

Año Nuevo State Park Seabird Conservation and Habitat Restoration Report 2021



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Land acknowledgement: 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

Table of Contents

Introduction.....	3
Seabird Breeding Success and Population Status.....	4
Rhinoceros Auklet.....	4
Cassin’s Auklet.....	6
Western Gull.....	7
Brandt’s Cormorant.....	9
Pelagic Cormorant.....	11
Black Oystercatcher.....	12
Pigeon Guillemot.....	13
Ashy Storm-Petrel.....	13
Brown Pelican.....	14
Common Raven.....	14
Prey Studies.....	15
Habitat Restoration.....	16
Ceramic Nest Modules.....	16
Erosion Control	19
Historic Building Maintenance.....	20
Acknowledgements, Partners, Volunteers, Staff.....	20
Funding.....	22
Literature Cited.....	22
Presentations, Conferences and Meetings.....	23
Peer-reviewed Publications.....	24

I. Introduction

The year 2021 marks the 29th 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 2021 seabird breeding and diet monitoring results into the context of our time series datasets, and describes our most recent habitat restoration efforts.

Despite the persistent challenges posed by the continuing Covid-19 pandemic, we were able to complete our objectives of the year. We are grateful for the support we received from funders and Año Nuevo State Park this year, and for the opportunity to steward a unique wildlife refuge. Our triumphs would not have been possible without the dozens of dedicated volunteers that joined restoration work days and the student interns that played integral roles in research efforts.

Specific accomplishments in 2021:

- **Continued** 28 year time-series of reproductive success and population of the seven breeding seabirds at the island
- **Improved** the habitat safety and quality for breeding auklets by stabilizing soil and reinforcing the habitat ridge
- **Educated and engaged** Año Nuevo docents and wider community with volunteer days
- **Trained** four early career biologists as interns in field research, scientific interpretation seabird conservation science, and developing independent learning goals

Season Highlights:

- 600 Rhinoceros Auklets bred at Año Nuevo Island, tied with 2020 for the highest number on record
- Ceramic artificial nests provided homes for 39 breeding seabird pairs of three different species
- The highest number of Cassin's Auklets on record nested in ceramic nests
- With community volunteers, we installed 450m² of biodegradable erosion control material in areas of fragile soil



II. Seabird Breeding Success and Population Status

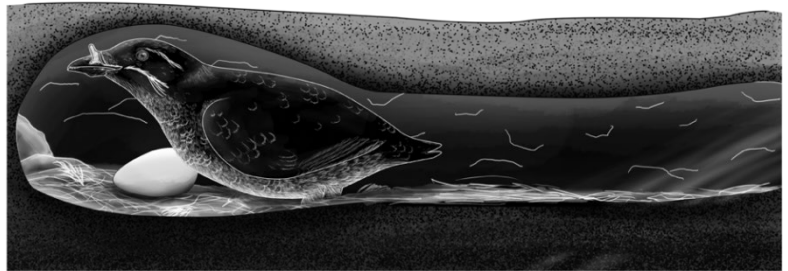
Año Nuevo Island provides important, predator-free habitat for breeding birds and pinnipeds in the productive California Current. Adjacent to the Monterey Bay and just a kilometer offshore, Año Nuevo Island's location allows marine predators to access both nearshore resources and nearby submarine canyons (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, such as Rhinoceros and Cassin's Auklets, are unique to Año Nuevo Island in the Monterey Bay region.

In 2021, we documented the nesting success and population size of seven species of seabirds that breed at Año Nuevo Island: the Rhinoceros Auklet, Cassin's Auklet, Pelagic Cormorant, Brandt's Cormorant, Western Gull, Pigeon Guillemot, and Black Oystercatcher. Many of the approximately 10,000 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.

Rhinoceros Auklet

The Rhinoceros Auklet (*Cerorhinca monocerata*) is a burrowing seabird in the family Alcidae. Alcids, like many seabirds, are long-lived with delayed maturity and low fecundity. Año Nuevo Island (ANI) is one of just three island groups where Rhinoceros Auklets breed in California, the southernmost tip of their breeding range.

At ANI, Rhinoceros Auklets are monitored in the central terrace via an infrared burrow camera and visually in artificial ceramic nests. On the south terrace, burrows are counted twice (once early and once late in the season) to determine viable burrows to include in the population count. To determine breeding population for the entire island, the total number of burrows is multiplied by a year-specific burrow occupancy rate. In 2021, we generated this occupancy rate by checking the contents of 53 burrows, 46 of which were occupied by a breeding pair. Reproductive success was measured by checking the contents of 36 burrows weekly for hatching and fledging success. The total number of chicks fledged on the island was estimated by multiplying the number of occupied nests by the number of chicks fledged per pair.



Rhinoceros auklet in burrow. All illustrations by CSUMB scientific illustration intern Kylie Kathleen Smith



Tahiry Langrand

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 2011, when major restoration work was initiated. In 2021, we documented 600 Rhinoceros Auklets breeding at ANI (Fig. 1), of which 548 (91% of the breeding population) nested within the central terrace where habitat enhancement work has been focused (Fig. 2). The breeding population in 2021 tied 2020 for the highest on record, and was driven by an increase in natural burrows in the central terrace (a 15% increase in burrows from 2019). In the last ten years, the population of Rhinoceros Auklets nesting on Año Nuevo Island has increased by 129%.

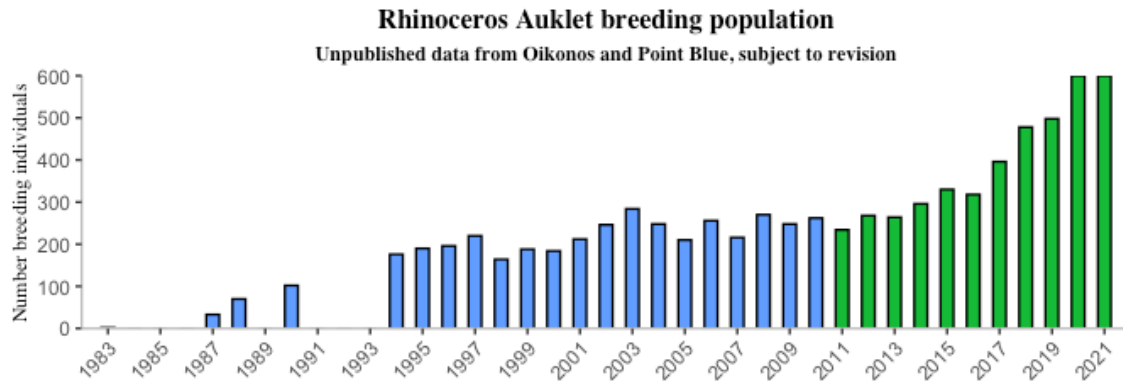


Fig. 1: Total numbers of Rhinoceros Auklets breeding at Año Nuevo Island from 1982 to 2021. Green bars (2011 – 2021) represent years of central terrace habitat improvements including erosion control, native plant restoration, raised pedestrian boardwalks, and ceramic nest modules replacing wooden nest boxes. In 1982, at least two breeding birds were believed to be present, but burrows were not counted (LeValley & Evans 1982). Burrow counts from the literature were multiplied by long-term burrow occupancy correction factors to get population estimates for 1986-87 (Lewis & Tyler 1987) and 1989 (Carter et al. 1992). Methods were standardized 1993 – 2021.

