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Año Nuevo State Park
Seabird Conservation and Habitat Restoration: Report 2018

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Data herein are unpublished and subject to revision—contact Oikonos before citing or distributing

E. Coletta, J. Beck, R. Carle, and M. Hester. 2018. Año Nuevo State Park Seabird Conservation and Habitat Restoration: 2018. Unpublished Report to California Dept. of Parks and Recreation, Año Nuevo State Park.

I. Introduction

The year 2018 marks the 26th year of seabird research and conservation on Año Nuevo Island (ANI) at Año Nuevo State Park. Oikonos has led the seabird research and habitat restoration of the island for the last ten of these 26 years. Through research and habitat restoration, Oikonos seeks to conserve seabirds breeding on the island, understand their prey resources, and protect and restore their breeding habitat. This report places the 2018 seabird breeding and diet monitoring results into the context of our time series datasets, and describes our most recent habitat restoration efforts.

Specific goals for 2018 included:

- **continue** time-series of breeding success and population of the seven breeding seabirds on the island
- **improve** the habitat quality for auklets via soil stabilization
- **collaborate** with the California State Parks Resource Crew on specialized tasks to maintain or improve habitat qualities for nesting seabirds
- **educate** the wider community about seabird conservation by engaging Año Nuevo docents and visitors during field days
- **train** undergraduate interns in the field methods of seabird conservation science and **support** these students in their specific learning goals

Summary: 2018 Highlights

- **478 Rhinoceros Auklets bred on the island**, the highest number on record
- **Anchovy** dominated the diet of Rhinoceros Auklet chicks
- Clay nest modules provided safe homes for **74 breeding seabirds of 3 different burrowing species**
- With the assistance of the CA State Parks Resource Crew, we installed **500 square meters of erosion control** material, spread native seed, and **maintained a critical feature of our habitat restoration project: the Habitat Ridge**

II. Seabird Breeding Success and Population Status

Año Nuevo Island provides important breeding and roosting habitat for seabirds and pinnipeds in the California central coast. As a colony close to the continent and halfway between the Gulf of the Farallones and Monterey Bay, the island has a unique ecology that allows seabirds to utilize nearshore resources, as well as resources in nearby submarine canyons (such as Año Nuevo and Ascension Canyons). Additionally, island habitats are limited in central and northern California, and species such as Rhinoceros Auklets that depend on islands for breeding sites are unique to Año Nuevo in the Monterey Bay area.

In 2018, 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.

Rhinoceros Auklet

Rhinoceros Auklets (*Cerorhinca monocerata*) breeding on the central terrace portion of the island were monitored via an infrared burrow camera in natural burrows, or by hand in artificial nest modules. Rhinoceros Auklet burrows located outside of the central terrace area were counted before and after the breeding season, and viable burrows were included in the population size estimate for the island. To determine breeding population for the entire island, the total number of burrows was multiplied by a year-specific burrow occupancy factor. In 2018, we generated this occupancy factor by monitoring 56 natural burrows and determining if they were occupied. To determine the breeding success for the island, the nest contents of a 34 burrow sub-sample were observed weekly for hatchling and fledgling success. We estimated total chicks produced on the island by multiplying the number of occupied nests by chick fledging success.

Rhinoceros Auklet population

Rhinoceros Auklets were first documented breeding on Año Nuevo Island in 1982 (LeValley and Evans 1982). From 2011-2018, the population has had a steady growth trend. In 2015, the population surpassed 300 individuals for the first time. In 2018, a major increase occurred, and 478 Rhinoceros Auklets bred on the island (Fig. 1). A total of 432 individuals bred on the central terrace, where habitat improvements have been focused (Fig. 2). The 2018 population was likewise the highest number ever recorded for central terrace. On the south terrace, there were 46 breeding individuals. These record population estimates were driven by both an increase in the total number of burrows and above-average occupancy of burrows (95% of monitored burrows were occupied). Since 2011, the total island breeding population of Rhinoceros Auklets has doubled. Population growth since 2011 has been primarily from pairs excavating new burrows, as the number of pairs using artificial nest sites dropped over the same period (Fig. 2).

Rhinoceros Auklet reproduction

Rhinoceros Auklets had an above average year for burrow productivity. Birds breeding in natural burrows fledged 0.79 chicks per pair (Fig. 3). Productivity in the artificial nest modules was lower at 0.50 chicks fledged per pair. See below in Results: Nest Modules (page 15) for discussion of module productivity.

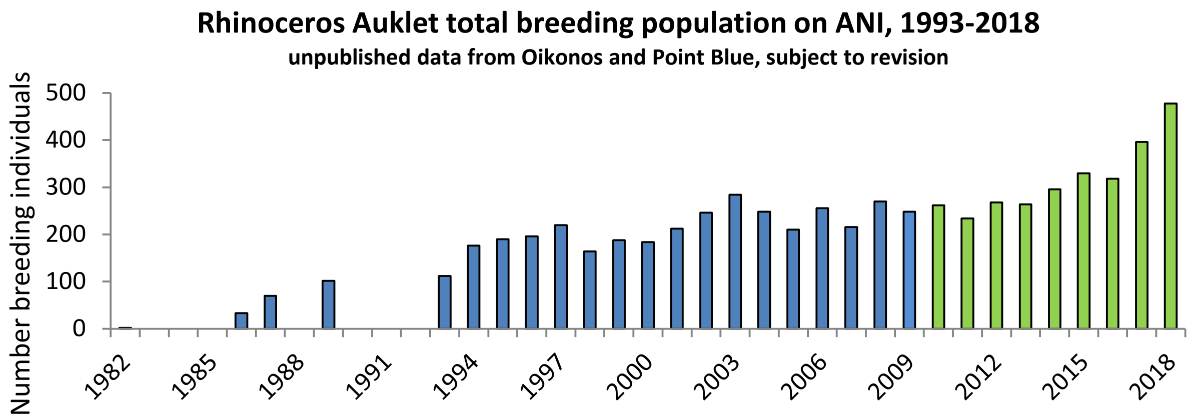


Fig. 1: Total number of Rhinoceros Auklets breeding on ANI from 1982 to 2018. Green bars (2011-2018) represent years of central terrace habitat improvements including erosion control, native plant restoration, and ceramic nest modules. In 1982, at least two breeding birds were believed to be present, 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 1993-2018.

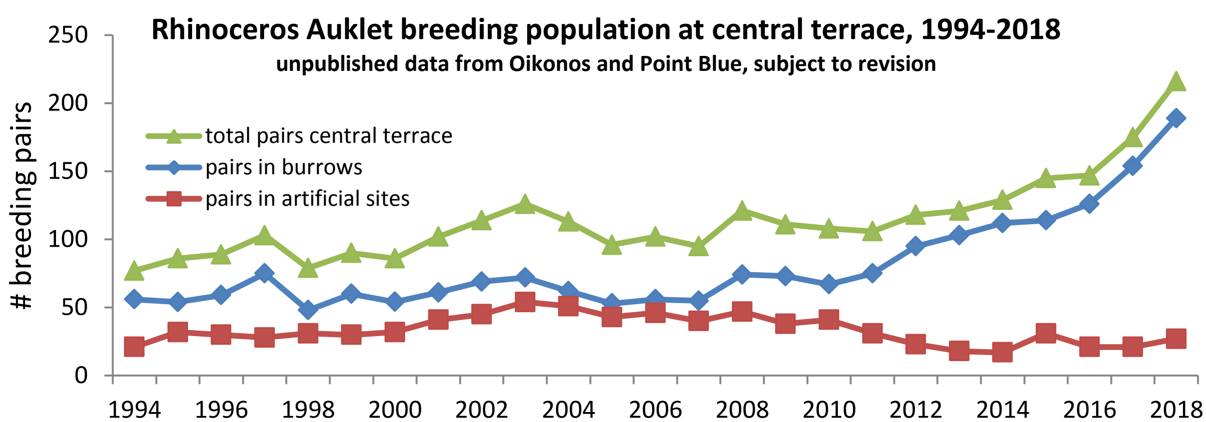


Fig. 2: Rhinoceros Auklet breeding population in the central terrace of Año Nuevo Island, 1994-2018. Green line is total pairs breeding in the central terrace, blue line is pairs breeding in natural burrows, and red line is pairs breeding in artificial nest sites.

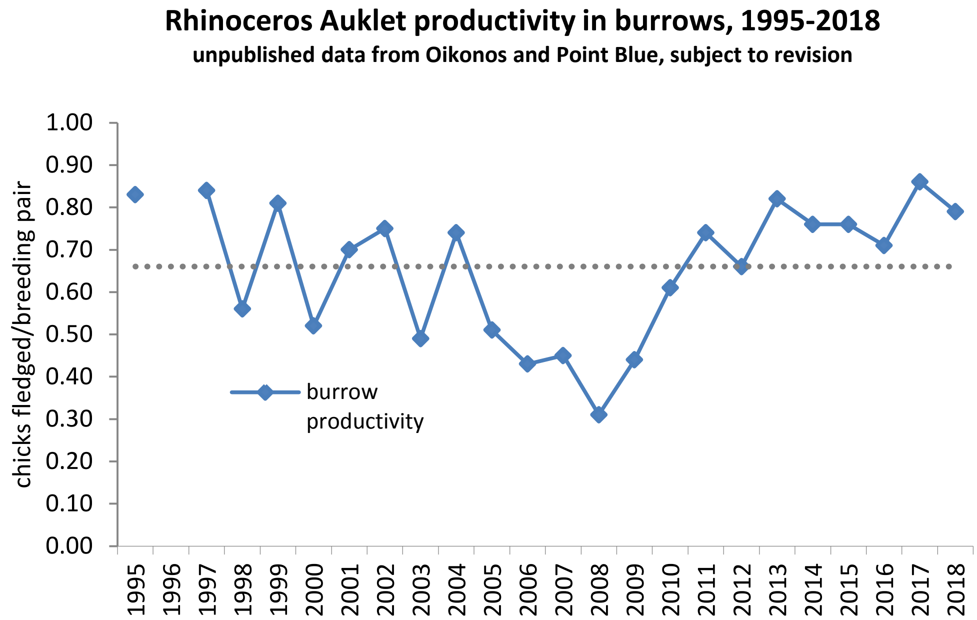


Fig. 3: Average number of Rhinoceros Auklet chicks fledged per pair in natural burrows, 1995-2018. Burrows were not monitored in 1996. The dashed line represents the long term average of 0.66 chicks fledged per pair. Sample size for burrows monitored for productivity ranged from 25 to 72.

Cassin's Auklet

Cassin's Auklets (*Ptychoramphus aleuticus*) were monitored with the same methods as described above for Rhinoceros Auklets.

