Año Nuevo Island Seabird Habitat Restoration Final Report: 2009 - 2011

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Summary

The main goal of the Año Nuevo Island Seabird Habitat Restoration Project is to **increase the number of breeding Rhinoceros Auklets** on Año Nuevo Island by restoring and creating stable breeding habitat. The habitat restoration efforts were successfully completed during 2009 – 2011, accomplishing three core objectives:

1. **Protection**: To protect the seabird nesting area from destructive trampling by California sea lions, we designed and built an innovative *Habitat Ridge*.

2. **Nest Modules**: To provide stable and low maintenance auklet nesting sites, we designed, produced and installed 87 clay nest modules.

3. **Restoration**: To stabilize the burrow habitat and improve nesting success, we installed over 14,000 native coastal grasses and shrubs.

Partnerships

This project is a collaborative, multi-disciplinary endeavor managed by **California Department of Parks and Recreation, Año Nuevo State Reserve, and led by Oikonos - Ecosystem Knowledge, Go Native and Rebar**. In 2009-2011, the other key partners were **California College of the Arts, Nathan Lynch, and UC Natural Reserve System** (see *Acknowledgements* page 16 for personnel).

In addition to the key project staff and partners who donated free time and inkind resources, this project was dependent on extensive volunteer skills and energy. In 2009-11, over 110 volunteers helped with the habitat restoration and seabird studies.

Funders

In 2009-11, direct funding was provided by the **USCG National Pollution Fund Center** for oil spill mitigation actions managed by the **Luckenbach and Command Oil Spill Trustee Councils.** Direct matching was awarded by the **Creative Work Fund,** a program of the Walter and Elise Haas Fund, supported by the William and Flora Hewlett Foundation and The James Irvine Foundation. **All partners** above provided substantial matching support and other donors included Peninsula Open Space Trust, Patagonia, and USGS. We also acknowledge the Coastal Conservancy for funding the pilot work and initial restoration efforts from 2003 - 2005.

Introduction & Methods

Restoration Area

The main objectives of this project are to mitigate injuries to seabirds from oil contamination and protect biodiversity on Año Nuevo Island. Mortality to Rhinoceros and Cassin's Auklets by oil contamination from leakages of the sunken *S.S. Jacob Luckenbach* and other mystery spills off the coast of San Mateo County, California, were estimated to be 593 and 1,509 adults, respectively, from 1990 to 2003 (Luckenbach Trustee Council 2006).

After a public review process, the Trustee Council determined that damages could be addressed by restoration efforts that improve auklet reproductive success at Año Nuevo Island. If no action was taken, the breeding colony would likely decline rapidly due to soil erosion. Thus, the restoration benefits are derived from the difference between modest colony growth versus loss of the colony without the project.

Año Nuevo Island was selected for the following reasons: it is the closest colony to the leaking vessel, oiled Rhinoceros Auklets were documented on the colony, the island is free from introduced predators, and public access is not permitted. No other significant predator-free habitat will exist in the region to support Rhinoceros Auklets if this colony becomes uninhabitable.

The central marine terrace was selected for restoration because it harbours the majority of the burrowing seabirds and the highest elevation with soil on the island. The target area was approximately one acre. In 2011, we expanded the restoration treatments to an additional 0.25 acres where Cassin's Auklet nesting is concentrated (not shown above).

Rhinoceros Auklets naturally began colonizing the island in the early 1980s (Lewis and Tyler 1987) and Cassin's Auklets in the mid 1990s. Given the highest density of burrows in prime habitat on Año Nuevo Island (1 burrow per 6 meter squared), the restoration area could potentially support four times the current population of Rhinoceros Auklets (~ 900 breeding birds). Prior to 2003, the colony was increasing (*Population Graph* on page 11), underscoring the potential for population growth when habitat quality is improved.

In 2011 the estimated island-wide population of Cassin's Auklets was 52 breeding birds, the highest number on record. While most of the Cassin's Auklets currently nest in central terrace areas outside the priority restoration plots, in 2011 four pairs bred in the planted areas with Rhinoceros Auklets (*Nesting*

Activity map page 14). In addition, Cassin's Auklets experienced high breeding success in 2010 and 2011 indicating the potential for further population growth in response to restoration.

The restoration project will also improve nesting conditions for three other seabirds species injured by oil pollution: Pigeon Guillemot, Western Gull, and Brandt's Cormorant. In addition to the threats that Año Nuevo Island seabirds encounter at sea (oil pollution and reduced prey availability), their main threats on the colony are soil erosion, human disturbance, sea lion trampling, and inter-species interference for nesting space. This project will reduce all four of these colony threats by stabilizing the soil with a native plant community, designing variable habitat structure to reduce direct conflict among species, preventing California sea lion access to prime burrow nesting space, and creating visual barriers to protect wildlife from human disturbances.