Productivity

Rhinoceros Auklets burrow productivity is defined as the number of chicks fledged per active nest. Productivity in 2021 (0.67 chicks per pair, $n = 36$ pairs) was similar to the long term average (0.66 ± 0.15 ; Fig. 3). Productivity in the artificial nest modules was slightly lower, at 0.56 per pair ($n=25$). See pg. 16 for further discussion of nest module results.

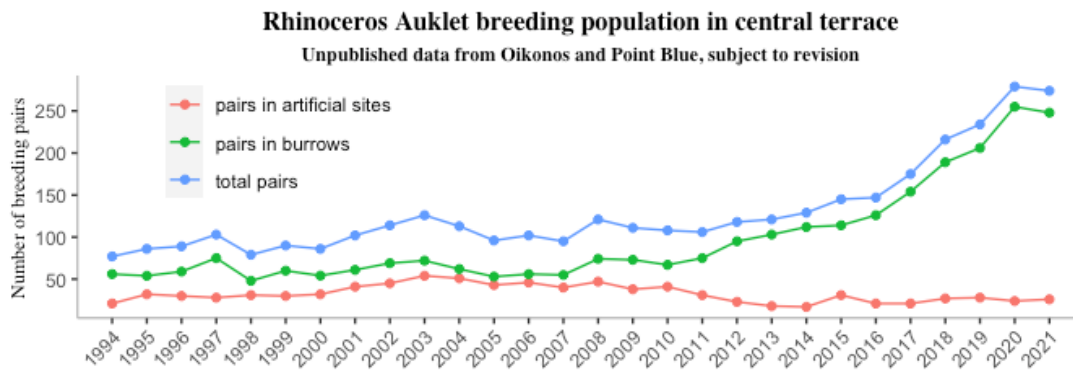


Fig. 2: Rhinoceros Auklet breeding population in the central terrace of Año Nuevo Island, 1994 – 2021. Artificial nest sites were changed from wooden boxes to ceramic nest modules after the 2010 breeding season. Pairs in artificial nests have stayed relatively stable since ceramic module installation, while pairs in natural burrows have increased dramatically since restoration efforts began in 2011.

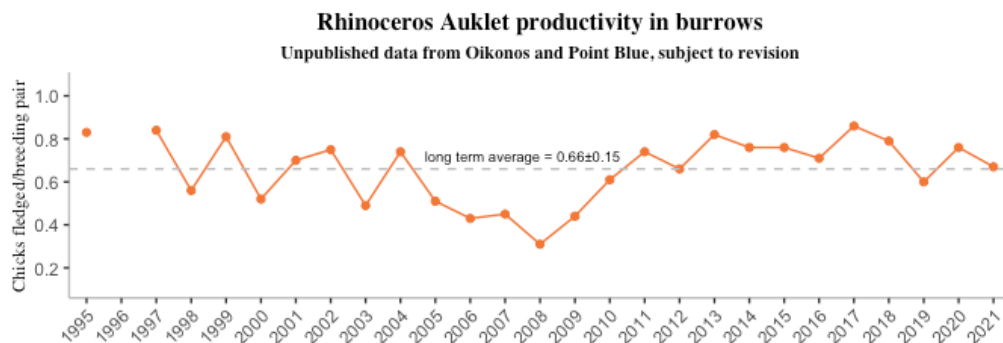
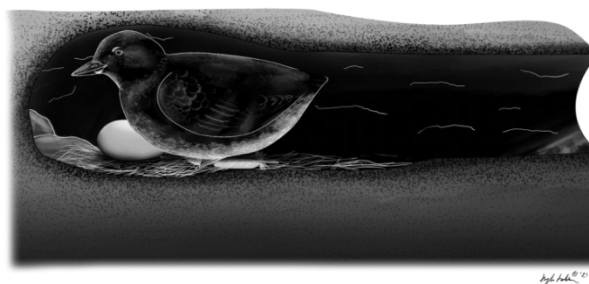


Fig. 3: Average number of Rhinoceros Auklet chicks fledged per pair in natural burrows, 1995 – 2021 (n=36 in 2021). Burrows were not monitored in 1996. The dashed line represents the long term average of 0.66 ± 0.15 chicks fledged per pair. Sample size for burrows monitored for productivity ranged from 25 to 72.

Cassin's Auklet

Cassin's Auklets (*Ptychoramphus aleuticus*) are also in the family Alcidae, and nest in crevices, shallow burrows, and artificial nests. They were monitored with the same methods as the Rhinoceros Auklets.



Population

Cassin's Auklets were first recorded breeding at Año Nuevo Island in 1995 (Carle et al. 2020). Their population grew slowly for 10 years. No breeding was recorded for 2005, and very low numbers (i.e. less than 10 breeding pairs) bred in 2006 and 2007. The population grew for the last 11 years, and in 2021 we estimated 160 breeding individuals on the island (Fig. 4), indicating the population may be stabilizing. Of these, 140 birds (88% of the island population) nested in the central terrace, where habitat improvement efforts have been focused.

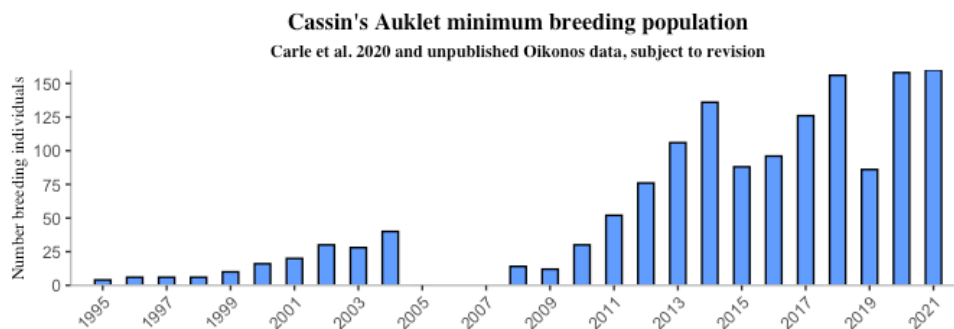


Fig. 4: The minimum number of breeding Cassin's Auklets at Año Nuevo Island, 1994 – 2021. No data in 2006 or 2007. The years 1994 – 2010 are minimum estimates because the whole of the island was not checked for nests, while the numbers from 2011 – 2021 represent total island estimates. 1995-2017 results are published in Carle et al. 2020.

Productivity

Cassin's Auklets laid their eggs earlier than average in 2021, and three pairs "double clutched" (laying another egg after successfully fledging a first chick). At Año Nuevo Island, the overall Cassin's productivity was 0.75 chicks per pair (n=44, both burrows and modules), slightly above the long-term average and similar to productive success in 2020.