Cassin's Auklet population

Cassin's Auklets first were recorded breeding on Año Nuevo Island in 1995 (Hester and Sydeman 1995). Over the next 10 years, their numbers slowly increased. No breeding was recorded for 2005 and the data for 2006 and 2007 was insufficient for a definitive count, though the limited data suggest a very low count (i.e. less than 10 breeding pairs) for 2006 and 2007. The year 2018 represents the largest population on record on the island: there were 156 Cassin's Auklets breeding on the island (Fig. 4). Of these 156, 144 birds (92% of the island's total breeding population) bred in the central terrace portion of the island where habitat improvements have been focused.

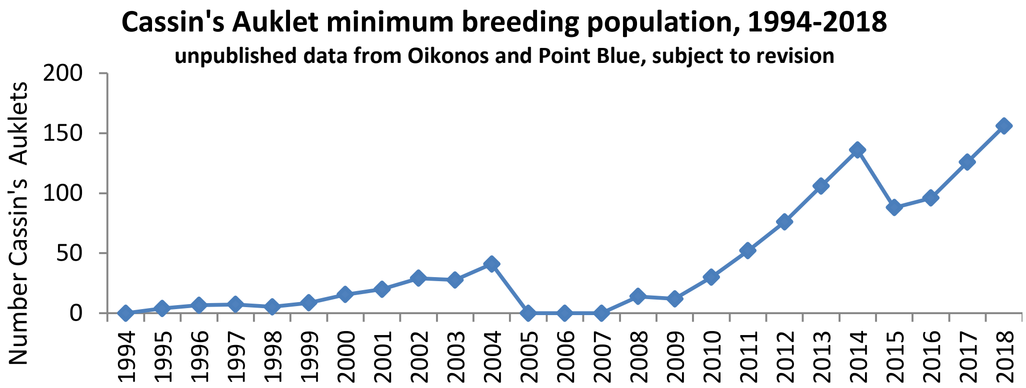


Fig. 4: The estimated number of breeding Cassin's Auklets on Año Nuevo Island annually, 1994-2018. No data in 2006 or 2007. The years 1994-2010 are minimum estimates because the whole of the island was not checked for nests, while the numbers from 2011 - 2018 represent total island estimates.

Cassin's Auklet reproduction

Cassin's Auklets breeding on Año Nuevo Island in 2018 fledged 0.68 chicks per breeding pair (Fig. 5; all site-types and clutches). This is lower than the annual average of 0.71 chicks fledged per pair. There was a single "double clutch" attempt recorded in 2018. "Double clutching" is a second breeding attempt after the breeding pair successfully fledges the first chick. The single attempt at double clutching in 2018 did not successfully fledge its second chick, resulting in a productivity of 0% for double clutches in 2018.

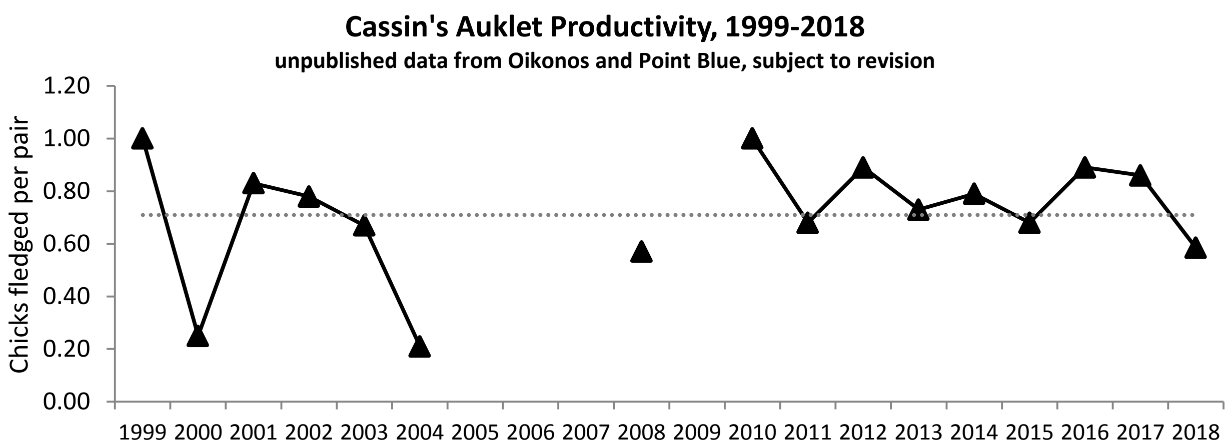


Fig. 5: The average number of Cassin's Auklet chicks fledged per pair per year from 1999 to 2018 in both natural burrows and artificial nest modules. The average includes both single and double clutch efforts. Dotted line represents the annual average of 0.72 chicks fledged per pair. There were no Cassin's Auklets breeding on the island in 2005 and insufficient data in 2006, 2007, and 2009.

Brandt's Cormorant

Brandt's Cormorant population

Nesting Brandt's Cormorants (*Phalacrocorax penicillatus*) were first documented at ANI in 1989 (Carter et al. 1992). Counts began in 1999. Each year, the total peak nesting population was estimated using an aerial photograph. Sources of the aerial photos and counts varied by year (see Fig. 6 caption). Population this year was censused via US Fish and Wildlife Service/UC Santa Cruz aerial photographs. Ground counts of portions of sub-colonies were conducted weekly by Oikonos to assess nesting pulses and determine if the aerial photograph captured the peak of breeding effort at ANI. USFWS/UC Santa Cruz reported 1,872 nests or 3,744 breeding individuals on June 6th, 2018 (Fig. 6; USFWS/UC Santa Cruz, unpublished data). An additional 78 nests were estimated inside the Lightkeeper's House based on post-season ground counts (not included in the total shown in Fig. 6). Ground counts of well-built nests in a sub-sampled area in the Light tower sub-colony peaked on June 21nd. Within that sub-sampled area, the nest count was 19% higher on June 21st than on June 6th when the aerial count was made. Although not all sub-colonies have equal growth trends, this indicated that the June 6th count may be an underestimate.

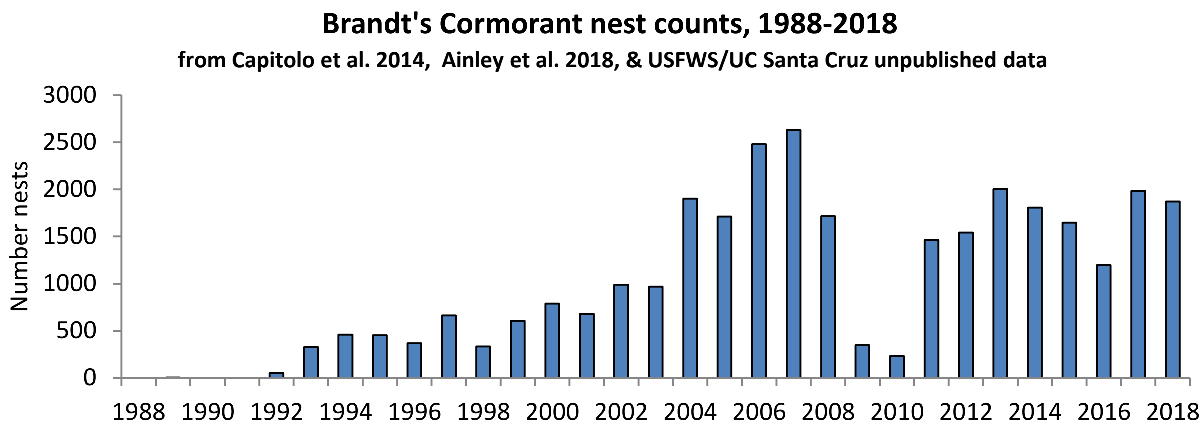


Fig. 6: Aerial counts of Brandt's Cormorants nests on Año Nuevo Island from 1988 to 2018. The first documented nesting on ANI was in 1989. Zero nests were recorded in 1988 and 1990, and no data exists for 1991. Data sources: 1988-2015 were published in Ainley et al. 2018; numbers for 1988-1990, 1995-1997, 1999-2003, and 2006 were published first in Capitolo et al. 2014. 2016-2018 are unpublished aerial counts from the US Fish and Wildlife Service and UC Santa Cruz.

Brandt's Cormorant reproduction

Brandt's Cormorant productivity was calculated by following a subsample of 34 nests within the sub-colony near the fallen light tower on the south terrace of ANI. Of these 34 nests, five nests were added four to six weeks after the initiation of egg laying to represent late nesters. Subsampled nests were followed weekly for egg and chick counts and feathering status of chicks. Productivity in 2018 was above average at 1.91 ± 0.9 chicks fledged per pair. The long-term average from 2002 to 2018 is 1.66 ± 0.74 chicks per pair (Fig. 7).

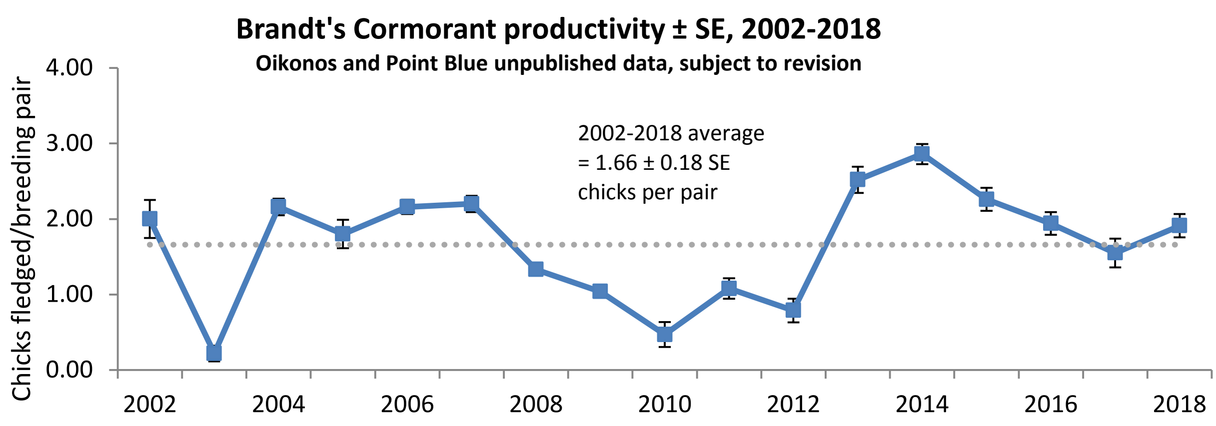


Fig. 7: Brandt's Cormorant productivity (mean ± SE number of chicks fledged per breeding pair) at Año Nuevo Island 2002-2018. A sub-sample of nests was followed from one or both of two main visible sub-colonies, the Light Tower and Blind 17 (shown here combined). Sample size ranged from 20- 57 nests annually. In 2008 and 2009, productivity was calculated as the total number of chicks that meet 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 error estimate in 2018 = 0.001.

Pelagic Cormorant

Pelagic Cormorants (*Phalacrocorax 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. During the breeding season, we recorded the contents of all visible nests on the mainland cliffs, island bluffs, and the island Lightkeeper's Residence. To document Common Raven disturbances to nesting Pelagic Cormorants, we observed interactions at a mainland sub-colony with a remote camera daily from March to August 2014-17.

