Año Nuevo State Park
Seabird Conservation and Habitat Restoration
Report 2022

Photo by Danielle Devincenzi

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Land acknowledgment: Año Nuevo is part of the unceded territory of the Awaswas-speaking Quiroste people. Their contemporary descendants are the Muwekma Ohlone and Amah Mutsun Tribal Band. You can support ongoing indigenous stewardship of these lands by donating to the Amah Mutsun Land Trust at www.amahmutsunlandtrust.org

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I. Introduction

2022 marks the 30th year of seabird research and conservation at Año Nuevo State Park. Through long-term monitoring and habitat restoration, Oikonos seeks to protect seabirds breeding on the island and conserve the natural resources they rely on. This report places the 2022 seabird breeding and diet monitoring results into the context of our time series datasets and describes our most recent habitat restoration efforts.

In 2022, we continued to see significant changes to the Brandt's cormorant population on the island. In 2021 Brandt's cormorants began to colonize new nesting areas in the central terrace. In the 2022 season, the breeding population of Brandt's cormorants increased from 2021 by 521 nests and birds returned to the new sites from 2021. These changes have led to the exclusion of breeding space for other species, including Western Gulls, Rhinoceros Auklets, Cassin's Auklets, and Pelagic Cormorants. The booming Brandt's cormorant population may have been a reason for the reduced populations in 2022 of breeding Rhinoceros Auklets and Cassin's Auklets in the central terrace.

Specific accomplishments in 2022 include:

- **Continued** the 30-year time series of reproductive success and population of the seven breeding seabirds on the island
- **Improved** the habitat safety and quality for breeding auklets by placing four ceramic nest modules on the island
- **Trained** three early career ecologists as interns in field research, scientific interpretation of seabird conservation science, and data management and analysis

Season highlights:

- Ceramic artificial nests provided homes to 37 breeding seabird pairs of three different species
- We recorded the largest population of breeding Brandt's Cormorants ever on the island, with 9,942 individual breeding birds
- Western Gull nests counts were the lowest they have been since 1987, with 555 nests counted in 2022
- Rhinoceros Auklet diet was dominated by anchovy, 68% of their diet sampled during mist netting was Northern Anchovy

II. Seabird Breeding Success and Population Status

Año Nuevo Island provides critical, predator-free habitat for breeding birds and pinnipeds in the productive California Current. Adjacent to Monterey Bay and just a kilometer offshore, Año Nuevo Island's location allows marine predators to access both nearshore resources and nearby submarine canyons (such as Año Nuevo and Ascension canyons). Island habitat is a rare and limited resource in central and northern California, and species that depend on them to breed, such as Rhinoceros and Cassin's Auklets, are unique to Año Nuevo Island in the Monterey Bay region.

In 2022, we documented the nesting success and population size of seven species of seabirds that breed at Año Nuevo Island: Rhinoceros Auklets, Cassin's Auklets, Pelagic Cormorants, Brandt's Cormorants, Western Gulls, Pigeon Guillemots, and Black Oystercatchers. Many of the approximately 13,000 birds that breed annually on Año Nuevo Island nest within the central terrace, a one-acre plot surrounded by the Habitat Ridge sea lion exclusion structure built in 2011 to reduce trampling of seabird burrows by California Sea Lions. We also monitored a small population of Pelagic Cormorants breeding on the mainland cliffs of Año Nuevo State Park.

Rhinoceros Auklet

The Rhinoceros Auklet (*Cerorhinca monocerata*) is a burrow-nesting relative to puffins *(Fratercula)* in the family Alcidae. Alcids, like many seabirds, are long-lived with delayed maturity and low fecundity. Año Nuevo Island (ANI) is at the southernmost tip of the Rhinoceros Auklet breeding range and is one of just three island groups where they breed in California.

At ANI, we monitor Rhinoceros Auklets in the central terrace via an infrared burrow camera and visually in artificial ceramic nests. On the south terrace, we count burrows twice annually (once early and once late in the season) to determine viable burrows to include in the population count. We multiply the total number of burrows by a year-specific burrow occupancy rate based on a sample of monitored burrows to determine breeding population for the entire island. In 2022, we generated this occupancy rate by checking the contents of 49 burrows, 45 of which were occupied by a breeding pair (92% occupancy). Reproductive success was measured by checking the contents of 38 burrows weekly for hatching and fledging success. We estimated the total number of chicks fledged on the island by multiplying the number of occupied nests by the number of chicks fledged per pair.

Population

The first documentation of breeding Rhinoceros Auklets on ANI was in 1982 (LeValley and Evans 1982). Breeding colony monitoring began in 1993. The population has grown steadily since major habitat restoration work was initiated in 2011.

We could not conduct island-wide burrow counts in 2022 due to disturbance to Brandt's cormorants. However, most of the population breeds within the central terrace where habitat enhancement work has focused. In 2021, 91% of the breeding population nested within the central terrace, in 2022, we estimate that this has remained the same. We used our central terrace counts in 2022 (506 individuals) and added them to our 2021 burrow counts of the south terrace (26 burrows) to estimate the island population for 2022 (558 individuals). From 2011 to 2022, the central terrace population of Rhinoceros Auklets nesting on Año Nuevo Island increased by 139%. There were 42 fewer breeding birds in the central terrace in 2022 than in 2021. This decline may be due to competition with Brandt's Cormorants for breeding space. Brandt's cormorants can block burrows with guano and nesting material, which may cause Rhinoceros Auklets to abandon or not attempt reproductive efforts.

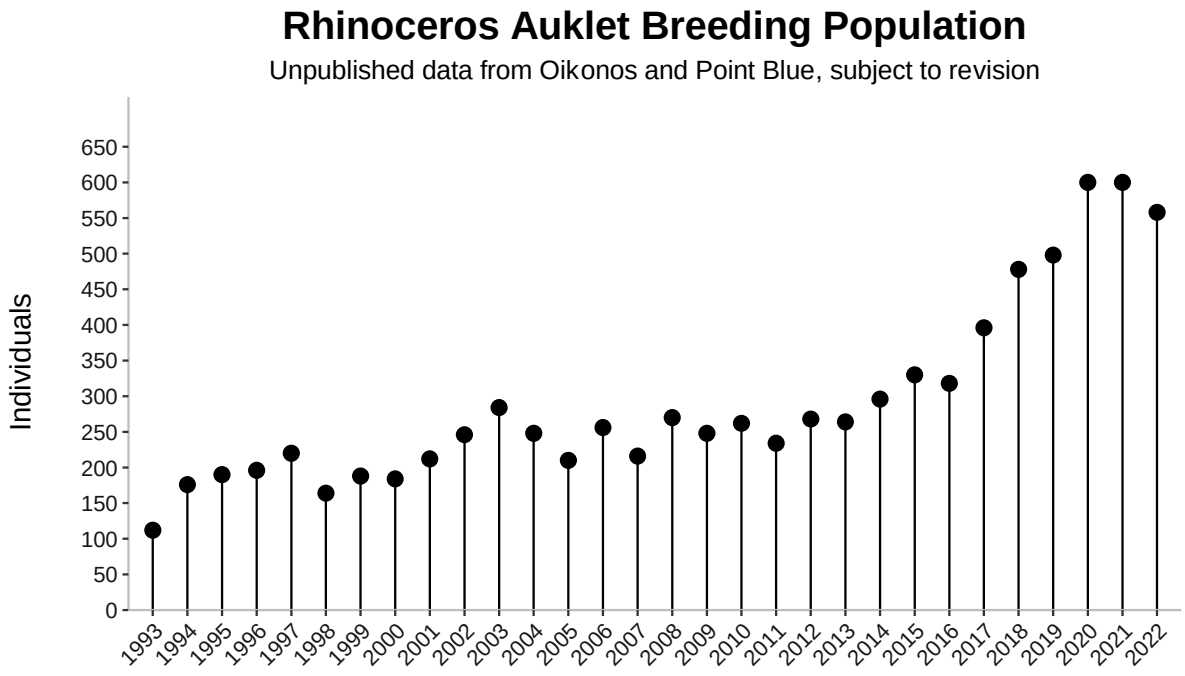


Fig. 1: Total numbers of Rhinoceros Auklets breeding at Año Nuevo Island with standardized methods from 1993 to 2021.

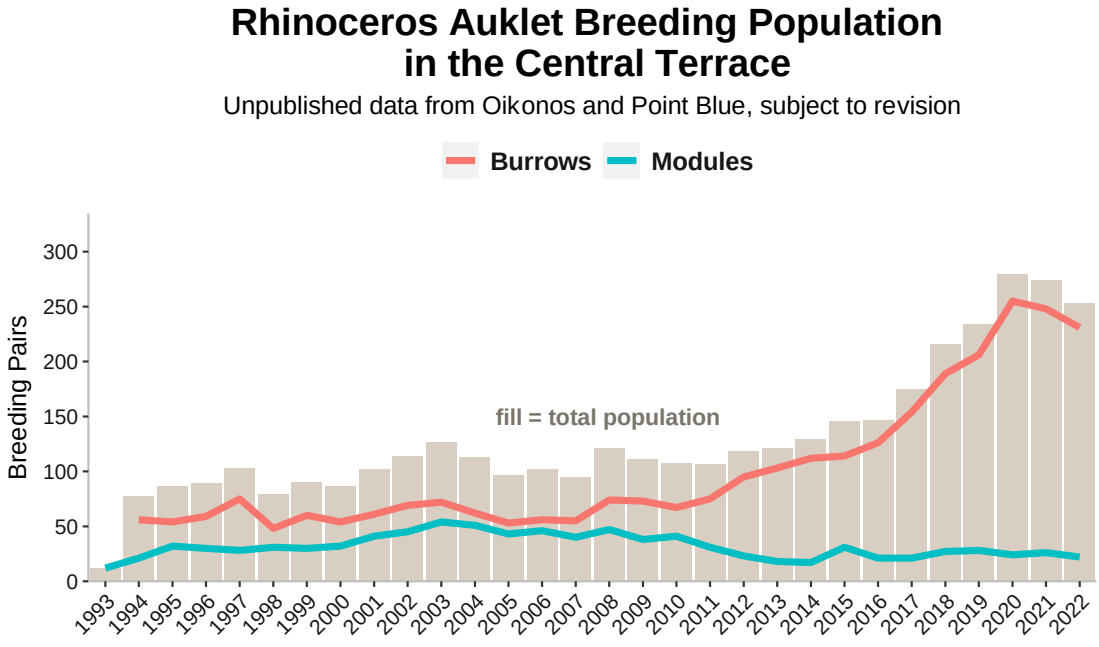


Fig. 2: Rhinoceros Auklet breeding population in the central terrace of Año Nuevo Island, 1993 – 2022. Artificial nest sites were changed from wooden boxes to ceramic nest modules after the 2010 breeding season. Pairs in artificial nests have stayed relatively stable since ceramic module installation, while pairs in natural burrows have increased dramatically since restoration efforts began in 2011.

