2015/2016 Annual Report

Año Nuevo Reserve

UC Natural Reserve System

Photo: ©Abe Borker

(NMFS 19108)

Contents

Introduction 1

Visitation 2

Undergraduate Research 3

Degrees, Faculty Positions, and Honors 6

Peer-reviewed publications 9

Media Coverage and Outreach 11

Research Projects 14

Crocker, Daniel - Sonoma State University – Elephant Seal Physiology 14

Costa, Daniel - UC Santa Cruz - Elephant Seal Diving, Tracking, and Physiology 14

Dayton, Gage – UC Santa Cruz – Terrestrial Surveys 16

Thayer, Julie - UC Santa Cruz - Ecosystem Based Management and Apex Predators in the California Current System 16

Hester, Michelle – Oikonos Ecosystem Knowledge– Año Nuevo Island Habitat Restoration 17

Howard, Beth – UCSC's Younger Lagoon Reserve – Seed Collection for Native Plan Restoration 17

Langlois, Gregg - California Department of Public Health - Phytoplankton Monitoring for Toxigenic Species of Public Health Significance 18

Morris, Patricia – UC Santa Cruz - Observation of Branded California Sea Lions on Año Nuevo Island 18

Prager, Katherine - UC Los Angeles - Investigating the Dynamics of *Leptospira interrogans serovar Pomona* in California Sea Lions 18

Reichmuth, Colleen - UC Santa Cruz - The Study of Elephant Seal Bioacoustics and Behavior at Año Nuevo State Reserve 19

Shaffer, Scott - San Jose State University - Western Gulls and Urban Foraging Behavior 21

Teaching Activities 22

Education and outreach 24

Introduction

This was another very productive year at Año Nuevo Reserve. The researchers working at the reserve published 16 new peer-reviewed research papers, all based on data collected at the Reserve. Most of the core long-term projects continued for another year, including studies of northern elephant seal demography/tracking, sea bird monitoring/tracking, and sea lion disease dynamics. The research at the reserve also attracted film crews from popular television shows and news agencies as well as print media.

The Reserve staff took an active role in facilitating undergraduate involvement in research activities and training the State Park docents that act as ambassadors to the thousands of public visitors each year. Efforts to develop outreach material via social media outlets generated thousands of unique visits to reserve websites.

The Reserve continued to support boat transportation needs for researchers working on Año Nuevo Island. This service not only acts to ensure the safety of researchers, but also attracts projects that would otherwise be cost-prohibitive. For example, Professor Scott Shaffer selected Año Nuevo Island for his gull research and is now conducting research and training both graduate students and colleagues at the Reserve.

Finally, hundreds of user-days from undergraduates were logged as many classes from UCSC and neighboring institutions visited the reserve. Many of these students were integrated into hands-on field research – a key example being the Field Methods for Large Marine Vertebrates course taught by the reserve director in which all of the students assisted on seal sedation procedures. This is a unique experience that many of the students used to collect data for independent projects; and, many students use their experience at the Reserve as a launching point for their career in marine science!

Undergraduate intern and senior thesis student, Trevor Barclay, uses an sUAS (drone) to measure elephant seals at Año Nuevo Reserve (NMFS 19108)

Visitation

institution	Government Org	NGO	Research Assistant	Faculty	Graduate Student	Professional Scientist	Undergraduate	Teaching Instructor	Volunteer	Grand Total
CSU			1	50	151		11			213
Government	1					20				21
International University				1	32	3				36
Other		177				5			70	252
Other California University		108	1		2	31				142
Other UC		1			11	5				17
Out of State University				11	26	21	1		14	73
UCSC			8	4	311	284	438	5	67	1117
Grand Total	1	286	10	66	533	369	450	5	151	**1871**

Año Nuevo Reserve had 1,871 user-days of research and teaching activity from nearly 500 unique individuals. This includes research from all levels of the university - undergraduates through tenured faculty. Class visits included students from high school through graduate school and most undergraduates who visited were under direct-supervision and actively engaged in hands-on research activities either in a volunteer capacity or working on their own independent project / senior thesis. Throughout this report are examples of the tangible benefits that come from experiential-learning in the unique environment provided by Año Nuevo Reserve.

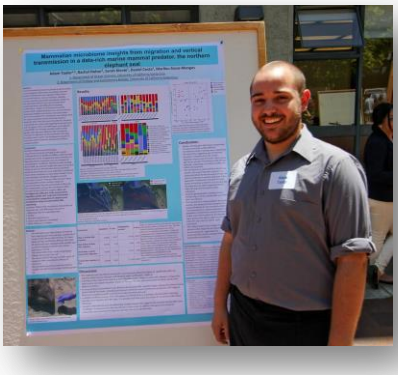
Undergraduate Research

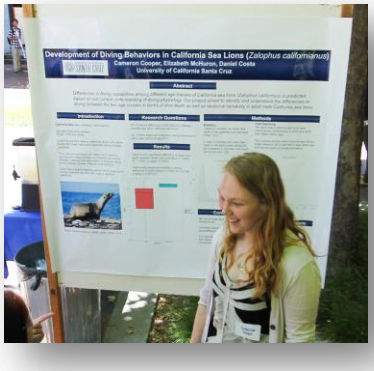
BIOE128L student Kelly Shrader learns how to mark a recently weaned elephant seal with hair dye for the Reserve's long-term demographic study.

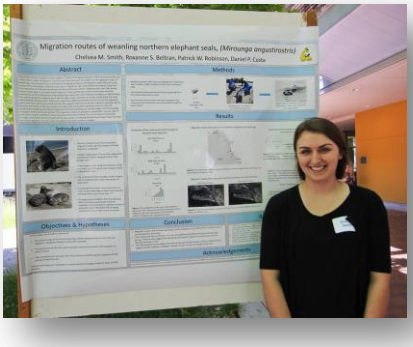
This course provides an unparalleled opportunity for students to engage in hands-on learning of marine mammal research techniques. (NMFS 19108)

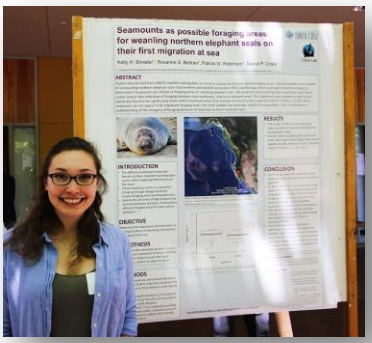
Undergraduates Max Taus and Danay Nipar conduct snake surveys at Año Nuevo Reserve. These data will be used for independent study projects and to aid the State Park in resource-management decisions.

