Point Blue Report

Population size and reproductive performance of seabirds on Southeast Farallon Island, 2014

Report to the U.S. Fish and Wildlife Service
Farallon National Wildlife Refuge

December 2014

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Warzybok, P.M., M. Johns, and R.W. Bradley. 2014. Population Size and Reproductive Performance of Seabirds on Southeast Farallon Island, 2014. Unpublished report to the U.S. Fish and Wildlife Service. Point Blue Conservation Science, Petaluma, California. Point Blue Conservation Science Contribution Number 2010.

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 2014, breeding populations increased or remained stable for all species except Brandt's Cormorant and Western Gull, when compared to 2013. Cassin's Auklets had the highest rate of nest box occupancy we have ever recorded, as well as the highest population estimates in a decade. Tufted Puffin and Pigeon Guillemot populations are at their highest numbers in our 45 years of monitoring.

(3) Reproductive success was lower for most species when compared to 2013, but remained near or above long-term mean values. Pigeon Guillemots, Pelagic cormorants (highest in 12 years) and Ashy Storm-Petrels (highest in 20 years) were the only species to exhibit higher reproductive success during 2014.

(4) Brandt's Cormorants suffered nest loss and abandonment early in the season, but rebounded to achieve overall high productivity as in 2013. Cassin's Auklets had the highest success for first broods in 45 years but failed to fledge any chicks from second attempts for the first time since 2008.

(5) In general, breeding success was high in the early to mid-season but declined in the last month due to an incursion of warm, nutrient poor water into the region. Chick growth rates and fledging success declined while chick mortality (mostly due to starvation) increased in July and August.

(6) Sea-surface temperature (SST) was warmer than average throughout the spring and summer. The mean seasonal SST for 2014 was the warmest since 1998 and approximately 1.2°C above the long term average. The mean monthly values for both July and August were the second warmest for those months in the last 45 years.

(7) The proportions of juvenile rockfish (Sebastes spp.) in chick diet were at their highest levels in 27 years. Anchovies remained virtually absent. Krill was also abundant close to the island through mid-July. Both krill and juvenile rockfish are important prey resources which disappeared from seabird diet in the late summer, leading to late season nest failures.

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 2014. 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 2014. Canada Geese did breed for the fifth straight year and fledged two chicks.

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 43 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 2014. After suffering very poor reproductive performance from 2008 to 2012, this marks the second year in a row of high reproductive success. Mean productivity for the colony was 2.36 fledglings per pair. While this is slightly (3%) lower than last season it remains more than 70% higher than the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 7 May at the Corm Blind and 13 May at the Sea Lion Cove colony. The mean laying date for the colony was 27 May. This is approximately 2 weeks later than last season and 9 days later than the long-term mean for this species. Of the 108 sites followed for productivity assessment, 17.5% (19 nests) were abandoned after egg laying. In addition, there were 13 well-built nests established by banded individuals and many more that were initiated by unbanded birds that were abandoned before any eggs were detected. This is significantly higher than the 3.6% abandonment rate observed during 2013, but well below the rates observed during 2008 to 2012. Mean clutch size was 3.0 eggs per nest and hatching success was 65%. Mean brood size was 2.10 chicks per nest, 94% of which survived to fledging age.

Pelagic Cormorant **–** PECO also experienced very high reproductive performance during 2014. Mean productivity for the colony was 2.34 chicks fledged per breeding pair. This is the highest success for this species since 2002 and the 3rd highest on record for the Farallon colony. 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 3.16 eggs per nest, and brood size was 2.69 chicks per nest. Eggs and/or chicks were observed in 50 of the 93 followed sites and there were an additional 3 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 3 June. Four nests were abandoned during 2014 and an additional nest was taken over by a Brandt's cormorant after chicks had hatched.

Western Gull **–** WEGU productivity declined in 2014 when compared to last season, resulting in an average of 0.76 chicks per pair. This is 30% lower than 2013 and 24% below the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on the island on April 26th and in study plots on May 1st. Sixty-seven percent of the eggs hatched but only 39% of those chicks survived to fledge. Mean clutch size was 2.75 eggs per nest and mean brood size was 1.88 chicks per nest.

California Gull **–** CAGU once again suffered complete reproductive failure during 2014. 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. Productivity for this species 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 2014, of which 23 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 15 of these sites (65%). A total of only 4 chicks fledged from these nests, yielding an average estimate of 0.26 fledglings produced per pair. While the number of breeding sites was greater than last season, there was a 76% reduction in the number of chicks produced, making 2014 the lowest productivity observed for this species since we began keeping records in 1997. The first eggs were observed on May 9th and the first chicks on June 8th. BLOY nests are cryptic and difficult to observe; therefore clutch size, hatching success and fledging success were not determined.

Common Murre **–** During 2014, 266 Common Murre sites were monitored daily in the Upper Shubrick Point (USP) study plot, of which 242 were breeding sites (where an egg was laid). Productivity was 0.67 chicks fledged per pair. This is approximately 18% lower than last season and 8% below the long-term average of 0.73 (Fig. 1a). The first egg was observed in this plot on 29 April, approximately two weeks earlier than last year. Overall mean laying date for the plot was 14 May; approximately equal to the long-term mean laying date for this colony. Hatching success was very low with only 67% of eggs hatching. However, 94% 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 May 3rd this season and the mean lay date for the plot was 18 May. There were a total of 138 sites monitored this season (up 2 from 2013); 89 of which were breeding sites. Reproductive success for this colony was higher than USP in 2014 with 0.82 chicks fledged per breeding pair. Eighty-two percent of the eggs hatched and 99% 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 122 sites were monitored during 2014, of which 87 were observed with at least one egg (71% 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, four in Rhinoceros Auklet nest boxes and one in a Cassin's Auklet nest box. Productivity was 1.17 fledglings produced per pair (Table 1). This was approximately 14% higher than 2013 and 44% above the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 17 May, and the mean egg laying date was 28 May. This is approximately equal to the long-term mean laying date for this species. The mean clutch size was 1.76 eggs per nest with 85% of those eggs hatching successfully. Mean brood size was 1.51 chicks per nest with 78% of the chicks produced survived to fledging age. There were 29 sites which were able to fledge a complete brood of two chicks (up from 16 sites in 2013).

Rhinoceros Auklet – There were a total of 145 sites (boxes, crevices, and cave sites) monitored in 2014, 49% (n=71) of which were occupied by a breeding pair. This includes three Rhinoceros auklets which bred in Cassin's Auklet nest boxes. Forty-eight percent of nest boxes were occupied compared to 67% of camera sites. There were also 16 boxes occupied by other species (12 CAAU and 4 PIGU). Productivity during 2014 was 0.65 fledglings per pair. This is equal to the productivity observed in 2013 and 16% above the long-term mean productivity for this species (Fig. 1a). The first eggs were observed on 11 April. Seventy-eight percent of the eggs successfully hatched and 84% of those chicks produced survived to fledge.

Cassin's Auklet – Occupancy of breeding birds in study boxes was exceptionally high during 2014 with 91% of the boxes (435 of 478) occupied this season, including 42 of 44 PRBO study boxes (98%). This is slightly higher than in 2013 and the highest site occupancy ever recorded on the Farallones. Productivity of auklets breeding in PRBO study boxes continued to be high with 0.98 chicks fledged per breeding pair (including relay attempts). While this was down 14% when compared to 2013, it remains 33% greater than the long-term average of 0.74 chicks per pair for this species (Fig. 1a). Ninety-eight percent of the eggs hatched and 100% of those chicks produced survived to fledge. During 2014, 70% of birds in PRBO study boxes and 48% of all sites that successfully fledged a chick attempted a second brood. All of these attempts however, were subsequently abandoned and no chicks fledged from second broods this season. The first egg was observed on 22 March and the mean laying date for PRBO boxes was 8 April, approximately 2 weeks later than last season but still 9 days 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 be 0.86 chicks per pair (n=184). This is approximately 12% lower than the estimate derived from PRBO boxes and 16% lower than the "all sites" estimate for 2013.

Ashy Storm-Petrel – ASSP pairs laid eggs in 38% of the 100 followed sites (n=38) in 2014, approximately equal to the occupancy rate observed last season. Four of these 38 sites were new breeding sites discovered during 2014. The first eggs were observed on 4 May Overall productivity for this species was 0.75 chicks fledged per pair (including all relay attempts). This is approximately 3% higher than last season and 14% above the long-term average productivity for this species (Fig. 1a). This is the second straight year of strong reproductive performance for the species and the highest productivity observed since 1993.

Other breeders – In past seasons, Peregrine Falcons, Common Ravens and Canada Geese have bred on SEFI during the seabird season. However, during 2014, it appears that only the Canada Geese attempted to breed. Three pairs of Canada Geese were present on the island by mid-March and two of those pairs nested on the Marine Terrace. The first nest was discovered on 19 March with 7 eggs and the second was discovered approximately 2 weeks later. By 30 April the sewer gulch nest had been destroyed while a minimum of 2 chicks hatched from the second nest. Two almost adult sized goslings were frequently seen accompanying the adults and are assumed to have fledged. All geese departed the island by late July. From mid-March until early May, 1-4 Peregrine Falcons were seen daily on SEFI. However, by early May, there was only one falcon sporadically seen around the island and there were no signs of nesting behavior. Common Ravens were not observed at the island this season and there was no evidence of nesting. Finally, a pair of Rock Wrens bred on the island during 2013 but did not appear to do so this season. Only 1 individual was detected a few times in the spring and no nesting behavior was observed.

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 378 Ashy storm-petrels and recaptured 22 that had been banded in previous years. In addition, there were 12 birds banded this season that were recaptured later in the season. Catch per hour of netting effort was 24.22 birds per hour (see Figure 10). This is down approximately 8% from 2013 and 21% lower than the mean capture rate for the last 10 years. Our largest single night was 30 June when 165 birds were caught at the Lighthouse Hill site. There were also 2 Leach's storm-petrels banded this season. One Fork-tailed storm-petrel was seen flying around the Carp Shop net but was not captured.

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 16 counts were made in 2014, beginning on 26 April and ending on 15 July, when juveniles became indistinguishable from adults. On 16 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 equal to that from 2013 and 17% above the 10-year average population for this species (Table 2). There was a high count of 232 chicks observed during the 30 June census.

Brandt's Cormorant – The BRCO breeding population was censused during ground-based surveys on 5 June. There was no boat census conducted this season so we applied a correction factor to account for those areas that would typically be surveyed during the boat census. This correction factor was calculated by determining the average proportion of the overall population counted from the boat during the last 5 years in which a boat census was completed. On average 16% of the Brandt's breeding sites are only visible from the boat (range 10-24%), leaving 84% of the breeding sites visible during our ground census this year. To account for the nests not visible, we multiplied our census count by a correction factor of 1.19 (1/.84). During the survey we counted 2,757 "well-built" nests. After applying the correction factor, we estimated a grand total of 3,283 nests on the island (Fig. 2). We then multiplied the number of nests by 2 to yield an overall population estimate of 6,566 breeding birds (Table 2). This estimate is 11% lower than 2013 and approximately 29% 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 7,750 fledglings.