Accomplishments

Activity	2009 Contract 2008-073-012 + 022	2010 Contract 2008-073-022 + 038	2011 Contract 2008-073-050
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
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 90 modules ✓ Installed 87 in the restoration area ✓ Monitored nesting success in modules
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 irrigation	✓ Planted 4,000 grasses and shrubs in selected areas ✓ Seeded with native species ✓ Weeded invasive plants

Other annual activities completed (2009 – 11):

1. Measured Vegetation Composition
2. Measured Seabird Breeding Response
3. Coordinated and Trained Volunteers
4. Managed Boat Operations
5. Maintained Island Field Station
6. Tested for the Mice Presence
7. Coordinated Partners
8. Managed Permitting

Photo: Ryan and Jessie collecting vegetation cover data to quantify restoration progress.

Habitat Ridge

The first objective of the restoration project was to safely exclude California sea lions from the burrow nesting area while creating additional seabird nesting habitat. This was accomplished by the construction of a modular *Habitat Ridge* structure around the restoration area. The total linear length of the *Habitat Ridge* is approximately 440 feet in variable sections (photo below). The height is between 6-7 vertical feet, enough to prevent male California sea lions from making purchase with their fore flippers. No marine mammals pup in the restoration area (central terrace), so this project will not negatively impact these populations.

Photo: Habitat Ridge built across the North Terrace with California Sea Lions in the background.

We carefully chose locally sourced, bio-degradable, and site sensitive construction materials for the *Ridge*. The final design was built entirely from Eucalyptus logs, wooden dowels, and installed on the island in October-November 2010 and 2011. When the lifespan of the *Ridge* has expired, these materials will become driftwood rather than toxic trash. The materials and design also match the color and contours of the island, making the *Ridge* blend in from the mainland. We constructed four gates for human access with reclaimed redwood and recycled stainless steel hinges (the only metal used in the entire *Ridge*) forged by master blacksmith David Calleri.

Designing and building this unique structure required extensive efforts spanning four years. Ridge prototypes were developed on the mainland at a site provided by the Peninsula Open Space Trust. Go Native, Rebar, Oikonos, and volunteers experimented for a year before deciding on the final Ridge design. The Santa Cruz District State Parks natural resource crew cut over 1,000 eucalyptus logs from the

Habitat Ridge Innovations

- Built a strong barrier made of biodegradable recycled materials
- Wind blows through the structure to reduce scour and erosion
- Adaptable, modular design for variable slopes and topography

Año Nuevo watershed. We transported materials, tools and people to the island using a landing craft and small inflatable zodiacs.

In the year since installation, the *Habitat Ridge* has been proven to be effective. There have been zero sea lion intrusions into the restoration area, no wildlife injuries, and no design concerns associated with the structure. In 2011 Brandt's Cormorants nested against the outside wall of the southern portion of the *Ridge*, taking advantage of the visual barrier from human activity that it provides.

Nest Modules

We replaced wooden nest boxes with 87 clay nest modules for Rhinoceros Auklets that are able to withstand trampling by sea lions, require minimal maintenance, and allow researcher access to the nest cavity. The modules augment existing breeding habitat by acting as 'permanent' nest sites below ground. Over the last 13 years, we have documented that Rhinoceros Auklets will successfully raise young in artificial nests on Año Nuevo Island (*Occupancy Graph* page 12). The design of the new clay modules addressed the problems with previously used wooden and plastic boxes that required regular maintenance, were prone to flooding and high temperatures, and had a short lifespan (3 - 5 yrs).

Nest Module Innovations

- Responsible materials—built entirely of clay
- Transportable by small boat and carried by hand
- Un-crushable by occasional sea lion trampling
- Mimics natural burrow qualities
- Life span 15+ years

Photo: The CCA students and instructors remove the plaster from a clay module before firing.

In the spring semester of 2010, an interdisciplinary design course at the California College of the Arts in Oakland (CCA) was taught by project partners Nathan Lynch and Rebar with the goal to design, create, and deploy a new, sustainable, reproducible system of nest modules. The modules were built using clay-based "grog" - a strong, porous type of clay that has the consistency of sand. Nathan Lynch, the chair of the CCA Ceramics Department, provided matching support in the form of ceramic studio access, mold materials, and significant kiln costs for firing 90 large modules (reserving some for outreach).

Five nest module prototypes designed by students in the class were installed in April 2010 in the restoration area. A pair of auklets successfully fledged a chick in one of the prototypes in summer 2010, demonstrating that the modules are suitable breeding sites. One design was created incorporating the best ideas from the prototypes and consisted of a curved nest chamber and a detachable entrance tunnel. A two-piece design was decided on for ease of transport and adaptability in sloping terrain. We installed 87 underground in the restoration area in November 2010.

Because Rhinoceros Auklets often breed in the same burrow in consequtive years, we installed the clay modules in the exact locations of old nest boxes if at least one replacement criteria was met:

i. The nest box was occupied in 2010
ii. At least 2 chicks fledged in the last five years
iii. Breeding activity in the last 2 years and at least one chick fledged in the last 5 years

If old nest box sites did not meet any of these criteria, it indicated that the site had poor productivity and we would not be disrupting a pair bond by removing it. We also selected new locations for the extra modules in given areas proportional to the density of natural burrows. We will document occupancy and reproductive performance for at least eight years to evaluate the success of these modules as quality nesting sites for Rhinoceros Auklets.