Support for UCSC undergraduates extends well beyond their time at the Reserve – students are mentored through projects, presentations of their research, and use this as an opportunity to launch their careers in research. A growing number of students who worked at the Reserve are now in graduate schools and professional research positions.









Undergraduate interns and BIOE128L students presenting their independent research projects at the UCSC Undergraduate Research Symposium

Testimonials: BIOE128L – Large Marine Vertebrates

Teng Keng-Vang (BIOE128L Spring 2016)

“Field Methods for Large Marine Vertebrates was the first full-fledged field course that I've taken part in and was exactly the reason I came to UCSC. I was looking for a course that gave students a great field experience paired with rigorous academic training. I found it in this course. Fortunately, I'll be able to continue on with my project through the summer with the Costa Lab as a Packard Scholar.”

Emma Chiaroni (BIOE128L Winter 2013)

“I was a student when the class first launched. ‘Field Methods for Large Marine Vertebrates’ was the first class that fit my learning style. The class helped me discover that I learn the best in hands-on situations (experiential-based learning) and has helped to guide my career path. Currently, I work for Point Blue Conservation Science as Research Assistant within the Farallon program. I work with large marine vertebrates (surprise!) such as seabirds and marine mammals on the Farallon Islands.”

Degrees, Faculty Positions, and Honors

Año Nuevo Reserve supports a large number of graduate-level research projects and this year we had one student complete her Master's degree with Dr. Scott Shaffer at San Jose State University, focused on elephant seal endocrinology. We also had three former Año Nuevo Reserve researchers take faculty positons – two of these at local universities, allowing them to start research programs, mentor graduate students, and teach classes – all at Año Nuevo Reserve! Long-term Año Nuevo Reserve researcher and Sonoma State University Professor, Dr. Daniel Crocker, was named an Academy Fellow at the California Academy of Sciences in recognition of his research program that is based at the Reserve. Two former undergraduates who worked at Año Nuevo Reserve used their experience to launch their careers and were accepted into graduate school. Finally, a former Año Nuevo Reserve senior thesis student formed his own electronic tag manufacturing company in Japan to enable a future generation of researchers to collect the same types of data that inspired him as an undergraduate.

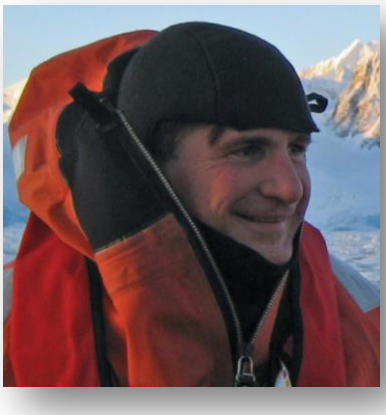
Jen Jelincic. Master's degree San Jose State University (Professor Scott Shaffer). Thesis: Variation in adrenal and thyroid hormones in juvenile northern elephant seals

Dr. Birgitte McDonald, who received her Master's degree working at Año Nuevo Reserve, took a faculty positon at Moss Landing Marine Labs. She has already started conducting her own fieldwork at the reserve, mentoring graduate students working at the Reserve, and teaching a class that gives students hands-on research experience.

Dr. Jane Khudyakov, a former post-doctoral researcher working at Año Nuevo Reserve, took a faculty position at the University of the Pacific which will allow her to continue her work at the Reserve and begin mentoring students. She has already accepted one of Dan Costa's former undergraduate assistants as her first graduate student.

Dr. Melinda Fowler, a former Master's student (Dr. Dan Crocker - Sonoma State University) and Ph.D. student (Dr. Dan Costa – UC Santa Cruz) working on elephant seals at Año Nuevo Reserve, took a faculty position at Springfield College.

CALIFORNIA ACADEMY OF SCIENCES



Professor Daniel Crocker, based at Sonoma State University, was named an Academy Fellow at the California Academy of Sciences. Dr. Crocker conducts most of his research at the Año Nuevo Reserve and has mentored a growing number of students through Master's degrees based on elephant seal physiology and behavior.

David Krucik, a former undergraduate volunteer at Año Nuevo Reserve and former student in BIOE128L – Large Marine Vertebrates, was accepted into the Tufts University Conservation Veterinary Medicine Program where he will work toward becoming a marine mammal veterinarian.

Lora Johansen, a former undergraduate volunteer at Año Nuevo Reserve and former student in BIOE128L – Large Marine Vertebrates, was accepted into the graduate program at the University of the Virgin Islands where she will be studying the movement ecology of sea turtles.

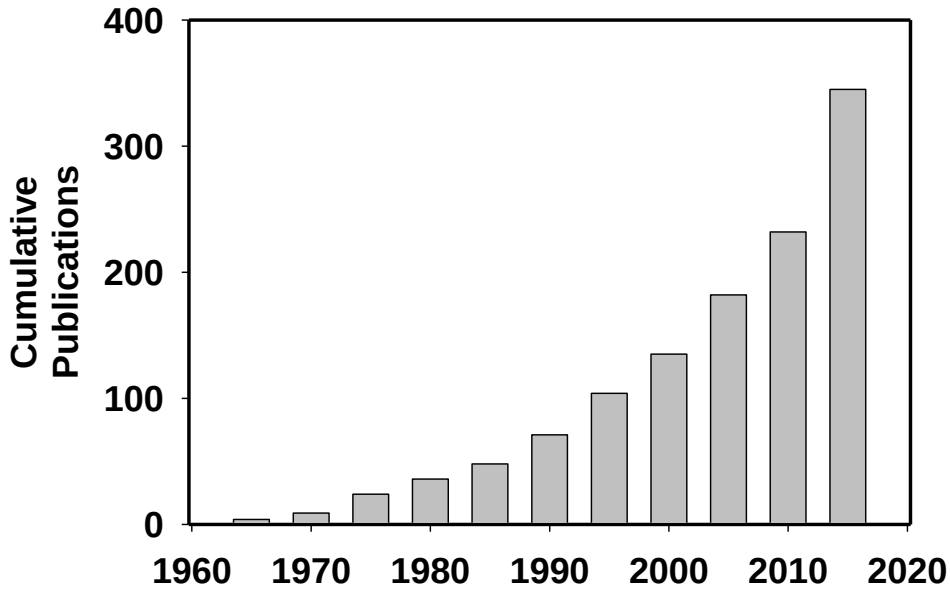
BIOLOGGING SOLUTIONS INC.