Pelagic Cormorant – The PECO breeding population was censused during a ground-based survey on 6 June. There was no boat survey conducted this year, so as with Brandt's Cormorants, we generated a correction factor to account for areas not censused. Using the same methods described above, we calculated an average correction factor of 1.42 with roughly 30% of all nest sites visible only from the boat based survey. During the census, we counted a total of 155 fair to well-built nests (Fig. 3). After applying the correction factor, we estimated a grand total of 220 nests on the island. We then multiplied this number by 2 to yield an overall breeding population of 440 birds (Table 2). This estimate for Pelagic Cormorants is approximately 18% higher than 2013 and 73% 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 515 fledglings.

Western Gull – The WEGU census was conducted on 10 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 11,452 (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 (1.632) 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 18,686 birds (Table 2). We then multiplied the population estimate by the mean annual reproductive success to estimate an overall production of 7,100 fledglings on SEFI in 2014. The population estimate for WEGU is approximately 12% lower than in 2013 but still 6% greater than 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 257 “well-built” nests was counted on 10 June resulting in a breeding population estimate of 514 birds. This estimate is approximately 2% lower than the estimate for last season but remains 60% higher than the 6 year mean for this population. The peak count for total birds was 570 on 10 June, down from a peak count of 849 in 2013. 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, 23 were considered active sites. Therefore, we estimated a breeding population of 46 birds, an increase of 27% relative to 2013 and 24% higher than the 10-year average population. We estimated an island wide production of 4 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. The mean plot counts for this season were essentially the same as for during 2013 (Figure 11) and remain among the highest we have observed in the time series.

As in previous years, a correction factor was calculated using data from three of our study plots (Upper Shubrick Point, Upper Upper and Tower Point) to account for breeding adults not present during the census (see Nur and Sydeman 2002). Note that for 2014, we changed one of the plots used for this analysis from X-plot to Tower Point. We no longer follow breeding activity in X plot and hence cannot determine the total number of breeding sites. The correction factor 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 1.63. 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 4,459 birds on 19 April. This count was approximately 15% higher than the peak count from 2013 and 52% greater than the 10 year mean for morning surveys (Table 2 and Fig. 7). This the highest number of PIGU ever recorded at SEFI in our 45 years of monitoring.

Tufted Puffin – The island-wide TUPU survey was conducted primarily in two parts; a one-week period from 2 to 10 June and a second survey from 2 to 12 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 2014 surveys, a total of 144 active sites were observed, 31 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 288 birds (Table 2). This estimate is only a single breeding pair greater than 2013 but 64% greater than the 10 year average population for this species, and the highest in our time series (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 2014. A total of 62 new birds were banded and 73 were recaptured (20 birds were captured multiple times during the season and 5 birds that were banded in 2014 were later recaptured). There were fewer new birds banded this season but more 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 2014, we counted a total of 441 burrows/crevices in the index plots, a greater than 25% increase compared to 2013 and the highest burrow count since index plots were established in 1991. Therefore, using the same methodology, but with the updated whole island estimate generated in 2009, we estimated a 2014 breeding population of roughly 28,444 birds ([441/225] x 14512) on Southeast Farallon Island. Total island-wide production (number of breeding pairs x mean productivity) was estimated at 13,938 fledglings on SEFI. The breeding population estimate is 25% greater than in 2013 and approximately 56% greater than the 10-year average (Table 2). This represents the highest Cassin's auklet population observed on the Farallones since 2004. However, caution should be used in comparing the 2014 value to the 10-year average since a different baseline was used in previous seasons.

<u>Ocean conditions and Seabird Diet</u>

Sea surface temperature (SST) is measured daily from water temperature point near East Landing as an indicator of local ocean conditions. During 2014, the mean seasonal SST from March to August was 13.16°C. This was 1.86°C warmer than 2013 and 1.23°C warmer than the long-term mean for these months. Likewise, monthly values were above the mean for all individual months (Fig. 6a, b), with exceptionally warm SST values recorded for July (14.27°C) and August (16.0°C). These are the second highest monthly means observed for both months in 45 years of continuous monitoring (Fig. 6a).

Chick provisioning data is collected throughout the chick rearing period for five species as a means of determining diet and feeding rates and as an indicator of local ocean conditions. Diet data is determined from standardized diet watches (COMU and PIGU), collection of dropped or regurgitated prey items (CAAU and RHAU) or by collecting regurgitated pellets of indigestible materials at the end of the season (BRAC). During 2014, juvenile rockfish were the dominant prey item in chick diet throughout much of the chick rearing period (Figs. 8 and 12). Overall, rockfish comprised 75% of the diet for Pigeon Guillemots, 81% for Rhinoceros

Auklets, 89% for Common Murres and 96% for Brandt's Cormorants. For all species, this represents the highest or second highest proportion of rockfish observed in the diet in 27 years. Greater than 95% of the juvenile rockfish that were identified to species this season 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 over the past two decades when a more varied species assemblage (including Yellowtail, Widow, Blue and Black Rockfish) has been more common. In contrast to the high abundance of rockfish, anchovies were virtually absent during 2014. Anchovy accounted for only 3% of the diet for Common Murres, 2% in the Rhinoceros Auklet diet and were completely absent in preliminary analysis of Brandt's Cormorant pellets (Figs. 8 and 12). Sculpins, lingcod, saury, smelt, octopus and squid were other important components of the diet this season but in relatively small proportions. Cassin's auklet diet cannot be identified in the field and is still being analyzed but preliminary results suggest that krill was abundant for much of the season but dropped out of the diet during July and August, coinciding with warmer water and reduced chick survival.

DISCUSSION

Weather and Ocean Conditions

Oceanic conditions were highly variable during 2014. Generally cool and productive conditions persisted through the winter but sea-surface temperatures began to rise during spring and becoming very warm in summer. Generally, cool SSTs are correlated with greater ocean productivity in the California Current System resulting from stronger upwelling along the coast whereas warmer waters are generally nutrient poor and less productive (Barber et al. 1985). Moderate northwest winds throughout the winter and early spring drove upwelling and high productivity early in the season. However, by mid-July the Gulf of the Farallones had become inundated with warm, nutrient poor water leading to a reduction in prey resources available for seabirds.

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 exceptionally 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. 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. However, as sea surface temperature rose in July, juvenile rockfish disappeared from the diet, virtually eliminating that important food source for later breeding individuals.

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. Cormorant pellets were collected from breeding colonies in August and are currently being analyzed. Figure 12 depicts the recent trends in Brandt's Cormorant diet, including preliminary results from a subsample of pellets collected during 2014. Note that cormorant diet during 2013 and 2014 was dominated by juvenile rockfishes, with more than double the amount of rockfish present than in any observed period in the last 20 years. This was similar to what was observed for all other seabird species (Fig 8). Based on the high reproductive performance from cormorants and the dominance of rockfish in the pellets analyzed to date, we expect these preliminary data will be similar to, and representative of, the overall diet composition this year. Of particular interest is the relative scarcity of anchovy, flatfishes and sculpins compared to previous years.

Productivity

The 2014 seabird breeding season was a productive year for most species (Fig. 1a, b). Brandt's Cormorants, Pelagic Cormorants and Cassin's Auklets all exhibited high breeding success during 2014. Rhinoceros Auklets and Pigeon Guillemots also had productive years with higher productivity than last season and also above the long-term mean. Western Gulls and Common Murres saw a decline in productivity both relative to last year and to the long-term mean. Black Oystercatchers had very poor reproductive success in 2014 with only 4 chicks fledged despite an increase in the number of breeding sites. This is the fewest number of chicks produced in the 18 years we have been following oystercatcher breeding success. We suspect that the low success for oystercatchers this season was due primarily to disturbance from sea lions hauling out higher on the marine terrace than in previous years.

We have included the 80% prediction interval (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 2014, Brandt's Cormorant and Pelagic Cormorant exceeded the upper confidence interval, indicating especially high productivity for these species. Cassin's Auklets productivity, while remaining high, fell back within the prediction interval for the first time in five years. No species were below the lower prediction interval for average productivity this season (Fig. 1a).

Cassin's Auklets continued to exhibit high productivity despite a 14% decline relative to 2013. First brood success rates were exceptionally high with 98% of eggs laid resulting in a fledged chick. This was 13% higher than last season and the highest success rate for first attempts ever observed in the time series. This unique result suggests that auklet adult condition and prey availability were extremely good in spring and early summer. 2010 was the only other season during which first brood success exceeded 0.90. All other high productivity years are driven by high rates of successful second broods. 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). The overall rate of double brooding was high this season with 48% of all birds that successfully fledged a chick attempting a second brood. However, unlike the previous four years, zero chicks fledged from these second brood attempts. All second brood attempts were abandoned in late July or early August, corresponding to the increase in sea surface temperature and reduction in prey resources. Furthermore, post fledging chick survival will likely be very low this season. During November, large numbers of hatch year birds were washing up on mainland beaches with preliminary analysis indicating that they were emaciated and dying of starvation.

Reproductive success of COMU was much lower than 2013 and below the long-term mean for this species. The majority of this decline was due to eggs failing to hatch. Hatching success was lower than average in all plots and particularly low in the USP study plot where only 67% of the eggs hatched this season. This is approximately 18% lower than the long term mean hatching success for this colony and comparable to the hatching success observed during low productivity years of 1998, 2006 and 2009 (Fig 1a). However, in contrast to those years, fledging success was high with 94% of chick hatching surviving to fledge. Therefore the decline in overall productivity was not as great as during other seasons with low hatching success. The reasons for the lower hatching success are unclear. Foraging conditions in the pre-breeding and egg laying stages appeared favorable and egg failures were spread fairly evenly through the different study plots, suggesting that localized contaminants or disturbance were not involved. Regardless, murres seemed to thrive once again on a high abundance of juvenile rockfish available during the chick rearing period. 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 higher success in 2014 (see Table 1). There was a lower proportion of eggs that failed to hatch and no losses from Western Gull predation; something very unusual for this plot.

Rhinoceros Auklets and Pigeon Guillemots both exhibited high breeding success this season. Rhinoceros auklets equaled last season's high productivity while guillemot productivity increased. Both species also exceeded their respective long-term mean productivity values. The high success was likely due to the greater abundance of juvenile rockfish available for chick diet. Guillemots in particular seemed to thrive with many sites able to fledge two. As with the Cassin's Auklets, those sites where chicks hatched later in the season had much reduced success compared to the rest of the population. After mid-July, when warm water inundated the region, rockfish disappeared from the diet, chicks began losing weight and several died. Most chicks, however, had already fledged by that point, resulting in the overall high productivity observed.