Pelagic Cormorant population and productivity

The total number of breeding Pelagic Cormorants on the mainland and island in 2018 was 104 birds (Fig. 8). There were 34 breeding individuals on the island and 70 individuals on the island (Fig. 8). The reproductive success of the birds was notably lower on the mainland vs. the island (Fig. 9). The mainland sub-colonies fledged 0.36 ± 0.74 chicks per pair, while the island sub-colonies fledged 1.07 ± 0.81 chicks per pair (Fig. 9). We did not observe any Common Raven interactions at any Pelagic Cormorant sites in 2018. In 2018, there was only one nest in the mainland cove that has been historically depredated by Common Ravens ("East Cove 2"). For a discussion on Common Raven depredation on Pelagic Cormorants in the Año Nuevo State Park mainland colony, see Carle et al. 2017.

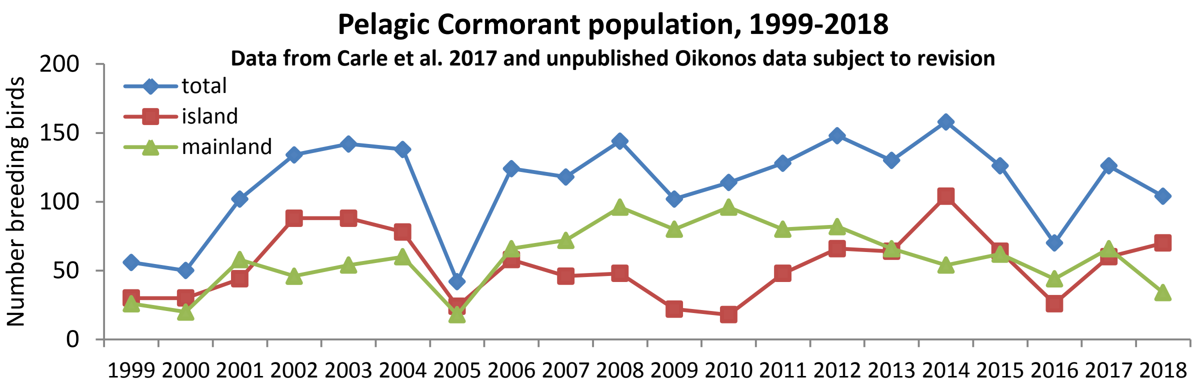


Fig. 8: Pelagic Cormorant population on Año Nuevo Island, 1999-2018. The blue line represents the total number of nesting Pelagic Cormorants on both the island and mainland, while red represents the island sub-colony counts and green represents the mainland sub-colony counts.

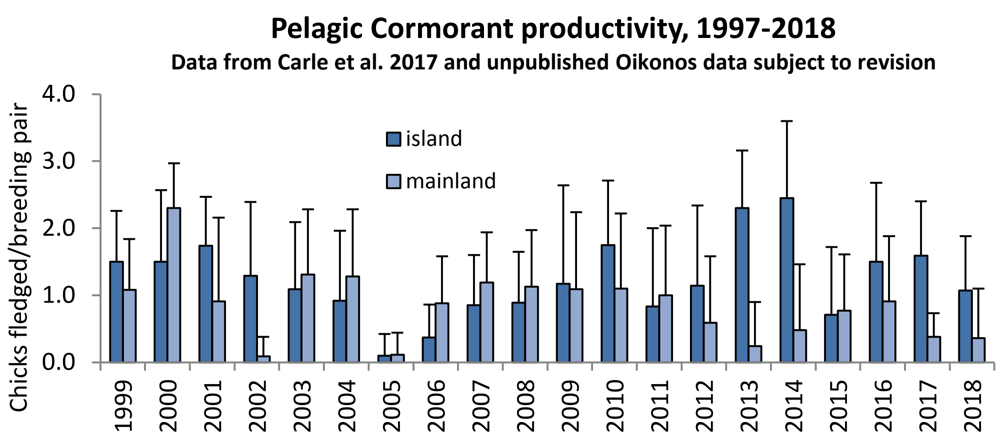


Fig. 9: Average number of chicks fledged per breeding pair of Pelagic Cormorants on the island 1999-2018 (dark blue) and on the mainland (light blue) + 1 SD (error bar).

Western Gull

Population counts of breeding Western Gulls (*Larus occidentalis*) on Año Nuevo Island began in 1976 (Sowls et al. 1980) and standardized monitoring began in 1999. Since 1999, ground- and boat-based counts of Western Gull nests were conducted during peak egg incubation. Depending on the conditions and year, sometimes areas such as the far ends of the north and south terraces were not accessible by ground or boat, in which case we used aerial photographs to survey the area (2016 USFWS/UC Santa Cruz aerial, 2017/2018 UCNRS drone aerial). In order to measure reproductive success, we followed a subsample of 35 nests in the central terrace during 2018.

Western Gull population

In 2018, we counted 637 Western Gull nests on the island (Fig. 10). Western Gull nest numbers on ANI historically have been affected by human disturbance on the island in the form of a lighthouse station (operating from 1872-1948) and unrestricted human access until 1967 (Tyler and Briggs 1981). From extremely low nesting numbers in the 1970s and early 1980s, Western Gull population rapidly grew and peaked in 2005 at 1,234 (Fig. 10). The years since have seen a significant decline in Western Gull nests. There was a drop of around 30% in nesting numbers between 2014 and 2015 at both ANI and Southeast Farallon Island (Russ Bradley, Point Blue, pers. comm.), see discussion in our 2016 annual report (Carle et. al 2016). Since 2015, gull nest numbers have remained relatively stable in the low to mid six hundreds (Fig. 9).

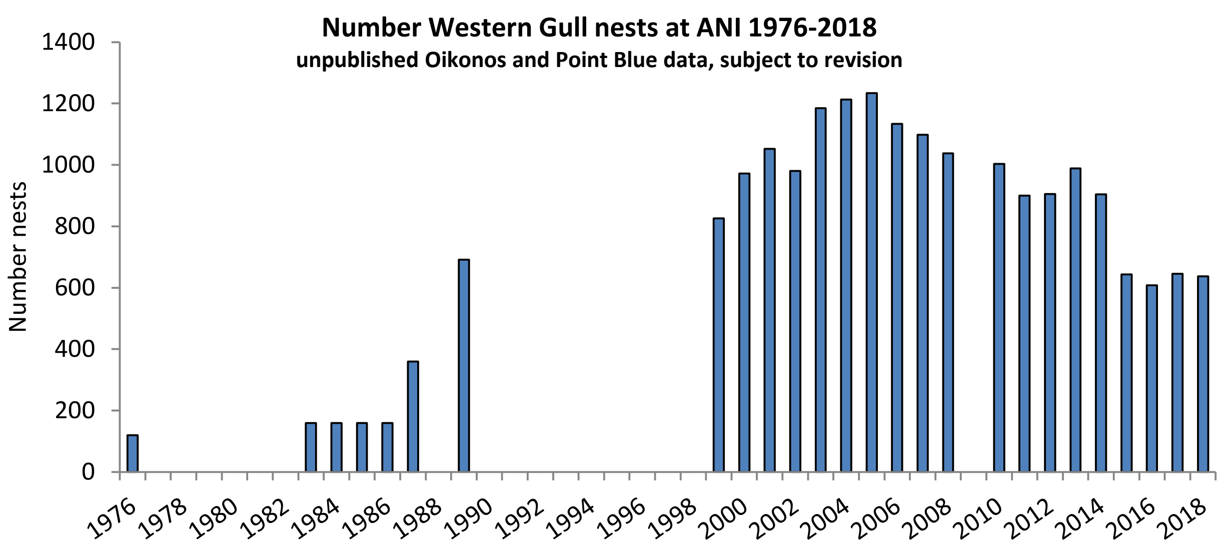


Fig. 9: Western Gull nests on Año Nuevo Island 1976-2018. In 2018, nests were counted via ground counts and by boat with the exception of portions of the north and south terrace which was counted using UCNRS aerial drone photographs. The years 1999-2018 are standardized ground counts, all previous years 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 and Tyler 1987, 1989 data from Carter et al. 1992. 1983-1987 had 150-170 nests each year (A. Huntley pers. comm. in Lewis & Tyler 1987).

Western Gull productivity

Western Gulls in 2018 fledged 0.91 ± 0.97 chicks per pair. This was below the 1999-2018 average of 1.25 ± 0.08 chicks fledged per pair (Fig. 10). This was the first year of below-average gull productivity at Año Nuevo Island since 2012.

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 managed central terrace to the north and south terraces. In 2016-2018, this census has shown the central terrace to have a much higher density of Western Gull chicks (Fig. 10). In 2018, the central terrace again had a density of gull chicks 9 times greater than the north terrace, and 4 times greater than the south terrace (Fig. 11). We believe this is primarily because California sea lions crush or discourage Western Gull nests on the north and south terraces. California sea lions are excluded from the central terrace. The major difference in chick density between terraces may also indicate that productivity numbers shown in Fig. 10 are representative of only the central terrace, where our sub-sample was located, and not the rest of the island—where productivity may be severely affected by trampling. This is likely especially true in the years since the habitat ridge sea lion exclusion fence was constructed (2011 on).

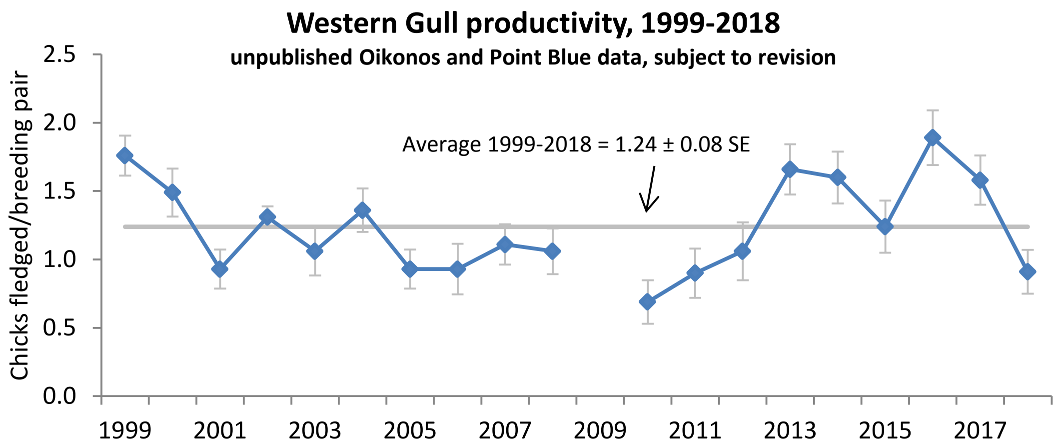


Fig. 10: Annual productivity (average chicks fledged per breeding pair ± standard error) of Western Gulls nesting in the central terrace region on Año Nuevo Island, 1999-2018 (no data for 2009). Subsamples of 28–155 nests were monitored annually for breeding success.