In 2011, 31 pairs of auklets laid eggs in the modules, and 90% of the modules contained fresh nesting material brought in by the birds. We expect module occupancy to increase as the birds adapt to the habiat changes. See *Rhinoceros Auklet Results* section below for further clay module results.

Photo: The final Rhinoceros Auklet nest module design installed underground on Año Nuevo Island.

Burrow Nesting Habitat Restoration

For three years (2002 to 2005), we experimented with plant species, erosion control, and irrigation methods on Año Nuevo Island to meet restoration goals, taking into account the variable winds, salt influence, and resilience to periodic trampling, growth season, water requirements, and logistical constraints of the field site. Based on these results, we refined the techniques to stabilize the Rhinoceros Auklet burrowing habitat (see *Treatment Methods* page 7) and conducted the first plantings in 2004 and 2005.

Photo: American dune grass (Elymus mollis) growing in Go Native's greenhouse in preparation for island restoration. This is one of the key native plants adapted to salt, wind and excellent at stabilizing loose sandy soil.

In support of the current effort, from 2008 to 2011 Go Native propagated and grew plants at their nursery in Pacifica, CA. We collected seed at Año Nuevo State Reserve and nearby coastal dunes. We initiated the full scale habitat work after seabirds and marine mammals finished raising young in October 2010. Once the Habitat Ridge was constructed to a sufficient height, it was safe to transport and install the 10,000 native grasses and shrubs in November 2010. In 2011, we augmented the entire area with native seed and added an additional 4,000 plants to selected areas. In addition, we expanded treatments into areas where Cassin's Auklet nesting density was higher and where plants were more protected from weather to serve as a local seed source (an additional approx. 0.25 acres).

Transplants in 2010 were helped along by a wet winter, and many species sprouted and survived from seed. Positive impacts of soil stabilization were quickly evident by the low incidence of burrow erosion during the 2011 breeding season (see *Documenting Success* page 7). In November 2011 we adapted the planting techniques, plant species, and locations as necessary and filled in the remaining bare patches with plants and seed. An interesting indicator of success was that we began removing non-native plant species. In previous years, even weeds

considered invasive on the mainland were allowed to remain on the island to slow erosion. We now need to remove these species so they do not compete with native plants more adapted in the long-term to the island environment.

Habitat Stabilizing Treatment Methods

1. Planted mature native grasses every 1 - 2 foot on center: salt grass (*Distichlis spicata*) and American dune grass (*Elymus mollis*) are the core stabilization ground cover
2. Planted native shrubs and spread native seed in site-specific areas (see Appendix I for species list)
3. Applied sterile barley seed for temporary and rapid soil stability
4. Distributed straw over seeds and plants to hold moisture and provide temporary structure
5. Wrapped biodegradable erosion control matting on top of the plant and seed layer
6. Installed a temporary manual irrigation system to safely water the restoration plots without disrupting breeding birds
7. Created edges and burrow-starts to encourage new prospecting breeders (recruitment)
8. Opened holes in erosion control material so established breeders can access their burrows (auklets usually return to the same nest site in consecutive seasons)

Documenting Success

The 2011 season was the 19th consecutive year of long-term seabird studies at Año Nuevo State Reserve (initiated by ANSR and PRBO Conservation Science in 1993). It is advantageous to have this quality of baseline data to study response of a restoration effort. The four main pre and post metrics we measured to determine the success of the restoration annually included:

1. Nesting attempts damaged by erosion (burrow-nesting seabirds)
2. Vegetation cover in burrow-nesting areas
3. Adult breeding population trends (Rhinoceros and Cassin's Auklets)
4. Nesting success metrics (Rhinoceros and Cassin's Auklets)

Burrow Damage Metric

Description: The purpose of the burrow damage metric is to quantify the incidence and severity of direct damage to nesting burrows by soil erosion annually. This burrow damage metric is ideal because the response to habitat stability improvements to nesting birds is immediate showing results within the span of short grant cycles.

Method: We recorded the burrow number, erosion type and severity codes, and any injury to adults or chicks on a weekly basis for all active (open) burrows in the central terrace restoration area from April through July.

Results: From 2002 to 2004, we implemented restoration experiments that enhanced the survival of native plants and reduced the rate of burrow collapse during the incubation and chick-rearing periods (*Burrow Damage* table below). In the four years prior to the pilot restoration (1998 – 2001), when the habitat was virtually denuded, the percentage of active burrows damaged ranged from 37% to 61% (*Burow Damage* table below), sometimes resulting in the death of an adult or chick.

In the fall of 2005, California sea lion abundance was the highest on record and the animals expanded their usual haul out distribution to the center of the island and damaged the first planting efforts. While plant growth was severely stunted in most areas, the remaining erosion control material and patches of resilient salt grass in the most dense burrow areas helped stabilize nest cavities and limit damage (2008 - 2009 shaded brown in *Burrow Damage* table below).

Results from the last two years of restoration (2010 – 2011) show a direct and positive response to habitat stabilization efforts. We expect the incidence of three damaged nesting burrows a year to be a realistic goal of success given the sandy soil and sporadic gale force winds.