Brandt's Cormorants achieved high reproductive success again in 2014 with greater than two chicks fledged per breeding pair. The overall breeding success was slightly lower, but similar to, last season. However, unlike last season, Brandt's Cormorants struggled early in the season and there was a high rate of nest abandonment. Birds were observed setting up nests and laying eggs in early May but abandoned those attempts a short time after. A second pulse of breeding activity occurred in late May, with many of those nests also abandoned. Finally in early June, the colony seemed to settle in and breeding success for these birds was very high, leading to an overall productive season. Reasons for this unusual pattern of colony attendance are as yet unclear. Although cormorant diet samples have not yet been completely analyzed for this season, preliminary analysis indicates a high proportion of juvenile rockfish in the diet. Anchovies and other large forage fishes continued to be scarce in the diet of murres and auklets and have so far not been encountered in those cormorant pellets analyzed.

Pelagic Cormorants also experienced high breeding success in2014. Fledging success was high and there was a low rate of abandonment. Unlike the Brandt's, Pelagic Cormorants were more stable, establishing nests in April and continuing to attend them throughout the season. 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 during 2014 when compared to the long-term means for those sites (USFWS unpublished; R. Berger pers. comm.). As with the Farallon cormorants, there were periods of early season nest failure and abandonment but they eventually settled in and overall productivity for the season was high. Point Blue monitoring sites at Vandenberg Air Force Base again exceeded past breeding population values for Brandt's cormorants, with pelagic cormorants at their second highest population count since 1999. However, productivity for both species was below the long term average, with pelagic cormorants experiencing the highest rate of nest failure ever recorded at this site (Robinette et al. 2014; J. Howar pers. comm)."

Western Gull productivity declined to below the long term mean again this season after a productive year in 2013 (Fig. 1). Clutch size, brood size and hatching success were all similar to last season, but fledging success declined by 26%. Intraspecific predation continued to be the single greatest cause of mortality, but starvation also played a role later in the season. Many large, close to fledging chicks were discovered dead without any obvious injuries. As with other species, warmer, less productive water and a decline in prey availability late in the season likely contributed to the poor fledging success.

Ashy storm-petrel productivity increased relative to last season and was the highest observed in 20 years. In contrast to other species, late breeding storm-petrels seemed to do well and fledging success was exceptionally high. Perhaps their extended foraging range allowed them to exploit prey resources that were not available for other species like auklets.

Populations

Breeding population sizes were higher than the 2013 estimates for Cassin's Auklets, Pigeon Guillemots, Pelagic Cormorants and Black Oystercatcher while declining for Brandt's Cormorants, Western Gulls and California Gulls. Estimates were essentially unchanged from last season for Tufted Puffin and Double-crested Cormorant. Population increases ranged from approximately 15% for PIGU to 28% for BLOY when compared to last season, while declines ranged from 2% for CAGU to 12% for WEGU.

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 2014, Guillemot numbers increased by approximately 15% to a new all-time high estimate of 4,459 individuals, continuing the positive growth trend observed in this population since 2002. Occupancy of monitored PIGU crevices was also high with approximately 72% of followed sites used by breeding guillemots during 2014. This is equal to the occupancy rate observed during 2013 despite a greater number of birds present at the island.

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 slight decrease (<1%) in murre numbers this year when compared to 2013, though overall numbers remain approximately 25% higher than the last full island census in 2006. There were a fewer new breeding sites established in the study plots and several historic sites which did not breed this year, likely contributing to the small decrease observed. 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 2014 were 26% higher than in 2013 and the highest ever recorded since the index plots were established in 1991 (Table 3). The greatest changes in burrow counts were in areas with deep soil on the marine terrace. Overall population estimates for 2014 suggest that this is the first year that populations have recovered to the level they were at prior to the 2005 breeding failure. The greatest changes in burrow counts were in areas with deep soil on the marine terrace. 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 2014, almost 60% of our followed sites were occupied by birds between 2 and 5 years of age, including many birds from the 2012 cohort which were breeding for the first time. This is the fourth consecutive year of increasing population (Table 2), coinciding with greater reproductive success and higher ocean productivity. It is worth noting that there have been varying periods of growth and decline throughout this period and while this was the highest number of individual burrows counted, the overall population estimate remains lower than the peak count in 1991. Estimates are now made in comparison to the most recent (2009) all island burrow census and occupancy survey which produced a lower population estimate than if we still used the 1989 survey as the baseline. Our breeding population estimate assumes that habitat availability and mean nest site occupancy rates are relatively stable and similar to those observed during the last full island census in 2009. However, we know that the occupancy rate of our nest boxes has been steadily increasing the last 5 seasons. If a similar increase has occurred in natural burrows and crevices, then we may be underestimating the current population.

Tufted Puffins are surveyed during two surveys, one week long survey in May/June 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 though only slightly higher than last season, 2014 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 a population index derived from catch per unit effort during netting suggests alternating periods of growth and decline (Nur et al. in prep). The mean standardized capture rate (number of birds caught per hour of effort) for 2014 was 24 birds/hour (s.e. = 5.8, n= 6; see Fig. 10). This is approximately 8% lower than the capture rate for 2013. 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. 2014). 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 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. 2014).

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 during 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. After a large increase in the breeding population during 2013, the Brandt's population again declined during 2014. The 11% decline relative to last season was likely the result of poor foraging conditions during the winter and early spring which led some individuals to skip or abandon breeding attempts. Brandt's numbers remain less than one-third of the population observed before the crash but are equivalent to population estimates made during the early 2000's. 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 seven years. During 2014, the population was almost 20% greater than last season and is now approximately equivalent to the population observed during the early 2000's (Fig. 7).

Summary

2014 was a mixed year for Farallon seabirds with higher breeding populations and increased productivity for some species while declines were observed for others. Cassin's Auklets were again able to take advantage of high zooplankton production in the early part of the season and fledge almost all of the chicks from their first broods with unprecedented success. Likewise, murres, guillemots, auklets, and cormorants were able to capitalize on a high abundance of rockfish throughout the early season to achieve high fledging success. During mid-July, ocean conditions deteriorated, leading to a reduction in prey availability and poor success for later breeding individuals of all species. This was most notable with auklets. Chick growth rates and fledging success declined late in the season and there were no successful second broods for Cassin's auklets for the first time since 2008. Anchovies and other larger 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, primarily extremely high levels of juvenile Shortbelly rockfish not seen in more than 25 years. The high productivity of cormorants in 2014 is encouraging after several years of very poor breeding success, 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. Ashy Storm-petrels remain a species of concern on the Farallones. Recent analysis of netting data demonstrate a declining trend over the last 5-7 years and a still reduced population when compared to historic estimates. Analysis of the complex dynamics of the relationship between House Mice, Burrowing Owls and Ashy Storm-Petrels was completed during 2014 and the results are available in Nur et al. (2014 submitted). 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. The first step in this direction was taken this year with the deployment of small GLS tags on Rhinoceros Auklets.

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. To understand and mitigate the effects of increasing average air temperature on seabirds nesting in artificial nest boxes, we have conducted a series of studies which examine differences in microclimate among shaded nest boxes, unshaded nest boxes, and natural burrows (see Appendix III in the 2010 Farallon Island Seabird Report) as well as the effect of temperature on incubation behavior and nest attendance (see Kelsey 2014). We are now in 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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TABLES

Table 1. Mean (± 1 SD) productivity of eight species of seabirds at Southeast Farallon Island, California, 2014. 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	3.00 ± 0.80 *(48)*	2.10 ± 1.36 *(49)*	2.04 ± 1.28 *(55)*	2.36 ± 1.11 *(55)*	0.65 ± 0.41 *(47)*	0.94 ± 0.15 *(37)*
PECO	3.16 ± 0.37 *(25)***	2.69 ± 0.98 *(49)***	2.34 ± 1.15 *(50)*	2.34 ± 1.15 *(50)*	0.88 ±0.25 *(25)*	0.88 ± 0.27 *(46)*
WEGU	2.75 ± 0.48 *(225)*	1.88 ± 1.05 *(225)*	0.76 ± 0.94 *(225)*	0.76 ± 0.94 *(225)*	0.67 ± 0.36 *(225)*	0.39 ± 0.40 *(192)*
COMU* USP	1.00 (242)	0.67 ± 0.47 (242)	0.63 ± 0.48 (242)	0.67 ± 0.47 (242)	0.67 ± 0.47 (242)	0.94 ± 0.24 (163)
COMU* UU	1.00 (89)	0.82 ± 0.39 (88)	0.81 ± 0.40 (88)	0.82 ± 0.39 (88)	0.82 ± 0.39 (88)	0.99 ± 0.12 (72)
PIGU	1.76 ± 0.43 *(88)*	1.51 ± 0.64 *(87)*	1.15 ± 0.71 *(87)*	1.17 ± 0.69 *(87)*	0.85 ± 0.31 *(87)*	0.78 ± 0.35 *(80)*
RHAU*	1.00 *(64)*	0.78 ± 0.42 *(64)*	0.65 ± 0.48 *(63)*	0.65 ± 0.48 *(63)*	0.78 ± 0.42 *(64)*	0.84 ± 0.37 *(49)*
CAAU*	1.00 *(42)*	0.98 ± 0.15 *(42)*	0.98 ± 0.15 *(42)*	0.98 ± 0.15 *(42)*	0.98 ± 0.15 *(42)*	1.0 *(41)*
ASSP*	1.00 *(36)*	0.89 ± 0.32 *(35)*	0.75 ± 0.44 *(36)*	0.75 ± 0.44 *(36)*	0.89 ± 0.32 *(35)*	0.87 ± 0.34 *(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

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, 2004-2014. Estimates include Southeast and West End Islands unless otherwise noted.