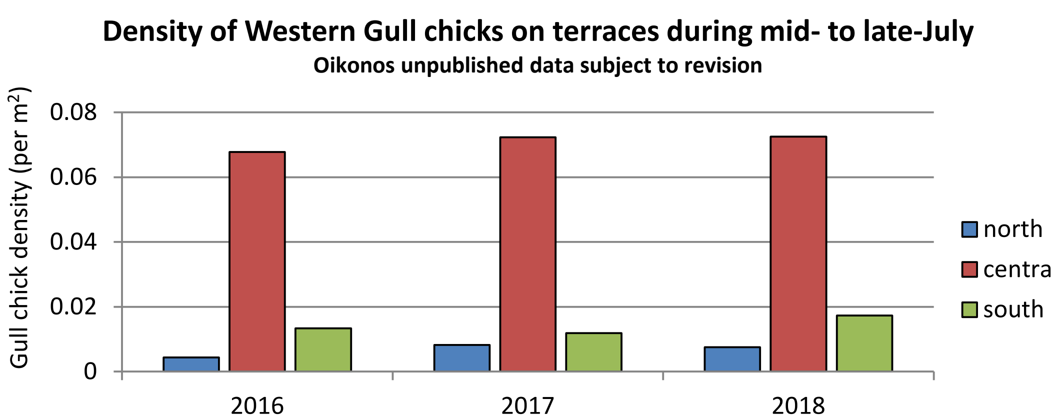


Fig. 11: Western Gull chick density (chicks per m^2) on ANI terraces during mid to late July, 2016-2018. Dates of counts were July 26, 2016, July 12, 2017, and July 13, 2018. Counts were timed to be when most chicks were mostly- to fully-feathered and few, if any, had fledged. The central terrace was defined as all areas inside the Habitat Ridge sea lion exclusion fence (397 chicks; 5,474 m^2). North terrace was all areas north of the Habitat Ridge (45 chicks; 5,978 $m^{2)}$, and South Terrace was all areas south of the Habitat Ridge (105 chicks; 6,078 m^2). Only the top of the raised part of the island was considered "terrace."

Pigeon Guillemot

Pigeon Guillemot (*Cepphus columba*) breeding sites were monitored by burrow camera or by hand in the accessible central portion of the island, and by site attendance and fish carrying for inaccessible sites. ANI had a breeding population of at least 13 Pigeon Guillemot pairs in 2018 (Fig. 12). Of these pairs, six bred in artificial clay modules designed for Rhinoceros Auklets, one pair bred in a burrow under a raised boardwalk, and the rest nested in crevices or burrows (see Fig. 17). Of these 13 pairs on the island, we were able to assess the productivity for seven pairs. For these seven pairs, productivity in 2018 was 0.86 ± 0.69 chicks fledged per pair. Nest modules provide a higher degree of researcher accessibility and allow for detailed productivity data.

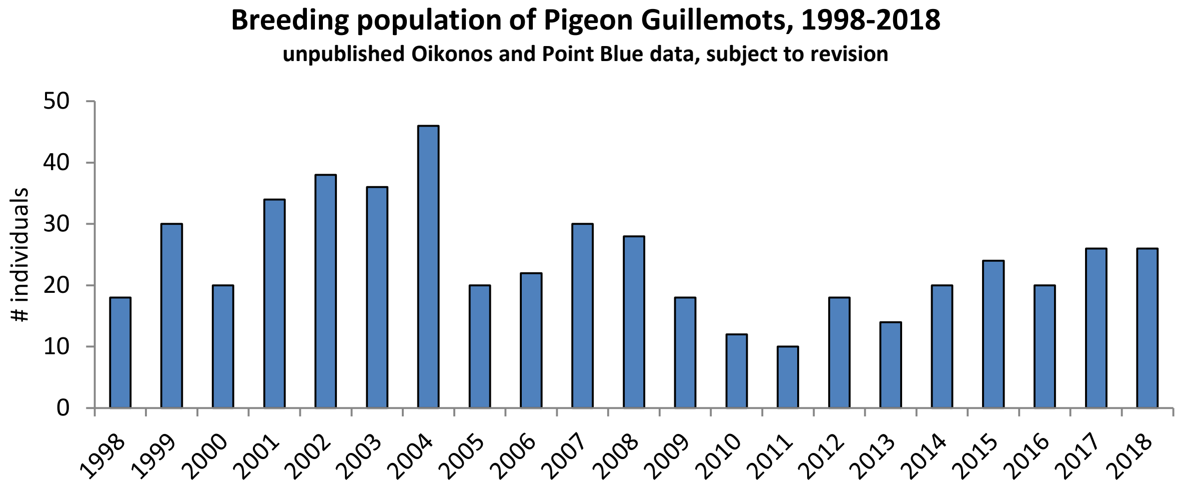


Fig. 12: Pigeon Guillemot breeding population on Año Nuevo Island 1998-2018.

Black Oystercatcher

Black Oystercatcher (*Haemaptopus bachmani*) nest in intertidal areas along the west coast of North America. Reproductive success of Black Oystercatchers has generally been poor at ANI (Fig. 13). In 2018, there were four confirmed active breeding pairs with known nest contents. None of these nests successfully fledged a chick. Most nests fail at ANI due to disappearance of eggs or chicks, suggesting predation or perhaps trampling by pinnipeds. Black Oystercatchers have been observed defending nests from Common Ravens frequently since 2004.

A recent population survey of Black Oystercatchers in California estimated a state-wide population of 4,749 to 6,067 individuals (Weinstein et al. 2014). This estimate was much higher than previous estimates, which emphasized that California is important core-habitat for the species (Weinstein et al. 2014). Despite the increased population estimate, there are still relatively few Black Oystercatchers in California and available nesting and foraging habitat is limited to the narrow intertidal zone (Weinstein et al. 2014). Sea level rise is expected to threaten much of this habitat, which will increase the importance of elevated island nesting sites like ANI in the future (Weinstein et al. 2014). We are contributing ANI Black Oystercatcher reproductive success data to a current project led by California Audubon to monitor breeding success state-wide.

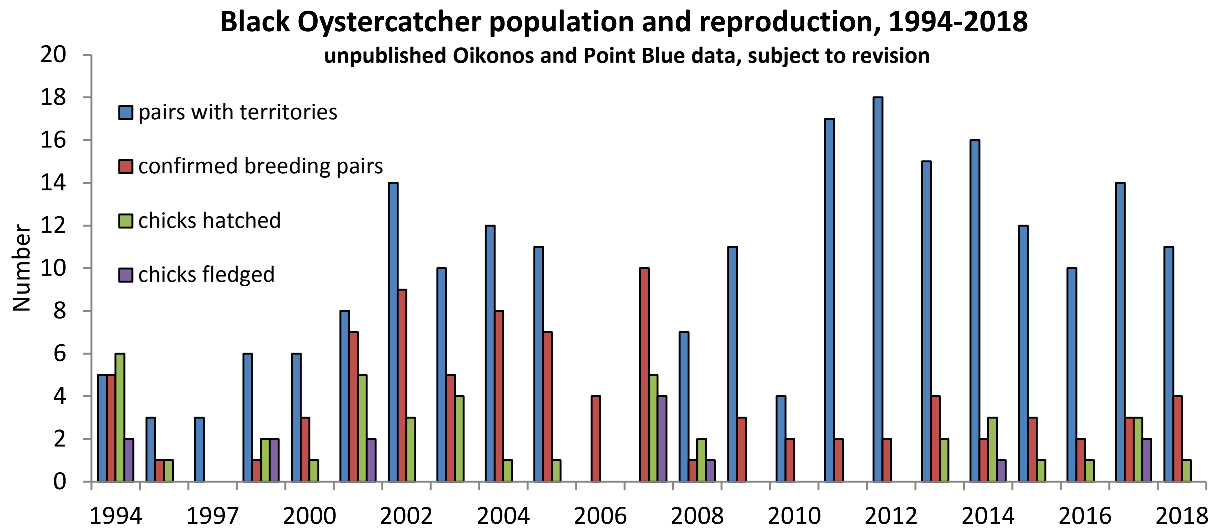
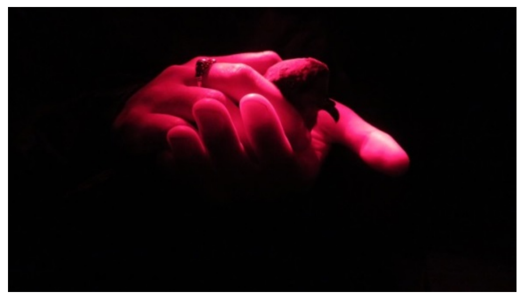


Fig. 13: Annual population and breeding metrics of Black Oystercatcher nests visible from Año Nuevo Island ground observations from 1994 to 2018 (purple – total number of chicks fledged, green – total chicks hatched, red - confirmed number of breeding pairs documented with eggs or chicks, blue - total nest sites with regular attendance by a pair). All the habitat visible from central terrace observation points was monitored annually (approximately 70% of the available habitat on the island).

Ashy Storm-petrel



Ashy Storm-petrel caught during 2017.

The Ashy Storm-petrel *(Oceanodroma homochroa)* is a tiny seabird related to albatrosses and is a possible breeder on ANI. From 1993-2018, 12 Ashy Storm-Petrels have been recorded at ANI (Fig. 14). All were captured during nighttime mist-netting for Rhinoceros Auklet prey, which takes place four nights a year during June and July. We began banding incidentally captured Ashy Storm-petrels in 2013. No Ashy Storm-petrels were caught in 2018.

During 2017 and 2018 we temporarily placed a song-meter sound recording on ANI to assess for Ashy Storm-petrel activity. During 2017 this device was near the Lightkeeper's House, and during 2018 the device was in the historical cistern northeast of the foghorn building. This effort is a part of a USGS project to study the range and attendance patterns of the Ashy Storm-petrel on offshore rocks, sea stacks, and islands. As of this writing, USGS/Conservation Metrics has not finalized analysis the audio data, though 2017 analysis indicated little or no audio activity of ashy-storm petrels picked up by the songmeter.