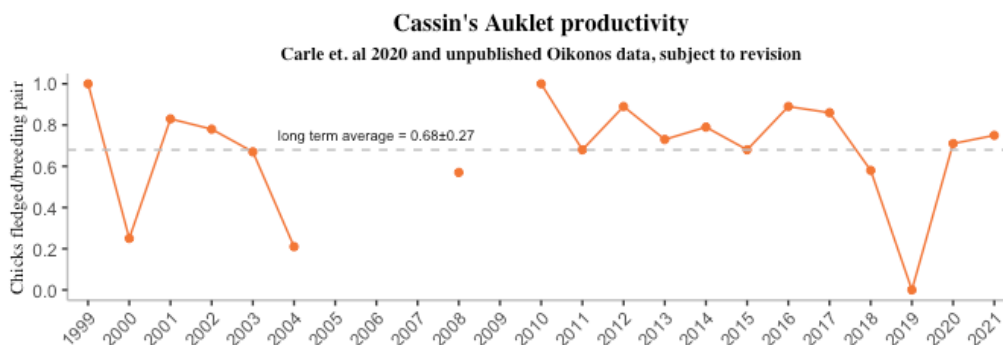
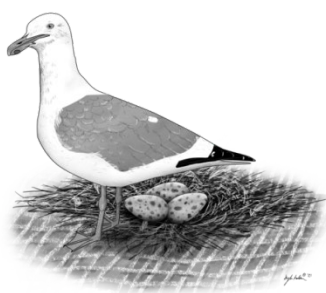


Fig. 5: The average number of Cassin's Auklet chicks fledged per pair, per year from 1999 – 2021 in both natural burrows and artificial nest modules, including both single and double clutch efforts ($n = 44$ in 2021). There were no Cassin's Auklets on the island in 2005 and insufficient data in 2006, 2007, and 2009. 1995–2017 data are published 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 endemic to the California Current, and 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), and in 1999 researchers began standard ground and boat-based monitoring, timed during the peak incubation period. Additionally, aerial photographs were used to survey inaccessible areas of the island during recent years. To measure reproductive success, we followed a subsample of 37 nests in the central terrace in 2021.

Population

In 2021, we counted 594 Western Gull nests on the island. 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 a period of unrestricted human access from 1949 – 1967 (Tyler and Briggs 1981). After extremely low 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 in the central coast (ANI, Alcatraz, and Southeast Farallon Island which is the largest Western Gull colony globally). During 2015 – 2019, gull nest numbers remained relatively stable in the low- to mid-600s, but 2020 and 2021 are the lowest counts since standardized monitoring began in 1999 (Fig. 6).

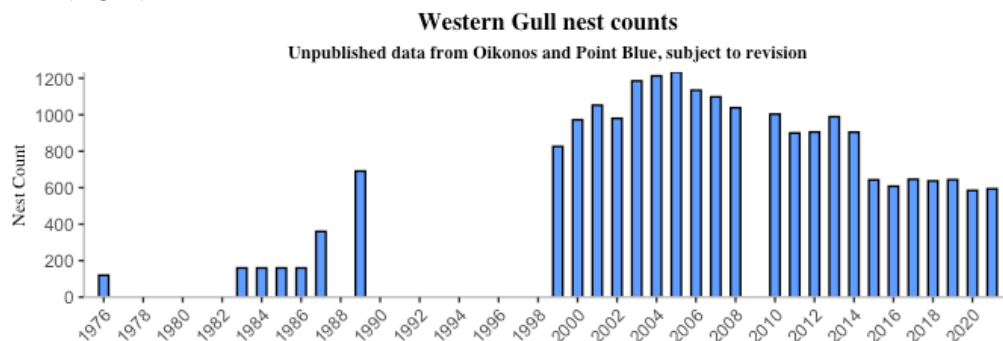


Fig. 6: Western Gull nests at Año Nuevo Island 1976 – 2021. In 2021, nests were counted via ground counts and by boat, with the exception of the north and south terrace which were counted using UCNRS aerial drone images. The years 1999 – 2021 are standardized ground counts, all previous years are from the literature. In years with no bars, population was not estimated. 1976 data is from Sowls et al. 1980, 1982–87 data is from A. Huntley (pers. comm. in Lewis & Tyler 1987) 1989 data is from Carter et al. 1992.

Productivity

In 2021, Western Gulls fledged 1.32 ± 1.23 chicks per pair ($n=37$; Fig. 7). This was above the long-term average of 1.27 ± 0.33 . In 2016, we began an annual island-wide Western Gull chick census during late June, just before chicks start to fledge, to compare the density of fully-grown chicks in the central terrace habitat restoration area to the north and south terraces, where there has been no habitat restoration. In 2016 – 2021, this census has shown the central terrace to have a much higher density of chicks. In 2021, the central terrace had a density of gull chicks 10 times greater than the north terrace, and 5 times greater than the south terrace (Fig. 8). This is believed to be primarily due to the presence of California sea lions outside the central terrace, which can crush nests and discourage breeding attempts.

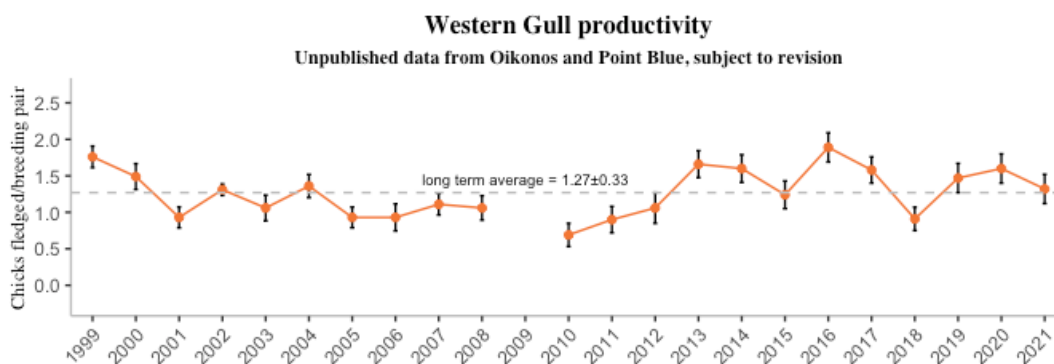


Fig. 7: Annual productivity (average chicks fledged per breeding pair $\pm$ standard error) of Western Gulls nesting in the central terrace region at Año Nuevo Island, 1999 – 2021 (no data for 2009; $n = 37$ in 2021). Subsamples of 28 – 155 nests were monitored annually.

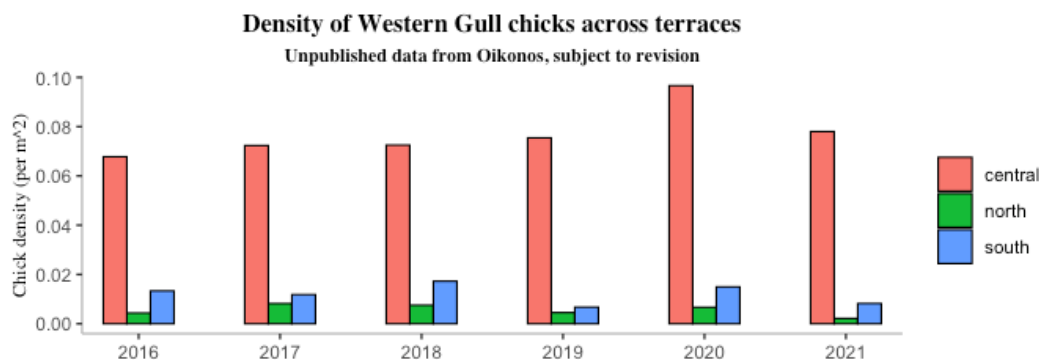


Fig 8: Western Gull chick density (chicks per m^2) on ANI terraces during mid to late July, 2016 – 2021. Timing of counts coincided with stage of chicks at mostly- to fully-feathered and few, if any, had fledged. The central terrace is defined as all area inside the Habitat Ridge fence ($5,474 m^2$). North terrace is all area north of the Habitat Ridge ($5,978 m^2$), and the south terrace is area south of the Habitat Ridge ($6,078 m^2$).