Productivity

We define Rhinoceros Auklets burrow productivity as the number of chicks fledged per active nest. Productivity in 2022 (0.8 chicks per pair, n=35 pairs) was higher than the long-term average (0.66±0.15; Fig. 3). Productivity in the artificial nest modules was lower, at 0.59 chicks per pair (n=22). See pg. 21 for further discussion of nest module results.

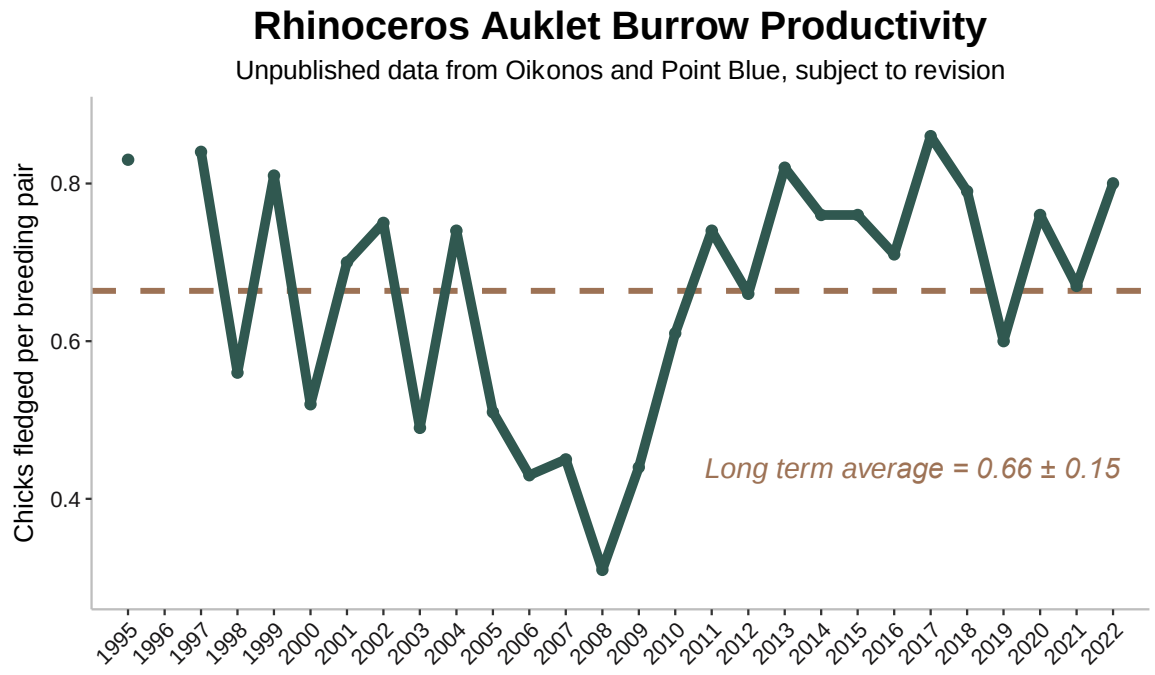


Fig. 3: Average number of Rhinoceros Auklet chicks fledged per pair in natural burrows, 1995 – 2022 (n=35 in 2022). Burrows were not monitored in 1996. The dashed line represents the long-term average of 0.66 ± 0.15 chicks fledged per pair. The sample size for burrows monitored for productivity ranged from 25 to 72.

Kleptoparasitism by Western Gulls

Kleptoparasitism, food stealing, is a phenomenon observed in other Rhinoceros Auklet breeding colonies (Senzaki et al., 2014; Watanuki, 1990; & Miyazaki, 1996). Gulls are well-documented kleptoparasites (Brockmann & Bernard, 1979). To investigate if kleptoparasitism occurs between Western Gulls and Rhinoceros Auklets on Año Nuevo Island, Doris Duke Scholar Kyra Madunich used wildlife cameras to monitor Rhinoceros Auklet feeding events on five modules in 2019. Camera recordings were monitored for Rhinoceros Auklet chick feedings, and we recorded all predations and attempted predations by Western Gulls.

From July 9th to August 5th of 2019, four of the five monitored burrows experience kleptoparasitism attempts by gulls. However, only two of the modules had confirmed successful kleptoparasitism attempts occur, in which the gull was able to steal prey from the Rhinoceros Auklet (see Fig. 4). We know little about this interaction on the island, but it is likely that the

proximity of modules and burrow entrances to Western Gull nests leads to increased rates of predation.

In 2022, intern Anna Douglas investigated if proximity to Western Gull nests influenced the final Rhinoceros Auklet chick weight. The presence of a Western Gull nest within 1m of a Rhinoceros Auklet artificial nest was not shown to significantly affect chick weight (Welch's t-test: t=1.25, df = 14.92, p-value = 0.229), however, average Rhinoceros Auklet final chick weight before fledging without a Western Gull nest present was 22.2 grams higher than those near a nest, but this interaction was not statistically significant (Fisher's exact test: p-value = 0.229). Kleptoparasitism had never been documented on Año Nuevo Island before this study. More studies are needed to explore the implications of these interactions.

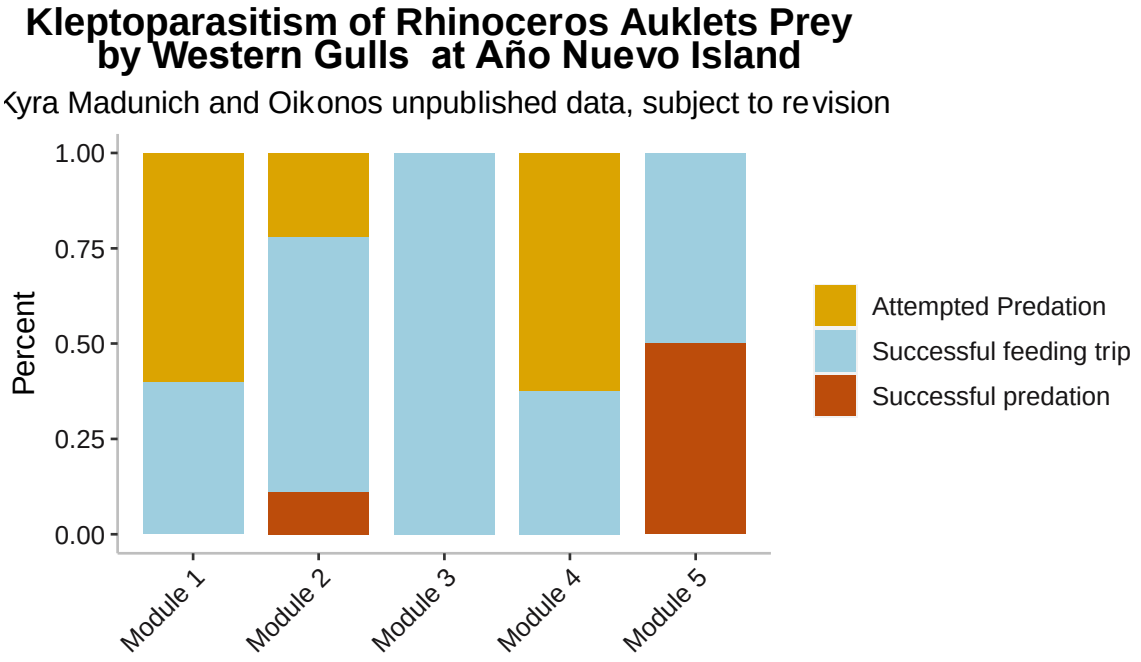


Fig 4: Kleptoparasitism attempts on breeding Rhinoceros Auklets by Western Gulls at Año Nuevo Island from July 9th – August 5th, 2019 (n= 2-10 feeding trips).

Cassin's Auklet

Cassin's Auklets (*Ptychoramphus aleuticus)* are small members of the family Alcidae. They breed on islands from the Aleutians in Alaska to the coast of Baja California by nesting in rock crevices and shallow burrows. On Año Nuevo Island, they breed in shallow natural burrows and artificial ceramic nests. We monitor Cassin's Auklets with the same methods as Rhinoceros Auklets.

A Cassin's Auklet chick ready to be weighed by researchers.

Population

Cassin's Auklets were first recorded breeding at Año Nuevo Island in 1995 (Carle et al. 2020), and their population has grown slowly for 10 years. We did not record breeding in 2005, and small numbers (i.e., less than 10 breeding pairs) bred in 2006 and 2007. The population grew over the last 11 years, and in 2022 we estimated 102 breeding individuals in the central terrace (Fig. 4). In 2021, 88% of the island population nested in the central terrace, where habitat improvement efforts were focused. We could not conduct island-wide surveys in 2022 due to disturbance to nesting Brandt's Cormorants. In 2022 there were 38 fewer breeding pairs in the central terrace than in 2021, which may be due to exclusion by cormorants. Brandt's cormorants can block existing Cassin's burrows, causing them not to attempt or abandon reproductive efforts.

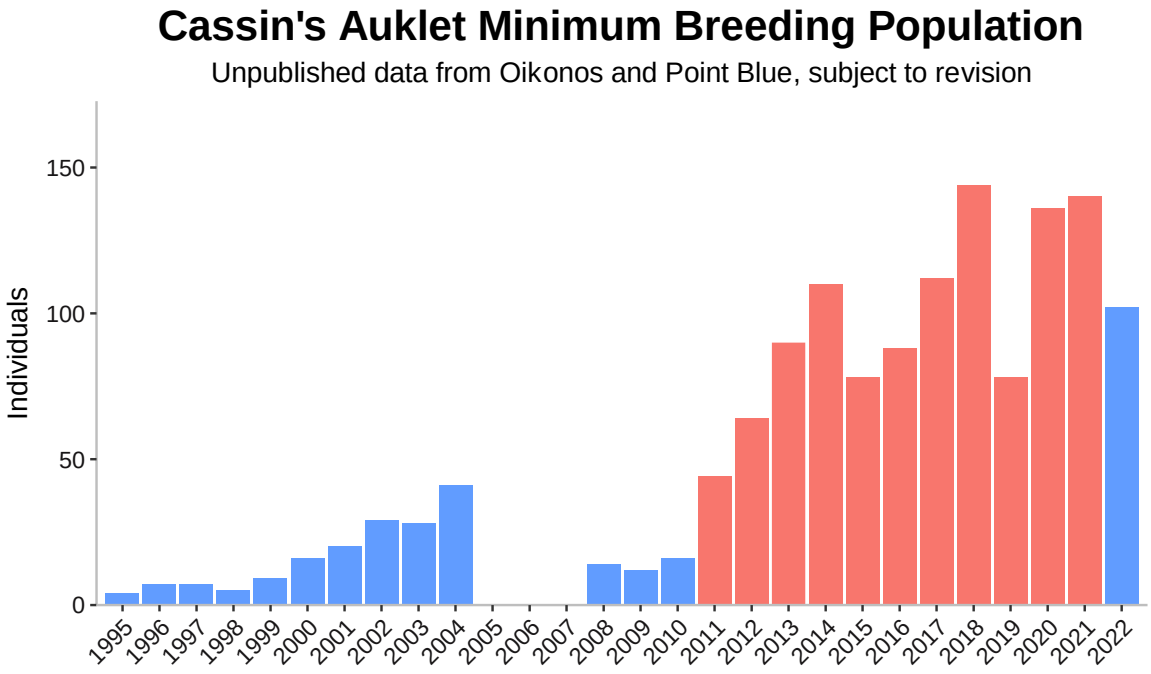


Fig. 5: The minimum number of breeding Cassin's Auklets at Año Nuevo Island, 1994 – 2022. No nests in 2005 and no data in 2006 and 2007. Blue bars (1994 – 2010 and 2022) represent minimum estimates because the whole of the island was not checked for nests, while the red bars (2011 – 2021) represent total island estimates. We published the 1995-2017 results in Carle *et al.* 2020.

