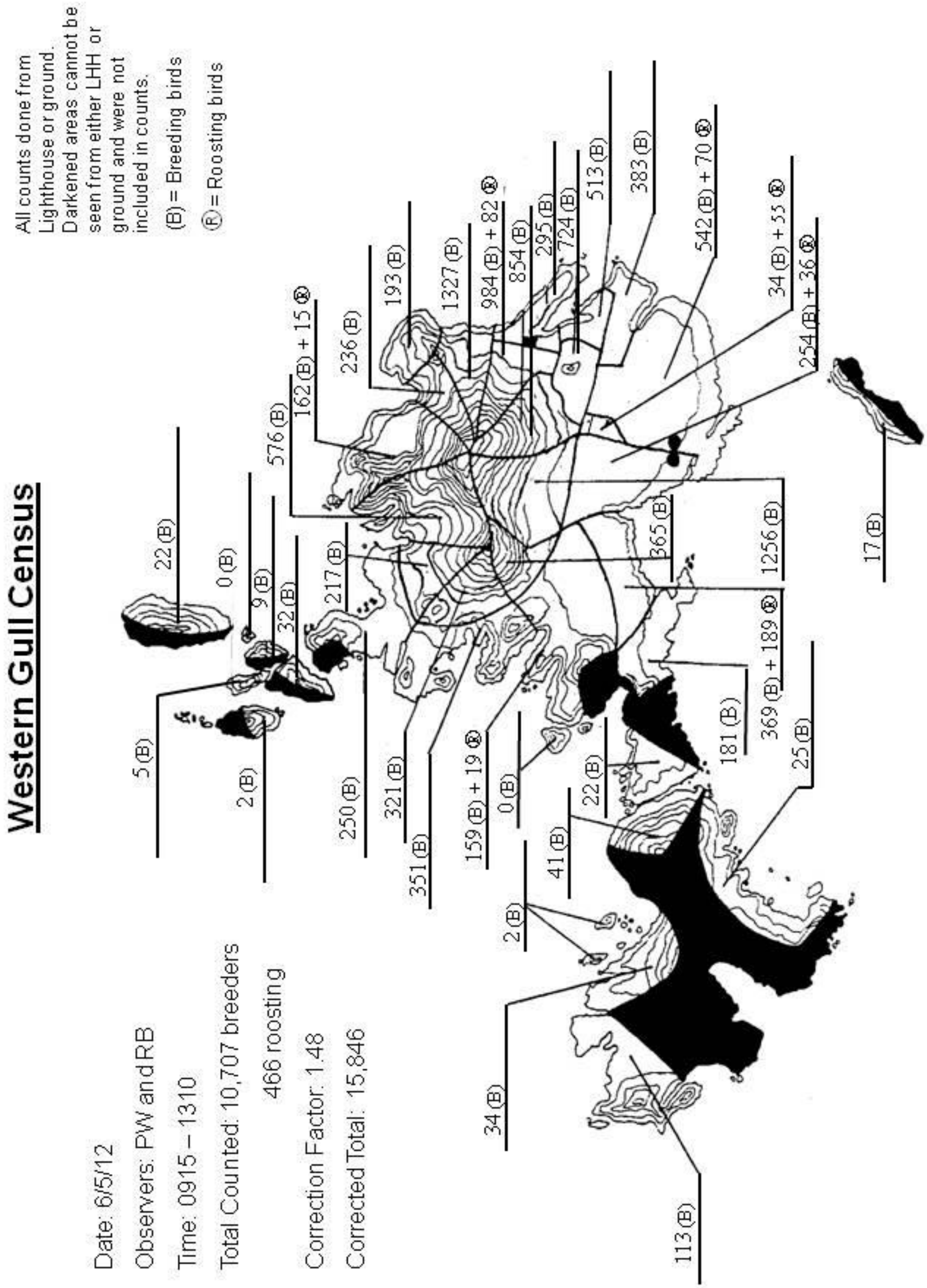


Figure 4: Counts of Western Gulls on Southeast Farallon Island during the 2012 census.