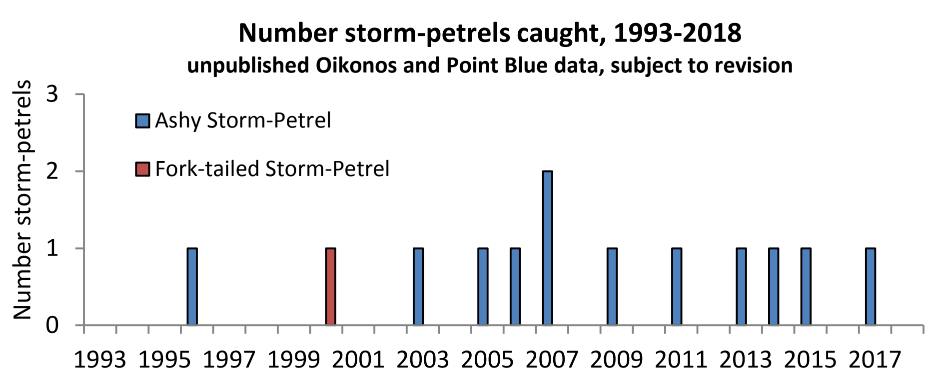


Fig. 14: The number of Ashy and Fork-tailed (*Oceanodroma furcata*) Storm-petrels incidentally captured at Año Nuevo Island from 1993-2018. All storm-petrels were captured during nighttime mist-netting targeting Rhinoceros Auklets, from late June to early August.

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 during which we were unable to determine if the island nest was active. In 2018, the mainland Common Raven nest had an adult on the nest twice during monitoring. No interactions between Pelagic Cormorants and Common Ravens on the mainland were observed, though remote camera images could reveal otherwise. We have yet to analyze camera image data for 2018.
The island's nesting Common Ravens appeared to have moved into the second story of the more southern of the Lighthouse Keepers House, from their nest on the outside of the Lighthouse Keepers House (pictured above). We discovered the nest remains during our post-season cormorant pellet collection. What appeared to be three juvenile Common Ravens and two adults were sighted in a cove adjacent to the foghorn building on May 17th. There were two active Pelagic Cormorant nests on the Light House Keeper's House in 2018. We did not observe any Pelagic Cormorant and Common Raven interactions at these nest sites.

Common Raven nest in Lighthouse Keeper's House 2018.

Prey Studies

Seabirds are top marine predators and understanding what they eat and what they provision their young gives us a picture of the health of the marine ecosystem and fisheries. In 2018, we collected diet samples from Rhinoceros Auklets, Pelagic Cormorants, and Brandt's Cormorants. Rhinoceros Auklet diet sample results are presented below. See Ainley et al. 2018 for Brandt's Cormorant diet results from ANI from 2000-2016.

Rhinoceros Auklet Prey Study

Rhinoceros Auklets return to the breeding colony at night to provision their chicks with whole fish and/or cephalopods carried cross-wise in their bills (Hester 1998). This assemblage of prey is called a "bill-load." Since 1993, we have collected data on Rhinoceros Auklet bill-loads by mist-netting provisioning adults in the central terrace four nights a year. In 2018, we caught a total of 146 individual Rhinoceros Auklets and collected 52 complete bill-loads of prey.

Northern Anchovy (*Engraulis mordax*) was the most prevalent prey species in the Rhinoceros Auklet diet during 2018. When analyzing the number of prey items per bill load, Northern Anchovy made up 92 ± 26 % of species present. Shortbelly Rockfish (*Sebastes jordanii*) made up only 3 ± 15% of prey provisioned to auklet chicks. When analyzing prey by the % mass of each species, Northern Anchovy accounted for 96 ± 20%, and Shortbelly Rockfish 2 ± 14%. Other prey observed in 2018 in smaller proportions (≤2%N) were market squid (*Doryteuthis opalescens*), juvenile lingcod (*Ophiodon elongatus*), and one instance of brown Irish lord (*Hemilepidotus spinosus*) (Fig. 15).

Rhinoceros Auklet chick growth and fledging success are typically higher in years when they are provisioned with either juvenile rockfish, anchovy, or both (Thayer and Sydeman 2007). Indeed, Rhinoceros Auklet productivity was above average in 2018 (Fig. 3), and anchovy was the dominant prey type (Fig. 15). See Thayer and Sydeman 2007 and Carle et al. 2015 for more information on Rhinoceros Auklet foraging ecology and chick diet at ANI.

Rhinoceros Auklet and Brandt's Cormorant diet and population data from ANI were included in a peer-reviewed manuscript published with many collaborators during 2018 entitled *Prey switching and consumption by seabirds in the central California Current upwelling ecosystem: Implications for forage fish management*

(Warzybok et al. 2018). This paper modeled the consumption of forage fishes by seabirds from 1987-2015 in the Gulf of the Farallones region south to Año Nuevo and compared results to stock sizes and commercial landings of forage fishes. The study found that in recent years Rhinoceros Auklets in the region have consumed 400-500 metrics tons (t) of forage fish annually, primarily juvenile rockfish and anchovy, and that Brandt's Cormorants consumed 3,000 t of forage fish annually in recent years, mainly composed of juvenile rockfish and anchovy but also with major quantities of flatfish and sculpin. Combined fishery landings of anchovy and rockfish fisheries in the region were around 20,000 t in 2015, whereas combined consumption of forage fish by Brandt's Cormorants, Rhinoceros Auklets, and Common Murres ranged up to 60,000 t annually. For more info see Warzybok et al. 2018. We also contributed Rhinoceros Auklet data to NOAA's 2018 California Current Integrated Ecosystem Assessment report.

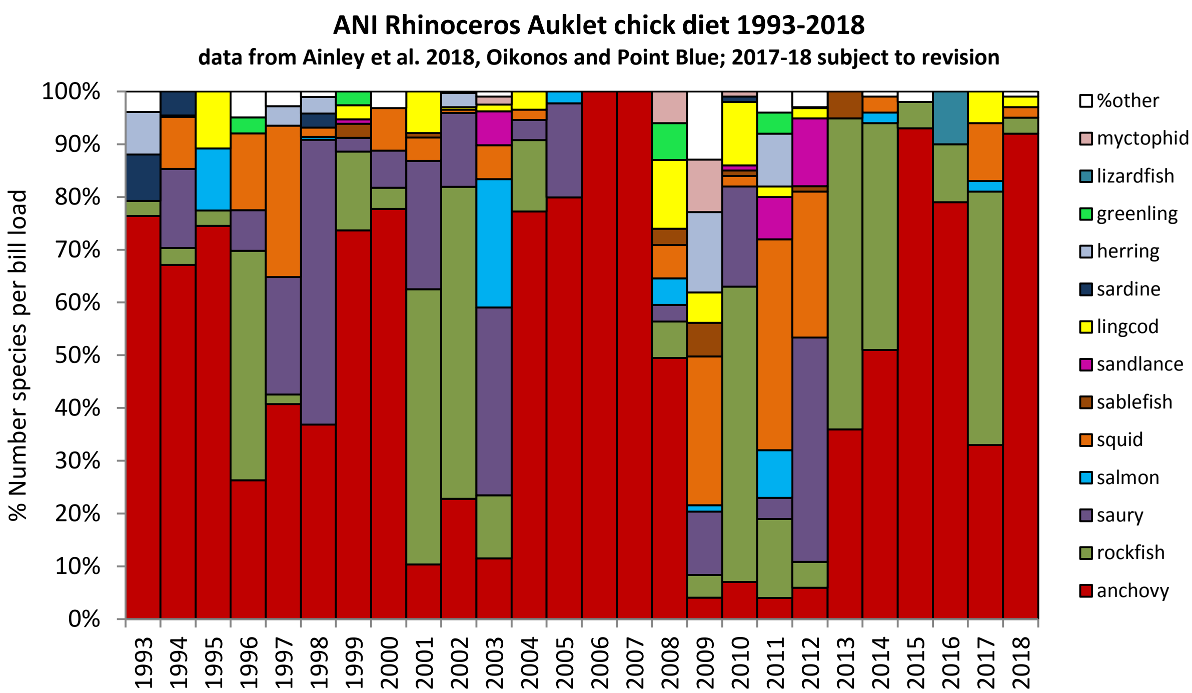


Fig. 15: Rhinoceros Auklet chick diet on Año Nuevo Island from 1993-2018 quantified as the percent number of prey per bill-load delivered to chicks. Sample size (*n*) ranged from 18-52 bill-loads annually; 2018 *n* was 52 bill-loads.

III. Habitat Restoration

The habitat restoration on ANI seeks to mitigate injuries to seabirds from oil contamination (Luckenbach Trustee Council 2006) and to protect biodiversity on ANI. After a public review process, the Luckenbach Trustee Council determined that oil spill damage to Rhinoceros Auklets could be addressed by habitat restoration efforts to improve reproductive success at Año Nuevo Island. If no action was taken, the breeding colony was predicted to decline rapidly due to soil erosion. Thus, the restoration benefits are derived from the difference between colony growth/persistence versus decline/loss of the colony without the project. The year 2018 marks the year of completion for the 10 year Luckenbach funded habitat restoration project.

Restoration Accomplishments in 2018

1. **Nest Modules**: This year we continued our collaboration with California College of the Arts and master ceramicist Nathan Lynch to prototype Cassin's Auklet specific nest modules. We have four new prototypes, and another six in development, which we will deploy in spring of 2019.

2. **Restoration**: We continued to reduce erosion of the central terrace portion of ANI by installing erosion control material, spreading native seed and, and maintaining an integral part of our restoration tools: the sea lion exclusion habitat ridge.

Clay Nest Modules

A Rhinoceros Auklet incubating its newly hatched chick in a ceramic artificial nest site; Photo by Tara Johnson Kelly

In the eight years since installation of clay nest modules, they have proven attractive to breeding Rhinoceros Auklets. Since 2011, Rhinoceros Auklets have laid 196 eggs and fledged 74 chicks from the modules. Twenty-seven pairs of Rhinoceros Auklets nested in modules in 2018. Cassin's Auklets and Pigeon Guillemots have also bred successfully in the Rhinoceros Auklet module design. Without a doubt, the clay modules have provided homes safe from erosion for many seabird pairs and have required less maintenance than previous wood and PVC box designs.

However, annual productivity of Rhinoceros Auklets breeding in clay modules from 2011-2018 averaged 0.48 ± 0.09 chicks fledged per pair, while natural burrow productivity averaged 0.76 ± .06 chicks fledged per pair when the same fledging criteria was used in both site types. In 2018, module productivity was 0.50 ± 0.51 chicks fledged per pair (Fig. 16).

It is still unclear why Rhinoceros Auklet productivity (i.e., proportion of eggs laid that resulted in fledged chicks) has been relatively low in clay modules. In 2011 and 2012, the first years after installation, productivity was low due mainly to low survival of chicks ("fledging success"; Fig. 16). In recent years, including in 2018, low productivity appeared to be driven by low hatching success (e.g. only 61% of eggs laid in modules hatched in 2018, Fig. 16), rather than chick survival. No design features have caused obvious problems with nesting success. It is possible that research disturbance at nest sites during incubation could cause lower hatching success due to abandonment or reduced visitation. Another possibility is that, for unknown reasons, modules are selected by lower-quality breeding pairs, resulting in lower productivity. These might be young and inexperienced birds, or newly-formed pairs. We plan to investigate these patterns using demographic data from banded birds nesting in modules.