Productivity

In 2022, Cassin's Auklet productivity in burrows and modules was 0.44 chicks per pair (n=36). Productivity was lower than in 2021 (0.75 chicks per pair; n=44) and the long-term average (0.67 ±0.26 chicks per pair). In addition, no pairs "double clutched" (laying another egg after successfully fledging a first chick).

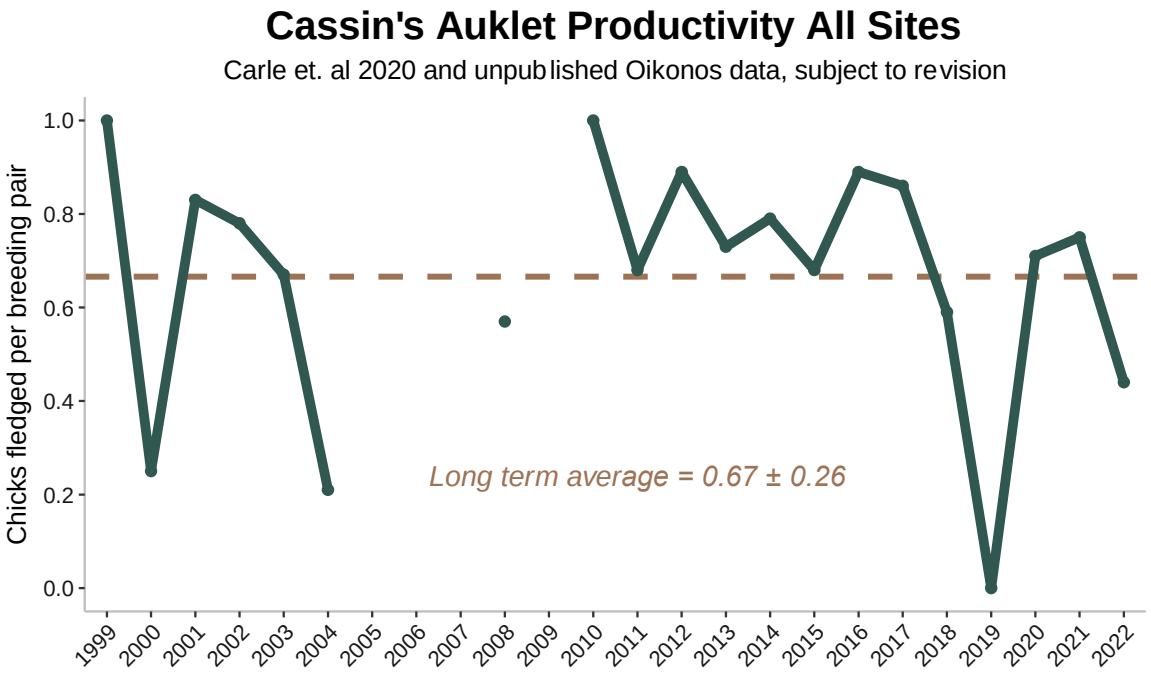


Fig. 6: The average number of Cassin's Auklet chicks fledged per pair per year from 1999 – 2022 in both natural burrows and artificial nest modules, including both single and double clutch efforts (n = 36 in 2022). There were no Cassin's Auklets on the island in 2005 and insufficient data in 2006, 2007, and 2009. We published the 1995-2017 data in Carle et al. 2020. Sample sizes for birds monitored for productivity ranged from 4 – 44 across the time series.

Western Gull

The Western Gull (*Larus occidentalis)* is a large gull endemic to the California Current. The colony at Año Nuevo Island is one of three major island populations in California's central coast. Population counts of breeding Western Gulls at Año Nuevo Island began in 1976 (Sowls et al. 1980). In 1999, researchers began standard ground and boat-based monitoring, timed during the peak incubation period. Additionally, we used aerial photographs to survey inaccessible areas of the island during recent years. Finally, to measure reproductive success, we followed a sample of 36 nests in the central terrace in 2022.

Photo by Danielle Devincenzi

Population

In 2022, we counted 555 Western Gull nests on the island, the lowest on record since 1987. The breeding population on Año Nuevo Island has been declining since 2005. Historically, Western Gulls nesting on the island were affected by human disturbance during 1872 – 1948, when the Coast Guard operated a light station, and during unrestricted human access from 1949 – 1967 (Tyler and Briggs 1981). After meager nesting numbers in the 1970s and early 1980s, the Western Gull population rapidly grew and peaked in 2005 at 1,234 nests. In the years since the ANI breeding population has declined by more than half. In 2014 and 2015 alone, there was a ~30% drop in nesting numbers at all three major Western Gull breeding colonies on the central coast (ANI, Alcatraz, and Southeast Farallon Island, the largest Western Gull colony globally). During 2015 – 2019, gull nest numbers remained relatively stable in the low- to mid-600s, but 2020 through 2022 are the lowest counts since standardized monitoring began in 1999 (Fig. 7).

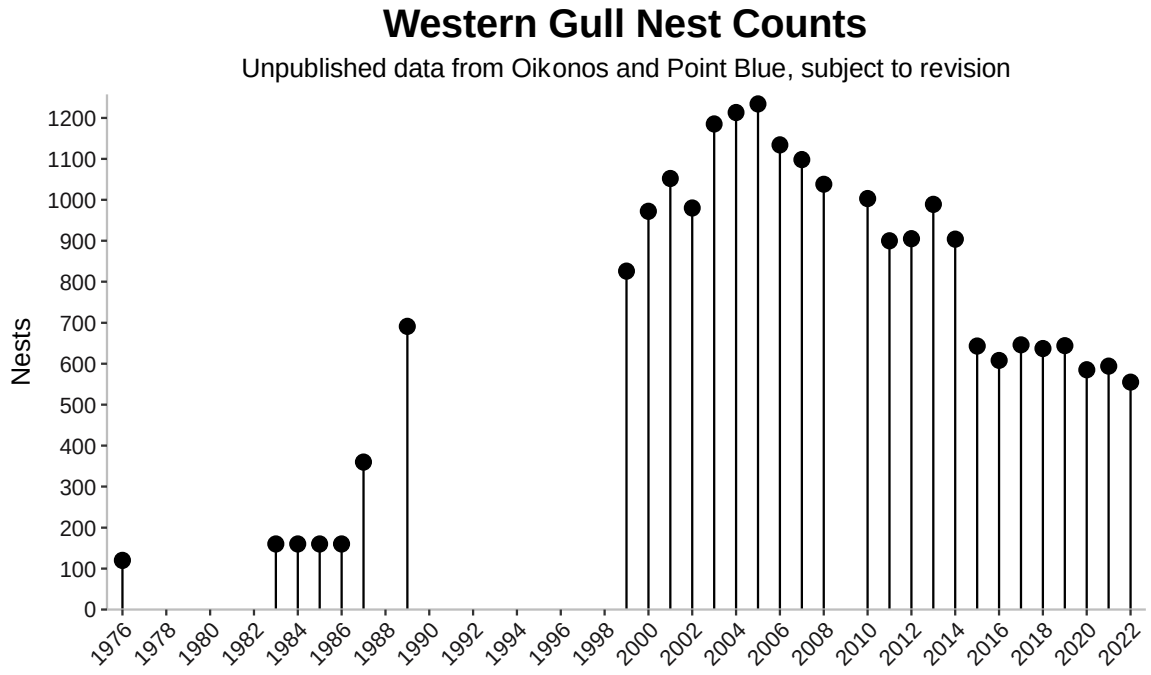


Fig. 7: Western Gull nests at Año Nuevo Island 1976 – 2022. In 2022, nests were counted via ground counts and by using UCNRS aerial drone images. In years with no bars, population was not estimated. The years 1999 – 2022 are standardized ground counts, and all previous years are from the literature. The 1976 data is from Sowls et al. 1980, 1982-87 data is from A. Huntley (pers. comm. in Lewis & Tyler 1987), and 1989 data is from Carter et al. 1992.

Productivity

Photo by Danielle Devincenzi

In 2022, Western Gulls fledged 1.19 ± 1.13 chicks per pair (n=36; Fig. 8). This was below the long-term average of 1.27 ± 0.32. In 2016, we began an annual island-wide Western Gull chick census during late June, just before chicks start to fledge. We use this census to compare the density of fully-grown chicks in the central terrace habitat restoration area to the north and south terraces, areas with no habitat restoration. In 2016 – 2021, this census showed the central terrace to have a much higher density of chicks surviving to fledging age. In 2021, the central terrace had a density of gull chicks 10 times greater than the north terrace and five times greater than the south terrace (Fig. 9). We believe this to be primarily due to the presence of California sea lions outside the central terrace, which can crush nests and discourage breeding attempts. We did not complete a Western Gull chick census in 2022 to reduce disturbance nesting Brandt's cormorants.