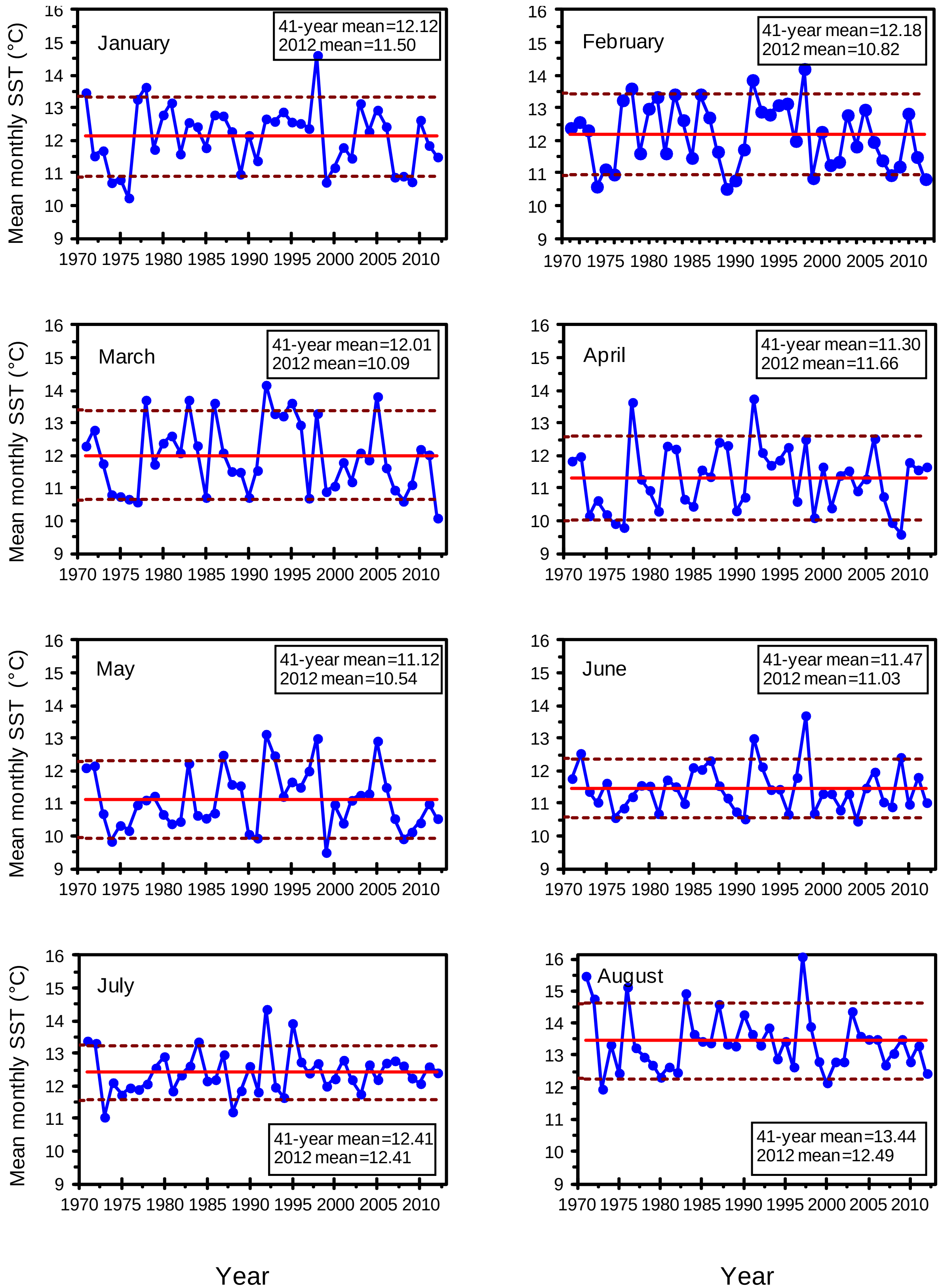


Fig. 6a. Monthly mean sea surface temperature (SST) at Southeast Farallon Island, 1971-2012. SST was measured daily from Water Sample Point, near East Landing. The bold horizontal line indicates mean monthly SST from 1971 to 2011. The dashed lines represent the 80% confidence interval for the long term mean.