Incidence of Rhinoceros Auklet Burrow Collapse During the Breeding Season on Año Nuevo Island

Year	Total Damaged Burrows	Occupied Burrows Damaged	Total Burrows	Total Occupied Burrows	Percent All Burrows Damaged	Percent Occupied Burrows Damaged
1998	29	24	69	50	**42%**	**48%**
1999	34	28	81	59	**42%**	**47%**
2000	42	33	63	54	**67%**	**61%**
2001	28	23	67	63	**42%**	**37%**
2004	12	10	100	67	**12%**	**15%**
2005	1	1	94	48	**1%**	**2%**
2008	7	7	88	74	**8%**	**9%**
2009	13	10	84	75	**15%**	**13%**
2010	8	unk	71	58	**11%**	**unk**
2011	3	3	91	74	**3%**	**4%**

The percentage of damaged burrows was calculated for only those nesting sites active during incubation "total burrows". The number "occupied" was determined by applying the breeding correction factor to represent the proportion that contained an egg or chick. A burrow was recorded as damaged if the tunnel or nest cavity was crushed, if a hole was found in the burrow, or if severe erosion was found at the entrance twice or more. In 2010, we did not have a functioning burrow camera until hatching time so the number "occupied" was unknown.

Vegetation Metrics

Description: The purpose of the vegetation metrics are to quantify the growth of stabilizing plant cover in the restoration area. Root structure in the sandy soil will improve the ability of auklets to dig protective burrows and withstand extreme wind events without collapse. A main objective was to encourage a mostly native plant community to improve natural resilience. While non-native species can improve soil stability as well, on Año Nuevo Island in past years, invasive plants (i.e. *Tetragonia* (New Zealand spinach) and *Malva* species) have suffered dramatic die offs.

Method: We conducted three surveys quantifying plant species composition in restoration areas in May, July, and October 2010 and 2011 (also in previous years 2003, 2004, 2005). All eight historical planting areas (table below) and three new areas were described by quantifying percent cover and average height by plant species. Leaf litter and bare categories were also recorded.

Results: Prior to the plant installments in November 2010, vegetation cover was between zero and 15% in the central terrace nesting areas. The most recent survey (conducted 1 November 2011) documented percent cover of live vegetation was over 35% in all areas (minimum 36% and maximum 81%, *Plant Cover* table page 10). The two areas with the highest density of Rhinoceros Auklet nests (Areas 5 and 7) had 56 and 81% coverage of live plants.

This high level of survivorship and growth after only 12 months exceeded our expectations based on previous planting efforts. This region experienced above average rain fall spread throughout the 2011 water year (over 40 inches between October 2010 – September 2011; www.cnrfc.noaa.gov). These conditions certainly contributed to the high plant growth and gave the restoration project with a solid start.

Photo: The restoration plot on Año Nuevo Island with the highest density of Rhinoceros Auklet burrows (Area 5) in November 2011. The dominant native vegetation was dune grass (34%) and salt grass (24%).

Fall 2011 Estimated Percent Cover by Plant Species Group ± Standard Error

Nesting Area*	Total % Alive Cover	Salt Grass	Dune Grass	Other Natives	Temporary Barley Treatment	Non-natives	Leaf Litter	Bare
1	53	4 ± 1	18 ± 5	6 ± 3	11 ± 3	17 ± 5	8 ± 3	42 ± 6
2	40	2 ± 1	1 ± 0	3 ± 2	30 ± 4	5 ± 1	7 ± 2	54 ± 5
2.1	59	14 ± 6	12 ± 4	4 ± 2	16 ± 4	17 ± 4	8 ± 2	36 ± 7
3	36	3 ± 1	0	0	20 ± 3	15 ± 4	15 ± 4	52 ± 6
2.2	59	19 ± 9	6 ± 5	0	32 ± 8	3 ± 1	8 ± 2	35 ± 10
4	65	37 ± 8	7 ± 4	4 ± 2	11 ± 2	9 ± 3	10 ± 2	27 ± 6
5	81	24 ± 5	34 ± 6	0	7 ± 2	22 ± 5	4 ± 1	16 ± 4
7	56	8 ± 4	21 ± 9	1 ± 1	22 ± 7	6 ± 2	16 ± 5	29 ± 7

* Areas are not equal in size

Seabird Breeding Metrics

Description: The purpose of the seabird breeding metrics are to quantify population growth and reproductive success of burrowing auklets following habitat improvements. 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 (Thayer 2009). While we do not expect to see significant increases in population size for several years, annual metrics are necessary to understand how variability in environmental conditions might be influencing seabird responses.

Method: We monitored the nesting activity and reproductive success of Rhinoceros Auklets and Cassin's Auklets (as well as other species not reported here) in the central terrace one or two days a week from February through August (2009 – 2011). We used a wireless burrow camera (*Pukamanu* 2.2, designed and created in 2010 by Oikonos and Abyssal Hawaii) to view the contents inside natural burrows without damaging nests. We recorded the presense of incubating adults, eggs, and chicks. The wooden boxes and clay modules were checked through a lid in the top allowing access to see nest contents, read adult bands and weigh chicks.