Brandt's Cormorant

Brandt's Cormorants (*Urile penicillatus*) were first documented nesting at Año Nuevo Island in 1989 (Carter et al. 1992) and 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. The majority of Brandt's Cormorants nest 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 2021, we used aerial images taken June 24th to count 4,348 nests (8,696 individual breeding birds), using the computer program DotDotGoose (Ersts 2020; Fig. 9). An additional 102 nests were estimated inside the Lightkeeper's House based on a post-season ground count, for a total of 4,450 nests (8,900 individuals). This was the highest number of nests on record, and may have been partially due to the first documented sub-colony of ~30 nests on the north terrace, and an additional ~150 nests that persisted in the central terrace, where typically Brandt's Cormorants experience too much human disturbance to nest. Brandt's Cormorant populations at the Farallon islands have similarly increased over the past five years, with high reproductive success (M. Johns, pers comm.). Another possible explanation for the robust breeding effort in 2021 was the abundance of Northern Anchovy (*Engraulis mordax*), which is an important prey species correlated with surges in population (Ainley et al. 2018). See page 15 for further discussion of Northern Anchovy.



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 they were left unattended. These intraspecific interactions caused some pairs (of all species) to lose their first eggs and relay second clutches, and/or experience reproductive failure.

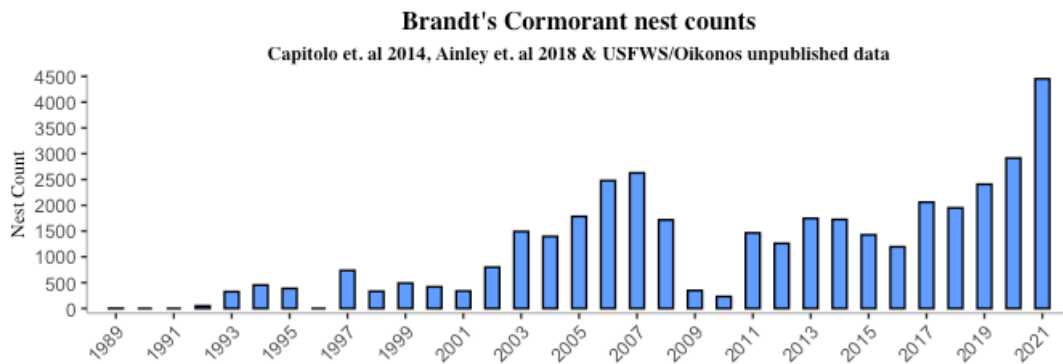


Fig. 9: Brandt's Cormorant nest counts from aerial images and inside Lightkeeper's house at Año Nuevo Island, 1988 – 2021. The first documented nesting at ANI was in 1989. Zero nests were recorded in 1990, and no data exists for 1991. Data sources: 1988 – 2015 were published in Ainley et al. 2018; numbers for 1988 – 1990, 1995 – 1997, 1999 – 2003, and 2006 were published first in Capitolo et al. 2014. 2016 - 2021 are unpublished aerial counts from the US Fish and Wildlife Service and Oikonos.

Productivity

Brandt's Cormorant productivity was calculated by following a subsample of 30 nests within the sub-colony near the fallen light tower on the south terrace, and 3 nests in the central terrace, added four to six weeks after the initiation of egg-laying to represent late nesters. Subsampled nest contents were followed weekly for egg and chick fates. Productivity in 2021 was 2.18 ± 0.92 chicks fledged per pair. This is above the long-term average of 1.67 ± 0.69 (Fig. 10) and the highest since 2015.

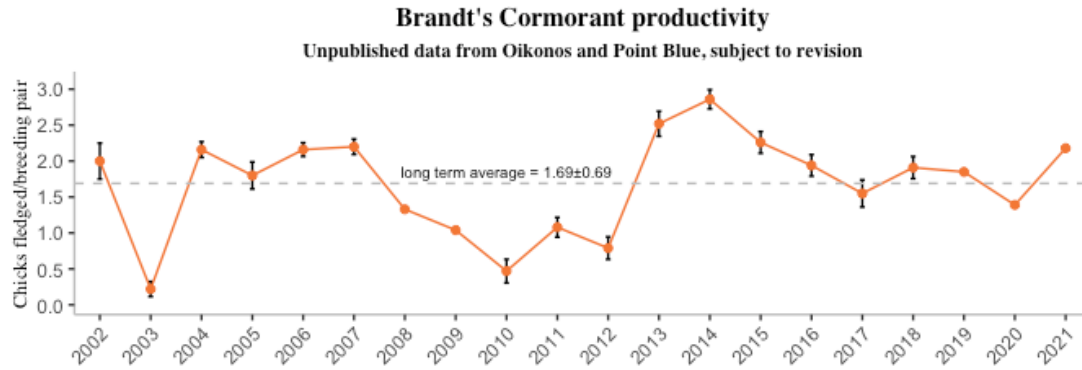


Fig. 10: Brandt's Cormorant productivity (mean $\pm$ se number of chicks fledged per breeding pair) at Año Nuevo Island, 2002 – 2021 (n = 33 in 2021). A sub-sample of nests was followed from one or both of two sub-colonies, the Light Tower and Blind 17 (showed here combined). In 2008 and 2009, productivity was calculated 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, no error estimate could be generated in 2008 – 2009. Standard errors 2019 – 2021 were less than 0.03. Sample size ranged from 20 – 57 nests annually.



Brandt's Cormorant nests around the blockhouse and cove, June 2021. Aerial image courtesy of UCSC Año Nuevo Reserve.

Pelagic Cormorant

Pelagic Cormorants (*Urile pelagicus*) were censused 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. All visible nests on the mainland cliffs, island bluffs, and historic lightkeeper's house were monitored for nest contents and activity.

Population & Productivity

The total number of breeding Pelagic Cormorants on the mainland and island was 96 birds in 2021 (Fig. 10), though this is a minimum count due to challenges accessing nesting areas on the Island's north terrace. There were 88 breeding birds on the island and 8 on the mainland. This is the fourth consecutive year of a declining population on the mainland bluffs. No interactions of depredation were observed between Common Ravens and Pelagic Cormorants were observed in 2021, though raven interactions were not intensively monitored (see Carle et al. 2017). The reproductive success of Pelagic Cormorants on the island was 1.22 ± 1.07 chicks per pair in 2021 (n=36). Documenting reproductive success on the mainland was not attempted, due to the small sample size of nests available and monitoring challenges posed by bluff access and visibility (Fig. 11).



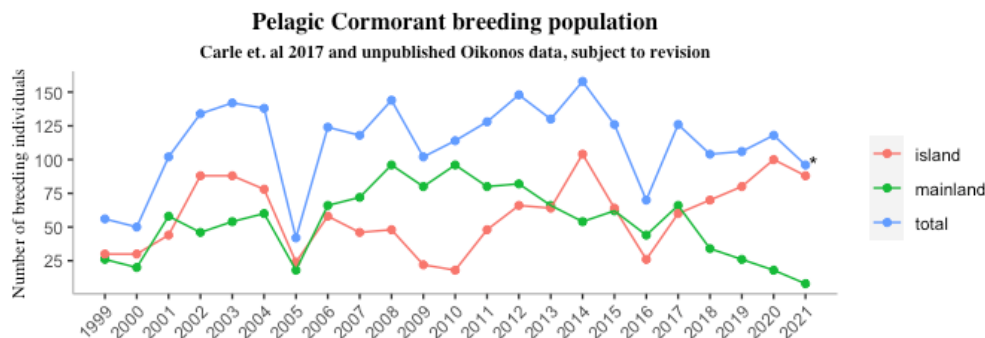


Fig. 11: Pelagic Cormorant populations at Año Nuevo, 1999 – 2021. The top blue line represents the total number of nesting birds on both the island and mainland, while green shows the mainland sub-colony and orange shows the island sub-colony. *2021 island population does not include birds that may have nested on the North Terrace due to inaccessibility.