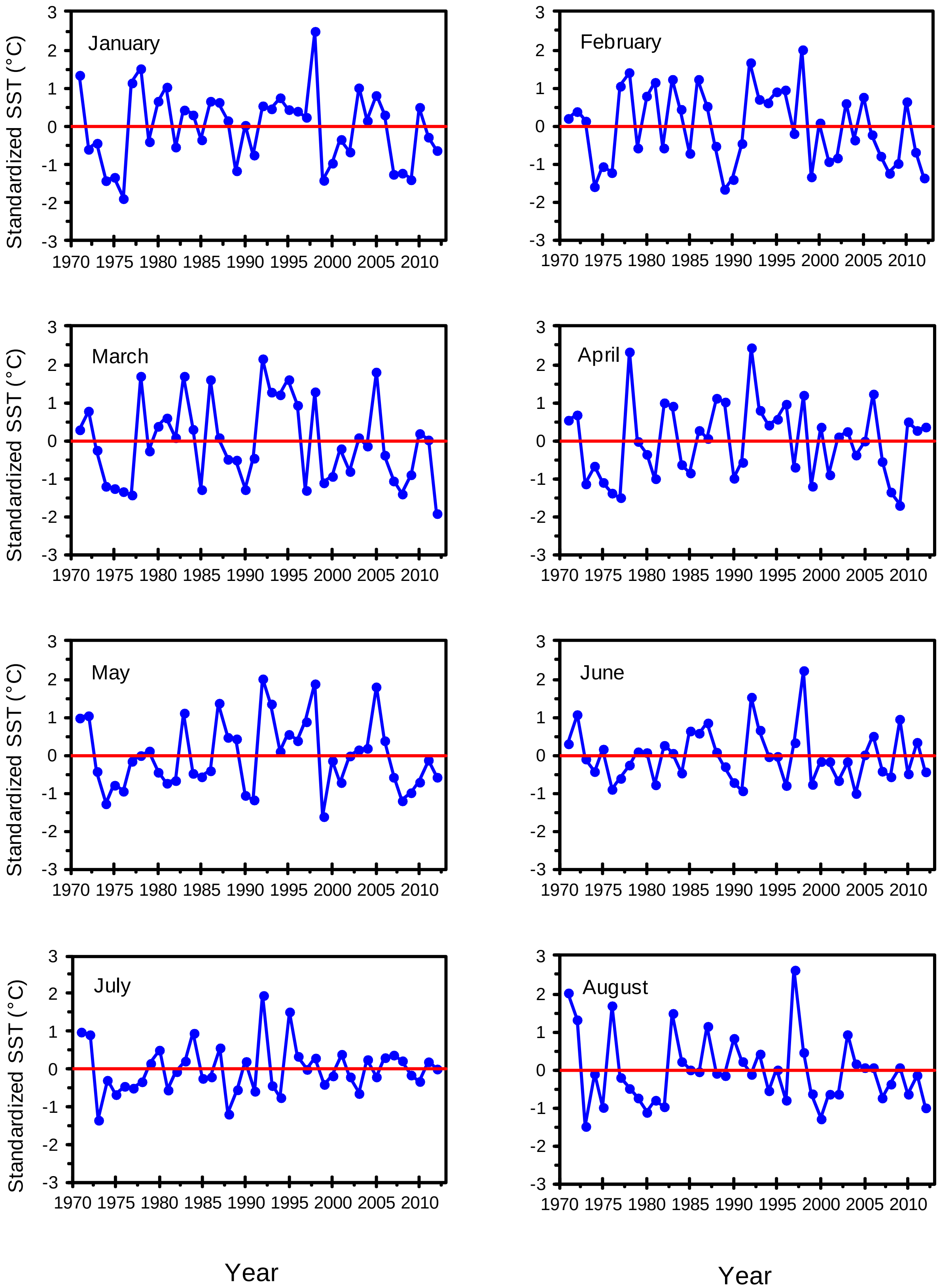


Fig. 6b Standardized Sea Surface Temperature (SST) anomalies (annual mean - long term mean) for SEFI, 1971-2012.