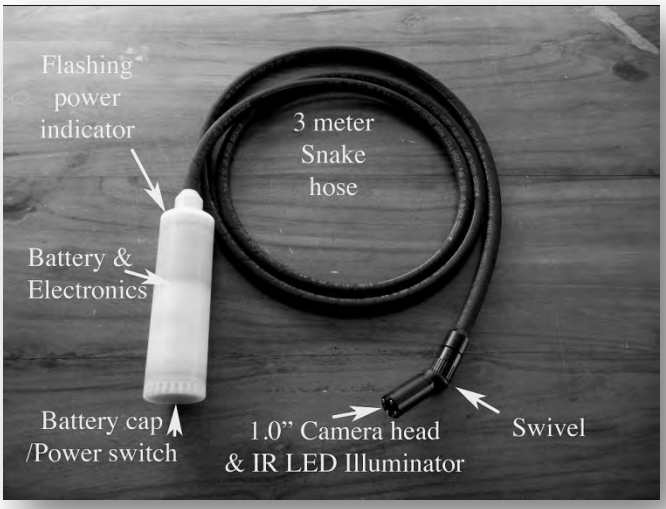
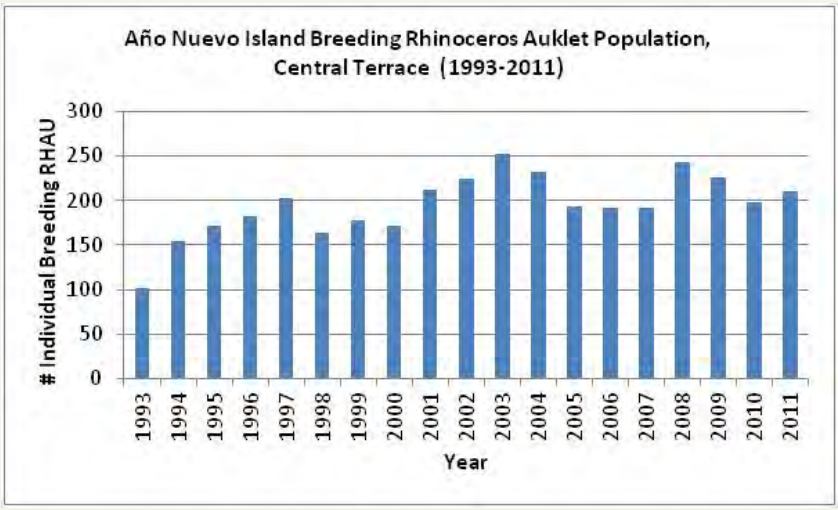


Photo: The Pukamanu wireless burrow camera was used to monitor underground seabird burrows. Designed by Mark Yarbrough, Abyssal Hawaii and Oikonos.

Rhinoceros Auklet Results:

Population Size

The estimated annual population of breeding Rhinoceros Auklets in the restoration area (central terrace) was 226 in 2009, 198 in 2010, and 210 in 2011. The central terrace population grew from 102 birds in 1993 to 212 birds in 2001, and then fluctuated at around 200 birds. In the period from 2002 to 2011 the population minimum was 192 in 2006 and 2007 and the maximum was 252 in 2003.



Rhinoceros Auklets were first documented breeding on Año Nuevo Island in 1982. Since then the population has increased and fluctuated annually. The estimated total island breeding population in 2011 was 242 birds (210 in the restoration area or central terrace shown in the trend graph above).

Nesting Success

From 2009 – 11, an estimated 165 fledged chicks were produced in the restoration area (90% of the entire island population). In 2011, 74% of the pairs that incubated an egg successfully raised their chick to 40 days old and mostly feathered (considered fledged). This was well above the long term average (1995-2011) of 60% productivity in burrows (± 17% SD).

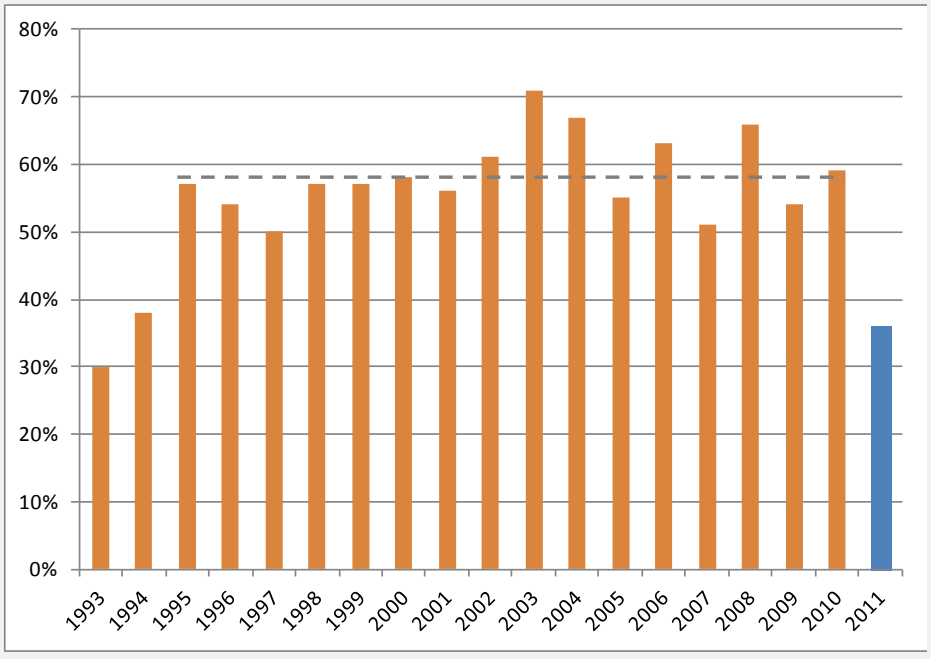
To monitor the success of clay modules used for the first time in 2011, several parameters were documented (*Clay Module* table page 12). We were encouraged by signs of significant prospecting, with fresh nesting material found in 91% of the modules. While the number of chicks that survived in modules was below that in natural burrows, the main contributing factor was poor growth after hatching. Lower productivity was expected in the first years after installation when birds are still adapting to the new breeding sites and habitat alterations from planting and erosion control applications. Moreover, these birds might be younger, less experienced, and/or breeding with a new mate.