Species	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2004-2013 average
DCCO	364	364	220	360	260	194	206	444	474	130	458	311
BRCO	6566[b]	7,412	3,450[b]	4,916	5,132	1,248	4,840	20,788	15,692	11,732	16,754	9,196
PECO	440[b]	372	298[b]	206	320	268	250	64	40	28	706	255
WEGU	18,686	21,148	15,846	17,406	18,218	15,747	20,152	15,852	17,399	16,547	17,969	17,628
CAGU	514	522	70	208	396	192	534	-	-	-	-	320
BLOY	46	36	40	48	38	38	40	42	36	30	26	37
COMU	[e]	[e]	[e]	[e]	271,787[e]	242,759[e]	248,321[e]	250,032[e]	211,355	183,092	169,079	n/a
PIGU [d]	4,459	3,880	3,645	3,461	3,317	2,851	2,875	2,774	2,607	1,375	2,530	2,932
TUPU [c]	288	286	244	246	234	216	106	59	108	82	166	176
CAAU [a]	28,444	22,574	19,607	17,866	12,964	14,512	16,121	19,540	13,597	16,202	29,229	18,221

[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)

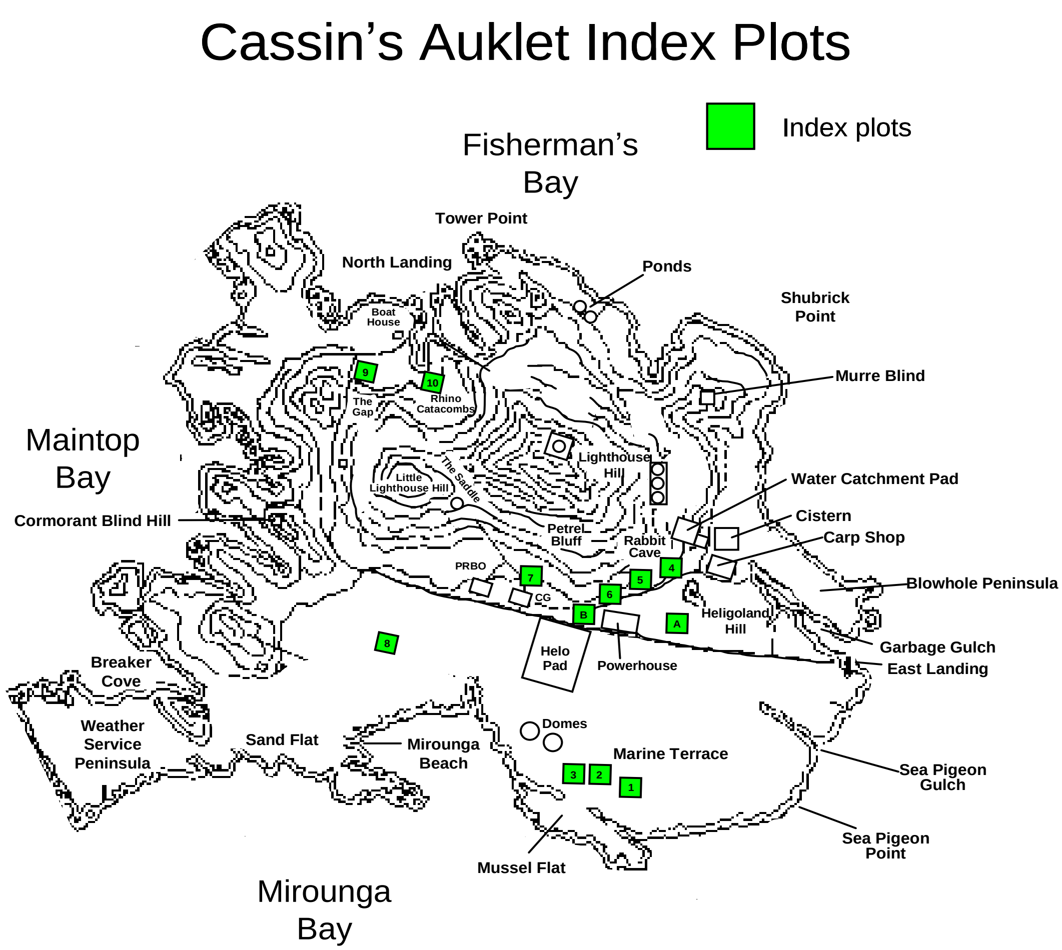
[d] Estimates derived from morning raft counts. Evening counts used prior to 2002 and are considerably lower (see text).

[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 2014. 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
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
2014	39	41	38	15	18	7	24	28	101	78	8	44	441
2004-2013 average	21	16	26	15	13	6	13	10	78	35	4	18	252

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



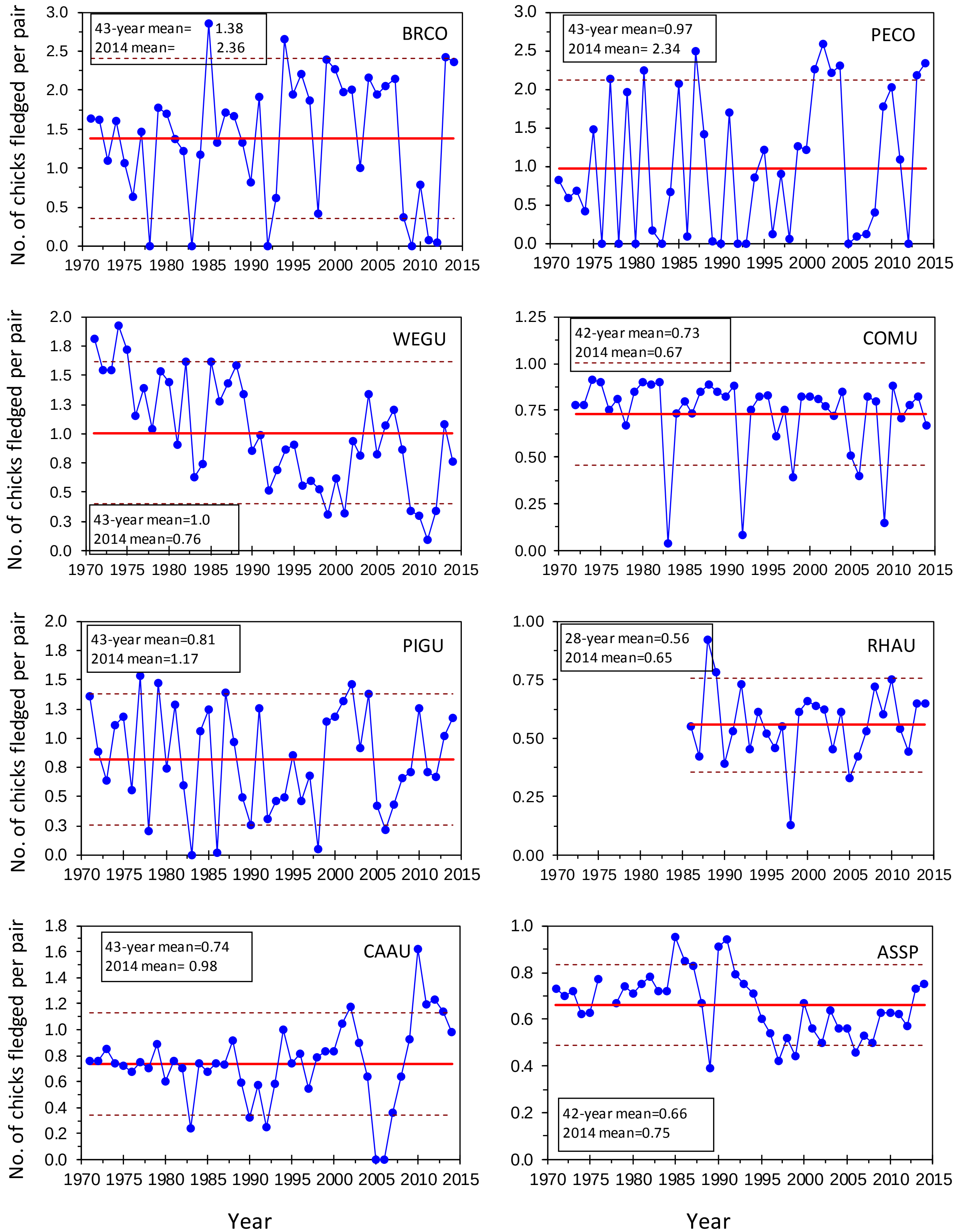


Fig. 1a. Productivity of 8 species of seabirds on Southeast Farallon Island, 1971-2014. Productivity is measured as number of chicks fledged per breeding pair (includes first attempts, relays and second broods). The bold horizontal line indicates mean productivity from all attempts between 1971 and 2013. The dashed lines represent the 80% prediction interval around the long term mean. Please note the different scales on the y-axis.

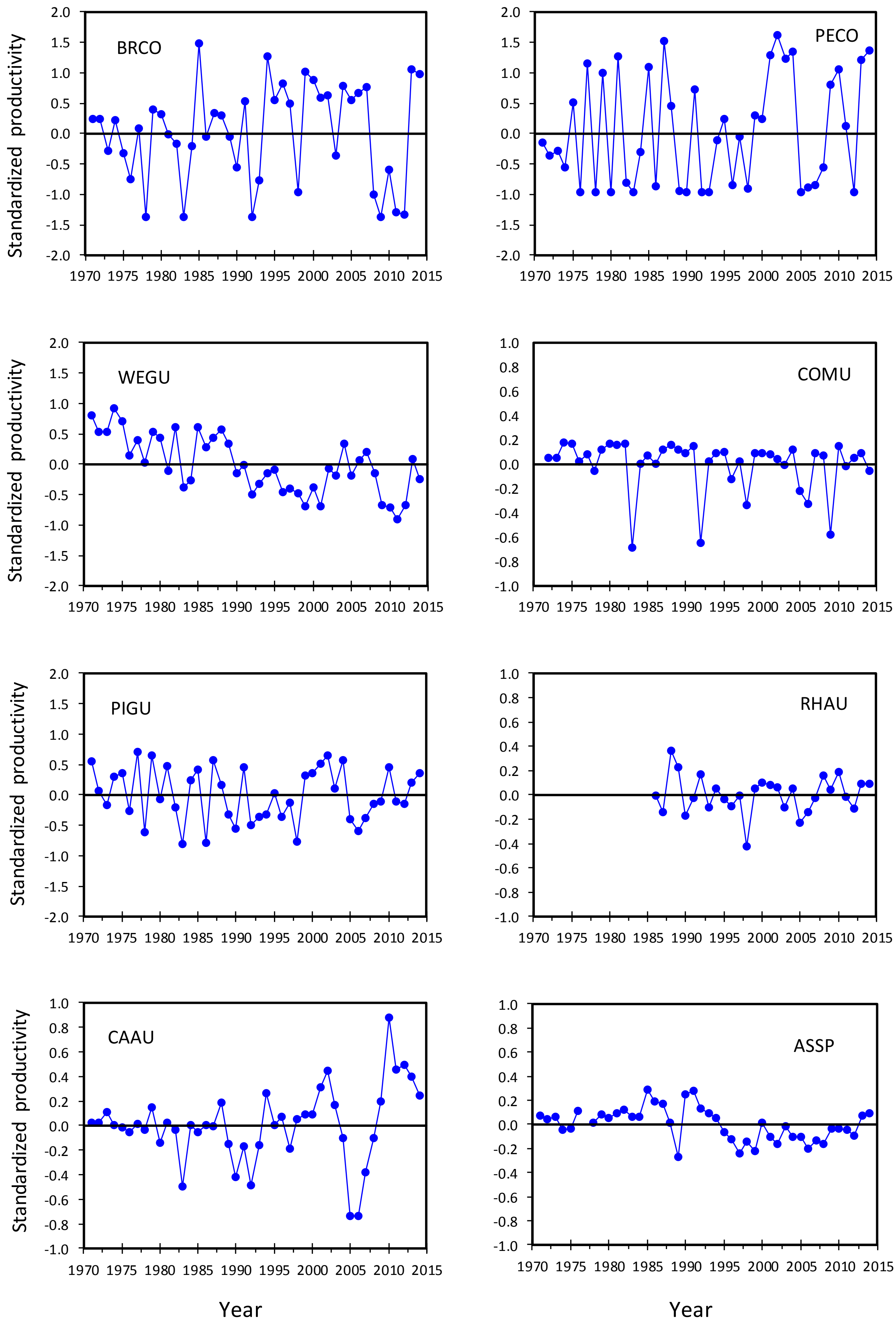


Fig 1b. Standardized productivity anomalies (annual productivity - long term mean) for 8 species of seabirds on SEFI, 1971-2014.