Interestingly, from 2013-2018 Cassin's Auklet productivity in clay nest modules (0.71 ± 0.35) tracked more closely to productivity in natural burrows (0.78 ± 0.09), though sample size in modules was limited (n = 2-7 nests). In 2018, Cassin's Auklet productivity in clay modules was low at 0.17 ± 0.41 chicks fledged per pair (*n* = 6 pairs), with most pairs failing at the pre-hatching stage. Six pairs of Pigeon Guillemots nested in clay modules in 2018 (Fig. 17). Twelve pairs of Pigeon Guillemots have attempted to breed in modules from 2014-2018, and have fledged 11 chicks total, for a productivity of 0.79 ± 0.70 (maximum possible productivity for Pigeon Guillemots is 2.0 because they lay two eggs, vs. the one-egg clutches of Rhinoceros and Cassin's Auklets.) We do not have a large enough sample size of Pigeon Guillemot nests to be able to compare this to natural burrows.

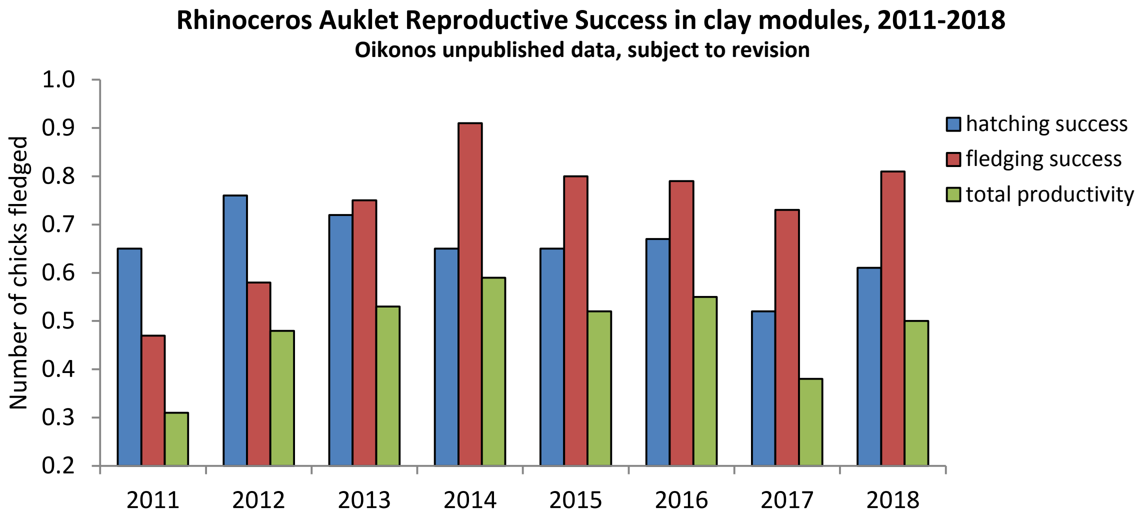


Fig. 16: Rhinoceros Auklet reproductive success metrics in clay nest modules at Año Nuevo Island, 2011-2018 (blue – proportion of eggs that hatched per pair, red – proportion of hatched chicks that survived to fledging, green – proportion of chicks that fledged per breeding pair). Sample sizes were between 20-39 nests annually.

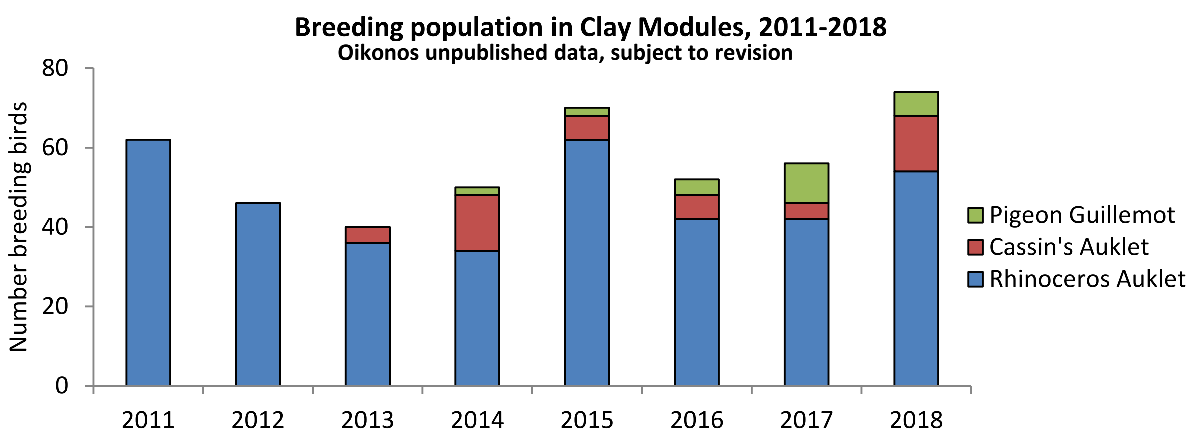


Fig. 17: Seabird breeding population in clay nest modules at Año Nuevo Island, 2011-2018. Birds were counted as breeding birds if they had a confirmed egg or chick.

Ecologist Emily Coletta maps Cassin's Auklet modules.

Cassin's Auklet nest modules

2018 was the first breeding season in which our new Cassin's Auklet specific nest module design was deployed on the island. In collaboration with California College of the Arts (CCA) and Patagonia-Santa Cruz, we designed, built, transported, and installed nine new Cassin's Auklet specific nest modules on ANI in November 2017. The design of the 2017 modules is overall elbow shaped, with a separate tunnel, nest cavity, and heat shield.

There was one breeding attempt in these new modules in 2018. A Cassin's Auklet laid an egg, which was subsequently abandoned and did not hatch. In addition to this nesting attempt, two of the new modules showed signs of prospecting (fresh nesting material).

Preliminary temperature logger data show that all modules maintained a bird-safe temperature. Our ambient, shaded temperature recording station registered a peak high of 92.74 degrees Fahrenheit on August 24, 2018. The mean peak temperature for seven Cassin's Auklet clay modules on August 24 was 84.82 degrees Fahrenheit (range 80.91 to 88.65 degrees Fahrenheit). Average peak temperature for all Cassin's Auklet module temperature loggers from November 2017 to September 2018 was 79.60 degrees Fahrenheit (n = 28 module peak temperature recordings).

A Cassin's Auklet nesting in a clay artificial nest site. Photo by Tara Johnson Kelly

In 2018, California College of the Arts master ceramist Nathan Lynch developed four new Cassin's Auklet prototype modules, with the significant design improvements of a removable lid on the top of the module, and an interior black glaze to reduce ambient heat. Another six modules are in production and will be added to our fleet of Cassin's Auklet specific modules in spring 2019.

New Cassin's Auklet modules will also be placed above the old, wooden tramway between the historical cistern lip and adjacent bluff edge. We are hoping that these modules will be occupied by birds otherwise nesting in this tramway which is dangerous for Cassin's Auklets given its precarious, eroding nature and dangerous for researchers given the proximity of the bluff edge.

Vegetation Metrics

Description: The purpose of the vegetation metrics is to quantify the growth of stabilizing plant cover in the restoration area. Plant cover and associated root structure in the island's sandy soil improves burrow stability. The objective of plant restoration is to stabilize soil to reduce damage to auklet nesting burrows and loss of auklet nesting habitat through erosion.

Method: We conducted two surveys per year quantifying plant species composition in restoration areas in May and October 2010 – 2017 (also in previous years 2003-2005). We conducted one survey in 2018. We quantified percent cover and average height by plant species. Leaf litter (dead plant material) and bare categories were also recorded.

Results: Prior to the plant installments in 2010, vegetation cover was around 5% in the burrow plots. Live native plant cover reached 60% in fall 2012 (Figure 18). A combination of drought and hundreds to thousands of roosting Brown Pelicans (*Pelecanus occidentalis*) caused vegetation cover to decline to 4% in 2014 (Figure 18). In 2018, the peak Brown Pelican count was relatively low compared to years past, at 529 roosting adults and juveniles counted on August 16, 2018 (Figure 19).

Since the low point of vegetation cover in 2014, native vegetation cover has slowly rebounded and stabilized at between 12-20%. In spring of 2018, total vegetation cover was 44% and native vegetation cover was 20%. The high vegetation cover was largely due to a spring boom in the agricultural weed *Malva parviflora*. Native vegetation was the highest on record this year since the spring of 2014. We have noticed, interestingly, that *M. parviflora* seems to serve as a nursey plant for *Distichlis spicata*, with *D. spicata* growing much taller and more vigorously under *M. parviflora* as compared to adjacent areas.

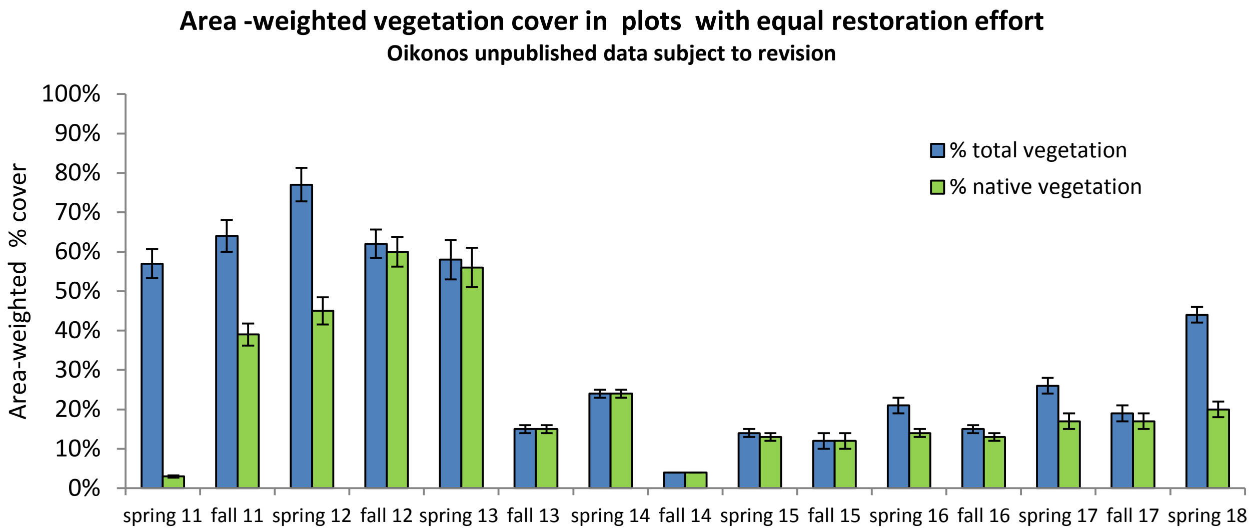


Fig. 18: Percent vegetation cover (average area-weighted ± SE) in four restoration plots that experienced equal restoration efforts on Año Nuevo Island, 2011-2018. Plants were first installed in fall 2010.