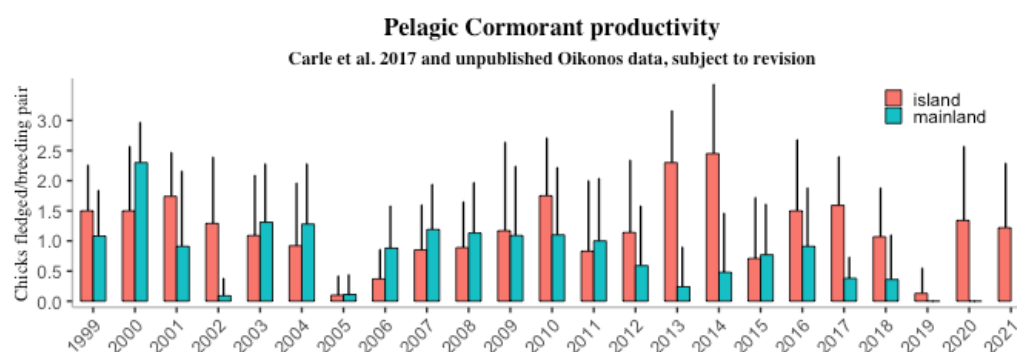


Fig. 12: Pelagic Cormorant productivity at island and mainland sub-colonies, plus SD (error bar), 1999 – 2021 (n = 36 on the island in 2021). From 2019-2021 productivity on the mainland was 0.0 chicks fledged per pair or not attempted. Sample sizes range from 4 - 43 pairs on the island and 5 – 40 pairs on the mainland. In 2021, monitoring was not attempted on mainland due to difficulty accessing sites.

Black Oystercatcher

Black Oystercatchers (*Haemaphysalis bachmani*) nest in intertidal areas along the west coast of North America. At ANI, they build depressions lined with small pebbles in coves and on bluff ledges to lay their eggs. Reproductive success at ANI has generally been poor. In 2021, there were three confirmed active breeding pairs with known nest contents, from which 2 total chicks hatched. One of these chicks survived to fledging (overall ANI productivity was 0.33 ± 0.58 SD chicks fledged per pair, n=3; Fig. 13). Most nests fail at ANI when eggs and chicks disappear, suggesting predation or perhaps incidental trampling by pinnipeds. Black Oystercatchers have been observed defending nests from Common Ravens frequently since 2004.

The coast of California has been identified as important 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 habitat. 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.



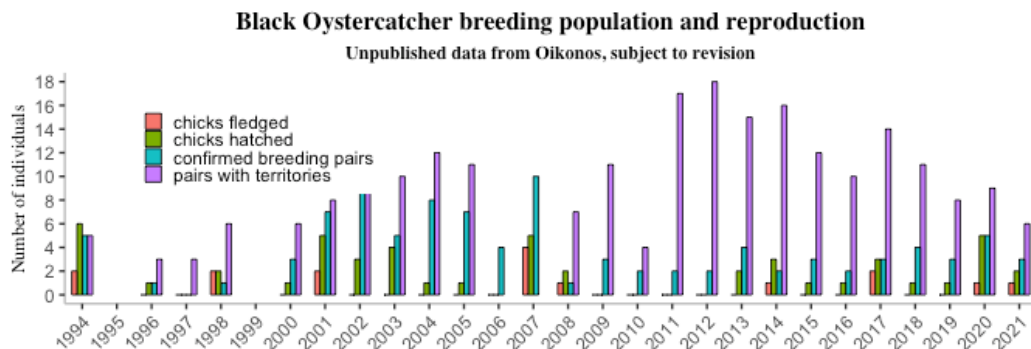
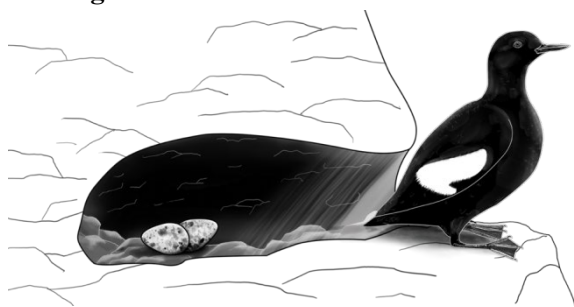


Fig. 13: Population and breeding metrics of Black Oystercatcher nests visible from Año Nuevo Island ground observations from 1994 – 2021. Purple bars – total nest sites with regular attendance by a pair, blue – breeding pairs documented with eggs or chicks, green – total chicks hatched, orange – total chicks fledged. All sites visible from central terrace was 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



new pair in blockhouse wall, which was 1.0 ± 0.82 SD chicks fledged per pair ($n=4$).

Pigeon Guillemots (*Cepphus columba*) were monitored by hand in ceramic modules within the central terrace, and by observations of site attendance and fish carrying in inaccessible sites. In 2021, ANI had a breeding population of at least nine pairs (Fig. 14). Of these, three 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 three pairs in the modules, and one

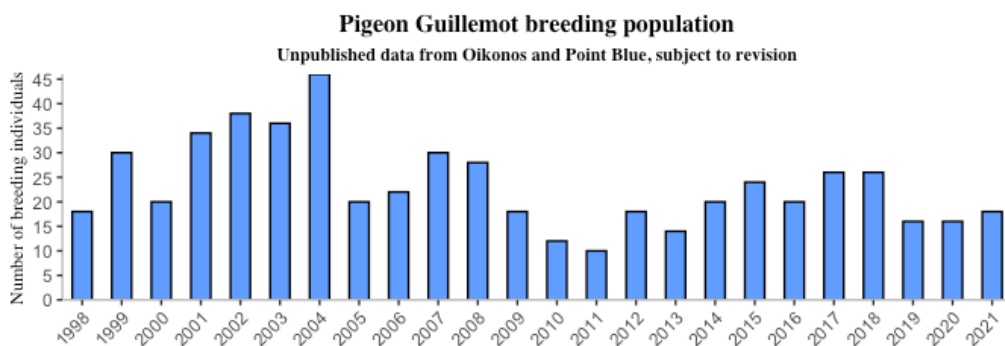


Fig. 14: Pigeon Guillemot confirmed breeding population at Año Nuevo Island, 1998 – 2021.

Ashy Storm-petrel

The Ashy Storm-petrel (*Oceanodroma homochroa*) is a tiny seabird related to albatrosses and is a possible breeder on ANI. From 1993-2021, 12 Ashy Storm-Petrels have been recorded at ANI (Fig. 15). All were captured during nighttime mist-netting for Rhinoceros Auklet prey, which takes place four nights a year during June and July. No Ashy Storm-petrels were caught in 2021.