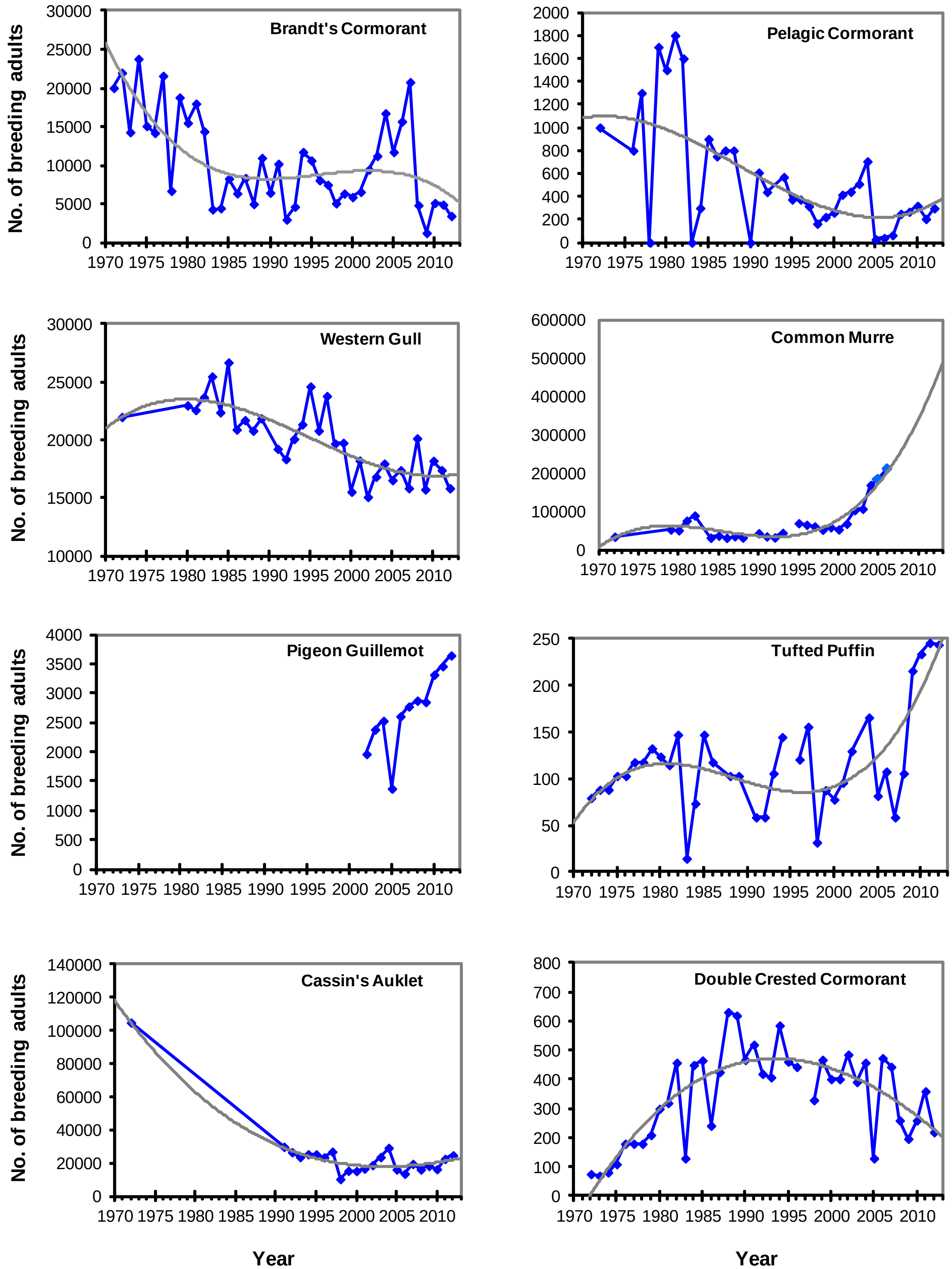


Fig. 7 Population trends for 8 species of seabirds on Southeast Farallon Island, 1972-2012. Populations were determined by counting either individuals or nests on all visible areas on SEFI and West End. We have fitted a third order polynomial trend line (in gray) for each species to help illustrate long term population trends. Please 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 estimates have not been made since 2006 (see Fig. 11 and text).