Takuya Koizumi, a former undergraduate senior thesis researcher at Año Nuevo Reserve, formed a new company in Japan called 'Biologging Solutions, Inc.' He now builds electronic data loggers used by researchers throughout Japan. His current work was inspired in part by working on the elephant seal tag data he analyzed for his senior thesis at Año Nuevo Reserve.

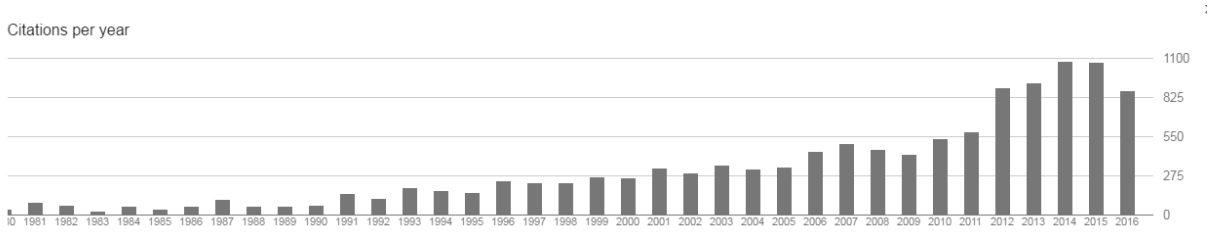
Peer-reviewed publications

Researchers working at Año Nuevo continued to be extremely productive. They generated 16 new scientific publications over the past year on topics ranging from 3D foraging behavior of elephant seals to bio-transport of Mercury from the deep sea, which was published in the high-tier research journal Proceedings of the National Academy of Sciences. All of the publications are publicly accessible on the UC Santa Cruz NRS website:

www.anonuevoreserve.com



*The cumulative number of publications from researchers working at Año Nuevo Reserve has grown rapidly in recent years and continues to be one of the most productive reserves across the entire UC Natural Reserve system. Data collected at the Reserve has contributed to a total of **370 publications**.*



The scientific impact of the research conducted at Año Nuevo Reserve is best measured by the number of citations to Reserve publications – averaging over 1,000 in recent years. (1-16)

Peer-reviewed publications from the 2015/2016 Fiscal year:

1. Adachi T*, et al.* (2016) Searching for prey in a three-dimensional environment: hierarchical movements enhance foraging success in northern elephant seals. *Functional Ecology*.
2. Beltran RS*, et al.* (2016) Seals and sea lions are what they eat, plus what? Determination of trophic discrimination factors for seven pinniped species. *Rapid Communications in Mass Spectrometry* 30(9):1115-1122.
3. Cossaboon JM, Ganguli PM, & Flegal AR (2015) Mercury offloaded in Northern elephant seal hair affects coastal seawater surrounding rookery. *Proceedings of the National Academy of Sciences* 112(39):12058-12062.
4. Costa DP*, et al.* (2016) A bioenergetics approach to understanding the population consequences of disturbance: Elephant seals as a model system. *The Effects of Noise on Aquatic Life II*, (Springer), pp 161-169.
5. Crocker DE, Khudyakov JI, & Champagne CD (2016) Oxidative stress in northern elephant seals: Integration of omics approaches with ecological and experimental studies. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*.
6. Fowler MA, Debier C, Champagne CD, Crocker DE, & Costa DP (2016) The demands of lactation promote differential regulation of lipid stores in fasting elephant seals. *General and Comparative Endocrinology* 225:125-132.
7. Fregosi S*, et al.* (2016) An animal-borne active acoustic tag for minimally invasive behavioral response studies on marine mammals. *Animal Biotelemetry* 4(1):1.
8. Girard YA*, et al.* (2016) Detection and characterization of diverse coccidian protozoa shed by California sea lions. *International Journal for Parasitology: Parasites and Wildlife* 5(1):5-16.
9. Louis C, Covaci A, Crocker DE, & Debier C (2016) Lipophilicity of PCBs and fatty acids determines their mobilisation from blubber of weaned northern elephant seal pups. *Science of the Total Environment* 541:599-602.
10. Maresh J*, et al.* (2015) Summing the strokes: energy economy in northern elephant seals during large-scale foraging migrations. *Movement ecology* 3(1):1.
11. Martinez B*, et al.* (2016) Glucose delays the insulin-induced increase in thyroid hormone-mediated signaling in adipose of prolong-fasted elephant seal pups. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology* 310(6):R502-R512.
12. Pérez-Milicua MB, Zenteno-Savín T, Crocker DE, & Gallo-Reynoso JP (2015) Hypoxanthine-guanine phosphoribosyltransferase and inosine 5'-monophosphate dehydrogenase activities in three mammalian species: aquatic (Mirounga angustirostris), semi-aquatic (Lontra longicaudis annectens) and terrestrial (Sus scrofa). *Frontiers in physiology* 6.
13. Peterson MG*, et al.* (2016) Serum POP concentrations are highly predictive of inner blubber concentrations at two extremes of body condition in northern elephant seals. *Environmental Pollution* 218:651-663.
14. Peterson SH, Ackerman JT, & Costa DP (2016) Mercury correlations among blood, muscle, and hair of northern elephant seals during the breeding and molting fasts. *Environmental Toxicology and Chemistry*.
15. Saijo D*, et al.* (2016) Linking mesopelagic prey abundance and distribution to the foraging behavior of a deep-diving predator, the northern elephant seal. *Deep Sea Research Part II: Topical Studies in Oceanography*.
16. Somo DA, Ensminger DC, Sharick JT, Kanatous SB, & Crocker DE (2015) Development of Dive Capacity in Northern Elephant Seals (Mirounga angustirostris): Reduced Body Reserves at Weaning Are Associated with Elevated Body Oxygen Stores during the Postweaning Fast. *Physiological and Biochemical Zoology* 88(5):471-482.