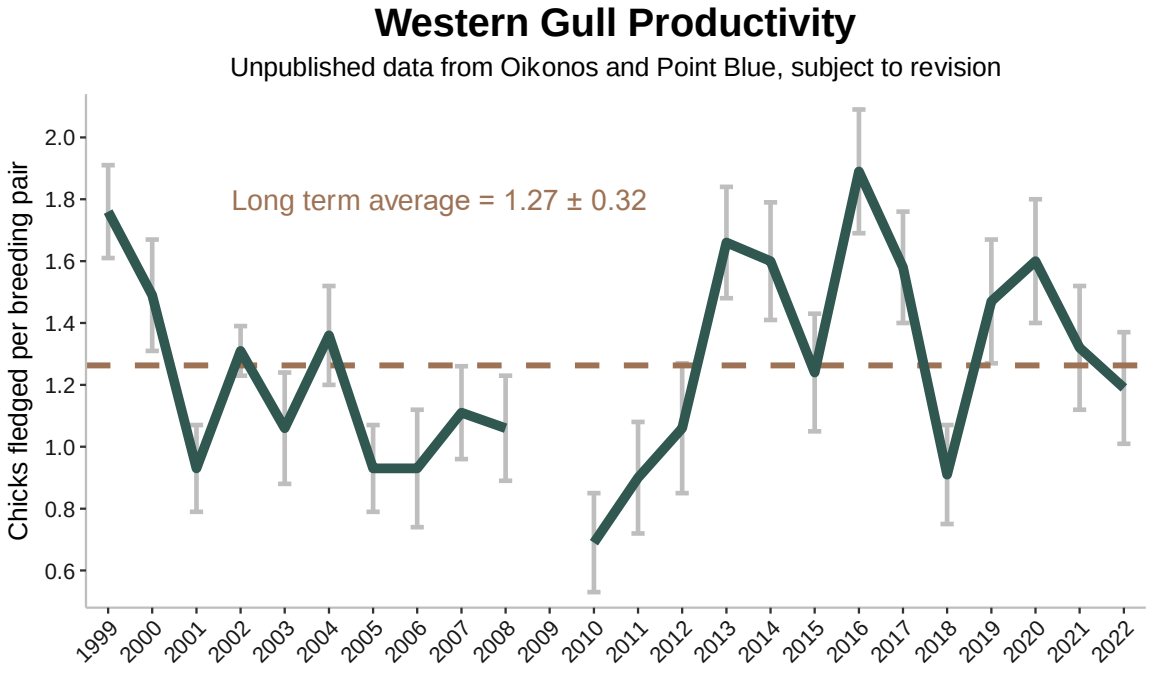


Fig. 8: Annual productivity (average chicks fledged per breeding pair ± standard error) of Western Gulls nesting in the central terrace region at Año Nuevo Island, 1999 – 2022 (no data for 2009; n = 36 in 2022). We monitored subsamples of 28 – 155 nests annually.

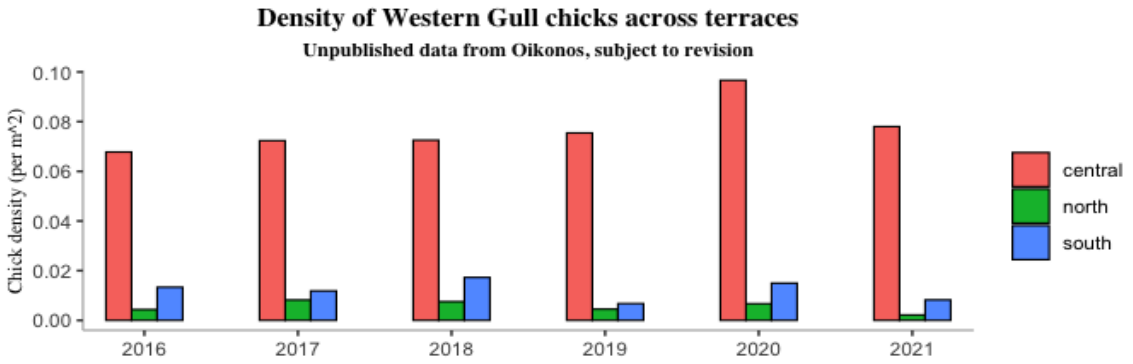


Fig 9: Western Gull chick density (chicks per m^2) on ANI terraces during mid to late July 2016 – 2021. Timing of counts coincided with chicks at mostly- to fully-feathered status, and few, if any, had fledged. We define the central terrace as all areas inside the Habitat Ridge fence (5,474 m^2). The North terrace is considered all areas north of the Habitat Ridge (5,978 m^2), and the south terrace is areas south of the Habitat Ridge (6,078m^2).

Brandt's Cormorant

Brandt's Cormorants (*Urile penicillatus)* were first documented nesting at Año Nuevo Island in 1989 (Carter et al. 1992) and regular nest counts began in 1999. The annual nesting population is estimated using a combination of ground counts and aerial images taken during the peak egg-incubation period. Most Brandt's Cormorants nest are on the south terrace in dense clusters around the historic light tower. Aerial drone images, taken every two weeks by UCSC Año Nuevo Reserve facilitate the assessment of nesting pulses since 2018.

Population

In 2022, we used aerial images taken May 10th to count 4,971 nests (9, 942 individual breeding birds). This year surpassed last year as the highest recorded number of breeding Brandt's cormorants on the island. In 2021, there were 8,900 birds and in 2022 the breeding population increased by 12% (1,042 birds). We first documented nests within the habitat ridge in the central terrace in 2021, where cormorants have historically experienced too much disturbance to nest, and in 2022, these new colonies persisted. This expansion of their nesting territory may be a reason the breeding population has increased. Another possible explanation for the robust breeding efforts in 2021 and 2022 was the abundance of Northern Anchovy (*Engraulis mordax),* an essential prey species correlated with surges in the population (Ainley et al. 2018). See page 20 for further discussion of Northern Anchovy. Brandt's Cormorant populations at the Farallon islands have similarly increased over the past five years, with high reproductive success (M. Johns, pers comm.).

Brandt's Cormorants nesting densely in the central terrace and bluffs excluded Western Gulls and Pelagic Cormorants from those breeding in those areas and caused erosion and obstruction to

Rhinoceros Auklet burrows. Simultaneously, Western Gulls opportunistically foraged on Brandt's Cormorants' eggs when left unattended. These intraspecific interactions caused some pairs (of all species) to lose their first eggs, relay second clutches, and/or experience reproductive failure.

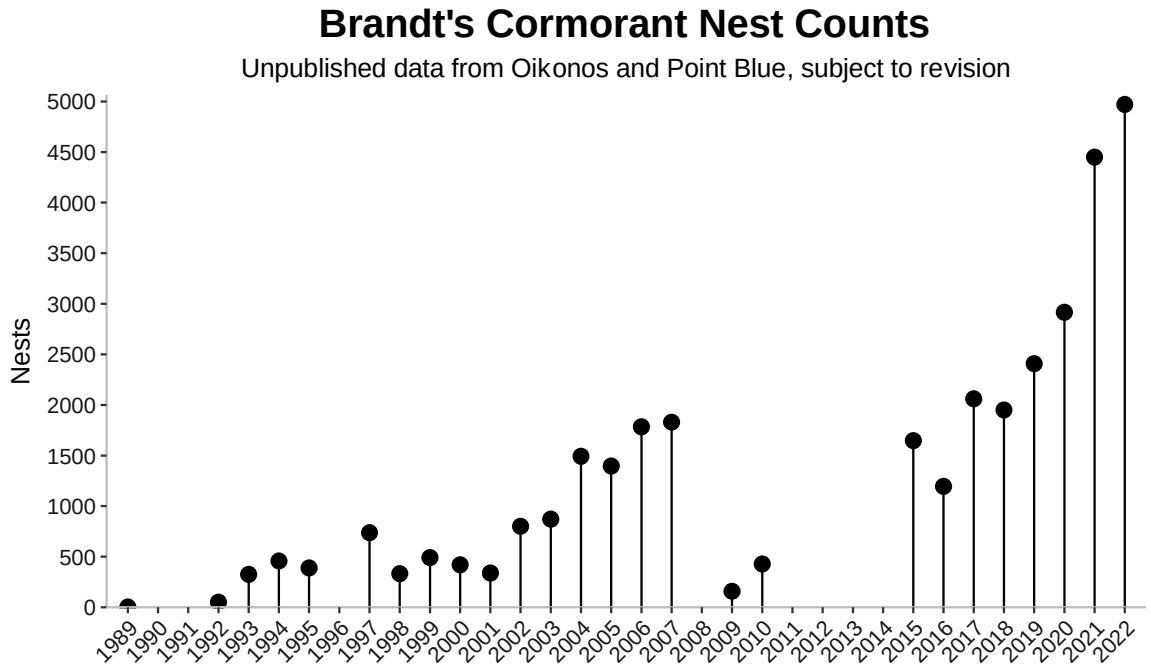


Fig. 10: Brandt's Cormorant nest counts from aerial images and inside Lightkeeper's house at Año Nuevo Island, 1988 – 2022. The first documented nesting at ANI was in 1989. Zero nests were recorded in 1990, and no data exists for 1991. Data sources: 1988 – 2015 were published in Ainley et al. 2018; numbers for 1988 – 1990, 1995 – 1997, 1999 – 2003, and 2006 were published first in Capitolo et al. 2014. 2016 - 2022 are unpublished aerial counts from the US Fish and Wildlife Service and Oikonos.

Productivity

Brandt's Cormorant productivity was calculated by following a sample of 35 nests within the sub-colony near the fallen light tower on the south terrace, 5 of which were added four to six weeks after the initiation of egg-laying to represent late nesters. Sampled nest contents were followed weekly for egg and chick fates. Productivity in 2022 was 1.28 ± 0.82 chicks fledged per pair (n=35). Productivity was lower than the long-term average of 1.69 ± 0.67 (Fig. 10) and the lowest year recorded since 2012, despite the boom in the population.