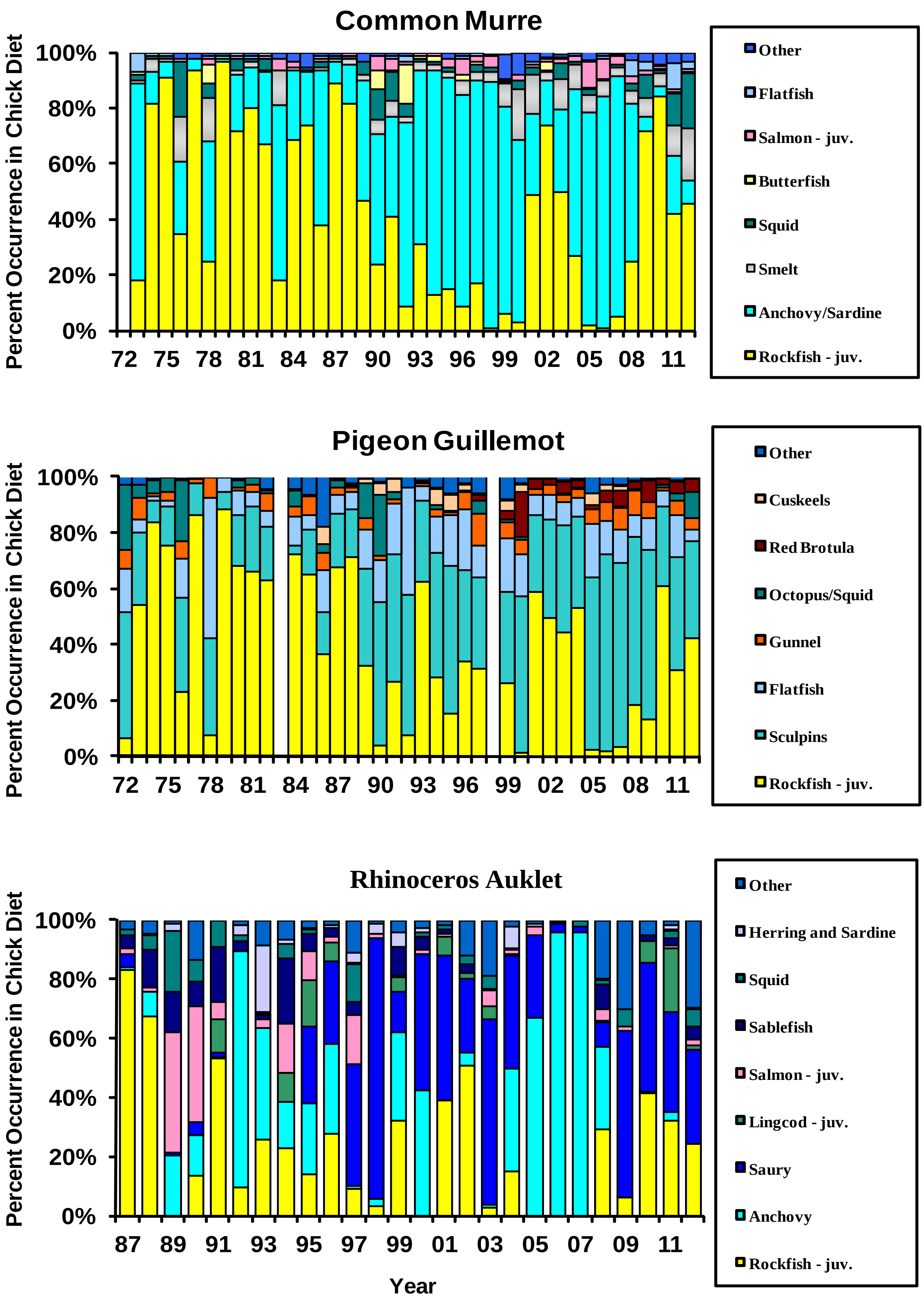


Fig. 8 Percent occurrence of common prey items by year in the diet of three species of seabirds on Southeast Farallon Island.