Media Coverage and Outreach

This was another high-profile year for Año Nuevo Reserve. The research and teaching opportunities at the Reserve continue to attract media coverage from around the world. This year we worked with film crews from the BBC, Discovery Channel, Animal Planet, NBC, and many local media outlets covered specific aspects of the elephant seal research program. These documentaries and news stories provide a unique opportunity to reach a broad audience and raise the profile of the Reserve. This not only highlight the amazing research being done at Año Nuevo Reserve, but also shines a positive light on the UC Natural Reserve System and the University of California system as a whole.

NBC BAY AREA

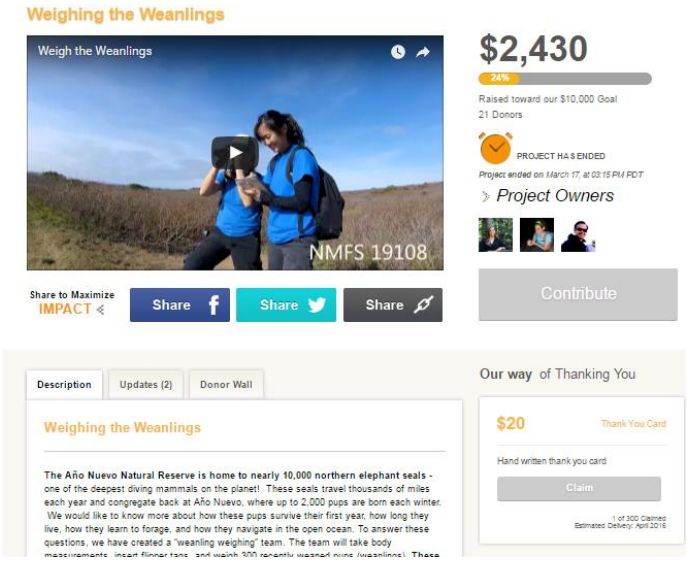
NBC Bay Area's "Open Road" series highlighted the Año Nuevo Reserve and the entire UC Natural System

In collaboration with Stanford's Hopkins Marine Station (Dr. Barbara Block) and the Discovery Channel, we deployed a video tag on an elephant seal with the help of UCSC undergraduates. The footage was aired nationwide as part of the popular "Shark Week".

"Breaking Trail" filmed an episode at Año Nuevo Reserve focused on the elephant seal research program. This provides an engaging way for the public to see how research is done at the Reserve. The video is well on its way to 1 million online views!

"Naomi's Nightmares of Nature", an educational children's television series on BBC-kids filmed an episode at Año Nuevo Reserve focused on the elephant seal demographic project. The episode highlighted the excitement of field research and the importance of preserving our natural world.

Mobile Ranger is a smartphone app designed to provide information to visitors of State Parks and other natural areas along the California coast. Año Nuevo Reserve provided content so public visitors can learn about the amazing research being done at the Reserve.



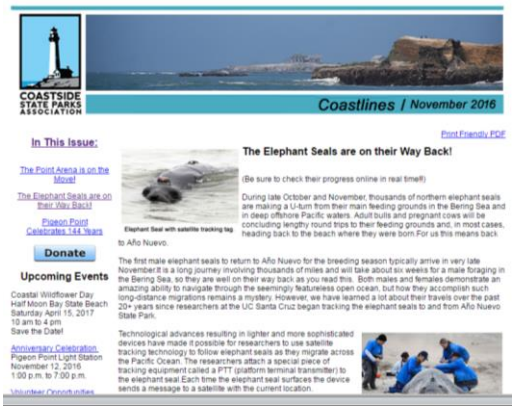
Año Nuevo Reserve had a successful crowdfunding campaign to fund student involvement in elephant seal research ("weaner weighing") each spring. This project not only helps with the research and teaching activities at the Reserve, but also provided an engaging way to highlight the mission of the Reserve to potential donors.

Año Nuevo Reserve was also featured in print-media which highlighted some of the newly published elephant seal research. One of these articles focused on the record-breaking migration of a seal we named after the donors who created the UCSC Sooy Graduate Fellowship. The story was picked up by the Associated Press and broadcast to a global audience.

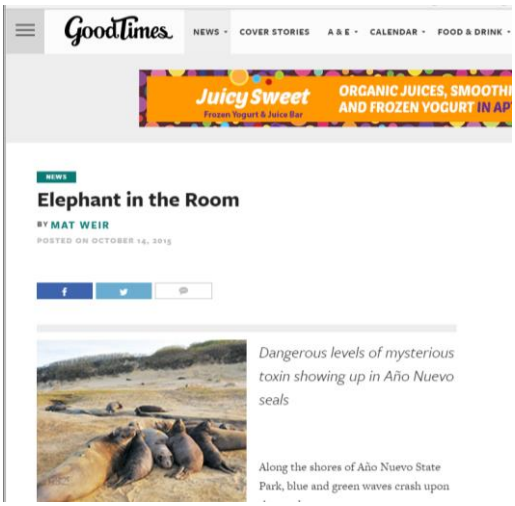

Santa Cruz Sentinel
WILDLIFE HEALTH
Scientists study fat burn in elephant seals at Año Nuevo Sate Park


Santa Cruz Sentinel
ENVIRONMENT
Molting elephant seals recycle mercury back into seawater


THE TRIBUNE
Markings, tags help researchers track elephant seals

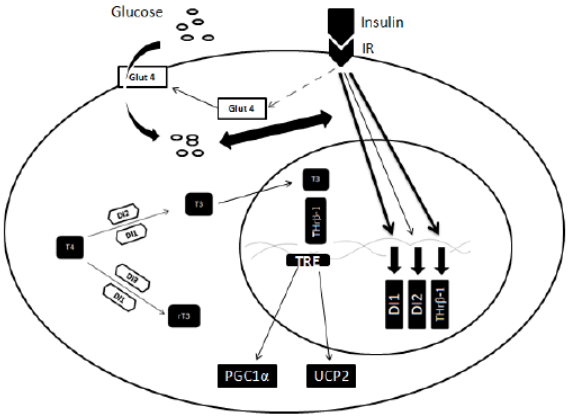

Coastlines / November 2016
The Elephant Seals are on their Way Back!