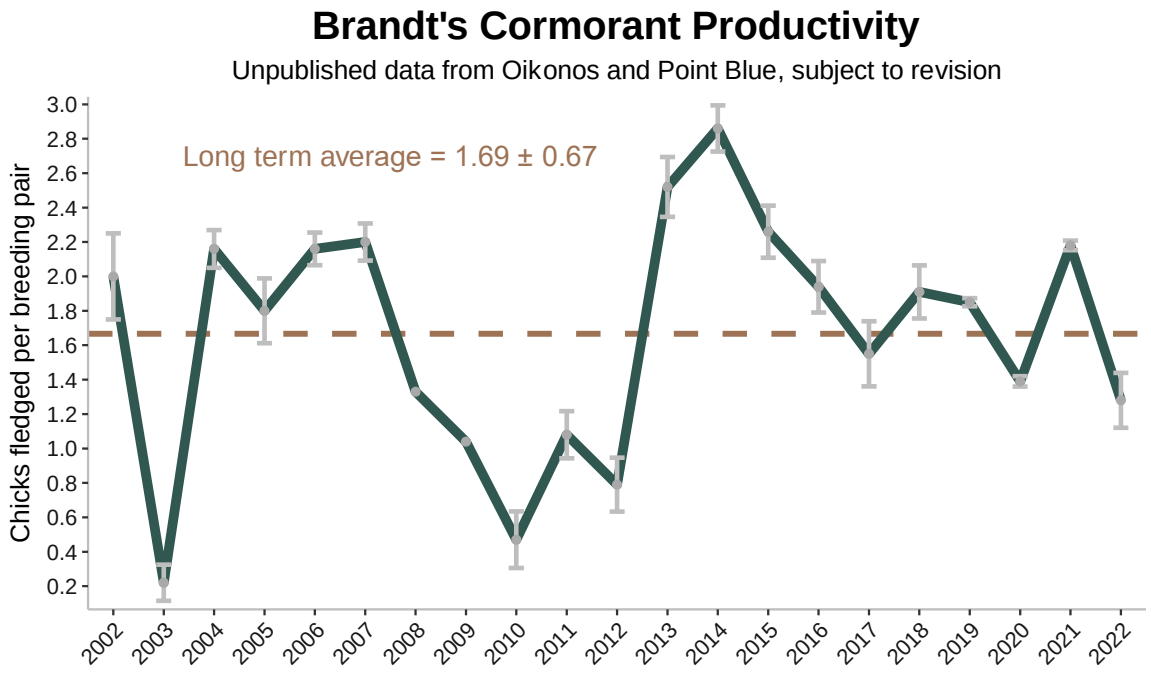


Fig. 11: Brandt's Cormorant productivity at Año Nuevo Island, 2002 – 2022 (n = 28 in 2022). We followed a sub-sample of nests from one or both of two sub-colonies, the Light Tower and Blind 17 (shown here combined). In 2008 and 2009, we calculated productivity as the total number of chicks that met fledge criteria divided by the total number of nests in the two sub-colonies rather than by following individual nests. Therefore, we could not generate error estimates in 2008 – 2009. Standard errors in 2019 – 2021 were less than 0.03. Sample size ranged from 20 – 57 nests annually.

Brandt's Cormorant nesting densely inside the habitat ridge, nests were first recorded here in 2021, May 2022. Aerial image courtesy of UCSC Año Nuevo Reserve.

Pelagic Cormorant

Pelagic Cormorants (*Urile pelagicus)* are a smaller relative to the Brandt's cormorant that nest on cliffs and bluffs. At Año Nuevo Island, they have also adapted to nesting on the windowsills of the historic Lightkeeper's house. Pelagic Cormorants were surveyed sporadically at Año Nuevo from 1967 to 1987 (Carter et al. 1992), and annual standardized population and productivity monitoring began in 1996 on the island and 1999 on the mainland. In addition, all visible nests on the mainland cliffs, island bluffs, and historic lightkeeper's house were monitored for nest contents and activity.

Population

The total number of breeding Pelagic Cormorants on the mainland and island was 94 birds in 2022 (Fig. 10), though this is a minimum count due to challenges accessing nesting areas on the island's north terrace. There were 76 breeding birds on the island and 18 on the mainland. The mainland bluff population declined between 2018 and 2021, but in 2022 there was an increase in the population by 10 individuals from 2021. The island population, however, declined from 2021 to 2022 by 12 individuals, leading us to believe that island nesting Pelagic Cormorants may have been outcompeted for breeding habitat by the increased population of Brandt's Cormorants and these individuals may have bred on the mainland instead. We did not observe any interactions of depredation between Common Ravens and Pelagic Cormorants in 2022, though raven interactions were not intensively monitored (see Carle et al. 2017).

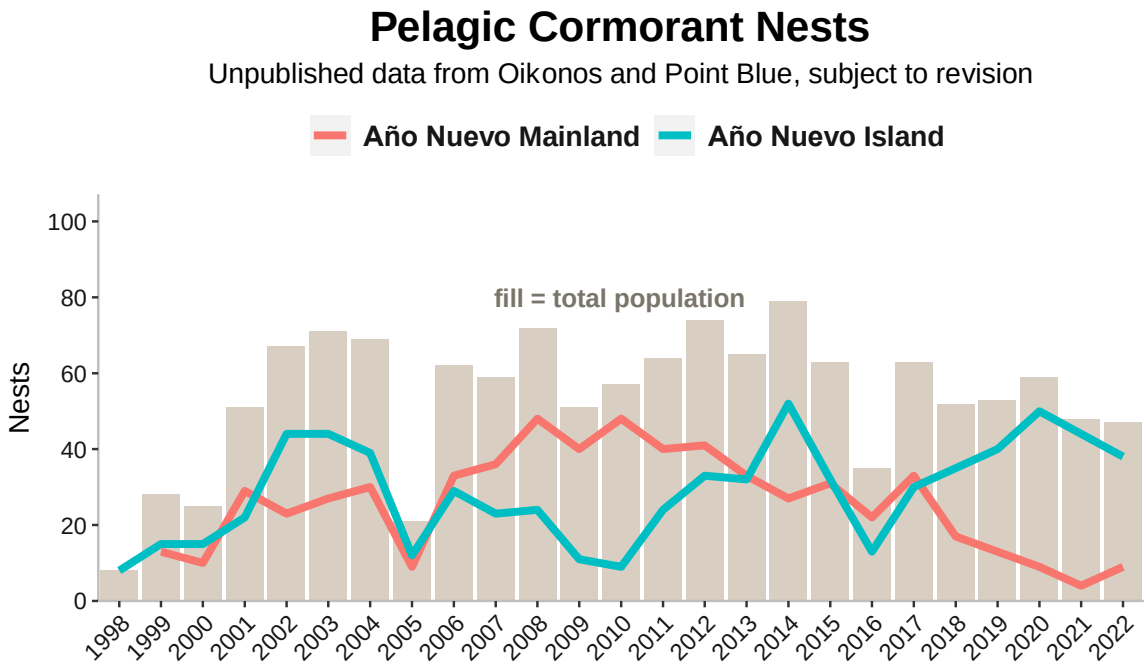


Fig. 12: Pelagic Cormorant populations at Año Nuevo, 1999 – 2022. The bars represent the total number of nesting birds on both the island and mainland, while the blue line shows the mainland sub-colony and the red line shows the island sub-colony.

Productivity

The reproductive success of Pelagic Cormorants on the island was 1.00 ± 1.04 chicks per pair in 2022 (n=30). Due to the small sample size of nests available and monitoring challenges, we did not attempt to document reproductive success on the mainland in 2021. However, in 2022 monitoring of the mainland cliffs began again and the reproductive success of these nests were 0.67 ± 0.75 chicks per pair (n=8).

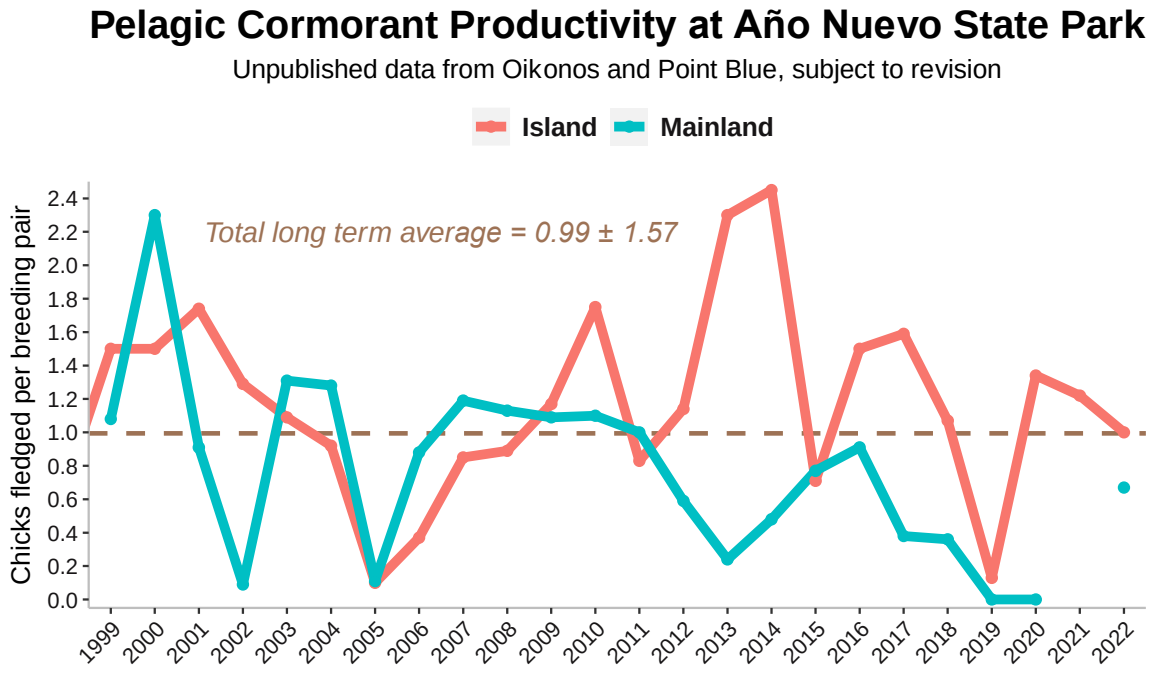


Fig 13: Pelagic Cormorant productivity at the island and mainland sub-colonies, 1999 – 2022 (n = 30 on the island and 8 on the mainland in 2022). Sample sizes range from 4 - 43 pairs on the island and 5 – 40 on the mainland. In 2021, we did not attempt monitoring on the mainland due to difficulty accessing sites.

Black Oystercatcher

The Black Oystercatcher (*Haemaptopus bachmani*) is a loud shorebird that nests in intertidal areas along the west coast of North America. At ANI, they build depressions lined with small pebbles in coves and bluff ledges to lay their eggs (see image right). Reproductive success at ANI has generally been poor. In 2022, two active breeding pairs were confirmed, from which at least 2 total chicks fledged. We know too little about nest contents to calculate overall ANI productivity in 2022. In 2021 overall productivity was 0.33 ± 0.58 SD chicks fledged per pair (n=3). Most nests fail at ANI when eggs and chicks disappear, suggesting predation or perhaps incidental trampling by pinnipeds.

Black oystercatcher eggs in a nest consisting of a depression and small pebbles

Black Oystercatchers have also been observed defending nests from Common Ravens frequently since 2004, this interaction was not observed in 2022.

The coast of California is considered critical core habitat for the species, with state-wide populations estimated at 4,749 to 6,067 individuals (Weinstein et al. 2014). Sea level rise is projected to threaten this population by reducing important intertidal habitats. Elevated nesting sites, like those at ANI, will become increasingly important for this species. Oikonos contributes ANI Black Oystercatcher reproductive success data to California Audubon to monitor the breeding population state-wide.