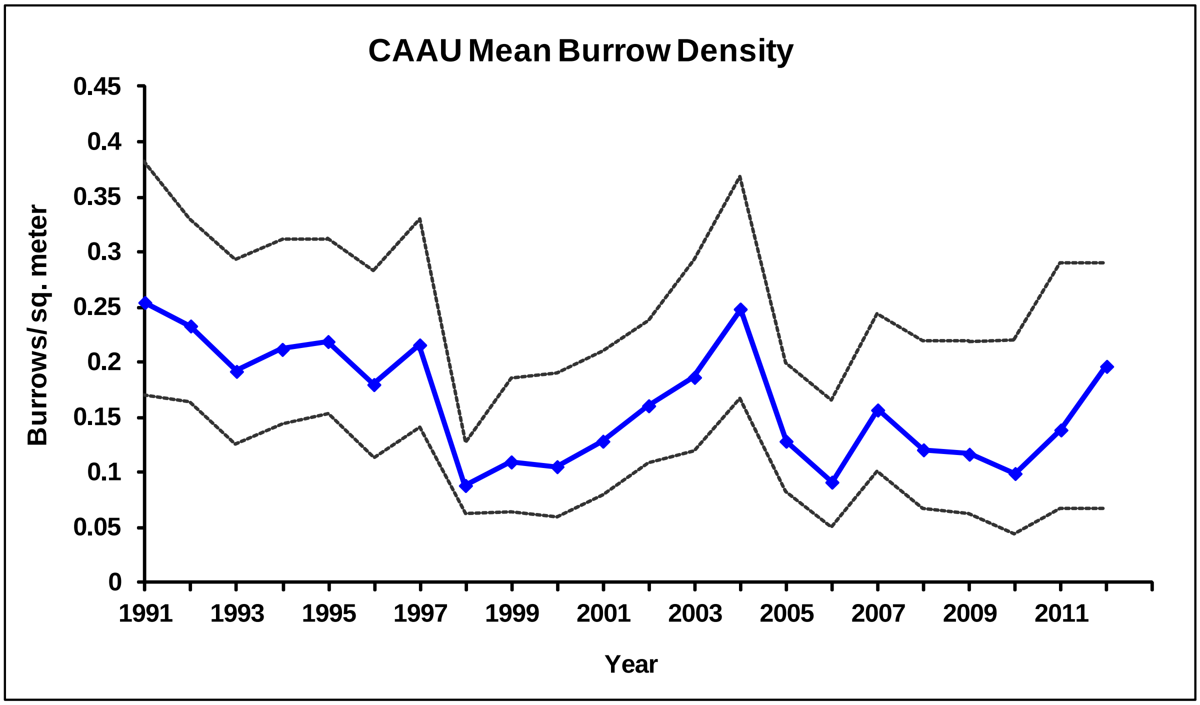


Fig. 9. Geometric mean burrow/crevice density in our 12 Cassin's Auklet Index Plots from 1991 to 2012. The blue line represents the annual mean values. The dashed lines represent the upper and lower bounds of the 95% confidence interval.