When the wooden nest boxes were first installed in 1993, productivity of pairs using these new boxes took three years to match that of pairs in burrows (*Occupancy Graph* page 12). We expect

that occupancy in the modules will eventually meet or exceed the 16-year mean of 58% (± 6% SD) in the wooden boxes resulting in at least 100 adults attempting to breed annually in modules.

Clay Modules 2011 Rhinoceros Auklet Nesting Activity Parameters	
Active (nest building)	91 % (79/87 modules with nests built in 2011)
Breeding	31 pairs laid eggs in modules
Hatching success	66 % successfully hatched a chick
Fledging success	31 % of pairs raised their chick to a stage of 40 days old and mostly feathered

Percent Occupancy of Nest Boxes and Modules by Breeding Rhinoceros Auklets on Ano Nuevo Island from 1993 - 2011



Previously there were 70 nest boxes on the island built with wood and plastic tubes that needed replacement every 1-3 years due to moisture and trampling. These artificial sites have been occupied by breeding Rhinoceros Auklets from 1993 to 2010 (orange bars) with similar reproductive success as natural sites. In 2011, all boxes were replaced with 87 new clay modules and 31 Rhinoceros Auklets attempted to breed in the first year (blue bar). We expect occupancy in the clay modules to meet or exceed the 16-year mean of 58% (dashed line) in three to four years.

Productivity per pair (burrows and artificial sites combined) fluctuated during the project period at least in part due to prey resources. In 2010, juvenile rockfish (*Sebastes* species) dominated chick diet and the combined reproductive success was 0.59 chicks per pair. This was above the 16-year mean (1995-2011) of 0.55 chicks (± 0.12 SD).

Photo: Rhinoceros Auklet chicks can be distinguished from other young alcids by the small immature horn structure on the upper bill.