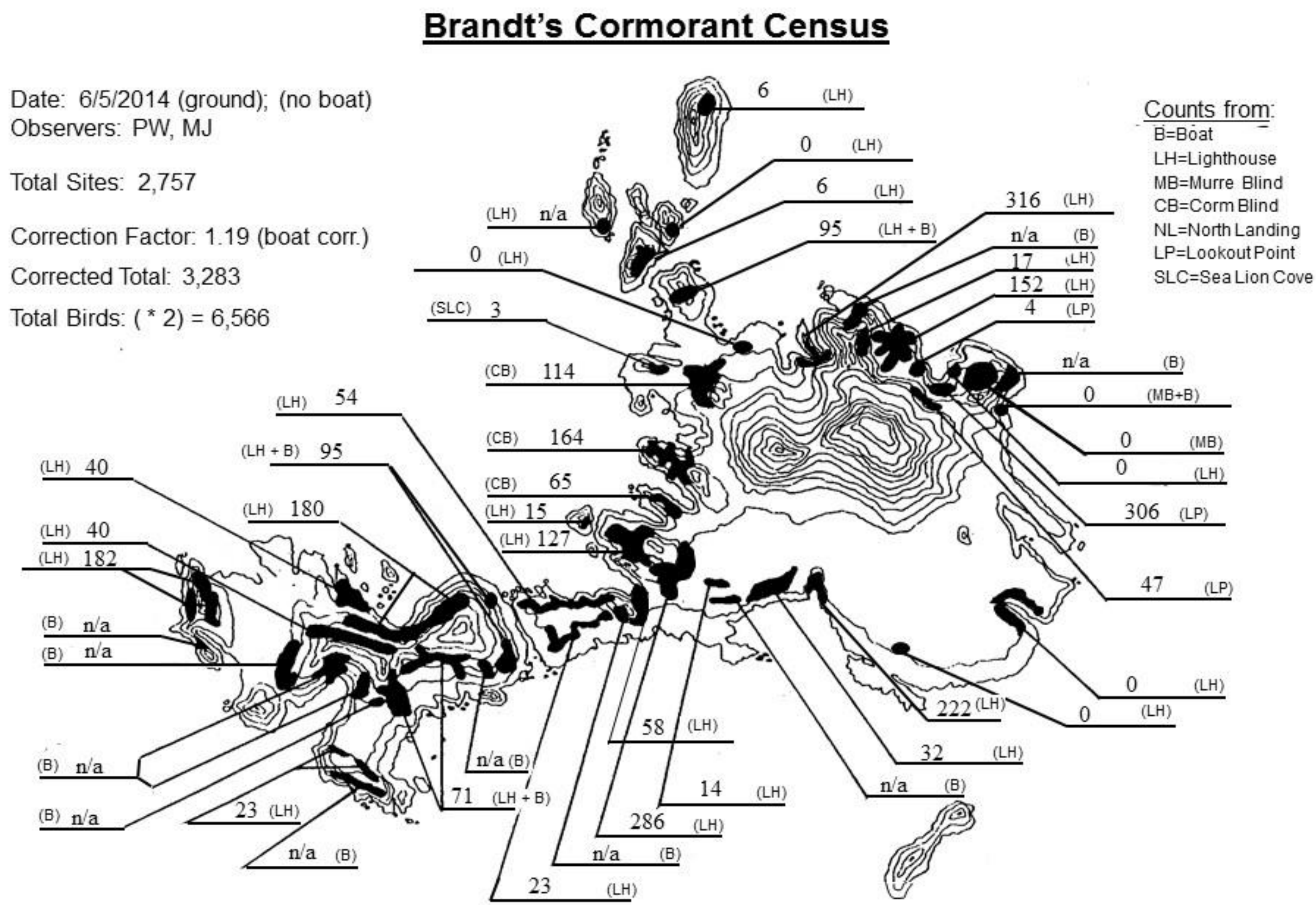


Figure 2: Counts of Brandt's Cormorants on Southeast Farallon Island during the 2014 census. Surveys were conducted from the following locations: Lighthouse Hill (LH), Murre Blind (MB), Cormorant Blind (CB), North Landing (NL), and Boat (B).

Pelagic Cormorant Census

Date: 6/6/2014 (land); (no boat)
Observers: PW, MJ

Total Sites: 155

Correction Factor: 1.42 (boat corr.)

Corrected Total: 220

Total Birds: (corrected total * 2) = 440

Counts from:
B=Boat
LH=Lighthouse
MB=Murre Blind
CB=Corm Blind
NL=North Landing
LP=Lookout Point
HS=USFWS House
MBT=Murre Blind Trail
SPG=Sea Pigeon Gulch

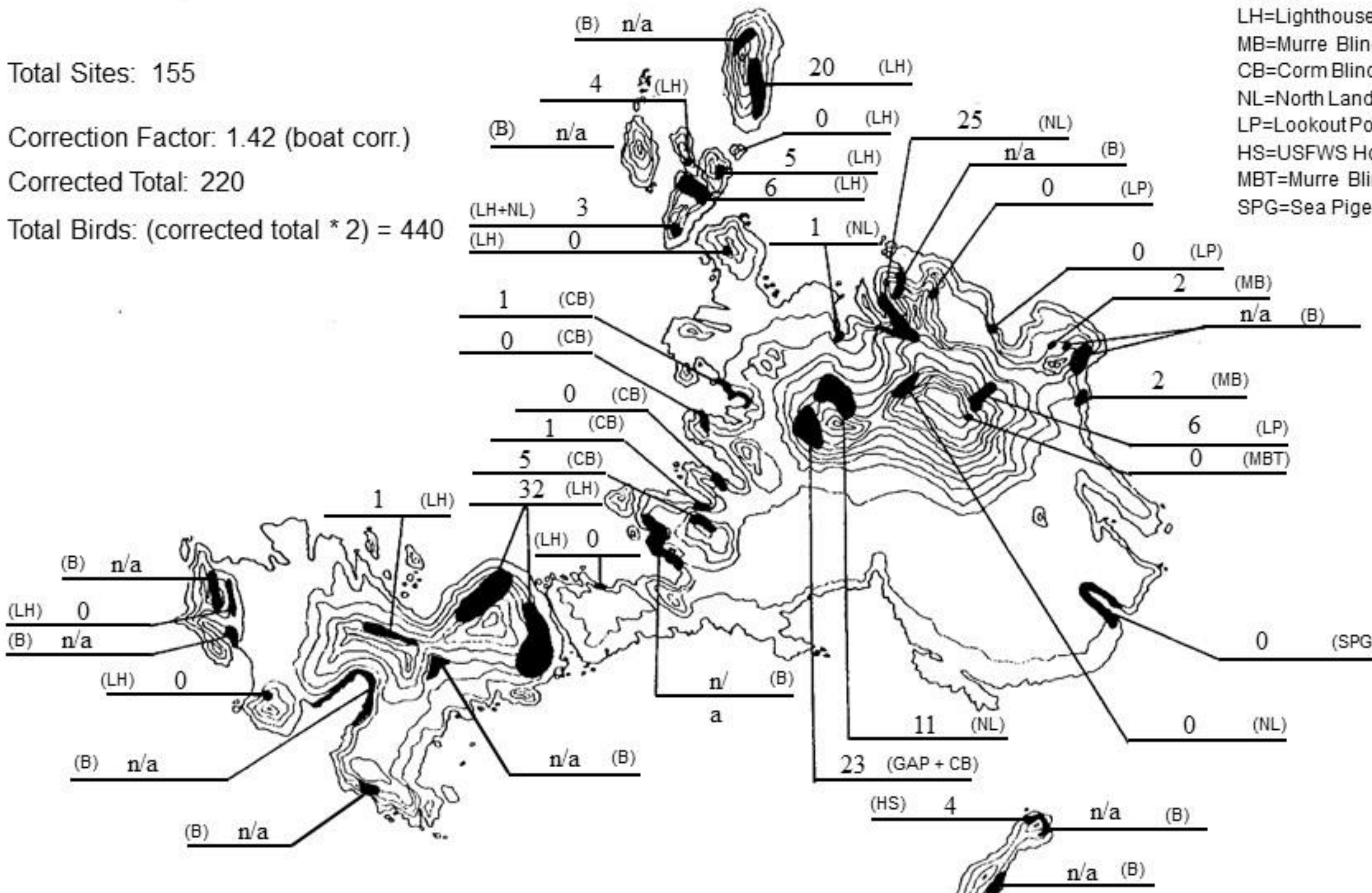


Figure 3: Counts of Pelagic Cormorants on Southeast Farallon Island during the 2014 census. Surveys were conducted from the following locations: Lighthouse Hill (LH), Lookout Point (LP), Murre Blind (MB), Cormorant Blind (CB), North Landing (NL), USFWS House (HS), Murre Blind Trail (MBT), Sea Pigeon Gulch (SPG), and Boat (B).