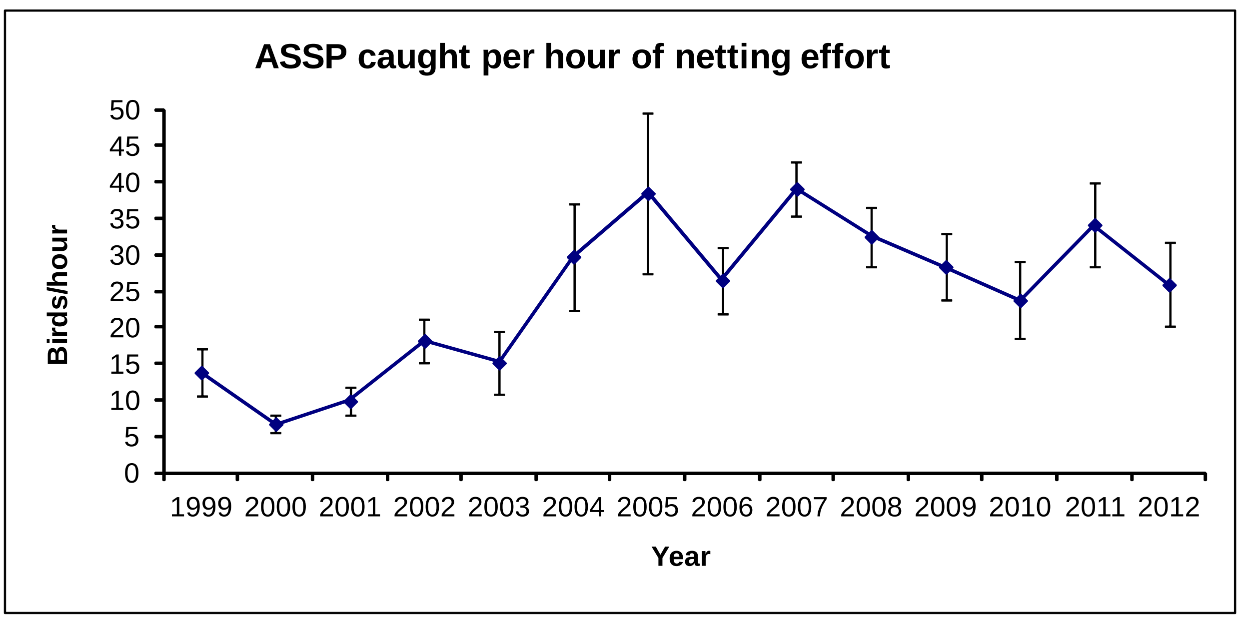


Fig 10. Mean number of Storm-petrels caught per hour of netting effort on SEFI from 1999 to 2012. Error bars represent the standard error for the mean calculated from all capture sessions in a given season.

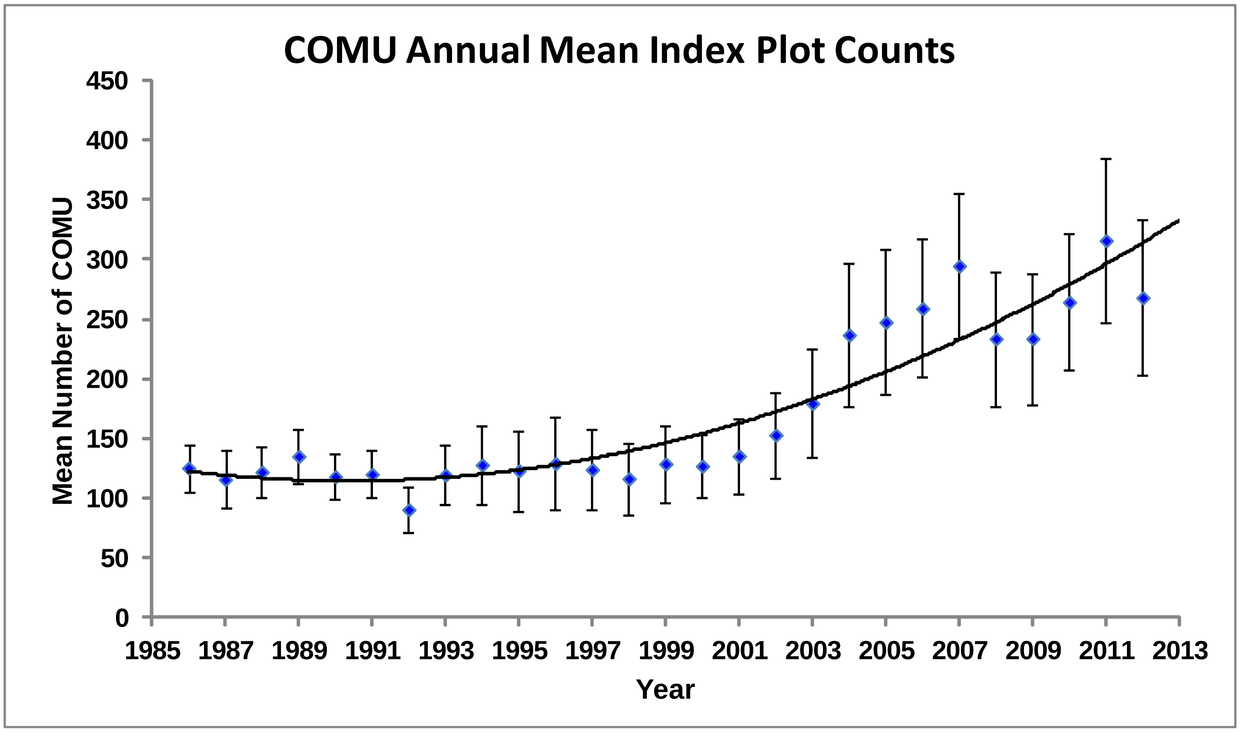


Fig. 11. Mean annual counts for Common Murre Index Plots from 1986 to 2012. Error bars represent the standard error of the mean calculated from all plots counted in any given season.