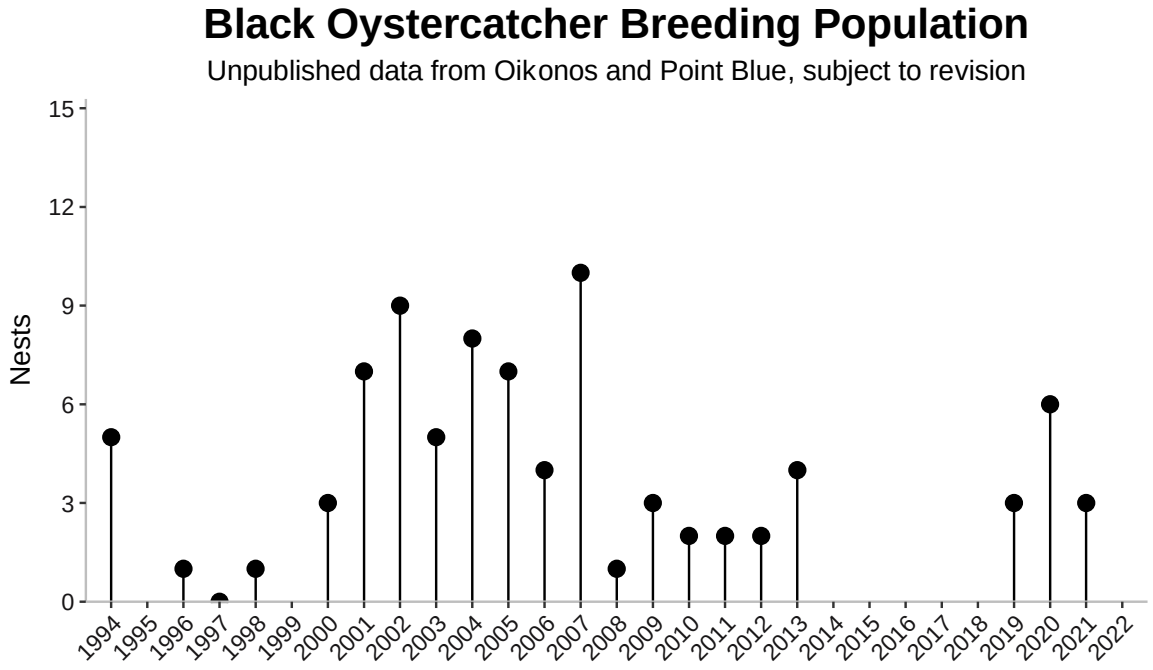


Fig. 14: Population of Black Oystercatcher nests visible from Año Nuevo Island ground observations from 1994 – 2022. All sites visible from the central terrace were monitored annually (approximately 70% of the available habitat on the island).

Dozens of Black Oystercatcher roost on the island bluffs during fall and winter.

Pigeon Guillemot

Pigeon Guillemots (C*epphus columba)* breed in small colonies from Alaska to California, nesting in burrows or rock cavities. They were monitored at ANI in ceramic modules within the central terrace and by observations of site attendance and fish carrying in inaccessible sites. In 2022, ANI had a breeding population of at least seven pairs (Fig. 14). Two bred in ceramic modules designed for Rhinoceros Auklets, and five were under human-constructed blinds or in rock crevices. We were only able to assess productivity for the two pairs in modules, which was 0.5 ± 1 chicks fledged per pair (n=2).

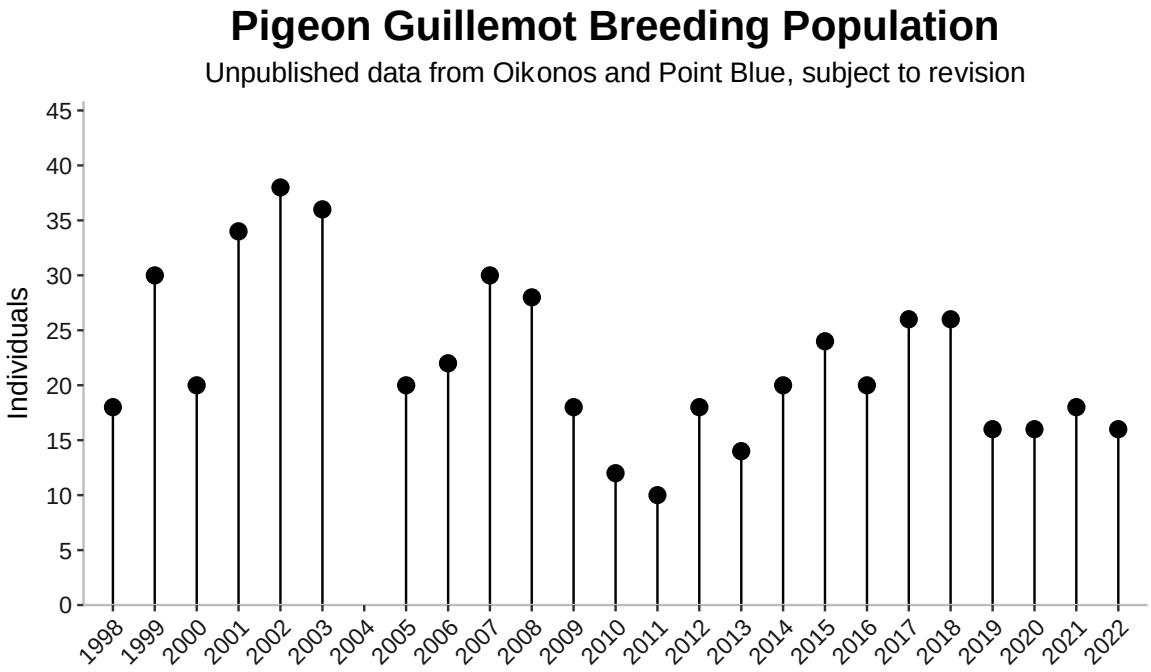


Fig. 14: Pigeon Guillemot confirmed breeding population at Año Nuevo Island, 1998 – 2022.

Storm-petrels

The Ashy Storm-petrel *(Oceanodroma homochroa)* is a small, endangered seabird related to albatrosses. From 1993-2022, 12 Ashy Storm-Petrels have been recorded at ANI. One Fork-Tailed Storm-Petrel was captured in 2000. All were captured during nighttime mist-netting for Rhinoceros Auklet prey, which takes place four nights a year during June and July. No Storm-petrels were caught in 2022.

Common Raven

Common Ravens (*Corvus corax*) were first recorded nesting at Año Nuevo in 1987 (Lewis and Tyler 1987). There has been at least one active Common Raven nest on the island and mainland every year since 2004, except for 2016 and 2020-2022. This year, we observed no breeding behavior on the island or mainland nor predatory interactions between Pelagic Cormorants and Common Ravens on the mainland bluffs.

Brown Pelican

Brown Pelicans (*Pelecanus occidentalis*) breed along southern California's Pacific coast to Mexico and roost at Año Nuevo Island and mainland bluffs during summer and fall. In 2022 we counted the highest recorded number of Brown Pelicans roosting on the island (1,478 birds). Since 1999, Oikonos has conducted weekly counts during the seabird breeding season (Fig. 16). Oikonos and UC Año Nuevo Reserve contributed data and aerial photos to state-wide surveys conducted by Deborah Jaques for California Audubon and USFWS. In their report, they list Año Nuevo as one of the four largest roosting sites on the entire U.S. West Coast (Jaques 2019).

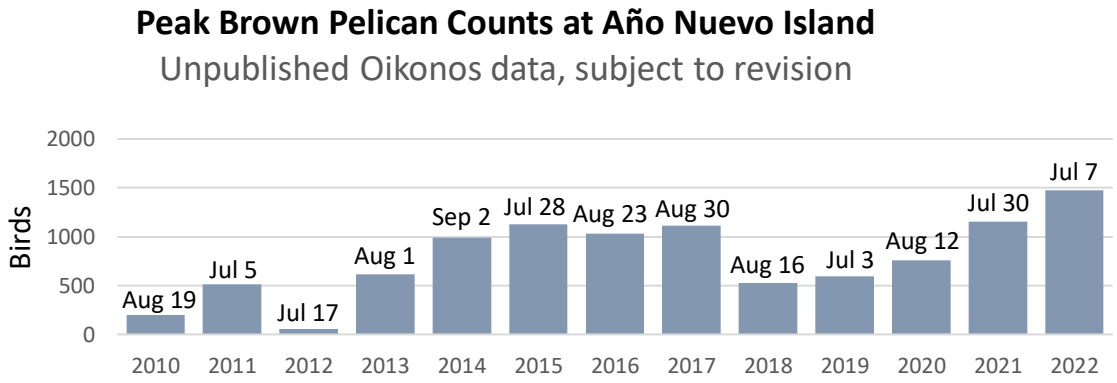


Fig. 16: Annual peak number of roosting Brown Pelicans at Año Nuevo Island, as counted from the central terrace, 2010 – 2022.

Brown Pelicans are heavy seabirds and prefer to stand and sit on vegetation. This has impacted habitat restoration efforts on the island, with birds often completely trampling plants and sometimes damaging Rhinoceros Auklet burrows within the central terrace. Trampling by pelicans has been mitigated somewhat by installing 25 Habitat Enhancement and Protection platforms (HEAPs), which protect fragile auklet burrows from crushing and provide additional pelican roosting habitat (see page 24).

In 2020 and 2021, Brown Pelicans were seen nest-building on Año Nuevo State Park mainland bluffs above Cove Beach. Several hundred adults and juveniles regularly roost at this site, but in

both years several adults were observed sitting on crude piles of sticks positioned along the cliff edges. We did not observe any eggs or consistent incubation postures in either year.

III. Prey Studies

Seabirds are top predators in marine ecosystems and are considered an indicator species for ecosystem health. Therefore, understanding prey sources during the breeding season helps illuminate the state of marine ecosystems and can inform sustainable fisheries management. In 2022, we collected diet samples from Rhinoceros Auklets and Brandt's Cormorants.

Rhinoceros Auklet Prey Study

Rhinoceros Auklets return to the breeding colony nocturnally to provision their chicks with whole fish and/or cephalopods carried externally in their bill (Hester, 1998). This assemblage of prey is called a "bill-load." In 2022, we continued our 30 year dataset on Rhinoceros Auklet diet by mist-netting provisioning adults in the central terrace for four nights during the peak of chick-rearing. These data have been used to inform ecosystem-based fisheries management in California, understand auklet foraging behavior, inform anchovy management, and more. All this work highlights the importance of long-term diet monitoring datasets such as the Rhinoceros Auklet diet studies at ANI and Southeast Farallon Island. In 2022 we shared diet data to help inform the 2022 California Current Ecosystem Status Report.