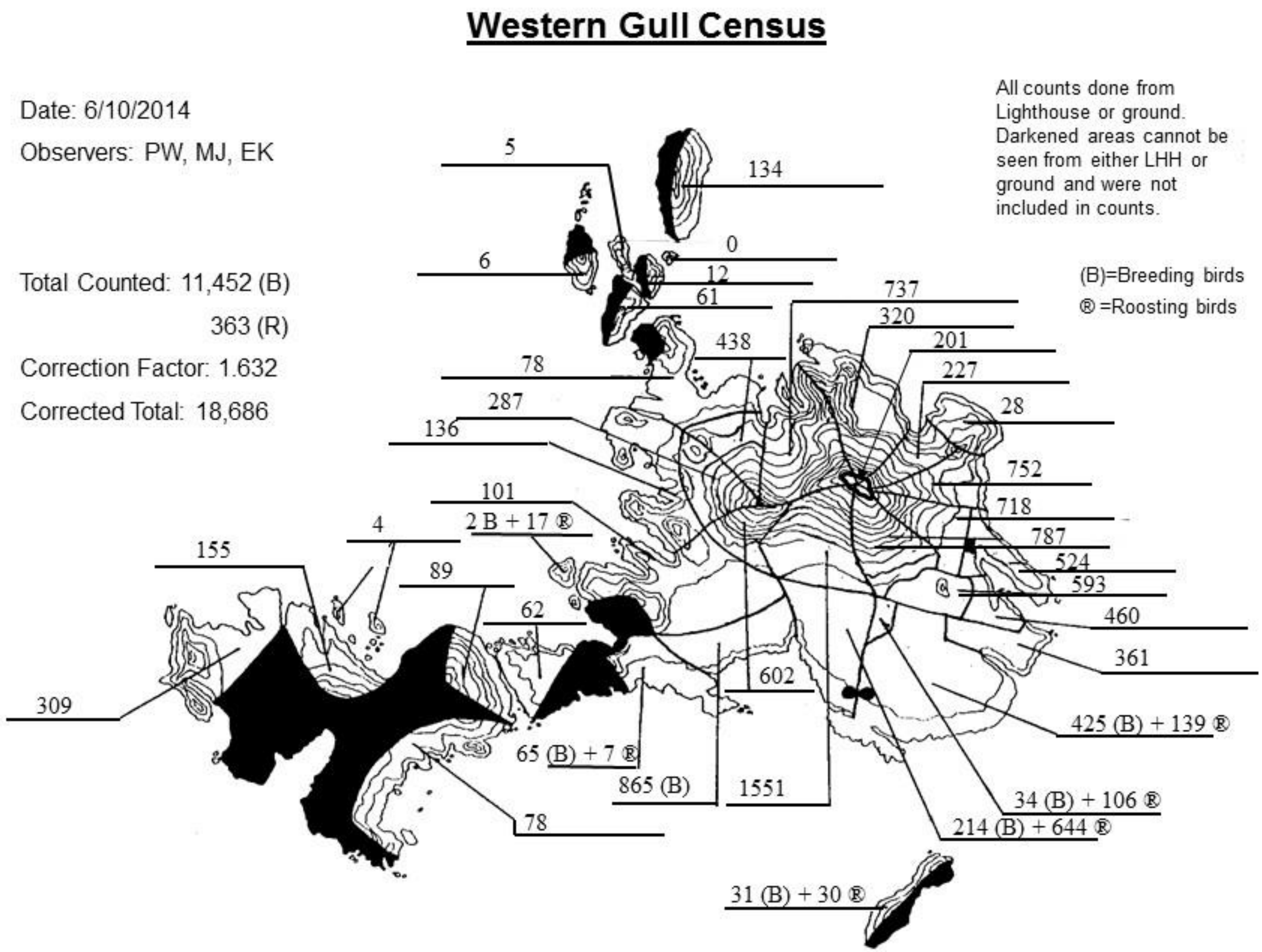


Figure 4: Counts of Western Gulls on Southeast Farallon Island during the 2014 census.

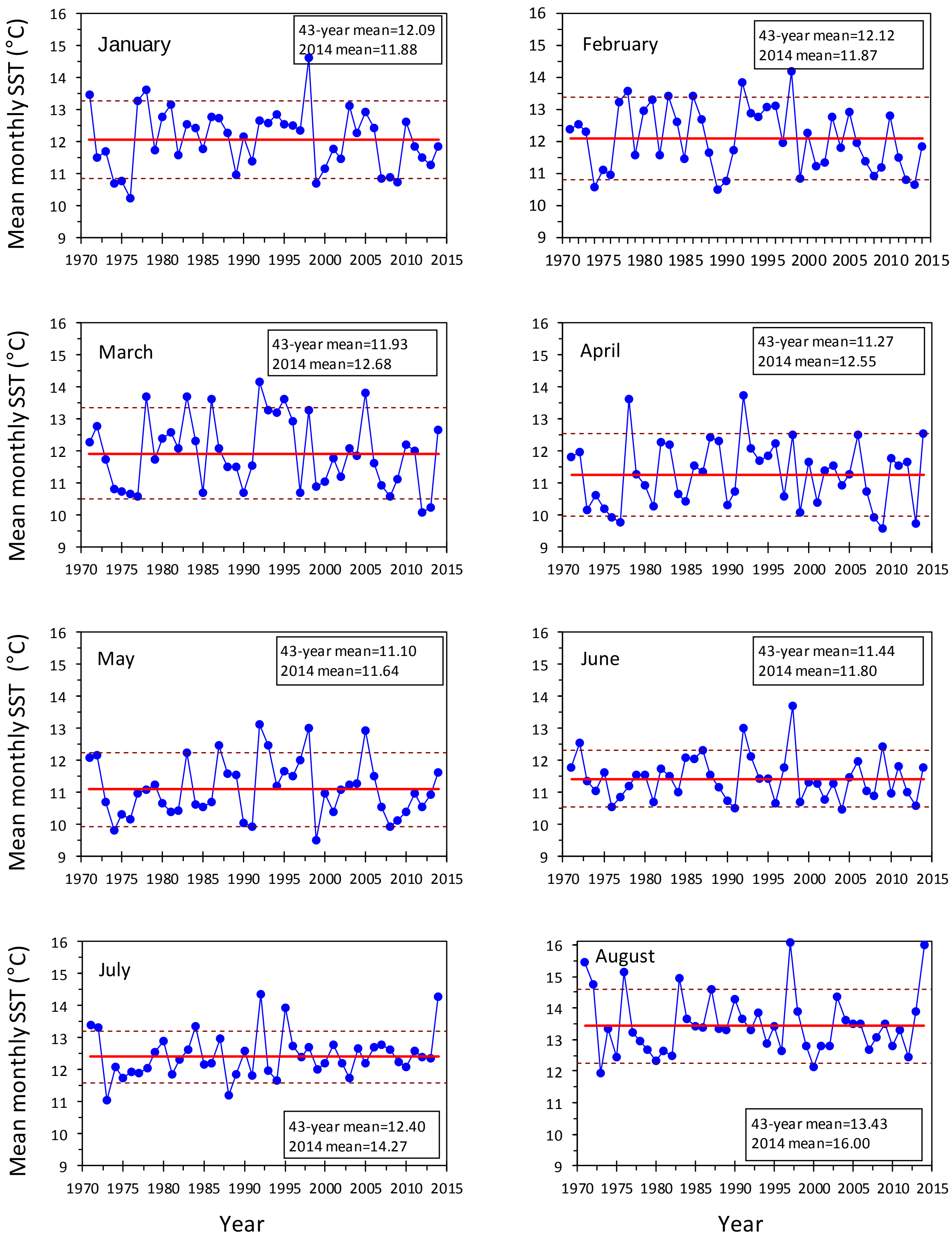


Fig. 6a. Monthly mean sea surface temperature (SST) at Southeast Farallon Island, 1971-2014. SST was measured daily from Water Sample Point, near East Landing. The bold horizontal line indicates mean monthly SST from 1971 to 2013. The dashed lines represent the 80% prediction interval for the long term mean.

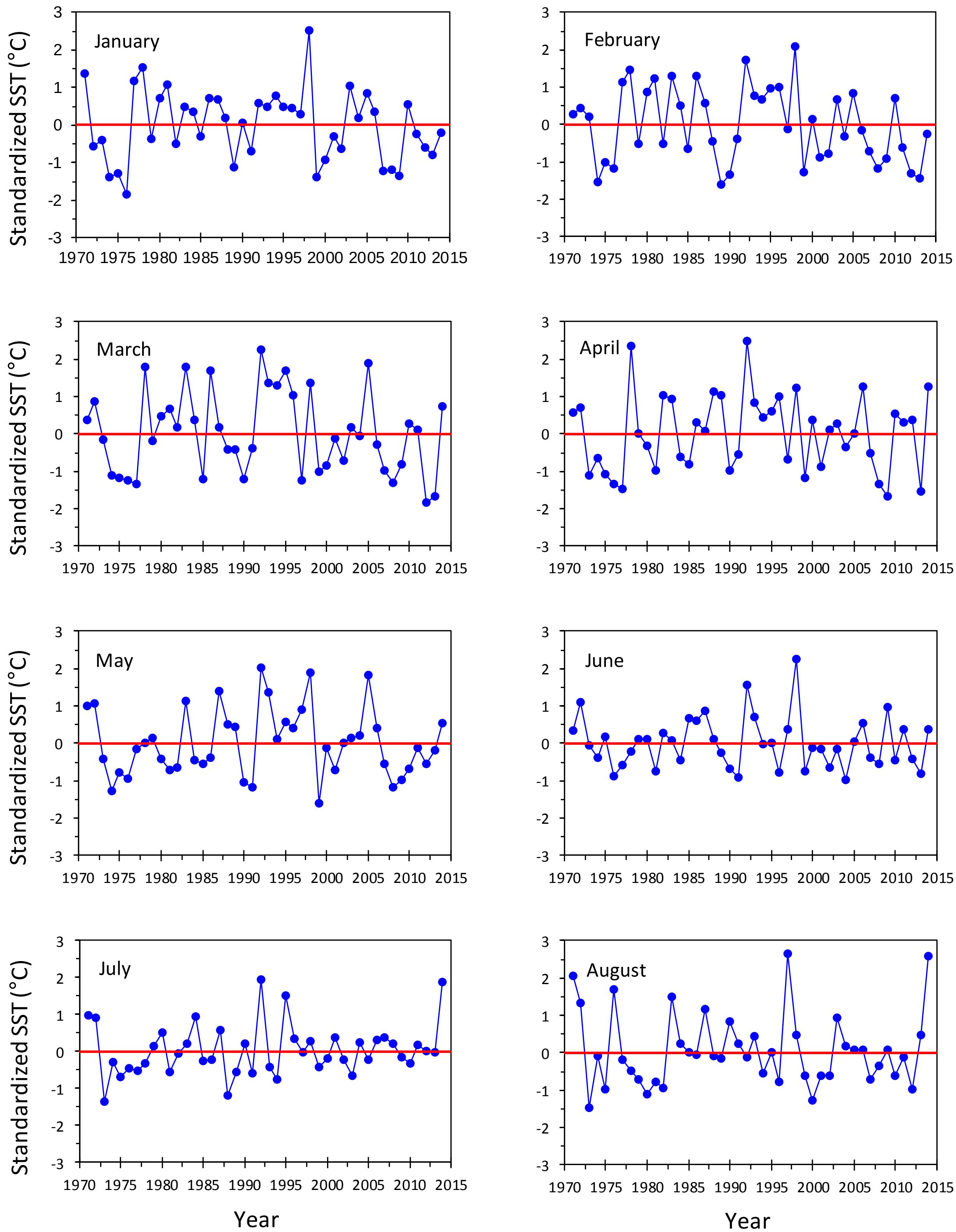


Fig. 6b Standardized Sea Surface Temperature (SST) anomalies (annual mean - long term mean) for SEFI, 1971-2014.