AP THE BIG STORY
Elephant seal sets record by swimming farthest west


GoodTimes
Elephant in the Room
BY MAT WEIR
Dangerous levels of mysterious toxin showing up in Año Nuevo seals

Research Projects

Crocker, Daniel - Sonoma State University – Elephant Seal Physiology



The Crocker lab continued to collaborate with researchers from around the country on a diverse suite of elephant seal physiology studies ranging from carbohydrate metabolism, fasting physiology, and even wound-healing ability. His lab continues to study the seals using state-of-the-art molecular approaches (transcriptome analyses). In collaboration with Dr. Shane Kanatous (Colorado State University) and his lab, they have developed elephant seal muscle cell lines that can be used for a variety of detailed experimentation. Another Colaborator, Dr. Rudy Ortiz (UC Merced), works extensively from elephant seal samples collected at Año Nuevo to study metabolic and fasting physiology. Dr. Dan Crocker also worked with graduate students at UC Santa Cruz to deploy real-time oceanographic tags on adult male elephant seals.

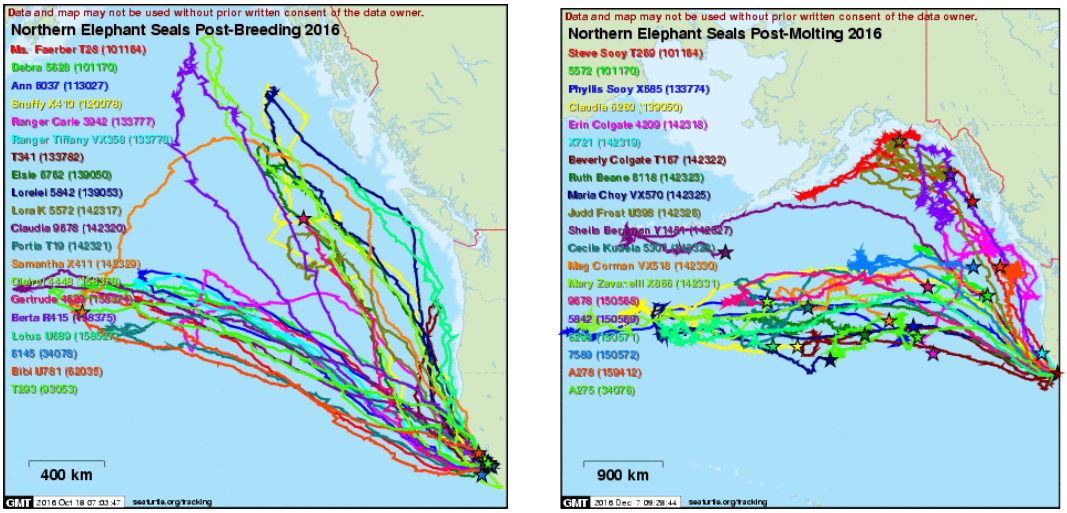
Costa, Daniel - UC Santa Cruz - Elephant Seal Diving, Tracking, and Physiology

The Costa lab continued the ongoing elephant seal research program supporting the work of several graduate students, post-docs, and collaborating researchers – and a large group of undergraduate volunteers and interns. The major field efforts were largely funded by the Office of Naval Research to collect real-time oceanographic data and use the elephant seals as a model system for the PCoD project - Population Consequences of Disturbance. The major fieldwork effort included (1) procedures to attach/remove electronic tags and collect tissue samples on adult female and adult male seals, (2) censusing and attaching/reading flipper tags for the long-term demographic study, and (3) conducting an elephant seal translocation study to validate new electronic tag technology.

General project goals include:

1. Oceanographic habitat association.
2. Fine-scale foraging behavior.
3. Determine the effects of El Niño on migration/distribution, foraging behavior, pup mass and survival, and population demography.

4. Incorporate tag data into local and international databases for multi-species analyses.

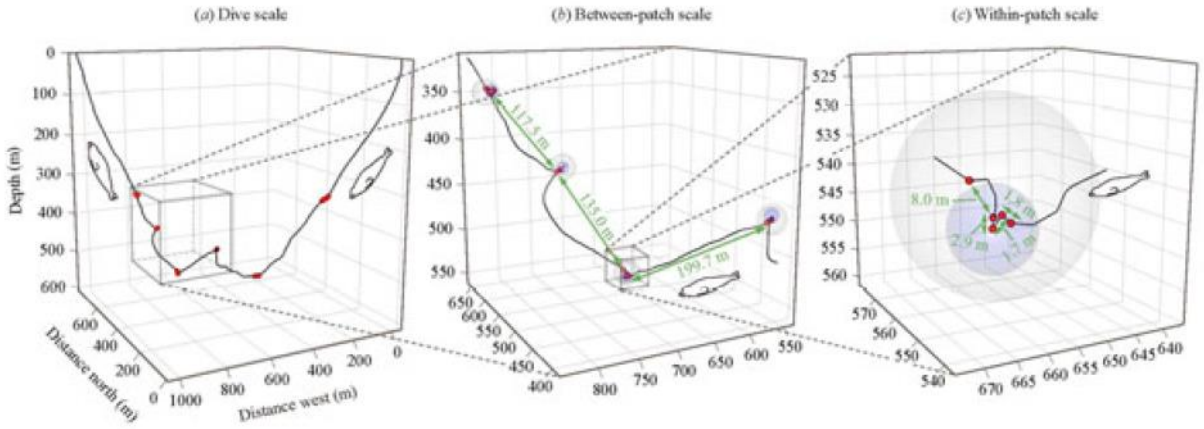


Elephant seal tracking data obtained over the past year from the post-breeding (left) and post-molting (right) migrations. These data are being used by researchers all over the world to study predator behavior as well as the oceanography of the north Pacific.

Twenty adult female seals were sedated for electronic tag recovery and deployment during both breeding and molting seasons. Ten of these tags measured Conductivity-Temperature-Depth throughout the water column, enabling the seals to collect oceanographic quality cast data. These data will be used by two graduate students in the Costa lab and made available to the oceanographic community.

Facilitating continued research with long-term Japanese collaborators Yasuhiko Naito and Akinori Takahashi, jaw acceleration loggers were deployed on seals to measure feeding events while custom camera loggers captured images of prey items. More than 1,000 prey images have been collected and are currently being analyzed by a Japanese graduate student.

There is also a continuing effort to flipper-tag hundreds of recently-weaned pups to maintain a population of known individuals. By combining the electronic tracking and energetics findings with the results of demographic analyses, the Costa Lab is using the elephant seal as a model species to study the impact of disturbance on marine mammal populations - part of a multi-university collaboration.



Lastly, a fine-scale analysis of three-dimensional swim paths revealed the spatial scale of intra-dive foraging behavior. This gives important insight into the distribution of prey in the mesopelagic and an estimate of foraging efficiency throughout the dive cycle.