In 2022, we caught 214 individual birds, with 80 complete bill-loads. Within our sample, Northern Anchovy (*Engraulis mordax)* was the most abundant prey species Rhinoceros Auklets brought back to their chicks (Fig. 18). When Northern Anchovies are abundant in the region, Rhinoceros Auklets will often feed predominately on the species. The presence of anchovies (along with juvenile rockfish) is usually associated with high chick growth and fledging success.

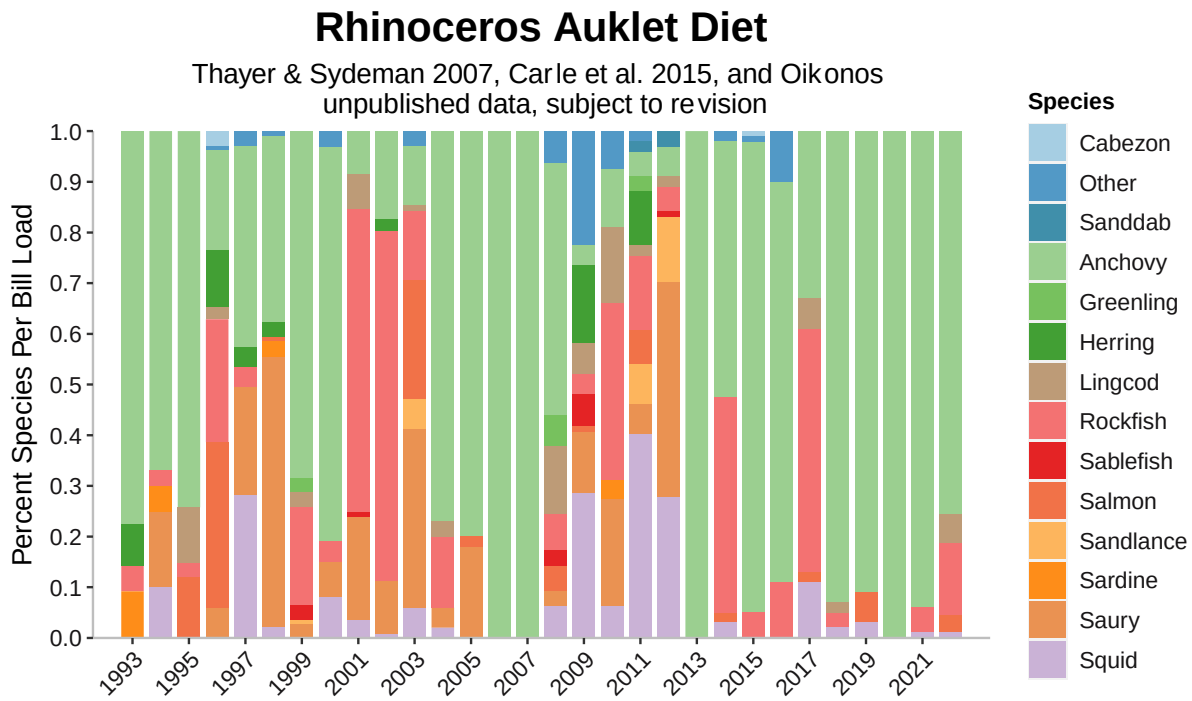


Fig. 18: Rhinoceros Auklet chick diet at Año Nuevo Island from 1993 – 2022, quantified as the percent number of prey per bill-load delivered to chicks. Sample size ranged from 18 – 80 bill-loads annually. The sample size in 2022 was 80.

IV. Habitat Restoration

Habitat restoration at ANI began to mitigating injuries to seabird populations from oil spill contamination. In 2008, The Luckenbach Trustee Council determined that injury to Rhinoceros Auklets from the S.S. Jacob Luckenbach oil spill could be addressed by habitat improvement at ANI through reducing soil erosion, protecting burrows from incidental crushing, and installation of artificial nest sites. The Luckenbach Trustee Council mitigation funds supported restoration and monitoring at ANI from 2009-2018. Habitat restoration efforts have also received funding from the CDFW's Environmental Enhancement Fund, the Honda Marine Science Foundation, the Sandhill Foundation, the Patagonia Santa Cruz store, and others (see page 26).

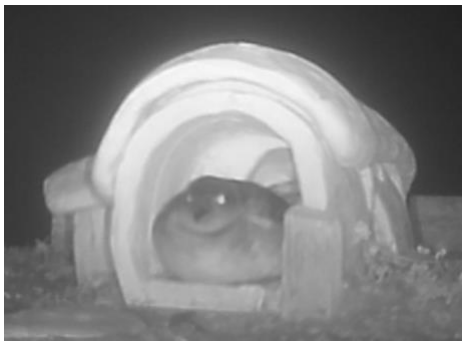
Restoration Accomplishments during 2022:

1. 4 new **Ceramic Nest Modules** were added to the central terrace
2. **Habitat Enhancement and Protection Platforms** (HEAPs) protected burrows in fragile areas.

Ceramic Nest Modules

Originally designed in 2010 by ceramicists at California College of the Arts, >100 clay nest "modules" provide erosion-resistant, uncrushable burrow-alternatives for the burrowing seabirds at ANI (Fig. 19). First installed in 2011, Rhinoceros Auklets have laid 267 eggs and fledged 115 chicks from the ceramic modules. In 2022, productivity in ceramic modules was above average

(0.59 chicks fledged per pair). Since 2019, ceramic module productivity has been more like natural burrows than ever (Fig. 20). This is possibly due to researchers no longer handling adult birds incubating eggs in ceramic nest modules after 2019. Instead, we only handled chicks when adults were not present.



An adult Cassin's Auklet using a ceramic nest module

Cassin's Auklets have also used ceramic nests explicitly designed for this smaller species (see Fig. 19). Averaging fledged per pair from 2013 – 2022 was 0.59 ± 0.35 (n = 2 - 10 pairs), which was like to the productivity in natural burrows (0.62 ± 0.30 chicks fledged per pair; n = 23 – 42 pairs/year). Cassin's Auklet pairs in modules remained relatively constant between 2020 and 2021, with 2021 being the highest number of Cassin's Auklets on record used modules (18 pairs). In 2022, this number has decreased to 10 pairs. Two pairs of Pigeon Guillemots nested in clay modules in 2022, and productivity was 2.0 ± 1.0 chicks a pair. Maximum productivity for Pigeon Guillemots is 2.0 chicks per pair, as they lay two eggs (versus the single egg laid by auklets).

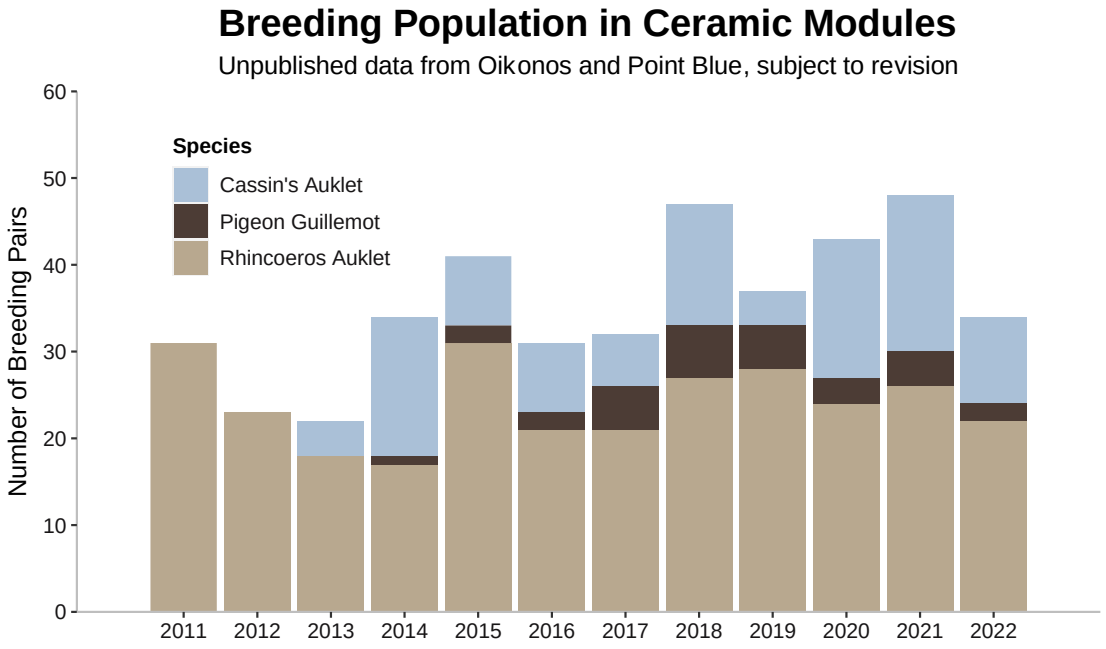


Fig. 19: Alcid breeding populations in clay nest modules at Año Nuevo Island, 2011 – 2022. Rhinoceros and Cassin's auklet pairs were considered breeding if they had a confirmed egg or chick. We considered Pigeon Guillemot pairs to be breeding if they attended the site greater than three times or carried fish into the site.