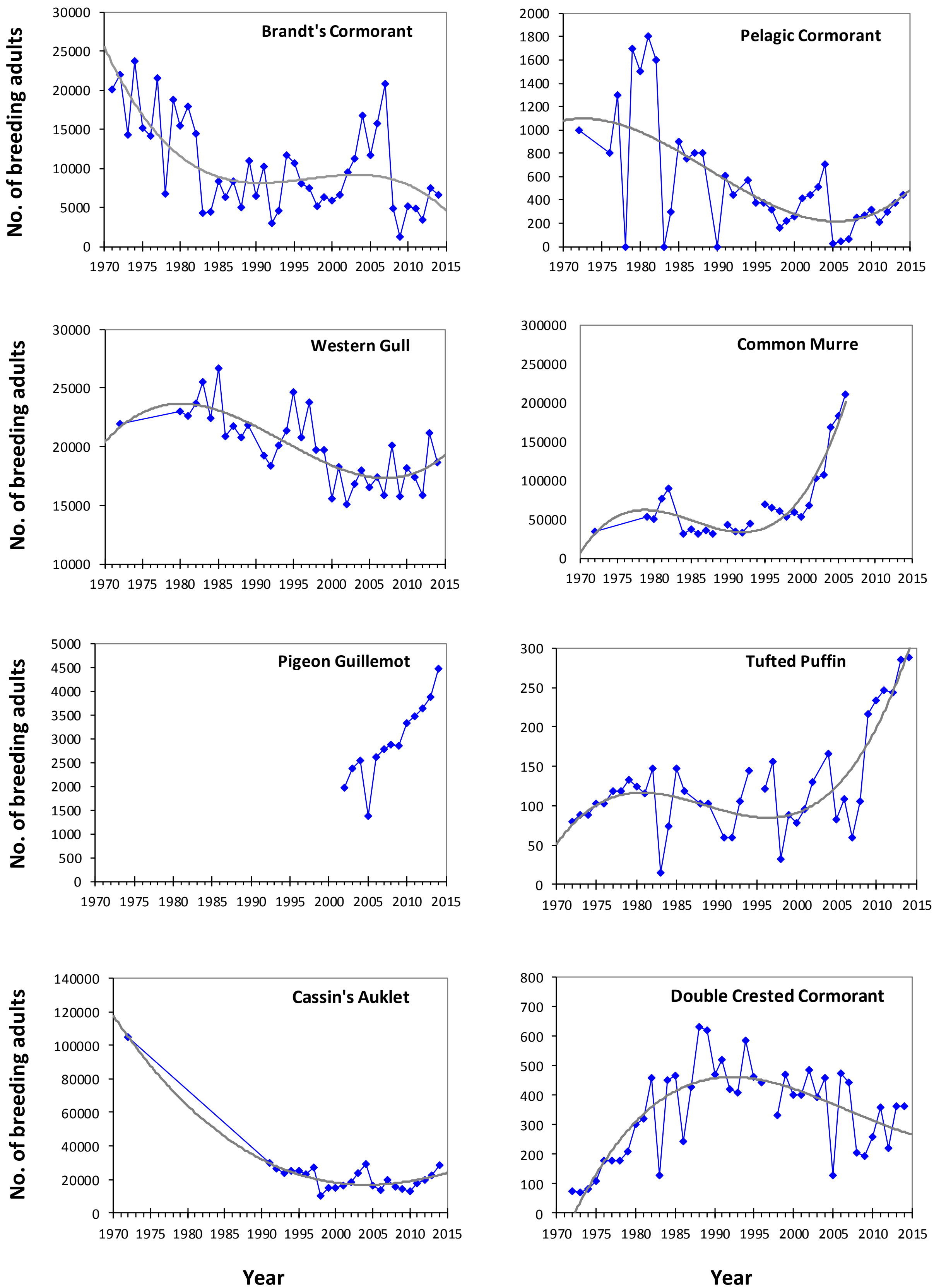


Fig. 7 Population trends for 8 species of seabirds on Southeast Farallon Island, 1972-2014. Populations were determined by counting either individuals or nests on all visible areas on SEFI and West End. We have fitted a third order polynomial trend line (in gray) for each species to help illustrate long 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 (see Fig. 11

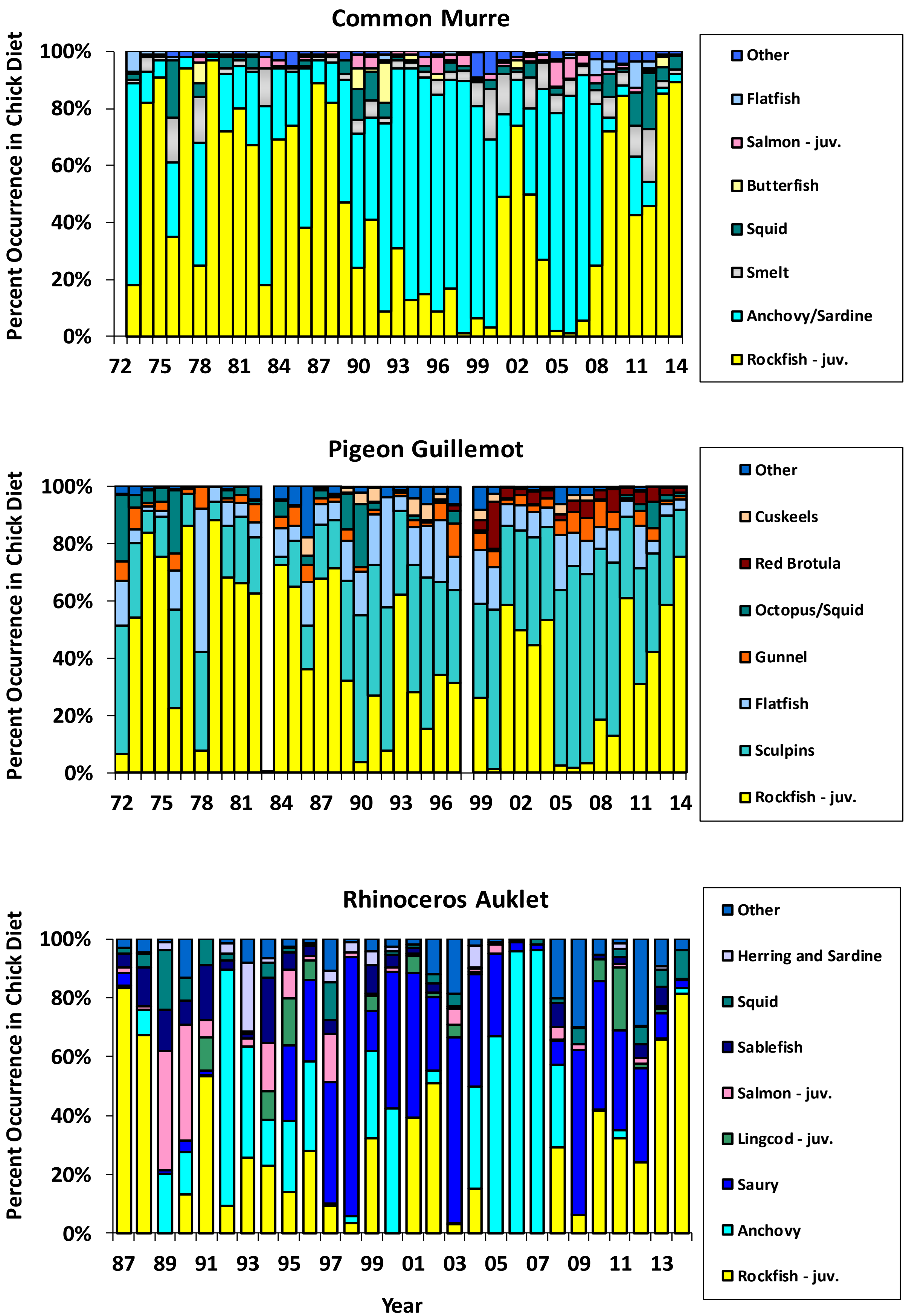


Fig. 8 Percent occurrence of common prey items, by year, in the diet of three species of seabirds on Southeast Farallon Island.

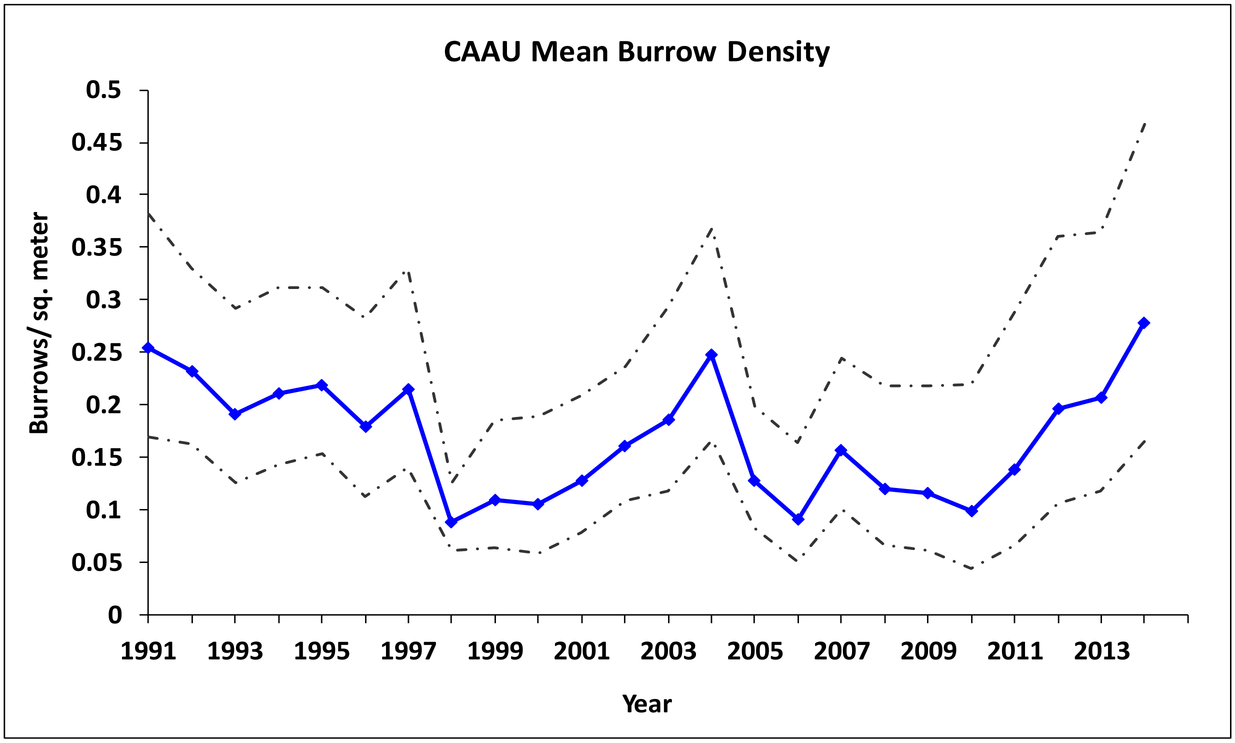


Fig. 9. Geometric mean burrow/crevice density in our 12 Cassin's Auklet Index Plots from 1991 to 2013. The blue line represents the annual mean values. The dashed lines represent the upper and lower bounds of the 95% confidence interval.