Dayton, Gage – UC Santa Cruz – Terrestrial Surveys

As a continuation of the monitoring conducted for the UC Santa Cruz course BIOE150 Ecological Field Methods, and to establish long-term monitoring of the newly acquired BART property, undergraduate volunteers conducted terrestrial coverboard surveys. Counts, photographs, and GPS locations of all snakes were recorded and incorporated into the reserve survey database. Camera traps are currently being set up by a new undergraduate senior thesis student to begin monitoring carnivore presence.

Undergraduate researchers flip coverboards to monitor the population of several snake species at Año Nuevo Reserve

Thayer, Julie - UC Santa Cruz - Ecosystem Based Management and Apex Predators in the California Current System

Prey composition and temporal changes in diet of California sea lions in Central California was obtained through the examination and identification of prey hard parts found in fecal samples. Researchers collected fresh fecal samples at haul-out sites used exclusively by California sea lions. The collaborating facility at Moss Landing Marine Laboratories (MLML) provided technician support, equipment, and

storage facilities to support this research effort. The Farallon Institute coordinated processing of sea lion fecal samples, dry samples, and shipped them to MLML for prey identification. This is part of a long-term study and will be an important year as the current El Nino conditions develop and alter local prey abundance.

We recently recruited a UC Santa Cruz undergraduate (and current Año Nuevo Reserve volunteer) to help process samples and she will then use the data for her senior thesis project.

Hester, Michelle – Oikonos Ecosystem Knowledge– Año Nuevo Island Habitat Restoration

OIKONOS continued their restoration and monitoring efforts at Año Nuevo Island. The sea lion exclusion area has been extremely effective in preventing sea lions from trampling seabird burrows and vegetation, though a high density of pelicans and drought conditions have slowed the recovery effort. They successfully raised the boardwalks on the island to minimize researcher impacts on burrows. Ryan Carle, a student out of Moss Landing Marine Labs, completed his master's degree focused on the diet on the Rhinoceros Auklets at Año Nuevo Island and continues to oversee the monitoring of the island's seabird populations.

Howard, Beth – UCSC's Younger Lagoon Reserve – Seed Collection for Native Plan Restoration

Younger Lagoon Reserve volunteers and staff collect local seed for native plant restoration projects within the Reserve. Seeds are collected from Cascade Field, one of the rare coastal prairies along the central California coast. The plants grown as part of this project are also used by other organizations, such as the State Park system, to restore farmed or disturbed habitat in the coastal zone.

Langlois, Gregg - California Department of Public Health - Phytoplankton Monitoring for Toxigenic Species of Public Health Significance

The California Department of Public Health manages the oldest established marine biotoxin monitoring in the U.S. traditional shellfish monitoring for the paralytic shellfish poisoning (PSP) toxins was augmented with a unique, volunteer-based phytoplankton monitoring program in response to the 1991 domoic acid event that killed hundreds of seabirds in Monterey Bay. Since that time, volunteer-based phytoplankton samples have allowed the Department to detect and track potentially toxic blooms. This in turn has allowed them to focus seafood monitoring efforts and to alert the public more rapidly. Sampling within this area fills a huge gap in coverage and provides additional insight into the distribution of toxigenic phytoplankton. Pat Morris collected water samples via net tows on her routine trips to the island.

Morris, Patricia – UC Santa Cruz - Observation of Branded California Sea Lions on Año Nuevo Island

Dr. Robert DeLong and Dr. Sharon Melin of the National Marine Mammal Laboratory established a long-term study of the life history parameters of California Sea Lions, the only sea lion species with an expanding population. The sea lions are tagged and branded as pups at their breeding rookery on San Miguel Island (California Channel Islands). Many juvenile California sea lions migrate north, and Año Nuevo Island is a principal haulout area for these juveniles. Researchers observe and record tagged and branded California sea lions on Año Nuevo Island three days each week during the months of June and July and opportunistically throughout the year (approximately 1,000 observations each year). These data are important for understanding juvenile survivorship, which appears to be declining in recent years. Current studies also include a comparison of survivorship between branded and unbranded (tagged only) California sea lions and a study on the comparative survivorship of pups given antihelminthics. There was a significant mortality event experienced by the 2008 and 2009 cohorts as well and lower pup production on San Miguel Island in 2010. Concurrently, there was unusually high pup production on Año Nuevo Island, making it especially important to monitor the California sea lion population in the next few years. This project is currently being funded through Katherine Prager's NSF sea lion project.

Census data over the past two years revealed a dramatic increase in the number of California sea lion pups born on the island during Summer 2016 (~300). Año Nuevo Reserve may soon be considered a California sea lion rookery.

Prager, Katherine - UC Los Angeles - Investigating the Dynamics of *Leptospira interrogans serovar Pomona* in California Sea Lions

Drs. Katie Prager (UCLA) and Denise Greig (The Marine Mammal Center - TMMC), with the help of a wonderful team of TMMC staff, and Guy Oliver and Patrick Robinson from UCSC, have been capturing and collecting health samples from wild California sea lions on Año Nuevo Island. Despite a challenging season, due to changes in beach topography, an adequate number of juveniles were sampled. This effort is part of a larger study led by Dr. Jamie Lloyd-Smith and Dr. Prager at UCLA, in close collaboration with researchers and veterinarians at TMMC and UCSC, which aims to understand patterns of the deadly bacterial disease leptospirosis in California sea lions. Over 30 years of data have been collected at TMMC showing how many sea lions strand due to this disease, including major outbreaks interspersed with quiet spells. One major aim of this study is to assess whether these patterns of stranding seen at TMMC reflect outbreaks that are occurring in California sea lions in the wild. After four years of sampling, preliminary results indicate that patterns in free-ranging sea lions at Año Nuevo do mirror those seen at TMMC – reinforcing the great value of TMMC as a sentinel for marine mammal health. These patterns are only truly detectable during a year when there is a large outbreak of the disease in sea lions, and the last time that this occurred was in 2011. The sampling will continue for at least another year in the hopes of capturing another large outbreak in order to confirm the patterns we have detected to date.