In 2018, salt grass (*Distichlis spicata*) made up 16% of total vegetation cover in the spring survey. The other most common plant, American dune grass (*Eleymus mollis*) made up 18% of total vegetation cover in the spring. Dune grass in 2018 continues to be trampled during the fall by roosting Brown Pelicans, though remains alive in patches where we protected this species from pelicans with circles of wooden stakes. Salt grass continues to be the plant species most resilient to pelican trampling and harsh island conditions.

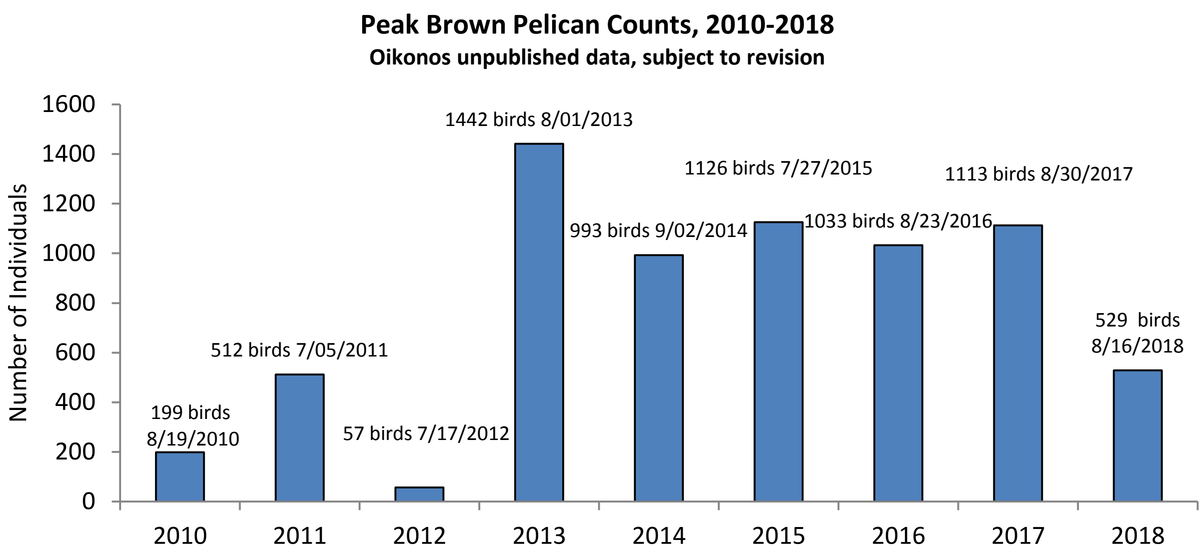


Fig. 19: Annual peak number of adult and juvenile roosting Brown Pelicans, as counted from the central terrace, 2010-2018.

Erosion Control Material

With the assistance of the California State Parks Santa Cruz District Natural Resource Crew (Resource Crew), we deployed approximately 500 square meters of erosion control material in 2018. We focused on installing the erosion control material in high density burrow areas and along the edges of the central terrace. Under this erosion control material we spread beach bur seed (*Ambrosia chamissonis*), which tends to germinate effectively on the island.

Habitat Ridge Maintenance

The habitat ridge separates the central restoration area from the north and south terraces on Año Nuevo Island and is an integral part of our habitat restoration management plan. The habitat ridge serves the dual role of preventing researcher disturbance on the California sea lions who haul out on the terraces and, increasingly, use the island as a rookery, while preventing these sea lions from trampling auklet burrows in the restoration area.

In 2018, with the help of the Resource Crew, we installed and backfilled a retaining wall adjacent to where the habitat ridge was being undermined by erosion. Brandt's Cormorants, by virtue of their nest building and guano deposition during the season, further rebuilt the soil in the area.

The State Parks natural resource crew behind the retaining wall outside the habitat ridge: Spencer, Alberto, Ashley and Jason of the CA State Parks Resource Crew, Jessie and Ryan of Oikonos, and California College of the Arts volunteers Sam and Graham. Photo by Taylor Johnson.

Seabird Mitigation Metrics

With no restoration efforts, it was estimated that burrowing seabirds would rapidly decline and no longer successfully nest on ANI due to habitat loss from erosion. Seabird populations often respond slowly to restoration efforts because they are long-lived, have low productivity, and chicks do not return for 3-7 years to breed as adults (Russell 1999). The annual reproductive metrics will demonstrate success if the breeding population remains stable and nesting attempts produce a healthy percentage of fledglings. Since restoration was implemented in 2010, the total number of chicks fledged in the restoration area has increased annually. This increase has almost certainly been facilitated by improved habitat quality on the island, though it may be influenced by other factors including prey availability, immigration from other colonies, and demography of the population. The annual increase in chicks fledged since 2009, however, is a clear indication of the restoration's success at preventing colony decline and loss.

Methods: See nest monitoring methods in Carle *et. al.* 2015.

Results: Since 2011, the central terrace habitat restoration area has produced more chicks every year, with a total of 823 fledged chicks 2011-2018. The Luckenbach Oil Spill killed an estimated 593 Rhinoceros Auklets (Luckenbach Trustee Council 2006). Although fledglings are not a direct replacement for the adults lost in the spill, this is nevertheless an important achievement, as it is likely that many of these chicks would not have been produced without the habitat restoration efforts. In 2018, the central terrace population produced an estimated 162 fledged chicks, the greatest number on record.

Table 1. Replacement (mitigation) of Rhinoceros Auklets injured by oil contamination during the Luckenbach oil spill, through reductions in habitat loss at Año Nuevo Island from 2011-2018. Note: all values are for the central terrace restoration area.

Year	Breeding Adults	Chicks Fledged Natural Burrows	Chicks Fledged Artificial Sites	Chicks Fledged Total
2011	210	55	9	**64**
2012	234	61	11	**72**
2013	242	85	9	**94**
2014	258	85	10	**95**
2015	290	80	16	**96**
2016	294	89	11	**100**
2017	350	132	8	**140**
2018	432	149	13	**162**
Total		736	74	**823**

Acknowledgements, Partners, Volunteers

Success of this project depends upon the hard work and collaboration of many different individuals and organizations. **California Department of Parks and Recreation, Año Nuevo State Park,** and **Oikonos - Ecosystem Knowledge** have partnered in the restoration of Año Nuevo Island**.** The other key partners were **Go Native, California College of the Arts, Nathan Lynch, Morelab, Rebar, UC Natural Reserve System, US Fish and Wildlife Service, UC Santa Cruz, and Point Blue Conservation Science**. We acknowledge the staff and volunteers who began the initial restoration work in 2002 – 05 and on whose shoulders we stand.

We are grateful for the **hundreds of volunteers** who contributed 6,784 hours to the project since 2009 (See Project Volunteers table). In addition, we thank the crew at Parker Diving for safe Landing Craft operations, and Lloyd Fales, Peck Ewer and Justin Holbrook for creating the restoration project videos. Mark Hylkema, Portia Halbert, and Jennifer Boyce gave many hours guiding the project through permitting. Thanks to the California State Parks Santa Cruz District Natural Resource Crew for three days of help in the field during 2018.

Thanks to the CA State Parks Santa Cruz District Natural Resource Crew for putting in 3 field days on Año Nuevo Island this year! Photo by Taylor Johnson.

We thank the following individuals who volunteered their time and energy on ANI during 2018. We also acknowledge the hundreds of volunteers who helped with on and off-island volunteer work from 2002-2017.

2018 Año Nuevo Seabird Project Volunteers

Chris Garrison	David Hyrenbach	David Calleri	Jalika Joyner	Michael Gonczarm	Sam Stowe
Chris Komlos	Emily Snider	Heidi Rogers	Janessa Minjarez	Natasha Vokhshoori	Taylor Johnson
Chris Santana	Gilles Faggio	Hermione Hu	Junyan Li	Rozy Bathrick	Troy Guy
Danielle Devincenzi	Graham Feddersen	Lisa Guy	Martha Brown	Sabrina Sanchez	Zeka Glucs

Project Volunteer Days/Hours 2009-2018

Year	Total Volunteers	New Volunteers	Volunteer person days	Total Volunteer Hours	Total Organizations
2009	10	9	31	248	4
2010	73	51	108	864	10
2011	26	16	99	792	9
2012	28	13	78	624	9
2013	43	23	110	880	11
2014	19	11	70	558	7
2015	25	11	91	728	7
2016	23	19	67	536	3
2017	35	30	106	842	7
2018	27	17	89	712	5
Totals	**308**	**200**	**849**	**6,784**	

Oikonos and California College of the Arts ANI project staff 2018

Jessie Beck	Project manager
David Calleri	Ecologist
Ryan Carle	Project manager
Emily Coletta	Ecologist
Michelle Hester	Program Director
Verónica López	Visiting scientist from Oikonos Chile program
Nathan Lynch (CCA)	Lead artist - ceramic nest modules
Kari Marboe (CCA)	Artist - ceramic nest modules
Trinidad Mena	Administrative manager
Kirsten Moy	Development manager
Tara Johnson-Kelly	Intern
Carrie Niblett	Intern
Sara Sirk	Doris Duke Conservation Scholar

Volunteer Heidi Rogers and Project Manager Jessie Beck enjoy sunset before a night of banding auklets (left), intern Tara Johnson Kelly holds at Rhinoceros Auklet (right).

Funding

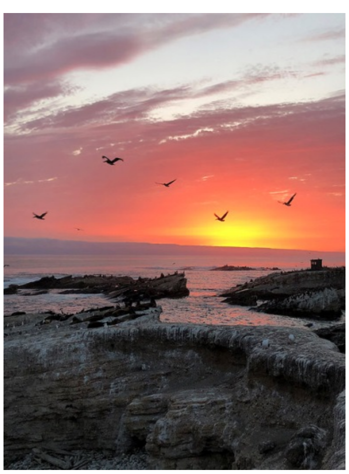
This collaborative project could not happen without the partnership of many agencies, foundations, and private donors. We extend a huge thank you to all the grant-makers and donors who have sustained this project for 26 years. Funding agencies and foundations and individual donors during 2016-2018 are listed in the tables below. Also a big thank you to **Wonderland Toys and Classroom, New Leaf Community Markets, Meeks Honey**, **Coastside State Parks Association**, and **Discretion Brewing** for donating prizes and beer sales proceeds during our Love Monday spring fundraiser event in March 2018.