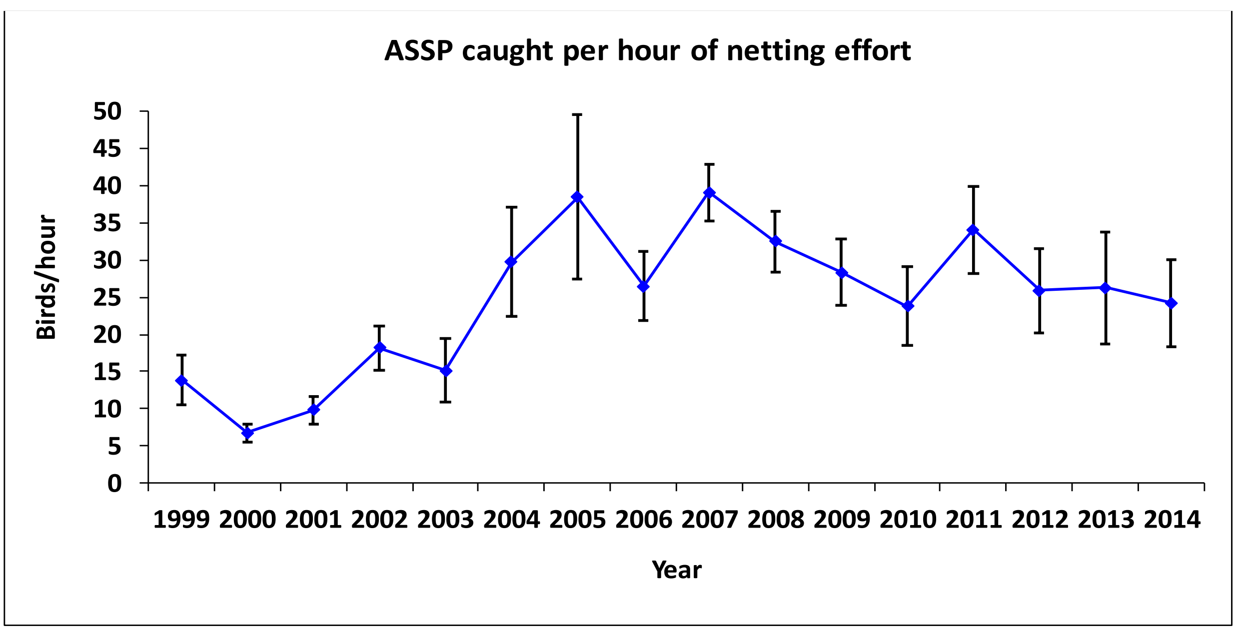


Fig 10. Mean number of Storm-petrels caught per hour of netting effort on SEFI from 1999 to 2014. Error bars represent the standard error for the mean calculated from all capture sessions in a given season.

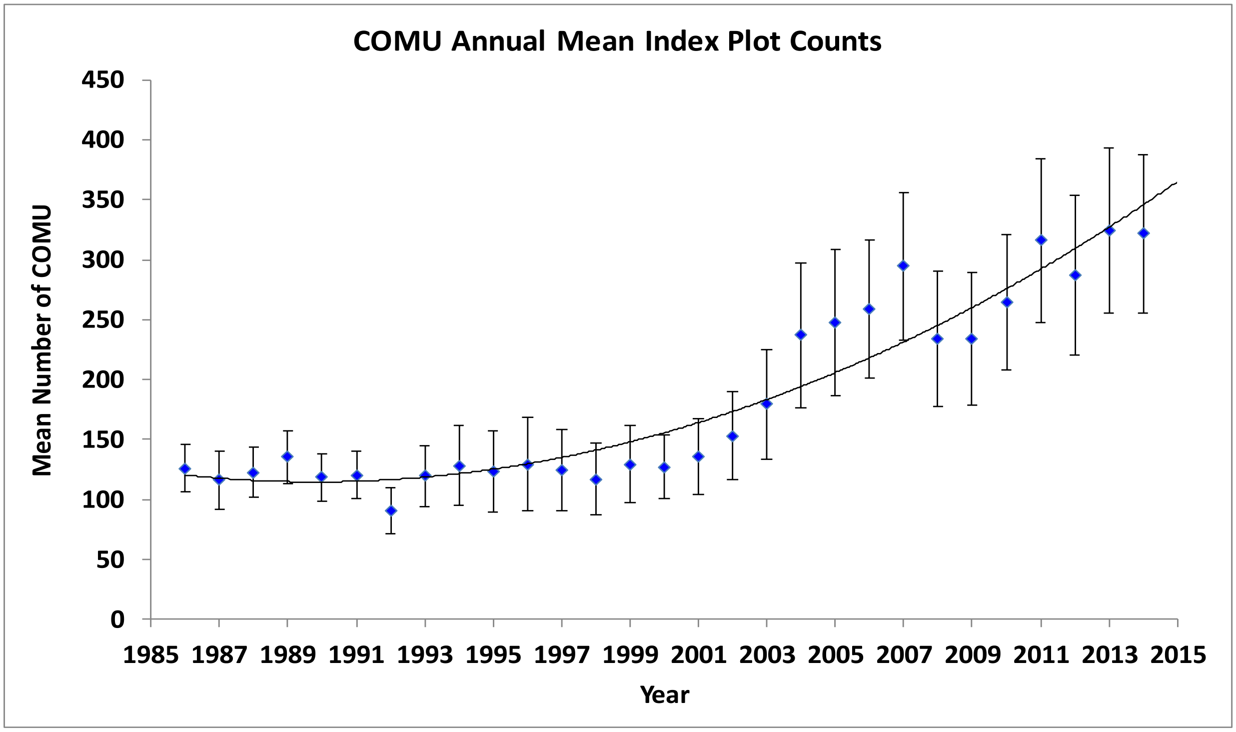


Fig. 11. Mean annual counts for Common Murre Index Plots from 1986 to 2014. Error bars represent the standard error of the mean calculated from all plots counted in any given season.

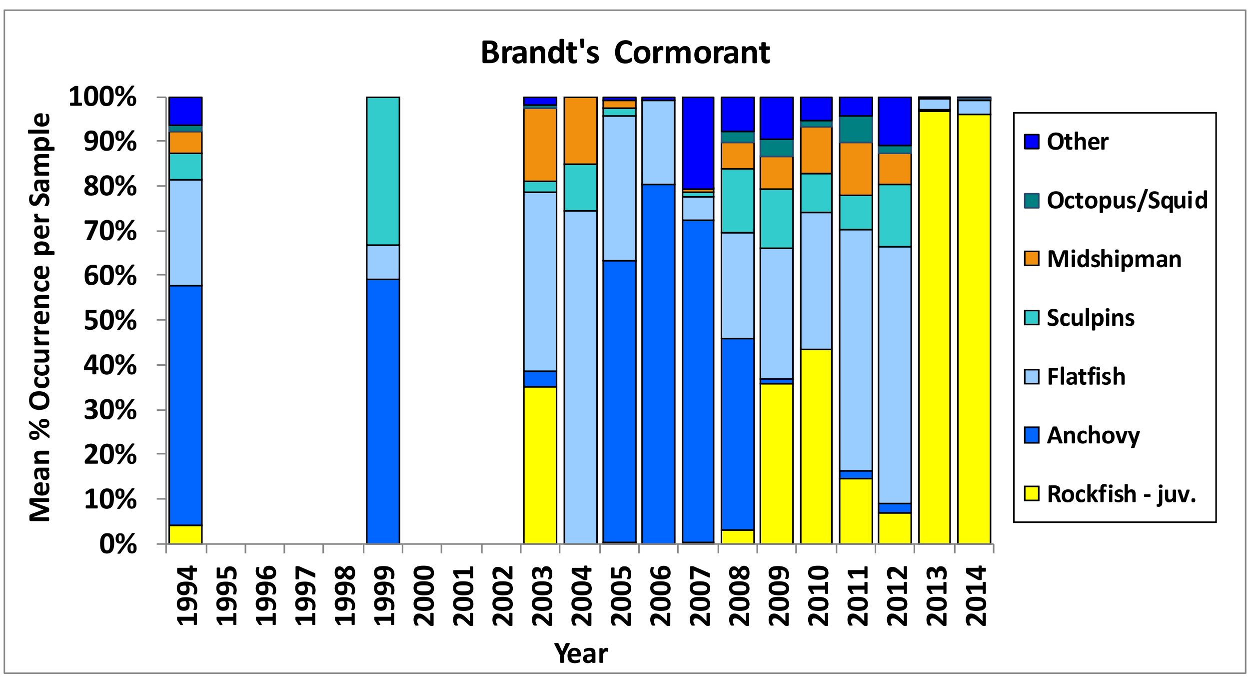


Fig. 12 Mean percent occurrence per sample of common prey items by year in the diet of Brandt's Cormorants on Southeast Farallon Island. Please note that 2014 results are based on ~50 pellets examined by Nov. 20th and should be considered preliminary until all pellets have been analyzed.

Appendix I. Calculation of correction factor for Western Gull census, 2014.

Area	Nest Count	Bird Count	Correction Factor
C	112	130	1.723
K	159	198	1.603
H (H1 only)	274	349	1.569
Total			**1.632**

Appendix II. 2014. The correction factor was derived by multiplying the number of breeding sites in three study plots (USP, UU, and TP) 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)	242	268	1.81
June 5 (1000)	242	260	1.86
June 6 (1000)	242	271	1.79
June 7 (1000)	242	252	1.92
Mean	242	263	**1.84**

UU

Date (Time)	Breeding Sites	No. of birds	Correction Factor
June 4 (1000)	89	109	1.64
June 5 (1000)	89	104	1.71
June 6 (1000)	89	112	1.59
June 7 (1000)	89	106	1.67
Mean	89	108	**1.65**

TP

Date (Time)	Breeding Sites	No. of birds	Correction Factor
June 4 (1000)	114	155	1.47
June 5 (1000)	114	176	1.29
June 6 (1000)	114	165	1.38
June 7 (1000)	114	157	1.45
Mean	114	163	**1.40**

Mean correction factor for SEFI 2014: **1.63**