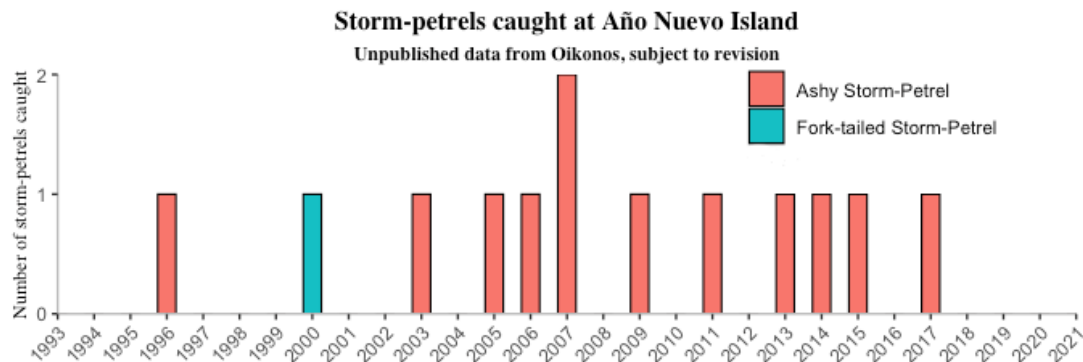


Fig. 15: Observations of storm-petrels during nocturnal mist-netting operations at ANI, 1993-2021.

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 both the island and mainland every year since 2004, with the exception of 2016 and 2020-2021. 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 the Pacific coast of southern California to Mexico, and roost at Año Nuevo Island and mainland bluffs during summer and fall. 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, Año Nuevo is listed as one of the four largest roosting sites on the entire U.S. West Coast (Jaques 2019).

Fig. 15: The number of Ashy and Fork-tailed storm-petrels incidentally captured at Año Nuevo Island from 1993 – 2021. All storm-petrels were captured during nighttime mist-netting targeting Rhinoceros Auklets, from late June to early August.

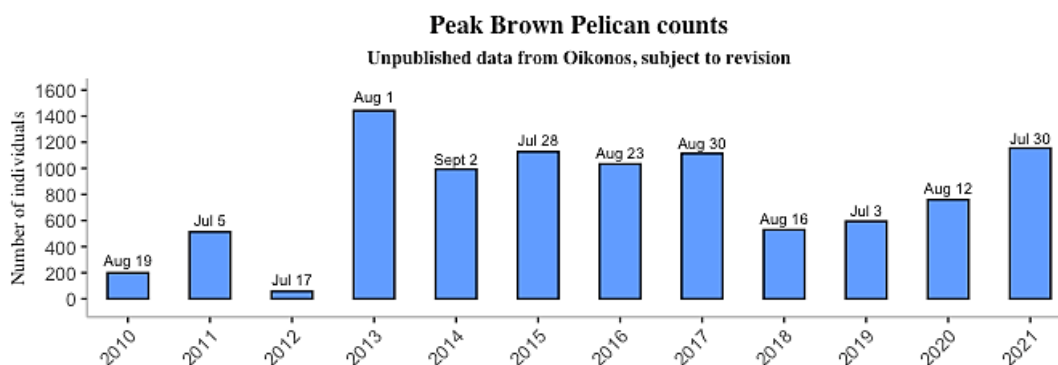


Fig. 16: Annual peak number of roosting Brown Pelicans at Año Nuevo Island, as counted from the central terrace, 2010 – 2021.

Brown Pelicans impact habitat restoration efforts on the island because of their preference to stand and sit on vegetation, often completely trampling plants, and sometimes damaging Rhinoceros Auklet burrows within the central terrace. This has been mitigated somewhat by installing wooden stakes in vegetated areas, which encourage pelicans to sit elsewhere on the island, and the installment of 25 Habitat Enhancement and Protection platforms (HEAPs), which protect fragile auklet burrows from crushing and provide additional pelican roosting habitat.



Fig. 17: Adult and juvenile Brown Pelicans roosting on Año Nuevo mainland bluffs in December 2020. Seven piles of nesting material can be seen in the photo.

In December 2020, Brown Pelicans were seen nest-building on Año Nuevo State Park mainland bluffs above Cove Beach. Several hundred adults and juveniles roost regularly at this site, but several (4 – 7) adults were observed sitting on crude piles of sticks positioned along the cliff edges (Fig. 17). Oikonos conducted weekly monitoring trips to document the progress of these individuals, well-north of their closest consistent breeding sites in the Channel Islands. No eggs or consistent incubation postures were observed. By December 24th 2020, the bluffs and stick-piles were abandoned by both the nest-building and roosting birds.

III. Prey Studies

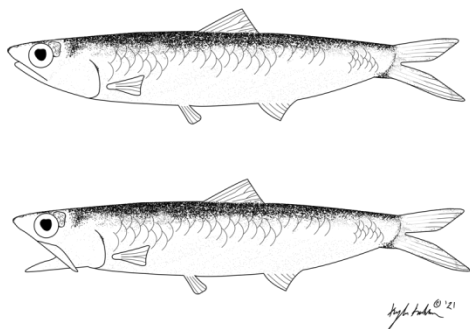
Seabirds are top marine predators and indicator species. Understanding the prey available during breeding season helps illuminate the state of marine ecosystems, and can inform sustainable fisheries management. In 2020, we collected diet samples from Rhinoceros Auklets, Pelagic Cormorants, and Brandt's Cormorants.

Rhinoceros Auklet Prey Study

Rhinoceros Auklets return to the breeding colony nocturnally to provision their chicks with whole fish and/or cephalopods carried cross-wise in their bill (Hester 1998). This assemblage of prey is called a “bill-load.” In 2021, we continued our 28th 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 (EBFM) in the California, understand auklet foraging behavior, inform anchovy management, and more. All of this work (see pg. 24) highlights the importance of long-term diet monitoring datasets such as the Rhinoceros Auklet diet studies at ANI and the Farallones.



In 2021, we caught a total of 185 individual birds, with 60 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 Anchovy are abundant in the region, often Rhinoceros Auklets will predominately feed on the species, and the presence of anchovies (along with juvenile rockfish) is usually associated with high chick growth and fledging success. In 2020, we also contributed our Rhinoceros Auklet diet time-series to a scientific publication comparing anchovy lengths sampled by seabirds to those sampled by trawls (Thayer et al. 2021). Lengths of forage fishes are a useful indicator of cohort strength and recruitment, growth rates, and reproductive capacity. The study found that Rhinoceros Auklet anchovy lengths were helpful for informing fisheries management because they were comparable to those recorded by trawls, and that seabird diet could be used to fill in time-series gaps in years without



trawls.