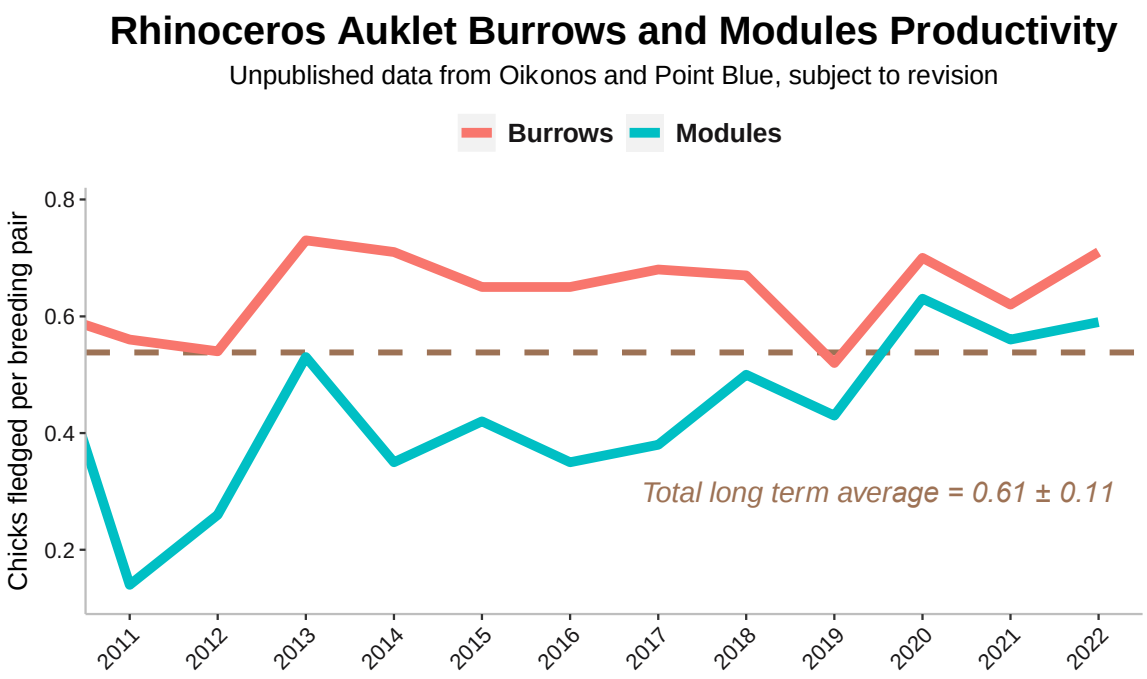


Fig. 20: Rhinoceros Auklet productivity in natural burrows (red) and ceramic modules (blue), 2011 – 2022. The long-term average is chick fledging success of both nesting sites combined. In 2020, the productivity rates of the two site types were the most similar on record, thought to be due to researchers no longer handling adult birds in modules. Our samples range from 33 to 56 pairs in burrows and 18 to 31 in modules. In 2022, n=35 in burrows, and n=23 in modules.

Erosion control

We calculated erosion rates to burrows by documenting the burrow condition weekly and classifying the severity and causes of damage from erosion. We documented natural erosion, incidental damage by researchers, and damage by wildlife – usually by Brown Pelicans, Brandt's Cormorants, or California sea lions. In 2022, 6.4% of all Rhinoceros Auklet burrows (16/249) were damaged from either natural erosion or wildlife (Fig. 21). Of the 16 burrows, 14 were damaged by wildlife, representing 5.6% of all burrows in the Central Terrace.

Erosion control material

Establishing erosion control material has been focused in high-density burrow areas and along the edges of the central terrace, particularly susceptible to erosion and soil loss. Erosion control material biodegrades in 3 to 5 years, and installation is staggered as burrow density and erosion rate vary from area to area. We generally install erosion control material annually, but in 2022 erosion control material was not deployed.

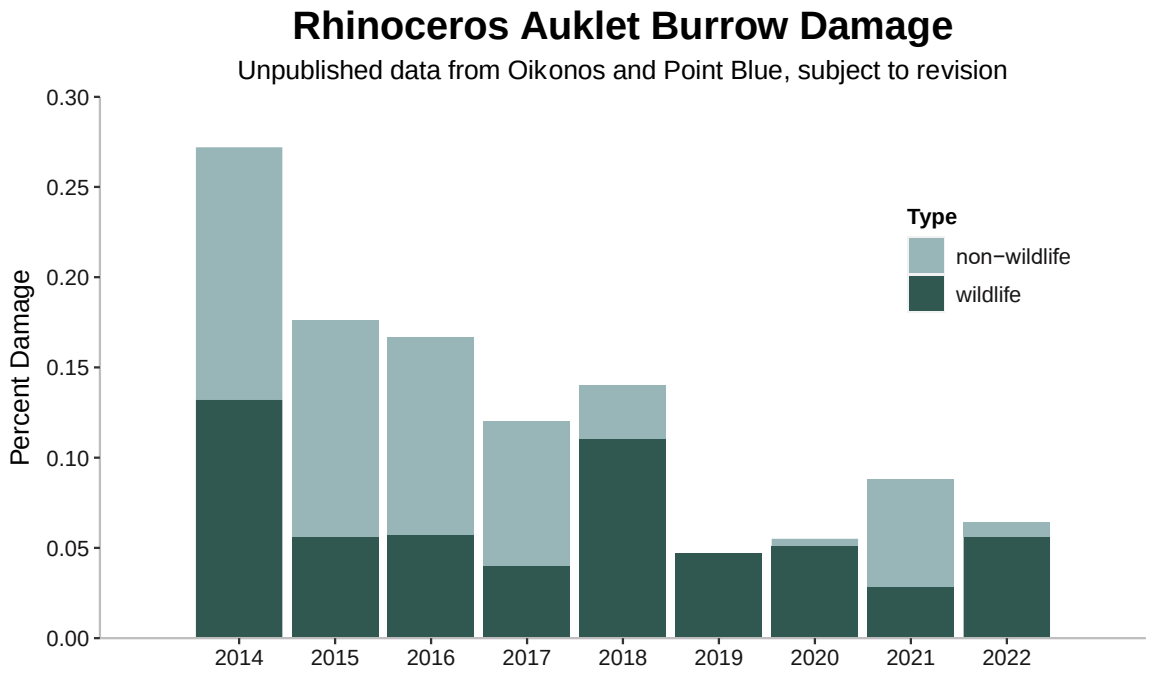


Fig. 21: Damage to Rhinoceros Auklet burrows in the central terrace (restoration area), 2014 – 2022. Wildlife damage included damage from Brown Pelican, Brandt's Cormorant, or California sea lion. Sample size was 112 – 286 burrows per year. In 2022, n=249.

Island Structures

Habitat Enhancement and Protection Platforms

In fall 2019, we installed 25 4x4 foot raised wooden platforms (HEAPs) over fragile areas in the central terrace. HEAPs were designed primarily to protect Rhinoceros Auklet burrows from trampling by Brown Pelicans while providing shelter for vulnerable Western Gull chicks and sheltering native salt grass underneath.

Habitat Ridge

Photo by Christopher Garrison

The custom-built Habitat Ridge fence surrounds the restoration area and separates California sea lion habitat from the densest population of burrowing auklets. It was constructed in 2011 almost entirely of eucalyptus logs harvested from Año Nuevo State Park mainland and designed to have a solid interlocking zig-zag pattern that requires no below-ground anchoring in the fragile soil. After 10 years, portions of the Habitat Ridge need maintenance, though structural integrity is intact, thanks to its zig-zag design. In the fall of 2021, we repaired two critical areas of the Habitat Ridge, along the southern barrier and

behind the foghorn building, where sea lions could climb over a portion that was eroding. In 2022, we did not need to reinforcement the ridge.

Acknowledgments, Partners, Volunteers

The success of this project depends on the hard work and collaboration of many individuals and organizations. California Department of Parks and Recreation, Go Native, and Oikonos Ecosystem Knowledge collaborate to conserve and improve habitat on the island. Our other vital partners include California College of the Arts, master ceramicist Nathan Lynch, UC Santa Cruz Año Nuevo Reserve, US Fish and Wildlife Service, and the University of California Santa Cruz. We are grateful to the staff and volunteers who began the initial restoration work in 2002-05 and on whose shoulders we stand. Our triumphs are shared with the hundreds of volunteers who have contributed **8,998 hours** to the project since 2009, representing a monetary value of $257,014 (based on the estimated value of volunteer time from independentsector.org). Thank you to the volunteers and student interns that joined us in 2022!

The 2022 field season team: top left Jessie Beck, lower left Grace Bahena, top center Anna Douglas, lower center Ryan Carle, top right Danielle Devincenzi, lower right Destiny Mendoza

2022 Año Nuevo Seabird Project Volunteers

Rozy Bathrick
Eric Medina
Christopher Garrison
Aspen Aellis
Abram Fleishman
Claire Nasr
Natalia Ocampo-Peñuela

Funding

Many agencies, foundations, and private donors support this project. We extend a huge thank you to all the grant-makers and donors who have sustained this project for 30 years. Funding agencies, foundations, and individual donors during 2016-2022 are listed in the tables below.

We need your support to keep training early-career ecologists, restoring seabird habitats, and monitoring the response of seabirds to climate change! Please consider donating at **Oikonos.org/donate.**

Oikonos Año Nuevo Seabird Project Funders

California Department of Oil Spill Prevention and Response
Environmental Enhancement Fund
Honda Marine Science Foundation
Sand Hill Foundation
Luckenbach Oil Spill Trustee Council
National Fish & Wildlife Foundation
Patagonia Santa Cruz store
National Endowment for the Arts
Talcott Fund of the New York Community Trust
Wildlife Conservation Society

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Aerial images courtesy of the UC Santa Cruz Año Nuevo Reserve, permit NMFS 19108 and MBNMS-2017-018.

Project Website
https://oikonos.org/locations/california-ano-nuevo-island

Social Media
https://www.facebook.com/Oikonos/
https://www.instagram.com/oikonos_org/

Presentations, Conferences & Meetings 2021-2022

Presentation for Monterey Bay Festival of Birds – September 2022
Seabird Conservation on Año Nuevo Island: the stinky seabird jewel of Monterey Bay. Presented by Ryan Carle.

Invited Plenary at the Waterbird Society Conference's Awards Ceremony session, for winning their Outstanding Conservation Paper of the Year Award—November 2021, online.
Long-term monitoring and proactive habitat management: the story of a successful new nesting colony of Cassin's Auklets at Año Nuevo Island, California. Presented by Ryan Carle, on work by: Carle, R. Coletta, E., Bathrick, R., Beck, J., Hester, M.

Año Nuevo State Park Outreach
Año Nuevo Docent Day, December 2022
Seal Day at Año Nuevo State Park, January 2020
Año Nuevo bird training presentation by Jessie Beck, November 2018

University and High School Guest Lectures
Lecture to UC Santa Cruz Natural History of Birds class, November 2021
Guest lecture to UC Santa Cruz Ornithology class, October 2021

Public Outreach & Press
- "Get to know the Cassin's Auklet", "Get to know the Rhinoceros Auklet", "Rhinoceros Auklet and Cassin's Auklet Chick Processing", Video series by Grace Bahena and Anna Douglas, 2022.
- "How can a seabird help us understand ocean health?" Outreach brochure by Tahiry Langrand, Doris Duke Conservation Scholar, 2021.
- "Restoration is a Success: Windswept island now home to burgeoning number of 'fancy' seabirds" article by Cypress Hansen. Published in Mercury News, Santa Cruz Sentinel. Jan 11, 2021.
- Blog posts on The Docent Rookery at Año Nuevo

Peer-reviewed Scientific Publications 2015-2022 (Oikonos-affiliated co-authors bolded)

Carle, R., Hester, M., Coletta, E., and J. Beck. 2020. Cassin's Auklet (*Ptychoramphus aleuticus)* population size, reproduction, and habitat management on a recently colonized island in California, USA. Waterbirds 42(4): 366 – 379.

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Sunset on Año Nuevo Island