Dr. Katie Prager is both a veterinarian and a disease ecologist investigating a disease called Leptospirosis in Califrnia sea lions. – Año Nuevo Island Beach 17

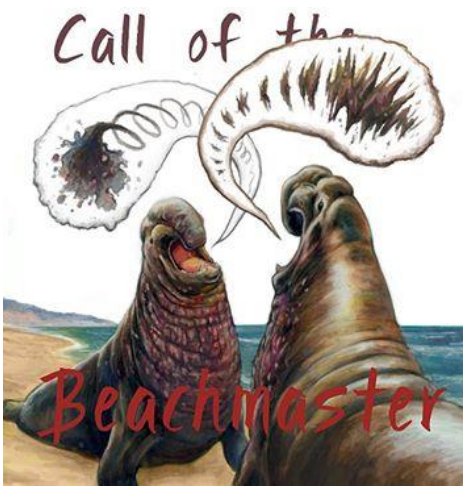
Reichmuth, Colleen - UC Santa Cruz - The Study of Elephant Seal Bioacoustics and Behavior at Año Nuevo State Reserve

The primary aim of this research is to characterize the acoustic environment of northern elephant seals throughout their breeding range. Specifically, we are sampling the vocalizations of elephant seals at different sites to determine whether there are reliable geographic differences within the population that correlate to range expansion. In addition to this broader geographic sampling, our group had a strong presence at the Año Nuevo breeding colony as part of a long-term field effort evaluating the role of vocal signaling among male northern elephant seals. This year we focused primarily on sub-adult and

adult male northern elephant seals observed and recorded in air during the breeding season. Also, limited behavioral and acoustic sampling took place at Año Nuevo. Our activities were non-invasive, minimally disruptive, and included measuring ambient (biotic and abiotic) sounds near breeding colonies and recording the vocalizations produced by wild seals.

Two acoustic databases were established for the year: one cataloging complete vocal clap threat bouts from marked males for spectral and temporal analysis of individual variation, and the other logging complete or partial clap threat signals recorded at very close range for the accurate estimation of vocalization source levels. To support these data sets, observational and photometric data were taken on all the males in the study to estimate age-class. Of all males observed, marks were placed on nearly all of the study individuals. All data, including photographs and GPS re-sight data on all study males are archived in the Reichmuth Lab at Long Marine Lab.

Main findings:



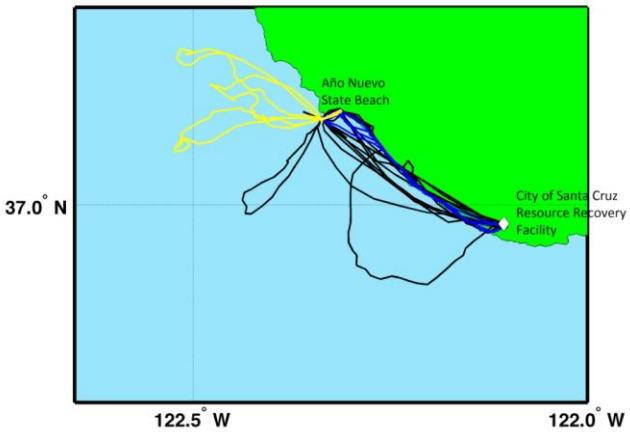
This effort is part of a long-term project evaluating the role of vocal signaling among male northern elephant seals. Analysis of the geographic data is ongoing, and will be included in UCSC graduate student C. Casey's dissertation research. This work includes characterizing the call patterns specific to this breeding colony, and comparing these with similar data from other breeding locations. This geographic information will be used to test the specific hypothesis that there are unique site-specific calls between elephant seal breeding colonies that have emerged as the species has recovered and expanded throughout the North Pacific. Our prior research on the functional significance of male acoustic displays and their relationship to maintenance of dominance relationships has been completed and accepted for publication in Proceedings of the Royal Society Open Science and should be published shortly.

The Reichmuth lab also collaborated with UC Santa Cruz's highly-regarded scientific writing program to generate a wonderfully illustrated description of their vocalization research. This is particularly exciting because it makes the research findings accessible to the general public and the visitors of the Año Nuevo State Park.

http://sciencenotes.ucsc.edu/2015/pages/seals/seals.html

Shaffer, Scott - San Jose State University - Western Gulls and Urban Foraging Behavior

Differences in foraging strategies may affect reproductive life-span, breeding performance, and fitness of individuals. Western gulls (*Larus occidentalis*), previously known as a distinctly marine gull, may forage at sea or in streams for fish and marine invertebrates, or scavenge for refuse on land. Annett and Pierotti (1999) found that foraging strategies among Western gulls can be passed horizontally among populations or vertically from parent to offspring. However, it is currently unknown which Western gull breeding populations forage where, how this choice may affect breeding performance, and exposure to harmful contaminants or bacteria found at local refuse sites. This study assesses the time activity budget of breeding Western gulls on Año Nuevo Island and Southeast Farallon Island by 1) attaching GPS data loggers to breeding adult gulls to obtain high resolution, GPS-quality movement patterns that will allow us to characterize habitat use and time-activity budgets, 2) collecting blood and feather samples to establish diet, body burdens of contaminants, and potential bacterial loads, 3) collecting morphometric measurements from the same adults to compare body condition of gulls with differing foraging habits, 4) Measuring breeding success by observing chick growth rates and hatching success. These data will be used to inform management decisions that affect the health of foraging seabirds in or near urban habitats.



GPS tracking data from western gulls tagged at Año Nuevo Island.

Teaching Activities

Dr. Krikor Andonian, UC Santa Cruz. BIOE82 Introduction to Field Research and Conservation

This group of transfer students visited Año Nuevo Reserve to learn about its unique flora and fauna, to observe natural patterns, and learn how to formulate research questions.

Dr. Daniel Costa, UC Santa Cruz. BIOE129/L Biology of Marine Mammals. Spring 2016.

Each of the lab sections visited Año Nuevo. The classes learned about elephant seal natural history while observing the seals. Several teaching assistants who are also a graduate students of Dan Costa accompanied the classes.

Dr. Daniel Crocker, Sonoma State University. BIOL 349 Animal Physiology. Winter/Spring 2016.

Students in this course assisted with the annual weaner-weighing of newly weaned elephant seal pups.

Dr. Donald Croll, UC Santa Cruz. BIOE150 Ecological Field Methods. Spring 2016

This class of 28 students and three instructors visited the eastern side of reserve to demonstrate and practice the methodologies and approaches used in terrestrial field research.