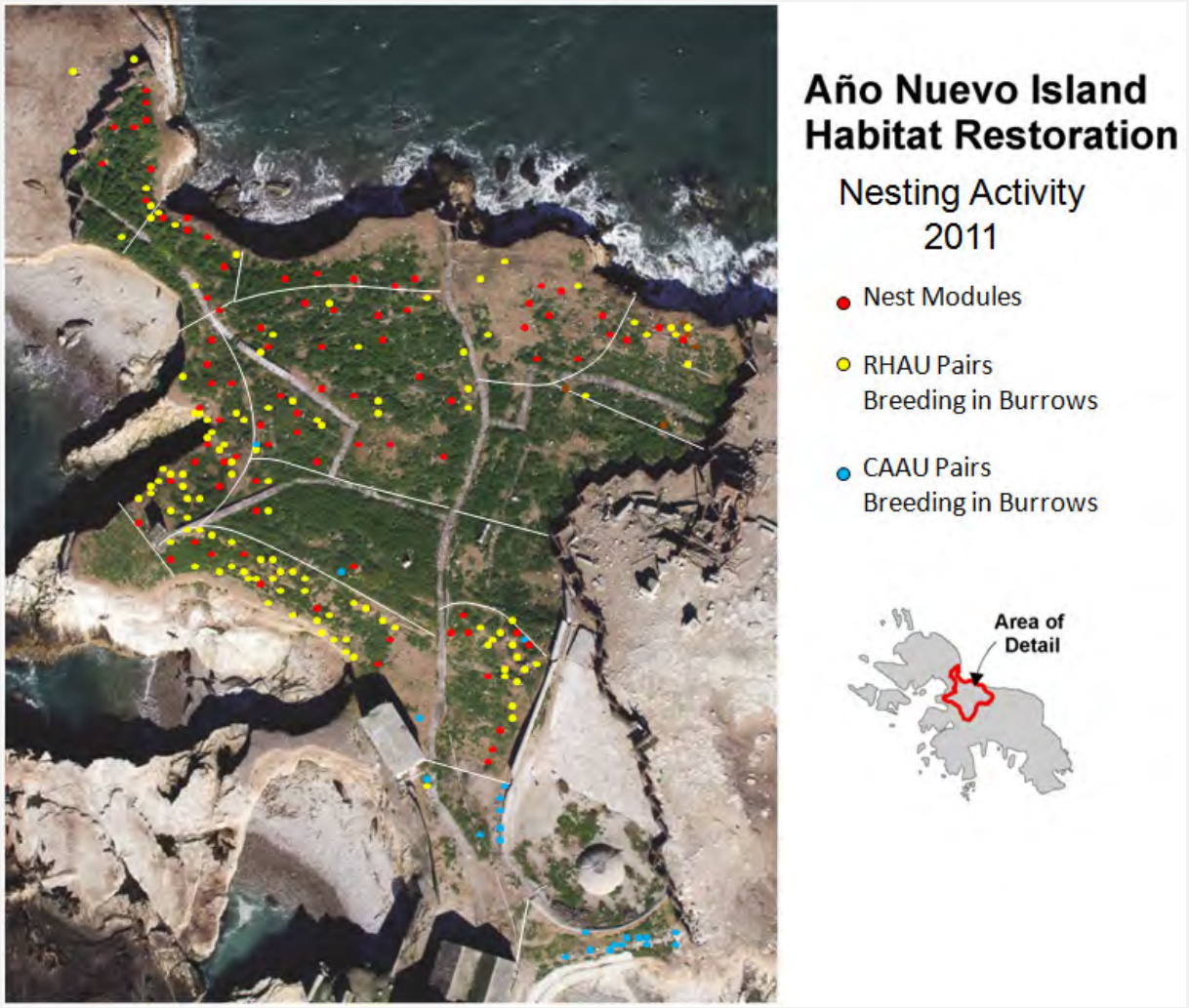
In contrast, less than half the pairs that attempted to breed in 2009 successfully fledged a chick (43%). The 2011 combined productivity was confounded by above average success in burrows and low chick survival in the modules. The availability of their preferred high caloric chick prey (Northern anchovy or juvenile rockfish; Thayer et al. 2007) appeared to be lacking in both these years. Parents fed chicks a high diversity of alternative prey in 2009 and a diet dominated by squid in 2011. Chick growth is often slow and compromised by a diet of squid instead of fish, but we were not able to weigh chicks inside fragile burrows, therefore only by studying pairs breeding in modules can we measure chick condition.

Given adequate prey resources during chick rearing, we expect a moderate increase in the number of Rhinoceros Auklet chicks produced on Año Nuevo Island within four years as pairs in modules gain nesting experience and the increasing plant community attracts more recruits.

Cassin's Auklet Results:

Cassin's Auklets were first found breeding on Año Nuevo Island in 1995. The population grew slowly initially but in recent years the growth rate increased and reached 52 breeding adults (44 in the central terrace) in 2011. In both 2010 and 2011, several Cassin's Auklet pairs successfully raised two consecutive chicks (termed double-clutching). This is an uncommon breeding strategy in marine birds, and allows for greater population growth in years with favorable breeding conditions. The double-clutching and the high productivity per breeding pair (100% in 2010, and 68% in 2011), indicated sufficient availability of krill for this small colony and possible growth in the future.

Photo: Cassin's Auklet chicks are roughly half the size and weight of Rhinoceros Auklets and are fed primarily euphausids by their parents.



Burrow-nesting auklets are distributed throughout the central terrace with higher concentrations along the windward cliffs and edges. Note that while Cassin's Auklet (blue dots) and Rhinoceros Auklet (yellow dots) have distinct nesting areas there was overlap. The nest modules (87) were placed in existing breeding sites and new locations (red dots). The restoration treatments were applied between the southern (right side) and northern (top left) *Habitat Ridges*.

Dissemination and Outreach

Oikonos' mission includes sharing knowledge gained through our conservation projects with diverse audiences and engaging communities. Oikonos and partners created the following products in 2009 - 2011 with all inkind and matching support:

- Two Project Videos
  - A Plan Was Hatched produced by Lloyd Fales and Peck Ewer, Swell Pictures *http://www.anonuevoisland.org/video/restoring-an-island*
  - Students Design Auklet Nests produced by a CCA Student, Justin Holbrook *http://www.anonuevoisland.org/video/cca-engage-students-design-auklet-nests*
- Project website, gallery and blog AnoNuevoIsland.org
- California College of the Arts, Engage Program "Designing Ecology" Course Article
- Project outreach to urban communities through the ENGAGE program at the Center for Art and Public Life at the California College of the Arts.
- Bay Nature Magazine "Art for Auklets"
- Real-world Art School – article in American Craft Magazine
- Not Your Average Birdhouse, UC Santa Cruz Science Communication Blog
- Rebar's Doxa, blog about the restoration
- Habitat Restoration: One Bird At a Time, Moss Landing Marine Lab blog
- ANSR Docent and Volunteer Training Presentations
- Luckenbach Trustee Council Newsletters

Art by Sonja Murphy, CCA Student

Scientific Presentations

Pacific Seabird Group – February 2010, Long Beach, CA

Presentation entitled:
DESIGNING ECOLOGY: RECONSTRUCTING SEABIRD HABITAT ON AÑO NUEVO ISLAND

Future

In 2012, Oikonos and partners will focus on documenting the success of restoration efforts that will include conducting studies to quantify the response of the flora and fauna to the improvements in habitat quality. We will measure native plant cover, erosion rates, and breeding success in relation to habitat characteristics of three focal seabird species: Rhinoceros Auklet, Cassin's Auklet, and Western Gull.