Project Manager Ryan Carle staffing the outreach table at the Love Monday fundraiser for the Año Nuevo Seabirds Project at Discretion Brewery in March 2018

2017-2018 Project Funding – Grant funding
Luckenbach Oil Spill Trustee Council
National Fish and Wildlife Foundation
Sand Hill Foundation
Patagonia Santa Cruz Store
Doris Duke Conservation Scholars Program
New Leaf Community Markets Envirotoken Program
The New York Community Trust

Año Nuevo Seabirds Project Individual Donors, 2016-2018

Seabird Stewards ≥$1,000	Cormorant-ributors ≥$100	Gull-getters ≥$50	Burrow Buddies $1-$49
Doris & Albert Broughton	Carleton Eyster	Brian Kliesen	Anonymous
Steve & Vicki Beck	Charles Fetter II	Carl S Chavez	Anonymous
	Chris Lay	Charles Chuck Kozak	Anonymous
Auklet-vocates ≥$200	Christine Lee	Chelsea Fetter	Robert W. Henry III
Alayne Meeks	David & Cheryl Calleri	Corinne Gibble	Brian Hester
Catherine Rose	Denise Greig	Diana Humple	Brooke Matteson
David & Nikki Sands	Dennis Long	Grant Ballard	Colleen Young
Discretion Brewery	Janet & David Carle	John M Mazza	Emma Kelsey
Janet Oulton	Janet Oulton	John Michael Jr	Ilana Nimz
Karen Holl	Jeb E. Bishop	Kelly A Harris	Jasmine Lynn
Laurie & Terry Sawyer	Jennifer Biehn	Linda A Jordan	Jeanne Oakeshott
Paul Abbassi	Katie Freeman	Lucas Sawyer	Jeb Barson
Sheryl Moy	Leonard Jankowski	Madeleine Pott	Jennifer Goza
Shirley Scharf	Linda Brodman	Marcelo Morales	Judy Broughton
Two Hands Project	Lisa Weetman	MaryEtta Hester	Kevin Condon
Aaron Hebshi	Lloyd Fales	Matt Miller	Larry Moy
	Martin Ward	Matthew Tedford	Mary Ann Rempel
	Martha Brown	Norine S. Yeung	Matthew McKown
	Rosemarie Willimann	Norman Taylor	Randy Chapin
	Valentina Colodro	Peter Hodum	Ryan Ganjitomari
		Roberto M. Zuban	Victoria Crawford
		Shawna Scharf	Zeka Glucs
		Sophie Webb	
		Susan McCarthy	
		Terry & Gary Strachan	
		Verónica López	
		Wonderland Toys & Classroom Resources	



All photos by Tara Johnson Kelly

Literature Cited

Ainley, D.G., Santora, J.A., Capitolo, P.J., Field, J.C., Beck, J.N., Carle, R.D., Donnelly-Greenane, E., McChesney, G.J., Elliott, M., Bradley, R.W., Lindquist, K., Nelson, P., Roletto, J., Warzybok, P., Hester, M., and J. Jahncke. 2018. Ecosystem-based management affecting Brandt's Cormorant resources and populations in the central California Current region. Biological Conservation 217:407-418.

Capitolo, P.J., G.J. McChesney, H.R. Carter, M.W. Parker, L.E. Eigner, and R.T. Golightly. 2014. Changes in breeding population sizes of Brandt's Cormorants *Phalacrocorax penicillatus* in the Gulf of the Farallones, California, 1979-2006. Marine Ornithology 42:35-48.

Carle, R., Calleri, D., Beck, J., Halbert, P., and M. Hester. 2017. Depredation by Common Ravens *Corvus corax* negatively affects Pelagic Cormorant *Phalacrocorax pelagicus* reproduction in central California . Marine Ornithology 157: 149-157.

Carle, R., Beck, J., Smith, N., Coletta, E., Calleri, D., and M. Hester. 2016. Año Nuevo State Park Seabird Conservation and Habitat Restoration: 2016. Unpublished Report to California Dept. of Parks and Recreation, Año Nuevo State Park.

Carle, R., Beck, J., Calleri, D., and M. Hester. 2015.Temporal and sex-specific variability in Rhinoceros Auklet diet in the central California Current system. Journal of Marine Systems 146: 99-108. DOI: 10.1016/j.jmarsys.2014.08.020

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

Hester, M.M. 1998. Abundance, reproduction and prey of Rhinoceros Auklet, Cerorhinca monocerata, on Año Nuevo Island, California. Master's Thesis, Moss Landing Marine Laboratories, San Francisco State University, California.

Hester, M. and W. Sydeman. 1995. Año Nuevo Island Seabird Conservation: 1993-1995. Unpublished Report to California State Parks and Recreation, Año Nuevo State Reserve.

LeValley, R. and J. Evans. 1982. The nesting season: middle Pacific coast region. American Birds 36: 1011-1015.

Lewis, D.B. and W.B. Tyler. 1987. Management recommendations for coastal terrace and island resources at Año Nuevo State Park. Unpublished Report to California Department of Parks and Recreation, Año Nuevo State Park. Institute of Marine Sciences, University of California Santa Cruz.

Luckenbach Trustee Council. 2006. S.S. Jacob Luckenbach and Associated Mystery Oil Spills Final Damage Assessment and Restoration Plan/Environmental Assessment. Prepared by California Department of Fish and Game, National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service, National Park Service.

Russell, R. 1999. Comparative demography and life history tactics of seabirds: implications for conservation and marine monitoring. American Fisheries Society Symposium 23:51-76.

Sowls, A.L., DeGange, A.R., Nelson, J.W., and G.S. Lester. 1980. Catalog of California seabird colonies. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program. FWS/OBS 37/80. 371 p.

Thayer, J. and W. Sydeman. 2007. Spatio-temporal variability in prey harvest and reproductive ecology of a piscivorous seabird, *Cerorhinca monocerata*, in an upwelling system. Marine Ecology Progress Series 329:253-265.

Tyler, W.B., and K.T. Briggs. 1981. Birds. *In* The Natural History of Año Nuevo (B.L. LeBoeuf and S. Kaza, Eds.). The Boxwood Press, Pacific Grove, CA.

Warzybok, P., Santora, J., Ainley, D., Bradley, R., Field, J., Capitolo, P., Carle, R., Elliott, M., Beck, J., McChesney, G., Hester, M., and J. Jahncke. 2018. Prey switching and consumption by seabirds in the central California Current upwelling ecosystem: Implications for forage fish management. *Journal of Marine Systems* 185:25-39.

Weinstein, A., Trocki, L., LeValley, R., Doster, R.H., Distler, T., and K. Krieger. 2014. A first population assessment of black oystercatcher *Haematopus bachmani* in California. Marine Ornithology 42:49-56.

Appendix 1. Año Nuevo State Park Seabird Program Resources: Articles, Videos, Outreach - 2016 to 2018

Oikonos' mission includes sharing knowledge gained through our conservation projects with diverse audiences and engaging communities. Oikonos and partners created the following products in 2016 - 2018 with in-kind and matching support:

Project Website
http://oikonos.org/ano-nuevo-island/

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

Public Outreach

- Radio
  - ***Año Nuevo Island is off-limits to humans- but not these scientists***— produced by Claire Stremple, KALW Radio – September 2017
- Informational Booth
  - Patagonia Santa Cruz Environmental Community Night—March 2017
- Project Presentation
  - Patagonia Santa Cruz—November 2017

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

Ainley, D.G., Santora, J.A., Capitolo, P.J., Field, J.C., **Beck, J.N., Carle, R.D., Donnelly-Greenan, E.,** McChesney, G.J., Elliott, M., Bradley, R.W., Lindquist, K., Nelson, P., Roletto, J., Warzybok, P., **Hester, M.,** and J. Jahncke. 2018. Ecosystem-based management affecting Brandt's Cormorant resources and populations in the central California Current region. Biological Conservation 217:407-418.

Warzybok, P., Santora, J., Ainley, D., Bradley, R., Field, J., Capitolo, P., **Carle, R.,** Elliott, M., **Beck, J.,** McChesney, G., **Hester, M**., and Jahncke, J. 2018. Prey switching and consumption by seabirds in the central California Current upwelling ecosystem: Implications for forage fish management. Journal of Marine Systems 185:25-39.

Carle, R., Calleri, D., Beck, J., Halbert, P., and **Hester, M**. 2017. Depredation by Common Ravens Corvus corax negatively affects Pelagic Cormorant Phalacrocorax pelagicus reproduction in central California. Marine Ornithology 157: 149-157.

Carle, R., **Beck, J., Calleri, D.,** and **M. Hester**. 2015. Variability in seasonal and sex-specific diet in Rhinoceros Auklets in the central California Current system. Journal of Marine Systems 146:99-108.

Scientific Presentations

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

Presentations entitled:

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 Docent Outreach

Año Nuevo bird training presentation by Jessie Beck, November 2018

Año Nuevo bird walk by Ryan Carle, September 2017

University and High School Guest Lectures

Guest lecture at Pajaro Valley High School, January 2016

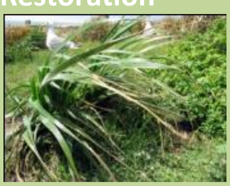
Guest lecture to UC Santa Cruz Restoration Ecology class, Winter Quarter 2016

Meetings

California Seabird Coordination Meeting, annually 2010-2019

Santa Cruz Seabird Coordination Meeting, December 2016

Appendix 2. – Habitat Restoration Accomplishments 2009 - 2018

Activity	2009	2010	2011 - 2018
Habitat Ridge 	✓ Created *Ridge* designs ✓ Built prototypes on the mainland ✓ Installed a temporary barrier on the island	✓ Removed and cut 850 Eucalyptus poles ✓ Transported poles by landing craft ✓ Built 400 ft. of the *Ridge* (85% completed)	✓ Removed and cut 150 Eucalyptus poles ✓ Transported all materials by small boat ✓ Completed the *Ridge* to 6 ft. in all areas ✓ Completed yearly maintenance work
Nest Modules 	✓ Held 4 design meetings ✓ Planned the CCA college course	✓ CCA students designed and created prototypes ✓ Installed five underground in the nesting habitat	✓ CCA ceramicists produced 95 Rhinoceros Auklet modules ✓ Installed 95 in the restoration area ✓ Monitored nesting success in modules ✓ Held CCA college course focused on Cassin's Auklets ✓ Prototyped Cassin's Auklet modules ✓ Created and deployed Cassin's Auklet module designs
Plant Restoration 	✓ Propagated, collected and grew native species in Go Native's greenhouse ✓ Patched sensitive areas with erosion control	✓ Transported all materials and gear to the island via landing craft ✓ Seeded and planted 10,000 grasses and shrubs ✓ Stabilized area with erosion control material ✓ Installed temporary	✓ Planted 12,000 grasses and shrubs in selected areas ✓ Seeded with native species ✓ Raised boardwalks ✓ Weeded invasive plants

		irrigation	

Map: The central terrace (green shading) was selected for restoration because it harbors the majority of the burrowing seabirds and the highest elevation with soil on the island. The target area was approximately one acre. The Habitat Ridges create the southern and northern border of the planted area. In 2011-2018, we expanded the restoration treatments to an additional 0.25 acres where Cassin's Auklet nesting is concentrated (not shown above).

Further Restoration Information

To learn more about the historic details about Habitat Ridge construction, nest module developments, and vegetation management, please see our 2016 Annual Report.