UCSC Professor Don Croll uses Año Nuevo as a natural classroom for his ecology course. Over the following two weeks, his students conducted a variety of rapid research projects to study interesting natural patterns.

Dr. Shawn Noren, UC Santa Cruz, COSMOS Marine Mammal Cluster, Summer 2016

This class of 40 students visited the park in the usual visitor areas. The students hiked to the observation areas, listened to a research talk on elephant seals, and worked on a lab assignment measuring breathing rates of seals.
http://cosmos.ucsc.edu/

High school students from the COSMOS program visiting the Año Nuevo Reserve and learning about the unique physiological adaptation of elephant seals.

Dr. Max Tarjan. BIOE129/L Biology of Marine Mammals. Summer 2016.

This is a small summer session course and the instructor, a former graduate student at UC Santa Cruz, brought her class to see the field site where the Costa lab conducts a diverse array of studies on the northern elephant seal.

Dr. Justin Cummings, Doris Duke Conservation Scholars program. Summer 2016

This is a group of students with diverse backgrounds from around the country involved in a conservation leadership program. Their visit to Año Nuevo Reserve gives the students an opportunity to learn about elephant seal research, but also how to start a successful career as a biologist.

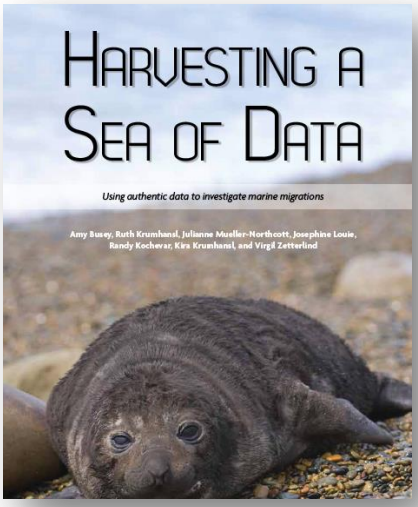
Dr. Patrick Robinson, UC Santa Cruz. BIOE128L Large Marine Vertebrates. Spring 2016.

This class of 14 students had one field trip to Año Nuevo focused on basic elephant seal biology, including the tag-resight program. All students in this course subsequently became volunteers for Dan Costa's elephant seal project and assisted with satellite tag deployment/recovery procedures.

Undergraduate students conducting an elephant seal translocation experiment (left) and a photogrammetry validation study (right) as part of their independent class projects (NMFS 14636).

Education and outreach

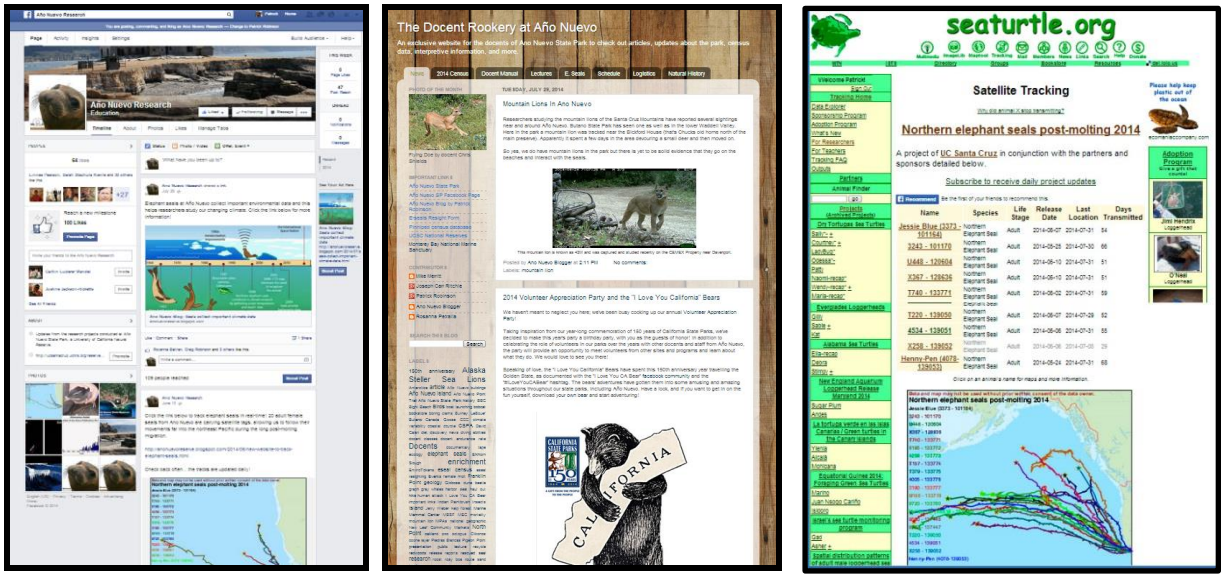
This was an incredible year for education and outreach activities at the Año Nuevo Reserve. The elephant seal tracking data collected by the Costa Lab continues to be incorporated into high school curricula plans in a unique collaboration between K-12 education experts, with detailed knowledge of learning/teaching standards, and scientists. Programmers have created a unique web-interface to allow individual students to explore the datasets collected at the Año Nuevo Reserve and ask novel questions. This inquiry-based-learning has proven to be highly effective at developing the independent thinking skills students need to succeed in the



future. The website and instructional materials are publicly accessible at this website: http://oceantracks.org/map/

In addition to the class visits and other experiential learning detailed above, reserve staff took an active role in training the new class of Año Nuevo docents through various lectures and coordinating the "sealabration" fundraiser. These docents act as ambassadors by teaching more than 100,000 visitors about the exciting research findings and the importance of the Año Nuevo Reserve. We continue to work with the Año Nuevo State Park staff to bring docents to elephant seal anesthetic procedure and observe first-hand how researchers collect measurements, sample tissues, and attach electronic tags.

We now routinely use social media outlets (Facebook, research blogs, etc.) to highlight research findings (Weekly unique page views number in the thousands) and seek out new and exciting ways to keep the public engaged after their visit to the reserve. For example, visitors can now subscribe to daily tracking updates from elephant seals equipped with satellite tags and time-depth recorders.



Websites used to enhance public outreach of research activities at the Año Nuevo Reserve: "Año Nuevo Research" Facebook page (left), updates to the docent blog (center), and real-time northern elephant seal tracking (right). Each of these sites have received thousands of independent visits over the past year and provide viewers with important and exciting updates about the reserve and associated research.