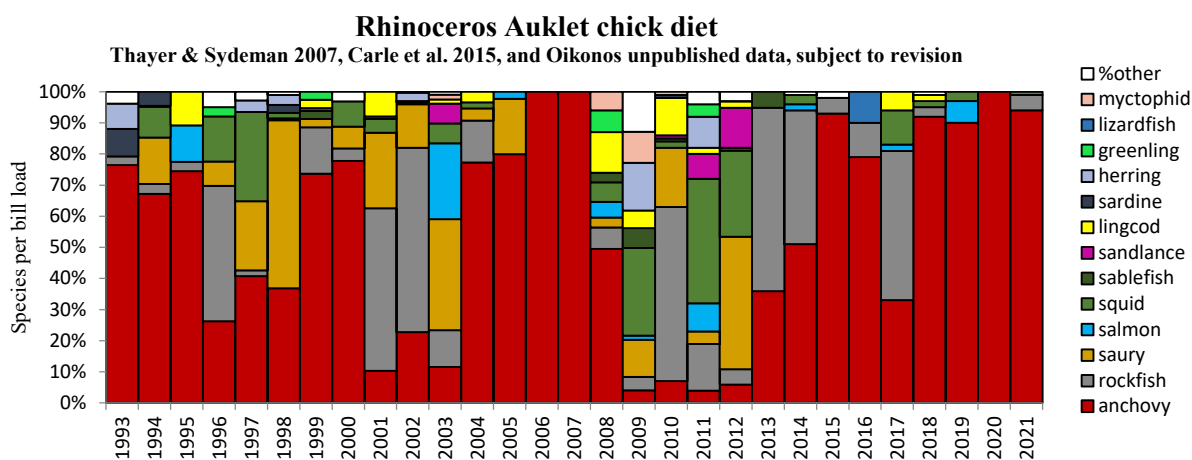


Fig. 18: Rhinoceros Auklet chick diet at Año Nuevo Island from 1993 – 2021, quantified as the percent number of prey per bill-load delivered to chicks. Sample size ranged from 18 – 73 bill-loads annually. Sample size in 2021 was 73.

IV. Habitat Restoration

Habitat restoration at ANI began with the goal of 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 Funders section).

Restoration Accomplishments during 2021:

1. Two new **Ceramic Nest Modules** were added in the central terrace
2. **Erosion control** material was laid over 450m² of the central terrace. The Habitat Ridge was assessed for structural integrity and repaired, with new reinforcement added to the west section.
3. **Habitat Enhancement and Protection Platforms (HEAPs)** protected 18 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 2021, productivity in ceramic modules was above average (0.56 chicks fledged per pair; Fig. 20), and was also the most similar to natural burrows (0.67) it has ever been (Fig. 21).

Cassin's Auklets have also used ceramic nest designed specifically for this smaller species. Averaging fledged per pair from 2013 – 2021 was 0.61 ± 0.37 ($n = 2 - 9$ pairs), which was similar to the productivity in natural burrows (0.69 ± 0.23 chicks fledged per pair; $n = 23 - 42$ pairs/year). In 2021, the highest number of Cassin's Auklets on record used modules (9 pairs), with an above average productivity of 0.67 chicks fledged per pair. Three pairs of Pigeon Guillemots nested in clay modules in 2021, and productivity was 1.0 ± 0.82 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).

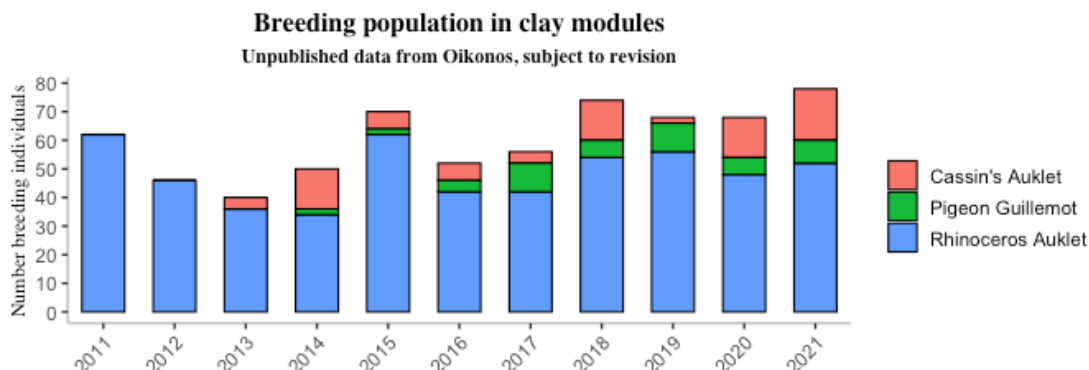


Fig. 19: Alcid breeding populations in clay nest modules at Año Nuevo Island, 2011 – 2021. Pairs were considered breeding if they had a confirmed egg or chick.

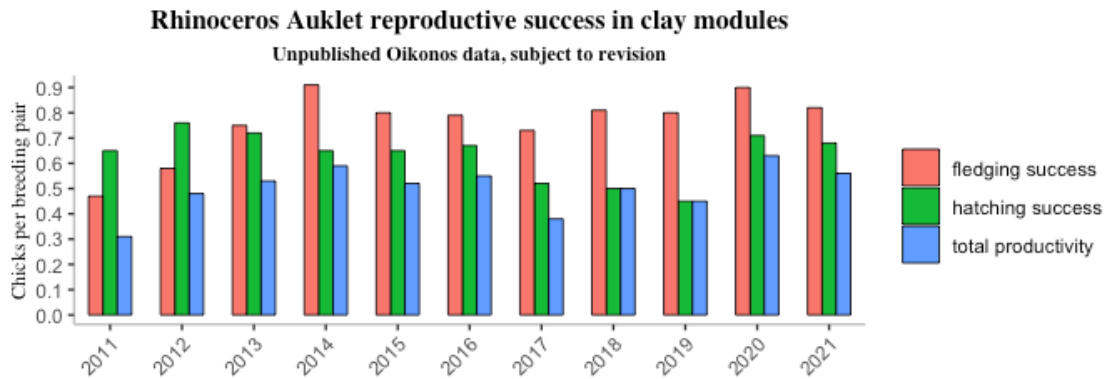


Fig. 20: Rhinoceros Auklet reproductive success metrics in clay nest modules at Año Nuevo Island, 2011 – 2020. Blue – proportion of chicks that hatched per pair, orange – proportion of chicks that hatched that survived to fledging, grey – number of chicks that fledged per breeding pair total). Sample sizes were between 18 – 31 annually. In 2021, n= 25.

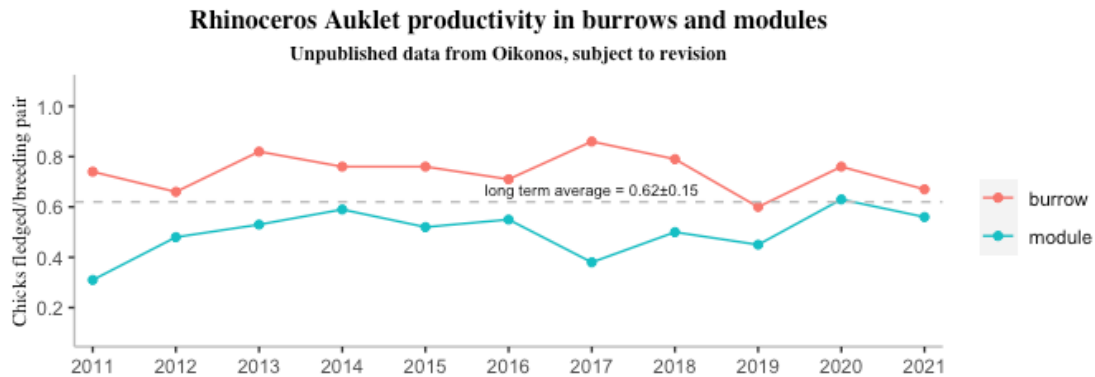
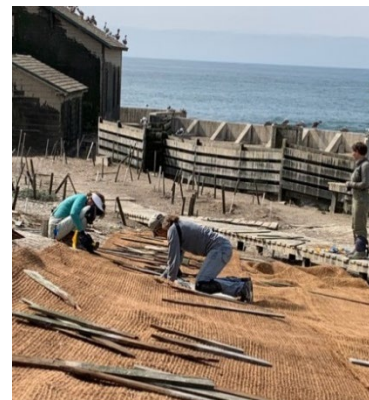


Fig. 21: Rhinoceros Auklet productivity in both natural burrows (blue) and ceramic modules (gray), 2011 – 2020. The long-term average is chick fledging success of both nesting sites combined. In 2020, the productivity rates of the two site-types were the most similar on record. Sample range from 33 to 56 in burrows and 18 to 31 in modules. In 2021, n=33 in burrows, 25 in modules.