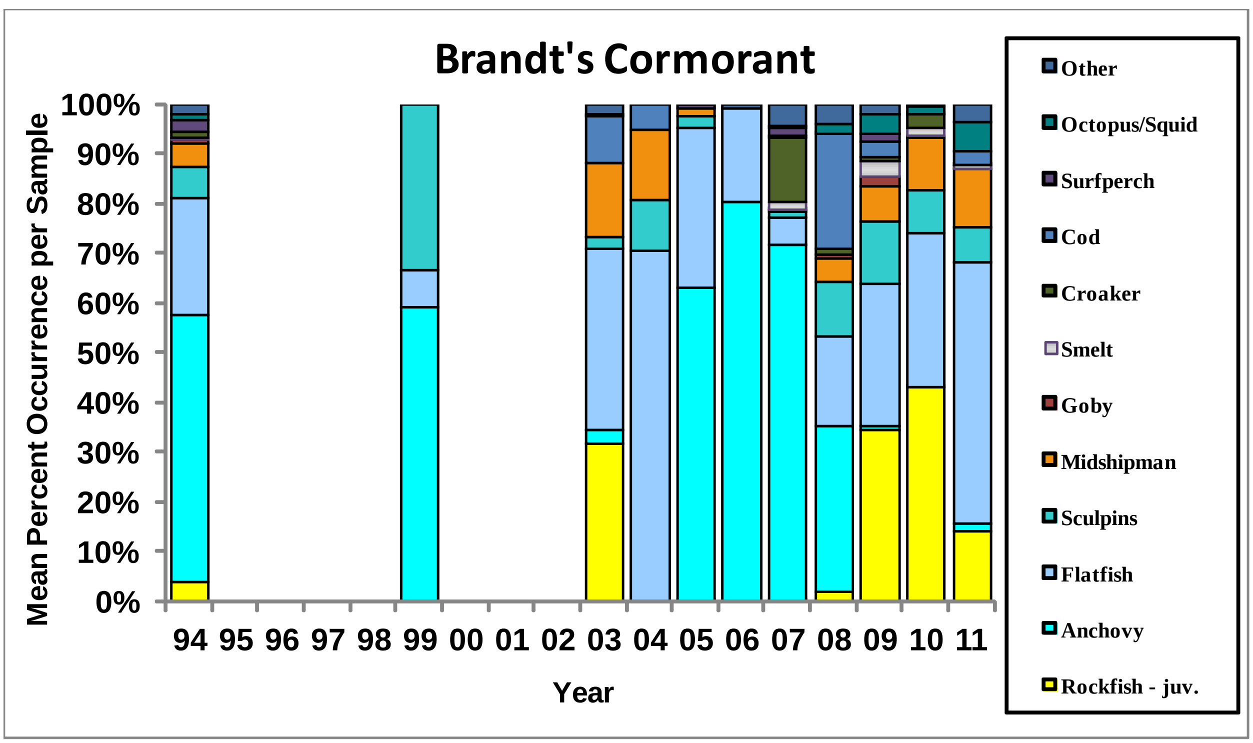


Fig. 12 Mean percent occurrence per sample of common prey items by year in the diet of Brandt's Cormorants on Southeast Farallon Island.

Appendix I. Calculation of correction factor for Western Gull census, 2012.

Area	Nest Count	Bird Count	Correction Factor
C	99	158	1.253
K	122	165	1.479
H (H1 only)	270	317	1.703
Total			**1.478**

Appendix II. Calculation of correction factor for Common Murre colony attendance, 2012. 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)	222	259	1.71
June 5 (1000)	222	267	1.66
June 6 (1000)	222	253	1.75
June 7 (1000)	222	259	1.71
Mean	222	260	**1.71**

UU

Date (Time)	Breeding Sites	No. of birds	Correction Factor
June 4 (1000)	90	106	1.70
June 5 (1000)	90	106	1.70
June 6 (1000)	90	101	1.78
June 7 (1000)	90	109	1.65
Mean	90	106	**1.71**

X plot

Date (Time)	Breeding Sites	No. of birds	Correction Factor
June 4 (1000)	94	150	1.25
June 5 (1000)	94	156	1.21
June 6 (1000)	94	140	1.34
June 7 (1000)	94	153	1.23
Mean	94	150	**1.26**

Mean correction factor for SEFI 2012: **1.56**