Future project activities will provide exciting insight into the success of the soil stabilization, clay nest modules, and the *Habitat Ridge*. Given the lack of similar restoration efforts on offshore islands, it is our hope that the knowledge gained during this project can be applied to other islands that have degraded habitat from human use and/or introduced species and are in need of restoration to conserve wildlife populations.

Acknowledgements

The successes and accomplishments described in this report are just a sample of the contributions made by the talented and dedicated individuals from many disciplines that helped the project between 2009 and 2011 (key personnel listed below). We are grateful for the over 100 volunteers who gave their expertise and muscles to the effort. In addition, we thank the Luckenbach Trustee Council members for their hard work securing funding for seabirds killed by oil pollution, the crew at Parker Diving for safe Landing Craft operations, and Lloyd Fales, Peck Ewer and Justin Holbrook for creating the project videos. We acknowledge the staff and volunteers who began the initial restoration work in 2004 – 05 and on whose shoulders we stand.

Key Project Personnel

Oikonos	***Go Native***	***Rebar***	***CCA***	***CA State Parks***	***UCNRS***
Josh Adams	Juan Arevalos	Teresa Aguillera	Kolle Kahle	Ziad Bawarshi	Pat Morris
Jessie Beck	Mario Aquino	John Bela	Nathan Lynch	Portia Halbert	Guy Oliver
David Calleri	Javier Castro	Blaine Merker	Sonja Murphy	Mark Hylkema	
Ryan Carle	Gillberto Chompa	Matthew Passmore	Carlos Ramirez	Paul Keel	***PRBO***
Phillip Curtiss	Shawn Dardenelle	Josh Berliner	Nathan Ring	Terry Kiser	Sara Acosta
Michelle Hester	Francisco Haro		Vlad Vladimir	Chris Spohrer	
Josie Moss	Chuck Kozak			Gary Strachan	
Julie Thayer	Carlos Rangel			Docents	
	David Sands			Natural Resource Crew	

Supporting Materials

High resolution images showing the progress of the restoration that can be downloaded and used for non-commercial purposes from this online album:

- http://www.anonuevoisland.org/photo/albums/restoration-slideshow

Two project videos created by Swell Pictures and a CCA Student can be viewed and shared online:

- http://www.anonuevoisland.org/video/restoring-an-island
- http://www.anonuevoisland.org/video/cca-engage-students-design-auklet-nests

Links to articles and other outreach products are presented above in the **Dissemination and Outreach** section.

Literature Cited

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Appendix I. Plant Species List

Native San Mateo County coast species planted or seeded on Año Nuevo Island in 2010 and 2011 to stabilize the soil and encourage a resilient plant community.

Transplants

Key Species

Ambrosia chamissonis	Beach Bur
Baccharis pilularis	Coyote Bush
Distichlis spicata	Saltgrass
Elymus mollis ssp. mollis	American Dune Grass
Eriophyllum staechadifolium	Lizard Tail

Species to build biodiversity

Achillea millefolium	Common Yarrow
Calystegia soldanella	Beach morning glory
Camissonia cheiranthifolia	Beach Evening Primrose
Ericameria ericoides	Mock Heather
Erigeron glaucus	Seaside Daisy
Eriogonum latifolium	Coast Buckwheat
Fragaria chiloensis	Beach Strawberry
Grindelia stricta var. stricta	Coastal Gum Plant
Juncus patens	Common Rush
Lasthenia maritima	Maritime Goldfields
Mimulus guttatus	Seep Monkey Flower
Salix lasiolepis	Arroyo Willow
Schoenoplectus pungens	Common Threesquare
Spergularia macrotheca	Sticky Sand Spurry
Tanacetum bipinnatum	Dune Tansy

Seed

Abronia latifolia	Yellow Sand Verbena
Achillea millefolium	Common Yarrow
Ambrosia chamissonis	Beach Bur
Baccharis pilularis	Coyote Bush
Camissonia cheiranthifolia	Beach Evening Primrose
Dudleya farinosa	North Coast Dudelya
Elymus triticoides	Beard-less Wild Rye
Ericameria ericoides	Mock Heather
Erigeron glaucus	Seaside Daisy
Eriogonum latifolium	Coast Buckwheat
Eriophyllum staechadifolium	Lizard Tail
Grindelia stricta var. stricta	Coastal Gum Plant
Lasthenia maritima	Maritime Goldfields
Lupinus arboreus	Yellow Bush Lupin
Pseudognaphalium stramineum	Cottonbatting Plant
Schoenoplectus pungens	Common Threesquare
Scrophularia californica	California Bee Plant