Erosion control

We calculated erosion rates to burrows by documenting the burrow condition weekly and classifying severity and causes of damage from erosion (i.e., natural erosion, incidental damage by researcher, and damage by wildlife – usually by Brown Pelicans, Brandt’s Cormorants, or California sea lions). In 2021, 8.7% of all burrows (25/286) were damaged from either natural erosion or wildlife (Fig. 22). Of the 25 damaged burrows, 8 of them were damaged by wildlife, representing 2.8% of all burrows in the Central Terrace.



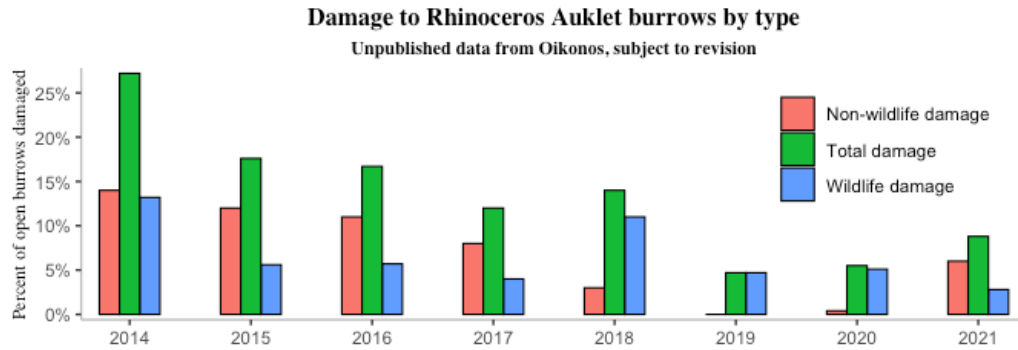


Fig. 22: Damage to Rhinoceros Auklet burrows in the central terrace (restoration area), 2014 – 2021. Green bars represent the percent of total burrows damaged from natural erosion, wildlife damage (Brown Pelican, Brandt's Cormorant, or California sea lion). Blue bars show percent of burrows damaged from wildlife alone, and orange bars show non-wildlife damage. Sample size was 112 – 286 burrows per year. In 2021, n=286.

Erosion control material

With the assistance of community volunteers, we deployed 450 m² of biodegradable, coconut husk erosion control material in 2021. We focused on installing the erosion control material in high density burrow areas and along the edges of the central terrace, which are 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 varies from area to area.



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 also providing shelter for vulnerable Western Gull chicks and sheltering native salt grass underneath. Of 286 total Rhinoceros Auklet burrows in the central terrace in 2021, 18 burrows (6.2%) were located beneath HEAPs. Total density of burrows beneath HEAPs was much greater (18 burrows in 37 m² = 0.49 burrows/m²) than density of burrows overall in the central terrace (burrows in 5,437 m² = 0.05 burrows/m²). Just one of 18 burrows underneath HEAPs was damaged by erosion.

Habitat Ridge

Installed in 2011, 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 almost entirely of eucalyptus logs harvested from Año Nuevo State Park mainland, and designed to have a strong interlocking zig-zag pattern that requires no below ground anchoring in the fragile soil. After 10 years, portions of the Habitat Ridge are experiencing some rot and need additional reinforcement. 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 were able to climb over a portion that was eroding.



Acknowledgements, Partners, Volunteers

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 key partners include California College of the Arts, master ceramicist Nathan Lynch, UC Santa Cruz Año Nuevo Reserve, US Fish and Wildlife Service, and 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 **8,848 hours** to the project since 2009, representing a monetary value of \$252,522 (based on the estimated value of volunteer time from independentsector.org). Thank you to the volunteers and student interns that joined us in 2021.



Oikonos Año Nuevo Seabird Project Staff, 2021

Rozy Bathrick	Ecologist
Jessie Beck	Project Manager
David Calleri	Ecologist
Ryan Carle	Oikonos Science Manager
Cameron Chao	UCSC Intern
Michelle Hester	Executive Director
Tahiry Langrand	Doris Duke Conservation Scholar
Nathan Lynch (CCA)	Lead artist - ceramic nest modules
Isabelle Maennle	UCSC Intern
Kari Marboe (CCA)	Artist - ceramic nest modules

Trinidad Mena Administrative manager
 Kylie Kathleen Smith CSUMB scientific illustration intern

2021 Año Nuevo Seabird Project Volunteers

Emily Coletta	James Farber	Natasha Lozanoff	Peter Lollo	Tatjana Beck
Emily Pomeroy	Jenna Sparks	Nick Williams	Ron Brost	Thomas Savoie
Evan Weissman	Lisa Guy	Nico Hodgson	Storey La Montagne	Rick Moe
Grace Kumaishi	Martha Brown	Nicole Plaskett	Tamar Ingber	



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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

Invited Plenary at the 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.

Pacific Seabird Group Conference—February 2018, La Paz, Mexico

Ecology of an increasing population of Cassin's Auklets at Año Nuevo Island. Poster presented by Emily Coletta on work by: Coletta, E., Carle, R., Beck, J., and Hester, M.

California Collaborative Oceanic Fisheries Investigation Conference—December 2017, La Jolla, CA

Ecosystem-based management affecting Brandt's Cormorant resources and populations in the central California Current region—presented by Ryan Carle (see co-authors on publication citation, above)

Beyond the Golden Gate Research Symposium—December 2016, Tiburon, CA

Clay nest modules for seabirds: a versatile and sustainable solution to diverse threats—presented by Ryan Carle; Authors Michelle Hester, Nathan Lynch, Ryan Carle, Jessie Beck, and Matthew Passmore

Common Raven depredation negatively affects reproductive success of Pelagic Cormorants at Año Nuevo State Park, central California—presented by Ryan Carle (see co-authors on publication citation, above)

Año Nuevo State Park Outreach

Año Nuevo Docent Day, December 2021

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
 Guest lecture to Scotts Valley High School, December 2020
 Guest lectures to UC Santa Cruz Restoration Ecology class, Winter Quarters 2015 – 2020
 Guest lecture at Pajaro Valley High School, January 2016

Meetings

California Seabird Coordination Meeting, annually 2010 – 2021
 Santa Cruz Seabird Coordination Meeting, December 2016

Public Outreach & Press

- ["How can a seabird help us understand ocean health?"](#) Outreach brochure by Tahiry Langrand, Doris Duke Conservation Scholar
- ["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 Dozent Rookery at Año Nuevo](#)
- ["Nesting on Año Nuevo Island: the importance of ceramic nest modules"](#) illustrated slideshow by Doris Duke Conservation Scholar Sara Sirk, 2018.
- ["Año Nuevo Island is off-limits to humans – but not these scientists"](#) radio story produced by Claire Stremple, KALW Radio, September 2017.

Awards and recognitions:

- Outstanding Conservation Paper of the Year award from the Waterbird Society for our paper on Cassin's Auklets at ANI (Carle et al. 2020, see below).

Peer-reviewed Scientific Publications (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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